LEBANON

RAPID ENVIRONMENTAL ASSESSMENT FOR

GREENING RECOVERY RECONSTRUCTION AND REFORM

2006

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PREFACE FROM THE MINISTRY OF ENVIRONMENT

Republic of Lebanon
Ministry of Environment

Peace & Good Will Win Over War & Evil…

Lebanese Citizens and Citizens of the Globe,

"We Should All Be Working Together
To Safeguard Environment
For A Better Quality of Life
& For a Better World"

When we truly think sustainable ecological development we can not wipe from our collective memories major environmental disasters. The past does leave us clues to learn from but… are we listening…

Japan, 60 years ago… the nuclear bomb of World War II… Now, there is a permanent "Sit In" in front of the White House in Washington that civil society is maintaining so we shall not forget…

Seveso 30 years ago… The 2,4,5T herbicide manufacturing industry blew up releasing dioxins… and environment became a priority and its civil movement in Italy keeps reminding us all so we shall not forget…

Bhopal 20 years ago, Union Carbide accident released methylisocyanates… and people in India are still struggling from its adverse effects on public health… research is still being conducted and articles are still being written so we shall not forget…

Ukraine 2 years after Bhopal… Chernobyl a nuclear power plant blew up… Then environment became a priority in Europe and Green Parties grew to be heard and gained more seats in the federal parliament thus influencing policy so we shall not forget…

Then Minamata in Japan…Mercury was released with industrial effluents contaminating the seafood chain… to commemorate that, the Japanese people built the Minamata museum so that generations shall not forget…

Toulouse, France, 6 years ago in 2001… an ammonium nitrate plant blew up causing an explosion equivalent to an earthquake of 3.4 on the Richter scale… major European legislation was enacted, so we shall not forget…

Last but not least, the most recent environmental catastrophe on the east coast of the Mediterranean is the Jiyeh power plant incident caused by the barbaric Israeli war on Lebanon spilling 12,000 – 15,000 Tones of Heavy Fuel Oil; now:

Oil Spill + Mediterranean Sea = ***Black Sea***

This new formula was devised so we shall not forget…

Yes indeed, the years of civil strife in Lebanon were difficult and we all thought that if we survived them we would have stood the test of most difficult times... until we all witnessed 2006 in all its vivid events…

Lebanon just before the July/August 2006 War was ranking 35 out of 133 countries on the Environment Performance Index (EPI) and one of the top ten destination for tourism, that for sure was not agreeable too many…

The July/August 2006 war caused severe impact on the environment. General severe environmental degradation was the end result. It is important for the collective memory of the World to share Lebanon's vivid adverse effect on environment resulting from the barbaric War. Three major environmental disasters emanated from the War.

1. The Oil Spill on the East Coast of the Mediterranean Sea: 150 Km of Lebanese coast was polluted with heavy fuel oil. Impacts were recorded on public health, on environmentally sensitive ecosystems like the Palm Islands protected area, on nature based tourism like public sandy beaches and private tourism service providers on the coast line and finally on economy such as the livelihoods of fishermen and communities dependent on healthy marine life.
2. The waste/rubble that was generated due to the heavily bombarded residential areas of the southern suburbs of the Beirut and the south of Lebanon, transport infrastructure, and other industrial facilities. The waste generated overburdened the existing solid waste management operations and lead to multiple haphazard solid waste dumps from where pollution emissions and effluents will find their way in to air and water bodies.
3. Unexploded ordinance (UXOs) sporadically sprinkled by Israeli Defense Forces infecting massive areas of land that is currently utilized for agriculture, reforestation, eco-tourism and other economically sustainable activities. These UXOs on top of the landmines that IDF had left behind upon their withdrawal in 2000 are seriously hindering rural development plans and programmes and exerting immense pressure on rural communities forcing them to internally migrate to urban environments thus leading to increased environment degradation in rural areas and overloading man-made-environments in urbanized cities.

Substantial progress has been made on combating these major environmental catastrophes. This would not have been possible without the 3***P***s, partnership, partnership and more partnership with local, national and international partners in the United Nations, Governments, Private Sector, Civil Society Groups and Academia. Much has been accomplished but much more still needs to be learned and done.

Much is recorded in the report “Lebanon Rapid Environmental Assessment for Greening Recovery, Reconstruction and Reform - 2006” about the impacts of the War. This is an opportune moment to thank UNDP-Lebanon for its generous financial contributions and for inviting us to write this preface to flag up the major effects of the war on the environment, and ELARD for its hard work, and Lebanese citizens who were alertly present during all the days and difficult hours of the War and documenting events for the sake of history and starting the process for extracting lessons to be learned.

Undoubtedly, the War damaged Lebanon’s environment in all its physical, chemical, biological and social forms, but it failed to undermine the Lebanese ***P***assion, ***P***erseverance, and ***P***atience to commit to a better quality of life for a better Mediterranean and World.

We are glad many of our fellow citizens and families have survived the war and God Bless the Lebanese souls that were lost... after all,

“For Change We Need Martyr…
For Martyr We Need Men…
For Men We Need Believers in Better a Lebanon & a Just World…”

Fellow citizens of the World, remember that Belief, Resistance, Courage, Faith and Hope are the ingredients and renewable energy source that will allow us all to prevail and let peace & good will win over war & evil.

Team Members
Ministry of Environment

Beirut, 29 January, 2007

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EXECUTIVE SUMMARY

INTRODUCTION

This Rapid Environmental Assessment for Greening Recovery, Reconstruction and Reform was initiated by the United Nations Development Programme (UNDP) in Lebanon during the July – August 2006 conflict in anticipation of the massive reconstruction and recovery efforts that would need to be undertaken by the Government of Lebanon (GoL). The assessment was implemented in close collaboration with the Lebanese Ministry of Environment (MoE). The assessment, which commenced in September, 2006, after the cessation of hostilities, was prepared by Earth Link and Advanced Resources Development (ELARD) and took 3 months to complete. The chapters of the report were reviewed during December 2006 by the different services of the MoE according to the nature of the chapter, and the report was finalized accordingly. The work was carried out in coordination with the United Nations Environment Program (UNEP) Post-Conflict Branch.

OBJECTIVES

The objectives of this assessment are to identify and prioritize environmental impacts caused by the war, to propose measures to alleviate those impacts rated as significant, and to recommend opportunities for greening the recovery, reconstruction and reform process, to the extent possible. Damages to the construction, transport, energy, industry and agriculture sectors were reviewed based on published information, associated environmental impacts were identified and assessed, and opportunities to introduce environmental standards in rebuilding were proposed. The various types of solid waste generated during the war were described to the extent possible and available treatment and disposal options were identified. An environmental impact assessment methodology was adopted to prioritize the impacts on air, water, soil, and biodiversity. The impact assessment methodology was adapted from that used for over a decade by the oil industry in the Gulf States, particularly by the United Arab Emirates (UAE) oil companies. Mitigation measures or further assessment, when needed, were proposed for the impacts ranked as high priority in the form of draft action plans. Furthermore, major gaps in national environmental law as unveiled by the war were identified and recommendations for improvement were made. Finally, options for compensation for environmental damage due to the war were compared and feasible options were discussed.

Since the ultimate aim of this report is to provide decision makers with a series of practical and integrated action plans to rebuild and restore damaged areas in an environmentally sound manner while identifying measures to incorporate environmental standards and practices in recovery and reconstruction, the proposed remedial measures were presented with preliminary budgetary estimates. These dollar value figures represent the preliminary costs for implementation of the proposed actions and do not necessarily indicate the actual cost of the damage.

SOURCES OF IMPACTS

The devastation wreaked during the 34 days of Israeli bombardment of Lebanon resulted in significant destruction of Lebanese infrastructure. The collective damages incurred across the country consisted of the destruction of approximately 445,000 m^2 of road network, 92 bridges and overpasses, as well as the destruction or damage of an estimated total of 130,000 dwelling units[1] in addition to water supply and wastewater infrastructure. Although the offensive targeted various types of infrastructure across Lebanon, the areas most directly impacted due to heavy shelling include the Dahieh region, a southern suburb of the capital Beirut, as well as the municipalities of Aita ech Chaab, Khiam, Bint Jbeil in South Lebanon and Nabatiyeh, and Baalbek in the Bekaa.

In the energy sector, key infrastructure damaged during the war include the Jiyeh power plant fuel storage tanks, the kerosene fuel storage tanks of the Beirut Rafic Hariri International Airport, transmission and distribution networks, and petrol stations. The Jiyeh power plant's fuel storage tanks were hit by the Israeli Defense Force (IDF) on July 13 and 15, 2006; two of the fuel storage tanks containing 10,000 m^3 and 15,000 m^3, respectively, as confirmed by personnel at the power plant, were directly damaged. Both tanks caught fire. The fire spread to the remaining tanks and continued to burn for 12 days. Plant personnel estimated that approximately 60,000 m^3 of fuel oil may have burned. About 15,000 m^3 is assumed to have spilled to the sea, causing one of the major environmental disasters experienced by Lebanon.

The airport fuel storage tanks were damaged by a direct strike from the IDF on the 13th of July, 2006. It is estimated that 5,000 m^3 of kerosene from the fuel tanks were burned. As for the transmission and distribution networks, the sources of damage are mainly indirect as most of the damages sustained by transformers were caused by shrapnel. In total, 199 transformers were damaged, some requiring replacement of certain parts, welding, retrofitting and/or refilling with oil. Out of the total, 59 were damaged beyond repair and require replacing. The majority of the transformers have already been replaced. However, no initiatives were reported regarding the assessment of potential contamination in the possibly affected areas.

Several petrol stations were also directly hit by the IDF during the war. Official reports state that 22 petrol stations were damaged during the war in the South, Nabatiyeh and Bekaa Governorates. This number could however be much higher. Local authorities in Bint Jbeil, Marjayoun, and Tyre alone reported that 47 petrol stations were damaged. A rapid survey conducted by ELARD in Baalbek has identified 7 damaged stations; five (5) stations were assessed as having probably leaked based on information provided by owners regarding the presence of diesel and gasoline at time of damage. A total amount of about 360,000 liters of gasoline and 140,000 liters of diesel were reported to be present in the storage tanks, and have either burned or leaked into the upper aquifer.

Several industrial facilities were also damaged during the war. The extent of damage was variable, ranging from insignificant to lightly or highly damaged. In total, 31 industrial facilities in South Lebanon, Bekaa and Beirut Suburbs were reported to have been completely or partially destroyed. However, after close inspection (and field visits conducted by

[1] Higher Relief Council (HRC) of the Government of Lebanon, 2006. *Daily Situation Report Siterep No: 78, dated 19/10/2006*, Posted on the official government website: http://www.lebanonundersiege.gov.lb

ELARD as part of a Reconnaissance Survey), a total of nine (9) industries were considered to have been highly damaged. The identified industries are: Al Arz Textile Factory (Bekaa), Ghabris Detergent Factory (South), Saffieddine Plasti-med (South), Lamartine (Bekaa), Maliban Glass Factory (Bekaa), Liban Lait (Bekaa), Transmed industrial storage facility (Mount Lebanon), Fine Tissue Factory (South), and Lebanon Co. for Carton Mince & Industry (Mount Lebanon). Two of these industries have relatively high potential to integrate cleaner production principles, namely the Maliban Glass Factory and Ghabris Detergent Factory.

The agriculture sector was also targeted during the war inflicting damage to Lebanon's forestry, freshwater and marine fisheries, agriculture warehouses, and animal husbandry farms. The Ministry of Agriculture (MoA) has estimated a total area of 1800 ha of forest and other wooded land to have been affected directly by fire or indirectly during and after the war in the South and Mount Lebanon Governorates. This value represents about 5 percent of total recorded forest and wooded area prior to the war in the affected areas. Freshwater fisheries particularly in the Assi River, known for its rich biodiversity, were hit and about 305 tonnes of rainbow trout were estimated by MoA personnel to have been left to decompose in the river.

Marine fishery was affected directly through the destruction of infrastructure during port bombardment as well as its oil contamination (more than 300 boats along with hundreds of kilometers of nets), and indirectly by the oil spill. Numerous agriculture warehouses were also destroyed during the war potentially leading to the spillage of concentrated pesticides and fertilizers in the environment. The FAO assessment[2] estimated the number of dead animal carcasses to reach over 3,050 head of dairy cattle, 1,250 bulls, 15,000 head of goats and sheep, 18,000 beehives and over 600,000 broilers; these have been either dumped or burned in the environment. Soil compaction due to the movement of military vehicles in the highly affected areas in the South could lead to loss of soil fertility and increased soil erosion if excessive. Contamination of agriculture land with white phosphorous is not believed to be a major issue of concern.

Damage caused by the war generated substantial amounts of solid wastes. Up to 3.5 millions of cubic meters of demolition wastes were generated. MoE reported that by the end of November, 971 m^3 of liquid oil and 4282 m^3 of oil contaminated waste were generated (polluted sand, pebbles, and garbage). Other wastes include agriculture wastes, hazardous and special wastes, pharmaceutical wastes, and domestic solid wastes.

MAIN IMPACTS

The most significant environmental impacts caused by the war when comparing effects to baseline conditions prior to the war include the impacts related to the construction sector, the oil spill, and the impacts from UXOs. However several other impacts are also important.

[2] FAO, 2006, Damage and Early Recovery Needs Assessment of Agriculture, Fisheries and Forestry, Special Emergency Programmes Service, Emergency Operations and Rehabilitation Division.

ENVIRONMENTAL IMPACTS FROM CONSTRUCTION SECTOR

The direct damage of the conflict on the construction sector is evident through the wide-spread destruction of building structures and generation of demolition waste. The total volume of generated rubble is estimated to be within the range of 2.5 to 3 million m^3. However, due to the nature of the construction industry, the impact extends to other stages of the construction process, such as the extraction of sand and aggregates and manufacture of building materials, the construction works, and the occupancy and maintenance of building structures.

Construction works typically consume a large portion of natural resources such as water, energy, as well as mineral products. Accordingly, it is estimated that the rebuilding of the 60,000 dwelling units reported as highly damaged or destroyed would require approximately 3.5 million tonnes of sand and aggregates (twice as much as needed prior to the war), 1.3 million tonnes of cement and 0.22 million m^3 of water. Due to the recent increase in domestic production levels, it is estimated that a collective 1.6 million tonnes of aggregates (30% of annual production) is available in various stockpiles around the country. Despite these values, increase in domestic quarrying activity to satisfy the war-related demand of an additional 3.5 million tones could be in the order of 75 percent. Concerns abound that this incremental demand shall be met with an uncontrolled increase in local mining and quarrying activities leading to irreversible impacts on Lebanon's fragile environment including the destruction of vegetation and natural habitats, permanent loss of biodiversity and natural resources, increase in the levels of noise, visual and air pollution, pollution of groundwater and surface water resources, soil erosion and potential land de-stabilization, as well as associated loss of real estate value.

A cost to benefit analysis recommends local manufacturing of 100% of the incremental demand for cement and the import of 25% of the required sand and aggregates assuming that <u>local production would follow a special plan</u> prepared by MoE to organize quarrying activities linked to the reconstruction phase. This could include the identification of dedicated quarries for reconstruction to avoid uncontrolled spread of quarrying activities throughout the country.

Another important impact related to the reconstruction activities, is the increase in the average concentrations of particulate matter in the vicinity of construction sites. Initial assessment has indicated that particulate matter concentrations could increase by 14 percent up to 400 percent (5 times) based on background concentrations in re-construction sites like Dahieh and will most likely exceed national and international standards set by the World Health Organization (WHO). Based on previous studies, economic benefits from reduced mortality and morbidity cases of pneumonia, chronic obstructive pulmonary disease (COPD) and emergency visits due to respiratory problems, attributed to a 10 $\mu g/m^3$ reduction in the concentration of PM_{10} could range from USD 400,000 to USD 15 million on a national scale. It is therefore highly recommended that specific interventions be implemented and enforced at construction sites to reduce dust emissions.

The report also addresses the costs of the treatment and disposal of the demolition wastes resulting from the Dahieh region as well as those from South Lebanon, Nabatiyeh and Bekaa

Governorates. A comparative analysis of costs indicates that the lowest cost alternatives consist of onsite volume reduction of the waste, and based on local market needs, disposal as landfill cover or backfill for quarry rehabilitation as appropriate. Estimated costs for processing and disposal of waste in Beirut would be in the order of USD 3.5 million and in the South, Nabatiyeh and Bekaa in the order of USD 8 million.

The study recommends the adoption of green-building standards for the reconstruction of the war-impacted areas of Lebanon with energy efficient measures having an estimated benefit-to-cost ratio of approximately 5.2, and water efficient measures of approximately 2.4. Measures evaluated in the energy assessment include the adoption of thermal building standards, solar water heaters and energy-efficient lighting, while those in the water assessment include the installation of low-flow plumbing fixtures and pressure reduction. The current situation presents a unique opportunity to adopt and enforce the existing draft thermal building standards.

IMPACTS FROM THE OIL SPILL

The Jiyeh power plant's fuel storage tanks were hit by the Israeli Defense Force (IDF) on July 13 and 15, 2006; two of the fuel storage tanks containing 10,000 m^3 and 15,000 m^3, respectively, as confirmed by personnel at the power plant, were directly damaged. Both tanks caught fire. The fire spread to the remaining tanks and continued to burn for 12 days. Plant personnel estimated that approximately 60,000 m^3 of fuel oil may have burned as a worst case scenario. A total quantity of heavy fuel oil in the order of 15,000 m^3 is assumed to have spilled to the sea, causing one of the major environmental disasters experienced by Lebanon. Coastal sandy and rocky stretches were severely damaged by the oil spill. About 150 km of coastline (out of 220 km) were directly affected by the oil spill. The MoE response to the spill has nevertheless been effective, and several stretches are being cleaned-up with the financial support of international organizations. MoE reported that by end of November, 971 m^3 of liquid oil and 4282 m^3 of oil contaminated waste were generated (polluted sand, pebbles, and garbage). These numbers are expected to increase considerably as clean-up efforts progress. Benthic ecosystem close to Jiyeh has been severely affected because of the oil that has sunken in the area. Such impact may well be irreversible in nature as baseline conditions prior to the war in the area will most likely not be recovered. Marine sediments other than at Jiyeh are not believed to have been impacted. Most of the oil is believed to have either volatilized, dissolved, or reached the coastline. However the spill has also affected sensitive biodiversity heritage including Palm Islands Nature Reserve in Tripoli causing damage to its sensitive ecological features. Such impacts are believed to be long-term in nature. The impact of the oil spill on seawater quality is considered to be temporary as previous studies demonstrate that seawater concentrations of pollutants tend to return to normal values within few months. The oil spill calls for the urgent establishment of an environmental and oil spill emergency response plan to avoid major impacts in case of future similar major accidents.

IMPACTS FROM UXOS

Over one million cluster bombs are reported to have been spread in Lebanon by IDF. This leads to a large number of unexploded ordnances which locations are not known, as compared to baseline conditions whereby the number and location of mines were known. UXOs are contributing to further destruction of forests, shrubs and bush lands. Their presence also poses a major hindrance to MoE reforestation plan. It is expected that thousands of hectares of scrubland may be lost to fires. Faunal assets, particularly large mammals, are also probably being lost or variably injured as a consequence of unexploded ordnance (UXOs) in the wild. The presence of UXOs is an additional stress factor on rural communities who are unable to reach their farmland and are thus increasing pressure on available resources and promoting unhealthy practices. Latest reports from competent authorities announced that the South would be cleared from UXOs by the end of 2007.

OTHER ENVIRONMENTAL IMPACTS

The most important impacts on air quality were identified to be the pollution generated by burning of fuel oil and kerosene at the Jiyeh power plant and Beirut airport, respectively, as well as the increase in particulate matter that is likely to occur in the vicinity of reconstruction sites, as discussed above. Air quality impacts from increased traffic at damaged roadway sections and bridge sections, forest fires and burning of fuel at petrol stations are not considered as priority impacts given their localized and temporary nature. Preliminary simulations using ALOFT-FT (A Large Outdoor Fire Plume Trajectory – Flat Terrain) model indicated that areas up to 7 km north of the Jiyeh fire would have been mostly affected based on estimated plume concentrations of particulate matter. Similar simulations for the Beirut airport fire indicated that areas up to 3 km north of the site could be mostly affected. Monitoring at these areas is necessary to confirm these facts. Main pollutants of concern include SO_2, NO_x, Carbon Monoxide (CO), particulate matter, Polycyclic Aromatic Hydrocarbons (PAHs), and dioxins and furans.

The most important impacts on fresh water resources are considered to be the damage to surface water streams from destroyed bridges, potential groundwater pollution from PCB leakage or leakage of gasoline and diesel from damaged petrol stations, potential surface and groundwater pollution at Transmed and Lebanese Company storage facilities in Choueifat, and surface water quality deterioration in the Assi River. Impact on groundwater at damaged industrial sites in the Bekaa depends on level of pollution at the sites; these are further confirmed by the UNEP assessment, and remedial studies in the area are highly recommended; impact at other damaged sites in the South is considered to be limited given local hydrogeological conditions.

Over 30 sites consisting of sections of permanent or intermittent surface water streams are considered to be possible hot-spots due to damage from over-passing bridges. A detailed survey is needed to further investigate and validate impact at these sites.

Initial assessment of damaged petrol stations in Baalbek has indicated that pollution of the upper aquifer could be an issue and should be urgently assessed for clean-up needs. Further assessments at sites in the South and Nabatiyeh Governorates where petrol stations were reportedly damaged are considered to be less critical given local hydrogeological conditions. Impact on water resources from weapon-related contaminants is covered in the UNEP environmental post-conflict assessment report.

Impacts on soil are closely related to impacts on water. In fact, soil often acts as a conduit to water receptors. The most severe impact on soil and land is the one on coastal sandy and rocky stretches that were severely damaged by the oil spill, as discussed above.

Biodiversity was affected both directly and indirectly by the war. Protected areas and fragile ecosystems were damaged leading to the destruction of wildlife and habitat. Surface water ecosystems were affected by damaged infrastructure especially under destroyed bridges or dead carcass decomposition in the case of Assi River. Use of heavy machinery by the Israeli army (tanks and bulldozers) to clear roads during the invasion resulted in disturbance and fragmentation of ecosystems and floral and faunal populations as well as eradication of marginal habitats by the sides of roads. At sea, the Mediterranean basin suffered significantly during the war and after. In general, the sea has been the ultimate receptor of most sources of in-land pollution caused by the war.

Indirectly, the war generated stress factors such as increased demographic pressure on resources due to population displacement and economic distress. Such pressures, which include the loss of an entire harvesting season for farmers and limited access to their lands, have likely promoted an over-use of remaining accessible resources in an attempt to recover some losses. The result was the adoption of unhealthy practices like drainage of wetlands for more aggressive irrigation or extensive use of pesticides with associated detrimental impacts on the natural resources namely water and birdlife. Unfortunately, the indirect impacts of war on biodiversity can have long-lasting effects. In the aftermath of the war, ecological resources have already come under more pressure from the haphazard dumping of demolition waste, a result of the haste of reconstruction, as well as the reclamation of coastal land, wild areas, valleys, hillsides and roadsides. Practices such as dumping of demolition waste at Ouzaii near the coastline pose serious threats to marine biodiversity and habitats, especially with the risk of collapse of part of the waste mound into the sea. The country is also witnessing increased quarrying activity and arson triggered in forests by impoverished communities producing charcoal.

The arrival of foreign armies and the deployment of the Lebanese army are introducing new pressure on natural resources and these impacts should not be overlooked. These troops enter natural areas with heavy machinery and vehicles to settle and carry out frequent patrols. Conservationists have also reported waste dumping by foreign troops coming in from the sea. The waste was seen shored on turtle nesting beaches used by the endangered Loggerhead and Green Turtles. Protected areas, wetlands, a biosphere reserve, Specially Protected Areas and Important Bird Areas were all affected in one way or another during the conflict.

Most of the damaged cultural sites already have on-going rehabilitation, clean-up or recovery plans, depending on the case. Some of these plans have already been implemented, such as in Byblos, where the clean up of archaeological structures was ended by December 2006. As for the other sites, actions are being undertaken, and budgets for rehabilitation and recovery have been set. One major impact is however related to the potential loss of the cultural heritage in affected villages that were not previously classified or assessed by DGA. The potential impact resulting from increased looting activities could also be important.

Table 1 presents a summary of the identified environmental impacts and their significance. Prioritization is based on likely impact effect and duration, following the environmental impact assessment methodology referred to earlier. Impact significance can be negligible, marginal, critical non-significant, critical significant, serious and severe (from least to most significant). A total of 46 environmental issues were addressed and 6 impacts were rated as severe and another 11 were rated as critical significant. Fourteen (14) impacts were rated as critical non-significant and it is also recommended to address such issues as well.

Table 1. Summary of Environmental Impacts and their Significance

Impact	Impact Effect	Duration	Severity/ Significance
1. Littoral pollution from oil spill	Catastrophic	Medium-term (1 to 10 years)	Severe
2. Impact on marine biodiversity from oil spill from Jiyeh power plant	Serious	Long-term (10 to 50 years)	Severe
3. Impact on natural resources from quarrying	Considerable	Long-term (10 to 50 years)	Severe
4. Soil erosion from forest fires	Considerable	Long-term	Severe
5. Loss of flora, fauna and degradation of ecosystems due to fires	Considerable	Long-term (10 to 50 years)	Severe
6. Impact on ecosystems, habitats, flora and fauna from military activities	Serious	Long-term (10->50 years)	Severe
7. Degradation of floral base and ecosystems from demolition waste disposal	Serious	Medium to long term (1 to 50 years)	Severe
8. Dust and PM release from construction works	Considerable in Dahieh and main villages	medium-term (1-10 year)	Critical - Significant
9. Air pollution from Jiyeh fire	Serious	Short-term (<1 year)	Critical - Significant
10. Water pollution from PCB leakage from damaged transformers	Limited (localized impacts)	Long-term (10 to 50 years)	Critical - Significant
11. Soil pollution from PCB leakage from damaged transformers	Limited (localized impacts)	Long-term (10 to 50 years)	Critical - Significant
12. Water pollution from fuel leakage from damaged petrol stations in Baalbeck	Considerable	Medium Term (1 to 10 years)	Critical - Significant

Impact	Impact Effect	Duration	Severity/ Significance
13. Water pollution from Transmed and Lebanese Co. storage facilities	Considerable	Medium-term (1 to 10 years)	Critical - Significant
14. Marine sediment impact from sunken oil	Limited	Medium-term (1 to 10 years)	Critical - Significant
15. Soil pollution from deposited contaminants of fuel burning at Jiyeh and airport	Considerable	Medium-term (1 to 10 years)	Critical - Significant
16. Indirect impacts on nature reserves and himas	Considerable	Medium-term (1 to 10 years)	Critical - Significant
17. Impact from Leniency in law enforcement or control over disturbing activities	Considerable	Medium-term (1 to 10 years)	Critical - Significant
18. Air pollution from traffic congestion	Considerable	Short-term (less than 1 year)	Critical – Non significant
19. Air pollution from airport fuel storage tanks fire	Considerable	Short-term (<1 year)	Critical – Non-significant
20. Impact on surface water streams from construction of bridges	Considerable	Short-term (less than 1 year)	Critical Non-significant
21. Impact on seawater quality from oil spill	Considerable	Short-term (less than 1 year)	Critical Non-significant
22. Water pollution from Lamartine, Maliban and Liban Lait factories	Limited	Medium-term (1 to 10 years)	Critical Non-significant
23. Water pollution from Fine Tissue Factory	Limited	Medium-term (1 to 10 years)	Critical Non-significant
24. Water pollution from pesticides and fertilizers from damaged storage houses	Limited	Medium-term (1 to 10 years)	Critical Non-significant
25. Assi river impact from fisheries bombing	Considerable	Short-term (less than 1 year)	Critical Non significant
26. Stream bank erosion from construction of bridges over permanent streams	Considerable	Short term (less than 1 year)	Critical Non-significant
27. Soil impact at Jiyeh Site	Limited	Medium-term (1 to 10 years)	Critical Non-Significant

Impact	Impact Effect	Duration	Severity/ Significance
28. Soil pollution from fuel leakage from damaged petrol stations	Limited (localized impacts)	Medium Term (1 to 10 years)	Critical Non-significant
29. Soil pollution from Fine Tissue Factory	Limited	Medium Term (1 – 10 years) (possible presence of dioxins)	Critical Non-significant
30. Soil pollution from pesticides and fertilizers from damaged storage houses	Limited	Medium Term (1 to 10 years)	Critical Non-significant
31. Over-grazing in non-affected areas by unexploded ordnances	Limited	Medium-term (1 to 10 years)	Critical Non-significant
32. Air pollution from fuel tanks burning in petrol stations	Considerable	Momentary (<1 week)	Marginal
33. Air pollution from forest fires	Considerable	Momentary (<1 week)	Marginal
34. Water quality deterioration from disposal of Debris and Rubble	Limited	Short-term (less than 1 year)	Marginal
35. Physical impact from dust generated from debris and rubble	Limited	Short-term (less than 1 year)	Marginal
36. Water pollution from fuel leakage from damaged petrol stations in South	Limited	Short-term (less than 1 year)	Marginal
37. Water pollution from Al Arz factory damage	Limited	Short-term (less than 1 year)	Marginal
38. Water pollution from disposal of animal carcasses	Limited	Short-term (less than 1 year)	Marginal
39. Soil impact from disposal of Debris and Rubble	Limited	Short term (less than 1 year)	Marginal
40. Soil impact at airport site	Limited	Short-term (less than 1 year)	Marginal
41. Soil pollution from Al Arz factory damage	Limited	Short-term (less than 1 year)	Marginal

Impact	Impact Effect	Duration	Severity/ Significance
42. Soil pollution from Food Industries (Lamartine and Liban Lait)	Limited	Short Term (less than 1 year)	Marginal
43. Pollution to plants and ecosystem from fuel burning in Jiyeh and airport	Limited	Short-term (less than 1 year)	Marginal
44. Water pollution from Ghabris and Saffieddine factories	Insignificant	-	Negligible
45. Chemical and physical impact from explosions, bombings, and fires	Insignificant	Short-term (less than 1 year)	Negligible
46. Impact on coastal aquifers from oil spill	Insignificant	Short-term (less than 1 year)	Negligible

PROPOSED INTERVENTIONS

Proposed interventions address those impacts ranked as severe and critical significant, as well as some impacts ranked as critical non-significant.

Specific interventions need to be implemented and enforced at construction sites to reduce dust emissions. Best-practices for dust reduction at construction sites are well-documented and should be imposed on contractors. Such initiative has already been undertaken at the Dahieh site by the National Council for Scientific Research (NCRS), the American University of Beirut and Université St. Joseph and should be extended to other construction sites.

A major intervention should also address demolition wastes management, especially wastes disposed of in the South and the Bekaa and which could be affecting natural resources and ecosystems. Wastes need to be collected, processed, recycled and remaining disposed in identified landfill sites.

A detailed remedial investigation is recommended to be initiated at the Ghadir River to assess the impacts and clean-up needs originating from the damage to Transmed and Lebanese Company storage facilities.

Measures to prevent flooding and erosion, as well as post-construction stream bank stabilization should be assessed and implemented at the critical surface water sites identified by a comprehensive survey.

A remedial investigation and feasibility study is recommended to be conducted in the Baalbeck area due to pollution from damaged petrol stations and industrial facilities, and given the local geological and hydrogeological conditions as well as presence of human receptors.

Soil monitoring at the areas north of the Jiyeh and airport fires as described above is recommended to ensure that pollutant levels are within acceptable levels. Soil erosion in areas affected by forest fires could be a significant problem, and interventions to control soil erosion should be implemented in coordination with biodiversity monitoring related activities.

Clean-up efforts along the coastline should be supported by a comprehensive monitoring campaign aimed at conducting a full marine biodiversity assessment which will become the backbone of a long-term monitoring strategy for the Lebanese coastal zone. Supporting activities to alleviate damage to localized ecosystems could include the creation of marine protected areas and artificial reefs. This could further enhance recovery of marine biodiversity when well-designed and planned. Additional clean-up efforts shall be assessed during spring to identify further needs to completely mitigate oil spill impacts along the coast.

Interventions at forest areas damaged with fire and other sources are needed. Such interventions should include more detailed assessment, monitoring of the ecosystems, identification of further remedial actions such as those needed to prevent soil erosion or further degradation, and direct work with local communities so that they are involved in the preservation of the vulnerable areas after the war. Interventions to mitigate indirect impacts in protected areas which were affected by loss of revenues among others, are also recommended.

Unexploded ordnance is being cleared and should be accelerated as much as possible to avoid further environmental and socio-economic impacts.

On the legal front, key recommendations to improve environmental legislation based on gaps unveiled by the recent conflict include: 1) development of a comprehensive legislation regulating the management of construction and demolition wastes; 2) adoption of the thermal building standards and enforcement of environmental standards in reconstruction; 3) adoption of a formal plan for provision of natural resources in the reconstruction phase; 4) adoption and implementation of the draft Integrated Solid Waste Management Law prepared by the Ministry of Environment; 5) updating existing legislation to take into consideration post-war conditions in the area of reforestation; 6) creating incentives for farmers to adopt sustainable agriculture practices in affected areas; 7) development and adoption of a fish resource management policy; 8) adoption of the National Implementation Plan for Persistent Organic Pollutants prepared by MoE; and last but not least 9) development of the necessary legal framework related to environment response in emergency situations.

Table 2 summarizes major proposed interventions together with an estimated cost to be used for guidance only. The interventions are meant to serve as working papers in preparing a comprehensive environmental programme of action. Table 3 also presents those measures that are proposed to enhance greening of the reconstruction efforts in Lebanon.

Table 2. Proposed Short-Term Interventions to Mitigate Environmental Impacts from War

Proposed Intervention	Budgetary Estimate (USD)
Mitigating the Impact of the War on Lebanon's Natural Resources	75,000
Management of Demolition Wastes of Dahieh	3,590,000
Management of Demolition Wastes of South, Bekaa and Nabatiyeh	8,235,000
Alleviating Environmental and Socio-Economic Impacts from Stone Pine Forest Destruction in Lebanon	1,375,000
Rehabilitation of priority dumpsites affected by war	730,000
Reducing Particulate Matter and Noise Levels at Construction Sites	220,000
Mitigating Impacts on Surface Water Streams from Damaged Bridges and Reconstruction Activities	605,000
Mitigating Water and Soil Pollution in Ghadir Area	535,000
Mitigating Potential Impacts from Deposition of Contaminants from Jiyeh and Airport Fires in Soil	70,000
Clean-up Needs for Sites Potentially Affected by PCBs, Petroleum Hydrocarbons and Pesticides	400,000
Assessment of damage to marine ecosystems and biota, monitoring of recovery and proposing a set of water quality standards for post conflict Lebanon	1,500,000
Remediate damage to marine ecosystems and fisheries: Creating marine protected areas and artificial reefs using war rubble and decommissioned military vehicles	475,000
Mitigating Impact of War and Post War Threats on Biodiversity in South Lebanon	634,000
Rehabilitation of Nature Sites Affected by Fires	338,000
Mitigating Indirect Impacts on Protected Areas	260,000
Mitigating Impacts on Palm Islands Nature Reserve	705,000
Survey of the South and Classification of Assets as National Heritage	75,000
Protection of Archaeological Artifacts in the South	25,000

Table 3. Proposed Interventions to Green Reconstruction Efforts

Proposed Intervention	Budgetary Estimate (USD)
Promoting Green Building Standards in the Reconstruction of Post-Conflict Lebanon	100,000
Integrating Environmental Standards in the Reconstruction of Roads and Bridges in Lebanon	60,000
Promoting Public Transport to Alleviate Traffic and Reduce Emissions from Transport Sector	500,000 + land rental
Promoting Sustainable Cropping Patterns in Affected Agricultural Areas in South Lebanon	105,000
Sustainable Revitalization of Fresh Water Aquaculture In Assi River	160,000
Changing Marine Fishing Behavior	1,550,000

The options available for Lebanon to seek compensation for environmental damage from the war include diplomatic and judicial methods, but most methods were found to be either non-applicable or not realistic in the case of Lebanon. The only possibly feasible, but yet difficult, alternative is to seek a resolution from the United Nations Security Council. This would nevertheless require that a balanced resolution, addressing damages on both sides be prepared, since it is unlikely that a unilateral resolution will be adopted by the Security Council. It is noteworthy that the second committee of the UN General Assembly has approved on November 22, 2006, a draft resolution expressing “deep concern over the destruction by Israeli Air Force, particularly for its adverse impacts on sustainable development (…) and would call on Israel to assume responsibility for prompt and adequate compensation to the government of Lebanon for the costs of repairing the environmental damage caused by the destruction”.

SUMMARY AND CONCLUSION

The July war in Lebanon has caused severe environmental impacts, some of them being unprecedented in Lebanese and regional history, such as the impacts from the oil spill, resulting from the Israeli Air Force targeting of the Jiyeh fuel tanks. Environmental impacts resulting from the war were identified and prioritized, and specific interventions to mitigate these impacts were proposed to serve as a basis for a national environmental response program. Additional interventions that would promote the greening of the reconstruction phase are also proposed, and would serve as a first step towards leading Lebanon back to its path to sustainable development.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AFDC	Association for Forest Development and Conservation
AFR	Alternative Fuel and Raw material
AR	Artificial Reefs
AUB	American University of Beirut
BAT	Best Available Technology
BRT	Bus Rapid Transit
CDM	Clean Development Mechanism
CDR	Council for Development and Reconstruction
CEDRE	Centre de Documentation de Recherche et d'Experimentations sur les Pollutions Accidentelles des Eaux
CIP	Cleaning In Place
COPD	Chronic Obstructive Pulmonary Disease
CRT	Cathode Ray Tube
DGA	Directorate General of Antiquities
DRF	Dose -Response Function
EDL	Electricite du Liban
EE	Estimated Emissions
EF	Emission Factors
ELARD	Earth Link and Advanced Resources Development
EPA	Environmental Protection Agency
EUSC	European Satellite Centre
FAO	Food and Agriculture Organization
GAC	Government Appointed Committee
GIS	Geographic Information System
GoL	Government of Lebanon
GRP	Glass Reinforced Plastic
HRC	Higher Relief Council
IBA	Important Bird Area
ICC	International Criminal Court
ICRAM	Instituto Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare
IDF	Israeli Defense Force
IPM	Integrated Pest Management
IUCN	World Union for the Conservation of Nature

JRC	Joint Research Center
LCPC	Lebanese Center for Cleaner Production
LU	Lebanese University
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoI	Ministry of Industry
MoPTW	Ministry of Public Works and Transport
MPA	Marine Protected Area
MPH	Ministry of Public Health
MSW	Municipal Solid Waste
NCMS	National Center for Marine Science
NCRS	National Council for Scientific Research
NF	nanofiltration
NGO	Non-governmental Organization
OCHA	Office for the Coordination of Humanitarian Affairs
OSOCC	Oil Spill Operation and Coordination Center
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PCDD	Polychlorinated dibenzo-*p*-dioxins
PCDF	Polychlorinated dibenzofurans
PCIJ	Permanent Court of International Justice
PINR	Palm Island Nature Reserve
REMPEC	Regional Marine Pollution Emergency Centre
RO	reverse osmosis
SPA	Special Protected Area
SPNL	Society for the Protection of Nature in Lebanon
UNCC	United Nations Compensation Commission
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNIFIL	United Nations Interim Force in Lebanon
USAID	United States Agency of International Development
UXO	Unexploded ordnance
WHO	World Health Organization

Elements, compounds and physical-chemical characteristics

ABS	Alkyl benzene sulfonates
BOD	Biological Oxygen Demand
Cd	Cadmium
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
Cr	Chromium
Cu	Copper
EDTA	Ethylene-diamino-tetra-acetate
H_2S	Hydrogen sulfide
LAS	Linear alkyl benzene sulfonates
Mn	Manganese
NH_3	Ammonia
Ni	Nickel
PEG	Polyethylene glycol
PM	Particulate Matter
Pb	Lead
PVC	Polyvinyl chloride
Sb	Antimony
Se	Selenium
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSP	Total Suspended Particle
V	Vanadium
VOCs	Volatile Organic Carbons
Zn	Zinc

Units

($\mu g/s.m^2$)	microgram per second square meter
$\mu g/m^3$	microgram per cubic meter
Gg	Gigagrams (1000 tonnes)
ha	hectares
kg/L	kilogram per liter
kg/mg	kilogram per milligram
m	meter
m/s	meters per second
Mg	Megagrams
T	Tonnes
Vol%	percent by volume
WT%	percent by weight

1 INTRODUCTION

1.1 THE CONTEXT OF THE ASSESSMENT

This Rapid Environmental Assessment for Greening Recovery, Reconstruction and Reform was conducted at the initiative of the United Nations Development Program (UNDP) in Lebanon and in close coordination with the Ministry of Environment (MoE). The assessment was prepared following the 34-day war that started on July 12, 2006 and ended on August 14, 2006. Two other environmental assessments were conducted in parallel to this one. The United Nations Environment Programme (UNEP) post-conflict branch has conducted a post-conflict environmental assessment which includes primary data collection, identification of major environmental impacts and drawing of recommendations to mitigate identified impacts. The World Bank is conducting a study to estimate the cost of environmental degradation from the war. The results from the three studies should form the basis for a comprehensive environmental response programme for Lebanon.

1.2 OBJECTIVES OF THE ASSESSMENT

According to its terms of reference (ToR), the objective of this assessment is to develop the basis for an environmental action programme for rebuilding Lebanon with the least environmental damage and to propose measures to promote the incorporation of environmental standards in the recovery and reconstruction. Main tasks include:

1. Assess the key issues of concern including a description and quantification, to the extent possible, of the associated environmental impacts and their significance;
2. Prioritize the issues of concern;
3. Identify for each issue of concern concrete, feasible actions that need to be undertaken to minimize environmental damage or promote greening measures, when relevant;
4. Develop an environmental action plan for each issue of concern which summarizes the action plan related to the issue, including actions to be undertaken, distribution of responsibilities, and estimated budget required to implement the action.

1.3 ASSESSMENT METHODOLOGY

1.3.1 FOCAL THEMES OF THE ASSESSMENT

The assessment was structured based on the following focal themes:

1. Construction sector
2. Transport sector
3. Energy sector
4. Industry sector
5. Agriculture sector
6. Solid Waste
7. Air/Noise
8. Water
9. Soil
10. Biodiversity
11. Cultural Heritage
12. Environmental law

Sector chapters (construction, transport, energy, industry, and agriculture which are considered as sources of environmental stress), provide an overview of the sector damage, a description of initiatives undertaken to address damage after the conflict, and briefly describe possible issues of environmental concern. Action plans in sector chapters aim at proposing activities that would integrate environmental standards and principles in the recovery and reconstruction process. When specific action plans could not be proposed, at least guidelines were described to be used when applicable.

Among the sector chapters, the construction chapter assesses in more detail several issues related to the war and provides policy recommendations to decision-makers regarding demolition waste management, procurement of natural resources for reconstruction, and introduction of environmental standards in reconstruction.

Media chapters (air, water, soil, biodiversity and cultural heritage which are sinks of environmental stress) provide an assessment of the impacts which could originate from sector damage or from military actions. Environmental receptors are described to the extent possible to support the impact assessment. Initiatives undertaken after the war to address these impacts are also described. Action plans in media chapters propose measures to mitigate or further assess the impacts when further assessment is needed.

The solid waste chapter is structured based on the main categories of wastes generated during the war, except for demolition wastes which are covered under the construction chapter. Main waste types addressed are oil-spill related waste, agricultural wastes, other hazardous and special wastes, medical and pharmaceutical wastes and municipal solid wastes. Options for the management of these wastes are compared and where applicable, preferred options are recommended.

The environmental law chapter covers two separate issues. First, important gaps in environmental law that were unveiled during the conflict are described and recommendations are proposed, hence providing a framework for improvement of the current environmental legislation in Lebanon. Second, international law is covered whereby those options that the Government of Lebanon has to seek compensation for environmental damage caused by the war are analyzed and compared.

1.3.2 TEAM ORGANIZATION

A multi-disciplinary team was responsible for the implementation of the assessment. The team leader was responsible for team coordination, development of the detailed work methodology in cooperation with task leaders, preparation of templates, peer review of the chapters and ensuring that the final output meets the objectives set for the assessment. The team leader was supported by task leaders, whereby each focal theme was lead by an expert in the field. Task leaders were responsible for carrying out the individual assessments per sector, media, solid waste or environmental law. Task leaders were further supported by experts when needed, as for example in the biodiversity assessment, where experts in different fields were involved (flora and ecosystems, fauna, avifauna and marine biodiversity). Research assistants have also supported the team.

1.3.3 MAIN TASKS

1.3.3.1 Data Collection

The assessment relied primarily on published information. Field assessments were not conducted except where otherwise stated in the chapters. Notably, a reconnaissance survey was undertaken in parallel to this study in support to the UNEP post-conflict assessment team. The survey covered the most damaged areas and facilities. Interviews were made with key stakeholders to validate information when possible. Personnel from the Ministry of Environment, Ministry of Agriculture, Electricité du Liban (EDL), Jiyeh power plant, Directorate General of Antiquities (DGA), Council for Development and Reconstruction (CDR), environmentalists and several municipalities in affected areas were consulted during the assessment. Some owners of damaged industries and petrol stations were also contacted by the team.

1.3.4 RESEARCH

Research on specific issues related to war-related environmental impacts was conducted to support the assessment. A total of 19 short research papers were developed as part of the process and used, when relevant, in the assessment.

1.3.5 IMPACT IDENTIFICATION

An impact identification matrix was filled in order to include the possible impacts that need to be further considered in the assessment. The matrix includes the main sources of impacts and sinks of the impacts (Table 1.1).

1.3.6 IMPACT ASSESSMENT

Impact assessment was conducted for the media chapters. In order to be able to prioritize the impacts, an environmental impact assessment methodology was adopted. The impact assessment methodology was adapted from that used for over a decade by the oil industry in the Gulf States, particularly by the United Arab Emirates (UAE) oil companies. It is important to note that the method was used as a screening methodology to allow for prioritization of the impacts; actual impact severity could vary in reality, but the methodology is considered to be acceptable to fulfill the requirements of this assessment. Impact assessment is conducted in two steps. First, impact effect is evaluated using the guidance provided in Table 1.2 (impact effect evaluation matrix). This table includes a 5-point impact effect scale varying from insignificant to catastrophic. The matrix is mainly used as a guide in assessing the potential effect of impact on the environment. The effect is a function of the area affected as well as the level of the impact in the affected media. The impact effect definitions are issued as guidance and not definitive for all potential event scenarios. Expert judgment was applied for impact effect estimation.

Table 1.1. Impact Identification Matrix

Sink / **Sources**	Air/Noise	Water	Soil	Biodiversity	Cultural Heritage	Solid waste
Construction						
Transport						
Energy						
Industry						
Agriculture						
Direct military actions						

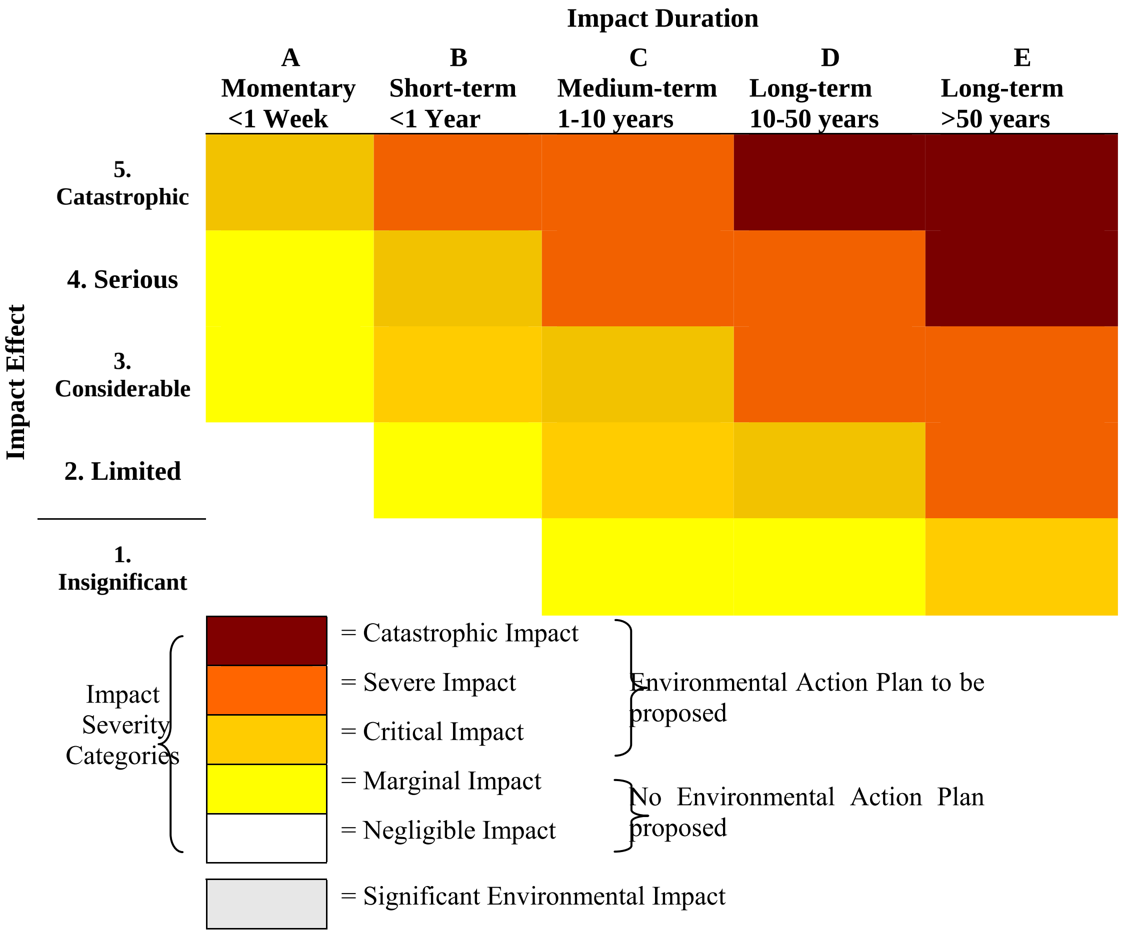
Table 1.2. Impact Effect Evaluation Matrix

Effect	Area	Air	Water	Waste	Biodiversity	Resources
Catastrophic (5)	Extending over a wide area (>100 km^2)	Severe acute Impact on the receptor(s) potentially leading to fatality. Significant deterioration of air quality on a regional or global level.	Regional contamination or depletion of potable groundwater. Regional contamination of marine environment.	Severe uncontrolled generation handling, storage or disposal of priority hazardous waste leading to catastrophic contamination of valued groundwater, soil and/or loss of non-renewable natural resources.	Catastrophic effect on regionally important attributes of the ecological environment is observable or measurable over a wide area.	Significant damage to archeological, cultural or natural resources regional/International importance.
Serious (4)	Extending over 10km^2 from site	Acute impact on the receptors. Significant deterioration on a national level	Serious local contamination or depletion of potable groundwater. Serious local or considerable national contamination of marine environment.	Serious uncontrolled generation handling, storage or disposal of hazardous waste leading to serious contamination of valued groundwater, soil and/or loss of non-renewable natural resources.	A serious effect on locally important attributes of the ecological environment is observable or measurable locally.	Significant damage to archeological, cultural or natural resources of national importance.
Considerable (3)	Extending over 1 km^2 area.	Significant deterioration of air quality on a local level Strong odour and irritation caused by deterioration of air quality.	Considerable local contamination or depletion of potable groundwater. Considerable local contamination of marine environment	Considerable uncontrolled generation handling, storage or disposal of hazardous waste, or serious uncontrolled for non-haz-waste, leading to considerable land contamination putting valued groundwater at risk, and natural resources	A considerable effect on significant attributes of the ecological environment is observable or measurable.	Significant damage to archeological cultural or natural resources of local importance.
Limited (2)	Extending over 10,000 m^2 area.	Significant deterioration of air quality on a limited level Strong odour and irritation caused by deterioration of air quality	Limited degradation of potable groundwater quality or reduction of its volume Limited contamination of marine environment	Limited uncontrolled generation handling, storage or disposal of waste leading to limited loss of natural resources and/or land contamination without putting valued groundwater at risk.	A limited effect on significant attributes of the ecological environment is observable or measurable.	Limited impact on natural resources or damage any archeological or cultural resources
Insignificant (1)	Measurable above background Confined within Fenceline	Slight change of ambient air quality over a limited area. Some local influence.	Slight degradation of quality or reduction of volume of potable groundwater. Some contamination of marine environment.	Controlled generation handling, storage or disposal of waste.	An effect on any attribute of the ecological environment is observable or measurable above background.	Some impact on natural resources or damage any archeological or cultural resources.

Professional judgment was used in each case to select the combination of area and level of impact that would best reflect the impact in question. *As an example*, large open oil fires such as the ones experienced during the war at Jiyeh power plant fuel tanks and the international airport kerosene tank typically cover large areas; however the areas most severely impacted are smaller; hence although the total area impacted could be large (say extending over 100 km^2 from the site), severe acute impact on receptor is not likely to have occurred over this entire area and the impact effect is not classified as catastrophic; rather, a smaller area (in the order of 10 km^2) where acute impact on receptors could be possible was estimated, and the impact effect is ranked as serious.

The second step consists of the use of the environmental impact severity matrix (EISM) (Table 1.3). The EISM assumes that the event "is occurring or is going to occur". Impact duration is also estimated based on professional judgment and scientific facts when possible (based on existing knowledge) and includes duration of event and recovery time from end of event. Impact duration ranges from momentary (less than one week) to long-term (more than 50 years). Crossing impact effect and duration leads to an impact severity category. A six-point impact severity scale is also used including negligible, marginal, critical non-significant, critical significant, severe and catastrophic impact. The assessment is done mainly to identify those impacts which could be critical, severe or catastrophic, and which would need to be addressed in an environmental action program.

Table 1.3. Environmental Impact Severity Matrix (EISM)



The nomenclature used in this assessment should no be interpreted as defining those impacts mentioned in international conventions dealing with environmental impacts from war. Its only purpose is to provide a framework to prioritize impacts and serve as guidance to direct decision-makers to address the most significant environmental impacts caused by the war.

1.3.7 ENVIRONMENTAL ACTION PLANS

Draft proposals were developed during the assessment to green the recovery phase and to mitigate significant environmental impacts. The proposals included in this report are considered to be a basis for a comprehensive environmental action program following more close consultation and validation with key stakeholders. Proposals include preliminary budgetary estimates to be used for guidance only.

1.3.8 DURATION OF THE ASSESSMENT

The study was conducted over a period of 12 weeks from September 8 to December 8, 2006, including incorporation of initial feedback from MoE. The report was reviewed by the different services of the MoE during December and comments were incorporated before issuing this final version.

LEBANON

RAPID ENVIRONMENTAL
ASSESSMENT FOR

GREENING RECOVERY,
RECONSTRUCTION
AND REFORM
2006

CONSTRUCTION

2.1 DAMAGE ASSESSMENT

Despite the generally inert nature of construction and demolition debris, the war-related impacts of the construction sector on the environment of Lebanon are noteworthy. The extent of damage is not only limited to the direct consequences of the Israeli bombardment such as destruction of infrastructure, emissions of dust and particulates, release of potentially hazardous materials, generation of demolition debris and associated visual intrusion; the conflict brings into effect indirect environmental impacts associated with the various stages of the construction chain, such as an incremental demand for quarrying products, a rise in the manufacturing of building materials, in addition to a foreseeable increase in polluting reconstruction works.

Post-conflict initiatives by the public and private sector must be carefully undertaken to avoid any aggravation of the situation. In fact, the war presents an opportunity for the adoption of much-needed environmental standards in the reconstruction efforts. Otherwise, Lebanon's flora and fauna could pay a significant toll due to the direct and indirect war-related impacts of the construction sector.

For the purpose of this assessment, the construction sector shall encompass building structures of residential, commercial, or industrial usage in addition to transportation infrastructure. The war-inflicted damages on houses, apartments, factories, offices, schools, roads, and bridges, as well as the ensuing demolition waste are addressed within this chapter with specific focus on the residential damages. Waste streams of industrial, municipal or other sources, though in some cases may commingle with demolition waste, shall be separately assessed in the Solid Waste chapter.

This chapter aims at providing decision makers with an assessment of the war-related impacts of the construction sector on the environment coupled with recommendations for controlling and mitigating these impacts. This was done through compilation of the limited primary and secondary data on the direct damages, followed by an analysis of the issues of environmental concern. Specific focus is given to the management of the inert demolition waste, the predicted impact on Lebanon's resources, as well as the feasibility of introducing green building standards in the reconstruction works. Due to the lack of available data, and the need for policy indicators, this chapter relies heavily on secondary data, informed estimations and assumptions.

2.1.1 OVERVIEW OF SECTOR DAMAGE

The devastation wreaked during the 34 days of bombardment of Israel's offensive against Lebanon resulted in significant destruction of Lebanese infrastructure. The collective damages incurred across Lebanon consist of the destruction of approximately 445,000 m^2 of road network, 92 bridges and overpasses, as well as the destruction or damage of an estimated total of 130,000 dwelling units (HRC, 2006). Table 2.1 below lists the major damages inflicted by the war on Lebanon's construction sector.

Table 2.1. List of the Major Damages to the Construction Sector (HRC, 2006)

Description	Quantity
Residential Infrastructure	
Private houses/ apartments (destroyed)	30,000
Private houses/ apartment (major damage)	30,000
Private houses/ apartment (minor damage)	70,000
Transportation Infrastructure	
Airports[3]	3
Sea port	4
Roads (445,000 m^2)	151[4]
Bridges and overpasses	92
Commercial Infrastructure	
Commercial sector (factories, markets, farms, medium size enterprises)	900
Small-size enterprises	2800
Public Infrastructure and Utilities	
Government institution (buildings)	66
Schools (destroyed or damaged)	350
Hospitals (major damage)	2
Health care buildings (destroyed or severely damaged)	50
Power plants / generation stations	15
Water distribution network (main and secondary)	330
Water dam	1
Sewage treatment plant	1
Sewage disposal systems (main and secondary)	158

Although the offensive targeted various infrastructure across Lebanon, the areas most directly impacted due to heavy shelling include the Dahieh region, a southern suburb of the capital Beirut, as well as various villages scattered within the Governorates of South Lebanon, Nabatiyeh and Bekaa. Table 2.2 presents a listing of the highly impacted regions of Lebanon as well as a description of the damages incurred.

[3] Rafik Hariri International Airport, Klayaat Airport, and Riyak Military Airbase
[4] Value updated based on (GoL, 2006a)

Table 2.2. Summary of the Areas with Significant Damages to their Construction Infrastructure (UNOSAT, 2006 a-e)

Location	Directly Impacted Structures	Description	Indirectly Impacted Structures[5]
Beirut[6] (UNOSAT, 2006a)	180	178 general buildings 2 roads	718 bldgs
Bint Jbeil (UNOSAT, 2006b)	306	274 general buildings 2 industrial buildings 17 roads 5 cultivated fields 8 uncultivated fields	Not Available
Majdel Zoun (UNOSAT, 2006c)	196	122 general buildings 2 bridges 46 roads 21 cultivated fields 5 uncultivated fields	717 bldgs
Rmaych (UNOSAT, 2006d)	341	265 general buildings 33 roads 28 cultivated fields 15 uncultivated fields	Not Available
Nabatiyeh (UNOSAT, 2006e)	169	103 general buildings 24 roads 33 cultivated fields	609 bldgs

With regards to transportation infrastructure, a study by the Economic Research Center (ESC, 2006) estimated the damage to reach approximately 4,000,000 m^2. Accordingly, the cost of reconstruction was calculated to be no less than USD 2 billion based on an assumption of USD 450-550/m^2 for reconstruction and debris clearance. A total of 151 roads were reported to be damaged by the conflict (PCM, 2006). Although figures published by the Higher Relief Council (HRC) claimed slightly lower values (Table 2.1), a study undertaken by the Council for Development and Reconstruction (CDR), indicated the partial or total damage of 107 bridges and overpasses, as well as USD 55 million worth of damages to Lebanon's airports (GoL, 2006).

In addition to the destruction of dwellings and transportation infrastructure, the Israeli bombardment also extended to public utilities, such as water distribution networks, as well as public institution building structures. Based on information from the South Lebanon and the Bekaa Water and Wastewater Establishments as well as the Litani River Authority, the main impact on water utilities comprise damage to major water reservoirs in Saida, Bint Jbeil, Wazzani, wells in Fakhreddine area, Kasmieh Canal, as well as general distribution pipes. These damages were estimated to reach approximately USD 74 million. Table 2.3 lists a selection of the 66 public administration buildings reported to have been impacted by the conflict (GoL, 2006).

[5] This includes structures that are within a 100m radius of the point of impact.
[6] Includes the Dahiet Suburb of Southern Beirut and the Haret Hreik area.

Table 2.3. Selection of Public Institution Buildings Impacted by the Conflict

Public Institution	Description of Damage
National Social Security Fund	7 damaged structures 1 destroyed
Community Development Centers of the Ministry of Social Affairs	8 partially destroyed 6 totally destroyed
Ministries[7]	> 10 buildings
Civil Defense	4 centers completely destroyed 5 centers severely damaged 7 centers lightly damaged

Primary inspections have estimated the rubble generated from the bombardment of the Dahieh region at approximately 1,000,000 m^3 (OCHA/UNEP, 2006). Based on typical Lebanese civil works, and assuming the heavy damage or total destruction of 60,000 housing units (HRC, 2006), industry experts estimated that approximately 1.8 million m^3 of rubble is scattered throughout the war-impacted villages of South Lebanon, Nabatiyeh and Bekaa[8]. A recent official report indicated an estimated 1.1 million tonnes to have been generated from the South Lebanon and Nabatiyeh governorates (PCM, 2006). No values for the rubble generated in Bekaa were cited in this report. Accordingly, the total volume of rubble is estimated to be within the range of 2.5 to 3 million m^3. Preliminary inspections of the rubble have indicated no presence of toxic gases, no evidence of radioactivity or asbestos contamination. However further testing is necessary.

Although the HRC contracted the rubble clearance works in all Lebanese regions (PCM, 2006), post-war initiatives also consisted of collaboration between the private and public sector. The South and Bekaa regions initially witnessed a predominance of local-based initiatives. In many cases, local municipalities contracted private sector haulers to transport and dump the waste in haphazard locations. The popular choice of dumpsite were empty lots, or in many cases inconspicuous valleys and ravines. Recently, the Ministry of Public Works and Transport (MoPWT) executed three contracts for rubble removal in the South, while the Council for the South is executing the rest of the contracts (PCM, 2006). The MoPWT was also responsible for debris removal in the Bekaa region.

As for the rubble generated from the Dahieh region, a government based initiative, headed by the MoPWT called for the transport of the demolition debris to two major temporary storage sites located within the Greater Beirut Area, prior to disposal. The plan sanctioned by the government consists of segregating and processing the waste at these temporary storage sites prior to disposal for sea reclamation by SOLIDERE under the supervision of CDR (CoM Decision 91/2006).

[7] Ministries of Economy and Trade, Culture (Baalbek Museum), Justice, Labor, and Agriculture
[8] Estimations of volume of rubble were calculated as follows: Volume of C&D waste= number of households*0.35*average household surface area. Number of households estimated at 55,000; Average household surface area assumed 120m^2 .

The direct damage of the conflict on the construction sector can clearly be seen through the destruction of building structures and generation of demolition waste. However, due to the nature of the construction industry, the impact shall proceed to other stages of the construction process: the extraction and manufacture of building materials, the construction works, and building occupancy and maintenance.

2.1.2 DAMAGED INFRASTRUCTURE

2.1.2.1 Dahieh / Haret Hreik Site

2.1.2.1.1 Location and source of damage

Located to the south of the capital Beirut, the Dahieh suburb comprises sections of several municipalities most notably Haret Hreik, Chiyah, and Bourj El Barajina. This site, which was a major target of the Israeli bombardment of Lebanon, lies adjacent to the Mediterranean to its west, and is encompassed by urban residential fabric in the remaining directions. The affected site was reported to have an area of approximately 200 x 240 m or 48,000 m^2 (OCHA/UNEP, 2006) (Figure 2.1).

Figure 2.1. Photographic Image of Destruction at the Dahieh Suburb of Beirut

2.1.2.1.2 Damage quantification

In general, most of the buildings in the affected quarter were of residential nature, comprised of 6 to 10 stories and 1 to 3 basements. They were mostly built with steel-reinforced concrete. Ground floor levels of the buildings of the Dahieh region were generally comprised of small-scale commercial enterprises such as small retail shops and car mechanics. Although data varies according to source, it is estimated that approximately 150 - 200 buildings were damaged by the Israeli attacks (GoL, 2006), comprising about 80% of the buildings in the area (OCHA/UNEP, 2006), or an estimated 5000 – 6000 dwelling units[9].

A recent report published by the government indicates that as of November 21, 2006, 1,146,000 m^3 of rubble were removed from the region (PCM, 2006). Primary visual

[9] Assumption of 150 - 200 buildings with 30 dwelling units per building.

inspections estimated the rubble generated from the bombardment of the Dahieh region at approximately 1,000,000 m^3 (OCHA/UNEP, 2006) consisting mostly of masonry, concrete, metal, furniture, clothes, household appliances and white goods (Figure 2.2). The same study indicated the following debris composition: concrete: 50-70 %, steel/iron 5-8 %, bricks 10-25 %, other metals 2-5 %, plastics (including styrofoam) 5-15 %, organic waste 2-8%, and hazardous household waste less than 2% (OCHA/UNEP, 2006).

Figure 2.2. Photographic Image of Cleanup Works and Rubble at the Dahieh Suburb of Beirut

2.1.2.1.3 Post-conflict initiatives

Due to private sector and public sector initiatives, a considerable portion of the debris and rubble has already been cleared and transported to temporary storage sites. Various equipment and machinery, such as bulldozers and welding equipment, are being used to clear the site of rubble generating considerable dust. Municipal waste, furniture, white goods and electronics are being removed from the debris prior to transport.

2.1.2.1.4 Environmental concerns

No toxic gases, radioactivity or asbestos were found upon preliminary site assessment. Small quantities of hazardous wastes can be expected among the debris due to the likely presence of transformers, generators and fuel storage tanks in the ground floor commercial spaces. The risk of unexploded ordnance (UXO) at the site is considered low.

There is concern for the structural soundness of the remaining buildings including those that were partially damaged. It is recommended that an assessment be completed prior to the completion of the clearing since more demolition waste may be generated.

A 1,000 m^2 open dumpsite within the residential area was established for the segregation of the waste during clearance of the mixed demolition wastes. In general white goods, furniture, tires, paint canisters and household appliances are separated from the rubble prior to transport to the temporary disposal sites. The dumpsite poses considerable health and safety risks for the residents of the area due to proliferation of pests and disease vectors, risk of fire, and noxious odors.

2.1.2.2 Municipalities of South Lebanon, Nabatiyeh and Bekaa

2.1.2.2.1 Location and source of damage

In contrast to the heavily targeted Dahieh site and vast quantities of resulting demolition debris, the damage to the construction sector of South Lebanon, Nabatiyeh and Bekaa are scattered within hundreds of small towns and villages; Information from UNOSAT and HIC maps (UNOSAT, 2006 b-e, and HIC, 2006 a-b) indicates that the heavily damaged municipalities include those of Aita ech Chaab, Khiam, Bent Jbeil and Baalbek (Table 2.4). A detailed listing of the highly impacted municipalities of the Cazas of Tyre, Nabatiyeh, Marjayoun, and Bint Jbeil can be found in Appendix 2-A.

Table 2.4. Highly Impacted Areas of Bekaa, South Lebanon and Nabatiyeh (HIC, 2006a-b)[10]

Municipality	Governorate - Caza	Dwellings Destroyed	Dwellings Damaged	Repairable Dwellings
Zabqine	South Leb - Tyre	150	50	500
Mansouri	South Leb - Tyre	100	50	400
Siddiqine	South Leb - Tyre	150	50	400
Maaroub	South Leb - Tyre	150	50	550
Aabbassiye	South Leb - Tyre	100	35	0
Srifa	South Leb - Tyre	250	100	500
Khiam	Nabatiyeh - Marjayoun	580	708	2300
Taibe	Nabatiyeh - Marjayoun	135	100	450
Majdel Silim	Nabatiyeh - Marjayoun	145	140	160
Jmaijime	Nabatiyeh - Bint Jbeil	115	50	50
Chaqra	Nabatiyeh - Bint Jbeil	125	25	100
Braachit	Nabatiyeh - Bint Jbeil	172	170	250
Yater	Nabatiyeh - Bint Jbeil	180	150	400
Aainata	Nabatiyeh - Bint Jbeil	100	50	800
Aita Ech Chaab	Nabatiyeh - Bint Jbeil	450	100	500
Bent Jbeil	Nabatiyeh - Bint Jbeil	375	500	1900
Baalbek	Bekaa - Baalbek	250	400	Not available

2.1.2.2.2 Damage quantification

Although final figures on the exact location and extent of the damage, as well as the status of the repairs have still not been officially released, the available data indicates that approximately 15,472 housing units were considered destroyed, damaged or repairable in the Caza of Tyre, 14,799 in Caza of Bint Jbeil, 10,927 in the Caza of Marjayoun, and 3,488 in the Caza of Nabatiyeh (Table 2.5). These figures, in the case of Bint Jbeil, represent up to 87.1% of buildings of a Caza (Table 2.6).

[10] The table classifies damages based on severity: destroyed (complete destruction), damaged (moderate), or repairable (lightly damaged)

Table 2.5. Summary of the Damage Inflicted on the Infrastructure of the Caza of Tyre, South Lebanon (HIC, 2006a-b)

Governorate	Caza	Dwellings Destroyed	Dwellings Damaged	Repairable Dwellings	Total Impacted Dwellings
South Lebanon	Tyre	1601	1322	12549	15472
Nabatiyeh	Bint Jbeil	2512	1908	10379	14799
Nabatiyeh	Marjayoun	1318	1676	7933	10927
Nabatiyeh	Nabatiyeh	113	125	3250	3488
Bekaa	n/a	333	469	2	804

Table 2.6. Percentage of Building Structures Impacted in the Nabatiyeh Governorate

Area	Total Buildings in Caza	Buildings Impacted by Conflict[11]	Percent of Buildings Impacted by Conflict
Caza of Tyre, South Lebanon	33170[12]	15472	46.6%
Caza of Nabatiyeh, Nabatiyeh	24806[13]	3488	14.1%
Caza of Marjayoun, Nabatiyeh	13565[14]	10927	80.6%
Caza of Bint Jbeil, Nabatiyeh	16988[15]	14799	87.1%

Other damages consist of the generation of demolition wastes. Housing units in the targeted villages are typically of not more than 2 floors[16]. Consistent with typical Lebanese civil works, they are mostly built with steel-reinforced concrete.

The HRC consultants estimated the removed quantity of wreckages in 103 villages and towns in Southern Lebanon and Nabatieh to be around 607,441 m^3, knowing that the final quantity is expected to reach more than 1,100,000 m^3 (PCM, 2006). Based on the number of destroyed dwelling units reported in Daily Situation Report 78 of the Higher Relief Council, the official information source of the Government of Lebanon (HRC, 2006), industry experts estimated the volume of mixed demolition waste generated collectively from the devastation of municipalities of South Lebanon, Nabatiyeh and Bekaa at approximately 1.8 million m^3.

The generated demolition waste is considered to be of similar composition of that of the Dahieh area, with a lower scrap metal component. Based on visual inspection of disposal sites, Table 2.7 presents an estimated composition of cleared demolition waste resulting from the villages of South Lebanon and Bekaa (Figure 2.3).

[11] Includes building structures that were completely destroyed, damaged, and repairable (HIC, 2006a-b).
[12] Buildings of the Caza of Tyre constitute 49.1% of the 67557 buildings of the Governorate of South Lebanon (CAS, 2006).
[13] Buildings of the Caza of Nabatiyeh constitute 39.5% of the 62801 buildings of the Governorate of Nabatiyeh (CAS, 2006).
[14] Buildings of the Caza of Marjayoun constitute 21.6% of the 62801 buildings of the Governorate of Nabatiyeh (CAS, 2006).
[15] Buildings of the Caza of Bint Jbeil constitute 27.05% of the 62801 buildings of the Governorate of Nabatiyeh (CAS, 2006).
[16] An overwhelming 83% of housing units in Nabatiyeh and 78% of those in South Lebanon are of no more than two stories (CAS, 2006).

Table 2.7. Estimated Composition of the Demolition Waste Resulting from South Lebanon, Bekaa and Nabatiyeh[17]

Component	Percent Composition
Concrete	40 - 60%
Ferrous and Non-Ferrous Metals	4 - 8 %
Aggregates and sand	30 - 40%
Others (plastics, municipal waste, household items, furniture)	5 - 15 %

Figure 2.3. Photographic Image of Roadside Rubble in the Village of Abbasiyeh, South Lebanon

2.1.2.2.3 Post-conflict initiatives

In the initial postwar period, most municipalities took the initiative to clear and dump their inert demolition waste. In most cases, roadside curbs, valleys and ravines were selected as disposal sites. In the city of Tyre, an open debris disposal site was selected for the temporary disposal of the rubble of the Caza within the heart of a residential neighborhood jeopardizing public health and safety (Figure 2.4).

A recent report by the Government of Lebanon maintained that the MoPWT executed three contracts with the private sector for the removal of the rubble generated from the war-impacted regions of South Lebanon. The same report also claimed that the Council for the South is executing the rest of the contracts in the South Lebanon and Nabatiyeh regions, and that the MoPWT has already completed debris removal in the Bekaa (PCM, 2006).

[17] Values are based on visual inspection by the ELARD reconnaissance mission and on figures presented in (OCHA/UNEP, 2006).

Figure 2.4. Photographic Image of Tyre Dumpsite

2.1.2.2.4 Environmental concerns

No official reports on asbestos contamination of the waste have been published to date. Nevertheless visual site inspections for asbestos containing materials suggest that asbestos contamination is not a major issue of concern. Although conflicting reports on the use of radioactive depleted uranium missiles in the South have appeared in the press, there is no conclusive evidence to support these claims. Very small quantities of household hazardous wastes can be expected amongst the debris. The risk of unexploded ordinance (UXO) mixed with the demolition debris is considered moderate in these areas.

2.1.2.3 Ouzaii Temporary Debris Storage Site

2.1.2.3.1 Location and source of damage

Located directly on the Mediterranean shore, the Ouzaii coastal site was selected as one of the two main temporary storage sites for the demolition waste generated from the bombardment of Dahieh. With an area of around 25,000 m^2, the site is intersected by the Beirut-Saida Highway, dividing it into a section adjacent to the runways of the Beirut International Airport, and a 100 meter coastal section. The site was selected based on its proximity to the Dahieh region, ownership status (public), accessibility to trucks, and surrounding non-residential land-use.

2.1.2.3.2 Damage quantification

The war-inflicted damage at the Ouzaii site results from the on-going initiative of dumping demolition debris mainly originating from the Dahieh site. Minor amounts of debris were dumped by some southern municipalities of close proximity. With regards to the debris composition, a significant portion of white goods, electronics and municipal solid waste was removed at the Dahieh site giving rise to rubble consisting mostly of aggregates, soils, concrete and metals, with minor household goods and clothing. Based on visual inspection of the sites, Table 2.7 presents an estimated composition of demolition debris stored at the Ouzaii Site (Figure 2.5).

Table 2.8. Estimated Composition of the Demolition Waste Stored at the Ouzaii Coastal Site[18]

Component	**Percent Composition** (volume)
Concrete	35 - 50%
Ferrous and Non-Ferrous Metals	5 - 12%
Aggregates and sand	35 - 50%
Others (plastics, municipal waste, household items, furniture)	5 - 10%

Figure 2.5. Photographic Image of Rubble at the Temporary Ouzaii Storage Site

2.1.2.3.3 Post-conflict initiatives

The Government of Lebanon authorized a plan calling for the clearance of the approximately 1 million m^3 of demolition waste resulting from the bombardment of Dahieh. Accordingly, the competent executing agency, the Ministry of Public Works and Transport, selected the Ouzaii site for temporary storage, and authorized a private hauler for the clearance of the debris and transport to temporary storage sites.

Early dumping activities by authorized haulers lacked effective monitoring and control by the Ministry of Interior and Municipalities based upon the request of the Ministry of Public Works and Transport, resulting in minor amounts of rubble being dumped in the Mediterranean Sea.

At an estimated rate of 400 truck loads per day (10,000 tonnes/day), the waste continues to be unloaded on the site where private sector workers use welding equipment, forklifts, bulldozers and other machinery for the handling of the waste and removal of scrap metal to be sold for recycling.

[18] Values are based on visual inspection by the ELARD reconnaissance mission and on figures presented in (OCHA/UNEP, 2006).

2.1.2.3.4 Environmental concerns

The waste showed no signs of hazardous material contamination from asbestos or radioactive materials. Also contaminants in the form of white goods, electric and electronic equipment, batteries, and organics waste were mostly removed from the rubble prior to transport. Therefore, the rubble is mostly inert in nature. Its impacts are mainly heavy dust emission during haulage, and high-sediment run-off. Due to its location on the coast, and its high visibility (adjacent to the Beirut-Saida highway), the site has a significant visual impact on the surrounding, particularly since it is in the vicinity of popular beaches targeted by tourists in the summertime (Figure 2.6). Accordingly, it is critical that the rubble be further processed and disposed of at the earliest possible time with specific consideration for the associated environmental impacts due to transport such as dust and noise emissions, fuel consumption, in addition to damage to roads network.

Impacts from the sea disposal of the mainly inert demolition waste include increased turbidity of the water column, obliteration of the underlying benthic environment, in addition to smothering of adjacent benthic habitats due to the settlement of suspended particles. Seeing as sea dumping activities were rapidly halted by local law enforcement, the quantities dumped in the sea are predicted to be minor. Therefore, little to no changes in the currents and hydrodynamic regime of the area, and associated coastal erosion and sediment accumulation impacts are expected. With the data available, there is limited risk of contamination with non-inert substances of hazardous nature, however additional sampling is recommended.

The site poses significant safety and health concerns due to the ease of its accessibility by the public, in addition to the absence of warning signs and lack of separating barriers. Also, no personal protective gear is donned by the workers onsite.

Figure 2.6. Photographic Image of Rubble Spilling into the Mediterranean Sea at the Temporary Ouzaii Storage Site

2.1.2.4 El-Shiyah Temporary Debris Storage Site

2.1.2.4.1 Location and source of damage

Part of a 33,000 m^2 plot of land belonging to the Municipality of Burj el Barajna, and with an estimated area of 8,000 m^2, the El-Shiyah temporary storage site lies adjacent in its southern border to the main highway leading to Lebanon's Rafik El-Hariri International Airport. The site is mainly surrounded by the residential fabric of Dahieh and Haret Horeik. It lies within direct proximity (100 m) to sensitive sites including a hospital, religious shrine (El Rasoul El-Azam Mosque) and restaurant.

A partition of the site was recently being used as a local football field, while another was used as a municipal solid waste dumpsite during the Lebanese Civil War. Due to the intense bombardment of Dahieh during the 34-day conflict, the site is currently being used for the temporary storage of the demolition debris and rubble (Figure 2.7 and Figure 2.8).

Figure 2.7. Photographic Image of the El-Shiyah Temporary Storage Site

Figure 2.8. Photographic Image of the Rubble at the El-Shiyah Site

2.1.2.4.2 Damage quantification

The war-inflicted damage at the El-Shiyah site results from the vast quantities of demolition debris dumped in the site. The debris was cleared of a significant portion of white goods, electronics and municipal solid waste prior to transport. Thus the rubble consists mostly of aggregates, soils, concrete and metals, with minor household goods and clothing. Moreover, the debris has a similar volume composition as that of the waste stored at the Ouzaii site (Table 2.7).

2.1.2.4.3 Post-conflict initiatives

Similar to the Ouzaii coastal site, the El-Shiyah site was selected by the Ministry of Public Works and Transport for the storage of a portion of the approximately 1 million m^3 of demolition waste resulting from the bombardment of Dahieh. The site was used for this purpose in the early days of the cease fire, but was later abandoned in preference to the Ouzaii debris disposal site. Scrap metals are being salvaged onsite to be sold for recycling.

2.1.2.4.4 Environmental concerns

The rubble is mostly inert in nature with no signs of contamination by hazardous materials. Its impacts are mainly heavy dust emissions during haulage, transport and handling, in addition to high-sediment run-off during the rainy season. It is necessary that the rubble be further processed and disposed of in the near future with specific consideration for associated dust and noise emissions, fuel consumption, in addition to damage to roads network.

2.2 ENVIRONMENTAL ACTION PLANS

The direct war-inflicted impacts of Lebanon’s construction sector on the environment comprise the impacts resulting from the destruction of infrastructure. These impacts, which include dust emissions from bombardment, generation of demolition debris, physical harm of underlying flora and fauna, blockage of water ways due to demolition debris, typically require end-of-pipe remediation. In contrast to these direct impacts, most indirect impacts, such as pollution from reconstruction works (dust emissions, soil erosion, water pollution, and construction waste generation), forthcoming building occupancy and associated energy and water consumption, as well as the extraction of raw materials for reconstruction can be altogether avoided or controlled to limit the harm to natural resources.

This section addresses the existing and predicted conflict-generated impacts of the construction sector on the environment. It offers general recommendations for the adoption of green-building standards for the reconstruction of Lebanon. It also provides policy-based action plans for the 1) remediation of the demolition debris resulting from Dahieh, 2) remediation of the demolition debris resulting from the villages of South Lebanon, Nabatiyeh and Bekaa, and 3) mitigation of the expected impacts of Lebanon’s quarrying sector on natural resources.

2.2.1 PROMOTING GREEN BUILDING STANDARDS IN THE RECONSTRUCTION OF POST-CONFLICT LEBANON

2.2.1.1 Problem Statement and Rationale

Innumerable green building alternatives ranging from simple no-cost building practices to complex and costly solutions can be implemented by the construction sector so as to maximize energy savings, improve the visual appearance of buildings, minimize water consumption, improve the comfort, health, and safety of building occupants, and limit the detrimental effects of reconstruction works on the environment through the use of environmentally friendly materials.

International case studies have demonstrated that these sustainable building standards provide both economic and environmental gains. In general, the minimal increases in upfront costs of implementing green standards range from 0-2% of construction costs and result in life cycle savings of 20% of total construction costs (Kats, 2003); in other words, an initial upfront investment of up to $100,000 to incorporate green building features into a $5 million project would result in a savings of $1 million in today's dollars over the life of the building.

In Lebanon, green building standards for site planning and design, energy and water consumption, materials and waste management, as well as indoor air quality are not being applied due to a variety of reasons. Foremost amongst these reasons is the lack of a solid legal framework to stipulate such requirements. Other reasons include the absence of general awareness coupled with public disregard of the economic and environmental benefits of green construction. Moreover, practical experience of field professionals in the implementation of sustainable building practices is very limited.

The recent Lebanese conflict can serve as an opportunity to incorporate sustainable green building standards in the reconstruction of the war-ridden regions of Lebanon as an initial step prior to incorporation within all future construction works. The scale of the damages and resulting reconstruction works (approximately 60,000 housing units completely destroyed or highly damaged) are ideal to demonstrate the economic and environmental viability of such efforts for the reconstruction of both public and private building structures as is demonstrated in the energy and water-saving scenarios presented in Sections 2.2.1.2 and 2.2.1.3.

This proposed action evaluates the feasibility of adopting energy and water efficient measures in reconstruction of Lebanon's demolition infrastructure, and accordingly suggests an action plan to address the legal, technical and awareness obstacles to the application of green building standards in the country.

2.2.1.2 Added Value of Energy Efficient Standards in the Reconstruction of Beirut

Assuming the reconstruction of 18,500 housing units in Beirut, Table 2.9 summarizes the costs and benefits of adopting energy efficiency measures including thermal standards, solar water heaters and energy efficient lighting with regards to energy conservation as well as reduction of CO_2 emissions and global warming. Since all of the three energy conservation measures have a benefit-cost ratio greater than one, then it is recommended that these measures be adopted in the reconstruction works in all regions damaged by the war.

Table 2.9. Added Value of Implementing Energy Efficiency Standards

	Thermal Standards	**Solar Water Heaters**	**Energy Efficient Lighting**	**All**
Incremental Cost (USD)[19]	46,000,000	14,500,000	1,100,000	61,600,000
Energy Saving (KWh/yr)[20]	76,200,000	73,200,00	26,000	175,400,000
Monetary Saving (USD.yr)[21]	9,144,000	8,784,000	3,120,000	21,048,000
CO2 Reduction (t/yr)	*72,300*	*69,500*	*24,700*	*166,500*
25-Year Lifetime[22]				
Incremental Cost (USD)	46,000,000	55,865,490	12,295,225	114,160,715[23]
Energy Saving (KWh)	1,905,000,000	1,830,000,000	650,000,000	4,385,000,000
Monetary Saving (USD)	228,600,000	219,600,000	78,000,000	526,200,000[24]
B/C	**4.9**	**3.9**	**6.3**	**4.6**
CO2 Reduction (t)	*1,807,500*	*1,737,500*	*617,500*	*4,162,500*
Damage Reduction(USD)(L) [25]	*30,727,500*	*29,537,500*	*10,497,500*	*70,762,500*
Damage Reduction (USD)(H)	*148,215,000*	*142,475,000*	*50,635,000*	*341,325,000*
Total Monetary Saving (USD) (L)	258,327,500	249,137,500	88,497,500	596,962,500
Total B/C (L)	**5.6**	**4.5**	**7.2**	**5.2**

2.2.1.3 Added Value of Water Efficient Standards in Lebanon

Assuming the reconstruction of 60,000 housing units in Lebanon (HRC, 2006), Table 2.10 summarizes the costs and benefits of adopting water efficiency measures including the installation of plumbing fixtures such as low flush toilets (1.6 gallons per flush), low flow showerheads (<2.5 gallons per min), and faucet aerators (<2.5 gallons per min), as well as pressure reduction through valve manipulation. The benefit to cost ratio of the four measures was estimated for low, average and high water consumption rates. It is recommended to install faucet aerators and low-flow showerheads, as well as to reduce barometric pressure from 100 psi to 50 psi at water outlets in the reconstruction of the war impacted regions of Lebanon.

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[19] (UNDP LCECP, 2006)
[20] (UNDP LCECP, 2006)
[21] Assuming a cost of energy of 0.12 USD/KWh
[22] Future Value FV = X * $(1+r)^t$ where r is the inflation rate estimated at 2.35% (based on data from the International Monetary Fund's 2005 World Economic Outlook, Lebanon's weighted average annual rate of inflation was 2.35 percent from 1995 to 2004); t is the time frame (25 years): lifetime of Thermal Standards is 25 years, lifetime of Solar Water Heaters is 10 years (i.e. two replacement during the 25-yr lifetime of the project) and lifetime of Energy Efficient Lighting is 3 years (i.e. eight replacements over the 25-yr lifetime of the project)
[23] Net Present Value (NPV= $x/(1+r)^t$) at 3% discount rate = 54,523,792 USD, at 5% = 33,711,975 USD
[24] Net Present Value (NPV) at 3% discount rate = 251,316,050 USD, at 5% discount rate= 155,388,318USD
[25] Current literature indicates that the climate change damage costs within a range of 17 – 82 USD per tonne of CO_2 emitted (Smekens et al., 2006)

Table 2.10. Added Value of Implementing Water Efficiency Standards

	Low Flush Toilets[26]	Low Flow Showerheads[27]	Faucet Aerators[28]	Pressure Reduction[29]	All[30]
YEAR 1 OF INITIATIVE					
Incremental Cost (USD)[31, 32]	18,000,000	1,440,000	1,200,000	1,200,000	20,640,000
Water Saving - *low* **(m^3/yr)**[33]	3,942,000	1,971,000	1,971,000	3,942,000	11,826,000
Water Saving - ***avrg*** **(m^3/yr)**[34]	3,252,150	1,626,075	1,626,075	3,252,150	9,756,450
Water Saving - *high* **(m^3/yr)**[35]	1,971,000	985,500	985,500	1,971,000	5,913,000
Monetary Saving - *low* **(USD.yr)**[36]	1,656,000	828,000	828,000	1,656,000	4,968,000
Monetary Saving – *avrg* **(USD.yr)**[37]	1,366,200	683,100	683,100	1,366,200	4,098,600
Monetary Saving - *high* **(USD.yr)**[38]	828,000	414,000	414,000	828,000	2,484,000
20 YEAR LIFETIME					
Incremental Cost[39] **(USD)**	18,000,000	5,548,021	4,623,351	1,200,000	29,371,372[40]

[26] *Low flush toilets* (1.6 Gpf): incremental cost: $150/toilet, lifetime: 20 yrs, water saving of 50% of approximately 40% of indoor water use; Assumption of 2 low flush toilets installed per household.

[27] *Low flow shower heads* (<2.5 gpm): incremental cost: $12/showerhead, lifetime: 7-10 yrs, water saving 50% of approximately 20% of indoor domestic water use; Assumption of 2 low flow shower heads installed per household.

[28] *Low flow aerators* (<2.5 gpm): incremental cost: $5/aerator, lifetime: 7-10 yrs, water saving 50% of approximately 20% indoor domestic wateruse; Assumption of 4 aerators per household.

[29] A reduction in pressure from 100 psi to 50 psi at an outlet can result in a water flow reduction of about one-third.

[30] Sources: US EPA website on water conservation: http://www.epa.gov/water/you/chap3.html; Suppliers: Eartheasy: http://eartheasy.com/live_lowflow_aerators.htm; Conserv-a-store: http://www.conservastore.com/productlist.php?c=5 ; http://www.terrylove.com/crtoilet.htm;

[31] Number of dwelling units destroyed or highly damaged: 60,000 (Higher Relief Council, 2006, Daily Situation Report 78

[32] Capita per household in South Lebanon, Nabatiyeh, Bekaa and Dahiet regions: 4.5/household, CAS - Living Conditions National Survey 2004 - Table 24: Average Household Size by Mohafaza

[33] A lower rate of water consumption is assumed: 100L/day-capita.

[34] Average per-capita water consumption of 165 L/day, based on Ecodit, 2002, State of the Environment Report, Ministry of Environment of Lebanon: and Amery H, Chapter 2 - Assessing Lebanon's Water Balance, 2000, Water balances in the Eastern Mediterranean, IDRC, Edited by David B. Brooks and Ozay Mehmet. Accessed on: http://www.idrc.ca/en/ev-33225-201-1-DO_TOPIC.html

[35] A higher rate of water consumption is assumed: 200L/day-capita.

[36] Assuming a cost of water of $0.42/m3-yr. Annual subscription to a daily 1m3 supply of water is approximately LBP 230,000 / 1m3 per day in Beirut and Mount Lebanon

[37] Assuming a cost of water of $0.42/m3-yr. Annual subscription to a daily 1m3 supply of water is approximately LBP 230,000 / 1m3 per day in Beirut and Mount Lebanon

[38] Assuming a cost of water of $0.42/m3-yr. Annual subscription to a daily 1m3 supply of water is approximately LBP 230,000 / 1m3 per day in Beirut and Mount Lebanon

	Low Flush Toilets[26]	**Low Flow Showerheads**[27]	**Faucet Aerators**[28]	**Pressure Reduction**[29]	**All**[30]
Water Saving - *low* **(m^3)**[41]	39,420,000	19,710,000	19710000	39420000	118,260,000
Water Saving - *avrg* **(m^3)**[42]	65,043,000	32,521,500	32521500	65043000	195,129,000
Water Saving - *high* **(m^3)**[43]	78,840,000	39,420,000	39420000	78840000	236,520,000
Monetary Saving - *low* **(USD)**	16,560,000	8,280,000	8,280,000	16,560,000	49,680,000[44]
Monetary Saving - *avrg* **(USD)**	27,324,000	13,662,000	13,662,000	27,324,000	81,972,000[45]
Monetary Saving - *high* **(USD)**	33,120,000	16,560,000	16,560,000	33,120,000	99,360,000[46]
B/C - *low*	0.92	1.49	1.79	13.80	1.69
B/C - *avrg*	1.52	2.46	2.95	22.77	2.79
B/C - *high*	1.84	2.98	3.58	27.60	3.38

2.2.1.4 Proposed Actions

The proposed action consists of three subcomponents: legal, technical and awareness. For the legal component, the proposed actions include:

1. Prepare a detailed assessment of existing guidelines and standards for the planning, design, siting, energy consumption, water management, materials, resources and waste management of the construction sector in Lebanon, and comparison with similar international guidelines.

2. Review of the existing institutional framework for the regulation, monitoring and supervision of the construction sector, identifying gaps and overlaps, as well as proposing recommendations.

3. Evaluate existing financial obstacles for implementation of sustainable building, and means to overcome these barriers.

4. Based on the recommendations of the previous activities, conduct consultations with the relevant private and public sector stakeholders including the Ministry of Public

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39 Future Value FV = $X * (1+r)^t$ where r is the inflation rate estimated at 2.35% (International Monetary Fund's 2005 World Economic Outlook, Lebanon's weighted average annual rate of inflation was 2.35 percent from 1995 to 2004); t is the time frame (20 years); lifetime of low flush toilets is 20 years; lifetime of is low-flow showerheads is 10 years (i.e. two replacement during the 20-yr lifetime of the project); lifetime of faucet aerators is 10 years; Pressure reduction is a plumbing practice and therefore has no lifetime.
40 Net Present Value (NPV= $x/(1+r)^t$) at 3% discount rate = USD 53,047,965, at 5% = USD 77,930,993.
41 Low domestic water consumption rate is assumed (100 L/day-capita).
42 Average domestic water consumption rate is assumed (165 L/day-capita).
43 High domestic water consumption rate is assumed (200 L/day-capita).
44 Net Present Value (NPV= $x/(1+r)^t$) at 3% discount rate = USD 89,727,606, at 5% = USD 131,815,830.
45 Net Present Value (NPV= $x/(1+r)^t$) at 3% discount rate = USD 148,050,550, at 5% = USD 217,496,119.
46 Net Present Value (NPV= $x/(1+r)^t$) at 3% discount rate = USD 179,455,212, at 5% = USD 263,631,660.

Works and Transport, Ministry of Environment, Ministry of Energy and Water, Council for Development and Reconstruction, Ministry of Finance, the Syndicate of Engineers and Architects, as well as municipalities and Ministry of Interior and Municipalities.

5. Based on the stakeholder feedback, incorporate the financial, institutional and technical recommendations of the above activities into the appropriate legislative text.

6. Disseminate the final outcomes of the legal component to the public and private sector stakeholders.

The capacity building component addresses the technical standards for green building, including site planning and design, energy efficiency, water consumption during construction works and occupancy, materials and resources efficiency, waste reduction, as well as occupant health and safety (indoor environmental quality, ventilation, etc). The proposed actions for this component include the preparation and delivery of technical capacity building workshops on the practices of green construction targeting public and private sector professionals (engineers, architects, contractors, academics, etc).

The public awareness component, which is of high priority, involves the launching of an awareness campaign targeting the general public through awareness seminars and other media (brochures, posters, etc) on the economic and environmental benefits of green construction.

2.2.1.5 Legal and Institutional Aspects

The main public stakeholders concerned with this action are the Ministry of Public Works and Transport, Ministry of Environment, Ministry of Finance, Ministry of Energy and Water, LIBNOR and the Council for Development and Reconstruction (CDR).

The development of technical guidelines and standards for sustainable building will need to be formally endorsed by the Ministry of Public Works and Transport, the Ministry of Environment, the Ministry of Energy and Water, LIBNOR as well as the Council of Ministers. Draft Thermal Building Standards already exist and are being reviewed by LIBNOR prior to formal approval by the government.

Financial incentives, such as tax reductions or exemptions on the purchase of recycled or recyclable construction products, will require the endorsement of the Ministry of Finance.

The CDR, responsible for the management of the demolition debris generated from the Dahieh region, as well as the reconstruction of the region, plays a role in promoting and overseeing contractor compliance with these standards through various mechanisms such as project contracts and bidding documents. It is recommended that the various stakeholders mentioned above be included in the preparation of the demolition debris management plan.

2.2.1.6 Budgetary Estimates

The total budgetary for the proposed action amounts to an estimated **USD 100,000.** Budget breakdown is as follows:

- Legal review of national and international green building standards: USD 10,000
- Review of national institutional framework: USD 5,000
- Study of financial barriers and incentives: USD 10,000
- Realization of standards through legal text through consultations and drafting: USD 10,000
- Technical capacity building workshops: USD 35,000
- Public awareness campaign: USD 30,000

2.2.1.7 Timeframe

It is recommended that the proposed action start at the earliest opportunity so as to complement reconstruction efforts. The estimated timeframe for implementation is 6 months.

2.2.2 MITIGATING THE IMPACT OF THE WAR ON LEBANON'S NATURAL RESOURCES

2.2.2.1 Problem Statement and Rationale

Construction works typically consume a large portion of natural resources such as water, energy, as well as mineral products. Accordingly, the vast reconstruction works for the areas targeted by the Israeli assault shall unavoidably create a newly founded demand for natural resources, most notably primary and secondary construction materials. In fact, it is estimated that the rebuilding of the 60,000 dwelling units that were reportedly completely destroyed or highly damaged (HRC, 2006), and which in turn generated an estimated 2.5 - 3 million m^3 of demolition waste, would require approximately 3.5 million tonnes of sand and aggregates, 1.2 million tonnes of cement, and 0.22 million m^3 of water[47].

Concerns abound that this incremental demand shall be met with an uncontrolled increase in local mining and quarrying activities leading to irreversible impacts on Lebanon's fragile environment including the destruction of vegetation and natural habitats, permanent loss of biodiversity and natural resources, increase in the levels of noise, visual and air pollution, pollution of groundwater and surface water resources, soil erosion and potential land de-stabilization, as well as associated loss of real estate value. Based on a study by the World Bank, the annual costs of the environmental degradation caused by the quarry sector in

[47] Composition of demolition waste was assumed to be as reported in Table 2.7; It was assumed that every cubic meter of concrete requires 1.3 m^3 of constituents including: 0.43 m^3 cement, 0.17 m^3 water and 0.71 m^3 of total aggregates (coarse, fine and crushed) and sand.

Lebanon were estimated at 0.1% of the GDP (Sarraf et al, 2004) or a value of USD 2,216,000,000[48].

Accordingly the objective of this proposed activity is to find an environmentally sustainable and economically viable solution for the incremental demand on Lebanon's natural resources due to the conflict.

2.2.2.2 Analysis of Alternatives

Although the solution to avoid the impact on Lebanon's natural resources seems to simply opt for importation of all the required construction materials, the construction industry in Lebanon constitutes approximately 7.0[49] to 9.2[50]% of Lebanon's Gross Domestic Product (MoI, 1999) – a value of 1.5 to 2 billion USD[51]. A solution may exist that allows Lebanon to prosper economically without sustaining harmful environmental impacts.

With regards to cement production, Lebanon reportedly produces approximately 4.3 million tonnes annually (Yager, 2004), with domestic demands in 2003 amounting to 2.7 million tonnes annually (Yager, 2004). Exports, as indicated by Lebanese Customs Authorities, approached 1.6 million tonnes in 2005, while imports were negligible[52]. According to the above, it can be assumed that the incremental demand for 1.25 million tonnes of cement can be satisfied by the current production levels (Table 2.11) without any additional exploitation of natural resources.

However, a more in-depth analysis of the cement market indicates a steep increase in the future domestic demand. In fact, according to an industry quarterly report by Bank Audi, the demand for cement in the construction industry increased two fold from the first quarter of 2005 to that of 2006 (Bank Audi, 2006). This trend becomes more apparent in the sharp decline of cement exportation witnessed in 2006 even prior to the conflict (Table 2.12). There is a considerable possibility that due to the predicted increase in domestic demand for cement, the reconstruction works may lead to increased quarrying for cement production.

[48] GDP of Lebanon (2005) was estimated at USD 22,161,000,000. (IMF, 2006)
[49] Ministry of Industry, 1999
[50] Value published on the website for the Lebanese Embassy in the United States of America. http://www.lebanonembassyus.org/country_lebanon/economy.html
[51] Gross Domestic Product of Lebanon in 2005 was estimated at USD 22,161,000,000. Source: International Monetary Fund, 2006, IMF Country Report - Lebanon No 06/204 - Lebanon Statistical Appendix, Washington DC.
[52] Source: www.customs.gov.lb; Data scope: From 1/1/2005 To 31/12/2005

Table 2.11. Comparison of the Current Production Levels of Mineral Resource with the Expected Increment in Demand due to Reconstruction

Resources	Incremental Demand[53] *(due to conflict)*	Local Production	Local Demand	Imports (2005)[54]	Exports (2005)[55]	Available Stockpiles[56]
Cement (million tonnes)	1.25	4.35[57]	2.70[58]	0.00	1.65	
Aggregates & Sand (million tonnes)	3.50	4.80[59]	3.97	0.77	0.00	1.60

Table 2.12. Trend of Cement and Aggregate Production in Lebanon based on 2004 – 2006 Foreign Trade[60]

	Imports			Exports		
	2004	**2005**	**2006**	**2004**	**2005**	**2006**
Cement (tonnes)	481	706	27	1,830,011	1,653,600	563,648
Aggregates & Sand (tonnes)	1,615,660	766,870	226,922	199	193	261

With regards to available aggregate resources, as is indicated in Table 2.11, Lebanon reportedly produces 3 million m^3 of aggregates and sand annually (CAS, 2006). Data published by the Lebanese Customs Authority indicated that imported aggregates in 2005 amounted to 0.77 million tonnes, while exports were negligible. However, over the last few years, the quarrying sector has been subject to administrative changes concerning operating permits; a fact which has lead to significant variations in the levels of domestic production and importation. In fact, due to the recent increase in domestic production levels[61], it was estimated that a collective 1.6 million tonnes of aggregates (30% of annual production) is available in various stockpiles around the country. Despite these values, an overview of the

53 Refer to paragraph 2.2.2.1
54 Lebanese Custom Authorities: www.customs.gov.lb Data scope: From 1/1/2005 To 31/12/2005
55 Lebanese Custom Authorities: www.customs.gov.lb Data scope: From 1/1/2005 To 31/12/2005
56 Estimates based on interviews with industry experts.
57 Yager, 2004
58 Yager, 2004
59 CAS, 2006
60 Source: Lebanese Custom Authorities: www.customs.gov.lb, Data scope: 1/1/2004 – 1/9/2006
61 Following the promulgation of Decree 8803/2002, the majority of quarries in Lebanon were shut down leading to an increase in importation and drastic decrease in local production. In 2005, the Lebanese Government shifted its policy and granted approximately 500 administrative authorizations to quarry operators leading to an increase in domestic production and drastic reduction of imports.

sector as presented in Table 2.11 indicates a predicted 72.84% increase in domestic quarrying activity to satisfy the war-related demand of an additional 3.5 million tonnes[62].

Four scenarios are evaluated based on their costs (environmental and fiscal) and benefits (economic and government returns): 1) domestic supply of 100% required materials; 2) importation (external supply) of 100% required materials; 3) domestic supply of 25% of materials and importation of 75%; and 4) domestic supply of 75% of materials and importation of 25%.

Results of the cost to benefit analysis presented in Table 2.13 indicate that the preferred alternative for the supply of cement primarily consists of local manufacturing of 100% of the required quantities (Appendix 2-B). With regards to sand and aggregates, the analysis indicates that the preferred alternatives are to either to rely on local production or to import 25% of the required materials (Table 2.14 and Appendix 2-B). Keeping the availability of products in mind (Table 2.12), the latter option is recommended.

Table 2.13. Cost to Benefit Analysis of the Alternative Scenarios to Mitigate the Impacts of Quarrying for Cement Production

	Local Resources	External Resources	25% Local, 75% Foreign	25% Foreign, 75% Local
Costs (Mil USD)	716.73	142.06	285.73	573.06
Benefits (Mil USD)	75.92	67.68	232.24	561.36
B/C	**1.01**	0.48	0.81	0.98

Table 2.14. Cost to Benefit Analysis of the Alternative Scenarios to Mitigate the Impacts of Quarrying for Sand and Aggregate Production

	Local Resources	External Resources	25% Local, 75% Foreign	25% Foreign, 75% Local
Costs (Mil USD)	1234.67	19.67	323.42	930.92
Benefits (Mil USD)	720.43	1.97	181.58	540.81
B/C	0.58	0.10	0.56	**0.58**

[62] Percent increase was calculated as the percent ratio of the incremental demand to the local production levels.

2.2.2.3 Proposed Actions and Recommendations

The proposed action includes:

1. Preparation of an in-depth feasibility study to evaluate the quantities of materials required for reconstruction, costs and analysis of alternatives taking into consideration available stockpiles[63].
2. Based on the results of the study, preparation of a resource management plan for the additional material demand due to the 34-day conflict. The plan would specify quarries that satisfy the following: superior quality of products, proximity to reconstruction sites, and minimal environmental disturbance.
3. Granting temporary permits for the selected quarries based on quality of products, location (transportation costs) and environmental impact. The permit would specify the period of operation of the quarry, approved destination sites for the extracted materials, extraction rates, operational standards[64], and rehabilitation standards and dates.
4. Monitoring and supervision of extraction activities followed by quarry rehabilitation.

2.2.2.4 Financial Mechanisms/Incentives

In compliance with Decree 8803/2002 (dated 04/10/2002) amended by Decree 16456/2006 (dated 27/02/2006), all quarry operators must place a financial guarantee in order to assure the rehabilitation of the quarries following extraction.

2.2.2.5 Legal and Institutional Aspects

The key stakeholders involved in this process include:

- The National Council for Quarries headed by the Ministry of Environment plays a major role in planning and organizing the sector as well as approving permits for operation based on the recommendations of the other member ministries[65]: Ministry of Public Works and Transport (Directorate General of Urban Planning), the Ministry of Interior and Municipalities (Directorate General of Administrations and Local Councils), Ministry of Energy and Water, Ministry of Public Health, Ministry of Defense, Ministry of Finance, Ministry of Agriculture (Directorate General of Rural Development), Ministry of Culture (Directorate General of Archeology).
- The Ministry of Environment plays an additional role of establishing guidelines and standards for quarry operation and rehabilitation.

[63] The values and estimations sited within this report aim at recommending general guidelines for resource management. Further studies are recommended for the preparation of a comprehensive resource management plan.
[64] MoE Guidelines on the operation of quarries for cement, sand or aggregate production
[65] According to Decrees # 8803/2002 and 16456/2006 on the Organization of the Quarry Sector, the Council of Ministers is responsible for the approval of permits for the operation of quarries located outside the regions designated by Decree # 16456/2006.

- Ministry of Interior and Municipalities specifically the Governorates, local municipalities and Security Forces that play a major role in the monitoring and supervision of operation and rehabilitation.
- Ministry of Finance, based on the production values reported by the Governorates, estimates taxes on the quarry operators.

2.2.2.6 Budgetary Estimates

The total budgetary for the proposed action amounts to an estimated **USD 50,000.** Budget breakdown is as follows:

▪ Feasibility Study	USD 10,000
▪ Resource Management Plan	USD 15,000
▪ Logistics of Permitting System	USD 5,000
▪ Supervision and Monitoring	USD 20,000

2.2.2.7 Timeframe

It is recommended that the proposed action start at the earliest opportunity so as to complement reconstruction efforts. The estimated timeframe for implementation is 6 months.

2.2.3 MANAGEMENT OF THE DEMOLITION WASTE OF DAHIEH

2.2.3.1 Problem Statement and Rationale

An estimated 1,000,000 m^3 of demolition debris generated from the Israeli attacks on the Dahieh Suburb of Beirut is being transported and dumped on public land situated directly on the Lebanese shore in Ouzaii, as well as adjacent to a residential area in El Shiyah region near the Beirut International Airport. Although white goods were removed from the waste due to their value, no additional segregation was made prior to dumping. Scavengers are removing metal bars for recycling onsite and the debris is rapidly losing its recycling value.

The aim of the proposed intervention is to find a sustainable solution for the demolition waste through its treatment (volume reduction) and reuse as Alternate Daily Cover (ADC) for the operation of the Bsalim inert waste landfill and for the closure of the Naemeh landfill, or as backfill for the Normandy landfill. All additional inerts are to be land-filled in the Bsallim landfill (remaining capacity 300,000 m^3).

2.2.3.2 Analysis of Treatment Alternatives (Recycling)

Three main treatment alternatives were assessed including 1) the do nothing scenario, 2) treatment in a fixed recycling facility, and 3) on-site treatment with mobile equipment. Additionally, each scenario was evaluated for the three levels of material recovery: i) volume reduction with no material recovery, ii) typical levels of material recovery (30-40%) producing scrap metals and mixed aggregates for use in road-base or landscaping, and paving, and iii) full material recovery (85%) generating scrap metals, mixed aggregates, and clean aggregates for use in asphalt and other aggregate mixes. Values are estimations for the cumulative costs of the treatment and disposal of the waste stored at both the Ouzaii and El-Shiyah sites. They serve as indicators for the comparison of alternatives and not for detailed cost calculations.

Results indicated that the lowest cost alternative consists of on-site volume reduction of the Dahieh demolition waste at the Ouzaii and El-Shiyah temporary storage sites (Table 2.15). For more details on the treatment costs, refer to Table 2.17.

In the case of Lebanon, an active market exists for scrap metal products which are exported for recycling and valued at $175/tonne. The potential market for recycled mixed aggregates in Lebanon remains undetermined. Since a considerable portion of the high-value scrap metals were already removed from the waste, 30 - 40% recovery and sales of the recycled material is not financially viable.

Table 2.15. Estimated Costs of the Alternative Treatment Scenarios for the Dahieh Demolition Waste

Treatment Alternatives	**Profits from Recyclables**[66] (Mil USD)	**Treatment Costs** *including sales profits* (Mil USD)	**Treatment Costs** *excluding sales profits* (Mil USD)
1 - Do Nothing	0	**0**	**0**
2 - Transport and Treatment at Central Facility			
Volume Reduction[67]	0	3.84	3.84
30 - 40% Recovery	1.75	13.18	14.93
85% Recovery[68]	4.62	23.19	27.81
3 – Onsite Treatment with Mobile Plant (Temporary Storage Sites)			
Volume Reduction[69]	0	**1.87**	**1.87**
30 - 40% Recovery	1.75	11.20	12.96
85% Recovery[70]	4.62	19.13	23.75

2.2.3.3 Analysis of Disposal Alternatives

Each of the treatment alternatives was also assessed for different disposal options. In general four alternative disposal options for inert demolition waste were considered: 1) landfilling in

[66] Market Prices: scrap metals: $175/tonne, mixed aggregates (landscaping, paving): $2/tonne; clean aggregates (asphalt, etc.): $4/tonne. Values do not include transportation of the recyclables and are based on market information obtained through informal interviews with industry experts.
[67] Includes informal scrap metal removal by scavengers
[68] Operational and capital costs for 85% recovery of mixed C&D waste: $55/tonne for fixed plant (Lennon 2005), and assumed $50/tonne for mobile plant.
[69] Includes informal scrap metal removal by scavengers
[70] Operational and capital costs for 85% recovery of mixed C&D waste: $55/tonne for fixed plant (Lennon 2005), and ssumed $50/tonne for mobile plant.

an inert waste landfill (Bsalim[71]), 2) backfilling for quarry rehabilitation, 3) donating to landfills[72] to be used as daily cover, ad 4) donating to SOLIDERE for sea reclamation.

Cost estimations indicate that disposal costs are the lowest when the waste is disposed of as landfill cover or for sea reclamation (Table 2.16) since in both cases, the debris is of value to the third party, and therefore no tipping fee is required. Moreover, for the case of 85% material recovery, only 15% of the original quantity of demolition waste is disposed reducing the costs of disposal. Table 2.18 presents a detailed listing of the cost estimations for each alternative for the management of the Dahieh demolition debris.

The alternative that provides the lowest cost for the complete management of the demolition debris, including transport, treatment, disposal and environmental costs, consists of onsite treatment of the waste with mobile plants allowing for volume reduction. The resulting inert materials could be used in sea reclamation, landfill cover, or quarry rehabilitation based on market needs.

Table 2.16. Estimated Costs of Alternative Disposal Scenarios for the Dahieh Demolition Waste

Debris Management Alternatives	Disposal Options	Disposal Costs (Mil USD)	Total Costs[73] (Mil USD)
1 – Do Nothing	*None*	0.00	44.33
2 - Transport and Treatment at Central Facility			
Volume Reduction[74]	*Inert Waste Landfill (Bsalim)*	13.56	17.41
	Sea Reclamation (SOLIDERE)	1.69	5.62
	Landfill Cover	1.69	5.53
	Quarry Fill	7.16	11.01
30 - 40% Recovery	*Inert Waste Landfill (Bsalim)*	8.82	21.99
	Sea Reclamation (SOLIDERE)	1.10	14.37
	Landfill Cover	1.10	14.28
	Quarry Fill	6.41	19.58
85% Recovery	*Inert Waste Landfill (Bsalim)*	2.03	25.23
	Sea Reclamation (SOLIDERE)	**0.25**	27.07
	Landfill Cover	**0.25**	27.70
	Quarry Fill	5.32	33.14
3 – Onsite Treatment with Mobile Plant (Temporary Storage Sites)			
Volume Reduction[75]	*Inert Waste Landfill (Bsalim)*	13.56	15.43
	Sea Reclamation (SOLIDERE)	1.69	**3.65**

[71] This option is not valid since the remaining capacity of the Bsalim landfill is only 300,000 m^3.
[72] Landfills typically accept incoming C&D waste that has not been processed at no cost since it is used as alternate daily cover.
[73] Total costs are estimated for the project lifetime of 2 years and account for full sales of recyclables and environmental costs.
[74] Includes informal scrap metal removal by scavengers
[75] Includes informal scrap metal removal by scavengers

Debris Management Alternatives	**Disposal Options**	**Disposal Costs** (Mil USD)	**Total Costs**[73] (Mil USD)
	Landfill Cover	1.69	**3.56**
	Quarry Fill	7.16	9.03
30 - 40% Recovery	*Inert Waste Landfill (Bsalim)*	8.82	20.02
	Sea Reclamation (SOLIDERE)	1.10	12.40
	Landfill Cover	1.10	12.30
	Quarry Fill	6.41	17.61
85% Recovery	*Inert Waste Landfill (Bsalim)*	2.03	21.16
	Sea Reclamation (SOLIDERE)	**0.25**	23.01
	Landfill Cover	**0.25**	23.64
	Quarry Fill	5.32	29.07

Table 2.17. Detailed Cost Estimations of the Treatment Alternatives of the Dahieh Demolition Debris[76]

Treatment Alternatives	**Transport**[77] (Mil USD)	**Initial Studies**[78] (Mil USD)	**Segregation**[79] (Mil USD)	**Crushing**[80] (Mil USD)	**Processing**[81] (Mil USD)	**Supervision**[82] (Mil USD)	**Recovered Products** (Mil tonnes)		**Profits from Sales**[83] (Mil USD)	**Total Trmt Costs** (Mil USD)
1 - Do Nothing	0.00	0.00	0.00	0.00	0.00	0.00	*None*	0.00	0.00	**0.00**
2 - Transport and Treatment at Central Facility										
Volume Reduction[84]	1.69	0.18	0.00	1.43	0.00	0.55	*None*	0.01	0.00	3.84
30 - 40% Recovery	1.69	0.18	0.91	1.43	10.18	0.55	*Scrap Metals*	0.01	1.45	13.18
							Mixed Aggregates	0.15	0.30	
85% Recovery[85]	1.69			26.13			*Scrap Metals*	0.02	3.53	23.19
							Clean Aggregates	0.18	0.73	
							Mixed Aggregate	0.18	0.36	

[76] Costs are general estimations based on the limited data available, on assumptions by industry experts or derived from local or international case studies. They aim at providing a means to compare alternatives and not accurate costing. Assumed quantity of waste is 1,000,000 m^3 or approximately 0.5 million tonnes (UNEP/OCHA, 2006).
[77] Transportation costs were estimated to be 3.6$/tonne based on the assumption of 20 – 25 tonnes of demolition waste per truck load, and an average of $80/trip. Values are based on market information obtained through informal interviews with industry experts.
[78] Value derived from the case of the Normandy Landfill (METAP, 2004). Cost of initial study for 5.5 million m^3 of waste: USD 1,000,000. Cost of initial study assumed at $0.18/$m^3$
[79] Value derived from the case of the Normandy Landfill (METAP, 2004). Cost of segregation for 5.5 million m^3 of waste: USD 5,000,000. Total cost of segregation assumed at $0.91/$m^3$
[80] Capital and operational costs of a fixed crushing facility (100 tonnes/hr): $3/tonne; Capital and operational costs of a mobile crushing facility (100 tonnes/hr): $2.4/tonne; Source: Symonds, 1999. Prices adjusted to reflect inflation and currency exchange rate of 1.28 USD/Euro.
[81] Value derived from the case of the Normandy Landfill (METAP, 2004). Cost of additional processing and handling for 5.5 million m^3 of waste: USD 56,000,000. Total cost of segregation assumed at $10.18/$m^3$
[82] Value derived from the case of the Normandy Landfill (METAP, 2004). Cost of supervision for 5.5 million m^3 of waste: USD 3,000,000. Cost of supervision assumed at $0.55/$m^3$
[83] Assumed waste composition of 45% concrete, 45% aggregates and sand, 5% metal and 5% misc. Market prices for sales of recyclables: scrap metals: $175/tonne, mixed aggregates (landscaping, paving): $2/tonne, clean aggregates (asphalt, etc.): $4/tonne. Values do not include transportation of the recyclables and are based on market information obtained through informal interviews with industry experts.
[84] Includes informal scrap metal removal by scavengers
[85] Operational and capital costs for 85% recovery of mixed C&D waste: $55/tonne for fixed plant (Lennon 2005). Assumed at $50/tonne for mobile plant.

Treatment Alternatives	**Transport**[77] (Mil USD)	**Initial Studies**[78] (Mil USD)	**Segregation**[79] (Mil USD)	**Crushing**[80] (Mil USD)	**Processing**[81] (Mil USD)	**Supervision**[82] (Mil USD)	**Recovered Products** (Mil tonnes)		**Profits from Sales**[83] (Mil USD)	**Total Trmt Costs** (Mil USD)
3 – Onsite Treatment with Mobile Plant (Temporary Storage Sites)										
Volume Reduction[86]	0.00	0.18	0.00	1.14	0.00	0.55	*None*	0.00	0.00	1.87
30 - 40% Recovery	0.00	0.18	0.91	1.14	10.18	0.55	*Scrap Metals*	0.01	1.45	**11.20**
							Mixed Aggregates	0.15	0.30	
85% Recovery	0			23.75			*Scrap Metals*	0.20	3.54	19.13
							Clean Aggregates	0.18	0.73	
							Mixed Aggregates	0.18	0.36	

[86] Includes informal scrap metal removal by scavengers

Table 2.18. Detailed Costs Estimations of the Alternatives to the Disposal of the Dahieh Demolition Debris[87]

Alternatives	Treatment Costs[88] (Mil USD)	Waste for Disposal[89] (Mil Tonnes)	Disposal Options	Disposal Costs[90] (Mil USD)	Environmental Costs[91] (Mil USD/yr)	Total Costs[92] (Mil USD)
1 – Do Nothing	0.00	0.00	*None*	0.00	22.16	44.33
2 - Transport and Treatment at Central Facility						
Volume Reduction[93]	3.84	0.48	*Inert Waste Landfill (Bsalim)*	13.56		17.41
			Sea Reclamation (SOLIDERE)	1.69	0.05	5.62
			Landfill Cover	1.69		5.53
			Quarry Fill[94]	7.16		11.01
30 - 40% Recovery	13.18	0.31	*Inert Waste Landfill (Bsalim)*	8.82		21.99
			Sea Reclamation (SOLIDERE)	1.10	0.05	14.37
			Landfill Cover	1.10		14.28
			Quarry Fill	6.41		19.58

87 Costs are general estimations based on the limited data available, on assumptions by industry experts, or derived from local or international case studies. They aim at providing a means to compare alternatives and not accurate costing. Assumed quantity of waste is 1,000,000 m^3 or approximately 0.5 million tonnes (UNEP/OCHA, 2006).
88 These costs include those of transport and treatment. The profits from sales of recyclables are included. Refer to Table 2.17.
89 Initial volume of waste estimated at 1 million m^3 or 0.5 million tonnes assuming a density of 2.3-3 m^3/tonne (Lennon, 2005). Tonnage remains the same for the cases of no management and volume reduction. 35% of tonnage remains for disposal in the case of 30 - 40% Recovery. 15% of tonnage remains for disposal in the case of 85% Recovery.
90 Transportation to disposal site was included within these costs. Assumptions for disposal costs: transportation $3.6/tonne, inert waste landfill: $25/tonne (Bsallim Landfill Rate); Sea Reclamation: assumed at no cost other than transport since it is inert waste to be processed by SOLIDERE to complete its reclamation plans and rehabilitation of Normandy Landfill; Landfill cover: assumed at no cost other than transport to Bsalim or other landfills; Quarry fill: includes costs of land appropriation, transport, and civil works.
91 Environmental costs took into account the annual costs of environmental degradation of coastal zones (0.68% of GDP) and the annual cost of degradation from waste management (0.1% of GDP) based on (Sarraf, 2004). Value were modified according to the type of impact and surface area. For the do nothing alternative, the area of the Ouzayeh and Shiyah sites (32,000 m^2) was taken into consideration with regards to impact on coastal zones. For the sea reclamation alternative, the area of the SOLIDERE's Normandy landfill (600,000m^2) was taken into consideration with regards to impact on coastal zones. GDP of Lebanon (2005): USD 22,160,000,000 (IMF, 2006).
92 Total costs are estimated for the project lifetime of 2 years. They include the treatment costs (including transportation if applicable), the disposal costs, and the environmental costs.
93 Includes informal scrap metal removal by scavengers
94 Quarry costs are for the MoE selected quarry of Mr. Mohammad Kujok, located in Jiyyeh, Chouf, Area: 250,000 m^2. Assumptions: appropriation costs: $20/$m^2$, civil works: $1/tonne.

85% Recovery	23.19	0.07	*Inert Waste Landfill (Bsalim)*	2.03	0.05	25.23
			Sea Reclamation (SOLIDERE)	0.25		27.07
			Landfill Cover	0.25		27.70
			Quarry Fill	5.32		33.14
3 - Mobile Treatment at Temporary Storage Sites						
Volume Reduction[95]	1.87	0.48	*Inert Waste Landfill (Bsalim)*	13.56	0.05	15.43
			Sea Reclamation (SOLIDERE)	1.69		3.65
			Landfill Cover	1.69		3.56
			Quarry Fill	7.16		9.03
30 - 40% Recovery	11.20	0.31	*Inert Waste Landfill (Bsalim)*	8.82	0.05	20.02
			Sea Reclamation (SOLIDERE)	1.10		12.40
			Landfill Cover	1.10		12.30
			Quarry Fill	6.41		17.61
85% Recovery	19.13	0.07	*Inert Waste Landfill (Bsalim)*	2.03	0.05	21.16
			Sea Reclamation (SOLIDERE)	0.25		23.01
			Landfill Cover	0.25		23.64
			Quarry Fill	5.32		29.07

[95] Includes informal scrap metal removal by scavengers

2.2.3.4 Proposed Actions

The proposed action consists of the construction and operation of two mobile recycling units at the temporary storage sites (Ouzaii and El-Shiyah) allowing for 30 – 40% material recovery and disposal of 60 – 70% inert demolition waste as backfill for quarry rehabilitation or landfill cover. Accordingly, the following actions are needed:

1. Conduct feasibility studies for in-depth assessment of selected alternative, the quantity and quality of the waste stored at the Ouzaii coastal dumpsite and El-Shiyah airport dumpsite, and the market for recycled aggregates and disposal options.
2. Based on the findings of the above, launch a tender for the engineering design and equipment selection for onsite recycling at the temporary storage sites (Ouzaii and El-Shiyah), for the necessary works for the selected disposal options, as well as the management and supervision of the above works.
3. Procurement of equipment, plant installation and commencement of treatment and disposal works.
4. Training of workers on equipment operation and maintenance.

2.2.3.5 Legal and Institutional Aspects

The main stakeholders involved include the Council for Development and Reconstruction (CDR), the Ministry of Public Works and Transport, and the Ministry of Environment.

The Ministry of Public Works and Transport is responsible for public infrastructure as well as transportation networks. It is mainly responsible for the management of the demolition debris.

CDR is mainly responsible for the planning, commissioning and supervision of reconstruction projects as well as waste and sanitation projects.

The Ministry of Environment plays an additional role of establishing guidelines and standards for the treatment and disposal of the demolition waste, in addition to quarry rehabilitation, sea reclamation and landfill operation.

Legal aspects of high importance to the proposed activity include issue of waste ownership, quarry ownership in the case that quarry rehabilitation is selected as a disposal option, as well as contractual matters (ownership of equipment, type of contract, etc.) regarding the privatization of the debris management operation.

2.2.3.6 Budgetary Estimate

The total budgetary estimate for the proposed action amounts to **USD 3,590,000.** Budget breakdown is as follows:

- Feasibility Study $ 25,000
- Tendering Process (launch, evaluation, awarding contract) - Design $50,000

- Equipment procurement, installation and operation ~$ 3,500,000
- Capacity building $15,000

2.2.3.7 Project Duration

This initiative should start as early as possible. It is estimated that its implementation would require a minimum of 2 years.

2.2.4 MANAGEMENT OF THE DEMOLITION WASTE OF SOUTH LEBANON, BEKAA AND NABATIYEH

2.2.4.1 Problem Statement and Rationale

Recent initiatives for the management of the demolition debris resulting from the Israeli bombing of the Beirut Southern Suburb and villages of South Lebanon and Bekaa have fallen short of safe treatment and disposal. Hundreds of heterogeneous piles of demolition waste, particularly in the South, remain scattered following clearance from residential neighborhoods and removal of valuable metals for recycling. In addition to it being a visual intrusion and constant reminder of the war, the rubble has been dumped in sensitive ecological sites such as in valleys and alongside river beds and near coast lines. There are several valid and environmentally-sound alternatives to the management of the demolition debris dumpsites.

The objective of this proposal is to provide the necessary infrastructure for processing demolition wastes and create the opportunity for processed materials recovery and re-use as daily or final cover for landfills, reclamation material, or fill for quarries rehabilitation.

2.2.4.2 Analysis of Treatment Alternatives (Recycling)

Three main treatment alternatives were assessed including 1) the do nothing scenario, 2) treatment in a fixed recycling facility, and 3) on-site treatment with mobile equipment. Additionally, each scenario was evaluated for three levels of material recovery: i) volume reduction with no material recovery except for informal scavenger collection of scrap metals, ii) typical levels of material recovery (30-40%) producing scrap metals and mixed aggregates for use in road-base or landscaping and iii) full material recovery (85%) generating scrap metals, mixed aggregates, and clean aggregates for use in asphalt and other aggregate mixes.

Results indicated that, the lowest cost alternative for the treatment of the estimated 1.8 million m^3 of demolition debris consists of on-site treatment with mobile plants (crushers) aiming at volume reduction (Table 2.19). A more detailed accounting of the treatment costs can be found in Table 2.21.

Table 2.19. Costs of the Alternatives Treatment Scenarios for the Demolition Waste Generated by the War-Impacted Regions of South Lebanon, Bekaa and Nabatiyeh

Treatment Alternatives	Profits from Sales of Recyclables[96] (Mil USD)	Treatment Costs *with sales profits* (Mil USD)	Treatment Costs *w/out sales profits* (Mil USD)
1 - Do Nothing	0.00	**0.00**	**0.0**
2 - Transport and Treatment at Central Facility			
Volume Reduction[97]	0.00	8.43	8.43
30 - 40% Recovery	3.99	24.94	28.93
85% Recovery[98]	10.52	52.78	63.30
3 – Onsite Treatment with Mobile Plant (Temporary Storage Sites)			
Volume Reduction[99]	0.00	**3.94**	**3.94**
30 - 40% Recovery	3.99	20.44	24.43
85% Recovery	10.52	43.53	54.05

2.2.4.3 Analysis of Disposal Alternatives

Each of the treatment alternatives was also assessed for different disposal options. In general four disposal alternatives for the inert demolition waste were considered: 1) landfilling in an inert waste landfill (Bsalim[100]), backfilling for quarry rehabilitation, 3) donating to landfills[101] to be used as daily cover, and 4) donating to SOLIDERE for sea reclamation.

Cost estimations indicated that disposal costs are generally the lowest when the waste is disposed of as landfill cover or as material for sea reclamation (Table 2.20), since both do not involve additional charges (other than transport) such as tipping fees or processing charges. Moreover, since the alternative of 85% material recovery requires that the remaining 15% of inerts to be disposed, this reduces disposal costs of this alternative. Table 2.22 presents a detailed listing of the cost estimations for each alternative for the management of the South Lebanon, Nabatiyeh and Bekaa demolition debris.

The main alternative providing the lowest cost for the complete management of the demolition debris, including transport, treatment, disposal and environmental costs, consists of onsite volume reduction of the debris with disposal of inerts through sea reclamation,

[96] Market Prices: Scrap Metals: \$175/tonne, Mixed Aggregates (landscaping, paving): \$2/tonne; Clean Aggregates (asphalt, etc.): \$4/tonne. Values do not include transportation of the recyclables and are based on market information obtained through informal interviews with industry experts.
[97] Includes informal scrap metal removal by scavengers
[98] Operational and Capital costs for 85% recovery of mixed C&D waste: \$55 for fixed plant (Lennon 2005). Assumed \$50 for mobile plant.
[99] Includes informal scrap metal removal by scavengers
[100] This option is not valid since the remaining capacity of the Bsalim landfill is only 300,000 m^3.
[101] Landfills typically accept incoming C&D waste that has not been processed at no cost since it is used as alternate daily cover.

landfill cover, or quarry rehabilitation, based on market needs, amounting to an estimated total of 7 – 10 million USD.

Table 2.20. Comparative Costs of Alternative Disposal Scenarios for the South Lebanon, Bekaa and Nabatiyeh Demolition Waste

Debris Management Alternatives	**Disposal Options**	**Disposal Costs** (Mil USD)	**Total Costs**[102] (Mil USD)
1 – Do Nothing	*None*	0.00	234.82
2 - Transport and Treatment at Central Facility			
Volume Reduction[103]	*Inert Waste Landfill (Bsalim)*	30.87	39.30
	Sea Reclamation (SOLIDERE)	3.84	12.37
	Landfill Cover	3.84	12.27
	Quarry Fill	6.31	14.74
30 - 40% Recovery	*Inert Waste Landfill (Bsalim)*	20.07	45.00
	Sea Reclamation (SOLIDERE)	2.50	27.53
	Landfill Cover	2.50	27.43
	Quarry Fill	4.58	29.52
85% Recovery	*Inert Waste Landfill (Bsalim)*	4.63	57.41
	Sea Reclamation (SOLIDERE)	**0.58**	61.49
	Landfill Cover	**0.58**	63.05
	Quarry Fill	2.12	65.42
3 – Onsite Mobile Treatment			
Volume Reduction[104]	*Inert Waste Landfill (Bsalim)*	30.87	34.81
	Sea Reclamation (SOLIDERE)	3.84	**7.88**
	Landfill Cover	3.84	**7.78**
	Quarry Fill	6.31	**10.25**
30 - 40% Recovery	*Inert Waste Landfill (Bsalim)*	20.07	40.51
	Sea Reclamation (SOLIDERE)	2.50	23.04
	Landfill Cover	2.50	22.94
	Quarry Fill	4.58	25.03
85% Recovery	*Inert Waste Landfill (Bsalim)*	4.63	48.16
	Sea Reclamation (SOLIDERE)	**0.58**	52.24
	Landfill Cover	**0.58**	53.80
	Quarry Fill	2.12	56.17

[102] Total costs are estimated for the project lifetime of 2 years and account for full sales of recyclables and environmental costs.
[103] Includes informal scrap metal removal by scavengers
[104] Includes informal scrap metal removal by scavengers

Table 2.21. Detailed Cost Estimations for the Treatment Alternatives of the Demolition Debris Generated by the War-Impacted Regions of South Lebanon, Bekaa and Nabatiyeh [105]

Treatment Alternatives	Transport[106] (Mil USD)	Initial Studies[107] (Mil USD)	Segregation[108] (Mil USD)	Crushing[109] (Mil USD)	Processing[110] (Mil USD)	Supervision[111] (Mil USD)	Recovered Products (Mil tonnes)		Profits from Recyclables[112] (Mil USD)	Total Trmt Costs (Mil USD)
1 - Do Nothing	0.00	0.00	0.00	0.00	0.00	0.00	*None*	0.00	0.00	0.00
2 - Transport and Treatment at Central Facility										
Volume Reduction[113]	3.84	0.34	0.00	3.24	0.00	1.01	*None*	0.00	none	8.43
30 - 40% Recovery	3.84	0.34	1.68	3.24	18.82	1.01	*Scrap Metals*	0.02	3.31	24.94
							Mixed Aggregates	0.34	0.68	
85% Recovery[114]	3.84			59.46			*Scrap Metals*	0.05	8.04	52.78
							Clean Aggregates	0.41	1.65	

[105] Costs are general estimations based on the limited data available, on assumptions by industry experts, or derived from local or international case studies. They aim at providing a means to compare alternatives and not accurate costing. Assumed quantity of waste is 1.8 million m^3 or approximately 1.1 million tonnes.
[106] Transportation costs were estimated to be 3.6$/tonne based on the assumption of 20 – 25 tonnes of demolition waste per truck load, and an average of $80/trip. Values are based on market information obtained through informal interviews with industry experts.
[107] Value derived from the case of the Normandy Landfill (METAP, 2004). Cost of initial study for 5.5 million m^3 of waste: USD 1,000,000. Cost of initial study assumed at $0.18/$m^3$
[108] Value derived from the case of the Normandy Landfill (METAP, 2004). Cost of segregation for 5.5 million m^3 of waste: USD 5,000,000. Total cost of segregation assumed at $0.91/$m^3$
[109] Capital and operational costs of a fixed crushing facility (100 tonnes/hr): $3/tonne; Capital and operational costs of a mobile crushing facility (100 tonnes/hr): $2.4/tonne; Source: Symonds, 1999. Prices adjusted to reflect inflation and currency exchange rate of 1.28 USD/Euro.
[110] Value derived from the case of the Normandy Landfill (METAP, 2004). Cost of additional processing and handling for 5.5 million m^3 of waste: USD 56,000,000. Total cost of segregation assumed at $10.18/$m^3$
[111] Value derived from the case of the Normandy Landfill (METAP, 2004). Cost of supervision for 5.5 million m^3 of waste: USD 3,000,000. Cost of supervision assumed at $0.55/$m^3$
[112] Assumed waste composition of 45% concrete, 45% aggregates and sand, 5% metal and 5% misc. Market prices for sales of recyclables: scrap metals: $175/tonne, mixed aggregates (landscaping, paving): $2/tonne, clean aggregates (asphalt, etc.): $4/tonne. Values do not include transportation of the recyclables and are based on market information obtained through informal interviews with industry experts.
[113] Includes informal scrap metal removal by scavengers
[114] Operational and Capital costs for 85% recovery of mixed C&D waste: $55 for fixed plant (Lennon 2005). Assumed $50 for mobile plant.

Treatment Alternatives	**Transport**[106] (Mil USD)	**Initial Studies**[107] (Mil USD)	**Segregation**[108] (Mil USD)	**Crushing**[109] (Mil USD)	**Processing**[110] (Mil USD)	**Supervision**[111] (Mil USD)	**Recovered Products** (Mil tonnes)		**Profits from Recyclables**[112] (Mil USD)	**Total Trmt Costs** (Mil USD)
							Mixed Aggregate	0.41	0.83	
3 – Onsite Treatment with Mobile Plant (Temporary Storage Sites)										
Volume Reduction[115]	0.00	0.34	0.00	2.59	0.00	1.01	*None*	0.00	None	3.94
30 - 40% Recovery	0.00	0.34	1.68	2.59	18.82	1.01	*Scrap Metals*	0.02	3.31	20.44
							Mixed Aggregates	0.34	0.68	
85% Recovery	0			54.05			*Scrap Metals*	0.05	8.04	43.53
							Clean Aggregates	0.41	1.65	
							Mixed Aggregates	0.41	0.83	

[115] Includes informal scrap metal removal by scavengers

Table 2.22. Detailed Cost Estimations of the Alternatives to the Disposal of the Demolition Debris Generated by the War-Impacted Regions of South Lebanon, Bekaa and Nabatiyeh [116]

Alternatives	Treatment Costs[117] (Mil USD)	Waste for Disposal[118] (Mil Tonnes)	Disposal Options	Disposal Costs[119] (Mil USD)	Environmental Costs[120] (Mil USD/yr)	Total Costs[121] (Mil USD)
1 – Do Nothing	0.00	0.00	*None*	0.00	117.41	234.82
2 - Transport and Treatment at Central Facility						
Volume Reduction[122]	8.43	1.08	*Inert Waste Landfill (Bsalim)*	30.87		39.30
			Sea Reclamation (SOLIDERE)	3.84	0.05	12.37
			Landfill Cover	3.84		12.27
			Quarry Fill[123]	6.31		14.74
30 - 40% Recovery	24.94	0.70	*Inert Waste Landfill (Bsalim)*	20.07		45.00
			Sea Reclamation (SOLIDERE)	2.50	0.05	27.53
			Landfill Cover	2.50		27.43
			Quarry Fill	4.58		29.52

[116] Costs are general estimations based on the limited data available, on assumptions by industry experts, or derived from local or international case studies. They aim at providing a means to compare alternatives and not accurate costing. Assumed quantity of waste is 1.8 million m^3 or approximately 1.1 million tonnes.
[117] Refer to Table 2.17.
[118] Initial volume of waste estimated at 3,000,000 m^3 or 6,900,000 tonnes assuming a density of 2.3-3 tonnes/m3 (Lennon, 2005). Tonnage remains the same for the cases of no management and volume reduction. 35% of tonnage remains for disposal in the case of 30 - 40% Recovery. 15% of tonnage remains for disposal in the case of 85% Recovery.
[119] Transportation to disposal site was included within these costs. Assumptions for disposal costs: transportation $3.6/tonne, inert waste landfill: $25/tonne (Bsallim Landfill Rate); Sea Reclamation: assumed at no cost other than transport since it is inert waste to be processed by SOLIDERE to complete its reclamation plans and rehabilitation of Normandy Landfill; Landfill cover: assumed at no cost other than transport to Bsalim or other landfills; Quarry fill: includes costs of land appropriation, transport, and civil works.
[120] Environmental costs took into account the annual costs of environmental degradation of coastal zones and from waste management: 0.68% of GDP and 0.1% of GDP respectively (Sarraf, 2004) modified to the area of impact assumed to be the area of the South Lebanon, Bekaa and Nabatiyeh Governorates (7,487 km^2). GDP of Lebanon (2005): USD 22,160,000,000 (IMF, 2006).
[121] Total costs are estimated for the project lifetime of 2 years.
[122] Includes informal scrap metal removal by scavengers
[123] Quarry costs are for the MoE selected quarries of average area: 69,100 m^2. Assumptions: appropriation costs: $20/$m^2$, civil works: $1/tonne.

85% Recovery	52.78	0.16	*Inert Waste Landfill (Bsalim)*	4.63		57.41
			Sea Reclamation (SOLIDERE)	0.58	0.05	61.49
			Landfill Cover	0.58		63.05
			Quarry Fill	2.12		65.42
3 – Onsite Mobile Treatment						
Volume Reduction[124]	3.94	1.08	*Inert Waste Landfill (Bsalim)*	30.87		34.81
			Sea Reclamation (SOLIDERE)	3.84	0.05	7.88
			Landfill Cover	3.84		7.78
			Quarry Fill	6.31		10.25
30 - 40% Recovery	20.44	0.70	*Inert Waste Landfill (Bsalim)*	20.07		40.51
			Sea Reclamation (SOLIDERE)	2.50	0.05	23.04
			Landfill Cover	2.50		22.94
			Quarry Fill	4.58		25.03
85% Recovery		0.16	*Inert Waste Landfill (Bsalim)*	4.63		48.16
			Sea Reclamation (SOLIDERE)	0.58	0.05	52.24
			Landfill Cover	0.58		53.80
			Quarry Fill	2.12		56.17

[124] Includes informal scrap metal removal by scavengers

2.2.4.4 Proposed Actions

The following actions are proposed:

1. Field survey of demolition waste including: waste characterization (quality and quantity), identification of the locations of the existing dumpsites, assessment of potential disposal options (landfills, quarries, etc) and market demands.
2. Based on the above, preparation of a debris management plan for the regions addressing the costs and alternatives and expected timeframe for the treatment of the debris.
3. Launching of tender and commissioning of i) engineering design, ii) facility procurement and installation, iii) facility operation and iv) supervision of the works
4. Procurement of equipment, plant installation and commencement of treatment and disposal works.
5. Training of workers on equipment operation and maintenance.

2.2.4.5 Legal and Institutional Aspects

The main stakeholders involved include the Council for Development and Reconstruction (CDR), the Municipalities of the war-impacted regions of South Lebanon, Nabatiyeh and Bekaa, the Ministry of Public Works and Transport, and the Ministry of Environment.

- The Ministry of Public Works and Transport is responsible for public infrastructure as well as transportation networks. It is mainly responsible for the management of the demolition debris, with the municipalities.
- CDR is mainly responsible for the planning, commissioning and supervision of reconstruction projects as well as waste and sanitation projects.
- The Ministry of Environment plays an additional role of establishing guidelines and standards for the treatment and disposal of the demolition waste, in addition to quarry rehabilitation, sea reclamation and landfill operation.

Legal aspects of high importance to the proposed activity include issue of waste ownership including the recyclables, in addition to contractual matters (ownership of equipment, type of contract, etc) regarding the privatization of the debris management operation.

2.2.4.6 Budgetary Estimates

The total budgetary for the proposed action, consisting of the treatment and disposal of the South Lebanon, Nabatiyeh and Bekaa demolition debris, amounts to an estimated **USD 8,235,000.** Budget breakdown is as follows:

- Field Survey $25,000
- Plan Preparation $ 35,000

- Commissioning (preparation of bidding documents, proposal evaluation, awarding contract) for engineering design, mobile plant procurement, facility operation, and work supervision $150,000
- Equipment Procurement, Installation and Operation ~$8,000,000
- Capacity Building $25,000

2.2.4.7 Timeframe

This initiative should start as early as possible. It is estimated that its implementation would require a minimum of 2 years.

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APPENDIX 2-A. DETAILED LISTING OF THE DAMAGES IN THE GOVERNORATES OF SOUTH LEBANON, BEKAA AND NABATIYEH

Table 2-A1. Summary of the Damage Inflicted on the Infrastructure of the Caza of Tyre, South Lebanon (HIC, 2006b)

Municipality	Governorate - Caza	Dwellings Destroyed	Dwellings Lightly Damaged	Repairable Dwellings
Naqoura	South Leb - Tyre	15	100	200
Yarine	South Leb - Tyre	10	40	400
Zalloutiye	South Leb - Tyre	3	8	10
Jebbain	South Leb - Tyre	12	4	59
Tair Harfa	South Leb - Tyre	25	7	217
Chamaa	South Leb - Tyre	50	100	100
Marouahine	South Leb - Tyre	5	50	150
Majdel Zoun	South Leb - Tyre	50	120	400
Zabqine	South Leb - Tyre	150	50	500
Mansouri	South Leb - Tyre	100	50	400
Hanniye	South Leb - Tyre	0	10	100
Jabal el Botm	South Leb - Tyre	75	100	100
Siddiqine	South Leb - Tyre	150	50	400
Rechkananney	South Leb - Tyre	3	12	65
Zahriye	South Leb - Tyre	9	15	35
Aamrane	South Leb - Tyre	0	10	150
Chaaitiyeh	South Leb - Tyre	5	5	300
Rmadiyeh	South Leb - Tyre	1	1	200
Biyad	South Leb - Tyre	1	10	300
Deir Aamess	South Leb - Tyre	6	3	300
Qana	South Leb - Tyre	60	40	40
Mahrouneh	South Leb - Tyre	0	6	65
Mazraat Mechref	South Leb - Tyre	0	0	0
Hannouiye	South Leb - Tyre	25	10	400
Knisse	South Leb - Tyre	0	0	15
Malkeit es Sahel	South Leb - Tyre	5	5	150
Sammaaiye	South Leb - Tyre	10	20	300
Batouliye	South Leb - Tyre	4	2	200
Ain Baal	South Leb - Tyre	25	20	300
Aaitit	South Leb - Tyre	15	10	200
Jouaya	South Leb - Tyre	10	40	250
Mjadel	South Leb - Tyre	20	10	400
Chehabiye	South Leb - Tyre	12	13	215
Tyre	South Leb - Tyre	35	60	600
Boustane	South Leb - Tyre	5	5	50
Borj ech Chmali	South Leb - Tyre	20	7	300
Bazouriye	South Leb - Tyre	10	20	150

Debaal	South Leb - Tyre	17	4	75
Bafliye	South Leb - Tyre	8	7	200
Salaa	South Leb - Tyre	25	25	300
Derdghaiya	South Leb - Tyre	3	2	3
Bestiyat	South Leb - Tyre	0	0	40
Jannata	South Leb - Tyre	2	0	50
Maaroub	South Leb - Tyre	150	50	550
Haumeiri	South Leb - Tyre	0	0	200
Halloussiye	South Leb - Tyre	15	5	300
Deir Qanoun en Nah	South Leb - Tyre	40	15	500
Bedias	South Leb - Tyre	0	0	300
Toura	South Leb - Tyre	3	10	155
Aabbassiye	South Leb - Tyre	100	35	0
Chabriha	South Leb - Tyre	4	20	400
Borj Rahhal	South Leb - Tyre	6	2	250
Bourghliye	South Leb - Tyre	0	0	45
Qasmiye	South Leb - Tyre	3	2	10
Tair Filsay	South Leb - Tyre	2	2	200
Srifa	South Leb - Tyre	250	100	500
Deir Kifa	South Leb - Tyre	2	10	150
Barich	South Leb - Tyre	45	20	300
TOTAL		1601	1322	12549

Table 2-A2. Summary of the Damage Inflicted on the Infrastructure of the Caza of Nabatiyeh, Governorate of Nabatiyeh (HIC, 2006b)

Municipality	Governorate - Caza	Dwellings Destroyed	Dwellings Lightly Damaged	Repairable Dwellings
Jbaa	Nabatiyeh - Nabaiyeh	25	25	350
Kfar Kila	Nabatiyeh - Nabaiyeh	0	0	0
Houmine et Tahta	Nabatiyeh - Nabaiyeh	0	0	100
Roumine	Nabatiyeh - Nabaiyeh	0	0	50
Sarba	Nabatiyeh - Nabaiyeh	0	10	250
Ain Qna	Nabatiyeh - Nabaiyeh	0	0	100
Aazze	Nabatiyeh - Nabaiyeh	0	0	0
Houmine el Faoua	Nabatiyeh - Nabaiyeh	0	10	150
Jarjouaa	Nabatiyeh - Nabaiyeh	0	0	50
Arab Salim	Nabatiyeh - Nabaiyeh	5	10	350
Kfour	Nabatiyeh - Nabaiyeh	7	10	250
Toul	Nabatiyeh - Nabaiyeh	13	15	250
Aadchit ech Chqif	Nabatiyeh - Nabaiyeh	21	15	300
Braiqaa	Nabatiyeh - Nabaiyeh	2	0	50
Qsaibe	Nabatiyeh - Nabaiyeh	1	10	250
Kfar Sir	Nabatiyeh - Nabaiyeh	18	0	300
Qaaqaait j Jisr	Nabatiyeh - Nabaiyeh	20	15	200
Sir el Gharbiye	Nabatiyeh - Nabaiyeh	1	5	250
TOTAL		113	125	3250

Table 2-A3. Summary of the Damage Inflicted on the Infrastructure of the Caza of Majayoun, Governorate of Nabatiyeh (HIC, 2006b)

Municipality	Governorate - Caza	Dwellings Destroyed	Dwellings Lightly Damaged	Repairable Dwellings
Blat	Nabatiyeh - Marjayoun	3	30	100
Dibbine	Nabatiyeh - Marjayoun	53	20	150
Baiyouda	Nabatiyeh - Marjayoun	0	1	1
Marjayoun	Nabatiyeh - Marjayoun	35	50	200
Ebel es Saqi	Nabatiyeh - Marjayoun	1	5	64
Khiam	Nabatiyeh - Marjayoun	580	708	2300
Qlaiaa	Nabatiyeh - Marjayoun	0	15	100
Borj El Mlouk	Nabatiyeh - Marjayoun	0	4	50
Deir Mimas	Nabatiyeh - Marjayoun	3	54	160
Sarda	Nabatiyeh - Marjayoun	0	0	6
Ain Aarab Marjaayoun	Nabatiyeh - Marjayoun	0	20	30
Kfar Kila	Nabatiyeh - Marjayoun	7	40	200
Deir Siriane	Nabatiyeh - Marjayoun	0	33	80
Aalmane	Nabatiyeh - Marjayoun	0	0	0
Qsair	Nabatiyeh - Marjayoun	6	14	10
Aadchit el Qsair	Nabatiyeh - Marjayoun	7	10	100
Taibe	Nabatiyeh - Marjayoun	135	100	450
Qantara	Nabatiyeh - Marjayoun	25	100	200
Aadaisse	Nabatiyeh - Marjayoun	15	10	22
Rabb et Talatine	Nabatiyeh - Marjayoun	10	40	200
Qabrikha	Nabatiyeh - Marjayoun	70	100	70
Touline	Nabatiyeh - Marjayoun	30	16	60
Markaba	Nabatiyeh - Marjayoun	55	0	740
Beni Haiyane	Nabatiyeh - Marjayoun	1	6	50
Tallouse	Nabatiyeh - Marjayoun	15	10	40
Souane	Nabatiyeh - Marjayoun	25	15	60
Houla	Nabatiyeh - Marjayoun	35	0	1150
Majdel Silim	Nabatiyeh - Marjayoun	145	140	160
Meiss el Jabal	Nabatiyeh - Marjayoun	39	60	500
Mhaibib	Nabatiyeh - Marjayoun	6	15	80
Blida	Nabatiyeh - Marjayoun	17	60	600
TOTAL		1318	1676	7933

Table2 A-4. Summary of the Damage Inflicted on the Infrastructure of the Caza of Bint Jbeil, Governorate of Nabatiyeh (HIC, 2006b)

Municipality	Governorate - Caza	Dwellings Destroyed	Dwellings Lightly Damaged	Repairable Dwellings
Ghandouriye	Nabatiyeh - Bint Jbeil	82	35	100
Borj Qalaouiye	Nabatiyeh - Bint Jbeil	21	10	165
Qalaouiye	Nabatiyeh - Bint Jbeil	12	15	250
Kfar Dounine	Nabatiyeh - Bint Jbeil	20	15	500
Khirbit Silim	Nabatiyeh - Bint Jbeil	25	15	965
Froun	Nabatiyeh - Bint Jbeil	80	90	100
Ghandouriye	Nabatiyeh - Bint Jbeil	82	35	100
Jmaijime	Nabatiyeh - Bint Jbeil	115	50	50
Deir Ntar	Nabatiyeh - Bint Jbeil	25	3	250
Soultaniye	Nabatiyeh - Bint Jbeil	79	30	150
Safad el Battikh	Nabatiyeh - Bint Jbeil	35	35	120
Tebnine	Nabatiyeh - Bint Jbeil	40	20	850
Chaqra	Nabatiyeh - Bint Jbeil	125	25	100
Braachit	Nabatiyeh - Bint Jbeil	172	170	250
Beit Yahoun	Nabatiyeh - Bint Jbeil	45	30	160
Hadatha	Nabatiyeh - Bint Jbeil	80	40	130
Haris	Nabatiyeh - Bint Jbeil	35	20	15
Kafra	Nabatiyeh - Bint Jbeil	40	35	300
Yater	Nabatiyeh - Bint Jbeil	180	150	400
Sribbine	Nabatiyeh - Bint Jbeil	19	30	100
Beit Lif	Nabatiyeh - Bint Jbeil	90	30	380
Beit Yahoun	Nabatiyeh - Bint Jbeil	45	30	160
Kounine	Nabatiyeh - Bint Jbeil	40	120	320
Rachaf	Nabatiyeh - Bint Jbeil	10	20	50
Taire	Nabatiyeh - Bint Jbeil	15	50	140
Aainata	Nabatiyeh - Bint Jbeil	100	50	800
Ramiye	Nabatiyeh - Bint Jbeil	0	2	50
Qaouzah	Nabatiyeh - Bint Jbeil	4	0	40
Debel Oummiya	Nabatiyeh - Bint Jbeil	7	0	110
Aita Ech Chaab	Nabatiyeh - Bint Jbeil	450	100	500
Hanine	Nabatiyeh - Bint Jbeil	14	26	200
Ain Ebel	Nabatiyeh - Bint Jbeil	3	7	54
Bent Jbeil	Nabatiyeh - Bint Jbeil	375	500	1900
Aaitaroun	Nabatiyeh - Bint Jbeil	4	90	300
Maroun er Ras	Nabatiyeh - Bint Jbeil	23	30	150
Yaroun	Nabatiyeh - Bint Jbeil	20	0	170
TOTAL		2512	1908	10379

Table 2A-5. Summary of the Damage Inflicted on the Construction Sector of the Bekaa Region (HIC, 2006a)

Municipality	Governorate - Caza	Dwellings Destroyed	Dwellings severely Damaged	Clinics Damaged	Hospitals Damaged	Schools Damaged
Boudai	Bekaa - Baalbek	3	3	1	0	1
Baalbek	Bekaa - Baalbek	250	400	0	2	6
Tariya	Bekaa - Baalbek	6	11	1	0	1
Chmistar	Bekaa - Baalbek	4	9	0	0	0
Britel	Bekaa - Baalbek	17	8	0	0	1
Bednayel	Bekaa - Baalbek	3	2	0	0	0
Nabi Chit	Bekaa - Baalbek	34	20	0	0	0
Aita el Foukhar	Bekaa - Rashaya	0	1	0	0	0
Mashgara	Bekaa - West Bekaa	13	14	0	0	0
Sohmor	Bekaa - West Bekaa	0	1	0	0	1
Loussia	Bekaa - West Bekaa	1	0	0	0	0
Dlafy	Bekaa - West Bekaa	2	0	0	0	0
TOTAL		333	469	2	2	10

APPENDIX 2-B. COST TO BENEFIT ANALYSIS OF ALTERNATIVES FOR RECONSTRUCTION MATERIALS

	Fiscal Cost		Impact on Quarrying Activity[125]		Environmental Costs[126]		Economic Benefits[127]		Government Returns[128] (Benefit)	
Reconstruction Scenarios	Aggr & Sand[129] (mil $)	Cement[130] (mil $)	Aggr & Sand (% increase)	Cement (% increase)	Aggr & Sand (mil $)	Cement (mil $)	% increase	mil $	Aggr & Sand (mil $)	Cement (mil $)
Local Resources	24.04	78.92	72.84%	28.78%	1,614	638	40.0%	718	2.40	7.89
Foreign Resources	19.67	142.06	0	0	0	0	0.0%	0	1.97	67.68
25% Local 75% External	20.76	126.28	18.21%	7.20%	403.54	159.45	10.0%	180	2.08	52.74
75% Local, 25% External	22.94	94.71	54.63%	21.59%	1,210.63	478.35	30.0%	539	2.29	22.84

[125] Impact on quarrying activity was estimated as the ratio (percentage) of the additional demand due to conflict over available supply (domestic production levels including stockpiles).

[126] Environmental Cost was calculated as: (Impact on Quarrying Activity) * (Cost of Environmental Degradation due to Quarries). Annual cost of environmental degradation due to quarrying activity is considered as 0.1% GDP (Sarraf et Al, 2004). GDP of Lebanon in 2005 was estimated to be USD 22,161,000,000 (IMF, 2006)

[127] Construction Industry is assumed to contribute 7.0 – 9.2% of GDP Sources: MoI, 1999 and website for the Lebanese Embassy in the United States of America. http://www.lebanonembassyus.org/country_lebanon/economy.html. Assumption of 40% increase in economy of construction industry due to the 68% and 36% increase in domestic supply of aggregates and cement respectively.

[128] Government returns or taxation is based on values reported on the Lebanese Customs Authorities website: www.customs.gov.lb. For all domestic and imported products: Value Added Taxation (VAT) of 10%. Imported cement is subject to 30% customs (average) and excise taxation of LBP 13,000/tonne. Imported aggregates and sand are neither subject to custom duties nor to excise taxation.

[129] Average cost of sand and aggregates (domestic): $11/m3; foreign (typically Syrian): $9/tonne; Lebanese market prices of construction materials, including transportation costs, based on interviews with industry experts, 2006

[130] Average cost of cement (domestic): $63/tonne - Lebanese market prices of construction materials, including transportation costs, based on interviews with industry experts, 2006. Average cost of imported cement: $113/tonne (assumed 80% more expensive than domestic product due to custom duties of 25 - 75%, and excise taxation of LBP13,000 / tonne (net) and added transportation / shipping costs).

LEBANON

RAPID ENVIRONMENTAL
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GREENING RECOVERY,
RECONSTRUCTION
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2006

TRANSPORT

TRANSPORT

3.1 DAMAGE ASSESSMENT

3.1.1 OVERVIEW OF SECTOR DAMAGE

Preliminary damage assessment in the transport sector has been carried out by the government through the Council for Development and Reconstruction (CDR). Other organizations conducted similar assessments with the same source. The Joint Research Center (JRC) and the European Satellite Centre (EUSC) in Torrejon carried out a rapid preliminary damage assessment on the Beirut area and in three districts (Tyre, Bint Jbeil and Marjayoun) of South Lebanon (89% of the area south of the Litani River was covered by the analysis) (Buda and Al-Khudairy, 2006). This preliminary damage assessment forms part of the joint JRC and EUSC contribution aiming at supporting damage assessment and subsequent reconstruction efforts by means of very high resolution satellite imagery, both at short and medium term.

The overall damage estimate of roads and bridges[131] throughout the country shows the following:

Roads sections damages:

- A total of 445000 m^2 of roads
- Estimated Cost: USD 91,845,000

Bridges damages:

- Total of 107 bridges damaged
- 94 bridges fully damaged
- 9 bridges half damaged
- 3 bridges 20% damaged
- 1 bridge 10% damaged
- Estimated Cost: USD 337,000,000

As a result of the observed damage to road infrastructure, access to several relatively important towns (Tyre, Bint Jbeil, Meiss el Jabel) and social infrastructure (hospitals, etc.) are disrupted. Numerous villages in South Lebanon are equally affected by the problem of access due to damaged road infrastructure, including access to cultivated fields.

3.1.2 DAMAGED INFRASTRUCTURE

3.1.2.1 South Lebanon

The key damages observed by the JRC and EUSC in South Lebanon related to the transport sector revealed that 535 road sections and 21 of the 29 bridges over Litani River were affected. The road length damaged or destroyed in South Lebanon is estimated to amount to 16 km.

[131] *Source CDR: Preliminary estimates of roads and bridges damages*

3.1.2.1.1 Tyre District

The damage caused to road infrastructure has been very important in Tyre district: more than 250 road sections were destroyed or damaged (mean length of 15m) (Buda and Al-Khudairy, 2006). In the Tyre area, in particular in the cadastral limits of Borge el-Chemali and Abbassyat, the damages to road infrastructure are particularly important (highway and other major roads). Not only the main North-South highway, but also many other roads leading to Tyre have been affected, thereby potentially hampering access to important social infrastructure (hospitals, schools, port) and/or industry situated there. Access towards Beirut and the other parts of Lebanon has been almost interrupted, because all four bridges for car traffic over the Litani River in this district have been affected (3 of them completely destroyed). In the rural areas, important roads have been affected in the Zebkine and Izzié areas. Overall damage is summarized in Table 3.1.

Table 3.1. Transport Infrastructure Affected in the Tyre District (Buda and Al-Khudairy, 2006)

Infrastructure type	Destroyed	Damaged	Total
Roads	86	165	251
of which unpaved	48	90	138
Bridges	16	2	18
Other (public spaces, irrigation channels)	-	30	30
Estimated total length of road network destroyed/damaged			7.5 km

Other municipalities, in particular the cadastral limits of El-Mansouri, Deir Kanoun Ras El Äin, El-Kleile and Deir Kanoun El-Nahr (all three close to Tyre) as well as Srifa (Northeast of the district), have been seriously affected in the context of impacted road infrastructure and buildings. Numerous villages in less populated cadastral limits, such as El-Mansouri, Majdalzoun, Izzié, Bafliyé, Tair Harf, are affected due to difficult accessibility to their land, and/or being cut off as a result of damage to relevant road infrastructure. Apart from the direct damage to cultivated land, a much stronger impact on agriculture is noticed by the fact that access to agricultural land is potentially hampered due to the high number of road sections (also unpaved) destroyed or damaged in rural areas (in the zones mentioned above).

3.1.2.1.2 Bint Jbeil District

The main areas concerned are the district capital town Bint Jbeil and its surroundings (Ainata, Maroune el Ras) as well as the municipalities in the cadastral limits of Baraachite, Ghandouriyé and Froune. Road infrastructure has been destroyed or damaged in these areas as well as in the cadastral limits of Yaroune, Kounine, Kafra, El-Tarï, Aita-el Chaab and Aïn-Ebel. Damage in the district is summarized in Table 3.2.

Table 3.2. Infra-Structure Destroyed /Damaged in the Bint Jbeil District

Infrastructure Type	Destroyed	Damaged	Total
Road sections	12	228	240
Bridges	-	-	-
Other (public places, irrigation channel etc.)		16	16
Estimated total length of road			
Network destroyed/damaged			7.2 Km

The damage to infrastructure is equally important in Bint Jbeil and adjacent cadastral limits (Ainata, Maroune-el-Ras, Yaroune, Aïn-Ebel) as well as in Aita-el Chaab close to the Israeli border. As a result, access to important local social infrastructure in Bint Jbeil such as hospitals and schools may be difficult.

Apart from this, the damage to infrastructure seems to focus on roads of minor importance and appears to be less important than in the Tyre district. Nevertheless, several municipalities and villages, in particular in the cadastral limits of Froune, Kounine, Baraachite, Kafra and Debel may be concerned by problems of access to/from their village and/or their land. The direct damage to agricultural land is of minor importance.

3.1.2.1.3 Marjayoun District

The damage mainly concentrates in the cadastral limits of Touline and Kabrikha (both buildings and infrastructure) and Meiss-El-Jabel and Deir Seriane (mostly infrastructure). Damage is summarized in Table 3.3.

Table 3.3. Infra-Structure Affected in Marjayoun District

Infrastructure type	Destroyed	Damaged	Total
Road sections	12	32	44
Bridges	3	-	3
Other (public places, etc.)		13	13
Estimated total length of road network destroyed/damaged			1.3 km

The JRC and EUSC assessment of damage report based on the satellite imagery available only partly covers the Marjayoun district and so the damage analysis reported below only partly covers the district.

The cadastral limits of Al Taibe (with the district's major town Taibe) are marked by a notable damage to buildings and some damage to road infrastructure. The access to hospitals situated in Meis El-Jabel may also be difficult due to damage to local road infrastructure. Three of the eight existing bridges over the Litani River have been destroyed.

Furthermore, damage to several secondary roads of minor importance is observed. Related to this, several villages in the cadastral limits of Touline, Mhaibib, Kabrikha, Souane may be concerned by problems of access to/from their villages and/or their land.

3.1.2.2 Beirut

In Beirut, all runways of Beirut airport and 6 strategic highway sections including overpass are severely damaged. The damaged sections of the highways each have an average length of 20 m; the damaged airport runway sections each have an average length of 10 m.

3.1.2.3 North Lebanon

3.1.2.3.1 Akkar District

The main transport infrastructure damages in Akkar district are summarized in Table 3.4, including damage to bridges and roads.

Table 3.4. Summary of Transport Infrastructure Damage in Akkar District

Municipal District	Type of Damages
Halba	Bridge destroyed on Al-Awik River
Kowikhat	Part of the bridge on Oustwan River (Halba – Koweikhat main road) destroyed
Mazraat Baldeh	Bridge on the main road of Halba – Deir Jannein totally destroyed
Deir Jannein	Main road of Deir Jannein – Fseyqeen cut due to crater (10 meters depth)
Al-Heisa	Bridge totally destroyed on Oustwan River
Kobayat	Large crater on main road, at the western quarter Large crater on the main road of Kobayat – Andakit
Andakit	Andakit – Akroum main road destroyed
Kabeet	Large crater on Al Jerd main road close to Habsheet intersection Main road cut
Beit Ayyoub	Crater on Al Jerd main road in Sadaqa area, near the civil defense center leading to closure of the road
Rihaniyeh/ Al-Qaiteh	Damage of a bridge on Bared River, near the embankment lake that link Akkar with Dinnyeh region and damages in agricultural lands
Zouk Haddara Municipality/ Arqaa	Arqaa bridge totally destroyed
Al-Heisa	Crater in the bridge and partial damage
Tal Abbas Southern part	Small bridge destroyed
Al- Aboudiyeh	Limited damage of the main road

3.1.2.3.2 Keserwan and Jbeil Districts

The main transport infrastructure damages in Keserwan and Jbeil districts are summarized in Table 3.5, including damage to bridges and roads.

Table 3.5. Summary of Transport Infrastructure Keserwan and Jbeil districts

Municipal District	Type of Damages
Ghazir	Casino bridge
Maameltein	Total damage of the west section of the bridge
Fidar	Total damage of Fidar bridge
Batroun	Total damage of the Madfoun bridge
Terbol	Large crater on the main road

3.1.2.4 Bekaa

The joint JRC-EUSC assessment did not cover the Bekaa Governorate. Important transport infrastructure damage in the Bekaa includes the partial destruction of the Mdairej bridge and Dahr El Baidar road (Figure 3.1).

(a) Dahr El Baidar Road

(b) Masnaa Road

(c) Mdairej Bridge

(d) Closer View of Mdairej Bridge

Figure 3.1. Transport Infrastructure Damage in the Bekaa

3.1.2.5 Summary of Bridge Damages

Appendix 3-A provides a list of damaged bridges as per the preliminary CDR assessment and indicates whether the damage could potentially affect a surface water stream. About 30 potential hotspots are identified and would need further verification and assessment in the field.

3.1.3 POST-CONFLICT INITIATIVES

3.1.3.1 Bridges

For all of the damaged bridges, traffic was completely disrupted at least for one of the directions if not for both directions. Major highway bridges south of Beirut and in the south of Lebanon were temporary replaced by metallic bridges. This option was not applicable to all damaged bridges in Lebanon depending on the type of damage and the length of the section. Temporary solutions to enable traffic flow were adopted. In some locations a parallel road to the bridge was constructed following the natural slope of the land. In most cases, temporary culverts were built. In some other cases, traffic had to be diverted using detours on the local roads going through towns and villages.

3.1.3.2 Roads

As for roads damages, temporary solutions also have been adopted. Where damages were not significant, a temporary filling of holes was carried out permitting a somehow normal traffic circulation. In the cases where major damages happened to the road section, a temporary road was constructed alongside the existing damaged one in order to keep traffic circulating during reconstruction phase.

3.1.4 ENVIRONMENTAL CONCERNS

Although rapid solutions have been adopted for the transport sector, it is not without an important impact on the environment and the socio-economic sectors. Main environmental concerns in the transport sector are due to the temporary post-conflict solutions. The following are the main environmental and socio-economic impacts related to the damage inflicted to the transport sector during the war:

- Increase in air pollution and noise in towns and villages where traffic is diverted;
- Increase in air pollution, mainly dust emissions, in areas where temporary unpaved roads were built through agriculture terrain;
- Impact on water courses under the bridges, especially where culverts have not been constructed or where demolition wastes have not been removed (example of the Mdeirej viaduct); structural impacts to river banks and the hydraulic properties of streams may lead to flood events during winter;
- Increase in travel time delays due to congestion related to small temporary bridges or local roads with small capacity;
- Increase in road accident risks involving heavy vehicles due to construction trucks traffic circulating among regular traffic.

3.2 ENVIRONMENTAL ACTION PLAN

Two major environmental impacts have resulted from the damage inflicted to the transport infrastructure in Lebanon: increase in air pollution in congested areas and direct impact on surface water streams from damaged bridges. The former is a temporary impact that would affect urban areas during the reconstruction period; addressing it needs political will to introduce new policies for the improvement of the public transport sector. Nevertheless, addressing this issue in the short-term could serve as a demonstration project for the enhancement of public transport in the country. The second issue is addressed in the water chapter. Two action plans are proposed in this section, one is promoting the incorporation of environmental standards in the reconstruction of damaged roads and bridges, and the other is promoting public transport to alleviate traffic and reduce emissions from transport sector.

3.2.1 INTEGRATING ENVIRONMENTAL STANDARDS IN THE RECONSTRUCTION OF ROADS AND BRIDGES IN LEBANON (DRAFT PROPOSAL)

3.2.1.1 Problem Statement and Rationale

Post-conflict initiatives in the transport sector could negatively affect the environment. Several mitigation measures should be applied in the very short term, and there is now the opportunity to integrate environmental measures and standards in the reconstruction phase. For example, non-paved roads can have substantial impact on the environment, often more than paving and existing roads.

Some of the recommendations for incorporation of environmental standards in transport sector during and after constructions that can be promoted are listed below:

- **Reconstruction of villages in the south including road infrastructure:**
  - Planting vegetation, creation of buffer zones as noise reducers
  - Use of trees and other greeneries in urban street design for environmental-friendly neighborhoods
  - Design streets in their context (urban, rural, bypasses, etc.)

- **Reconstruction of roads and bridges in urban and rural areas**
  - Design roads and highways in their context (urban, rural, bypasses, freeways, etc.)
  - Use of noise barriers in urban areas that are close to freeways and highways.
  - Paving secondary roads
  - Reconstruction of bridges and roadbeds to reduce flooding or flood damage can be a major component of road and highway improvement projects.

Numerous towns and villages were severely destroyed and are in the process of building or repairing their infrastructure. These are given a unique opportunity to carry out their urban expansion with appropriate incentives for more efficient and environmentally sound patterns. In this sense, sound urban planning is a powerful tool to aid in abating the detrimental effects of traffic on air quality. Land-use and transport are closely related parts of the human activity system. Many of the direct impacts on natural systems, historical and cultural resources, and right-of-way land uses can be avoided by judicious route selection. It is much more difficult to manage the impacts of new development and penetration into natural areas that may be induced by road construction or improvement.

Because of its unplanned nature, induced development proceeds without comprehensive consideration of impacts. Other infrastructure especially that needed for waste management may not exist. Natural resources formerly protected from unplanned exploitation simply by their inaccessibility may become accessible and thus unprotected. Natural systems, visual amenities and historic and cultural resources may be disturbed. These individual developments also generate traffic, possibly overloading the very roads and highways, which led to their existence in the first place.

A special attention has to be given to the loss of agriculture land due to poor land-use planning and route selection. Prime agricultural land, relatively level and well-drained, provides an ideal alignment for roads, and many are located on it. The loss of land to the right-of-way itself may be relatively insignificant and is usually taken into account in deciding whether or not to proceed with a project. However, the phenomenon of induced development, coupled with increasing land values along roads, can lead to conversion of large tracts of agricultural land which were not considered in planning. Such conversions may turn out to have negative impacts on national programs for sustainable agriculture and food self-sufficiency as well as on the viability of the local agricultural economy.

The objective of this action is to promote the use of environmental standards in the reconstruction efforts of roads and bridges, ensuring a sound land use planning in areas that need to be rebuilt with appropriate considerations of transport measures.

3.2.1.2 Proposed Actions

The following actions are proposed:

1. Conduct an awareness campaign on negative impacts of road and bridge construction, maintenance and operation on the environment; target groups should include public agencies staff, particularly those of the Ministry of Public Works and Transport, including DGUP staff, as well as members of relevant parliamentary committee;
2. Compile a good practice manual based on available manuals in the country on environmentally sound construction of roads and bridges, and conduct training sessions to relevant public agency officials, contractors and consultants.
3. Incorporate environmental standards based on international practices in the terms of reference of contractors to enforce their use.

3.2.1.3 Legal Aspects

Environmental standards related to the transport sector are weak in the national legislation.

3.2.1.4 Institutional Aspects

The following institutions play a major role in this initiative:

- Ministry of Public Works and Transport is the main authority responsible for the construction of roads and bridges; within the Directorate of Roads, there is a special environmental unit; this unit can play a critical role in promoting environmental standards in the reconstruction phase;
- Directorate General of Urban Planning also plays an important role by ensuring that land use plans in villages that need to be rebuilt properly incorporate environmental standards and criteria for transport;
- Ministry of Environment is responsible for setting environmental standards;
- LIBNOR plays a central role in setting standards in Lebanon.

3.2.1.5 Budgetary Estimates

This budgetary estimate of this initiative amounts to **USD 60,000**. Budget breakdown is as follows:

1. Implementation of awareness campaign: USD 10,000
2. Training sessions (4 training sessions; 3-day duration): USD 40,000
3. Incorporation of standards in terms of references of contractors: USD 10,000

3.2.2 PROMOTING PUBLIC TRANSPORT TO ALLEVIATE TRAFFIC AND REDUCE EMISSIONS FROM TRANSPORT SECTOR (DRAFT PROPOSAL)

3.2.2.1 Problem Statement and Rationale

In most of the locations where highway bridges were damaged, vehicular traffic is detoured through urban areas causing congestion and thus increasing air pollution in town in addition to travel delays and stress caused to drivers. It is important that traffic regulations and management in urban areas should be improved, as soon as possible, as they could provide a cost-effective means of reducing transport-related pollution. Remedies can be induced by adopting schemes to improve public transit systems.

The current traffic situation, where detour routes during construction are highly congested at peak hours, presents a good opportunity to give people the incentive to use public transport. It is to be noted that the northern entrance to the Greater Beirut area witnesses nowadays around 161,141 vehicles as an average daily traffic for the North Bond (NB) and South Bound (SB). The southern entrance to Beirut counts an average daily traffic of 57,337 vehicles. Peak hour volumes are around 24,000 at northern entrance (NB and SB) and around 10,000 at southern entrance (NB and SB). In congested areas where detours occur, the average speed could be as low as 20 to 25 km/h at peak hours (MoPWT, 2003).

The government could take specific measures to ensure the efficiency of public transit systems, especially at the northern and southern entrances to the Greater Beirut Area. For example, it could provide bus interchanges locations as well as bus-only dedicated lanes at peak hours. Previous studies in Lebanon have shown that the use of public transport affects positively the following economic indicators (MoPWT, 2003):

- Travel time savings
- Impact on emissions (overall reduction of pollutants emissions)
- Savings due to reduction in parking demand
- Savings due to reduction in additional roadway construction
- Impacts on the trade balance and government revenues resulting from the reduction in automobile, automobile parts and fuel imports
- Impact on job gains and job losses posed by the implementation of mass transit
- Capital costs
- Operating and maintenance costs

The objective of this action is to promote the use of public transport and eventually guide policy makers towards a more effective transit system by seizing the opportunity presented by the current situation.

3.2.2.2 Proposed Actions

The following actions will serve as a demo-project for the initiation of a BRT (Bus Rapid Transit) along the coastal corridor.

On the Short term:

1. Propose additional public transport for long distance trips between North and South and Beirut. In order to enhance incentive to use public transport, it is proposed to have a Bus-Only dedicated traffic lane on all congested routes on the coastal road. For this proposal to be efficient, the following points have to be achieved:

    a. Review of the Beirut Suburban Mass Transit Corridor Feasibility Study (MoPWT, 2003) and adapt it to the current road infrastructure including detours. A site survey will show locations where dedicated lanes can be implemented.

    b. Securing political will (Ministry of Interior, Ministry of Transport, related municipalities). Dedicated lane should be allowed to all public transport (public and private buses, vans, jitneys).

    c. Delineation of the proposed lane with plastic or concrete delineators, and install adequate signs on the road at locations where dedicated lane starts and ends.

    d. Very strict enforcement should be adopted. Only few locations should be allowed for stops, and if possible, not on dedicated lanes.

    e. Announcement / Advertising should be made on media.

    f. Look at possibilities for park-and-ride locations in main cities (Tripoli, Batroun, Jbail, Tyre, Saida): Suburban stations on the coastal right of way need to be served by local feeder minibus services from residential areas to coastal right of way stations and local commercial centers. The design of suburban stations must anticipate and provide convenient access and transfer for pedestrian, feeder bus, and in some locations "park & ride", to make the suburban stations pleasant and effective. The physical layout for this must be planned before implementing the project.

2. Increase traffic law enforcement in order to minimize congestion (no parking on detour routes, intersection regulation to be firmly handled by the police, etc.).
3. When possible, select routes that could avoid towns crossing.
4. When possible, chose truck routes away from towns.

On the Medium to long-term:

1. Propose efficient public transport system (car parks at main stations, regular and fixed bus stops, etc.)
2. Implement an air quality monitoring network to evaluate impact of measures on air quality.

3.2.2.3 Legal Aspects

There are no legal issues in implementing the above actions on the short term. It needs decision-makers willingness to enhance the public transport sector in the current situation. Legal aspects would be looked at in the medium and longer term policy making.

3.2.2.4 Institutional Aspects

The following institutions play a major role in this initiative:

- Ministry of Public Works and Transport is the main authority responsible for the Public Transport in the country.
- Ministry of Interior, where implementing such measures, would need a high level of enforcement by the Police.

3.2.2.5 Budgetary Estimates

This budgetary estimate of this initiative is as follows:

1. Road delineators and signs: US$ 500,000.00
2. Park-and-Ride locations: Chose municipal land if available, or estimate of : $12,000/month ($3,000/month/location for at least 4 locations)

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APPENDIX 3-A: SUMMARY OF BRIDGE DAMAGE AND POTENTIAL IMPACT ON SURFACE WATER STREAMS

Name	Percentage of damage	Crossing Surface Water Stream	Type of Stream
Aadloun bridge	100	Yes	Permanent
Ablah Riyak bridge	100	Yes	Permanent
Aboo Zebli bridge	100	No	
Abou Jajeh bridge	100	No	
Adwi bridge	100	No	
Akkar-Hermel bridge (Beit Jaafar)	100	Need verification	
Al Assi bridge	100	Yes	Permanent
Alman Awwali bridge	100	Yes	Permanent
Alman Bkasta bridge	100	No	
Alman steel bridge	100	No	
Alman underpass	20	No	
Arqa bridge	100	Yes	Permanent
Awali bridge	100	Yes	Permanent
Baabda Alhadath bridge	100	Needs verification	
Baysariyyeh main line highway bridge	100	Needs verification	
Bayzoun bridge	100	No	
Bqosta Karkha bridge	100	No	
Bebliyyeh bridge	100	Needs verification	
Bridge over Bir el Abed	100	No	
Bridge over Chatila Kafaat	100	No	
Bridge over old Saida road	100	No	
Chakaa	100	No	
Culvert el Nabatiyeh	100	No	
Damour bridge	100	Yes	Permanent
Damour interchange	100	No	
Damour-oceana beach	100	No	
Darb Essim	100	No	
Debieh overpass	100	No	
Deir Zahrani Roumin bridge	100	Yes	Permanent
El Khardaly bridge	100	Yes	Permanent
Ferzol Jarmashiyyeh bridge	100	No	
Ghazieh overpass	100	No	
Ghazir bridge	50	No	
Habbouch overpass interchange	50	No	
Hajjeh bridge	100	No	
Halat bridge (Fidar)	100	Yes	Intermittent
Hasbany bridge	100	Yes	Permanent

Name	**Percentage of damage**	**Crossing Surface Water Stream**	**Type of Stream**
Hawsh el Rafka bridge	100	No	
Jadra-wadi Zaineh bridge	100	Needs verification	
Jarmak bridge	100	No	
Jernaya culvert	100	No	
Jieh overpass -zaroot	100	No	
Kaakaiyyeh bridge	100	Yes	Intermittent
Kark Terbol bridge	100	No	
Maameltain bridge	50	No	
Madfoun bridge	100	Yes	Intermittent
Marj el Zohoor bridge	100	No	
Litani bridge Massnah road	100	Yes	Permanent
Mdairege bridge	100	No	
Mechmech Beit Ayoub bridge	100	No	
Naameh entry bridge	100	No	
Nahmeh interchange	100	No	
Namlieh bridge	100	No	
National Road Aboul Aswad bridge	100	Yes	Permanent
Old Dammour bridge	100	Yes	Permanent
Old Naameh underpass	100	No	
Old Zahrani road bridge	100	Yes	Permanent
Over pass -Saida Estern Boulvard	20	No	
Qasmiyeh local road bridge	100	Yes	Permanent
Qasmiyeh national road bridge	100	Yes	Permanent
Regie overpass	100	No	
Runway over coastal road	10	No	
Saksakiyyeh interchange overpass	100	No	
Sarafand bridge	100	Yes	Permanent
Saynik steel bridge	100	Yes	Permanent
Sayniq bridge	50	Yes	Permanent
Six February bridge	100	Yes	Permanent
Small bridge near Ain el Helweh	100	No	
Steel bridge_Chyah Blvd_airport bl	50	No	
Sultan Ibrahim bridge	50	No	
Tafahta culvert	100	No	
Tahrir bridge	100	No	
Terbol Ferzol bridge	100	No	
Wadi el Akhdar Habbouch bridge	100	Yes	
Wadi Zaineh viaduct	20	Yes	Intermittent
Zahrani bridge ramp to saida	50	Needs verification	

Name	Percentage of damage	Crossing Surface Water Stream	Type of Stream
Zahrani highway bridge	50	Yes	Permanent
Abou Asswad bridge	100	Yes	Permanent
Charoun bridge	100	No	
Wadi Chahrour bridge	100	No	
Jlala bridge	100	No	
Nabi Ayla bridge	100	No	
Litani Faour bridge	100	Yes	Permanent
Litani-Fourzol bridge	100	Yes	Permanent
Mechref bridge	100	No	
Clifa-Iaat bridge	100	No	
Clifa - Deir Al Ahmar bridge	100	No	
Akibeh square	100	No	
Ali Annahri bridge	100	No	
Hawch al Rafiqua bridge	100	No	
Dallafa Esper bridge	100	No	
Dalhamieh bridge	100	No	
Dalhamieh Zahleh bridge	100	No	
Dimashkieh bridge	100	No	
Rmeyleh	100	No	
Rmeyleh principale	100	No	
Saideh-Majdaloun	100	No	
Saksakiyyeh bridge	100	Yes	Permanent
Adoussieh bridge	100	No	
Alaak bridge	100	No	
Ain elsawda bridge	100	N	
Saadiyat bridge	100	No	
Hisah bridge	100	No	
Kowaykhat 1	100	No	
Kowaykhat 2	100	No	
Ras baalbeck bridge	100	No	
Arka marine bridge	50	Yes	Permanent

LEBANON

RAPID ENVIRONMENTAL
ASSESSMENT FOR

GREENING RECOVERY,
RECONSTRUCTION
AND REFORM
2006

ENERGY

4.1 DAMAGE ASSESSMENT

4.1.1 OVERVIEW OF SECTOR DAMAGE

Energy-related infrastructure was damaged during the war in Lebanon causing impacts of varying severity on the environment. The following infrastructure was considered in this chapter:

1. Jiyeh power plant fuel storage tanks;
2. Airport fuel storage tanks;
3. Transmission and distribution networks; and
4. Petrol stations.

Jiyeh power utility's and the international airport's fuel storage tanks were hit by the Israeli Defense Forces (IDF). The transmission and distribution networks were also damaged. Some transmission grids (cables and towers) were partially or completely damaged resulting in the disruption of power supply to several regions in the country. From the environmental point of view, damaged transformers, both in the transmission and distribution networks, are of particular importance. Official reports put the number of damaged transformers as high as 200 separate units all over the country. Several petrol stations were also hit.

4.1.2 DAMAGED INFRASTRUCTURE

4.1.2.1 Jiyeh Thermal Power Plant

4.1.2.1.1 Location

The Jiyeh power utility is located around 30 km south of Beirut and directly on the coastline. Figure 4.1 to Figure 4.4 show the power plant fuel storage tanks before they were hit, during the fire and afterwards.

4.1.2.1.2 Source of Damage

The site was hit by IDF on July 13th and 15th, 2006; two of the fuel storage tanks holding 10,000 m^3 and 15,000 m^3 respectively were directly damaged[132].

[132] Based on personal communication with personnel at the Jiyeh power plant.

Figure 4.1. Jiyeh Thermal Power Plant and its Fuel Storage Tanks

Figure 4.2. The Plume Rising after the Tanks Caught Fire

Figure 4.3. A Closer View of the Fire at the Fuel Tanks

Figure 4.4. The Fuel Tanks after the Fire Consumed the Stored Fuels

4.1.2.1.3 Damage Description

The power plant houses five (5) fuel storage tanks holding in total 75,000 m^3 of fuel (two tanks holding 10,000m^3 each, two tanks holding 15,000 m^3 and one tank holding 25,000 m^3). Two of these tanks were hit (one holding 10,000 m^3 and the other 15,000 m^3) and caught fire; the fire spread to the remaining tanks and stayed burning for 12 days. Around 60,000 m^3 (55,764 tonnes)[133] of fuel oil were reported to have burned by the plant personnel. The remaining oil (15,000 m^3) is believed to have spilled to the sea, causing one of the major environmental disasters that Lebanon and the eastern basin of the Mediterranean Sea were ever subject to.

[133] Based on a 0.9294 kg/l density as shown in table 1.

The quantities of oil that have burned and spilled are only estimates; exact values can not be obtained. The quantity of oil that has spilled could eventually be correlated with the total amount of oil and oil-containing waste collected once clean-up operations are completed. The oil has been identified as heavy Fuel Oil – number 6 fuel. The oil specifications are shown in Table 4.1 as provided by EDL. The majority of the oil spilled on the 13th of July while a smaller proportion is believed to have spilled two days later, i.e., 15th of July, 2006. It is important to note that with the exception of the fuel tanks, the power plant was not hit.

Table 4.1. Analysis of Fuel Oil Sample (provided by EDL)

Test	Method	Result
Density at 15°C (kg/L)	ASTM D-4052	0.9294
Kinematic viscosity at 50°C	ASTM D-445	138
Flash point, PM closed tester (°C)	ASTM D-93	96
Ramsbottom Carbon Residue (WT%)	ASTM D-524	4.5
Sulfur content (WT%)	ASTM D-4294	0.84
Sediment by extraction (WT%)	ASTM D-473	0.02
S&W Centrifuge (Vol.%)	ASTM D-1796	0.3
Ash content (WT%)	ASTM D-482	0.01
Sodium Content (mg/kg)	IP-288	15
Vanadium Content (mg/kg)	IP-288	16
Pour point (°C)	ASTM D-97	+24
Asphaltenes (WT%)	IP-143	1.2
Gross Calorific Value MJ/kg	ASTM D-4868	43.9

4.1.2.1.4 Post-conflict Initiatives

The Ministry of Environment (MoE) mobilized an emergency team within the ministry to respond to the oil spill during the months of July and August. MoE has liaised with several bi-lateral and multi-lateral agencies to mobilize the support Lebanon needed to manage the oil spill crisis. The Regional Marine Pollution Emergency Response Center for the Mediterranean Sea (REMPEC) has supported MoE in coordinating oil spill response through mobilizing/filtering international assistance and providing the technical expertise needed. Table 4.2 shows the type of assistance provided to Lebanon until November 2006. The Lebanese NGO Bahr Loubnan and other local NGOs contributed to clean-up in Jiyeh and other stretches of the coast. The International Union for Conservation of Nature (IUCN) has conducted a rapid biodiversity assessment of Palm Islands Natural Reserve and provided support in the mobilization of resources for clean-up activities for Palm Islands Natural Reserve.

Table 4.2. Approximate Value of Assistance provided to Lebanon (services, equipments and expertise) related to the Oil Spill as at November 7, 2006[134]

Country/ Organisation	Type of Assistance	Sites
Canada	Funding	Assessment & clean up operations to collect free floating oil in Beirut, Byblos & Jiyeh
Cyprus	Equipment	
Finland	Personnel/expertise/equipment	
France	Personnel/expertise/equipment	
Kuwait	Equipment	
Monaco	Funding	
Norway	Personnel/expertise/equipment	
Spain	Personnel/expertise/equipment	
OPEC/OFID	Funding	
UNDP	Funding	
Denmark	Personnel/expertise	Support & assessment
Germany	Personnel/expertise	
Italy	Personnel/expertise/equipment Aerial surveillance	Mapping & cleaning Jiyeh
Sweden	Personnel/expertise	Assessment
Switzerland	Funding	Cleaning Anfeh to Northern border (including Palm Islands)
USA	Funding/SEACOR	Anfeh to Byblos

4.1.2.1.5 Environmental Concerns

The estimated 60,000 m^3 of fuel that burned are thought to have caused extensive **atmospheric contamination** in a plume reportedly reaching as far as 60 km, releasing 2.45PJ[135] of heat. In the vicinity of Jiyeh, this atmospheric plume may have caused some **short-term respiratory symptoms** among exposed population. Small droplets (mainly in the form of soot particles) rained within a radius of 5 km around the power plant. Open burning typically produces soot and particulate matter that are visible as smoke plume, carbon monoxide, methane, and other light hydrocarbons, volatile organic compounds, such as benzene, and semi-volatile organic compounds, including polycyclic aromatic hydrocarbons (PAHs) such as benzo[a]pyrene. Polychlorinated dibenzo-*p*-dioxins and

[134] Oil Spill Operations and Coordination Centre (OSOCC), Ministry of Environment, Lebanon.
[135] Based on a calorific value of 43.9 MJ/kg (see table 4.1).

polychlorinated dibenzofurans (PCDDs/Fs) or polychlorinated biphenyls (PCBs) could have been emitted as well. Air quality impacts are further assessed in the air chapter.

Some of the compounds from these classes of pollutants are persistent, bioaccumulative, and toxic. These include PCDDs/Fs, PCBs, hexachlorobenzene, and some of the PAHs such as benzo[a]pyrene. They do not break down and can persist in the environment for many years and accumulate in different media such as **soil**, **water**, **plants** and **animals**.

The fire caused the total meltdown of the fuel tanks. The area is covered with ash potentially containing high levels of dioxins and furans. The debris were collected from the site and relocated (dumped) at a nearby coastal stretch within the premises of the Jiyeh power plant, exposing the surrounding environment to potential dioxin contaminated ash.

The estimated 15,000 m^3 spilled oil contaminated most of the beaches from Jiyeh and northward – covering a distance of approximately 150 km of Lebanese littoral. Early observations have indicated that pooled oil coming from cracks is still leaking into the sea. However, once this pooled oil has been cleaned, leakage into the sea has stopped.

The wastes generated by the fire debris and oil spill clean-up activities can generate substantial amounts of **hazardous waste**, **an indirect** environmental **impact** caused by the Israeli aggression. Oil collected from the surface of the sea can contain debris such as seaweed, wood, plastic materials of various types, oily sand, gravel, pebbles, rocks, sorbent materials, gloves and other materials used during the clean-up process. Collection and disposal are greatly complicated by the variation in waste composition and appropriate disposal techniques have to be selected for the particular circumstances (refer to solid waste chapter).

4.1.2.2 Beirut Rafic Hariri International Airport

4.1.2.2.1 Location

The airport is located near residential areas in southern Beirut. Figure 4.5 shows the rising plume due to the burning kerosene.

4.1.2.2.2 Source of Damage

The airport fuel storage tanks were damaged by direct hit from the Israeli attack on Lebanon on the 13th of July, 2006.

4.1.2.2.3 Damage Description

It is estimated that 4 tonnes[136] (or 5,000 m^3) of kerosene from the fuel tanks were burned.

4.1.2.2.4 Post-conflict Initiatives

On-site debris was cleaned-up. Waste disposal practice was not known. UNEP post-conflict team visited the site and took soil samples.

[136] Personal Communication with Mr. Samir Fakih, Director of Airports, Directorate General of Civil Aviation.

Figure 4.5. The plume (foreground) of the Kerosene fire at the airport

4.1.2.2.5 Environmental Concerns

The fires resulting from the hits have contributed to the emission of **toxic pollutants into the atmosphere** that can result in adverse **health risks among the population**. The airport is situated near a highly populated residential area. The open burning has environmental concerns similar to the fire in Jiyeh. Some of the emitted compounds do not break down and can persist in the environment for many years and accumulate in different media such as **soil**, **water**, **plants** and **animals.**

4.1.2.3 Transmission and Distribution Networks

4.1.2.3.1 Location

Multiple locations were affected. These include mainly networks in Jounieh, Tyre, Nabatiyeh, Bint Jbeil, Wadi Al-Zineh, El-Shiyyah, and Halba.

4.1.2.3.2 Source of Damage

The sources of damage are mainly indirect as most of the damages sustained by transformers were caused by shrapnel.

4.1.2.3.3 Damage Description

In total, 199 transformers have been reported by EDL to be damaged, some requiring replacement of certain parts, welding, retrofilling and/or refilling of oil. Out of the total, 59 were damaged beyond repair and require replacements. The distribution of these damaged transformers is as follows:

- 2 in Halba
- 45 in Tyre
- 5 in Bint Jbeil
- 6 in Nabatiyeh
- 1 in Shiyah

Of all the above, only 4 have been manufactured before 1989 with the oldest being manufactured in 1975 (1 transformer). It is important to note the following:

- From the remaining 140 transformers, only 97 had oil replacement. From these, 15 have been manufactured between 1982 and 1989.
- A non-official communication[137] reported the number of total transformers hit were 725 units from which 35 percent were new and 65 percent were old and thus could contain PCBs. In fact, half of the 65% (or 33% of the total) are reported to have PCB oil.

4.1.2.3.4 Post-conflict Initiatives

The majority of the transformers were replaced. However no initiatives were reported regarding assessment of potential contamination in the affected areas.

4.1.2.3.5 Environmental Concerns

In general, it can be assumed that electrical equipment manufactured after July 2, 1979 (date when production of PCB was banned worldwide), is non-PCB (i.e., contains less than 50 ppm PCBs). Accordingly, there is only one transformer (manufactured in 1975) that falls outside this category, and thus might have contained PCB oil. Nevertheless, there is the risk that post-1979 dielectric oils manufactured in Eastern Europe, Soviet Union and China might contain PCB-based dielectric fluids. Non-official reports also pointed to the possibility of having about 240 damaged units containing PCBs. Hazardous wastes could be generated from the following:

- PCBs contaminated transformer parts;
- PCB release from poorly maintained storage sites;
- Illegal or improper dumping of PCB wastes, such as old or damaged transformer fluids; leaks or releases from electrical transformers containing PCBs;

[137] Email sent by Dr. Basel Alyousfi on October 17, 2006.

- Disposal of PCB-containing or contaminated equipments into municipal or other dumps not designed to handle hazardous waste.

Contamination of **soil and water** could be an issue of environmental concern. PCBs stick strongly to soil and will not usually be carried deep into the soil with rainwater. Evaporation appears to be an important way by which the lighter PCBs leave soil. As a gas, PCBs can accumulate in the **leaves** and above-ground parts of **plants and food crops**.

4.1.2.4 Petrol Stations

4.1.2.4.1 Location

Several petrol stations were directly hit by IDF during the war. These were primarily located in Bint Jbeil, Tyre, Marjaayoun, Nabatiyeh, Saida, Jebb Jannine, Beirut, and Baalbeck.

4.1.2.4.2 Source of Damage

These stations were either directly damaged by IDF missiles or have been indirectly affected by nearby explosions.

4.1.2.4.3 Damage Description

Official reports by the Higher Relief Council indicate that a total of 22 stations were either completely or partially damaged: these include 4 in Bint Jbeil, 2 in Tyre, 4 in Marjaayoun, 1 in Nabatiyeh, 5 in Saida, 1 in Jebb Jannine, 1 in Beirut, and 4 in Baalbeck. However local authorities have reported a total of 47 petrol stations damaged in Bint Jbeil, Marjayoun, and Tyre alone. Local authorities have provided a detailed list of these stations and contact persons details. A field survey conducted by ELARD in Baalbeck has also shown that seven (7) stations were damaged instead of four. The owners of five stations have reported possible leakage and burning of fuel oil. Table 4.3 shows the coordinates of these sites and the quantities of diesel and gasoline present at the time of damage. Figure 4.6 provides a photographic illustration of damage.

Table 4.3. Petrol Stations in Baalbeck with Amounts of Diesel and Gasoline Present at Time of Damage

Site	Coordinates (UTM)	Amount of fuel (in liters)
1	X: 0237332 Y: 3765045	50,000 Diesel 70,000 Gasoline
2	X: 0240597 Y: 3765680	33,000 Diesel 30,000 Gasoline
3	X: 0240939 Y: 3765687	25,000 Diesel 225,000 Gasoline
4	X: 0241070 Y: 3765718	15,000 Diesel 22,500 Gasoline
5	X: 0240669 Y: 3764889	17,000 Diesel 13,500 Gasoline

(a)

(b)

(c)

(d)

(e)

(f)

Figure 4.6. Damaged petrol stations (a & f), fuel storage tanks (b & e) and water well within premises (c & d)

4.1.2.4.4 Post-conflict Initiatives

Some station owners have repaired damage, including storage tank replacement, and resumed normal operations. Others are awaiting for compensation from the authorities. No on-site environmental assessment has been reported in these sites during the duration of this study. The UNEP post-conflict team has managed to visit some petrol stations all around Lebanon and where appropriate took samples.

4.1.2.4.5 Issues of Environmental Concern

Several issues of environmental concern result from the damage of the petrol stations. These can be summarized as follows:

- Air pollution from burning of fuel;

In Baalbeck, 5 stations had various amounts of fuel (140,000 l of diesel and 361,000 l of gasoline) stored in their tanks when the damage occurred. All of them caught fire and produced air pollution. A similar impact is expected to have occurred in the petrol stations in the South.

- Fuel seepage into groundwater from petrol stations

In Baalbeck, and with reference to Table 4.3, site 1 is reported to have observed leakage; two water wells are located within the premises; owner reported vomiting symptoms upon trying to consume water from the well; this vomiting might be a result of the water being contaminated by the leaking fuel. A well is located downstream of site 2; the well is used by around 1,000 housing units. No complaints were reported to be received by the date of the field visit (October 28, 2006). A well is located also within the premises of sites 3, 4 and 5.

4.2 ENVIRONMENTAL ACTION PLAN

The war has damaged several structures and facilities related to the energy sector. Their environmental impacts are related to the respective media that could have been potentially affected (water, soil or biodiversity) and are addressed in more details in the media chapters.

On the other hand, most of the structures damaged were either already repaired or are under repair. The fuel tanks that have burned should be replaced; most of the transformers were already replaced or repaired, and petrol stations repair is also on-going. While a specific action plan was not identified to green the reconstruction of the damaged facilities, some recommendations are provided in this section together with their legal and institutional foundations. A specific project related to energy efficiency is recommended in the construction chapter.

4.2.1 ENVIRONMENTAL GUIDELINES

4.2.1.1 Transformers

Many of the transformers that were damaged during the war were repairable and only needed retrofilling with dielectric oil. There are several types of dielectric oils that can be employed for refilling transformers. Mineral oils, silicone fluids and synthetic ester materials can all be considered as different classes of replacement fluids available for consideration. The most frequently used alternatives for transformers are mineral oils and silicone oils; other alternatives may also be used but they do not represent a similar commercial interest. Mineral oils, silicone oils and ester-based materials all represent biodegradable alternatives and are preferable from an environmental perspective. Alternative engineering designs such as encapsulated transformers equipped with air cooling have been recommended for PCB substitutes that are not biodegradable.

It is already a practice in Lebanon to use mineral oils as an alternative to PCB-containing dielectric fluids. When choosing an alternative oil, it is important to consider its electrical characteristics, fire resistant-properties, density, coefficient of thermal expansion, viscosity, flash point and flammability, combustion products and environmental characteristics. Not all of those properties are equally important. Generally, fire resistance, coefficient of thermal expansion, environmental considerations and viscosity are the most important ones. A transformer is designed firstly to allow electrical field changes with minimum electrical losses, and secondly to cool the oil which is absorbing the energy losses and producing heat. This heat is removed by circulating the oil through cooling fins that are an essential part of the transformer design. The movement of the liquid through small channels is more efficient for lower oil viscosities. The temperature dependence of the oil viscosity is also of importance.

Replacement oils offered on the market today are all suitable for use in electrical equipment. However the choice of oil depends on the particular use of the transformer. For instance, transformers with an expansion chamber outside the transformer can accommodate temperature changes. In this kind of transformers, it is possible to use oil with a relatively high coefficient of thermal expansion. On the other, in sealed transformers, the replacement oil must have the same thermal expansion coefficient as the original oil.

There are in fact conventional oils that can be, and have been used in transformers. The basic difference with the PCB oils is their greater flammability. However in many environments, this risk is not an overriding factor, or the fire safety can be as good through other means. A closer analysis of the fire risks in certain transformer applications may make it acceptable to use such a higher flammability fluid. Certain transformers, because of the way in which they operate and the place in which they are located, can accept a higher fire risk, for example in outdoor uses. Thus conventional hydrocarbon oils can be considered as replacements for PCB oils in well-analyzed situations. The decision will be a matter of trading off advantages and disadvantages from the environmental, fire risk, economic, and regulatory points of view.

Silicone oil is widely used in newer transformers. The transformers are then designed to fit the properties of silicone oil. When used as a replacement for PCB oils in an existing transformer, it is necessary to modify the transformer, to take account of different properties, in particular concerning the thermal expansion coefficient. Synthetic ester materials are well established replacements with good properties. The fluid has marked technical advantages over many other alternatives, namely: no de-rating factor after conversion, good electrical properties and suitable for upgrading oil transformers to become classified as less flammable. The disadvantage of synthetic ester oils is their higher price.

In addition, the installation of a new appliance involves a number of additional criteria, including the likelihood that the appliance will cause fire in the event of a fault and its behavior in a fire which originates from a source other than the appliance itself, as well as the toxicity, corrosiveness and opacity of the smoke release in the event of a fire. The toxicity to humans and the environment of the insulating materials is also an important factor to take into account. Other criteria include its cost, noise level and possibility of its destruction. Table 4.4 below shows the alternatives of PCBs in the electricity sector, i.e. dielectric fluids in transformers and capacitors.

Table 4.4. Alternatives to PCBs[138] (Nordic Council of Ministers, 2000)

Use	PCB-substitutes
Dielectric fluid in transformers	Mineral oil
	Silicone oil
	Tetrachlorobenzene
	Chloroalkylene
	Biphenyl
	Chlorinated diphenylethane
Dielectric fluid in capacitors	Mixture of Methyl (phenyl-methyl) benzene and Methylbis (phenyl-methyl) benzene
	Phenylxylethane

4.2.1.2 Fuel storage Tanks[139]

The main three concerns of above-ground fuel storage tanks are: fire and explosion risks; evaporation losses and condensation problems. In addition to these three concerns, installing an above-ground storage system must also address the problem of rain or surface water accumulation in the impervious containment system, which must be constructed around and under an above-ground storage system.

The location of storage tanks is a crucial factor in safety measures. Therefore, it is recommended that an above-ground fuel storage system be located on a high, well-drained site, away from any buildings and other non-fuel combustible materials. Where open flames and smoking are not permitted under any circumstances.

The above-ground system is usually made up of the tank itself, a catch basin to trap fuel (should a tank leak or rupture), and a concrete pad to retain fuel spilled during vehicle servicing.

The tank size should be chosen on the basis of the maximum estimated future fuel consumption, because once in place, fuel tanks and systems are expensive to change. Therefore, a proper planning is needed in order to avoid the construction of a system that might soon be obsolete. Such information as well as information on tank openings should be obtained before beginning the layout and construction of the system to prevent excessive piping, cost and potentials for leaks.

[138] Adapted from: Nordic Council of Ministers. 2000. A Survey of Alternatives to 12 Persistent Organic Pollutants. DIVS 2000:825. www.norden.org.
[139] Adapted from: Becker, W., Bucklin R.A., and Hood, C.F. 1992. Above-ground Fuel Storage Systems. University of Florida, Florida Cooperative Extension Service. EES-61.

Tanks should be painted a reflective color, such as white or aluminum to reduce evaporation losses and moisture condensation within the tank. A low pressure valve installed on top of the tank will also reduce the amount of evaporation and condensation. Tanks should be marked with the name of the product which they shall contain as well as a caution note such as "Flammable – Keep fire and Flame away" should also be painted in the tank.

A catch basin, an impervious containment system, should be constructed around and under a tank – or alternatively a group of tanks. The catch basin can be a semi-below ground pit designed to catch and contain any fuel from the storage tank if a spill, leak, or rupture should occur. This would prevent any fuel from coming in contact with the surrounding soil, and halt the contamination of surface or groundwaters. If a leak does occur, all fuel will be contained by the concrete catch basin until it can be disposed of properly.

The catch basin should be designed to contain a volume of at least 25 percent more than the largest tank contained in the basin area. This is large enough to capture the fuel from the largest tank plus any accumulated water which may be in or may enter the basin. The basin should be at least 12 m longer and 12 m wider than the tank.

Basin walls can be either concrete block or cast in place. Block walls are generally easier and less expensive to build, while walls that are cast in place are less prone to leaks. However, either type of wall must be impervious to water, corrosives and, most importantly, the fuel in the tank. In addition, the catch basin floor should also be impervious to water, corrosives, and the fuel in the tank. The floor thickness must be designed for the load it may incur. However, the weight of the filled tank will impose the largest load on the pad.

Since the catch basin is a closed system –except from the above, quantities of rainwater will accumulate in the catch basin, more than can be expected to dissipate by evaporation. In such cases, a sump pump system can be used to handle this excess water. An opening at the base of the basin wall to drain excess water is not an acceptable practice since this might drain some fuel along with the rainwater and thus contaminate the surrounding. For this reason, the sump pump must be manually controlled. An automatic system would pump fuel out of the catch basin should there be a leak, spill, or rupture. The pump should cause a minimum of turbulence in the pit and be designed to leave the bottom 15 cm of sludge and liquid in the pit and also the top 15 cm of liquid in the pit, since these will contain the lighter-than-water petroleum products. When a visible quantity of petroleum products can be seen floating on top of the water, they can be skimmed off and disposed of properly, normally by burning. Spill control pads, blankets, or pillows designed to absorb petroleum can be floated on top of the liquid in the pit. These will absorb the fuel and can then be removed and burned.

To maximize the safety of fuel tank systems it is recommended that the floors, bottom of the pit, and walls of the pit and catch basin be sealed with a petroleum-resistant surface coating. As a minimum, the bottom and sides of the sump pit should be treated.

4.2.1.3 Petrol Stations

Because petroleum is a mixture of organic compounds, its properties may vary, but generally, it is a volatile liquid that gives off vapor at low temperatures. The vapor is heavier than air and has the tendency to sink and accumulate in tanks, pits and other hollows under still air conditions. When the vapor is present in air at certain proportions (1-8% petroleum in air), an explosive atmosphere is created. Petroleum also floats on water surfaces and can be transported over long distances via drainage canals and other watercourses. In Lebanon, the primary petroleum products used at filling stations include unleaded gasoline, diesel, and lubricants. While rebuilding/reconstructing the damaged petrol stations, several measures are to be taken into account to prevent leakages. MoE Decision 5/1 (2001) specifies environmental guidelines for the establishment and operation of petrol stations. Oil spills and careless disposal of oil wastes into drainage can ultimately reach receiving surface water bodies, ground water and land areas. This can consequently have a severe impact not only on plant and animal life, but also on humans. The operation of gas stations has the potential to cause pollution. This however, can be avoided or minimized if waste management, spill control procedures and other pollution procedures mechanisms are put in place.

The potential sources of pollution include:

- Refilling of storage tanks;
- Fuelling of vehicles;
- Dewaxing and cleaning of vehicles;
- Disposal of polluting liquids (e.g., oil wastes, coolant additives, brake fluids);
- Disposal of solid wastes (e.g. oil filters, used lube oil, batteries and tires).

Hydrocarbons which escape from containment at a petrol filling station may enter the soil directly beneath the site, or around its perimeters. Some products may escape from containment to groundwater during normal site operations. The principle sources of loss of product containment, in approximate descending order of frequency of incidents (not volume of products) are shown in Table 4.5.

Table 4.5. Sources of Discharges

Possible discharges in runoff to surface watercourses	
Leaks from:	Under dispenser valves & flexible couplings
	Pipework
	Tanks & offset fill pipes
	Faulty oil/water separator operation
Possible discharges to soakaways	
Spill during:	Customer refueling, including leaking car fuel tanks
	Filling of petrol filling station underground storage tanks directly or by below ground level offset fill points
	Filling of petrol filling station underground storage tanks via above ground level offset fill points
	Overfilling of portable containers

Experience has shown that dispenser (pump) leaks are the most common form of containment failure at petrol filling stations and may range from air separators, dispenser valves or flexible couplings. As dispensers can be set over open soil, any leak may go straight to ground. It is therefore recommended that all dispensers should be fitted with a leak proof drip tray or membrane arrangement beneath the dispenser to ensure that product from small internal leaks flows onto the forecourt surface where it will be noticed, and diverted to the site drainage system.

It has been reported that leaks in underground pipework outnumber leaks from storage tanks by ten folds and in terms of leak size are the principle source of soil and groundwater contamination beneath petrol stations. This is a direct consequence of the vulnerability of buried steel pipework to corrosion which, coupled with inadequate attention to corrosion protection during installation, particularly of the vulnerable cut threads of screwed joints, has led to serious point corrosion and early failure of pipework. Design considerations for the selection of new pipeworks can be summarized as follows:

- It is essential that steel pipework has adequate protection against corrosion, particularly of the joints, or is secondarily contained and provided with a system which continuously monitors the interstitial space for the integrity of both skins.

- Joints for steel pipework should always be connected to tanks or dispensers using flexible connections to allow for relative movement and ensure no resulting load is transmitted to the pipework.

Of particular importance, petrol stations should incorporate a multi-layered system to contain any leakage from their storage tanks or the forecourt. These include:

- Double-skinned tanks in a concrete vault lined with synthetic polymer membranes;

- Compacted clay;

- Fiberglas inner and outer coating (to exclude a possibility of oil products leakage, as well as internal and external corrosion).

Tanks are commonly manufactured from steel, glass reinforced plastic (GRP) or using a combination of steel, plastic and GRP. They may be single skinned or double skinned depending on the type and construction and the intended use. If a breach in tank integrity is identified, several options could be followed. A breach of underground storage tank integrity on the lid or high in the ullage space may not necessarily result in a leak. However, the lower down the body of the tank the greater the potential for loss of product. Any corroded or defective tank which has been identified underground should be taken out of use. The new tank should be constructed of a material that is resistant to local ground conditions or provided with appropriate corrosion protection. New metal tanks are generally protected against corrosion by the application of an external protective coating.

When decommissioning a tank, it is important that it does not become a potential source of pollution. It is recommended that whenever a tank is not going to be used again, it should be removed whenever possible. Where tanks are abandoned in situ they should be purged and filled with hydrophobic foam or concrete.

It is not possible to prevent certain types of spillage occurring during the routine petrol filling station operations. The most frequent spills are customer refueling incidents, spills caused by leaking car fuel tanks, spills caused during the filling of portable containers and spills during the filling of the underground storage tanks, either directly, or by below or above ground offset fill points.

Areas susceptible to contamination, e.g. near pump islands or tanker off-loading points, should be impermeable to hydrocarbons and other liquids and should not allow seepage through or below the surface. Typically, concrete (recommended minimum 180 mm thick, laid in accordance with a recognized standard), or similar highly impermeable materials such as sealed block paving will fulfill this requirement provided any associated jointing material is also impermeable and resistant to attack by motor fuel. Other areas may be surfaced with materials such as hot rolled asphalt, macadam, unsealed block paving, gravel, etc. It should be recognized that hard-standing areas do not remain impermeable over a long period of time. They can be compromised by pipework repair, subsidence or wear and tear along pavement expansion joints. In general the extent of cracking, multiple joints and pavement subsidence are a good indication that potential contaminant pathways exist.

As for controlling surface run-off by appropriate drainage, all forecourt surface areas where contamination is possible, e.g. pump islands and tank off-loading points, and any drainage apparatus which could receive contaminated water, should be contained by peripheral surface drainage channels or curbs to divert all spills and runoff to an oil/water separator or constructed wetland. It is advantageous to use absorbent material to contain all surface spills. The drainage containment should be designed to provide an adequate number of channels and gullies so as to limit the surface travel of spilt hazardous products and prevent them reaching areas where surfaces are unprotected. Adequate containment of any contamination is required during routing to the oil/water separator or constructed wetland.

In general, the following points are advised to minimize environmental impacts from operating petrol stations:

- Provide drainage facilities to maximize drainage to prevent any spillage from leaving the premises;

- Pipelines from tanks to offset filling points, dispensing equipment and vent pipes should be routed below the ground surface and should not be located under buildings. Layout should be such that there is free access to the pipeline system to allow for maintenance;

- The walls of bund may be constructed of reinforced concrete, steel or other suitable material and should be designed to be liquid tight and able to withhold the weight of the tank when filled;

- When refueling is finished, hose, nozzles and other equipment must be stored in such a manner to avoid unnecessary spills;

- Yearly inspection of tanks should be promoted to ensure they are not damaged or leaking;

- All hazardous materials (reactive, flammable, corrosive) solvents, oils, and wastewater must be disposed of in a manner so as to prevent contamination of soil and of surface and groundwater;

4.2.2 LEGAL ASPECTS

- Under the Stockholm Convention, ratified by Lebanon by virtue of Law 432 (29/07/2002) the use of transformer dielectric fluids containing PCBs is prohibited. In case of use (in units already operational before the ratification of the convention), there is a phasing-out period extending to 2025.

- The full implementation of ministerial decision (Ministry of Environment) 5/1 titled "Environmental Guidelines for the Establishment and/or Operation of Stations Distributing Liquid Petroleum Products" dated 25/01/2001 should be promoted by MoE for already existing petrol stations.

- The full implementation of Decree 21/L "Hazardous, Harmful to Health and Annoying Establishments" dated 22/7/1932 and Decision of the Minister of Environment 8/1 "National Standards for Environmental Quality" dated 30/1/2001.

4.2.3 INSTITUTIONAL ASPECTS

- The Ministry of Environment is responsible for the implementation of the Stockholm Convention; in the issue of transformers, the Ministry of Economy and Trade, Directorate General of Customs, as well as Electricité du Liban and the Ministry of Energy and Water have a role to play.

- The Ministry of Environment is the authority mandated to control the implementation of the ministerial decision 5/1 dated 25/01/2001.

LEBANON

RAPID ENVIRONMENTAL ASSESSMENT FOR

GREENING RECOVERY, RECONSTRUCTION AND REFORM 2006

INDUSTRY

5.1 DAMAGE ASSESSMENT

5.1.1 OVERVIEW OF SECTOR DAMAGE

Several industrial facilities were damaged during the war. The extent of damage was however variable. In total, about 31 industrial facilities in South Lebanon, Bekaa and Beirut Suburbs have been reported to be completely or partially destroyed (GoL, 2006). However, after close inspection and field visits conducted by ELARD as part of a Reconnaissance Survey) (ELARD, 2006), some of the reports were dismissed. The list of industrial sites possibly representing potential environmental hazards is provided in Table 5.1. Priority column refers to extent of damage and not environmental concern. The nine (9) sites that were mostly damaged are further discussed in this chapter.

Table 5.1. List of Industries Damaged and Degree of Priority in Terms of Damage

No.	Site	Mouhafaza / Area	Priority
1	Al Arz Textile Factory	Bekaa	High
2	Ghabris Detergent Factory	South	High
3	Saffieddine Pasti-med	South	High
4	LAMARTINE	Bekaa	High
5	Maliban Glass	Bekaa	High
6	Liban Lait	Bekaa	High
7	Transmed	Mt. Lebanon / Choueifat	High
8	Fine tissue factory	South	High
9	Leb Co for carton mince & industry	Mt. Lebanon / Choueifat	High
10	Dallal Steel Industry	Bekaa	Low
11	Sinno	Mt. Lebanon / Choueifat	Low
12	Serum products	Mt. Lebanon / Choueifat	Low
13	Transtec	Mt. Lebanon / Choueifat	Low
14	Wood trading company	Mt. Lebanon / Choueifat	Low
15	Metal workshop	Mt. Lebanon / Choueifat	Low
16	Safieddine gas refill station	South	Low
17	Pepsi	Mt. Lebanon / Choueifat	No damage
18	Ghandour	Mt. Lebanon / Choueifat	No damage
19	ITA Plast	Mt. Lebanon / Choueifat	No damage
20	Moussawi construction	South	No damage

5.1.2 AL ARZ TEXTILE FACTORY

5.1.2.1 Location

The site is located in Al Khyaray – Al Manara, Bekaa and is surrounded by agricultural lands – olive trees, pines, cherry trees and vineyards to the West, South and North. There are two residential houses located at the East of the site. A small hill covers the location from the South and West and the site is located at incline of these hills. The factory has been built recently (ca. 4 years) and has been functional for the past year.

5.1.2.2 Source of Damage

The site was damaged by direct Israeli hit on 23rd of July 2006.

5.1.2.3 Damage Description

The site is entirely demolished (Figure 5.1). Oil leakage from storage tanks was visible. Raw materials partially burned by two large fires released toxic fumes. A well is located at the top west side of the factory (100 m of distance).

Figure 5.1. Al Arz Textile Factory

5.1.2.4 Post-conflict Initiatives

The site was visited by several parties, including:

- The Lebanese army; army personnel inspected the site for presence of UXOs;
- The Ministry of Industry;
- The UNEP post-conflict assessment team; samples of oil and water were taken.

5.1.2.5 Environmental Concerns

The site does not present major issues of environmental concern. Following facts can be highlighted:

- Soil contamination could be an issue; oil has leaked from damaged storage tanks; however the leaked oil is likely to have undergone chemical transformation due to exposure to external factors; the oil was used as a lubricant and is not of any hazardous type (Figure 5.2);
- Air quality might have been negatively affected for a limited period of time due to fire;
- Groundwater contamination is not a serious concern at this site since the water table is very deep and no major sources of hazardous materials were detected.

Figure 5.2. Lubricant Oil Covering the Soil

5.1.3 GHABRIS DETERGENT FACTORY

5.1.3.1 Location

The site is located at Borj Shmali, in the South and is leveled land and surrounded by residential buildings with no remarkable vegetation.

5.1.3.2 Source of Damage

The site was damaged by direct Israeli hit.

5.1.3.3 Damage Description

The factory was completely destroyed (Figure 5.3). Household detergent was spilled all over the damaged site. A water well is present off-site. The soil and water laboratory that was housed at the factory was also completely destroyed.

Figure 5.3. Ghabris Detergent Factory

5.1.3.4 Post-conflict Initiatives

Clean-up of debris took place at the site. The UNEP post-conflict assessment team visited the site. Oil, water and detergent samples were taken for analysis.

5.1.3.5 Environmental Concerns

The following issues can be highlighted:

- Minor spill of motor oil was visible; however it is not believed to pose major concerns of soil pollution given the apparently small amount of oil that leaked;
- Household detergent spilled all across the site; this raises concerns of soil and water pollution;
- Water well (off-site) is unlikely to be polluted; however, with rain, on-site pollutants could flow to nearby water storage tanks;
- Caustic soda (used as part of the process) could be a potential hazard, as it could increase pH in water bodies; phosphates and chlorates can also pose potential environmental hazards.
- Small amount of asbestos-cement was found on-site which could raise a potential issue for waste disposal.

5.1.4 SAFFIEDDINE PLASTIMED (PLASTIC FACTORY)

5.1.4.1 Location

The site is located in Borj Shmali, South. It is surrounded by agricultural fields of citrus plantation from the North, East, South and West, and pines from the West and North. It is a hilly/mountainous location surrounded by metal buildings/constructions.

5.1.4.2 Source of Damage

The site was damaged by direct Israeli hit.

5.1.4.3 Damage Description

Complete structural damage is noted at the site (Figure 5.4). The entire 7 dunum (7,000 m^2) complex of land and material is destroyed. Primary material tanks and gas containers have burnt, burst or exploded. The roof of the factory, which is made of metal, is scattered over a distance of 200 to 300 m. The storage house was burned along with the stocked plastics. Some surrounding trees have also burned. All machinery, fuel tanks and generators (2 in total – 650 KVA and 900 KVA), two hydraulic lifters and other vehicles on site were completely damaged.

5.1.4.4 Post-conflict Initiatives

UXOs were found at the site and are being cleared by the competent authorities.

5.1.4.5 Environmental Concerns

Following issues of environmental or health concern can be highlighted (Figure 5.5):

- Human casualty risks due to the presence of UXOs;
- Leakage of hazardous materials causing soil pollution;
- Possible hotspot of dioxin emissions due to fire of plastic materials and other hazardous chemicals;
- Demolition waste contaminated with hazardous material.
- Possible soil deposition of dioxins in the vicinity and surrounding agricultural fields (citrus) of the factory.


(a) General View of Factory


(b) Closer View of Factory

Figure 5.4. Saffieddine Plastimed

(c) Burned raw material tanks – potential source of PCDDs/Fs

(d) Unharmed tanks that may have leaked

Figure 5.5. Potential Sources of Environmental Concern at Saffieddine Plastimed Factory

5.1.5 LAMARTINE FOOD INDUSTRY

5.1.5.1 Location

The site is located in Taanayel, Bekaa. It is surrounded by agricultural land to its North and South, and the river Ghzayil to its South. A vegetable wrapping industry is located to its East and a rock saw to its West. It is built on a leveled ground/horizontal platform.

5.1.5.2 Source of Damage

The site was damaged by direct Israeli hit.

5.1.5.3 Damage Description

Three missiles damaged the quasi-totality of the site leading to the destruction of all machinery inside the factory. The building appears to be structurally unsafe (Figure 5.6). Fuel-oil and chewing gum flavorings leakages were observed. Approximately 45 barrels of pure glucose were stored in open air and some were damaged. Cardboard, packaging materials, and merchandise were littered throughout the site. Three freshwater wells, used for industrial and production purposes, are found on-site.

Figure 5.6. Lamartine Food Industry

5.1.5.4 Post-conflict Initiatives

Lebanese army and Ministry of Industry representatives have inspected the site. The UNEP post-conflict assessment team has visited the site and took dust and soil samples.

5.1.5.5 Environmental Concerns

The following issues can be highlighted:

- Air pollution could be an issue of concern; dioxin poses a major concern due to the presence of nylon and low density polyethylene filaments nearby the factory (Figure 5.7); pollutants might have deposited at nearby agricultural lands;
- Demolition wastes are considered not representing any major environmental concern.
- Fuel leakage may be a source of soil contamination;
- Water pollution risks are believed to be low.

Figure 5.7. Burned material – potential source of PCDDs/Fs

5.1.6 MALIBAN GLASS FACTORY

5.1.6.1 Location

The site is located in Taanayel, Bekaa. A gas station is located to its North, a parking lot for transit shipping trucks to its South and a dairy products industry to its West. A factory is located at its East. It is built on a leveled ground/horizontal platform with some trees on site and shrubbery surrounding the site.

5.1.6.2 Source of Damage

The site was damaged by direct Israeli hit on 18th July 2006.

5.1.6.3 Damage Description

The site consists of several buildings including offices, production process units and three glass ovens (Figure 5.8). The buildings are partially demolished and structural damage appears to be severe. Heavy machinery is damaged on-site; oil spills underneath the rubbles can be noticed. The three emission stacks of the glass oven are still standing.

Figure 5.8. Maliban Glass Factory

5.1.6.4 Post-conflict Initiative

Clean-up/reconstruction works has been initiated. EDL has visited the site and removed three transformers. The UNEP post-conflict assessment team has also visited the site and took groundwater and open water storage tank samples.

5.1.6.5 Environmental Concerns

The following issues can be highlighted:

- Soil contamination seems to pose no serious hazard;
- Raw material can be potential groundwater and open water contamination sources;
- Waste material on site consisting of demolition waste, metal scraps and plastics are a source of nuisance;
- Chrome is used for coloring of glass. Storage area is in open air; potential groundwater contamination with rain runoff is possible.

5.1.7 LIBAN LAIT DAIRY PLANT

5.1.7.1 Location

The site is located in the Bekaa. It is surrounded by agricultural lands from all sides, and the main Baalbeck highway is located to its East side. The factory is built on a plane land.

5.1.7.2 Source of Damage

The site was damaged by direct Israeli hit.

5.1.7.3 Damage Description

The dairy plant was the target of three direct missile hits, causing complete destruction of the plant's processing facility (Figure 5.9). The processing, packaging and short storage sections are totally demolished. Acid and other chemicals storage sites are undamaged.

Figure 5.9. Liban Lait Dairy Factory

5.1.7.4 Post-conflict Initiatives

On-site reconstruction and rehabilitation works are underway. Debris were transported to a waste disposal site located at Hawch Sned, few kilometers west of the site. The UNEP post-conflict assessment team visited the site and took ash samples.

5.1.7.5 Environmental Concerns

The following issues can be highlighted:

- Air pollution caused by persistent fires (nearly 3 weeks) resulted in the combustion of plastic products; possible emissions of dioxins and VOCs;
- Deposition of dust and pollutants on nearby agricultural land is a soil pollution concern;
- Veterinary waste constitutes a health concern;
- No concerns regarding water pollution is expected since groundwater is very deep at the site.

5.1.8 TRANSMED S.A.L.

5.1.8.1 Location

The site is located in Choueifat, Mount Lebanon. A serum producing factory is located to its North, bare land to its East, and the airport to its West. It is constructed on a leveled surface. The Ghadir River is at a distance of 250 meters.

5.1.8.2 Source of damage

The site was damaged by direct Israeli hit (bunker buster).

5.1.8.3 Damage Description

The site is located within the industrial zone of Choueifat; it is a storage facility (Figure 5.10). The facility is known to store recycled paper, carton and plastics. Household cleaning products and batteries are also found. Structural damage to the site is significant. The entire site was damaged leaving a significant amount of demolition waste, composed primarily of metal beams and aluminum sheets. Bunker buster destroyed basement and fractured rock underneath the site. The attack ignited a fire which burned for 18 days, reducing most of the stored products to ash. Residues of the charred products are on-site. Petrol cans are also on-site. Contamination can be classified as industrial due to the presence of liquid chemicals, batteries, and refrigerators covering an area of 2,000 m^2. No agricultural lands or residential areas are found in the vicinity.

Figure 5.10. Transmed Storage House

5.1.8.4 Post-conflict Initiatives

UNEP post-conflict assessment team visited the site and collected samples for analysis.

5.1.8.5 Environmental Concerns

The following issues of concern can be highlighted:

- Burnt chemical products left onsite pose a source of soil contamination;
- Air pollution is an issue due to the nature of the combusted materials (including chlorine containing materials); dioxin may potentially be found in the vicinity;
- The piled combusted materials constitute a source of hazardous materials (waste); potential of soil contamination is believed to be high;
- Area is susceptible to flooding – potential for pollution from run-off;
- Petrol cans are present onsite posing pollution potential after rain;
- Potential contamination from run-off of burnt household detergents is possible.
- Demolition wastes can be contaminated with potentially hazardous materials.

5.1.9 FINE TISSUE FACTORY

5.1.9.1 Location

The site is located in Kfar Jarra, South. Few houses are located to its North, a carton factory to its East, and open area to its South and West. The factory is constructed on a hilltop.

5.1.9.2 Source of Damage

The site was damaged by direct Israeli hit.

5.1.9.3 Damage Description

The site was completely destroyed (Figure 5.11). Some stored fuel barrels and generators were burned and evidence of leakage is present. All stored products and facility's machinery were completely damaged. The underground fuel storage tank was not damaged and is still full. A water well is present on-site. Surrounding area is cemented.

Figure 5.11. Fine Tissue Factory

5.1.9.4 Post-conflict Initiatives

UNEP post-conflict assessment team visited the site.

5.1.9.5 Environmental Concerns

The following issues can be highlighted:

- Large burn scar from oil/gasoline/diesel stored above ground pose concerns of minor soil contamination;
- Air pollutants could be emitted due to the combustion of some paper products. Use of Chlorine for bleaching not confirmed. However, dioxin may be present;
- Low concerns of groundwater contamination are expected since water table is deep (170-180 m).

5.1.10 LEBANESE COMPANY FOR CARTON MINCE AND INDUSTRY

5.1.10.1 Location

The site is located in Choueifat, Mount Lebanon. The Ghadir River is located at its East, a cow farm is located at its South and a secondary road at its West. The factory is built on a leveled surface/barren land.

5.1.10.2 Source of Damage

The site was affected by collateral damage.

5.1.10.3 Damage Description

The site is a food and household chemicals storage area (Figure 5.12). Paper and plastic products have burned. The site is located at the proximity of the Ghadir River. Solid wastes as well as combusted plastics are piled on site.

5.1.10.4 Post-conflict Initiatives

The land where damaged products were initially collected was emptied and most of the wastes were dumped on the bank of the Ghadir River (Figure 5.13). UNEP post-conflict assessment unit visited the site and took ash and water samples.

5.1.10.5 Environmental Concerns

The following issues can be highlighted:

- Ghadir water pollution might end up in sea; there is also a flooding risk caused by the dumping of the waste into the river stream;
- No evidence of dangerous chemicals on-site; air pollutants (including dioxin emissions) might have been released due to fires.
- Solid waste (hazardous in nature) from plastics and other could pose a threat.

Figure 5.12. Lebanese Company for Carton Mince and Industry

Figure 5.13. Waste being Dumped into the Ghadir River Stream

5.2 ENVIRONMENTAL ACTION PLAN

The impacts of the most severely affected industrial sites are assessed in the media chapters (mainly soil and water), and actions plans to address potential pollution are proposed accordingly, where relevant.

In this chapter, actions to promote the greening of the damaged industrial facilities are proposed. However from the nine listed industrial facilities, only two were assessed as having potential for greening, namely Maliban Glass Factory and Ghabresh Detergent Factory.

Al Arz textile factory is a very small factory with limited potential environmental impacts; the factory weaves textiles from imported threads. Saffieddine Plasti-med uses raw plastic material to produce serums and other medical supply material. Lamartine is a small factory producing confectionaries (mainly chewing gum) posing no major environmental impacts. Liban Lait already owned state-of-the-art technology, and hence it is believed that there is limited room for substantial improvements.

Transmed and Lebanese Co. for Carton Mince & Industry are storage houses. The Fine Tissue Industry imports ready tissue roles from Jordan and cuts the roles to standard tissue sizes with packaging.

It is also important to note that no data are available as to the technologies used in the two assessed industries. Therefore, the following section relies on the assumption that the industries were not equipped with best available technologies (BAT). The following sections present main issues of concern and guidelines that could be followed or promoted during the reconstruction of these facilities.

5.2.1 GLASS INDUSTRY

5.2.1.1 Energy Consumption and Pollutant Emissions

The main environmental problem associated with container glass production is that it is a high temperature, energy intensive process. This results in the emission of products of combustion and the high temperature oxidation of atmospheric nitrogen; i.e. sulfur dioxide, carbon dioxide, and oxides of nitrogen. Furnace emissions also contain dust (arising from the volatilization and subsequent condensation of volatile batch materials) and traces of chlorides, fluorides and metals present as impurities in the raw materials.

5.2.1.2 Water pollution

In general, glass container production should not present significant water pollution problems. Water is used mainly for cleaning and cooling and can be readily treated or reused.

5.2.1.3 Technical Improvements and Best Available Technologies

Technical solutions are possible for minimizing emissions, but each technique has associated financial and environmental implications. Major environmental improvements have been made within the sector, with major reductions in furnace emissions and energy usage. In particular, advances have been made with primary emission reduction techniques for oxides of nitrogen and sulphur dioxide.

5.2.1.3.1 Furnace (Melting Technique)

The melting techniques range in size from small pot furnaces to large regenerative furnaces producing over 600 tonnes of glass a day. In the case of Maliban, the production is about 200 tonnes/day. The choice of melting technique depends on many factors but particularly the required capacity, the glass formulation, fuel prices, and existing infrastructure. The choice is one of the most important economic and technical decisions made for a new plant or for a furnace rebuild. The overriding factors are the required capacity and the glass type.

5.2.1.3.2 Regenerative Furnaces

The choice between regenerative or recuperative furnace is an economical and technical decision that is not generally a significant consideration in the determination of BAT. However, the best technical and most economical way of producing high volume float glass is from a large cross-fired regenerative furnace.

The alternatives are either still not fully proven in the sector (e.g. oxy-fuel melting) or compromise the economics or technical aspects of the business (e.g. electric melting or recuperative furnaces). The environmental performance of the furnace is a result of a combination of the choice of melting technique, the method of operation, and the provision of secondary abatement measures. From an environmental perspective, melting techniques that are inherently less polluting or can be controlled by primary means are generally preferred to those that rely on secondary abatement. However, the economic and technical practicalities have to be considered and the final choice should be an optimized balance. **Use of regenerative furnaces are advised**.

These furnaces are generally more energy efficient than other conventional fossil fuel fired furnaces due to the more efficient combustion air preheating system. The low energy use per tonne of glass melted leads to reductions in many of the pollutants associated with combustion. However, the high preheat temperatures favor higher NO_x formation. With primary emission control techniques, NO_x reduction can be ensured. Of the two types of regenerative furnace, the end-fired furnaces tend to show better energy efficiency and lower emissions. The high capital cost of regenerative furnaces means they are normally only economically viable for large-scale glass production (generally more than 100 tonnes per day although there are examples of smaller furnaces).

5.2.1.3.3 Air Pollution Abatement

In soda-lime glasses, the main component of the dust is sodium sulphate (up to 95 %). Sodium sulphate is not considered harmful in itself, but as a solid it contributes to the emission of particulate matter. Several species of metals may also be found in the particulate matter from glass furnaces. Main components of concern are selenium (Se), lead (Pb), chromium (Cr), copper (Cu), vanadium (V), nickel (Ni), antimony (Sb), arsenic (As), cadmium (Cd), zinc (Zn) and manganese (Mn). The emission of these components strongly depends on the quantity and quality of recycled glass (cullet) used, whether or not fuel oil is used and the addition of metals to the batch formulation for coloring and/or decoloring the glass. Most of these components are predominantly bound in the particulate matter. However, especially for selenium, cadmium, lead and zinc, volatile emissions of these substances may also be significant. De-dusting **(electrostatic precipitator or bag filter system**, operating where appropriate, in conjunction with a dry or **semi- dry acid gas scrubbing system**) equipments are to be installed to reduce of emissions of (heavy) metals, either volatile or incorporated in the dust.

5.2.1.3.4 Chromium

Replacing Chromium(VI) with Chromium(III) is also advisable, since Chromium metal and chromium(III) compounds are not usually considered health hazards, but chromium (VI) compounds are toxic.

5.2.1.3.5 Non-melting Activities

The main source of emissions to air from non-melting activities in container glass production is the hot end coating operation. The first step in reducing emissions is to minimize the usage of the coating commensurate with the product requirements. The use of the material can be further optimized by ensuring good sealing of the application areas to minimize losses. The best option is **wet scrubbers**, which can be effective in reducing gaseous emissions but their effectiveness in treating fine dusts is limited by the pressure drop across the system. The performance will depend on the inlet composition, but a single stage scrubber may be sufficient to achieve compliance with most European requirements. If further reductions were desired then either a **bag filter** followed by **packed bed scrubber**, or a **venture scrubber** followed by **packed bed scrubber** is advised. These techniques could reduce HCl to less than 10 mg/Nm^3, particulates to 5–10 mg/Nm^3, and total metals to 1–5 mg/Nm^3. The costs of these alternatives will depend on the waste gas volume. Local circumstances may mean that comparable figures can be achieved with less sophisticated methods.

5.2.1.4 Costs

Combustion modifications can substantially reduce emissions of pollutants, along with fuel type (e.g., low sulfur content). The costs of combustion modifications are relatively low and can sometimes be off set by lower operating costs from energy savings. Low burner systems cost between USD 125,000 and USD 675,000 per furnace depending on size and type, and a further USD 80,000 to USD 110,000 can be added for monitoring and control systems. The costs for burners represent replacement costs not the additional costs; for a new furnace the extra costs would be very low.

5.2.2 DETERGENT INDUSTRY

The term detergent product applies broadly to cleaning and laundering compounds containing surface-active (surfactant) compounds along with other ingredients. Detergents can be in powder or liquid forms.

5.2.2.1 Ingredients and their Environmental impacts

The following list of ingredients commonly used in the manufacturing of detergents along with their respective environmental impacts serve as an introduction to the environmental issues concerning detergent manufacturing.

5.2.2.1.1 Alkyl benzene sulfonates or ABS (also linear alkyl benzene sulfonates or LAS, linear alkyl sodium sulfonates)

This is a class of synthetic surfactants, usually identified as "anionic surfactants." ABS are **very slow to biodegrade** and seldom used. LAS, however, are the most common surfactants in use. During the manufacturing process, carcinogens and reproductive toxins such as benzene are released into the environment. While LAS do biodegrade, they do so slowly and are of low to moderate toxicity. LAS are synthetic. The pure compounds may cause skin irritation on prolonged contact, just like soap. Allergic reactions are rare. **Since oleo-based alternatives are available, LAS should not be used**.

5.2.2.1.2 Alkyl phenoxy polyethoxy ethanols (also nonyl phenoxy ethoxylate or nonyl phenol)

This is a general name for a group of synthetic surfactants. They are **slow to biodegrade** in the environment and have been implicated in chronic health problems; even in trace amounts, they can activate estrogen receptors in cells, which in turn alters the activity of certain genes. For example, in experiments they have been found to stimulate the growth of breast cancer cells and feminize male fish. One member of this family of chemicals is used as a common spermicide, indicating the general level of high biological toxicity associated with these compounds. **These should not be used.**

5.2.2.1.3 Artificial fragrances

Artificial fragrances are made from petroleum. Many do not degrade in the environment, and may have toxic effects on both fish and mammals. Additionally, they often can cause allergies in certain persons and skin or eye irritation.

5.2.2.1.4 Diethanolamines (also diethanolamine, triethanolamine and monoethanolamine)

A synthetic family of surfactants, this group of compounds is used to neutralize acids in products to make them non-irritating. Diathanolamines are slow to biodegrade and they react with natural nitrogen oxides and sodium nitrite pollutants in the atmosphere to **form nitrosamines**, a family of potent carcinogens.

5.2.2.1.5 EDTA (ethylene-diamino-tetra-acetate)

EDTA is a class of synthetic, phosphate-alternative compounds used to reduce calcium and magnesium hardness in water. EDTA is also used to prevent bleaching agents from becoming active before they're immersed in water and as a foaming stabilizer. EDTA **does not readily biodegrade** and **once introduced into the general environment can re-dissolve toxic heavy metals trapped in underwater sediments, allowing them to re-enter and re-circulate in the food chain**.

5.2.2.1.6 Optical brighteners

Optical brighteners are a broad classification of many different synthetic chemicals that, when applied to clothing, convert UV light wavelengths to visible light, thus making laundered clothes appear "whiter." Their inclusion in any formula does not enhance or affect the product's performance in any way; they simply trick the eye. Optical brighteners **do not readily biodegrade**. They are **toxic to fish** when washed into the general environment and **can create bacterial mutations**. They can cause allergic reaction when in contact with skin that is exposed to sunlight.

5.2.2.1.7 Petroleum distillates (also naphthas)

A broad category encompassing almost every type of chemical obtained directly from the petroleum refining process. Any ingredient listed as a "petroleum distillate" or "naphtha" should be suspect as it is, firstly a synthetic and, secondly, likely to cause one or more detrimental health or environmental effects.

5.2.2.1.8 Phosphates

A key nutrient in ecosystems, phosphates are natural minerals important to the maintenance of all life. Their role in laundry detergents is to remove hard water minerals and thus increase the effectiveness of the detergents themselves. They are also a deflocculating agent; that is, they prevent dirt from settling back onto clothes during washing. While relatively non-irritating and non-toxic in the environment, they nonetheless contribute to significant eutrophication of waterways and create unbalanced ecosystems by fostering dangerously explosive marine plant growth. For these reasons they are banned or restricted in many countries. Products containing phosphates should be considered unacceptable.

5.2.2.1.9 Polycarboxylates

Similar in chemical structure to certain plastics and acrylic compounds, these are relatively new, synthetic phosphate substitutes. Because they are recent additions to the consumer product chemical arsenal, however, their effects on human and environmental health remain largely unknown. Though tests show they are non-toxic, do not interfere with treatment plant operation and generally settle out with the sludge during water treatment, until further study and analysis are conducted, use of this ingredient is not recommended. Further, they **are not biodegradable** and are petroleum based.

5.2.2.1.10 Polyethylene glycol (also PEG)

Another type of anti-redeposition agent, PEG is a polymer made from ethylene oxide and is similar to some non-ionic detergents. Not considered toxic, it takes large doses to be lethal in animals. However, PEG **is slow to degrade** and is synthetic.

5.2.2.1.11 Quaternium 15

It is an alkyl ammonium chloride used as a surfactant, disinfectant and deodorant that releases formaldehyde, **a potent toxin**.

5.2.2.1.12 Xylene sulfonate

Xylene is a synthetic that, when reacted with sulfuric acid, creates a surfactant. **Slow to biodegrade in the environment and moderately toxic**.

5.2.2.1.13 Zeolite A

Zeolite A is an inert, insoluble alumino-silicate. It was also shown to be a cost-effective alternative, both in terms of socio-economic and environmental impacts, to the use of STPP as a detergent builder. Only minor differences would be observed in overall production cost in terms of energy used and sludge produced. It is non toxic to aquatic fauna and humans and produces less toxic waste by-products.

5.2.2.2 Air Pollution

The main atmospheric pollution in detergent manufacturing is odor. The sources of this odor are mainly the storage and handling of liquid ingredients (including sulfonic acids and salts) and sulfates. Also, vent lines, vacuum exhausts, raw material and product storage, and waste streams are all potential odor sources. Control of these odors may be achieved by **scrubbing exhaust fumes** and, if necessary, incinerating the remaining volatile organic compounds. Odor emanating from the spray drier may be controlled by scrubbing with acid solution.

Blending, mixing, drying, packaging, and other physical operations may all involve dust emissions. The production of soap powder by spray drying is the single largest source of dust in the manufacture of synthetic detergents. The large particulates emitted from detergent manufacture can be prevented using high-efficiency cyclones installed is series. The largest contaminants are fine detergent particles and organics vaporized in the higher temperature zones of the detergent spray drying tower. Table 5.2 indicates the efficiency (in emission factors) of different technologies in particulate removal.

Table 5.2. Particulate Emission Factors for Detergent Spray Drying[140]

Control Device	Efficiency (% removal)	Kg/Mg of Product
Uncontrolled	0	45
Cyclone	85	7
Cyclone with:		
Spray chamber	92	3.5
Packed scrubber	95	2.5
Venturi scrubber	97	1.5
Wet scrubber	99	0.544
Wet scrubber/ESP*	99.9	0.023
Packed bed/ESP	99	0.47
Fabric filter	99	0.54

* Electrostatic precipitator

The dust particulates principally consist of detergent compounds, although some of the particles are uncombined phosphates, sulfates, and other mineral compounds. Dry cyclones and cyclonic impingement scrubbers are the primary collection equipment employed to capture the detergent dust in the spray dryer exhaust for return to processing. Dry cyclones can be used in parallel or in series to collect this particulate matter and recycle it back to the crutcher. The dry cyclone separators can remove 90 % or more by weight of the detergent product fines from the exhaust air. Cyclonic impinged scrubbers can be used in parallel to collect the particulate from a scrubbing slurry and to recycle it to the crutcher.

Secondary collection equipment can be used to collect fine particulates that escape from primary devices. Cyclonic impingement scrubbers can often be followed by mist eliminators, and dry cyclones followed by fabric filters or scrubber/electrostatic precipitator units. Several types of scrubbers can be used following the cyclone collectors. Venturi scrubbers have been used but are being replaced with packed bed scrubbers. Packed bed scrubbers are usually followed by wet-pipe-type electrostatic precipitators built immediately above the packed bed in the same vessel. Fabric filters have been used after cyclones but have limited applicability, especially on efficient spray dryers, due to condensing water vapor and organic aerosols binding the fabric filter.

In addition to particulate emissions, volatile organics may be emitted when the slurry contains organic materials with low vapor pressures. The VOCs (hexane, methyl alcohol, 1,1,1-trichloroethane, perchloroethylene, benzene, and toluene) originate primarily from the surfactants included in the slurry. The amount vaporized depends on many variables such as tower temperature and the volatility of organics used in the slurry. These vaporized organic materials condense in the tower exhaust airstream into droplets or particles. Paraffin alcohols and amides in the exhaust stream can result in a highly visible plume that persists after the condensed water vapor plume has dissipated.

[140] AP 42, Fifth Edition, Volume I Chapter 6: Organic Chemical Process Industry

Lead was identified as the only heavy metal constituent. No numerical data are presented for lead, hazardous air pollutants, or VOC emissions due to the lack of sufficient supporting documentation.

5.2.2.3 Water Consumption

At a liquid detergent production site where several different products are produced, there is a need to clean the equipments to avoid cross-contamination of products types. This process can create a large load of water demand as well as contamination. Therefore, and to reduce water demand, recycling of the water used within the process of the detergent manufacture is recommended.

Optimization of the water management in a liquid detergent production plant can be implemented according to the concept for retrofit optimization of water networks (CROWN) strategy, in order to reduce freshwater consumption and the costs for wastewater disposal. The plants are frequently cleaned by a cleaning in place (CIP) system. The disposals of the CIP wastewater batches with high loads of detergent products are economically the most important streams. The key species in the CIP wastewater are basically surfactants; additional components are dyes, salts, ethanol and other additives that are found in low concentrations.

The organic load of the CIP wastewater varies in the range of 60–120 kg COD/m^3. To treat this water, a prefiltration is recommended. For the separation of surfactants from aqueous solutions the following feasible unit operations are given in literature:

- Ultrafiltration (UF) for the retention of surfactant micelles
- Nanofiltration (NF) for the retention of surfactant monomers
- Fixed bed adsorbers
- Foam fractionation
- Biological degradation

Foam fractionation, chemical precipitation and adsorption can be precluded due to the high feed loads. The biological treatment produces high amounts of sludge for the same reason but the operation is inexpensive. The membrane systems work with a water conversion factor of about 80–90% even for the high feed concentrations. The NF produces a pure uncoloured permeate but the energy consumption and total surface area demand are higher than for the UF system.

A feasible combination, e.g. is the reduction of the organic load of the water stream with an UF process and an additional biological treatment of the permeates. Another option is the separation of the water with a NF step and a following enrichment of the retentate with UF. The recycle stream usually has to be disinfected (e.g. electrochemical disinfection or ozonation).

The initial water network should be subjected to a Water Pinch analysis in order to find possible links and potential for flow rate reduction. In the production of liquid detergents, deionized water is part of the product formulations. For this purpose, large quantities are necessary which are produced in a reverse osmosis (RO) plant causing large amounts of retentate. As the feed of the RO plant is softened by an ion exchanger, the retentate can be reused as rinsing water and cooling tower blow down water after a disinfection step to address microbiological concerns.

Analysis shows that 70% of the total wastewater disposal costs are caused by the relatively small amount of CIP rinsing water stream that comes from the hot water cleaning processes accomplished after every product change. The chemical oxygen demand (COD) load of this fraction is the main expense factor for wastewater disposal costs. The total freshwater consumption can be reduced by about 13% with the implementation of a membrane filtration step and disinfection if the inevitable amount of product water is not taken into account.

The application of ultrafiltration or nanofiltration membrane processes can be utilized for the separation of surfactants from CIP rinsing waters. Chemical Oxygen Demand reductions of up to 96% can be achieved which results in less negative environmental impact and lower wastewater disposal costs. So the integration of a membrane filtration step into the water network is technically appropriate and economically feasible.

5.2.2.4 Maintenance

One of the most common problems in detergent factories is the maintenance and upkeeping of the machines. Most industries have the same problem which is machine breakdown, the machines need repairs and in order to improve the operation efficiency of the factory or company to maintain the status of the organization. Maintenance management must be applied for upholding production efficiency and decreasing production costs.

Other problems include machine idleness, production loss, too much maintenance man hours, too much maintenance expenses, and plant capacity loss. Three sections of the plant must cooperate in order to increase the production capabilities, the production section, the maintenance section, and the engineering section. Low productivity as a result of machine breakdown result from five main production areas, the silo and tank yard, slurry blending, spray drying, granulation and after blending. Environment improvement includes inspection of the machine before cleaning for any need of repairs. Cleaning of the machines is to be done using water, or brush or clothes and by broom depending on the machine condition. Rechecking the machine after cleaning it is essential. After it is cleaned, the machine needs to be improved by mending the immediate repairs first, and then developing a maintenance and monitoring plan.

5.2.3 FINANCIAL MECHANISMS/INCENTIVES

- Law 444/2002 stipulates incentives in terms of tax deductions for the procurement of environmentally friendly products.

- A Draft legislation on incentives to green industries was prepared by MoE but has never been adopted by the Council of Ministers; it is important to adopt such a legal document to encourage industrialists to invest in cleaner technologies.

5.2.4 LEGAL ASPECTS

Following legislation should be considered and their implementation assessed:

- Lebanon has acceded to the Kyoto Protocol by virtue of Law 738 (15/5/2006). This has paved the road for the possibility of channeling investments through the Kyoto Protocol's Clean Development Mechanism. The process of informing the UNFCCC Secretariat of Lebanon's ratification of the Kyoto Protocol is underway, and the establishment of a designated national authority is in the process of development. The country cannot benefit from CDM projects unless the above two requirements are fulfilled.

- The full implementation of ministerial decision (Ministry of Environment) 15/1 titled "Environmental Guidelines for the Establishment and/or Operation of Glass Industries" dated 14/03/2002.

- The full implementation of ministerial decision (Ministry of Environment) 29/1 titled "Environmental Guidelines for the Establishment and/or Operation of Industries Producing Cheese, Yogurt, Butter, and all Dairy Products" dated 31/05/2001.

- The full implementation of Decision of the Minister of Environment 8/1 "National Standards for Environmental Quality" dated 30/1/2001 and table 2 of Annex 10 of Decision of the Minister of Environment 52/1 "National Standards for Environmental Quality" dated 29/7/1996.

5.2.5 INSTITUTIONAL ASPECTS

- By virtue of several laws and decrees including Law 690/2005, it is the mandate of the Ministry of Environment to implement the articles stipulated in the UNFCCC and resulting protocols, i.e. Kyoto Protocol and CDM projects.

- The Ministry of Environment is the authority mandated to control the implementation of the ministerial decisions 29/1 and 15/1 dated 31/05/2001 and 14/03/2002 respectively.

- The Lebanese Center for Cleaner Production (LCPC) can play an important role in implementing and promoting the above recommendations.

- The Ministry of Industry and the other concerned parties are the authorities mandated to re-permitting for the damaged facilities.

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LEBANON

RAPID ENVIRONMENTAL ASSESSMENT FOR

GREENING RECOVERY, RECONSTRUCTION AND REFORM 2006

AGRICULTURE

6.1 DAMAGE ASSESSMENT

6.1.1 OVERVIEW OF SECTOR DAMAGE

The agriculture sector comprises plant production, animal husbandry, forestry and fisheries. These activities were all affected by the war. The Ministry of Agriculture (MoA) has assessed damage in the affected areas by use of questionnaires and field surveys during the month of September. The Food and Agriculture Organization (FAO) conducted a damage and early recovery needs assessments of agriculture, fisheries and forestry (FAO, 2006)[141]. Initial groundwork was carried out by MoA and served to support the Stockholm document prepared by the Lebanese government (GoL, 2006).

Damages on the agriculture sector that have an impact on the environment could be categorized as follows:

- Impact on forestry related to forest fires caused directly or indirectly by the war;
- Damage/destruction of storage houses for agricultural inputs (chemicals);
- Destruction of animal husbandry farms;
- Destruction of agriculture material and equipment;
- Soil compaction and contamination with white phosphorus (in agricultural land);
- Destruction of fresh water fisheries;
- Damage to marine fisheries from oil spill.

This chapter describes the nature of the damages, quantifying the damage when data is available, establishes the relation between damage and environmental degradation, and proposes actions to address those damages which could lead to further environmental deterioration if not tackled. The proposed measures also tap on the opportunity to green the agriculture sector in the affected areas, hence serving as lessons to be replicated in other areas of the country.

6.1.2 DAMAGED INFRASTRUCTURE

6.1.2.1 Forest Fires and Windbreak Destruction

The forestry sector sustained damage during the war. Numerous forest fires were ignited during the hostilities as well as after their cessation.

6.1.2.1.1 Location

A field survey undertaken by MoA and the Association for Forest Development and Conservation (AFDC) identified several forest fire locations. Figure 6.1 shows the rough

[141] FAO mission was to perform an early recovery needs assessment of agriculture, fisheries and forestry. The mission reviewed questionnaires filled out by MoA and carried out field surveys in different affected sites in order to validate some of the data provided by MoA. The mission experts proposed urgent relief projects or measures. However, neither the questionnaires nor the FAO mission reports tackled issues related to environment or other types of damages that are not directly related to the agriculture sector.

geographical distribution of these fires in the South. Figure 6.2 shows pictures of affected areas. The major fires occurred in the following villages:

<u>South Lebanon</u>: El Rihane, El Loueizeh, Mlita, Houmine el Tahta, Zawtar ech Charqiyeh, El Aaychiyeh (including El Wazahiyeh), El Mahmoudiyeh, Khallet Khazen, Fardis, Miri, Zebqine, Naqoura, Aalma ech Chaab (including Labbouneh), Aita ech Chaab, Ain Ebel, Beit Lif, Tiri, Srobbine, Mlikh, Msaileh, Hannine, Debel, Ramiyeh, Rmeich, Qawzah, Aitaroun, Al Soltaniyeh and Majdel Selm.

<u>Mount Lebanon</u>: Deir Qoubil, Aramoun, Bsaba-Baabda, Baaqline, Mazraat Bmohray, Jisr el Qadi, Chartoun, Bouzreidi, Selfaya, Remhala, Dfoun, Kfar Matta, Ain Trez, Zaarouriyeh, Salima, Qornayel and Bzebdine.

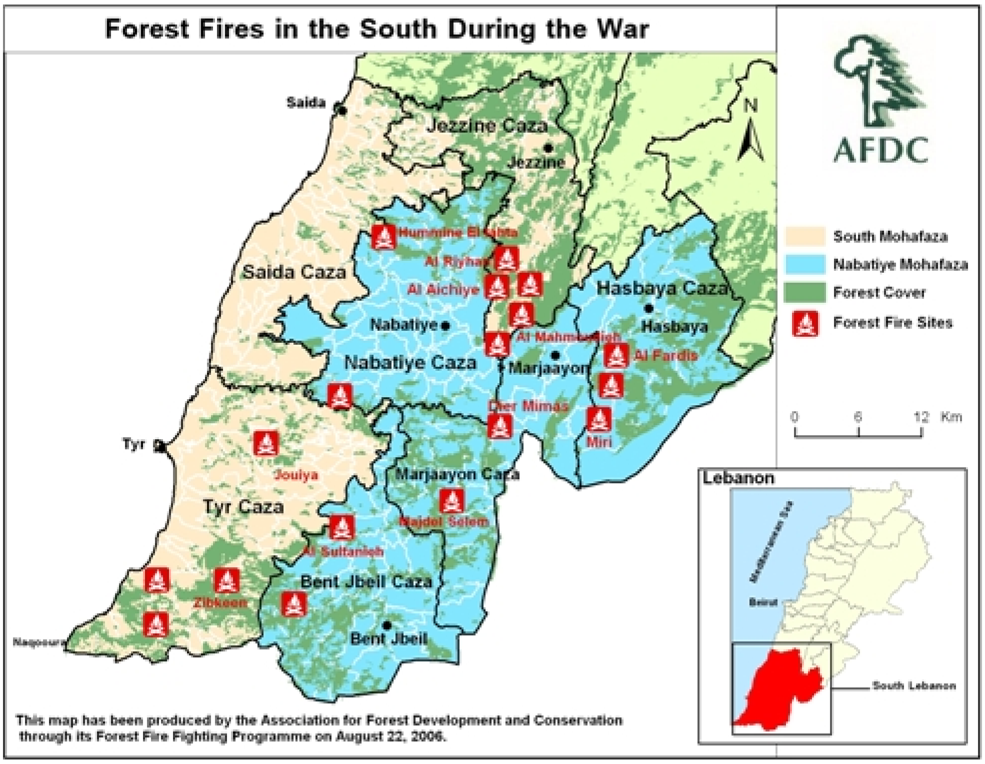

Figure 6.1. Overview of Forest Fires Sites in the South related to the War (Source: AFDC)

6.1.2.1.2 Source of damage

Fires were either accidental resulting from direct bombing (South Lebanon) or fallen flares (Deir Qoubil, Bsaba, Mazraat Bmohrai), or deliberate resulting from torching of the land to clear it from UXOs (Naqoura-Labbouneh). Fires also resulted from negligence and sometimes the incapacity of the civil defense and the Lebanese army to contain and extinguish the flames when Lebanon was under siege.

(a) Fires in Brutia pine stand due to flares in Aramoun

(b) Forest damage due to military actions in Labbouneh

(c) Burned broadleaved forest in the Chouf reserve-Mazraat Bmohray

(d) Burned stone pine forest in Selfaya-Remhala

Figure 6.2. Photographic Illustration of Areas Damaged by Forest Fires

6.1.2.1.3 Damage description

The total burned area was roughly estimated by MoA through a preliminary survey. MoA estimated that more than 100 ha of forest fires occurred in Mount Lebanon during the war; this number increased to more than 900 ha after the war. In South Lebanon, it is estimated that more than 800 ha of forests and other wooded land was burnt during the war. Table 6.1 shows the estimated area of forest and other wooded land affected by caza in Mount Lebanon and South Lebanon. The FAO assessment estimated a larger affected area by including indirect impacts on Juniperus excelsa mainly related to illegal cutting.

The significance of the damage differs from site to site. Stone pine (*P. pinea*) forests are located on sandstone soils and are unable to regenerate. In such a case, the impact on the environment may be manifested in an accelerated rate of soil erosion if the original forest formation (i.e. prior to the stone pine plantation) does not regenerate or is not allowed to, and if reforestation is not undertaken. Brutia pines (*P. brutia*), on the other hand, rapidly regenerates after a fire, although soil may be subject to degradation and erosion. Broadleaved forests and other wooded lands will regenerate if the fire is not totally destructive. However, regeneration may be difficult in some stands due to subsoil fires, land degradation, and soil erosion.

Moreover, the second phase of the reforestation plan that is undertaken by MoE, has been indirectly affected. The contracted company was unable to perform maintenance and protection activities during the summer, which also had a negative impact on the reforested sites all over the country.

Table 6.1. Estimated Area of Forest and Other Wooded Land (OWL) affected per caza in Mount Lebanon and South Lebanon (between July 12th and September 30th) (MoA)

Caza	Type of forest affected	Total forest area (ha)*	Affected forest area (ha)
Bent Jbeil	Broadleaved forests and OWL	939	100
Hasbaya	*P. pinea* and OWL	3407	30
Jezzine	*P. pinea* and OWL	7072	450
Sour	Broadleaved forests and OWL	2802	150
Nabatiyeh	OWL and mixed conifers	1504	70
Chouf	Broadleaved forest	10462	70
Aaley	*P. pinea* and *P. brutia*	4651	900
Baabda	*P. brutia* and OWL	7073	30
Total		37,910	1,800

* Source: Beydoun and Stephan, 2005

6.1.2.1.4 Post-conflict initiatives

A rough assessment of the burned surface area and type of burned species was performed by MoA engineers, the FAO team, and AFDC members. The United Nations Environment Programme (UNEP) post-conflict assessment team used remote sensing techniques to provide a more accurate estimate of the damaged areas. MoE has planned to undertake field visits during spring 2007 in order to further assess damage of the reforested sites.

6.1.2.1.5 Environmental concerns

Issues of environmental concern related to forest fires include primarily the following:

- Air pollution;
- Loss of biodiversity in forest ecosystems;
- Land degradation, including the loss of the water capacity and soil fertility of forest and other wooded land due to organic matter mineralization and soil erosion;
- Increase in wind erosion due to windbreak destruction.

6.1.2.2 Destruction of Storage Houses

Several storage houses of agricultural inputs, particularly fertilizers and pesticides, were destroyed during the war, representing a possible source of environmental impact. Storage houses are small modest huts made of cement and are scattered in agricultural land. Most chemicals are either found in these storage rooms or in farmers' houses (Nahhal I., 2006).

6.1.2.2.1 Location

Neither MoA nor FAO missions surveyed storage houses. Al Safir newspaper[142] cited in one article that 170 agriculture-related facilities were damaged, without specifying the type of construction or content. According to the land use/land cover map (MoE, 2002), the major agricultural lands in South Lebanon are located in the villages to the East and South of Tyre (Abbasiyeh, Borj Al Chemali, Rachidiyeh, Mansouri, Henniyeh, Qleileh…) and Khiam plain. Those are believed to be the most affected areas.

6.1.2.2.2 Source of damage

The main source of damage is from direct military activities.

6.1.2.2.3 Damage description

The quantities of fertilizers and pesticides that may have been discharged into the environment are not known and are difficult to estimate given the lack of records in such storage houses.

6.1.2.2.4 Post-conflict initiatives

Neither the MoA surveys nor the FAO mission reports tackled issues related specifically to storage houses of agricultural products. Some storage houses were subject to destruction as they were suspected to be bases for rocket launching. Farmers and engineers in South Lebanon confirmed that some of these small storage houses were destroyed, but an assessment of the number of destroyed units, their location, and the type of agricultural products stored inside has not yet been carried out.

6.1.2.2.5 Environmental concerns

Main issues of environmental concern are explained in Table 6.2 which lists possible impacts depending on the pathway of contamination.

6.1.2.3 Destruction of Animal Husbandry Farms

6.1.2.3.1 Location

The largest farms that were damaged during the war are located in Baalbeck (Tanmia, Libanlait), Ksara (Nahhas), and Choueifat-Dahyieh (sheep, goat and cow meat production farms). In South Lebanon, small scale farms in Tyre, Bent Jbeil, Marjayoun, Jezzine and Nabatieyh cazas were also damaged.

[142] Al Safir newspaper, August 26, 2006.

Table 6.2. Issues of Environmental Concern related to the Discharge of Pesticides and Fertilizers into the Environment

Pathway	Origin	Issues of Environmental Concern
Air	Vaporization and dissemination followed by eventual degradation by UV light	■ Possible impacts on humans health due to SO_2 emissions ■ Minor contribution to global warming (mainly through CO_2 emissions)
Water	Leaching by rain followed by percolation into the soil and ground water	■ High concentrations of nitrates in drinking water may cause blood disorders in babies and infants (blue baby disease) ■ Higher concentration of pesticides and nitrates in irrigation water may lead to plant phytotoxicity, mineral deficiency, and yield decrease
Soil	Direct deposition on the soil surface and vegetation cover of dioxins and metabolites from burnt chemicals	■ Possible plant phytotoxicity and deterioration of animal health

6.1.2.3.2 Source of damage

Animal husbandry farms were damaged through direct bombing. Losses are also attributed to abandonment of farms by farmers seeking safer regions.

6.1.2.3.3 Damage description

The number of animals lost amounts to 3,050 head of dairy cattle, 1,250 bulls, 15,000 head of goats and sheep, 18,000 beehives and over 600,000 broilers (FAO, 2006).

6.1.2.3.4 Post-conflict initiatives

In most cases, carcasses were left to decompose in the open air or left to burn after direct bombing. In some cases carcasses may have been dumped near rivers, burned or buried.

6.1.2.3.5 Environmental concerns

The inappropriate disposal of dead animals can lead to several impacts on the environment. Potential impacts are summarized in Table 6.3.

Table 6.3. Potential Impacts resulting from Inappropriate Disposal of Dead Animals

Pathway	Origin	Issues of Environmental Concern
Air	Decomposition or burning of dead cattle and aviary	■ Smell and pathogen spores released ■ Smoke released from burned carcasses
Water	Dumping of dead carcasses and aviary into surface waters (mainly the Litani River and tributaries in the Bekaa)	■ Oxygen depletion in case of excessive organic loading, possibly leading to eutrophication problems
Soil	Dumping of dead carcasses	■ Possible groundwater contamination depending on location

6.1.2.4 Destruction of Agriculture Equipment and Material

Agriculture equipment and material include machinery related to agriculture and irrigation, greenhouse structures, irrigation systems, and mulch. These were often subject to destruction in conflict areas and along the roads in South Lebanon and the Bekaa.

6.1.2.4.1 Location

Data on the location of damaged equipment and material is not available. The only specific location that can be mentioned where agriculture equipment was damaged is the Ouzaii fishing port in Mount Lebanon. However, various other equipment and material was damaged in South Lebanon and the Bekaa.

6.1.2.4.2 Source of damage

The source of damage is either through direct bombing (i.e. direct hit) or indirect bombing (i.e. shrapnel) of agriculture equipment and material.

6.1.2.4.3 Damage quantification

MoA identified 20 ha of directly hit greenhouses, and a total of 100 public and private nurseries almost all of them in South Lebanon (most of the damaged private nurseries are in Nabatieh). The MoA assessment covered mainly the crop losses and major infrastructure damage (greenhouses and irrigation systems) but did not focus on other damaged material (plastic, mulch, pots…). About 150 tractors and agriculture machinery were estimated to have been damaged in Saida, Tyre, Nabatiyeh, Bent Jbeil and Marjayoun (Al Safir, August 26, 2006). Also around 320 fishing boats, including wood and fiberglass boats, nets, traps and engines, were partially or totally damaged in Ouzaii fishing port according to the MoA assessment[143].

6.1.2.4.4 Post-conflict initiatives

The government of UAE, UNDP and Hezbollah have provided direct support to fishermen.

6.1.2.4.5 Environmental concerns

Environmental concerns are primarily related to the generation of special wastes that need to be disposed of. Equipment and engines can include oil and chemicals which could leak into the soil and water bodies, leading to their pollution. Burning of greenhouses can cause localized air pollution and generate dioxins through the burning of chlorinated plastic material. The melted plastic from the burnt greenhouses also constitutes a waste product that needs to be disposed of.

[143] MoA and FAO teams visited the Ouzaii port after the war. The FAO-MoA fishing vessels census conducted in 2005 had already inventoried the fishing vessels of Lebanon.

6.1.2.5 Compaction of Agricultural Land

6.1.2.5.1 Location

Agricultural lands close to the southern border in the villages of Ghajar, Sarada, Khiam and Kfar Kila were subject to intense military actions which made these areas subject to soil compaction.

6.1.2.5.2 Source of damage

Compaction of agricultural land is primarily caused by the movement of heavy military vehicles.

6.1.2.5.3 Damage quantification

Soil compaction symptoms cannot be revealed before heavy rainfall unless in-situ or laboratory tests are performed. When subject to heavy rains, compacted soils show water stagnation on their surface. However, due to the high security levels in the affected areas, site visits could not be performed to confirm that such phenomenon had taken place after heavy rains which have occurred after the war. While soil compaction can be easily remedied, subsoil compaction may persist for several years. The magnitude of this damage, however, is limited to the agricultural lands situated in the above-cited villages.

6.1.2.5.4 Post-conflict initiatives

No initiatives to address soil compaction related problems were identified during this assessment.

6.1.2.5.5 Environmental concerns

Excessive soil compaction would primarily lead to loss of soil fertility and increased rates of soil erosion. Loss of soil porosity and decrease in water retention capacity are not an issue of concern since the area subject to compaction is relatively small and mostly confined to flat land, which also makes the risk of flooding negligible.

6.1.2.6 White Phosphorous Contamination of Agricultural Lands

The use of white phosphorous-containing ammunition by the Israeli Defense Force (IDF) has been cited by several sources (i.e. FAS and ATSDR, 1997) [144]. Agricultural land in affected areas may consequently have been contaminated with that substance.

6.1.2.6.1 Location

All agricultural areas hit by ammunition, particularly South Lebanon and the Bekaa region, have probably been contaminated with white phosphorous. The area to the south of the Litani River is assumed to be the most affected by such contamination.

[144] Federation of American Scientists; Agency for Toxic Substances and Disease Registry www.fas.org

6.1.2.6.2 Source of damage

Main source of damage is white phosphorous-containing ammunition used by IDF. White phosphorous can lead to burning of surrounding crops and vegetation. Few studies tackled the persistence duration of white phosphorous in soil; on the other hand persistence was shown to be related to soil type and conditions; in the atmosphere, it quickly oxidizes and disintegrates (Walsh *et al.*, 1996).

6.1.2.6.3 Damage description

The JRC-EUSC report estimated the agricultural areas affected by white phosphorous to be less than 20 ha, distributed among hundreds of scattered plots south of the Litani River (without taking into consideration UXOs and white phosphorus that could be found in areas to the north of Litani as well as in the Khiam plain and in agricultural fields after harvest) (Buda and Al-Khudairy, 2006).

6.1.2.6.4 Post-Conflict initiatives

Farmers in the affected areas have started removing burned crops (mainly trees), which were burned by the white phosphorous. No sampling/ monitoring has so far been carried out.

6.1.2.6.5 Environmental Concerns

Environmental concerns related to the use of white phosphorous are summarized in Table 6.4 (ATSDR, 1997).

Table 6.4. Environmental Concerns and Contamination of Agricultural Lands with White Phosphorous

Pathway	Origin	Issues of Environmental Concern
Air	Rapid reaction with oxygen to produce relatively harmless chemicals within minutes.	■ The reaction with oxygen releases heat and facilitates the burning of the vegetation cover. ■ Breathing white phosphorus for short periods may cause coughing and irritation of the throat and lungs.
Water	White phosphorus reacts with oxygen within hours or days. In water with low oxygen content, it may degrade to a highly toxic compound called phosphine, which evaporates to the air and is eventually oxidized into less harmful chemicals.	■ White phosphorus can build up slightly in the bodies of fish that live in contaminated lakes or streams. The increasing phosphorous concentrations in surface waters raise the growth of phosphate-dependent organisms, such as algae. These organisms use large amounts of oxygen and prevent sunlight from entering the water. This makes the water fairly unlivable for other organisms.
Soil	White phosphorus may stick to particles and be changed within a few days to less harmful compounds.	■ In deep soil or sediments with little oxygen, white phosphorus may remain unchanged for many years.

6.1.2.7 Freshwater Fishery Destruction

Lebanon has 15 short permanently flowing rivers. Only Nahr Il-Kabir Al Janoubi is a relatively long one (58 km). Three of these rivers (Assi - 46 km, Litani - 160 km, and Hasbani - 21 km) are in the interior plains limited by Mount Lebanon on the west side and by Anti-Lebanon on the east side.

There are 4 hydrographic regions where aquaculture is practiced. These are the watersheds of Assi (Bekaa), Litani (Bekaa and South Lebanon), and Hasbani (South Lebanon), as well as the coastal areas of the north (North Lebanon).

There are around 150 trout culture stations or farms in Lebanon. These farms can be regrouped into 4 different regions with the same water source. The farms are concentrated in 4 areas of Bekaa, namely Zahle – Qaa El-Rim (in Zahle casa), Anjar (in western Bekaa casa), Yammouneh (in Baalbeck casa), and Hermel (in Hermel casa). Other farms are scattered in Bekaa mainly in Baalbeck, West Bekaa, Mount Lebanon and North Lebanon in different hydrolytic isolated points. The average annual production is 600 tons (Rainbow trout). During the Israeli hostilities, the Assi River was repeatedly hit along its banks in the area of Hermel and Al Zarka sections of Al-Assi (Bekaa). Assi River was bombarded on 3 occasions in 4 locations (14^{th} and 29^{th} of July and the 2^{nd} of August 2006).

6.1.2.7.1 Location

The locations that were hit are Maallaka (dam zone of Assi under construction), Al Zoueitini Area and Assi bridge, and Al Zarka river in West Bekaa.

6.1.2.7.2 Source of damage

Source of damage was from direct bombing of Assi river sites leading to destruction of nearby restaurants and fish farms scattered along the sides of the rivers that were hit (Figure 6.3).

6.1.2.7.3 Damage description

Based on preliminary field observations, it was estimated that a total of 305 tonnes of Rainbow trout in Assi river and another 30 tonnes in Al Zarka river were killed due to direct bombing or water contamination with weapon related residues. Impacts (i.e. dead fish) could be noticed one kilometer from bombarded areas (Al-Hawi, 2006). Large portions of dead fish were dumped or carried by effluents into the Assi River, potentially causing eutrophication of downstream lakes, ammonia problems, and possible contamination of wild populations.

The quality of fresh water, particularly water turbidity and pH, has possibly been affected by weapon related contaminants in the Assi (north Bekaa) and Al Zarka rivers (west Bekaa) leading to the loss of fish and other freshwater organisms.

Dumping of bomb-site demolition debris into the Assi river (north Bekaa) and Al Zarka rivers (west Bekaa) has also likely lead to losses in water organisms and changes in their habitat.

Figure 6.3. Damage to Freshwater Aquaculture Farms in Al Assi River

6.1.2.7.4 Post conflict initiatives

Initiatives to address the fresh water fisheries impact were not identified during this assessment.

6.1.2.7.5 Environmental concerns

The freshwater ecosystems of Assi (north Bekaa) and Al Zarka rivers (west Bekaa), home to numerous organisms (e.g., fish, amphibians, aquatic plants, and invertebrates), have been damaged. The fauna and flora of fresh water account for 987 species (Al-Zein, 1997). There are 25 fish species pertaining to the following families: *Cyprinidae, Cyprinodontidae, Cobitidae, Salmonidae, Anguillidae, Cichlidae, Mugilidae, Puciliidae, Blenniidae, Lutjanidea.* In addition, 10 species were introduced: *Salmo gaidneri and Salmo trutta fario (*Al Zein, 1997*), Salvelinus fontinalis, Cyprinus carpio, Gambusia affinis, Hypophthalmichthys molitrix, Rhopilema nomadic.* Endemic species include *Capoeta truttal and Phoxinellus syriacus* (Al-Hawi and Al Zein, 2004).

6.1.2.8 Marine Fishery

The marine fisheries sector was significantly affected by the war. Several seaports were subject to Israeli attacks which resulted in direct damages through the destruction of fishing boats, fishing equipment, and infrastructure. Additional damage was caused by the oil spill from the destroyed fuel reservoirs in Jiyeh, which affected the marine ecosystem and fish stock.

6.1.2.8.1 Location

The major direct damage due to bombing was sustained by the Ouzaii fishing port. The oil spill affected different sections of the seashore, including the fishing ports of Jiyeh, Ouzaii, Tabarja-Okaybe, Jbeil (Byblos), Fadaous (Kfar Abida), Batroun and Tripoli.

6.1.2.8.2 Source of damage

The Ouzaii fishing port was directly hit during air raids by the Israeli air force. The oil spill resulted from the Israeli bombing of oil storage tanks at the Jiyeh power plant and the subsequent leakage of oil into the sea and its drifting to the northern seashores of Lebanon. Damaged fishing boats at Ouzaii port are shown in Figure 6.4.

Figure 6.4. Damaged Fishing Boats in Ouzaii

6.1.2.8.3 Damage quantification

Dead fish were observed after the bombing of Ouzaii. Moreover, the fish stock may be affected indirectly later on due to the contamination of the continental shelf which serves as a nesting place. This may result in stock reduction in the medium term. The damage on the fishery sector therefore includes short and medium-term effects and can be categorized as follows:

Short term effects:

- Damage in the port of Ouzaii resulted in the loss of 328 boats with their gear, the auction hall, cafeteria, meeting rooms, workshop and boat yard (FAO, 2006).
- Fish (including demersal species like mollusks, crustaceans…) found in the seaports and on the seashore were directly affected by the oil spill and bombing, a factor that may lead to their contamination with oil and its derived products (MoA)[145].
- Fish catch of the artisanal fleet was presumably reduced. Adult fish avoid oil-affected areas in the coastal zone by swimming out to sea; however artisanal fleets cannot venture into the open waters beyond a certain distance (MoA).

Midterm effects: (Kineman *et al.*, 1980 and Baker *et al.*, 1990):

- Eggs and larvae may not escape the lethal effects of oil; therefore future fishing seasons could be negatively affected; the recovery period cannot be easily defined at this stage; nevertheless fish is normally able to efficiently metabolize oil contaminants, especially PAHs; the UNEP post-conflict assessment should provide more guidance on this issue;
- The marine ecosystem, fish and demersal species habitats may be affected by submerged oil in Jiyeh. The damage would be direct and localized habitats do not recover easily;
- Floating oil and heavy oil could have affected plankton, mollusks and crustaceans respectively.

6.1.2.8.4 Post-conflict initiatives

The following initiatives can be listed:

- MoA and the National Council for Scientific Research (NCSR), in coordination with MoE, are monitoring fish quality;
- Clean-up of seaports and coastal stretches is on-going (refer to biodiversity chapter);
- Fishermen have already removed the damaged boats from Ouzaii port; support from UNDP and the UAE government was obtained;
- The UNEP post-conflict environmental assessment team has taken samples and will provide more information on the impacts on fish stock.

6.1.2.8.5 Environmental concerns

The main issue of concern is related to the safety of future fish catches and the possibility of contamination via the food chain. The UNEP report provides more guidance and supportive information on this aspect.

[145] The MoA team and other institutes carried out several analyses on two demersal fish species ("Mwasta" and "Boori") and found them to be contaminated. Source: personal communication with Dr. Chady Mhanna

6.2 ENVIRONMENTAL ACTION PLAN

The environmental action plan for the agriculture sector focuses on opportunities to green the reconstruction of damaged infrastructure. Proposed action plans address:

1. Impact on forestry;
2. Risk of farmers changing to unsustainable cropping patterns in the South, particularly in the border areas;
3. Impact on fresh water aquaculture in the Assi River; and
4. Impact on marine fisheries.

6.2.1 ALLEVIATING ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS FROM STONE PINE FOREST DESTRUCTION IN LEBANON (DRAFT PROPOSAL)

6.2.1.1 Problem Statement and Rationale

A total of 1,800 ha of forest areas were directly or indirectly[146] affected by the war. The impact on the forestry sector and the livelihood of people is significant[147]. Besides their ecological importance, these areas are sources of livelihood to local communities and should therefore be restored. Stone pine forests, as opposed to other types like Brutia pines, do not regenerate, and human intervention is therefore critical.

The objective of this action is to initiate a reforestation program of the stone pine forest areas in the South, while taking into consideration socio-economic impacts. Local communities who incurred losses in income and revenue due to the loss of forestry resources are likely to exert further pressure on environmental resources. It is therefore important that alternative sources of livelihood be identified and secured for these communities before further environmental degradation occurs.

6.2.1.2 Proposed Actions

The proposed actions for this intervention can be summarized as follows:

1. Undertake an exhaustive field survey to assess the environmental and socio-economic impacts of the fires on land and the local community in the affected areas.
2. Prepare site-specific action plans that could include reforestation, enrichment, clearing, cutting of dead trees or simple protection, depending on site conditions;
3. Initiate removal of dead trees in stone pine stands based on above survey;
4. Rehabilitate the nurseries in the affected areas in order to produce the necessary seedlings (Tyre, Rmeich, Hammana, Chtaura and Aabdeh nurseries);

[146] Many reforestation sites have been indirectly damaged through the absence of maintenance and protection
[147] The MoE's reforestation program, particularly Phase II of the program in South Lebanon and the Bekaa, was significantly affected by the events of the war. In addition, indirect damage due to absence of maintenance measures affected some sites such as in Zawtar (15 ha).

5. Undertake awareness raising campaigns for forest fire prevention;
6. Implement reforestation activities in stone pine stands and ensure the maintenance of reforested plots for 2 years.
7. Propose alternative rangelands for shepherds in order to limit the grazing pressure.

6.2.1.3 Legal Aspects

Some legal aspects need to be taken into consideration:

- The cutting of conifer trees located inside forests is prohibited, even when the trees are dead or burned. This clause of Law 85 is a major obstacle for undertaking any action plan in burned forests and should be amended in order to address this issue.
- The removal of dead trees should be exempt from taxes and any related fees.

6.2.1.4 Institutional aspects

The main relevant institutions are the following:

- MoA is mandated to undertake reforestation activities and produce seedlings in the nurseries in the different regions of the country.
- MoA is responsible for all legal aspects related to forest management, range management and tree cutting licenses. MoA is also responsible for law enforcement through forest guards distributed in all cazas.
- MoE is implementing a program law to undertake reforestation activities which was initiated in 2002.
- MoE is responsible for the establishment and management of natural reserves.
- The Civil Defense and the Lebanese Army are the major actors in fighting forest fires. MoA forest guards are equipped with cars and small material for immediate intervention. Some municipalities, NGOs and CBOs have an important role in limiting fire extension and extinguishing starting fires.
- Some NGOs such as AFDC and SPNL are playing important roles in forest activities such as reforestation, forest fire protection and prevention, forest management, capacity building and awareness raising.
- UNIFIL and the Lebanese army are clearing forest areas from cluster bombs and are delineating contaminated areas.

6.2.1.5 Budgetary Estimate

The total budgetary estimate of such an intervention would amount to **USD 1,375,000**. The estimated budget breakdown is as follows:

1.	Detailed survey and site-specific assessment with preparation of action plans of damaged forest areas, including socio-economic assessment and identification of alternative livelihoods	50,000$
2.	Nurseries rehabilitation	225,000$
3.	Reforestation of 600 ha of stone pine forest and maintenance for 2 years	1,080,000$

4. Community awareness programs and identification of alternative source of revenue for affected populations 20,000$

6.2.1.6 Project duration

The duration of the proposed intervention is 2 years; it is recommended that the detailed survey be initiated as soon as resources are available.

6.2.2 PROMOTING SUSTAINABLE CROPPING PATTERNS IN AFFECTED AGRICULTURAL AREAS IN SOUTH LEBANON (DRAFT PROPOSAL)

6.2.2.1 Problem Statement and Rationale

Fruit orchards in South Lebanon were affected by bombs and were burned by white phosphorus. Since fruit crops would need several years to produce and bring in a return on farmers' investment, it is anticipated that farmers will shift to cash crops (i.e. banana, vegetables, watermelon, strawberry…), which lead to rapid return on investments. Such changes in the cropping pattern would negatively affect both the environment and the socio-economic equilibrium in South Lebanon. The cultivation of cash crops would result in a higher depletion of water resources with a higher risk of seawater intrusion, an increase in the use of chemicals (fertilizers, pesticides), higher levels of soil salinity, loss of soil fertility, and enhanced land degradation.

Accordingly, it is imperative that a sustainable cropping pattern be promoted in South Lebanon to avoid further environmental damage. The proposed intervention will identify such sustainable patterns, educate farmers, and provide financial incentives to farmers to sustain the shift in cropping pattern.

6.2.2.2 Proposed Actions

The following actions are proposed:

1. Identify sustainable cropping patterns in affected agricultural areas in South Lebanon, especially in the Khiam planes and the border areas, including proposals for crop rotation, measures for eliminating soil compaction, measures for higher water use efficiency, and appropriate practices for organic farming and integrated pest management (IPM);
2. Identify and promote suitable micro-financing mechanisms to assist farmers in implementing recommended measures; several institutions in Lebanon already provide micro-credits and could be interested in cooperating in such a project;
3. Undertake awareness raising campaigns in the selected areas to disseminate the study and the proposed financial mechanism to promote farmer participation in the program;
4. Carry out training sessions to assist farmers in the implementation of the proposed measures;
5. Develop a marketing strategy for farmers' products (including certification for organic produce and IPM);

6.2.2.3 Legal aspects

No legal issues were identified.

6.2.2.4 Institutional aspects

The following main institutions have responsibilities in such an intervention:

- MoA sets agriculture policies and is responsible for awareness raising of farmers through its extension service.
- IDAL is the institution responsible for the marketing and export of agriculture products.
- LIBNOR is the institution responsible for the elaboration of norms and standards for agricultural products.
- UNDP and MoE are implementing the methyl bromide project and represent an important resource in such an intervention through lessons-learned and experience gained in promoting sustainable practices.

6.2.2.5 Budgetary Estimate

The estimated initial budget of such an intervention amounts to **USD 105,000**. It is assumed that partners for the implementation of the micro-financing scheme are available and willing to participate. This is a fair assumption given the various institutions providing micro-credits to farmers, particularly ADR, Makhzoumi Foundation, Jihad El Binaa, Ameen SAL, and Al Majmouaa to name a few. Table 6.5 provides a non-exhaustive list of important service providers in the sector. The estimated budget breakdown is as follows:

1. Field survey, identification of sustainable cropping patterns, and financial partners 30,000$
2. Awareness raising including material distribution 30,000$
3. Capacity building 25,000$
4. Development of a marketing strategy 20,000$

Table 6.5. Larger Service Providers in the Micro-Finance Sector

Organization	Name	Type of service provided
Government and public organization	Economic and Social Fund for Development ESFD (part of the CDR)	▪ Micro credit loans (through NGOs, such as Majmoua) ▪ SME loans ▪ Business development services ▪ Employment creation mechanisms (various NGOs)
NGOs	Majmoua	▪ Micro credit loans
	CHF Ameen	▪ Micro credit loans
	Kard al Hassan	▪ Micro credit loans
	Mercy Corps	▪ Development projects ▪ Micro credit

Organization	Name	Type of service provided
	Makhzoumi foundation	▪ Micro credit ▪ Vocational training
	Caritas	▪ Micro credit loans
	Mouvement Social	▪ Micro credit ▪ Vocational training
	AEP	▪ Training ▪ Micro credit
	ADR	▪ Micro credit
	IDLES	▪ Micro credit
	YMCA	▪ Micro credit ▪ SME credit ▪ Vocational Training

This project can also be augmented by providing support to the micro-financing partners through a lending scheme.

6.2.2.6 Project Duration

The duration of this intervention is 1 year. During this time, the micro-financing scheme should be put in place to allow farmers to start shifting to sustainable cropping schemes.

6.2.3 SUSTAINABLE REVITALIZATION OF FRESH WATER AQUACULTURE IN ASSI RIVER (DRAFT PROPOSAL)

6.2.3.1 Problem Statement and Rationale

Fresh water aquaculture in the Assi River has been affected by the war. More than 330 tons of rainbow trout were killed. Furthermore, previous studies have indicated the presence of a relatively rich biodiversity in the river, including endemic species, which were likely affected by the changes in physico-chemical properties (increased turbidity). The livelihood of the local communities has also been affected and there is a need to address socio-economic impacts along with the environmental ones.

There is an immediate need to restore the ecological and socio-economic values of the affected area to avoid further environmental pressure.

6.2.3.2 Proposed Actions

The following actions are needed to restore and improve the previous functions of the area:

1. Remove cement and debris from the affected areas and restore the river bank;
2. Implement a short-term monitoring campaign to evaluate impacts on riverine biodiversity. This will include sampling of fish in different locations to investigate level of fish meat contamination and provide educated advice on the safety of fish farming in the short-term;
3. Perform physico-chemical analysis of river water to obtain further data on possible changes and their potential impacts; parameters of particular importance are turbidity and ammonia (due to large number of dead fish);
4. Create, revitalize and organize income-generating activities for local communities, including restaurant owners and fish farmers, to enable them to sustain their livelihood while contributing to river preservation;
5. Develop a comprehensive plan to renovate aquaculture facilities using modern and sustainable technologies, management practices and stocking rates;
6. Train fish farmers on the sustainable use of their resources;
7. Implement an awareness campaign targeting local communities and municipalities on conservation of natural resources, given the ecological importance of the affected area, with particular focus on the impacts from the war and the contribution of each person to alleviate further damage;
8. Train and empower Hermel and Anjar Aquaculture centers of MoA with equipment and training on sampling and conservation of Assi River;
9. Perform the necessary legal and regulatory measures to support the intervention (as defined below).

6.2.3.3 Legal Aspects

The following regulatory measures are needed to support this intervention:

- Preparation and adoption of legislation pertaining to organization and regulation of aquaculture farms to protect Assi watershed and organize its exploitation;
- Existing regulations should be strongly enforced to protect watershed management of Assi River and its biodiversity; these include regulations by the Ministry of Public Health (MPH) pertaining to the feeding of fish with animal slaughter by-products for food safety and public health, banning the dumping of solid waste and sewage from restaurants into the river (MoE and Ministry of Energy and Water (MoEW)), and the control of illegal fishing using dynamite or Lannate insecticide (MoA).

6.2.3.4 Institutional Aspects

The following institutions have a role in the implementation of the proposed intervention:

- MoA, MoE, MoEW and MPH due to their role in the sector or the implementation of legislation;
- Research institutions such as NCSR and universities (American University of Beirut (AUB), Lebanese University (LU)) given their work in the field;
- Municipalities of Hermel and Shouagheir, as well as fish farmers and local restaurant owners;
- Aquaculture centers pertaining to the Bekaa rural development and natural resources department of MoA (Hermel and Anjar), which can play a facilitation and coordination role for the proposed initiatives.

6.2.3.5 Budgetary Estimate

The total budgetary estimate for this initiative amounts to **USD 160,000**. The estimated budget breakdown is as follows:

1.	Clean-up and restoration of river banks	50,000$
2.	Biodiversity monitoring	10,000$
3.	Physico-chemical analysis of the river	5,000$
4.	Identification of income-generating activities	10,000$
5.	Development of new comprehensive aquaculture plan including training of fish farmers on proper and sustainable use of their resources	50,000$
6.	Awareness campaign	20,000$
7.	Capacity building of Hermel and Anjar Aquaculture centers (including provision of basic in-situ monitoring equipment such as pH and TDS probes)	10,000$
8.	Legal reform	5,000$

6.2.3.6 Project Duration

The duration of the proposed intervention is two years.

6.2.4 CHANGING MARINE FISHING BEHAVIOR (DRAFT PROPOSAL)

6.2.4.1 Problem Statement and Rationale

Fishing ports north of the Jiyeh power plant were affected by the oil spill. In addition, Ouzaii port was directly hit by IDF. The medium to long-term impacts of the marine pollution is difficult to assess. At the same time, the destruction of infrastructure of an entire fishing community in Ouzaii opens up the opportunity to assess new fishing policies that would take into consideration the new conditions set by the war, particularly the possible impacts related to the oil spill. Also fishermen lack the necessary infrastructure to implement changes in fishing behavior.

This intervention is therefore meant to assess the fish stock in Lebanese waters with the objective of formulating a sustainable fishing policy for Lebanon.

6.2.4.2 Proposed Actions

The following actions are proposed:

1. Prepare a comprehensive assessment of fish stock in marine waters up to 12 miles from shore and formulate a new policy for sustainable fish resource management, taking into account impacts related to fishing in shallow waters affected by oil pollution; data from the integrated marine pollution monitoring program proposed under the biodiversity chapter will be taken into account during policy formulation;

2. Identify alternative sources of livelihood to selected fishermen communities, particularly in Ouzaii, while new policy is being formulated;

3. Provide capacity building to fishermen in affected areas to be able to implement recommendations of the new policy, including fishing nets with appropriate sizes, fishing boats, and needed accessories;

4. Identify necessary institutional measures such as formation of cooperatives, mechanisms for revenue sharing, etc.;

5. Implement a communication and awareness campaign for Lebanese fishermen on sustainable fish resource management based on the new policy.

6.2.4.3 Legal Aspects

Development of a new sustainable fish resource management policy will need to be formally endorsed by MoA and the Council of Ministers. Other incentives may be needed such as, for example, tax exemption on the purchase of new fishing nets and gears.

6.2.4.4 Institutional Aspects

The following institutions have a role in the proposed intervention:

- MoA is the authority responsible for any regulation concerning fisheries including fish stock monitoring and assessment;
- The National Center for Marine Science (NCMS) is responsible for fish analysis; other academic institutions are also playing an important role, particularly AUB;
- MoE is responsible for the environmental protection and identification of measures to reduce environmental pollution; MoE is coordinating the cleanup operations of the polluted coastal sites and addressing the impacts from the oil spill;
- MPH is responsible for monitoring health issues; this intervention will have a beneficial role in mitigating future health impacts through food chain contamination; MoA also

performs some microbiological analysis on fish samples at the LARI laboratories in Fanar;

- Ministry of Public Works and Transport (MoPWT) has full authority on the marine waters and therefore any action to be taken must be implemented in collaboration with that ministry.

6.2.4.5 Budgetary Estimate

The budgetary estimate of the proposed intervention amounts to **USD 1,550,000**. Budget breakdown is as follows:

1. Fish stock assessment and policy development	500,000$
2. Identification of alternative sources of livelihood for fishermen	20,000$
3. Capacity building to fishermen at affected areas	1,000,000$
4. Identification of necessary institutional measures	10,000$
5. Implement a communication and awareness campaign	20,000$

6.2.4.6 Project Duration

The total project duration is at least 2 years and could be extended to 3 years depending on project development.

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LEBANON

RAPID ENVIRONMENTAL ASSESSMENT FOR

GREENING RECOVERY, RECONSTRUCTION AND REFORM 2006

SOLID WASTE

7.1 INTRODUCTION

One of the notable impacts of the war in Lebanon was the generation of very large amounts of solid wastes. Two waste streams are of particular importance: construction mixed demolition wastes and oil-spill related solid waste. These are notorious for the very large quantities produced and their quality, which may require special equipment and means for treatment and/or disposal.

The quantity and composition of other types of wastes were also affected in one way or another during the war. These include agricultural wastes, domestic municipal wastes, industrial wastes, medical wastes, and other special wastes.

Demolition wastes are covered in the construction chapter. Oil-spill related wastes are covered in more detail in this chapter. Options for disposal of the different oil waste streams are analyzed to provide guidance to decision-makers on the best alternative for waste disposal. Other waste streams are covered to a lesser extent, however enough to document the facts and provide general recommendations for their management that can be used to improve existing policies and practices in the country.

7.2 OIL-SPILL RELATED WASTE

On 13 and 15 July 2006 the Jiyeh power utility located 30 km south of Beirut and directly on the coastline was hit by Israeli bombs. The estimated amount of oil spilled is 15,000 m^3; another 60,000 m^3 in storage at the Jiyeh tank farm are thought to have burned, causing extensive atmospheric contamination in a plume reportedly reaching 60 km (Steiner R., 2006).

Preliminary survey conducted by the Ministry of Environment (MoE) revealed 31 polluted sites spread over 150 km on the Lebanese shoreline to the north of Jiyeh. Seven sites with high priority have been identified by MoE, amongst which Byblos port and Raouche Fishermen's Wharf were categorized as first priority. Thirteen "confined" sites are categorized as second priority (Steiner R., 2006). Table 7.1, prepared by MoE, indicates the name and characteristics of the sites affected according to surveys conducted between July 18 and August 3, 2006. Figure 7.1 shows one stretch contaminated with oil in Beirut.

Table 7.1. List of Surveyed Sites by MoE Impacted by Oil Spill (July 18 to August 3, 2006)

Site #	Site Name	From		To		Length (km)	Area (sq.m.)	Open/ Confined*	Rocky/ Sandy/ Other	Length of Confined Space Entrance (m.)
		Coordinates N	Coordinates E	Coordinates N	Coordinates S					
1	Jyeh	33º 38' 58.07"	35º 23' 59.88"	33º 39' 13.77"	35º 24' 55.27"	1.5	-	Open	Sandy	-
2	Rmaileh	33º 39' 09.83"	35º 24' 53.17"	33º 40' 03.55"	35º 25' 02.78"	1.6	-	Open	Sandy	-
3	Damour	33º 42' 01.91"	35º 26' 23.91"	33º 44' 22.85"	35º 26' 49.04"	4	-	Open	Sandy	-
4	Ramleh Baida	33º 52' 14.45"	35º 28' 52.48"	33º 52' 59.59"	35º 28' 39.05"	2.1	-	Open	Sandy	-
5	Movenpick	33º 53' 00.23"	35º 28' 21.19"	-	-	-	12,000	Confined	Rocky	25
6	Sporting	33º 53' 35.02"	35º 28' 01.81"	-	-	-	900	Confined	Rocky	71
7	Raouche (fishermen)	33º 53' 12.85"	35º 28' 17.07"	-	-	-	1,800	Confined	Rocky	17
8	Long beach	33º 53' 38.47"	35º 28' 01.48"	-	-	-	6,300	Confined	Rocky	53.2
9	Tabarja	34º 01' 06.61"	35º 37' 25.74"	34º 01' 24.02"	35º 37' 20.48"	3	-	Open	Rocky	-
10	Byblos sandy beach	34º 06' 04.89"	35º 39' 02.46"	34º 06' 58.60"	35º 38' 48.54"	1.7	-	Open	Sandy	-
11	Byblos port	34º 07' 17.96"	35º 38' 36.12"	-	-	-	7,700	Confined	Rocky	30
12	Byblos sur mer (Marina)	34º 07' 21.20"	35º 38' 31.57"	-	-	-	1,500	Confined	Rocky	42
13	Byblos gravel beach	34º 07' 23.50"	35º 38' 34.90"	34º 07' 45.89"	35º 38' 29.89"	0.7	-	Open	Gravel	-
14	Batroun	34º 13' 41.40"	35º 39' 19.09"	34º 14' 48.80"	35º 39' 35.12"	1.5	-	Open	Sandy	-
15	Batroun Bay	34º 15' 08.22"	35º 39' 25.12"	-	-	-	76,320	Confined	Pebbles	188.32
16	Heri (Rocca Marina)	34º 18' 26.98"	35º 42' 00.66"	-	-	-	15,000	Confined	Sandy	56.5
17	Saint Antoine	34º 18' 18.82"	35º 42' 06.93"	-	-	-	2,000	Confined	Sandy	61
18	Blue beach	34º 18' 22.52"	35º 42' 36.17"	34º 18' 38.38"	35º 42' 55.31"	0.7	-	Open	Sandy	-
19	Chekka	34º 18' 41.34"	35º 42' 56.00"	34º 19' 31.81"	35º 43' 20.45"	0.7	-	Open	Sandy	-

Site #	Site Name	From		To		Length (km)	Area (sq.m.)	Open/ Confined*	Rocky/ Sandy/ Other	Length of Confined Space Entrance (m.)
		Coordinates N	Coordinates E	Coordinates N	Coordinates S					
20	Ras El Sakhr & Mina Public Beach	34º 32' 47.25"	35º 49' 14.76"	34º 25' 05.24"	35º 49' 13.68"	0.7	-	Open	Rocky	-
21	Ras Maska- Bahsas	34º 25' 10.16"	35º 49' 13.83"	34º 25' 37.38"	35º 49' 04.08"	1	-	Open	Sandy	-
22	Al Zreira (Borders of Kfarabida)	34º 14' 38.68"	35º 39' 37.19"	34º 14' 44.90"	35º 39' 38.41"	0.22	-	Open	Rocky	-
23	Sawari Beach	34º 14' 48.86"	35º 39' 31.61"	-	-	-	5,292	Confined	Sandy	-
24	Saint Stephano Beach	34º 14' 53.30"	35º 39' 28.81"	-	-	-	2,220	Confined	Rocky	-
25	Aqualand	34º 14' 55.81"	35º 39' 29.08"	-	-	-	630	Confined	Rocky	-
26	National Center for Marine Sciences	34º 15' 04.37"	35º 39' 23.41"	34º 15' 11.33"	35º 39' 22.84"	0.23	-	Open	Rocky	-
27	Phoenician Wall	34º 15' 10.89"	35º 39' 21.58"	34º 15' 28.12"	35º 39' 23.06"	0.53	-	Open	Rocky	-
28	Fishermen's Wharf-Batroun	34º 15' 27.68"	35º 39' 26.60"	-	-	-	11,776	Confined	Pebbles	-
29	Al Ghalaghili Beach	34º 15' 53.83"	35º 39' 31.12"	34º 16' 15.90"	35º 39' 22.04"	0.8	-	Open	Rocky	-
30	Palm Island Nature Reserve	34º 27' 43.31"	35º 48' 01.48"	34º 27' 48.10"	35º 48' 03.43"	0.2	-	Open	Sandy	-
31	Anfeh	34º 20' 48.59"	35º 43' 37.36"	34º 21' 37.74"	35º 43' 41.23"	1.4	-	Open	-	-
32	Kfar Abida	34º 13' 35.13"	35º 39' 14.54"	34º 14' 47.67"	35º 39' 34.96"	2	-	Open	-	-
33	Monsef- Pierre and Friends (Madfoun)	-	-	-	-	-	-	-	-	-
TOTAL						**21.18**	**143,438**	**-**	**-**	**544.02**

Figure 7.1. Beach Sand and Solid Waste Contaminated by Oil Spill at Ramlet Al Baydeh-Beirut

7.2.1 QUANTITY AND CHARACTERISTICS OF WASTE GENERATED

The oil that has leaked in the sea was characterized as heavy fuel oil. One of the most difficult problems to deal with the oil spill clean-up is related to the quantity of waste generated in a very short period of time and the difficulty to predict the waste quantity and quality generated. Historical data shows that oil spills impacting the shoreline can, in extreme cases, produce up to 30 times more waste than the volume of oil originally spilt (IFPMA, 2006).

Table 7.2 presents a list of the different types of oily waste generated and current storage and disposal methods adopted (MoE, 2006). By end of November 2006, MoE records showed that close to 1,000 m^3 of liquid oil had been removed as well as about 4,800 m^3 of contaminated sand, gravel and solid wastes (MoE, 2006). By the end of December, total waste contaminated volume reached 5,800 m^3 and about 30 km of sandy beaches from Jiyeh to Beirut were not yet cleaned-up. REMPEC had apparently under-estimated that about 4,000 tons of waste were to be treated or stored, in the form of liquids, pastes, sands, and pebbles, macro-wastes and contaminated cleaning equipment (GEIDE, 2006), quantity which has already been exceeded. Table 7.3 presents the typical waste streams generated by alternative oil response methods.

7.2.2 POST-CONFLICT INITIATIVES

A national oil spill cleanup operation for the Lebanese coast could not start immediately after the spill occurred or even after the cease fire due to the air and marine blockade enforced by the Israeli army on Lebanon as well as due to the lack of human, material and financial resources. The effective cleaning up started few weeks (52 days after bombardment) after cease fire (CNRS, 2006; Steiner R., 2006; MoE 2006).

Current ongoing cleaning activities involve several entities, local and international organizations as described in more detail in the biodiversity chapter. However the waste management issue remains relatively a major problem to be addressed.

**Table 7.2. Different Oil Contaminated Waste Streams[148]
(MoE, 2006)**

Type of Waste	Intermediate Storage	Temporary Storage Location and Capacity
Liquid Oil (recovered by dredge, skimmers or manually - pooled oil)	- tanks in plastic containers watertight	Soliver glass manufacture (Khalde) 4,000-tonne tank
Sunken oil collected in plastic bags (more or less burnt oil)	- oil in plastic bags placed in plastic containers watertight	Temporary storage out of beaches to be organised - Zahrani and Tripoli refineries are used by MoE
Sunken oil collected by vacuum pump/manually with minor quantity of sand (Italian team)	- watertight plastic containers - metallic drums	One safe temporary storage area to be prepared on private owned land and built by private company (2000 m^2)
Oily debris (plastic, woods, textile, protective suits, boots, sorbents, scrapers, etc.)	- drums - tanks - watertight plastic containers	
Oily sand	- more or less oily sediment collected in plastic watertight containers or plastic bags	-if minor contamination, material is sent back to the sea with oil recovery - if major contamination, material is sent to safe temporary storage

7.2.3 ENVIRONMENTAL CONCERNS

A large portion of the spill has emulsified and solidified along the Lebanese shore, clinging to sand, rock and stone. Oil that remained on water was more fluid, but it rapidly dried to a tarry residue once it was left on the beach.

The oil spill raises an important concern with respect to marine biodiversity. Oil spills may have an immediate impact on animals that use the surface of the sea such as birds, seals and dolphins; birds in particular are among the possible victims. The presence of Mediterranean monk seals, a listed endangered species, in the Palm Island region should be noted. Four species of turtles, including the green turtle, an endangered species, reproduce on the Lebanese coasts. Reproduction sites are indicated in the Tyre and Palm Island reserves. Concurrence of soiling of beaches and the egg hatching period, the eggs being laid from May to August and hatching 1 to 2 months later, could lead to severe negative impacts (Steiner R., 2006).

[148] MoE Daily Situation Reports

Table 7.3. Response Strategies and their Effect on Waste Generation[149]

Clean-up Technique		**Effect on Waste Stream**	**Waste Generated**
Dispersant application	Dispersant chemicals are used to break down the oil slick into small droplets so that the diluting effect of the ocean is better able to reduce hydrocarbon concentrations. This strategy will not work with all oils and is not appropriate for use in certain environments.	Waste concentrations are minimal as the oil is suspended in the water column and allowed to biodegrade naturally.	• No hydrocarbon waste is generated. • PPE • Empty dispersant drums/considerations
At-sea response operations	Recovery devices, e.g. booms and skimmers, are deployed from ships or small craft to recover oil from the sea surface. Suitably sized storage systems may be needed which, in the case of highly viscous or waxy oils, will require heating elements. Transfer systems and reception facilities will also be needed to sustain operations over the long term.	Recovery operations will potentially give rise to a large quantity of waste oil and water for treatment. The volume of the storage systems available must be consistent with the recovery capacity of the skimmers. The type of oil spilled will have an effect on the resultant waste; viscous and waxy oils in particular will entrain debris and can create large volumes of waste. They can also present severe handling difficulties.	• Oiled equipment/vessels • Oiled PPE and workforce • Recovered oil • Oily water • Oiled sorbent materials • Animal carcasses
Shoreline clean-up	Oils are recovered from shorelines either using mechanical or manual means. Manual recovery is the preferred method because it has the effect of minimizing the amount of waste generated. Machines can be used to transport the waste from the shoreline to the primary storage site. Portable tanks or lined pits can be used to consolidate recovered oil at the operating site. The shoreline type, and degree of access to it, will dictate the types of strategies used which, in turn, will determine the amount of waste recovered.	The type of spilled oil will often have a profound effect on the amount of oily waste generated. Waste segregation and minimization techniques are critical to ensure an efficient operation. These should be established at the initial recovery site and maintained right through to the final disposal site otherwise waste volumes will spiral out of control. Waste sites should be managed in such a way as to prevent secondary pollution.	• Oiled equipment/vessels • Oiled PPE and workforce • Recovered oil • Oiled vegetation • Oily water • Oiled sorbent materials • Oiled beach material (sand, cobbles, etc.) • Oiled flotsam and jetsam • Animal carcasses • Oiled transport

[149] IPIECA, 2004

Clean-up Technique		**Effect on Waste Stream**	**Waste Generated**
In-situ burning	This involves a strategy of burning spilled oil using fire booms to thicken the oil layer to sustain combustion. Weathering and emulsification of oil will inhibit the process. The strategy cannot be used on all oil types or in all environments. The resultant air pollution and the production of viscous residues can limit the application of the strategy.	In-situ burning can reduce the amount of oil in the environment. However, the remaining material may be more persistent.	• Burnt oil residues • Oiled/fire damaged boom • Oiled vessel • Oiled PPE

In some cleaning locations, limited attention was paid to segregation of waste and several temporary storage areas have already been created on the working sites, some of them being “uncontrolled”, while others are stored near the boarder coast line with possibility of being easily re-located by water waves (Figure 7.2), such as in Enfeh near “Phoenician wall”, 3 meters from sea (GEIDE, 2006).

Figure 7.2. Oil waste collection bags

In other cases, it was reported that PVC containers were used as temporary storage for removed oil waste which adds to the problem of final waste disposal. Stored oil waste tends to emulsify making it very difficult or impossible to be emptied. Incineration of PVC containers can lead to the production of dioxins due to the presence of chlorine. The Danish EPA found that doubling PVC feed in an incinerator increased dioxin levels by 32 percent (Hammer, 1998).

According to SEACOR, the American contractor cleaning the stretch from Byblos to Enfeh, the wastes collected on the beach are separated into clean wastes and contaminated wastes and subsequently put in containers. Containers of clean wastes were sent by truck in a "municipal discharge" with the approval of the mayor. Another potential critical impact is related to the final disposal of removed oily waste. Inadequate storage, handling and disposal of recovered oil waste could result in transporting the pollution inland with high possibility of secondary contamination of water resources, soil and air, depending on the selected option.

7.2.4 WASTE MANAGEMENT OPTIONS

7.2.4.1 Typical Oil Waste Management Options

The objective of an oil spill clean-up operation is ultimately to treat, recycle or dispose of the oily waste in the most efficient and environmentally sound manner. The disposal option chosen will depend upon the amount and type of oil and contaminated debris, the location of the spill, environmental and legal considerations and the likely costs involved.

Based on literature review, Table 7.4 identifies the typical treatment and disposal options with regard to different categories of collected oil-spill waste (IPIECA, 2004). Table 7.5 describes in further detail the various treatment and disposal techniques for oil waste, and presents recommendations and limitations of these alternatives. It should be noted that the tables present general guidelines for the management of oil-spill wastes, whereby the feasible techniques are currently being implemented in Lebanon by MoE and its partners.

Table 7.4. Waste Types and Disposal Methods[150]

Waste Type	Treatment and Disposal Methods								
	Re-processing	Oil water separation	Emulsion breaking	Stabilization	Bio-remediation	Sediment washing	Landfill	Thermal treatment	Heavy fuel use
Pure oil	√	X	X	X	X	X	X	X	√
Oil & water	√	√	√	X	X	X	X	X	√
Oil & sediment	√	X	X	√	√	√	√	√	X
Oil & organic debris	X	X	X	√	√	X	√	√	X
Oil & PPE	X	X	X	X	X	X	√	√	X

150 IPIECA, 2004

Table 7.5. Disposal and Treatment Options and Relevant Considerations[151]

Treatment method	Techniques	Considerations
Re-processing	▪ Oil is recovered with a low water and debris content and is then reprocessed through an oil refinery or recycling plant. ▪ Oil can then be reused - the preferred option, as identified in the waste hierarchy	▪ Refineries cannot accept oil with a high salt content because it can cause irreversible corrosion damage to the pipe-work. ▪ Oil that is heavily contaminated with water, sediment and debris is also unacceptable.
Oil/water separation	▪ Separation generally occurs by gravity i.e. oily water is put into a lined pit and allowed to separate out. A skimmer is then used to remove the oil from the surface. ▪ Special separation equipment, found at oil processing installations, is also often used.	▪ Oily water residue from separation techniques may then have to undergo further treatment through a system of weir separators, as the hydrocarbon content will still be too high for release into the environment.
Emulsion breaking	▪ Heating of emulsions can be used to break them down to oil and water phases. ▪ In some cases specialized emulsion breaking chemicals will have to be used. ▪ Once separated the recovered oil can be blended into refinery feedstock or reprocessed.	▪ Any chemicals used will remain in the water after separation so care will be needed when disposing of the water.
Stabilization	▪ The oil can be stabilized using inorganic substances such as quicklime (calcium oxide), fly ash or cement. ▪ Stabilization forms an inert mixture that reduces the risk of the oil leaching out and thus can be sent to landfill with fewer restrictions than free oil.	▪ Contact with quicklime can cause irritation to eyes, skin, respiratory system, and gastrointestinal tract. The material reacts with water, releasing sufficient heat to ignite combustible materials.

151 IPIECA, 2004

Treatment method	Techniques	Considerations
Bioremediation	▪ Bioremediation is used to accelerate the natural, microbial break-down of oil. ▪ One example of bioremediation is landfarming. Oily debris, with relatively low oil content, is spread evenly over the land and thoroughly mixed into the soil promoting natural breakdown of oil by micro-organisms.	▪ Bioremediated material may need mixing at intervals to encourage aeration; fertilizer may be added if necessary and consideration should be given to the suitability of location e.g. adequate distance from ground water supplies. ▪ Landfarms suitable for bioremediation are becoming difficult to find.
Beach washing	▪ Involves the cleaning of pebbles and cobbles, either in-situ or at a separate treatment site. ▪ For boulders and rocks coated in oil, cleaning may be carried out through washing on a grill allowing the oily water to drain off for treatment. ▪ For light oiling, boulders and pebbles can be moved into the surf zone for natural cleaning. The wave energy will move them back into their original position over time.	▪ This technique should only be considered when the sediments hold a large quantity of oil because it is time consuming, costly, produces a lot of oily water waste requiring treatment, and there is often difficulty in defining when material is oil free and can be returned to the beach.
Sand washing	▪ For sandy sediments, specialist sand cleaning equipment can be used. ▪ A suitable solvent may also be added to aid the process.	▪ This method is time consuming; costly; produces a lot of oily water waste requiring treatment; and it is often difficult to define when sediment is oil-or solvent-free and so can be returned to the beach.

Treatment method	Techniques	Considerations
Landfill	▪ Oily waste typically containing less than approximately 5 per cent oil can be co-disposed with non-hazardous, domestic waste and taken to designated landfill sites. ▪ Established landfill sites are usually lined which suits oily waste as it prevents the oil leaching out into surface water and aquifers. ▪ They are also usually covered daily which prevents infiltration of rainwater thus reducing the potential for an increase in contaminated water.	▪ The sites will need special permission from the local regulatory authority to receive this type of waste and volumes are often limited. ▪ Chemical testing should be conducted to determine the hazardous content of the oil at this stage. ▪ Facilities able to receive this waste are becoming more difficult to find.
Incineration	▪ A treatment technology involving the destruction of waste by controlled burning at high temperatures. In the instance of oiled waste, the hydrocarbons are broken down by the high temperatures which also reduces the remaining solids to a safe, non-burnable ash. ▪ Cement factories and kilns are an effective method and will keep costs down, as treated waste can sometimes be used as a raw material or for power generation.	▪ The use of portable incinerators is often prohibited by legislation which stipulates that the location must be licensed and an environmental impact assessment carried out because of atmospheric pollution. ▪ Permanent incinerators used for the disposal of domestic waste can be considered, although the highly corrosive nature of the salt in the oil may render these unsuitable. ▪ High temperature industrial incinerators are able to deal with the waste, although they are limited in supply, making them unable to deal with large quantities, and are often costly.

7.2.4.2 Oil Spill Waste Management Options in Lebanon

Lebanon generally lacks the necessary infrastructure for waste management. While facilities for treatment and disposal of municipal solid wastes exist, hazardous waste management facilities do not exist. Particularly lacking are hazardous waste landfills and industrial incinerators, which are options typically used in developed countries to treat and dispose of hazardous or special wastes.

Nevertheless, local options for the management of oil-related wastes were identified and are alternatives are compared in this section. Table 7.6 to Table 7.9 present an analysis of the different oil waste streams and their different treatment and disposal options available in Lebanon. These waste streams are removed liquid oil, low to medium contaminated sand, heavily contaminated sand, and contaminated solid wastes.

Table 7.10 presents a comparative analysis of different treatment technologies. When applicable, the option of exporting the waste to be treated in a facility outside Lebanon, in the framework of the Basel convention, is also considered.

Table 7.6. Options for Liquid Oil Waste Treatment in Lebanon

Waste stream #1[152]: Liquid Oil Waste				
Options	**Local Options**	**Benefits**	**Constraints**	**Estimated cost**
Option 1: Re-processing / oil recovery into original intended products	Processing equipment available in Zahrani refinery and in Dora	■ Recovered oil could be treated as "Material" rather than "Waste" if intended to be sent to refinery ■ Recovery of oil ■ Reduction of waste quantity disposal	■ Requires modern & expensive equipment only found in refinery ■ Requires approval of refinery management & MoEW ■ Requires pre-processing and screening ■ Quality of oil recovered could be a limiting factor	Re-processing cost not available Transportation cost estimated at $20 →$60/trip at $10m^3$/trip[153] Average transportation cost =$6,000
Option 2: Re-use directly as fuel source	Several heavy energy demand industries are available in the country such as: 1- Cement industry 2- Glass industry 3- Smelting industry	■ Recovery and re-use of valuable energy source ■ Cost recovery option ■ Demand in market for energy sources includes liquid oil waste	■ Need de-emulsification (solid to liquid) and decanting (separate oil/water) ■ Potential corrosion to equipment due to expected high salinity level ■ Oil should be free of mercury ■ Oil should be free of MgO and zinc (for cement industry) ■ Requires testing	Estimated at $40/tonne Transportation cost estimated at $20 →$60/trip at $10m^3$/trip[154] Total cost = $42,000 Average transportation cost =$6,000 Estimated total cost for liquid oil incineration = $48,000

[152] Total waste represents only those recovered until end of November 2006, calculations were based on these figures. Quantity = 1,000 m^3
[153] Taken from the cost for rubble removal in Beirut southern suburb
[154] Taken from the cost for rubble removal in Beirut southern suburb

Table 7.7. Options for Low to Medium Contaminated Sand in Lebanon

Waste stream #2[155]: Low to Medium Contaminated Sand & Pebbles				
Option	**Local Options**	**Benefits**	**Constraints**	**Estimated cost**
Option 1: Re-use as raw material in cement industry	■ Cement industries are available ■ Sand is a natural raw material consumed in cement production	■ Permanent elimination of contaminated sand	■ Transportation cost ■ Loss of natural beach sand resources	■ Removal and Transportation cost (around $20→$60/trip) ■ Mostly no additional cost if lightly contaminated soil with oil and solid waste[156] ■ Estimated cost =$12,500→$25,000
Option 2: Re-use in construction material and asphalt industry	■ High demand for raw material due to ongoing reconstruction activities in road construction	■ Reduces the demand on raw material needed for re-construction efforts ■ If non-hazardous can be reused	■ If test reveal hazardous then cannot be re-used ■ Requires pre-processing ■ Cost of raw material might be cheaper than cleaning of contaminated sand ■ Mishandling could result offsite contamination	■ Removal and transportation cost (around $20→$60/trip) ■ Pre-processing cost ■ Estimated cost = $ 12,500→$25,000 (excluding pre-processing cost)
Option 3: Natural Bioremediation or with Enzymes	■ Lack of available space especially for in situ treatment options	■ Recovery of natural resource (sand) ■ Low cost only for large quantity ■ Larger quantity will result in more economy of scale	■ Must meet hydro-geological and physical requirement for site selection criteria ■ No recovery of oil ■ Increase of VOC emissions ■ Requires a lot of testing, monitoring, foundation and mechanical work ■ Requires large surface area ■ Dispersed quantity of contaminated soil increases cost	■ $4→$67/m^3 for natural treatment (without leachate treatment) ■ $26→$220/tonne for bioremediation with enzymes (without leachate treatment) [157] ■ Estimated cost range =$160,000 without enzyme→$528,000 with enzyme (without testing, land, leachate treatment)

155 Values of light to medium contaminated waste not available; it is assumed for purpose of this assessment as 50 percent of total waste collected by end of November 2006. Quantity recovered until end of November 2006 = 4800 m^3; assumed volume of light to medium contaminated sand: 2,400 m^3

156 Cost provided by Holcim cement industry in Lebanon

Waste stream #2[155]: Low to Medium Contaminated Sand & Pebbles				
Option	**Local Options**	**Benefits**	**Constraints**	**Estimated cost**
Option 4: Oil extraction by surf-washing	■ Specialized equipment already purchased as part of oil clean up	■ Recovery of oil ■ Recovery of natural resource ■ Reduces quantity of waste to be disposed or treated	■ Increase in operational cost	Not Available but mainly human-resource cost

157 USEPA, 2003

Table 7.8. Options for Treatment and Disposal of Heavily Contaminated Sand

Waste stream #3[158]: Heavily contaminated sand & pebbles				
	Local Options	**Benefits**	**Constraints**	**Estimated cost**
Option 1: Co-processing in cement kilns	▪ Cement industries are available ▪ Could be used as solid fuel in cement kilns	▪ Final elimination of contaminated sand ▪ Previous successful experience in Holcim France for treatment of waste generated from Erika spill[159] ▪ Contaminated solid waste (woods, plastic, and other macro-waste) could be processed in kiln ▪ High feed capacity (around 3 tons/hr)[160]	▪ Transportation cost ▪ Loss of natural beach sand resources ▪ Should be Free of mercury, zinc, MgO and ferrous metals as it effects kiln operation ▪ Permit required ▪ Requires EIA ▪ Short-medium period implementation	▪ Removal and Transportation cost (around \$20→\$60/trip at 10m^3 per trip) ▪ Cost of treatment in kiln could reach up to \$200/tonne according to waste condition[161] ▪ Total cost estimated at \$20,500 (treatment & transport cost) for 100m^3
Option 2: Stabilization and storage in cells	▪ Quick Lime available and cheap ▪ Ex situ disposal space available ▪ <u>North Zone:</u> IPC Tripoli refinery. Already (50m x 30 m) of land found suitable for storage of 50 containers[162]. ▪ <u>South Zone:</u> Zahrani refinery under study	▪ Stabilizing the leachate of toxic compounds	▪ Requires written agreement between MoE and MoEW[163] ▪ Weatherproof containers and cover layer ▪ Subject to stringent long term monitoring ▪ Will no permanently eliminate the waste ▪ Requires EIA ▪ Medium-Long period for implementation	▪ Cost ranges from \$65→\$130/m^3 [164] ▪ Minimum feasible installation area required is 4,000 m^2 capable of handling 3,000 m^3 of oil waste, total cost for construction around \$200,000 to \$400,000 for construction of an engineered storage cell (similar to landfill cells).

158 Total waste as heavily contaminated sand assumed to be 100 m^3 for the sake of this assessment
159 (GTZ/Holcim, 2006; ITOPF)
160 Personal communication with Holcim cement industry-Lebanon
161 Personal communication with Holcim cement industry-Lebanon
162 (GEIDE, 2006)
163 (GEIDE, 2006)

Waste stream #3[158]: Heavily contaminated sand & pebbles				
	Local Options	**Benefits**	**Constraints**	**Estimated cost**
Option 3: Export under Basel convention	▪ AUB has been implementing this practice to dispose of its chemical wastes. Waste is exported to Europe (through Basel convention).	▪ Useful solution for disposal of hazardous waste ▪ Eliminates oil waste problem ▪ Preserve space and environment	▪ If non-hazardous, it could be treated locally at lower cost ▪ Regulated by Basel Convention ▪ Potential high cost ▪ Very long and complex process (from 3 months to one year for preparation) ▪ Requires approval of third party country to accept waste treatment ▪ Subject to conditions of third party treatment capacity and cost	▪ AUB's one tonne of chemical waste disposal cost about USD 10,000. This covers the charge of disposal per consignment, transport and contingency fee[165]. ▪ Economy of scale could play role in reducing the cost. ▪ Assuming each m^3 = tonne and cost = \$10,000/tonne → total cost could reach \$ 1,000,000 for exporting only $100m^3$

[164] (GEIDE, 2006)
[165] (Ecodit/MoE, 2001)

Table 7.9. Options for Treatment or Disposal of Contaminated Oil Solid Waste

Waste stream #4[166]: Contaminated solid waste *(miscellaneous detritus found on beach , PPE , cleaning equipment and containment products[167])*				
	Local Options	**Benefits**	**Constraints**	**Estimated cost**
Option 1: Landfilling	■ No industrial or hazardous waste landfill available ■ Only two municipal sanitary landfills available in the country namely, Naameh (Mount Lebanon) and Zahle (Bekaa).	■ Suitable for disposal of non-oil contaminated waste or waste with less than 5% oil contamination ■ Most cost effective solution	■ Naameh landfill out of space ■ Restriction on accepting all oil solid waste types ■ Potential release of toxic compounds ■ Potential higher cost for landfilling of oil waste compared to normal domestic waste disposal cost	■ Current disposal costs of municipal waste in Naameh estimated at 25→41 USD/tonne and in Zahle at 10→13 USD/tonne[168] ■ Disposal in Naameh mostly will be restricted due to space issue and waste type ■ Zahle is not suitable due to higher transportation cost (60km to the east from Beirut) and possibly will not accept waste type
Option 2: Co-processing in cement kilns	■ Available kilns ■ No need for new investment in incinerators	■ Accepted by cement industry as alternative fuel material ■ Permanent elimination of most solid waste material	■ No carcasses allowed in waste stream[169] ■ Change in emission characteristics due to waste characteristics ■ Requires pre-processing ■ Requires EIA and permit	■ Estimated cost range between $ 40→$200/tonne for treatment only[170] ■ Total cost from $ 96,000 up to $ 480,000 without transportation
Option 3: Separation, decontamination, washing and recycling	■ Could be implemented effectively since oil spill clean up activity is still on going ■ Waste separation is already taking place	■ Recovery of recyclable material ■ Reduction in waste streams ■ Recovery of oil	■ Labor intensive ■ Cost will increase	■ Not Available

166 Quantity assumed to be 50 percent of total waste recovered until end of November 2006, ie 4800 m^3. Assumed quantity of contaminated solid waste = 2,400 m^3
167 Containment products consists of marine containers, sacks, big bags, oil drums, and other waste containers
168 (Ecodit/MoE, 2001)
169 (GTZ/HOLCIM, 2006)
170 Total costs are only rough estimates and reflects only total waste recovered until end of November 2006.

Table 7.10. Analysis of Different Treatment Options in Lebanon

Treatment Option	**General comments**	**Benefits**	**Constraints & limitations**
Industrial Incineration	■ No industrial incinerators available	■ Permanent solution for oil waste elimination	■ Not available ■ High capital cost ■ Long period to implement ■ If available, cost would be very high in the range of 350→800 USD/tonne[171]
Waste incinerators	■ Estimated 21 waste incinerators available for medical waste disposal only	■ Permanent waste elimination ■ Could achieve up to 99% volume reduction ■ Operated at very high temperature (at 1,200°C) suitable for destruction of many hazardous air pollutants	■ All active waste incinerators in the country are used for medical waste disposal only ■ Capacity is limited ■ Public opposition ■ No energy recovery ■ Air pollution control devices might not be suitable ■ Possibly not approved by hospital management ■ Salt in recovered oil could increase corrosion in system
Co-processing	■ Cement kilns are available in Lebanon ■ <u>North zone:</u> Holcim-Chekka/North Tripoli and Cimenterie Nationale ■ <u>South zone:</u> Sibline-North Saida	■ Erika spill in France treated in Holcim cement kilns ■ Completely eliminates oil waste ■ Provides alternative fuel and Raw material (AFR) to cement kilns ■ High cost recovery (alternative fuel)	■ Waste should meet stringent technical specifications (compounded halogens, some metal) meeting Stockholm convention requirements; additional monitoring requirements should be followed by kiln operators ■ Additional cost for waste pre-processing (demulsification) and screening (absence of heterogeneous elements) ■ Volume limitation ■ No permit for co-processing of oil waste in cement kilns exists

[171] (USEPA, 2003)

Treatment Option	General comments	Benefits	Constraints & limitations
Mobile incinerator	▪ Not available in Lebanon ▪ Need to be purchased or leased from outside	▪ Flexible ▪ Reduces cost of transportation ▪ Could be cost effective for large quantities	▪ Public opposition ▪ Most stored waste are located near sensitive receptors ▪ No energy recovered ▪ Generally of low operation capacity ▪ Procedure refused by MoE for problems of potential air pollution and equipment control difficulty ▪ Will require an EIA and permit
Exporting	▪ This procedure has been experienced one with AUB. In this case, AUB chemical waste was exported to England (through Basel convention). ▪ Lebanon ratified Basel convention in Dec. 94	▪ Eliminates oil waste treatment & disposal problem ▪ Preserve space and protect local environment	▪ Regulated by Basel Convention ▪ Possibly high exportation cost ▪ Complex and very long process (from 3 months to one year for preparation) ▪ Requires approval of third party country to accept waste treatment ▪ Subject to conditions of third party treatment capacity and cost
Oil recovery	▪ Liquid oil is being recovered ▪ De-emulsification of solid oil is possible (heated tanks + chemicals) ▪ Sand washing will result in additional oil recovery	▪ Recovery of valuable energy source ▪ Reduces waste quantity difficult treatment ▪ Produces oil quality re-usable many heavy energy industry (glass industry)	▪ Air emissions in industrial furnaces not equipped with air pollution control units will result in local air quality degradation
Reconstruction material + asphalt industry	▪ Suitable for on going reconstruction efforts	▪ Saves raw material demand	▪ If tests proves hazardous, it can not be re-used
Landfilling	▪ Only two sanitary landfills available in Lebanon ▪ Naameh Landfill: Over capacity ▪ Zahle landfill: 60 km to east of Beirut	▪ Suitable for waste not contaminated by oil	▪ Restriction on acceptability by landfill operators ▪ Accepts only municipal waste ▪ No cost recovery

Treatment Option	**General comments**	**Benefits**	**Constraints & limitations**
Burial cells (engineered landfill cells)	▪ Two sites are defined as suitable by MoE ▪ North Zone: Tripoli old refinery (Al Badawi –IPC) ▪ South zone: Zahrani refinery	▪ Available and adequate space ▪ Meets most design conditions ▪ Secured and isolated locations ▪ Strategic locations ▪ Willingness to accept waste under some conditions	▪ Liquid oily waste not acceptable ▪ Requires written agreement between MoE and MoEW [12] ▪ Requires long term monitoring ▪ Leachate control and treatment ▪ No cost recovery ▪ Does not eliminate the waste
In situ treatment	▪ Land constraints (close to communities, private ownership, access control, small areas, etc.)	▪ Reduce transportation cost	▪ At lower quantities, treatment cost increases ▪ Difficult to monitor, confine and control

7.2.5 RECOMMENDATIONS

7.2.5.1 Recommendation for Liquid Oil Waste: Recovery & Co-processing

It is recommended that liquid oil be reprocessed in local refineries or private companies to improve quality level of recovered oil. The recovered oil could be mixed with heavy fuel oil or used as a fuel source.

The main issue about using recovered oil in its raw state is the level of salinity which increases the chance of equipment corrosion. The refined oil should be tested for halogens, metals and total hydrocarbon parameters to assess final quality. The final product could be used as a fuel source for heavy energy consuming industries available in the country such as cement, glass and smelting industries. This method will provide immediate and permanent disposal of liquid oil.

Cost includes primarily testing (to check adequacy of oil) and transportation. As of end of November, about 1,000 m^3 were generated. Transportation costs would reach USD 6,000. Processing costs are not known and should be checked with existing facilities (Zahrani and Dora). Heavy industries in the country can re-process the oil (de-emulsification and decanting) at a cost of USD 40 per tonne. Using this estimate, total cost of processing would reach for 1,000 m^3 about USD 40,000.

7.2.5.2 Recommendations for Light Contaminated Sand: Washing & Bioremediation

It is recommended that light contaminated sand be washed and treated using biological methods, if needed. The washing process reduces oil level in contaminated sand which reduces pollution load, eventually treatment duration and cost. It is understood that surf washing is actually being used in some stretches of the coast. The recovery of this natural resource is valuable for the environment. The cleaning process can be accelerated through the use of special enzymes to the soil to enhance the bacterial activity and natural bioremediation of the organic matter. Even though this method is time consuming, it ensures the recovery of a valuable natural resource.

Until end of November, the total reported quantity of low-to-medium contaminated sand and pebbles is assumed to have reached 2,400 m^3 (based on total waste contaminated volume generated of 4,800 m^3). The cost of using enzymes to accelerate bio-remediation could reach up to USD 528,000 (at enzyme cost of USD 220 per tonne).

The option of sending the sand to be used as raw materials at cement factories or glass manufacturing can be a more cost-effective option (factories should not charge disposal costs), however the natural beach resource would be lost.

7.2.5.3 Recommendations for Heavy Contaminated Sand: Stabilization (neutralization) & Co-processing as Solid Fuel

Heavy contaminated sand can be used as solid fuel for cement industry. The polluted sand should be mixed with quick lime to neutralize toxic release (as leachate) during storage and transportation. Cement industry can process the neutralized heavily contaminated sand with mixture of variable solid waste type (except for ferrous metals). Estimated cost for treatment in cement kilns could reach up to $200 per tonne to account for pre-processing costs and additional monitoring requirements to abide by the Stockholm Convention, as would be requested by MoE. This process provides an immediate and permanent disposal option of waste.

For a total quantity of heavily contaminated sand of 100 m^3, transport and treatment cost would be in the range of USD 20,000. Alternatives could be mode costly; the construction of an engineered storage cell would cost in the order of USD 200,000 and would not provide a final solution to the problem, as risks of leakage in the future would always exist. Costs of exporting the waste through Basel Convention can be extremely high, in the order of several thousands of dollars per tonne.

7.2.5.4 Recommendations for Oil -contaminated Solid Waste: Burial in Engineered Cells or Co-Processing in Cement Kilns

Oil contaminated macro-waste such as PPE, bags, plastics, cleaning products, shredded PVC tanks, and wood can be neutralized and disposed in secured engineered burial site or be co-processed in a local cement kiln.

For burial, feasible and secure sites might be the old refinery in Tripoli or/and in Zahrani. Both sites are secured and confined within industrial zones, which are from an environmental stand, eligible for such use. However, a hydro-geological and environmental assessment studies are necessary to confirm the suggestions. The construction cost for such engineered cells may be estimated at 65-130 USD/m^3. The necessary area will be determined once total quantity of waste need to be disposed is available. Additional costs include environmental and hydrogeological assessments and monitoring costs. The disadvantage is that the waste will remain and is not destroyed.

Co-processing in a cement kiln will require some pre-processing on-site. Cost of disposal will not exceed 200 USD per tonne and could be as low as 100 USD per tonne or even less, depending on negotiations with existing factories. MoE should request from the cement kiln operator that monitoring requirements as stipulated in Stockholm convention be followed. The total cost of disposal includes the additional cost incurred by the factory for environmental monitoring.

Assuming a total quantity of 2,400 m^3 of contaminated solid wastes based on a total of 4,800 m^3 collected by end of November 2006, the disposal of such wastes at an average cost of USD 150/m^3 would be USD 360,000.

7.3 AGRICULTURAL WASTES

Several types of wastes were generated from the agriculture sector during the war. These are further described and possible treatment and disposal options are discussed.

Most types of wastes generated during the conflict from the agriculture sector are scattered in several locations, primarily in the South and the Bekaa. Animal wastes from damaged husbandry farms were reported in Baalbek area (Tanmia, Libanlait), Ksara (Nahhas), Choueifat-Dahieh (few farms for sheep, goat and cow meat production) and South Lebanon [172](Buda and Al-Khudairy, 2006). Other hotspots include Assi River (freshwater aquaculture) and Ouzaii fishing port (boats).

7.3.1 QUANTITY AND CHARACTERISTICS OF WASTE GENERATED

7.3.1.1 Main types of Agricultural Waste

The main types of wastes from the agriculture sector generated during the conflict are:

- Organic waste from damaged crops;
- Dead animals and fisheries (carcasses);
- Damaged and dead trees from forests and orchards;
- Damaged equipment (water pumps, generators, etc.) and trucks;
- Green houses nylon sheets and steel structures;
- Irrigation networks (PVC pipes and concrete channels);
- Damaged aquaculture farm ponds; and
- Fishermen boats.

7.3.1.2 Quantity of Damaged Material Related to the Agricultural Sector

The available information on quantities of wastes is listed below (Buda and Al-Khudairy, 2006):

- Directly hit greenhouses (7 destroyed in the plain of Tyre). No data for areas to the north of Litani.
- Mulch, plastic of greenhouses, and pots: besides the damaged greenhouses, there are 100 nurseries affected in South Lebanon. No data about the quantities of these wastes are available.
- 170 agriculture warehouses affected in South Lebanon, without any further details about the type and area of these constructions.
- More than 300 fishing boats (wood, fiber glass, nets, traps and engines) were partially or totally damaged in Ouzaii fishing port (Figure 7.3).

[172] There are many small scale farmers in Sour, Bent Jbeil, Marjayoun, Jezzine and Nabatiyeh cazas.

- Dead carcasses amounting to 3,050 head of dairy cattle, 1,250 bulls, 15,000 head of goats and sheep, 18,000 beehives and over 600,000 broilers (FAO, 2006).

Figure 7.3. Damaged Fishermen Boats at Ozai Port-Beirut

Figure 7.4. Dead trout fish stocks in aquaculture farms at Assi River-Hermel

7.3.1.3 Other Potential Post-Conflict Waste Sources

Despite the end of the conflict, the agricultural sector is still suffering from its outcomes. Cluster bombs in the South present a major obstacle impeding agricultural recovery resulting in increase of damaged crops. Agriculture is the third largest contributor of the Lebanese economy after tourism and industry, and is under serious threat even after the cease-fire as the presence of cluster munitions prevents agricultural workers from returning to their land eventually resulting in the increase in damaged crops.

There is a potential for increase of dead/injured cattle's due to direct contact with UXO while grazing in contaminated areas (70% of south Lebanon), water/soil pollution or loss of grazing lands (PCM, 2006b).

Cutting of trees resulting in increase in uncontrolled charcoal production in impacted zones is also possible.

Figure 7.5. Charcoal production in open environment

7.3.2 POST-CONFLICT INITIATIVES

The following initiatives can be highlighted:

- Rapid re-construction works took place immediately after cease fire to fix damaged water irrigation channels and pipes, as was the case with Canal 900 near Qaraoun Dam in Bekaa region (ELARD, 2006).
- It was observed that carcasses were left to decompose in the open air or left to burn after direct bombing. On a later stage, carcasses were either dumped in rivers or burnt (ELARD, 2006).
- Damaged crops also were mostly left to decompose in open air due to difficulty to clean up and compost during conflict resulting in odor emissions. On later stage, some of the damaged/rotten crops scattered in agricultural fields were removed to decompose in piles (composting) or burnt.
- Destroyed green houses or those contaminated by the oil smoke from Jiyeh tanks fire are removed and disposed with municipal waste or near river banks (ELARD, 2006).
- For damaged boats, no actions have been undertaken yet, except the personal initiatives of some concerned farmers or fishermen to remove the damaged boats and repair the partially damaged machinery or recovery of their equipment; international assistance to support fishermen has however been mobilized.
- Intentional fires in open areas set by local people as an initiative to clear these lands from UXO’s resulting in aggravating the biodiversity loss in these burned lands.
- Recent surveys revealed that an increase in charcoal production is taking place near damaged area with high level of tree damage. Charcoal production is generally unorganized and lacks the basic environmental control measures especially on air quality control. The extent of damaged and dead trees attracted the charcoal producers resulting in the increase in the number of producers eventually leading to deterioration of local air quality, noticeable from odor and smoke (ELARD, 2006).

7.3.3 ENVIRONMENTAL CONCERNS

7.3.3.1 Environmental Impacts of the Disposal of Carcasses

Disposal of dead carcasses presents the following main issues of environmental concern:

- Smell and pathogen spores released due to the degradation of dead cattle and aviary or the smoke released from burned carcasses;
- Dumping of dead carcasses and aviary, milk, products, manure into rivers (mainly the Litani River and its tributaries in the Bekaa) which leads to the depletion of oxygen, with detrimental impacts on flora and fauna. In extreme cases, where the rate of utilization of oxygen is greater than the rate at which oxygen is replenished (i.e. in slow-flowing rivers in late summer), all the available oxygen may be consumed. These conditions favor anaerobic bacteria, which produce toxic hydrogen sulfide and ammonia.

7.3.3.2 Environmental Impacts of the Disposal of Other Agricultural Waste

Issues of environmental concern related to other agricultural waste types include:

- Air pollution due to smoke and unpleasant smell from burning of damaged crops and trees;
- Loss of biodiversity in freshwater ecosystems due to the depletion of oxygen, such as in Assi River due to the presence of dead fish;
- Soil pollution from disposal of oil contaminated agricultural waste or damaged equipment and trucks.

7.3.4 WASTE MANAGEMENT OPTIONS

7.3.4.1 Options for Treatment and Disposal of Dead Carcasses

Composting: The disposal of dead animals is a major environmental concern. Composting can be an economical and environmentally acceptable method of handling dead animals. This process produces little odor and destroys harmful pathogens. Composting of dead poultry is the most common process. The process does apply equally well to other animals. Some operators have composted dead animals weighing as much as 45 kg by grinding or cutting them into smaller pieces (7 kg). Dead animal composting facilities should be roofed to prevent rainfall from interfering with the compost operation. Dead animal composting must reach a temperature in excess of 55 °C to destroy pathogens. However, the addition of rainfall can elevate the moisture content and result in a compost mix that is anaerobic. Anaerobic composting takes much longer and creates odor problems (Fraser, 1994).

Incineration: One of the more attractive aspects of incineration relative to other carcass disposal options, such as composting and burial, is the complete destruction of pathogens. Another advantage is the relatively small mass of residual material (ash) requiring some form of ultimate disposal. Moreover, incineration has a relatively low labor requirement. Limitations associated with incineration include the potential air pollution problem resulting from improper operation or equipment in addition to the high initial investment cost. Another limitation of incineration for carcass disposal is fixed capacity. This can be problematic when disease or other factors such as conflicts cause a sizable increase in the rate of mortality (Fraser, 1994; UNDP/MoE/ELARD, 2002).

Burial pits: Any dead animal (i.e. horses, goats, sheep, swine or cattle) must be either picked up by a dead animal collector within 48 hours of death, or buried on the farm in an environmentally-safe place away from watercourses under 0.6 meters of soil or in a designed pit, within 48 hours of death. Poultry mortalities should be stored in a freezer as soon as possible after death and held for pickup by a dead animal collector, or buried on the farm in an environmentally safe place away from watercourses and under 0.6 meters of soil (UNDP/MoE/ELARD, 2002). The burial sites need to be at least 45 m down-gradient from any ground water supply source. Sites that have highly permeable soils, fractured or cavernous bedrock, and a seasonal high-water table are not suitable and should be avoided. In no case should the bottom of the burial pit be closer than 1.5 m from the ground water table. Surface water should be diverted from the pit. For large animals (cattle and mature swine), individual pits should be opened for each occasion of burial. The pits should be closed and marked after burial. For small animals (poultry and small pigs), pits can be constructed for use over a period of time. Typical pit sizes for small animals are 1.5 to 2 m wide, 1.5 to 4 m long, and 1.5 to 2 m deep. The sides of the pit should be constructed of concrete block, treated timber, or pre-cast concrete. The side walls must have some openings to allow for pressure equalization. The bottom of small animal pits is not lined. The top should be airtight with a single capped opening to allow for adding dead animals.

Composting and incineration of dead animals are not a viable option in Lebanon due to the absence of such specialized treatment plants, equipment, high capital & operational cost on small and medium size farms. Site burial with quicklime neutralization is the most recommended solution on smaller scale farms.

7.3.4.2 Disposal Options for Agricultural Wastes that can not be Composted

Disposal options for different agricultural waste streams other than animal carcasses, mainly animal health-care products, packaging, containers and related materials, farm building materials, machinery and equipment and preservatives are summarized in Table 7.11 (UNDP/MoE/ELARD, 2002).

Table 7.11. Summary of Preferred Disposal Options for Agricultural Wastes that cannot be Composted

Waste Category	Specific Waste	Reuse	Recycle	Return	HWD [173]	LWDS [174]
Animal Health-Care Products	Leftover But Usable			X	X	
	Leftover But Unusable			X	X	
	Banned Products			X	X	
	Biomedical Wastes			X		
Packaging Containers & Related Materials	General Packaging	X	X			X
	Petroleum Product Packaging	X	X			X
Farm Building Materials	Building Materials	X	X			X
	Restricted-Use Materials	X	X			X
Machinery & Equipment	Inert Components	X	X			X
	Restricted-Use Components	X	X	X		
	Tires	X	X			
Preservatives	Leftover But Usable				X	
	Used Oil	X	X			

7.3.5 RECOMMENDATIONS

The following recommendations can be made:

1- The Ministry of Agriculture could launch an awareness campaign among farmers on the environmental and health impacts from improper disposal of carcasses in the environment and disseminate and encourage proper disposal and recycling options among them; UNDP and the SPASI project had published a study on best practices for farm waste management which could be further disseminated (UNDP/MoE/ELARD, 2002);

2- Dumping or burning of animal carcasses and dead aviary and veterinary products as such, should be prohibited.

3- The Ministry of Agriculture with MoE and local authorities could collaborate to:

   a. Prohibit un-necessary tree cutting;
   b. Prohibit local people from setting intentional fires in open areas to clear UXOs;
   c. Minimize land clearance for opening new by-passes;
   d. Organizing and effectively monitoring charcoal production industry; and
   e. Control licenses issued to tree trimming activities.

[173] Hazardous Waste Depot
[174] Licensed Waste Disposal Site

7.4 INDUSTRIAL, HAZARDOUS AND SPECIAL WASTES

Sources of special waste generated from the conflict include:

- Hazardous waste possibly generated from destroyed industrial facilities (around 9 major industries) (ELARD, 2006);
- Bulky items and household hazardous waste generated in large quantities from destroyed residential units and commercial centers (around 30,000 units) (PCM, 2006b);
- Storage tanks used for temporary storage of oil-spill waste;
- Damaged fuel tank structures (25 underground tanks in damaged petrol stations, 40,000 m^3 jet Kerosen fuel tanks in air port and 75,000 m^3 oil fuel Jiyeh tanks) (Kelly, 2006; ELARD, 2006; PCM, 2006b);
- Damaged vehicles of different types (estimated to be in hundreds due to intentional attacks on vehicles by IDF, official record could be released by mid December, 2006), (PCM, 2006b);
- Radioactive contaminated soil;
- UXO’s.

7.4.1 QUANTITY AND CHARACTERISTICS OF WASTE GENERATED

1- The conflict resulted in the damage of petrol fuel stations, several damaged industries in addition to the main fuel storage tank farms in Rafik Hariri Air Port and Jiyeh Power Plant (Figure 7.6). The waste includes the sludge, ashes, filled tanks and tanks steel structures itself.

Figure 7.6. Different Types of Damaged Fuel Tanks in Jiyeh

2- Special household waste generated from 30,000 damaged residential/commercial units and storage house typically includes:

- Cleaning solvents;
- Cathode ray tubes and fluorescent light bulbs;
- Damaged electronic appliances;

- Household chemicals storage containers (made from plastic material);
- Dry cell batteries (containing Cadmium, Zink and Mercury) (Figure 7.7);
- Lead batteries (mostly used as backup energy source in houses);
- Shattered glass windows;
- Treated furniture (treated wood); and
- Damaged white goods.

Figure 7.7. Partially Incinerated Dry and Liquid Batteries in Plastimed and Jiyeh (from left to right)

3- Many electronic devices contain individual components made with hazardous constituents, primarily heavy metals. For example, some appliances include transformers and capacitors containing PCBs, others containing chlorofluorocarbons, HCFC, HFC, and equipment containing free asbestos. Cathode ray tubes (CRTs) found in color televisions and color computer monitors contain significant amounts of lead. Printed circuit boards and complex circuitry found in computers and other electronic devices may contain lead, chromium, and silver (SC-DEH, 2004).

4- Oil spill waste recovery activity is expected to generate significant number of variety size storage containers some being made of PVC (Figure 7.8). The significance is related to the fact that these tanks once emptied from its contents are contaminated and cannot be disposed with regular waste streams, burned or simply recycled without proper cleaning (VA-WRRC, 1998).

Figure 7.8. Large PVC containers used for storage of oil waste

5- Despite the fact that no figures are available on the number of damaged vehicles and trucks, it is estimated that hundreds were damaged during the conflict ranging from small passenger cars to large six wheel trucks (Figure 7.9).

Figure 7.9. Damaged Vehicles from Conflict-South Lebanon

6- Radio active waste is considered as a hazardous waste. The waste could be in the form of contaminated soil or structures or in debris. Debate regarding the presence of depleted uranium in the Lebanon took place after the release of two contradicting test results on this matter. CNRS reported that no DU was found in the samples measured at 25 different sites in the impacted areas, but stressed that available measuring devices might not be enough to detect DU (CNRS, 2006). However, independent scientists studying samples of soil after Israeli bombing in Lebanon have shown high radiation levels, suggesting that uranium-based ammunitions were used. Samples taken from two bomb craters in Khiam and Al-Tiri have been sent for further analysis to the Harwell laboratory in Oxfordshire, southern England, for mass spectrometry (British Daily news paper).

7- Millions of bombs, rockets, shells were fired on Lebanon during the conflict period. It is standard assumption that some 10 percent of total bombs do not explode on impact or considered having default in manufacturing; these UXO's need to be disarmed and disposed of safely. The majority of recovered UXO's are disposed in 15 special burial sites located by the Lebanese army and Mine recovery teams working in Lebanon.

8- Site visits to damaged industries in Lebanon revealed that most of the industrial waste has been incinerated (Plastimed), removed from site during land clearance (Ghabris soap) or considered as demolition and non-hazardous waste. One exception is at Safia el Deine medical plastic industry in Tyre; the industry is expected to have stocks of supplying medical plastics containing toxic components such as Vinyl chloride and PVC.

7.4.2 POST-CONFLICT INITIATIVES

7.4.2.1 Fuel-Tank Waste Management Initiatives

- Several petrol station owners already rebuilt their stations and many of them are already operational today. No data is available on the handling and disposal of the damaged underground tanks in these stations.
- No actions were reported dealing with the damaged fuel tanks in the Jiyeh and Air port.
- No actions were reported for disposal of contaminated oil waste storage tanks.

7.4.2.2 Household Hazardous Waste (HHW) Management Initiatives

- HHW is not collected separately and is co-disposed with the MSW stream. However, it was generated in relatively small quantities prior to the conflict and it is expected that due to the extent of the damaged residential units and commercial units, the amount generated post conflict will have increased significantly.
- HHW is generally not being recovered in an efficient manner or not recovered at all, except for those with high value such as damaged white goods, re-useable furniture and electronic appliances. One should take into consideration that part of the wastes has burned as a consequence of IDF bombardment and explosions, and the non-recovered part is possibly still mixed with the debris waste piles removed or already being disposed off with the regular municipal waste stream.

7.4.3 ENVIRONMENTAL CONCERNS

7.4.3.1 Impacts from Fuel and Oil Storage Tanks

For disposal purposes, tank wastes can be seen as consisting of two largely separate streams: the contents of the tank, both liquid and solid, and the tank itself. Even though these entities may both eventually be deposited in a landfill, either separately or while still intact from removal, their chemistry and environmental interactions remain sufficiently disparate to warrant separate treatment schemes (VA-WRRC, 1998).

The discussion of disposal strategies focuses on the fate of the tank itself since, in each case, most of the product and sludge is supposed to be removed beforehand and treated separately (VA-WRRC, 1998).

Impacts of Abandonment in Place: Because of the amount and type of material that is or may be left in the ground, tank abandonment presents probably the largest environmental threat of the various disposal choices. Under ideal circumstances - that is, when a tank is located above the ground and away from water table and is completely freed of product and sludge before filling -this environmental threat will be fairly small. More serious impacts are likely from tanks with damaged platforms or damaged structure tanks (mostly fuel barrels) leaking into ground water and contaminating nearby wells, if present.

Impacts of uncontrolled dumping of Tanks: The dumping of tanks and their contents presents risks of production of potentially toxic or hazardous leachate. The main components of potential contamination are sludge or product residuals. The long time periods involved and the potential for eventual interaction of different kinds of leachate may give rise to unexpected and unpredictable results. For this reason, dumping as a disposal alternative is not recommended especially that Lebanon does not have hazardous waste landfills.

Impacts of Recycling of Tanks: In the case of steel tanks, the recycling of tank steel is the most environmentally desirable method of tank disposal, since the steel is never, in fact, land-disposed but is melted down for recasting into other products. Heavy metals that may be of concern in land disposal become air contaminants in the steelmaking furnace; these are removed before emission and are treated as part of a hazardous solid waste. No metal foundries are located in Lebanon, however there are scrap dealers. Most recovered metals are shredded and exported to international markets.

7.4.3.2 Impacts from Dry Cell Batteries Disposal in Dumpsites

The Danish Environmental Protection Agency has reported that Ni-Cd batteries are the most substantial source of cadmium pollution, expected to account for up to 90 per cent of future human exposure to the metal in Denmark. Long-term exposure to cadmium, a suspected human carcinogen, can cause liver and lung disease.

Emissions of heavy metals (Cd, Hg, Pb, Cr) are also a major concern during waste burning. After combustion, metals are either emitted as particulate matter or vaporized into their gaseous state. Mercury is of particular concern for public health reason as it volatizes at low temperature. Virtually, all of the mercury in MSW is due to the disposal of household dry cell batteries (mercury, alkaline, and carbon-zinc type) with less extent to broken temperature thermometers (Tchobanoglous et al., 1993).

7.4.4 WASTE MANAGEMENT OPTIONS

7.4.4.1 Damaged Fuel Tanks (above and underground tanks)

The available means for fuel tank disposal are represented by a well-established set of technologies operating within tight and changing regulatory and industrial constraints. While innovative developments have refined some aspects of cleaning waste treatment and disposal, the available options for fuel tank disposal consist of two general sequences: 1) abandonment-in-place; and 2) tank removal, followed by either landfilling or recycling. Although differentiated largely by the final disposal location or treatment of the used vessel, both are preceded by a certain amount of tank cleaning.

Tank Cleaning: Most forms of disposal (with the exception of a hazardous waste landfill, in some cases) require that the tank be emptied and cleaned to an extent, depending on the final disposal site of the vessel. For all tanks (out of service or damaged), excess product must be pumped out and the interior space rendered gas free; sludge, if found, must be removed and disposed of according to national regulations for all tanks except those destined for a permitted hazardous waste landfill. Recycling usually requires, further, that the metal in contact with the sludge be scraped clean and that any scale or rust also be eliminated.

Tank cleaning is preceded by a thorough removal of the excess product, usually accomplished by a vacuum truck or - if no sludge is present - by filling the tank with water and pumping the floating product off the top. For tanks that have been removed from the ground and/or can be entered, sludge can be collected manually by individuals inside the tank provided that vapors are reduced to safe levels and proper protective clothing and respiratory devices are used.

Although some mixing of sludge and product is inevitable during external pumping, once the sludge clearly becomes the predominant component it should be diverted to suitable hazardous waste containers and handled accordingly; since it has different characteristics from the petroleum supernatant, it usually requires different treatment. Properly drummed, this sludge may be left on the site for up to 180 days before removal and disposal according to international guidelines. Tanks that contained unleaded gasoline or those free of sludge and scale from leaded gasoline, generally require no further cleaning. For tanks that do require cleaning for any reason, however, three technologies are available: commercial steam cleaning, sandblasting or abrasion cleaning, and chemical treatment. These can be implemented by local contractors.

Abandonment in-place: Abandonment in place is a relatively straightforward means of disposal that avoids the expense and difficulty of tank removal and transportation off-site. Although obviously involving the commitment of land to long-term storage of the out-of-service or damaged vessel, it is often the disposal strategy of choice in those cases where removal is difficult, unsafe, or otherwise unsuitable. Abandoned tank should be filled with a solid material to prevent eventual tank collapse and subsidence of the overlying surface (in case of underground fuel tanks). Sand has traditionally been the filler material of choice because of its ready availability and low cost, although mixtures of sand and earth or sand and rock have also been used. Typically, some water must be added during filling to spread the mixture throughout the tank and prevent coning beneath the fill hole.

Tank Removal: In most cases, land use imperatives, or preferred management practices necessitate the complete removal of the old tank from the site, followed either by backfilling or replacement with a new vessel. Although some of the pumping and cleaning steps are the same as abandonment, the need to excavate, elevate, and transport the tank makes this process more expensive, technically complex, and potentially dangerous. Once the tank has been withdrawn from the ground, it is either recycled at a scrap metal dealer or disposed of at an industrial or hazardous waste landfill. In Lebanon, only the former option is available (scrap metal dealers).

Tank Recycling: For many reasons, the recycling of steel vessels as scrap metal is the most desirable form of tank disposal. Several facilities are available in Lebanon to recycle scrap metal. However these facilities will normally require that the tanks be cleaned prior to accepting them.

Tank Landfilling: In some cases, where the condition of the tank (structure burnt) or distance to the scrap dealer discourages recycling, tank disposal in a landfill may be the preferred option. Although the tank then remains a rusting source of potential contamination for many years, a well-designed landfill is built to at least mitigate and contain the effects of all deposited substances, many of which are more harmful than gasoline residues. For tanks of material other than steel, especially PVC, or that have contained substances that render the steel unsuitable for recycling, landfilling is often the only option for disposal. The requirements for tank cleaning are rather less stringent for landfilling than for recycling. Tanks must be usually drained of liquid and free of hazardous sludge; if sludge is present it must be shown by analysis to be non-hazardous. Because of space and safety considerations, operators often require that tanks be cut up or that the ends be cutoff to facilitate compacting. A hazardous waste landfill will accept both the tank and the sludge, if present; an absorbent filler is often then poured into the tank to immobilize the residues and prevent collapse of the structure. Unfortunately, such facilities are not available in Lebanon.

7.4.4.2 Options for Dry Battery Recycling/Disposal

Recycling: The main advantage of battery recycling is the environmental benefit arising from a reduction in the primary production of materials and energy, and lower emissions of mercury, lead and cadmium from landfills and waste incinerators. Recycling silver oxide batteries is also currently economically viable, although as with lead - acid types the economics of recycling fluctuate according to the changes in the metals market (Residua, 2000). However recycling facilities in Lebanon are not available.

Export to other countries: A number of specialized plants now recycle batteries using the technique of pyrolysis. The Batrec process in Switzerland, for example, extracts most metal compounds in batteries, without generating toxic emissions. Spent batteries are heated in the absence of air (at 300 -750^{o}C). The mercury evaporates, is condensed and recovered. Other metallic components can be recovered in a subsequent induction furnace stage of the Batrec process. More than half of the materials in spent batteries can be recovered in this type of facility (NZ-MFE). This option would be very expensive and could cost several thousands of dollars per tonne of material to be disposed. Lead acid batteries are severely wanted by the Lebanese recycling industry.

Landfilling: Damaged batteries should be disposed of in hazardous waste landfills. Unfortunately such facilities do not exist in Lebanon. Nevertheless, and given the small quantities of such wastes generated during the war, the possibility of building a special cell to bury these wastes could be investigated. The costs would be similar to those shown in the oil waste section.

7.4.4.3 Options for Electronic Waste Management

Management of discarded electronic equipment is often considered alone in an electronic wastes management plan, given the characteristics of such wastes. E-waste includes those electronic products that are at or near the end of their useful lives. Computers, televisions, VCRs, DVDs, cell phones, stereos, speakers, microwaves, copiers, printers, and fax machines are common electronic products that fall into this category (SC-DEH, 2004). These wastes are expected to be mixed with demolition wastes. Unfortunately, options for disposal remain limited. The waste is most likely being dumped with demolition wastes. When disposed in dumpsites, these products (mostly the transformers and electronic boards) have the potential to contribute with significant levels of toxic materials to the leachate produced. These include lead, polychlorinated biphenyls (PCBs), mercury, cadmium, arsenic, zinc, chromium, and selenium. The CRTs found in computer monitors and television sets can contain 20 percent lead oxide by weight. According to a recent U.S. EPA report on electronics, CRT-containing products may contain four pounds of lead on the average. Possibility of re-use and recovery of these wastes, although preferred, remain limited.

7.4.4.4 White Goods, Damaged Vehicles and Demolition Wastes

The conflict generated considerable amounts of bulky items, damaged vehicles/trucks, tires and demolition waste. Available options for disposal of generated special waste includes: 1) re-use, 2) recycling and 3) construction of artificial reefs.

Re-use: Working or partially damaged white goods can be re-used if economic value of repair is justified. Re-use provides additional markets for low cost equipment and contributes to minimizing waste disposal. It is understood that such goods are being recovered from demolition wastes when possible.

Recycling: There are several facilities and collection centers in Lebanon for the recovery of scrap metal and end-of-life or damaged vehicles including (UNEP-CEDARE, 2000):

a) *Vehicle dismantlers* who typically strip vehicles for parts and send residual metals to metal merchants or shredder operators;
b) *Metal merchants* who collect and sort scrap metal. A certain amount of processing, for example crushing or coarse shearing, is sometimes carried out by metal merchants; and
c) *Shredder operators* who perform many of the same functions as metal merchants but also operate large scale shredding machinery to shred vehicles and other metal waste.

Construction of artificial reefs (AR):

The benefit of constructing AR in the Lebanese coast has two-fold: 1) potential increase in fish yield; and 2) enhancement of scuba-diving activities. With the current degradation of the marine environment due to the oil spill, construction of AR, when properly performed, could support the regeneration of marine ecosystems while offering a solution of some of the waste problems.

In Lebanon, it is indicated that there are between 3,000 to 4,000 fishermen and 8 major fishermen ports. One of the damaged ports during the conflict was the Ouzaii port in Beirut, whereby, 300 boats were completely or partially damaged (Nader, 2005).

Monitoring of AR from around the world showed that fish yields or catches increased between 10% and 50% (and more) when introducing AR (average of 30% in fish yields). Other expectations that AR would increase local dive club average diving trips ranged from a low of 5% to a maximum of 100%. Eliminating the upper value of a 100%, the average expectation with respect to the percentage increase in 'extra' dives is about 30%. There are at least twelve known diving clubs in Lebanon (Nader, 2005).

Concrete materials could be used for reef building (such as culvert, bridge decking or demolition debris). These materials perform very well and have a much longer lifespan as reef materials than might be predicted (between 30 and 50 years) for several reasons. Concrete, either in fabricated units specifically designed for artificial reefs or imperfect concrete manufactured products, such as culvert or rubble from razed buildings, sidewalks, roadways and bridges, has a demonstrated high success rate as artificial reef material in both marine and estuarine environments. The obvious reason for this high rate of success is the strong compatibility of the material with the environment in which it is placed, and for the purpose for which it is placed. Concrete is generally very durable and stable in reef applications (AGSMFC, 2004; Yip, 1998; Figure 7.10).

The total costs involved in collecting, transporting and submerging the AR material off the Lebanese coast will vary depending on the material used, quantity, condition and pre-processing level (AGSMFC, 2004; Yip, 1998). Table 7.12 presents an analysis of the different material that could be used in the construction of AR; materials are relevant to those generated from the conflict.

Introducing AR would potentially boost local tourism through diverse aquatic activities, and the local fishing industry through higher fish yield. Two of the main outcomes therefore of the AR are the enhancement of the standard of living of one of the poorer sectors of society and most impacted from the recent conflict, the fishing community, and secondly a boost to tourism through the provision of a new activity for divers and marine sport enthusiasts. However such a practice must be carefully studied prior to its implementation to avoid negative impacts.

Figure 7.10. Rubble and Prefabricated Concrete Material used for AR Construction

Table 7.12: Advantages and Disadvantages for use of different material in artificial reef construction

Material	**Advantages**	**Disadvantages**	**Considerations**
Vehicles	- Automobile bodies are readily available, inexpensive, and are relatively easy to handle, not requiring heavy equipment to move.	- *Automobile bodies require a great deal of preparation and removal of material prior to being ready for deployment. This activity can be labor-intensive.* - *Automobile bodies are not durable, lasting for one to five years in the marine environment.* Considering that about one year is required to establish an encrusting or fouling community, along with a relatively stable population of fish, and considering that significant deterioration has likely begun to take place at about year four, automobile bodies may have about three years of useful life as an artificial reef. - *Automobile bodies are not stable,* and likely can be moved easily by storm surge or a boat pulling a trawl, resulting in the material being moved from its original location. - Fiberglass, rubber, and plastics attached to automobile bodies, if not removed when deployed, may become unattached and free in the water column after the metal corrodes away. - *Recycling of the steel may be a more economically beneficial use of automobile bodies than allowing them to corrode within a few years on the ocean floor.*	- Automobile bodies must be carefully inspected prior to deployment as artificial reefs. - Fuel tanks must be drained and perforated to prevent flotation. - Oil must be removed from the engine block. - The engine, break line, electrical components should be steam-cleaned or removed. - Plastics that are not attached securely to the automobile body must be removed. - Electrical components capable of emitting PCBs must be removed. - The rear axle differential on rear-wheel-drive automobiles must be drained of oil or should be removed. - Steering sectors, both power and standard steering, should be drained of fluids or removed. - Transmissions, both standard and automatic, should be drained of fluid or removed. - The coolant system should be drained of fluid, mostly antifreeze, or removed.

Material	Advantages	Disadvantages	Considerations
Concrete	- Concrete materials are extremely compatible with the marine environment. - <u>*Concrete is highly durable, stable, and readily available.*</u> - The flexibility to cast concrete into a great variety of forms makes the material ideal for developing prefabricated units. - <u>*Concrete provides excellent surfaces and habitat for the settlement and growth of encrusting or fouling organisms, which in turn provide forage and refuge for other invertebrates and fish.*</u>	- A major drawback with the use of concrete material is its heavy weight, and the consequent need for heavy equipment to handle it. This increases the costs both at the landside transportation stage and loading and transport at sea. - Deployment of large concrete pieces or prefabricated units requires heavy equipment at sea, which is hazardous and expensive. Another drawback related to the weight of concrete materials is the potential for subsidence into the bottom. - Competition for scrap concrete, for such uses as roadbed construction, as well as the ability to recycle this material is currently reducing the availability of concrete for use as artificial reef construction in some areas.	- Concrete rubble from parking lots, buildings, or other sources may have other materials mixed in with it. Examples include dirt, plastic sheeting (moisture barrier), building materials (wood, fiberglass, etc.), among others. Loads of concrete rubble should be inspected for such associated, undesirable materials prior to deployment. - To enhance durability, use concrete materials which have Type II or greater Portland cement as the binding agent. Type II concrete should be used in designed structures and concrete ballasted tire units produced for reef applications. - Some scrap concrete may contain fly or other combustion ash, thus ash laden material could be inadvertently deployed.

Material	Advantages	Disadvantages	Considerations
Tires	- Vehicle tires are lightweight and easy to handle, particularly un-ballasted tires on small boats. - Vehicle tires may be readily available in large quantities, depending on regional scrap tire market value, and alternative government incentives. - Vehicle tires may be acquired free or at low costs, depending on local regulations and regional scrap tire market value. - Tires will last indefinitely in the marine environment. This is considered a benefit in the context of the material being durable. - Tires used as artificial reefs can be effective in attracting and holding fish and invertebrate populations	- Handling and access to waste tires is no longer unregulated. The storage, handling, and transportation of tires are carefully managed by all Gulf coast states. - Tire recycling alternatives are available. - Minor leaching of petrochemical or heavy metal toxicants from tires into the marine environment may occur under certain conditions, causing adverse effects to fish and epibenthic organisms (more research is needed from the marine environment on this subject). - Un-ballasted tires are unstable in open water marine environments. As a consequence, they must be properly ballasted in order to assure that tire units do not move in response to currents or storm wave forces. - Properly ballasted tire units are more expensive, bulky, heavy, difficult to handle, and difficult to transport without heavy equipment. - The expense and labor involved in creating a stable and durable tire unit may not make them as cost effective as other materials that can accomplish the same objective. - Tires must be stable in order for fouling or epiphytic communities to attach to tires, although there is some disagreement. Loose, mobile tires do not allow for invertebrate growth due to chafing and flexing. - Single tires lay flat on the bottom and provide little or no habitat value for fish. - Assuming that tires will last indefinitely in the marine environment, tire units will last only as long as the connectors or binding material holding them together remains intact (even when ballasted, multiple tire units that use steel reinforcement rods as a connector will separate after several years due to corrosion of the rods. Each tire used in multiple tire units must be ballasted.	- If used, tires should be clean and free of petroleum or other environmentally incompatible substances prior to deployment. - Tires should not be deployed under environmental conditions expected to cause leaching of toxicants; only used tires should be used as artificial reef materials, as new tires are known to leach petrochemical and heavy metal toxicants - Tire unit design should be ballasted and placed at appropriate depths according to recognized engineering principles. - • Each tire used should be ballasted in concrete. Compressing tires and connecting them with steel reinforcement rods can result in tires breaking free due to corrosion of the steel rods. - Tires can be chipped and incorporated into concrete as an aggregate; however, an engineering study has shown that this approach can reduce the density, thus the stability, of the units when compared to the same unit without the chipped tires

Material	**Advantages**	**Disadvantages**	**Considerations**
Fiber glass boats	- Discarded fiberglass boats are readily available	- Use of derelict, fiberglass, recreational vessels has been tied to their value as a delivery system for other readily available materials. These transported materials by themselves may have little long-term value as reef habitat due to instability, lack of durability, or the lack of proper preparation. Often the material transported is poorly secured. Once the boat and its contents are on the bottom, storm conditions may eventually detach and scatter the cargo. - Low density fiberglass, sometimes with floatation intact or incompletely removed, is then prone to movement. - Under turbulent conditions, hulls may break up, with gelcoat, fiberglass fibers, etc. becoming widely scattered. No information is available on the impact of broken up fiberglass, gelcoat, and resin products in the marine environment.	- Availability should not be the determining factor in accepting fiberglass boat hulls or any other secondary use material. - Better follow-up assessment of existing fiberglass boat and boat mold sites, which have been in place for some years but have not been recently evaluated, is needed. - Fiberglass hulls or boat molds should not be considered appropriate artificial reef material without heavy concrete ballasting. - With the use of any vessels it is highly recommended that coastal engineers provide an assessment of the forces to which any vessel would be exposed in a major storm.
Bulky goods (fridges, dryers, washers, etc.)	- White goods are readily available and are easy to handle, both onshore and at sea.	- White goods are thought to be short lived in the marine environment. If that is true, sites would have to be replenished regularly, in order to maintain habitat. - White goods are thought to be unstable, and may easily be moved offsite by storm surge or being dragged in nets. - Material such as appliances, while readily available, is not dense, and their durability and stability in the marine environment is poor.	- The use of white goods should be avoided. - Ballasting or chaining several units together may increase stability; however, this practice will not increase the durability of the material. - Motors and compressors should be removed or drained of all lubricants, where applicable. - All plastic knobs, valves, and wiring should be removed. - Removing the compressors and motors during predeployment preparation would eliminate the heaviest component of the materials, thus contributing to their instability

7.4.5 RECOMMENDATIONS

1- Fuel tank disposal must be considered from the separate standpoints of tanks and contents. Fuel tanks of all kinds should not be treated as ordinary municipal waste due to the potential toxic compounds attached. The most environmentally sound method is reclamation of product in tanks, followed by cleaning and recycling of the tank steel. Future selected contractors for large fuel tanks in Jiyeh and Airport should present strict compliance with tanks cleaning, health & safety procedures.

2- It is recommended that the deployment of AR should be complemented with the implementation of proper measures to curb and eventually stop illegal fishing practices, over fishing and pollution that negatively impact the productivity of the marine environment in general and the reef in particular. Lobbying for the adoption of appropriate fisheries management policies coupled with the establishment of AR ought to ensure the sustainable use of local resources, preserve fish stocks while increasing the standard of living of the fishermen and boosting local and foreign diving activities and tourism (Nader, 2005). Table 7.13 summarizes the applicability of the different wastes possibly generated during the war for AR.

Table 7.13: Recommended Post Conflict Material for AR Construction in Lebanon

Type	Life time	Recommended for AR construction
Vehicles and streetcars	≈ 6 years	Not recommended; they are subject to corrosion to debris –better off recycled
Wooden materials	< 1-6 years	Not recommended; they collapse even sooner from wave surge and destruction by marine borers-better off recycled
Household appliances (stoves, refrigerators and freezers)	≈ 6 years	Not recommended because they are buoyant and difficult to sink and keep in place-better off recycled
Tires, rock, concrete rubble and others	Very durable (30-50 years)	Highly recommended for prefabricated concrete structures (raw demolition waste is not highly favorable) and tires

7.5 MEDICAL AND PHARMACEUTICAL WASTE

The quantities and quality of health care waste were certainly affected during the conflict. Increased number of injured persons and fatalities has placed pressure to hospital facilities in some areas.

7.5.1 QUANTITY AND CHARACTERISTICS OF WASTE GENERATED

Hospital waste generated during the conflict includes non-risk waste, such as waste from cafeteria and administrative departments, as well as risk waste classified by the Ministry of Public Health into five categories:

(1) Highly infectious waste;

(2) Non-sharp infectious waste (pathological and anatomical waste);

(3) Sharps (discarded syringes, broken scalpels, etc.);

(4) Pharmaceutical and chemical waste, and

(5) Special waste (radioactive and cytotoxic waste, pressurized containers, etc).

As a direct cause of the conflict, medical waste generation increased significantly due to increase in causality numbers and hospital bed occupancy number (reported 1,200 deaths and 4,400 injured). Based on the figures above, it is calculated that around 200 to 250 tonnes of medical waste were generated during the conflict period.

However, this number does not include post-conflict health care waste quantity generated. It is expected that medical and pharmaceutical waste are generated in higher quantity compared to generation rate in the same period before the conflict.

Lebanon received large quantities of medical and pharmaceutical aid during and after the conflict. One of the medical aid providers is the International Federation of Pharmaceutical Manufacturers & Associations; the aid included anesthetics, antibiotics, anticonvulsants, antidepressants, antidiarrheals, antifungals, antiinflammatories, antiretrovirals, heart medicines (antiarrhythmic, anticoagulant, anticholesterol, antiplatelet & hypertension treatments), laxatives, stomach medicines (beta-blockers and H2- antagonists), painkillers and tranquilizers.

7.5.2 POST-CONFLICT INITIATIVES

It can be assumed that limited, if any, initiatives for separation, treatment and proper disposal of medical waste took place.

During the conflict large quantities of pharmaceuticals were donated to Lebanon as part of humanitarian assistance. Undoubtedly, many of the pharmaceuticals save lives and alleviate suffering, but some donations given by well-meaning but uninformed people may cause problems. Pharmaceuticals may arrive past or near their expiry date, may be inappropriate for the needs, and be unrecognizable because they are labeled in a foreign language or may have been sent in unwanted quantities. Donated pharmaceuticals with a long shelf-life may be mismanaged, particularly in the confusion during and after armed conflict. Staff and storage space may be lacking and the pharmaceutical management system in disarray. Such problems also occur when drug donations form part of development assistance. Smaller quantities of pharmaceutical waste may accumulate in the absence of emergency situations, due to inadequacies in stock management and distribution, and to lack of a routine system of disposal. Safe disposal of these unwanted or expired drugs often creates a major problem (WHO, 1999).

7.5.3 ENVIRONMENTAL CONCERNS

This section will focus mainly on the environmental issues related to disposal of pharmaceutical waste which is expected to be of concern regarding its disposal during post conflict phase.

In general, expired pharmaceuticals do not represent a serious threat to public health or to the environment. Improper disposal may be hazardous if it leads to contamination of water supplies or local sources used by nearby communities or wildlife. Expired drugs may come into the hands of scavengers and children if a landfill is insecure. Pilfering from a stockpile of waste drugs or during sorting may result in expired drugs being diverted to the market for resale and misuse. Most pharmaceuticals past their expiry date become less efficacious and a few may develop a different adverse drug reaction profile (WHO, 1999). There are some categories of expired drugs or defective disposal practices that carry a public health risk. The main health risks are summarized below:

- Contamination of drinking water must be avoided; inappropriate dumping of such wastes can pose a threat to groundwater resources;
- Non-biodegradable antibiotics, antineoplastics and disinfectants should not be disposed of into the sewage system as they may kill bacteria necessary for the treatment of sewage; antineoplastics should not be flushed into watercourses as they may damage aquatic life or contaminate drinking water. Similarly, large quantities of disinfectants should not be discharged into a sewerage system or watercourse but can be introduced if well diluted;
- Burning pharmaceuticals at low temperatures or in open containers and dumps results in release of toxic pollutants into the air. Ideally this should be avoided;
- Inefficient and insecure sorting and disposal may allow drugs beyond their expiry date to be diverted for resale to the general public. In some countries scavenging in unprotected insecure landfills and dumpsites is a hazard;
- In the absence of suitable disposal sites and qualified personnel to supervise disposal, unwanted pharmaceuticals present no risk provided they are securely stored in dry conditions.

7.5.4 WASTE MANAGEMENT OPTIONS

Waste management options focus on pharmaceutical wastes, as these are the ones mostly related to the war and the additional quantities generated may require special attention. The various disposal methods are briefly described and summarized in Table 7.14.

Table 7.14. Disposal Options of Pharmaceutical Wastes (WHO, 1999)

Disposal methods	Types of pharmaceutical	Local condition suitability
Return to Donor / Manufacturer *(trans-frontier transfer)*	All bulk waste pharmaceuticals, particularly antineoplastics.	Usually not practical due to high costs - if transferred across frontiers, become regulated and subject to the Basel Convention on the Transfrontier Shipment of Hazardous Wastes
High-Temperature Incineration *(>1200°C)*	Solids, semisolids, powders, antineoplastics, controlled substances.	Expensive. No specialized incinerator in Lebanon Cement kiln incineration is an option available in Lebanon
Medium temperature incineration or co-processing *(2-chamber incinerator with temp > 850°C)*	In the absence of high temperature incinerators, solids, semi-solids, powders. Controlled substances.	Antineoplastics best incinerated at high temperature. Local incinerators are available
Immobilization		
Waste encapsulation	Solids, semi-solids, powders, liquids, antineoplastics, controlled substances.	Requires monitoring Occupies valuable space
Inertization	Solids, semi-solids, powders, antineoplastics, controlled substances.	Requires monitoring Occupies valuable space
Landfill		
Highly engineered sanitary landfill	Limited quantities of untreated solids, semi-solids and powders. Disposal of waste pharmaceuticals after immobilization preferable. PVC plastics.	Occupies valuable space
Open uncontrolled non-engineered dump	As last resort untreated solids, semi-solids, powders – must be covered immediately with municipal waste. Immobilization of solids, semi-solids, powders is preferable.	Not for untreated controlled substances.
Fast–flowing watercourse	Diluted liquids, syrups, intravenous fluids; small quantities of diluted disinfectants (supervised).	Antineoplastics, and undiluted disinfectants and antiseptics not recommended.
Chemical decomposition	Not recommended unless special chemical expertise and materials available.	Not practical for quantities >50 kg.

7.5.5 RECOMMENDATIONS

Co-processing of pharmaceutical waste in cement kilns offers advantages for the authorities responsible for pharmaceutical waste management. This waste recovery method uses an existing facility, eliminating the need to invest in a new, purpose-built incinerator or secure valuable landfill site. Export of the waste is an expensive alternative but a technically attractive one.

Cement kilns are characterized by sufficient process conditions and primary measures to minimize the formation and release of chemicals listed in Annex C of Stockholm Convention and achieve concentrations of PCDD/PCDF in flue gas lower than 0.1ng TEQ/Nm^3 (GTZ/HOLCIM, 2006).

Estimated treatment cost: The cost for co-processing of pharmaceutical waste in cement kilns in Lebanon is estimated at USD 400 to 500 per tonne (*personal communication with Holcim-Lebanon*). The high cost is justified by cement industry due to relatively low quantities of waste that could be received as well as additional monitoring costs that will be required to comply with the Stockholm Convention.

7.6 MUNICIPAL SOLID WASTE (MSW)

While the war has only exacerbated an existing municipal solid waste management problem, this section briefly tackles its impacts on MSW.

7.6.1 QUANTITIES AND CHARACTERISTICS OF WASTE GENERATED

7.6.1.1 Quantities

The variation in the quantity of municipal solid waste can not be easily estimated, however the following can be noted:

- More than 3 million cubic meters of demolition waste mixed with household damaged waste was generated in the country as a result of the conflict (PCM, 2006a).
- The new incoming 15,000 UNIFIL personnel and 15,000 Lebanese military forces settling in the south, several new military posts are established to accommodate them. These posts will generate significant quantities (calculated around 15 to 30 tonnes/day) of mixed solid wastes. The majority of these posts are usually located in remote areas on the boundaries of villages with limited to no access to proper municipal waste services.
- According to the last inventory of distributed aid material by the higher relief commission it is expected that there will be an increase in waste generated from packaging aid material mostly cartoon, plastic bottles, tin cans, nylon bags, etc. which mostly will end up in the waste dumps. Table 7.15 is an estimated number of packaging waste generated from aid supply distributed in impacted areas (PCM, 2006b).

Table 7.15. Estimated Number of Packaging Wastes Generated from Aid Supply

Type of waste	Quantity (No.)[175]	Expected Final destination
Nylon Packaging Bags	5,830,995	Mostly disposed
Plastic Bottles & Containers	19,751,577	Partially recovered for recycling
Carton (box + bottles)	6,161,010	Partially recovered for recycling
Flour Nylon Packages	9,848	Mostly recovered for reuse by local flour mills and for other domestic uses
Glass Bottles	17,258,814	Mostly disposed
Tin cans	19,600,524	Partially recovered for recycling

7.6.1.2 Characteristics

Domestic municipal waste characteristics were mostly affected by increase of incoming food aid, temporary change in social behavior and early recovery and rehabilitation works (such as disposal of rotten food, shattered window glass, damaged bulky items, damaged furniture, greenery waste, etc.). Table 7.16 presents the expected changes in waste composition before and after the conflict.

Table 7.16. Expected Change in Waste Composition in Post-Conflict Phase[176]

Components	AUB study 1994			Post-conflict (Short Term)
	Summer	Winter	Annual (%)	General condition
Organic material	62.4	61.0	61.7	Returned to normal
Paper & cardboard	11.3	16.1	13.7	Increased
Plastics	11.4	10.9	11.1	Increased
Metals	2.9	2.6	2.7	High increase
Textiles	4.2	2.4	3.3	Increased
Glass	5.6	4.8	5.2	High increase
Others[177]	2.6	2.0	2.3	High increase

7.6.2 POST CONFLICT INITIATIVES

The following initiatives can be highlighted:

- Municipalities, volunteers and private collection companies immediately initiated an active waste removal, clean up and collection of waste piles from streets and storage bins. The collected waste in each village and town was channeled to regular disposal sites i.e. mostly to local dumpsites.

[175] Quantity was calculated based on the aid supply figures released by HRC, 2006
[176] MoE / Ecodit, 2001
[177] Others include bulky items, electronics, light bulbs, batteries, packages, etc.

- Dumping and open burning is the prevailing method for waste disposal in the majority of the impacted areas mostly in the South (except for very few villages served by material recovery and compost facilities) and Bekaa (except in Zahle caza which is served by a sanitary landfill).
- Beirut southern suburb, served by Sukleen, a private collection company, have removed stock piled waste during the first few days and transported the waste to the Naemeh sanitary landfill.
- Scavenging activities became an active business in the country mostly targeting highly valuable recyclable material (Figure 7.11). Typical recovered material in the Lebanese recycling industry includes are listed in Table 7.17.

Table 7.17. List of Recyclable Material Recovered in Lebanese Market[178]

Recyclable Material	**Types of Materials Found**
Aluminum	Damaged window frames and soft drink bottles *Represents the most valuable recyclable metal in the market.*
Corrugated cardboard (CCB), Carton Box (CB), Old mixed paper (OMP) and High Grade Paper (HGP)	Bulk packaging material and paper. *Contaminated paper/carton is not accepted*.
Plastics (PETE, PVC, HDPE, PS and LDPE)	Bottles, outdoor recreational chairs/tables, water storage tanks, drinking water bottles, packaging for electronic equipment, Styrofoam trays used for vegetables/fruits, etc.
Glass	Clear, green and brown glass bottles and containers *Not all kinds of glass can be recycled such as mirrors, light bulbs, car wind shields, heat resistant glass, and window glass enforced with wire mesh*.
Ferrous metals	Tin cans, white goods, boilers, scrap iron, etc.
Non-ferrous metals	Aluminum, copper in electric wirings, lead in water piping, and stainless steel
Lead acid batteries	Automobile and truck batteries shredded to recover plastic and lead
House hold items	Partial damaged furniture, appliances and equipment
Textile	Cloth, rugs, sheets, etc.

[178] UNEP-Blue plan, 2000.

Figure 7.11. Scavenging Activities at Ouzaii Debris Disposal Site

Scavenging was conducted by house owners (to retrieve what is left from their houses), private scavengers and licensed scavenger network groups. Appendix 7-A lists some of the recycling industries in the country.

7.6.3 ENVIRONMENTAL CONCERNS

7.6.3.1 General Issues

The environmental damage caused by burning of MSW during the conflict and post-conflict phase is irreversible and cannot be mitigated at this stage. However, the main resulting impacts are briefly described.

Waste dumps are directly contaminating soil, groundwater, surface water and air. Typically no liners and control measures are set to stop generated leachate from intermixing with water being used for irrigation or reaching surface water or marine water. The situation is further aggravated by the fact that open dumping is not limited to household waste, but also includes slaughterhouse, medical and industrial waste (Ecodit/MoE, 2001). It is expected that during the conflict the wastes disposed in the existing dumpsites have increased in both quantity and toxicity.

7.6.3.2 Air Pollution

Typical air emissions resulting from incomplete combustion related to open burning of mixed municipal waste includes CO_2, NO_x, SO_2, HCL, PM, and toxic byproducts such as polycyclic aromatic hydrocarbons, benzene and carbon monoxide (Tchobanoglous et al., 1993). In addition, POPs such as polychlorinated dioxins and furans are major products of incomplete combustion from open dump burning. According to the POPs inventory conducted in Lebanon, uncontrolled open burning (mostly dumpsites) is the major source of Dioxins and Furans releases in the country (UNEP/UNDP/MoE/ELARD, 2004).

Emissions of heavy metals (Cd, Hg, Pb, Cr) are also a major concern during waste burning. After combustion, metals are either emitted as particulate matter or vaporized into their gaseous state. Mercury is of particular concern for public health reason as it volatizes at low temperature.

On the other hand, biologically active dumpsites are exposed to anaerobic conditions resulting in the formation of CH_4, CO_2 (sources of green house effect), H_2S (highly corrosive, and toxic), and NH_3. These pollutants are discharged uncontrolled to open air (Tchobanoglous et al., 1993).

7.6.3.3 Water and Soil Pollution

Leachate generated from uncontrolled dumpsites are similar to industrial waste in its impact, whereby the contaminants of concerns are mainly the extremely high COD (~18,000 mg/L), TOC (~6,000 mg/L), and BOD (~10,000 mg/L for fresh leachate) with noxious odor and appearance. The presence of trace compounds (some of which are hazardous) depends on the concentration of these compounds in the gas phase (Tchobanoglous et al., 1993). UNEP post-conflict assessment team conducted leachate sampling for Tyre dumpsite; the results should be published by mid December (ELARD, 2006). Given the increase in the quantities of solid wastes generated during the war and the possible increase in overall toxicity, leachate strength and level of hazard may have also increased.

7.6.4 RECOMMENDATIONS

The impact of the war on solid wastes, whether hazardous or non-hazardous domestic wastes, calls for the urgent need to address the waste management problem in Lebanon. The insufficient number of adequate waste management facilities poses significant threats on the countries water resources and overall health of the population. The following recommendations can be made:

1. The draft integrated solid waste management law prepared by MoE should be adopted by the parliament to provide a comprehensive legal framework for waste management in the country;

2. A national waste management plan should be finalized and implemented, including the implementation of the necessary waste management facilities such as municipal and hazardous waste landfills;

3. In the short-term, an assessment of the impacts of the war on waste dumps is recommended to identify those dumps that received large quantities of wastes and could be posing increased impacts on the environment; the proper closure and rehabilitation of such dumps could be necessary; proposed actions are:

    a. Conduct a survey of dumpsites in affected areas (South and Bekaa) and collect initial information on post-war increase in quantities of wastes disposed and types of wastes disposed based on interviews with local population, waste collectors, etc.

b. Prepare a list of priority dumps to be further assessed based on pre-determined criteria including size, level of impact from war, possible environmental and human receptors, etc.

c. Conduct a detailed study on the selected dumpsites (ownership, size, capacity, age, methane emissions, impacts, , etc.) including detailed site assessments

d. Prepare rehabilitation plans based on findings of the assessment with detailed costing and needs.

e. Rehabilitate one priority dump to serve as a model for replication and remediate a major source of environmental impact identified by the assessment.

f. Assist local municipalities in preparing proposals to international agencies/organizations (Example: World Bank) under relevant funding programs (example: CDM, etc.) to finance the remaining rehabilitation plans.

The total budget of such an intervention is estimated at USD 730,000. Cost breakdown is as follows:

1. Field survey and selection of priority sites: USD 15,000
2. Detailed studies per priority sites (assuming 5 sites are selected and USD 20,000 per site) including rehabilitation plans: USD 100,000
3. Pilot rehabilitation project: USD 600,000
4. Back-stopping and resource mobilization: USD 15,000

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APPENDIX 7- A: DATA BASE OF DIFFERENT RECYCLING COMPANIES IN LEBANON

Company	Contact person	Type	Precondition	Transportation	Revenue	Location	Telephone
Liban Fonderies	Sami Nassar	Metal (all types)	Separation of different types of metals	40-50$/tonne	50% of stock market	Roumieh	01-897619
Ohanis Kasarjian	Ohanis Kasarjian	Metal (steel, fonts, cupper, aluminum)	less than 40cm and 4mm thick. Separated	not provided	not provided	Kfarchima	05-462462
Soliver	Khaled Ammourieh	Glass (all types and colors)	Free from metals, aluminum and lead. Separated	to be discussed	white: 40-45$/tonne, green: 30-35$/tonne, brown: 25-30$/tonne	Chwaifet	05-803903
Maliban	Hagop Chaparian	Glass (bottles and jars; all colors)	Free from metals and plastics. Separated	not provided	White: 50$/tonne, green: 40$/tonne, brown: 40$/tonne	Chtaura	08-510115
Nafekh Yadawi	Hsein Khalileh	Glass (all types without opaque glass)	Free from metals and plastics. Separated	50$/tonne	50$/tonne for each color	Sarafand	03-644747
Mazar plast	Ibrahim El-Aalawi	Plastic (PETE, PP)	Separated and free from organic matter	to be discussed	100-150$/tonne	Bekaa	03-843929
Rocky plast	Robert Khoury	Plastic (most common types)	Free from any organic or inorganic matter. Each type should be grouped alone	not provided	To be discussed	Jbeil	03-634400
Lebanese Recycling works	Elie Debs	Plastic, paper, metals	PETE and PVC should be separated other types could be sent mixed.	Plastic: 25$/tonne, paper: 15$/tonne	Plastic without PETE: 75$/tonne, PETE: 25$/tonne. Cartoon:35$/tonne, other: 35$/tonne, mixed metals:	Roumieh	01-890383

Company	Contact person	Type	Precondition	Transportation	Revenue	Location	Telephone
					40-50$/tonne, iron: 70-80$/tonne		
	Dikrane	used oil and car parts		included	Used parts: 40-50$/tonne, used oil: 40$/1000l.	Dora	03-376499
Daou	Elie Daou	Textile	Free from food, plastic, zippers, bottoms	not provided	40$/tonne	Mazraet Yachouh	04-913 300
Daou	Charbel Daou	Textile	Free from food, plastic, zippers, bottoms	could be provided	transported from site: 33.3$/tonne, without transportation: 50$/tonne	Mtaileb	03-620850
SOLICAR	Tony Bedrane	Paper	Free from waxed kraft, carbon kraft, plastic, food products	not provided	50$/tonne	Wadi shahrour	05-940248
SIPCO	Mohamed Ghandour	Paper	Free from plastic and food products	30$/3-4 tons Jbeil	45-55$/tonne	Kfarchima	05-431048
SICOMO	Jihad Aazar	Paper	Sent in ballet form	to be discussed	50$/tonne	Qab Elias	08-500550
NINEX	George Abou Jawdeh	Paper	Free from waxed kraft, carbon kraft, plastic, food products	not provided	40-75$/tonne	Zouk Mosbeh	09-218400
Unipack-Tissue mel	Imad Khoury	Paper	Free from plastic, metals and food	not provided	50-60$/tonne	Halat	09-477191
Mimoza	Pierre Abou Malham	Paper	Free from food, plastic, zippers, buttons	25$/tonne	45$/tonne	Qaa El-Rim	08-803052

Company	**Contact person**	**Type**	**Precondition**	**Transportation**	**Revenue**	**Location**	**Telephone**
(Collection and Separation)	Elie Sawma	Paper	Free from plastic, metals and food	25$/tonne	45$/tonne	Dekweneh	01-689105
DIAMETAL	George Salame	Ferrous and non-Ferrous Scrap (All types of metals)	Not contaminated by oil	NA	150$ - 200$/tonne	Mansourieh	01-566801
HATCO	Khatchig Hagopian	Secondary lead processing (used car batteries)	Acid free lead batteries	Not provided	NA	Dora-Burj hammoud fishermen port	
Lebanese Metal Industry	M. Ghazi Yaseen	Secondary Lead processing (used car batteries)	Acid Free lead batteries	Not provided	NA	Tripoli-El Baddaoui	03-281434

LEBANON

RAPID ENVIRONMENTAL ASSESSMENT FOR

GREENING RECOVERY, RECONSTRUCTION AND REFORM 2006

AIR

8.1 IMPACT ASSESSMENT

8.1.1 OVERVIEW OF IMPACTS

The air medium is usually severely affected during war times. In general, air quality can deteriorate due to dust emissions from collapsed buildings, air pollutants generated by fires as well as those generated by the explosion of ammunitions. However, most direct impacts on air quality related to war are usually temporary in nature. Air pollution is normally transferred to other media, mainly soil, water and eventually biota. Indirect impacts on air quality can nevertheless last longer such as in the cases of dust generated in re-construction sites and increased emission of air pollutants by the transport sector caused by reduced average speed in affected roads or highways, increased number of truck loaders on road networks and emissions from industries related to the construction sector such as the cement industry. Sources of air pollution caused by the war include:

1. Dust from reconstruction sites;
2. Increased emissions from transport sector;
3. Emissions from burning of petroleum products (mainly heavy fuel oil, kerosene, gasoline, and diesel);
4. Emissions from forest fires;
5. Emissions from damaged industrial facilities;
6. Emissions from exploded weapons and ammunitions.

Other sources of air pollution such as those generated by waste disposal and burning of dead carcasses, rotten vegetables/fruits, municipal and health care waste, do have their share of impact on air quality but are not further discussed in this chapter.

This chapter provides a preliminary assessment of the impacts on air quality caused by the July hostilities; emissions were quantified whenever possible to provide an order of magnitude of pollutants emitted and guide decision-makers as to the need to mitigate the impact. Most data used in the assessment are secondary data from published information, whenever available. Additional sources of uncertainties are introduced with the use of emission factors and modeling in the environmental assessment. The significance of impacts is assessed under the above uncertainties and mitigation measures for those priority impacts are proposed. Note that because some of the impacts are transferred from the air medium to other media, mitigation measures are presented in the respective chapters, when necessary. Air quality impacts from industrial facilities and weapons and ammunitions detonation were not assessed due to lack of data regarding the types of pollutants and amounts that may have burned in the case of the industries, and amount and type of ammunition in the case of weapons. Whenever relevant, noise pollution is also addressed in this chapter.

8.1.2 AIR POLLUTION FROM CONSTRUCTION SECTOR

8.1.2.1 Air Pollution from Construction Sites

Large construction sites are important sources of air pollutants. Building demolition, mechanical work process (grinding, drilling), debris dumping and storage, and diesel engines powering construction machines can cause an increase in health impacts on the population in the vicinity from airborne dust and respirable ultrafine particles. A substantial number of dwellings and houses are to be reconstructed after the war (refer to construction chapter). The large number of construction sites, particularly in residential areas, is considered as a major source of air and noise pollution due to dust and gas emissions (construction dust and diesel soot - classified as carcinogenic pollutant).

8.1.2.1.1 Location

Several locations in the country will be affected by this source of air pollution. The southern suburbs of Beirut (Dahyieh) could be a hotspot depending on the nature of reconstruction works to be done. The villages in the South and Bekaa areas affected by the war can also represent important sources of air pollution. Bridges reconstruction would also be a source of air pollution but possibly to a lesser extent.

8.1.2.1.2 Potential Environmental Receptors

Population living in the vicinity and along the major roads leading towards the construction sites can be affected by dust emissions as well as noise generation. Nearby soil and water bodies, depending on the construction site, could also represent potential receptors. Given the diversity of the sites, it is difficult to specify these receptors.

8.1.2.1.3 Impact Assessment

The composition of ambient particulate matter is of homogeneous nature, comprising particles varying in size and chemical composition. Particles differ in sources, size ranges, formation mechanism, and are characterized by various physical and chemical properties. While physical properties affect the transport and deposition of particles in the human respiratory system, chemical composition determines their impact on health.

Suspended particulate matter is ubiquitously recognized as the most important air pollutant in terms of human health effects considering that many epidemiological studies substantiate significant associations between particulate matter (PM) concentrations in the air and adverse health effects. While the effects of PM vary considerably depending on its composition and size distribution, generally, exposure to inhalable PM can cause an increase in cardiac and respiratory mortality, a decrease in levels of pulmonary lung function in children and adults with obstructive airways disease, an increase in daily prevalence of respiratory symptoms in children and adults, an increase in functional limitations as reflected by school absenteeism or restricted activity days, and an increase in physician and emergency department visits for asthma and other respiratory conditions. Sensitive groups that appear to be at greater risk for particulate pollution include the elderly, those with pre-existing respiratory conditions and cardio-pulmonary diseases such as asthma, smokers, and children (El Fadel and Massoud, 2000).

Heavy construction is a source of dust emissions that may have substantial temporary impact on local air quality. Building and road construction are two cases of construction activities with high emission potential. Emissions during the construction of a building or road can be associated with land clearing, drilling and blasting, ground excavation, and cut and fill operations (i.e., earth moving). Dust emissions often vary from day to day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions. A large portion of the emissions results from equipment traffic over temporary roads at the construction site. Table 8.1 summarizes the main dust-generating activities.

Table 8.1. Dust-Generating Activities in the different Phases of Construction

Construction Phase	Dust-generating Activities
Demolition and debris removal	1. Demolition of buildings or other (natural) obstacles such as trees, boulders, etc.
	a. Mechanical dismemberment ("headache ball") of existing structures
	b. Implosion of existing structures when needed
	c. Drilling and blasting of soil
	d. General land clearing
	2. Loading of debris into trucks
	3. Truck transport of debris
	4. Truck unloading of debris
Site Preparation (earth moving)	1. Bulldozing
	2. Scrapers unloading topsoil
	3. Scrapers in travel
	4. Scrapers removing topsoil
	5. Loading of excavated material into trucks
	6. Truck dumping of fill material, road base, or other materials
	7. Compacting
General Construction	1. Vehicular traffic
	2. Portable plants
	a. Crushing
	b. Screening
	c. Material transfers and other operations
	d. Power Generation

The temporary nature of construction differentiates it from other fugitive dust sources as to the estimation and control of emissions. Construction consists of a series of different operations, each with its own duration and potential for dust generation. In other words, emissions from any single construction site can be expected to have a definable beginning and an end and to vary substantially over different phases of the construction process.

The quantity of dust emissions from construction operations is normally proportional to the area of land being worked and to the level of construction activity. In fact, there are very few attempts to quantify dust emissions from construction sites. Emissions from heavy construction operations are positively correlated with the silt content of the soil (particles with a diameter less than 75 µm), as well as with the speed and weight of the average vehicle, and negatively correlated with the soil moisture content. The approximate emission factor for construction activity operations can be determined as (EPA, 1995):

E = 0.3 kg/m^2/month of activity[179]

Applying this equation to the case of Dahieh, assuming construction activities will last for 18 months, considering 30 days/month and 8 hours/day of work, this would lead to a temporal emission factor (S) equal to 347.2 µg/s.m^2. The following meteorological parameters with regard to air pollution dispersion namely, mixing height and mean annual wind speed, are used:

Parameter	Typical scenario	Worst case scenario
Mixing Height	1,000 m	100 m
Average wind speed	3.25[180] m/sec	1m/sec

To estimate air pollutant concentration, a Fixed Box Model is applied whereby the site is represented by a parallelepiped (Figure 8.1).

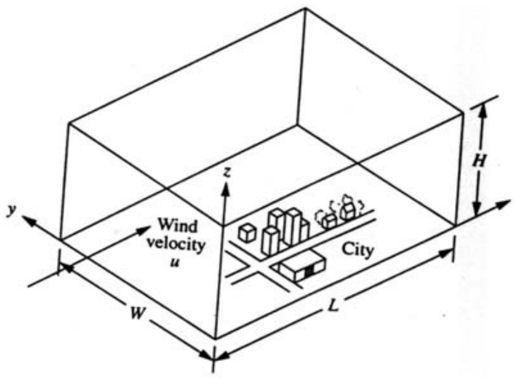

Figure 8.1. Rectangular City in a Fixed Box Model

The following simplifying assumptions are made:

- Mixing of pollutants occurs within a layer of height H, confined from above by a layer of stable air;
- The concentration of pollutant in the entire area is constant and uniform, and equals to c;

[179] The value is most applicable to construction operations with a medium activity level, moderate silt contents, and semiarid climate.
[180] Average monthly wind speed for the years 1971-2000 recorded by the Meteorological Department of the Directorate General of Civil Aviation at the Rafic Hariri International Airport.

- The wind velocity is constant and independent of time, elevation, and height above the ground;
- The concentration of pollutant entering the city (at x = 0) is constant, and equals to the base line measured Total Suspended Particle (TSP) concentration, b
- No pollutant enters or leaves the top of the box, nor the sides that are parallel to the wind direction;
- The destruction rate inside the box is zero.

The concentration of TSP in the entire area can be estimated using the following formula (De Nevers, 2000):

$$c = b + \frac{SL}{uH}$$

where,

c = Concentration of TSP in the entire site ($\mu g/m^3$)
b = Background TSP concentration ($\mu g/m^3$)
S = Emission rate of TSP ($\mu g/s.m^2$)
L = Site length (m)
H = Mixing height (m)
u = Wind speed (m/s)

The input data for the site under consideration are summarized in Table 8.2, based on two scenarios: the typical scenario and the worst-case scenario.

Table 8.2. Input Data for the Box Model

Parameter	Typical Scenario	Worst-case Scenario
L*	200 m	200 m
H	1,000 m	100 m
b**	166 $\mu g/m^3$	166 $\mu g/m^3$
u	3.25 m/s	1 m/s
S	347.2 $\mu g/s.m^2$	347.2 $\mu g/s.m^2$

* based on dimensions of Dahieh site, as described in construction chapter
** Average TSP concentration in Beirut (El-Fadel & Massoud, 2000)

By direct substitution of the values in the equation above, the predicted total TSP concentration at the Dahieh site could be in the range of 190 $\mu g/m^3$ under typical scenario conditions and 860 $\mu g/m^3$ under worst-case scenario conditions. Both of these values are above the Lebanese, EU, USEPA, and WHO 24-hr standard (120 $\mu g/m^3$, 300 $\mu g/m^3$, 75 $\mu g/m^3$, and 150 $\mu g/m^3$ respectively). This preliminary assessment shows that average concentrations could increase by 14 % and 418 % under typical and worst-case scenario conditions in such construction sites. While several sources of uncertainties exist in the above assessment, particularly in terms of data used, it is only intended to underline an impact that could turn to be significant and should be monitored and addressed.

Dust emissions can have several health impacts over the exposed population; impacts include aggravation and/or early onset of asthma and other respiratory diseases, and stress related issues from noise pollution. However the impact effect will gradually decrease once construction activities cease. Impact duration will vary from short-term (less than one year) to medium-term (1 to 10 years) depending on scale of construction site.

Using the impact severity matrix, the impact effect in Dahieh area and major villages in the South that were destroyed could be considerable (extending over 1 km^2 and having serious local deterioration of air quality at local level) and impact duration is medium-term; impact is therefore classified as **critical significant**.

8.1.2.1.4 Post-conflict Initiatives

UNEP post-conflict assessment team visited the southern suburbs of Beirut and took dust samples. The National Council for Scientific Research (NCSR), in collaboration with the American University of Beirut (AUB) and Université St. Joseph (USJ), has initiated an air pollution assessment study in the southern suburb of Beirut. The proposed assessment aims at characterizing the concentration and constituents of settled and airborne particulate matter, predicting potential acute/chronic health outcomes, advising health care providers, debris cleaning crews, and residents in the affected areas on how to reduce exposure to generated dust. The initial phase of the assessment study concentrates on sample collection and analysis for PM_{10}, PAHs and heavy metals and was scheduled to be completed by end of November, 2006. The phase two of the assessment should expand over several years and measure the concentrations of $PM_{2.5}$, fiberglass and asbestos, crystalline silica, VOCs and ground level ozone (O_3). Similar assessments in other construction sites were not reported during the period of this study.

8.1.3 AIR POLLUTION FROM TRANSPORT SECTOR

8.1.3.1 Increased Vehicular Emissions

Numerous highway sections and bridges were completely or partially destroyed during the war (refer to transport chapter). Traffic is severely affected in several highway or roadway sections thus contributing to a local deterioration of air quality and increase in noise levels.

8.1.3.1.1 Location

Multiple locations in the country are experiencing increased congestion because of damaged infrastructure during the war. Of special interest are northern and southern entrances of Beirut and to a lesser extent the Soufar (Beirut – Damascus) highway.

8.1.3.1.2 Potential Environmental Receptors

Population living in the vicinity and along the major damaged roads could be exposed to an increase in particulate matter and other transport-related pollutants; levels of such pollutants are expected to increase along congested highways and secondary roads through villages and residential areas, potentially affecting soil, water and biota. The northern and southern entrances of Beirut can be considered as hot spots given the increased traffic congestion.

8.1.3.1.3 Impact Assessment

Emissions from combustion engines are released to the environment via various routes. These can be summarized as emissions to air, water and land. The car exhaust system acts as a point-source emission of air pollutants. Therefore, most of the pollutants from combustion engines are emitted through the exhaust. Carbon dioxide, nitrogen oxides, particulate matter (PM_{10}), sulfur dioxide, VOCs and PAHs are the major pollutants emitted from the transport sector. Quantifying emissions from transport is important to predict ambient air quality in the areas possibly affected by the source. The emission factors for exhaust emissions from motor vehicles are normally expressed in kg or g per km (task-based emission factors) and vary with vehicle speed. Less commonly, they are also expressed in grams per amount of fuel used (mass-based emission factors). Figure 8.2 shows how emission factors increase with decreasing average speed. The curves were developed for a transport study for Lebanese vehicular fleet in Tripoli (ELARD, 2001). Emissions of CO and hydrocarbons are expected to increase by a factor of 6 or 7 in some sections due to significant decrease in average speeds.

Significant increase in air pollutants, particularly CO, hydrocarbons, and particulate matter is therefore anticipated at some hotspots due to increase traffic in damaged areas, especially the northern and southern entrances of Beirut.

Such increases will lead to deterioration of air quality at a localized level (possibly extending over a 1 km^2 area per affected area or more depending on meteorological conditions) with impact effect being considerable; assuming that traffic will return to normal conditions within one year, the impact duration is considered short-term and the impact is classified as **critical non-significant**.

8.1.3.1.4 Post-conflict Initiatives

Reconstruction works have started in several impacted areas, with temporary bridges being constructed and detours being made available. It is expected that the majority of sections and bridges will be repaired within one year. Only few sections and bridges may take longer to be repaired because of the magnitude of the damage and structure itself (such as Mdairej bridge).

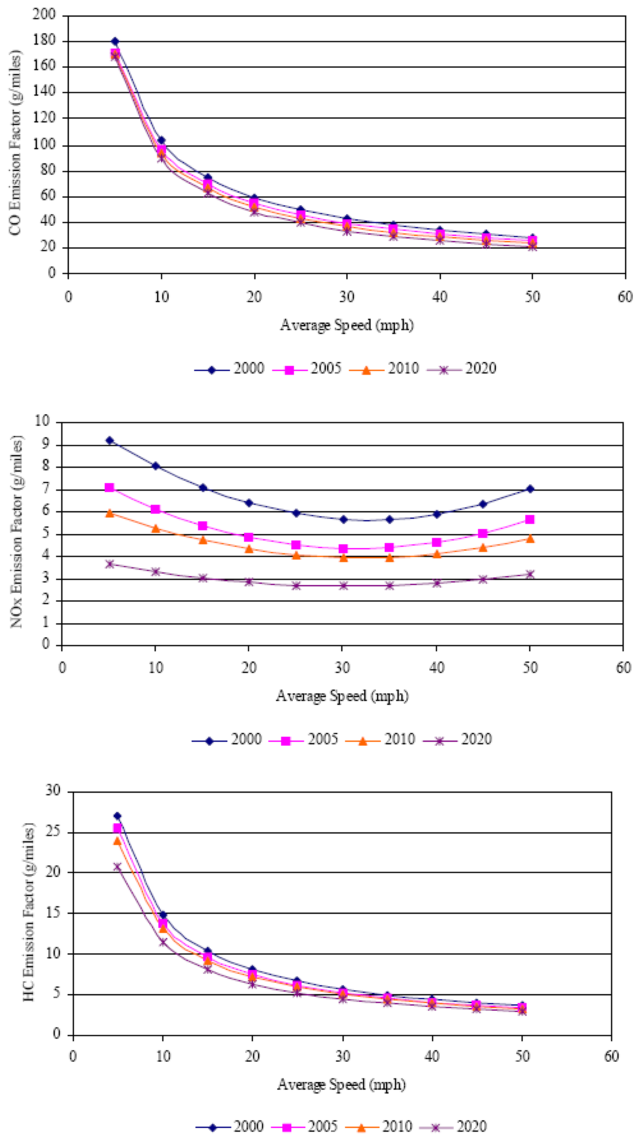

Figure 8.2. CO, NOx, and HC Emission Factor Variations with Average Speed

8.1.4 AIR POLLUTION FROM ENERGY SECTOR

8.1.4.1 Air Pollution from Fuel Oil Burning at Jiyeh Thermal Power Plant

The power plant houses 5 fuel storage tanks holding in total 75,000 m^3 of fuel (two tanks holding 10,000m^3 each, two tanks holding 15,000 m^3 and one tank holding 25,000 m^3). Two of these tanks were hit (one holding 10,000 m^3 and the other 15000 m^3 on the 13th and 15th of July 2006 respectively)[181] and caught fire; the fire spread to the remaining tanks and stayed burning for 12 days. Around 60,000 m^3 (55,764 tonnes) of fuel oil may have burned as per the plant's personnel. The estimated 60,000 m^3 of fuel that burned caused atmospheric contamination in a plume releasing 2.45PJ[182] of heat. Small droplets (mainly in the form of soot particles) rained within a radius of 5 km around the power plant, but mainly to the North and North East of the power plant (Steiner, 2006). The fire caused the total meltdown of the fuel tanks.

181 Based on personal communication with personnel at the Jiyeh power plant.
182 Based on a calorific value of 43.9 MJ/kg (see table 4.1).

8.1.4.1.1 Location

The Jiyeh power utility is located around 30 km South of Beirut and located directly on the coastline**.**

8.1.4.1.2 Potential Environmental Receptors

Several receptors may have been affected by the fire and the pollutants generated:

- The direct receptor was the air medium; pollutants however most likely have ended up in other media especially following the heavy rains that fell in the months of October and November;
- The sea and shorelines are another receptor, given the initial direction of the plume;
- Agriculture and rangeland located mainly to the North of power plant;
- Population living in the vicinity of the power plant and along the path of the plume.

8.1.4.1.3 Impact Assessment

The strikes at the Jiyeh thermal power plant caused an estimated 60,000 m^3 (55,764 tonnes)[183] to burn for 12 days. Pollutants generated during the fire and carried through the plume include sulfur dioxide, nitrogen oxides, carbon monoxide as well as soot and particulate matter, semi-volatile organic compounds, including polycyclic aromatic hydrocarbons (PAHs) and dioxins and furans, volatile organic compounds, such as benzene, and other compounds resulting from incomplete combustion of the oil and oil products. Some of the pollutants do not break down and can persist in the environment for many years and accumulate in different media such as **soil**, **water**, **plants** and eventually be transferred via the food chain. Emissions strongly depend on the combustion conditions, particularly flame temperature and the residence time. An estimate of the quantity of pollutants released from the burning of oil at the power plant is shown in Table 8.3. These values are intended to be used as an order of magnitude of the quantities possibly released, and Table 8.3 suggests that significant quantities of pollutants could have been emitted during the fire.

[183] Density of the oil is equal to 0.9294 kg/l

Table 8.3. Estimated Emissions (EE) from Jiyeh Oil Fire and Emission Factors (EFs)[184]

Type	SO_2	NO_x	Particles	Soot	Organic C	PAHs	PCDDs	VOCs	CO
EFs	40 g/kg	5 g/kg	15 g/kg	5 g/kg	8 g/kg	0.8 g/kg	2.6 µg TEQ/TJ	7 g/kg	5 g/kg
EE	2.2 Gg*	0.3 Gg	0.8 Gg	0.3 Gg	0.5 Gg	0.04 Gg	6 mg TEQ	0.4 Gg	0.3 Gg

* 1 Gg = 1000 tonnes

The rise of a smoke plume from a large fire is governed by the complicated mixing of the hot combustion products with the surrounding air, a process known as entrainment. During the oil fire, the large amounts of heat released during combustion caused strong entrainment of combustion air which increases the turbulence and the mixing of the plume with the surrounding air. The buoyancy of the warm combustion gases and the entrained air caused a strong-plume-rise effect. Under such circumstances, the combustion gases will not be observed at ground level near the fire site, but the plume may touch the ground several kilometers downwind of the source. The highest concentrations at ground level could therefore occur at distances several kilometers downwind of the fire, and would be determined by the emission source strength in kg/s, the wind velocity and the vertical and the horizontal dispersion in the plume. The air quality closer to the source is more likely to be affected by the smaller fires, and from emissions in the smoldering stages of the fire, when the large-scale entrainment of air has ceased. Smoke particulate is by far the most likely combustion product of oil burning to exceed ambient air quality standards at ground level beyond a few hundred meters from the fire.

Large outdoor oil fires are highly localized, intense emitters of heat, smoke, and other combustion products. The hazards associated with such fires occur on two widely separated length scales. Near the fire, over distances comparable to the flame length, the radiant flux can be sufficiently high to threaten both the structural integrity of neighboring buildings, and the physical safety of firefighters and plant personnel. At much greater distances, typically several times the plume stabilization height in the atmosphere, the smoke and gaseous products generated by the fire can reach the ground in concentrations that may be unacceptable for environmental reasons.

Burning of oil produces a visible smoke plume containing smoke particulate and other products of combustion which may persist over many kilometers downwind from the burn. This fact could give rise to public health concerns, related to the chemical content of the smoke plume and the downwind deposition of particulate.

The plume trajectory may be broken down into three regions – the first lies in the immediate vicinity of the fire, the second extends several tens of kilometers downwind of the fire, and the third, which can be described as the far field, extends hundreds of kilometers further downwind. The first region is characterized by large temperature gradients, significant radiation effects, and a velocity field dominated by the rising of the combustion products. The

[184] UNEP/UNCHS Balkans Task Force. Pancevo Site Report. October 1999.

second region is characterized by small temperature gradients, minimal radiation effects, and a velocity field in which the prevailing wind and the buoyancy in the plume are of comparable importance. In this region the plume gases ascend to a point in the atmosphere of neutral buoyancy, and then slowly descend as the heat from the fire dissipates. In the third region, or far field, the descent, dispersion, and deposition of the combustion products are governed by the regional meteorological conditions rather than the fire (Walton *et al*., 1993).

The extent to which the hot gases are cooled and diluted by the entrained air determines how high the plume will rise. The fires can generate hundreds of megawatts of energy, and the smoke plumes can rise a few hundred meters to a few kilometers into the atmosphere, depending on the temperature stratification.

Downstream of the fire, the particulate matter will, in general, rise with the heated plume and later descend after the plume has cooled. Since the combustion products and the particulate matter will produce a cooled plume only slightly denser than the surrounding air, the descent of the plume will be rather slow compared to its rise.

The smoke emission rate can be determined by calculating the burn volume rate of oil multiplied by the emission fraction or emission factor. The resulting plume will be driven by two factors, namely the smoke generation process itself and the heat produced by the fire, which provides buoyant lift to the smoke plume and determines, along with atmospheric stability and wind speed, the terminal height of the smoke. Two common models used to predict smoke plume trajectories are the Brigg's bent-over plume model which provides an analytical estimate, and the ALOFT (A Large Outdoor Fire plume Trajectory) model, which uses a numerical approach.

It is noteworthy to point out that even the most sophisticated atmospheric dispersion model cannot predict the precise location, magnitude and timing of ground-level concentrations with accuracy. However, most models used today have been thoroughly evaluated and the modeling results are reasonably accurate, provided an appropriate model and input data are used.

Errors are introduced into results by the inherent uncertainty associated with the physics and formulation used to model dispersion, and by imprecise input parameters, such as emission and topographical and meteorological data. The most significant factors that determine the quality and accuracy of the results are:

- the suitability of the model for the task;
- the availability of accurate source information;
- the availability of accurate meteorological data.

When there is an open burning of petroleum products, an important concern is the anticipated trajectory of the smoke plume and its subsequent dispersion. Measurements and observations at experimental burns have shown that the downwind distribution of smoke is not Gaussian and simple smoke plume models do not capture the observed plume features which are a complex function of the fire parameters, meteorological conditions and topographic features. To incorporate these features, the U.S. National Institute of Standards and Technology (www.nist.gov) developed a numerical model, ALOFT, to predict the downwind concentration of smoke and other combustion products. The ALOFT model is widely recognized as a tool for computing and displaying smoke plume trajectories from in situ burning.

The model has been used to estimate distances from oil fires under a variety of meteorological and topographical conditions. The ALOFT smoke transport model, is capable of predicting time-averaged downwind concentrations of smoke and other combustion products. The model is based on the fundamental conservation equations that govern the introduction of hot gases and particulate matter from a large fire into the atmosphere. Particulate matter, or any non-reacting combustion product, is represented by Langrangian particles that are advected by the fire-induced flow field.

Model assumptions include a uniform ambient wind blowing over relatively flat terrain[185]. The flat terrain assumption is crucial, for it leads to the assumption that the windward component of the flow of smoke and hot gases from the fire is the prevailing wind, and the numerical problem is reduced to solving for the fire-induced components of velocity and temperature in a plane perpendicular to the prevailing wind. ALOFT can predict the concentrations of combustion products over relatively flat terrain downwind of a large fire. It is worth to mention that the uncertainty of ALOFT model predictions is largely a function of the uncertainty in the meteorological conditions and fire emission rates.

Most guidelines for in situ burning target particulate matter as the combustion product most likely to exceed standards and therefore cause a health concern to population downwind of the burn (McGrattan, 1997; McGrattan et al, 1997). The ALOFT model uses smoke particulate concentrations as a tracer for all other pollutants.

The ALOFT model consists of the conservation equations of mass, momentum and energy that describe the steady-state convective transport of heated gases introduced into the atmosphere by a steadily burning fire. The fire itself is not modeled; the smoke plume is the main interest. The fire is represented as a source of heat and smoke, but not necessarily as a point source. Only the overall fuel consumption and heat release rates per unit burn area, plus the fuel-specific emission factors for the combustion products of interest, need to be specified. The local meteorological conditions that must be provided are the wind speed, the magnitude of the fluctuation of the wind from the prevailing direction, and the temperature stratification of the atmosphere.

The ALOFT model differs from most of the atmospheric dispersion models used today in its deterministic rather than empirical modeling. The approach is to solve the equations governing the flow rather than to rely on empirical formulae that approximate the extent of the dispersion. Empirical models typically assume the pollutant is Gaussian-distributed in the plane perpendicular to the direction of the prevailing wind. The parameters defining the distribution are estimated from experiments. However, Gaussian models are inappropriate for two reasons: (1) the characteristics of the 'source' are different from the smokestacks that are usually assumed by such models, and (2) the size and the source is well beyond those

[185] Flat in this case means that the variation in altitude of the terrain over which the plume lofts is no more than about 10% of the plume rise height

considered in industrial applications and thus outside of the experimental parameter range used to calibrate the models.

Two versions of the model now exist: the ALOFT-FT for flat terrain and ALOFT-CT for complex and mountainous terrain. The ALOFT-FT model is adequate in the case of the Jiyeh fire. The model contains a fuel properties-database that can be modified by the user, an optional user specified emission factors, and the ability to specify different wind fluctuations over water and land. The modeled distances are between 0.5 km and 20 km. Although the results for distances less than 1 km are shown, the predictions falling near the fire may not be valid since the details of the fires are not modeled.

The used emission factors are the same ones used for calculating the estimated emissions from the Jiyeh oil fire (Table 8.3). The mean wind velocity (4 m/s) and the surface temperature (25.7 ºC) were taken from Lebanese Meteorological Service of the Directorate General of Civil Aviation, Ministry of Public Works and Transport database. The monthly averages for the month of July, covering the period extending from 1971 to 2000 were used for both wind velocity and temperature at Rafic Hariri International Airport meteorological station. The B-C Pasquill Stability category was chosen (moderately to slightly unstable) with lateral wind standard deviation – sigma theta of 18 deg., and vertical wind standard deviation – sigma phi 11 deg. The selected Lapse Rate based on stability category is B (moderately unstable; -6ºC/km) with a surface temperature of 25.7ºC.

The parameters used during the model run are as follows:

Burning rate per unit area[186] = 0.035 kg/m^2.s

Heat release rate = 1.5 MW/m^2, calculated according to the following formula:

$Q = H_c \text{ x } m \text{ x } A$

where:

H_c is the heat of combustion for the fuel (43.9 MJ/kg)[187]
m is mass loss rate per unit area for the pool fire (0.035 kg/m^2.s)
A is the area of the pool fire (about 500 m^2)

The emission factors were user defined, incorporating the above mentioned EFs into the model. The model allows the calculation of downwind pollutant concentrations up to a distance of 20 km. The fire location was also taken into account (N: 33º38´44´´; E: 35º23´56´´).

Figure 8.3 shows the results obtained by the ALOFT-FT model for the vertical plane of the plume. Pollutant emissions from fires have a limited lasting interval due to its own range of intensity. Initially, impact zones are distributed to larger distances since the smoke plume top reaches significant height. The model predicts the existence of counter-rotating vortices which are generated by the fire and which entrain a substantial fraction of the particulate.

[186] http://users.wpi.edu/~ierardi/FireTools/pool_fires.html
[187] Table 4.1

Thus, it is not necessarily true that the maximum concentrations would be found along the centerline of the plume.

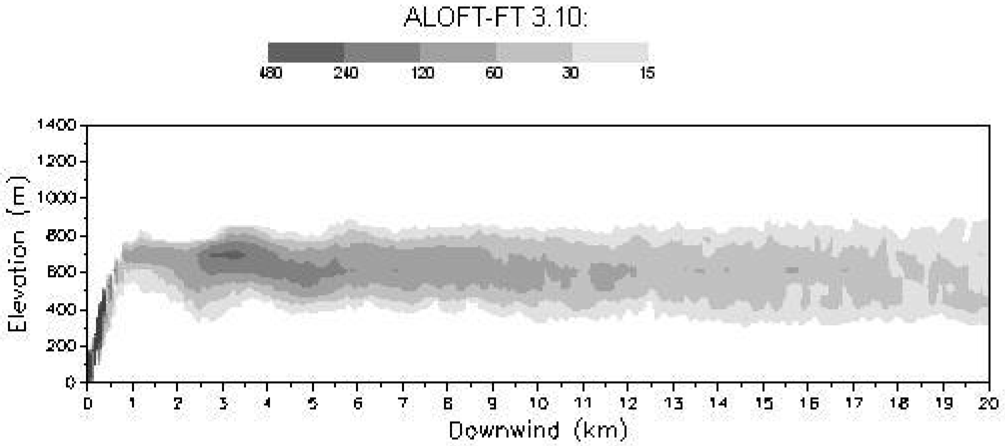

Figure 8.3. **Smoke Particulate (PM_{10}) Concentration ($\mu g/m^3$ – one hr avg) – vertical plan, 0 km crosswind**

Consequently, with decreasing fire intensity, impact zones approach to the closer vicinity of the targeted object. The model observations of the Jiyeh fire show that the plume height could have reached a maximum height of about 800 m, with the lower tip of the plume reaching about 400 m. The model indicates that the particle concentrations, as expected, are at their highest concentrations near the pool of fire, reaching approximating 34 mg/m^3 (vertical elevation 0 m). The concentrations drop to 217 –295 $\mu g/m^3$ at 1 to 4 km distance downwind with vertical elevation 695 m. The concentrations at 20 km downwind (maximum distance calculated by ALOFT) indicate a range of particulate concentrations between 21 $\mu g/m^3$ and 29 $\mu g/m^3$ (vertical elevations 780 m and 350 m respectively).

In such cases, and in order to assess the environmental impact of such plumes, it is important to indicate the plume direction, so that the target area, where final deposition of pollutants could have occurred, are identified. Satellite images of the plume indicate that during the first days of the fire (16th of July, 2006), the plume direction is SW, i.e. towards the sea, meaning that all pollutants settled into the sea (Figure 8.4). However, after few days, and with changes in wind direction, the plume direction is N (images taken on the 19th and 23rd of July, 2006) (Figure 8.5 and Figure 8.6).

The satellite images reflect the fact that the intensity of the fire, and thus the thickness of the plume is much denser on the initial days of the fire. In the subsequent days, with the consumption of the remaining fuel by the fire, the thickness of the plume is reduced; this also indicates that the amount of pollutants being emitted and consequently deposited decreased substantially as the fire consumed the fuel.

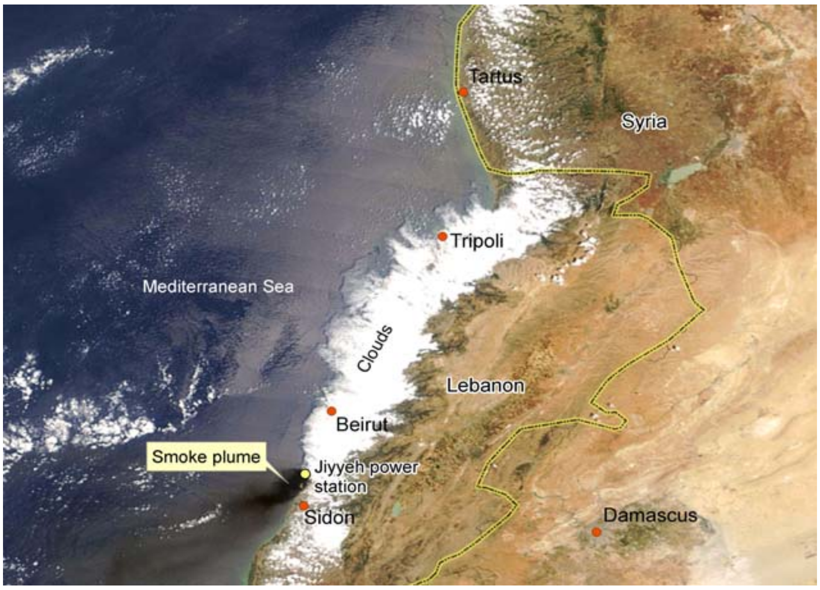

Figure 8.4. Satellite Image on 16th of July showing SW Plume Direction

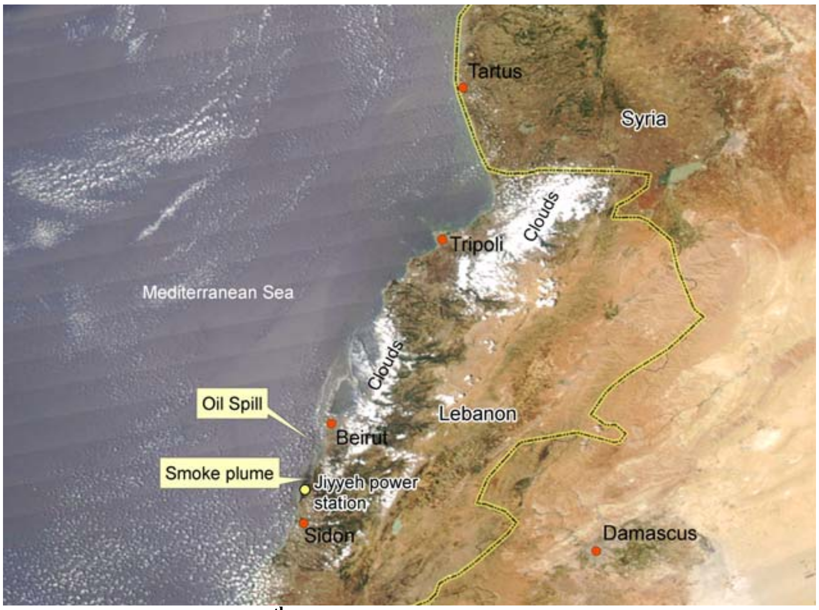

Figure 8.5. Satellite Image on 19th July 2006 showing a Plume directed towards the North

Figure 8.6. Satellite Image on 23rd of July 2006 showing a N Plume Direction

A change in wind direction played a major role in the dispersion of the pollutants; since the plume direction changed from SW to N, the potential environmental receptors from air pollution are located North of the power plant. The area depicted with the white arrow in Figure 8.7 is within a distance of 6 kilometers from the power station – where the fuel storage tanks caught fire. In fact, the highest concentrations of pollutants are reported within a distance of 1 to7 km downwind by the ALOFT model simulations, i.e., the area located North of Jiyeh. The concentrations of particulate matter according to the model, within the above-mentioned distances would range between 217 and 295 µg/m^3. This finding is consistent with previous studies which indicated that maximum ground level extent of the region where PM concentration would be in excess of maximum allowable values is 5 km over flat terrain (McGrattan *et al.*, 1997).

According to Annex 5 of the ministerial decision 52/1 (Ministry of Environment) dated 29/07/1996, the maximum allowable ambient air quality level of PM_{10} and Total Suspended Particles (TSP) for a 24-hour exposure is 80 µg/m^3 and 120 µg/m^3, respectively.

The particulate concentrations dropped to 217 – 295 µg/m^3 at a distance of 1 to 4 km and are about 80 µg/m^3 as far as 6 km downwind. From that distance and onward, all emissions are below that value. Hence, and although the national limit value is for 24 hour, it is assumed that the potential contaminated area would fall within a radius of 6 km.

Based on the above assessment and the impact severity matrix, impact of the oil fire on air quality extends over an area of about 15 km^2 (portion of a circle with a radius of 6 km based on predominant wind direction) and is serious; impact is however considered to be short-term (< than 1-year) and is classified as **critical significant**.

Figure 8.7. A satellite image of the Jiyeh Power Utility before it was hit (c), and the direction of the plume, (a) and (b), and the 6 km distance downwind area (d) in white.

(d)

(c)

(b)

(a)

8.1.4.1.4 Post-conflict Initiatives

The UNEP post-conflict assessment unit visited the site (Jiyeh power plant) and took soil and ash samples.

8.1.4.2 Air Pollution from Burning of Rafic Hariri International Airport Fuel Storage Tanks

The fuel storage tanks at the Rafiq Hariri International Airport were hit. It is estimated that 4 tonnes[188] (or 5,000 m^3) of kerosene from the fuel tanks were burned.

8.1.4.2.1 Location

The fuel storage tanks are located at the International airport in the southern Beirut area.

8.1.4.2.2 Potential Environmental Receptors

Environmental receptors are similar to those mentioned for the fire event at Jieh fuel tank, and include air, water, soil and population North of the fire site.

8.1.4.2.3 Impact Assessment

Burning of kerosene from the airport tank results in the emission of several pollutants including nitrogen oxides, particulate matter, formaldehyde, volatile organic compounds and polycyclic aromatic hydrocarbons into the atmosphere. The airport is situated near a highly populated residential area. The burning of 4 tonnes caused the emission of 176.4 MJ heat[189]. Emission factors are obtained from EPA AP-42 and Smith *et al.* (1993) and IPCC 2006 revised guidelines. The emission factors along with the total amount of pollution emission are given in Table 8.4.

Table 8.4. Estimated Emissions (EE) from Airport Kerosene Tank Fire and Emission Factors (EFs)

Type	NO_x	VOCs	CO	SO_2	PM_{10}	PCDDs	CH_4
EFs	11 g/kg	0.133 g/kg	2.8 g/kg	4 g/kg	1.4 g/kg	4.3×10^{-9} g/kg	0.02 g/kg
EE*	44 kg	0.53 kg	11.2 kg	16 kg	5.6 kg	17.2 µg	0.08 kg

ALOFT-FT is also used to model the plume trajectory and pollutant concentrations. The burning rate per unit area used is 0.039 $kg/m^2.s$[190] and the calculated heat release rate is 1.7 MW/m^2 (for a tank area of about 400 m^2).

The mean wind velocity (4 m/s) and the surface temperature (25.7 ºC) are taken from Lebanese Meteorological Service of the Directorate General of Civil Aviation, Ministry of

[188] Personal Communication with Mr. Samir Fakih, Director of Airports, Directorate General of Civil Aviation.
[189] IPCC 2006, Volume 2; Net Calorific Value = 44.1 TJ/Gg of kerosene.
[190] http://users.wpi.edu/~ierardi/FireTools/pool_fires.html

Public Works and Transport database. The monthly averages for the month of July, covering the period extending from 1971 to 2000 are used for both wind velocity and temperature at Rafiq Hariri International Airport meteorological station. The B-C Pasquill Stability category is chosen (moderately to slightly unstable) with lateral wind standard deviation – sigma theta of 18 deg., and vertical wind standard deviation – sigma phi 11 deg. The selected Lapse Rate based on stability category is B (moderately unstable; -6ºC/km) with a surface temperature of 25.7ºC.

Figure 8.8 shows the results obtained by the ALOFT-FT model for the vertical plane of the plume.

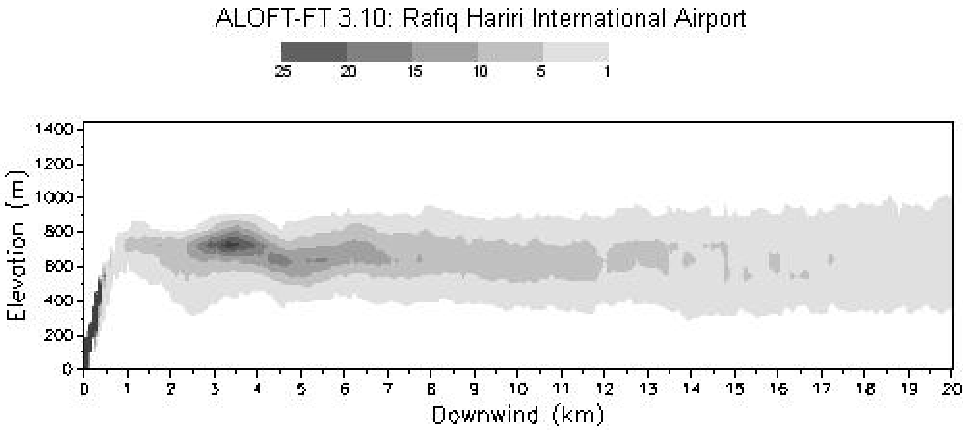

Figure 8.8. PM$_{10}$ Concentration (µg/m^3 – one hr avg) – vertical plan, 0 km crosswind

The model indicates that the particulate matter concentrations, as expected, are at their highest concentrations near the pool of fire, approximating to almost 3.1 mg/m^3 (vertical elevation 0 m). The concentrations drop to 30.3 µg/m^3 at 3 km distance downwind with vertical elevations 725 m respectively. The concentrations at 20 km downwind (maximum distance calculated by ALOFT) indicates a range of particulate concentrations between 1 µg/m^3 and 3.2 µg/m^3 (vertical elevations 260 m and 725 m respectively).

The particulate matter concentrations within 3 km distance are estimated at 30.3 µg/m^3. although the national emission levels are for 24 hour exposure (80 µg/m^3), the one hour average emission is still below this 24 hour exposure limit, indicating that the emissions were below this limit in the few first kilometers (radius less than 2 km).

From the above analysis, it can be concluded that the main area exposed to relatively high levels of pollutants falls within a radius of 1-6 km. Therefore, soil contamination and water contamination is suspected within this area including agricultural land located along the path of the plume.

Impact of the airport fire on air quality extends over an area of about 3.5 km^2 (portion of a circle with a radius of 3 km based on predominant wind direction) and is therefore considerable; impact is however considered to be short-term (< than 1-year) and is classified as **critical non-significant**.

8.1.4.2.4 Post-conflict Initiatives

Debris found on site were cleaned by the authorities. There is no information available on the final fate of the debris. The UNEP post conflict assessment unit visited the site and soil samples were taken for analysis.

8.1.4.3 Air Pollution from Fuel Burning in Petrol Stations

Several petrol stations have been deliberately hit by the Israeli air forces during the 33-day war on Lebanon. The Presidency of the Council of Ministers and the Higher Relief Council has put the number of damaged petrol stations to 22. However a field survey in Baalbek and reports from local authorities in the South raise this number to about 50 petrol stations severely damaged.

8.1.4.3.1 Location

Official government reports have confirmed 22 petrol stations having been hit distributed as follows: 4 in Bint Jbeil, 2 in Tyre, 4 in Marjaayoun, 1 in Nabatiyeh, 5 in Saida, 1 in Jebb Jannine, 1 in Beirut, and 4 in Baalbek. A field survey in Baalbek has revealed that 7 stations have been hit in that area. Reports from local authorities also state that up to 47 stations were hit in Bint Jbeil, Marjayoun and Nabatiyeh alone.

8.1.4.3.2 Potential Environmental Receptors

Besides the air medium, receptors of the fires are downstream soil and population; the sea is also a receptor, especially for the stations hit close to the coastline.

8.1.4.3.3 Impact Assessment

The total amount of fuel burned is considered to be in the order of 360,000 L of gasoline and 140,000 L of diesel. The fires resulting from the hits have contributed to the emission of highly toxic pollutants into the atmosphere that can result in adverse health risks among the population. These pollutants are particulate matter, sulfur dioxide, VOCs and PAHs, NO_x, and CO. The following can be noted:

- Emission factors for gasoline and diesel open burning were not found; accordingly, and given the limited information available, total quantities of pollutants emitted were not estimated;
- The open burning of gasoline and diesel has however environmental concerns similar to the fire in Jiyeh.

- Fires did not generally last long and were rapidly put down by station owners; areas affected are likely to be limited.

The impact from fuel burning in petrol stations affected several areas in Lebanon but with localized effects; impact effect is considerable (significant deterioration of air quality on local level); however most fires were put down in less than one week and impact duration is considered momentary; the impact is therefore classified as **marginal non-significant**.

8.1.4.3.4 Post-conflict initiatives

Some petrol stations owners have on their own initiative repaired the damages; others are awaiting for compensation by the relevant authorities prior to initiating work again.

8.1.5 AIR POLLUTION FROM AGRICULTURE SECTOR

8.1.5.1 Air Pollution from Forest Fires

One of the damages inflicted to the agriculture sector, and which is a direct source of air pollution, is forest fires. Other damages that could have a contribution to air pollution but are not further assessed are the bombing of agricultural inputs (chemicals) storage houses and destruction of animal husbandry farms.

Most of the fires were caused by direct Israeli bombing. However in many cases, the propagation of the fire was due to the inaccessibility of the site by civil defense forces; the Lebanese armed forces were not able to lend a hand and participate in firefighting missions because of their inability to fly their helicopters under military siege situation.

8.1.5.1.1 Location

The fire engulfed several green areas distributed between the South and Mount Lebanon regions as follows:

<u>South Lebanon</u>: El Rihane, El Loueizeh, Mlita, Houmine el Tahta, Zawtar ech Charqiyeh, El Aaychiyeh (including El Wazahiyeh), El Mahmoudiyeh, Khallet Khazen, Fardis, Miri, Zebqine, Naqoura, Aalma ech Chaab (including Labbouneh), Aita ech Chaab, Ain Ebel, Beit Lif, Tiri, Srobbine, Mlikh, Msaileh, Hannine, Debel, Ramiyeh, Rmeich, Qawzah, Aitaroun, Al Soltaniyeh and Majdel Selm.

<u>Mount Lebanon</u>: Deir Qoubil, Aramoun, Bsaba-Baabda, Baaqline, Mazraat Bmohray, Jisr el Qadi, Chartoun, Bouzreidi, Selfaya, Remhala, Dfoun, Kfar Matta, Ain Trez, Zaarouriyeh, Salima, Qornayel and Bzebdine.

8.1.5.1.2 Potential Environmental Receptors

The main receptors besides the air medium depend on where pollutants settle; it is likely that soil, water and biota may have been affected. From a public health perspective, forest fire emissions are troubling for several reasons; emissions are typically released at or near the ground level instead of through tall stacks that leads to better air dispersion; therefore, the pollutants are not transported long distances, but rather settle within the proximity of the fire. Since they are, by their very nature, non-point sources, they can be spread out over large areas.

8.1.5.1.3 Impact Assessment

Nearly 1000 ha of forest were burned in Mount Lebanon and another 800 ha were burned in South Lebanon[191]. The size and intensity, even the occurrence, of a forest fire depend directly on such variables as meteorological conditions, the species of vegetation involved and their moisture content, and the weight of consumable fuel per hectare (available fuel loading). Once a fire begins, the dry combustible material is consumed first. If the energy release is large and is of sufficient duration, the drying of green, live material occurs, with subsequent burning of this material as well. Under proper environmental and fuel conditions, this process may initiate a chain reaction that results in a widespread conflagration. These types of fires are dynamic events where a moving flame front passes over the fuel source. Because of this behavior, both smoldering and flaming combustion zones exist with each type of combustion dominating at different times.

It has been hypothesized, but not proven, that the nature and amounts of air pollutants emissions are directly related to the intensity and direction (relative to the wind) of the fire, and are indirectly related to the rate at which the fire spreads. The factors that affect the rate of spread are weather (wind velocity, ambient temperature, and relative humidity), fuel (fuel type, fuel bed array, moisture content, fuel size) and topography (slope and profile). Most of this information is not available, and thus hinders a complete and accurate assessment of the air pollution episodes experienced during the forest fires.

Nevertheless, emissions were estimated using emission factors[192] from US EPA. The main pollutants emitted from forest fires are particulate matter, carbon monoxide, total hydrocarbons or volatile organics (expressed as methane emissions), and nitrogen oxides. Sulfur oxides are also emitted, but in negligible amounts, and therefore are not considered as a potential hazard. The emissions are calculated using the following formula:

$$E_i = P_i L A$$

where:

E_i = total emission of pollutant "i" (mass pollutant)
P_i = yield for pollutant "i" (mass of pollutant/unit mass of forest fuel consumed)
L = Fuel loading consumed (mass of forest/unit land area burned)
A = Land area burned

In this case, A = 1,800 ha; 1000 ha in Mount Lebanon (estimated 950 ha conifers, and 50 ha broadleaved), and 800 ha in the South (estimated 100 ha conifers, and 700 ha broadleaved). The yield of pollutants used in this assessment is taken from the US EPA AP-42 and are shown in Table 8.5.

191 Chapter 6, War, Agriculture and Environment
192 AP-42, Compilation of Air Pollutant Emission Factors; Wildfires and Prescribed Burning.

Table 8.5. Emission Factor for Different Pollutants generated by Forest Fires

Pollutant	Total Particulate	CO	Volatile organics*	NO_x
Emission factor (P_i) (kg/Mg)	8.5	70	12	2

* as methane

The fuel loading consumed, i.e. the mass of forest/unit land area burned is estimated to be 1.3 Mg of fuel/ha for conifers and 12 Mg of fuel/ha for broadleaved. With these assumptions, following total emissions were estimated as an order of magnitude for the emissions:

- 88.1 Mg of particulates
- 725.6 Mg of carbon monoxide
- 124.4 Mg of VOCs
- 20.7 Mg of nitrogen oxides

As for dioxins and furans emissions, data is very limited or non-existent. Lemieux *et al.* (2004) reported an emission factor for total PCDD/Fs as $1.5 \times 10^{-4} – 6.7 \times 10^{-3}$ mg/kg burned, and for TEQ PCDDs/Fs $2.0 \times 10^{-6} – 5.6 \times 10^{-5}$ mg TEQ/kg burned. These would allow us to estimate the emissions of PCDDs/Fs from about 2,000 ha burned in Lebanon to 6,000 to 268,000 mg total PCDDs/Fs and 80 – 2,240 mg TEQ PCDDs/Fs. However, these figures should be interpreted with extreme caution, as the literature shows a wide range of estimated emissions, varying over an order of magnitude.

Impact of the forest fires on air quality is assessed to have a considerable effect (leading to significant deterioration of air quality on a local level); however since most fires did last for days up to few weeks, the impact duration is momentary and the impact is classified as **marginal non-significant**.

8.1.5.1.4 Post-conflict Initiatives

FAO, in collaboration with the Ministry of Agriculture, is conducting a thorough survey on affected forests and green areas in the country.

8.1.6 SUMMARY OF IMPACT ASSESSMENT ON AIR

The impacts on air quality are summarized in Table 8.6. Impacts were sub-divided as two critical-significant impacts, two critical non-significant and two marginal non-significant impacts.

Table 8.6. Summary of Impacts on Air Quality from the War

Impact	Impact Effect	Duration	Severity/ Significance
1. Dust and PM release from construction works	Considerable in Dahieh and main villages	medium-term (1-10 year)	Critical - Significant
2. Air pollution from traffic congestion	Considerable	Short-term (less than 1 year)	Critical – Non significant
3. Air pollution from Jiyeh fire	Serious	Short-term (<1 year)	Critical - Significant
4. Air pollution from airport fuel storage tanks fire	Considerable	Short-term (<1 year)	Critical – Non-Significant
5. Air pollution from fuel tanks burning in petrol stations	Considerable	Momentary (<1 week)	Marginal – Non-Significant
6. Forest Fires	Considerable	Momentary (<1 week)	Marginal – Non-Significant

8.2 ENVIRONMENTAL ACTION PLAN

One impact is addressed in this action plan: air pollution from construction sites. Air pollution from the burning of Jiyeh and Airport fuel tanks can no longer be addressed. However the impacts on other media from these sources are addressed under the soil and biodiversity chapters. Impact from transport sector is also addressed in the transport chapter.

8.2.1 REDUCING PARTICULATE MATTER AND NOISE LEVELS AT CONSTRUCTION SITES (DRAFT PROPOSAL)

8.2.1.1 Problem Statement and Rationale

The release of dust particles from demolition and construction activities, and particulate matter from onsite construction machines will cause significant deterioration of air quality on a limited level – mainly the area subject to reconstruction works. This impact would effectively cease once the first stages of the reconstruction are over (i.e. only work on the internal parts of the building is left: tiles, windows, doors, plumbing, paint jobs, etc.). It is however very important that air pollution from such activities are controlled to limit impacts related to increased particulate matter concentrations in the air.

Any reduction in particulate matter ambient concentrations will benefit the exposed population, more specially those that fall within the susceptible population or are part of sensitive groups. Valuing the health impacts of air pollution comprises the actual identification and measurement of health impacts and the estimation of monetary values for associated premature mortality and morbidity. Generally, health damage studies proceed by establishing average levels of ambient concentration of a pollutant and then relating those concentrations to health effects through dose-response functions (DRFs)[193]. Based on epidemiological time series studies (El Fadel and Massoud, 2000), it has been estimated that the decrease in mortality due to 10 $\mu g/m^3$ reduction in PM_{10} ranges between 0.1 and 4.6 %. Accordingly, the predicted total number of lives saved in Lebanese urban areas ranges between 11 and 617[194]. As for morbidity, it has also been estimated that the ranges of pneumonia and chronic obstructive pulmonary disease (COPD) cases avoided per 10 $\mu g/m^3$ reduction in PM_{10} are 15-214 and 35-498 respectively. Similarly the number of emergency visits avoided ranges between 609 and 25,578 cases.

Based on a published health assessment (El Fadel and Massoud, 2000), the ranges of lives saved per 10 $\mu g/m^3$ reduction in PM_{10} as well as reduction in morbidity were estimated (Table 8.7).

[193] DRFs correlate mortality and morbidity outcomes of susceptible population with ambient concentrations of certain air pollutants.
[194] Based on a baseline number of death calculated to be approximately 13,440 (El-Fadel and Massoud, 2000)

Table 8.7. Mortality Related Economic Benefits due to 10 µg/m^3 Reduction in PM_{10}

Age group likely to be affected	Number of lives saved	Average productivity years	Economic benefit (MUSD/yr)
40-59	2 – 102	20	0.2 – 9.7
60-69	3 – 122	5	0.07 – 2.9
Total			**0.27 – 12.6**
Average per case			0.055
Economic benefits due to reduced morbidity per 10 µg/m^3 reduction in PM_{10}			
Endpoint	**Average hospital stay (days)**	**Average cost (USD/day)**	**Economic benefit (MUSD/yr)**
COPD	6.6	261	0.01 – 0.9
Pneumonia	10	207	0.03 – 0.4
Emergency visit	–	76	0.05 – 1.9
Total			**0.14 – 3.2**

Particulate emission reduction will have multidimensional benefits considering the adverse effect of particulate air pollution on health and the environment. In addition to improved health status of the population, a decease in pollution levels will reduce work absence (arising from health problems), and the costs of health protection due to saved lives, lower hospital admissions and emergency room visits, reduced risk of symptoms associated with chronic bronchitis and asthma, and reduced risk of respiratory symptoms in children.

In conclusion, incorporating measures to curb down the particulate emissions by only 10 µg/m^3 will benefit the population in better health. In terms of economic value, this can be translated to economic benefit from mortality and morbidity reduction, which amounts to 0.41 – 15.8 million USD. Alternatively, if appropriate measures are not taken, the economic costs could be substantial due to deteriorated health conditions among affected population. Several measures can be taken to curb dust emissions in construction sites. These include among others:

- Wetting the dusty material to reduce dust emissions;
- Use of PPE among the construction workers;
- Fit soot filters and particle trap systems to machines;
- Use of low-sulfur diesel;
- Deploy electric powered tools whenever possible.

Table 8.8 presents a series of possible measures per emission source that could be further assessed by local contractors and adopted. Furthermore, the CDR has a published document for contractors on Health, Safety and Environment Measures in construction sites which can be enforced.

Table 8.8. Possible Control Measures per Emission Source

Emission Source	Recommended Control Method(s)
Debris handling	Wind speed reduction through provision of wind breakers Wet suppression[a]
Truck transport[b]	Wet suppression Paving Chemical stabilization[c]
Bulldozers	Wet suppression[d]
Pan scrapers	Wet suppression of travel routes
Cut/fill material handling	Wind speed reduction Wet suppression
Cut/fill haulage	Wet suppression Paving Chemical stabilization
General construction	Wind speed reduction Wet suppression Early paving of permanent roads

a Dust control plans should contain precautions against watering programs that confound trackout problems.
b Loads could be covered to avoid loss of material in transport, especially if material is transported offsite.
c Chemical stabilization is usually cost-effective for relatively long-term or semi-permanent unpaved roads.
d Excavated materials may already be moist and not require additional wetting. Furthermore, most soils are associated with an "optimum moisture" for compaction.

8.2.1.2 Proposed Actions

The following actions are proposed to promote air quality and noise abatement measures at construction sites:

1. Assess progress of construction activities and identify sites where baseline monitoring are not being conducted (as opposed to Dahieh where monitoring is taking place)

2. Identify key contractors and consultants involved in re-construction efforts

3. Design and implement a comprehensive training program on air pollution and noise abatement during reconstruction

4. Implement an awareness campaign to local communities in affected areas on how to avoid dust related health impacts

5. Monitor air quality and noise at construction sites to evaluate effectiveness of measures

8.2.1.3 Legal Aspects

Air quality and noise level standards specific to the construction sector do not exist in Lebanon. However, as a general guideline, the values in Decision of the Minister of Environment 52/1 "Standards and Limit Values for Air, Water and Soil Pollution" Annexes 10 and 14, dated 29/7/1996.

8.2.1.4 Institutional Aspects

The following institutions play a role in such an intervention:

- Ministry of Public Works and Transport
- Ministry of Interior and Municipalities (for enforcement)
- Ministry of Environment
- Ministry of Public Health
- CDR
- Ministry of Labor

8.2.1.5 Budgetary Estimate

The budgetary estimate for this intervention amounts to **USD 220,000**. Budget breakdown is as follows:

1. Monitoring activities at construction sites (baseline and follow-up monitoring): USD 20,000 per site – assuming 6 major sites: USD 120,000
2. Design and implementation of training program: USD 35,000
3. Implementation of awareness campaign: USD 15,000
4. Project management: USD 50,000

8.2.1.6 Timeframe

The proposed intervention should be launched urgently since many construction sites are already operational. Total project duration is one (1) year.

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LEBANON

RAPID ENVIRONMENTAL ASSESSMENT FOR

GREENING RECOVERY, RECONSTRUCTION AND REFORM 2006

WATER

9.1 IMPACT ASSESSMENT

9.1.1 OVERVIEW OF IMPACT ON WATER RESOURCES

Lebanon's surface and subsurface water resources were directly and indirectly impacted to varying degrees by the hostilities. Direct impacts were mostly in the form of damage and destruction of reservoirs, irrigation ponds, water conveyance structures (canals, pipelines, etc.), wellheads, and pumping stations, within the jurisdiction of the South Lebanon Water and Wastewater Establishment, the Bekaa Water and Wastewater Establishment, and the Litani River Authority. Most notably in the South, reservoirs in Bint Jbeil, Hasbaiya, and the Wazzani area and the Fakhereddine wells were either damaged or destroyed. In the Bekaa, a section of Canal 900, the irrigation canal conveying water from the Qaraoun reservoir, was destroyed.

Indirect physical damages mostly consisted of erosion, sedimentation or deposition of eroded particles in waterbodies. Indirect chemical impacts were generally in the form of seepage of chemicals from damaged facilities to groundwater resources or the transport of these chemicals along with runoff water into adjacent surface waterbodies.

Indirect impacts are widespread across the war-impacted regions due to Lebanon's extensive water courses whereby hardly any region is without an ephemeral or a permanent stream. Also, vast tracts of the country are underlain by water yielding geologic formations which form the backbone of the water supply of the nation.

Major streams in the targeted areas are the Litani (Beqa'a and South), Awali, Sainaiq, Zaharani, Abou Aswad (all in the South). Two major wadis (ephemeral streams) - Wadi Al Iziyye and Wadi Maarke - are located in the South.

The southern district of Beirut (Dahieh area) is underlain by two major aquifers. The first is the Quaternary-Miocene Conglomerate aquifer. It is a heavily exploited fairly shallow aquifer with the water table at about 30 to 40 m below ground surface. Water in this aquifer fluctuates greatly between summer and winter due to recharge in the latter and high demand during the former. The second aquifer in the area is the Sannine-Maameltein which is considered to be one of the most productive aquifers in the country. It consists predominantly of limestone, dolomite, and dolomitic limestone and is characterized by a high secondary porosity with groundwater flowing through fractures, joints, and karstified channels. Salt water intrusion and contamination from industrial waste and septic tanks prevail in the area. Groundwater tends to flow towards the west. There are several public water supply wells in the region which distributes water with TDS values exceeding 3000 ppm in the dry seasons. Due to the presence of densely populated areas, and significant industries (such as in Choueifat) in the outcrops areas (i.e. west of the sites), the aquifer is expected to be significantly polluted (at least with bacteriological pollution).

In the impacted areas of the Bekaa, two aquifers are identified. These are the Quaternary-Neogene aquifer system, and the Eocene aquifer. The former is the lower yielding of the two with yields of wells tapping this aquifer varying significantly depending on the amount of fine materials. In the Zahle area, wells tapping the Neogene conglomerate can yield more than 30 L/s, whereas in the central Bekaa (Sahl El Marj, Deir Taanayel, and Bar Elias) yields are generally significantly lower due the presence of a finer matrix. The Eocene aquifer consists predominantly of white Limestone and marly limestone and is considered a very good aquifer. The aquifer is several hundred meters below ground surface and is under confined condition.

The South is the least karstified area. The Sannine – Maamaltein aquifer extends to the Sour area where it is found at depths of several hundred meters. There the aquifer is overlain by the Chekka and Eocene formations. These formations act as an aquiclude which restrict seepage into the aquifer at this location and thus limiting any potential contamination from surface activities.

The relatively rapid movement of water in the rivers and aquifers in most areas impacted may divert environmental impacts from these bodies to the sea. As such in any future assessment or mitigation effort the sea and coastal zones must be included and treated as the final receptor of all contaminants that have impacted the terrestrial and land-based sites.

9.1.2 IMPACT ON WATER RESOURCES FROM CONSTRUCTION AND TRANSPORT SECTORS

9.1.2.1 Debris and Rubble from Damaged Residential and Industrial Buildings

9.1.2.1.1 Location

Two main sites located within the Greater Beirut Area were selected as temporary storage sites for the demolition debris generated from the bombardment of the Dahieh suburb of the capital Beirut. However, in the case of various war-impacted villages of Bekaa, South Lebanon and Nabatiyeh, the demolition debris was mainly dumped in valleys and streams.

9.1.2.1.2 Potential Environmental Receptors

The main direct receptor is the soil which acts often as a conduit to waterbodies.

9.1.2.1.3 Impact Assessment

Very large quantities of debris and rubble from damaged and destroyed residential and industrial buildings have been collected and disposed of (temporarily or permanently) in uncontained heaps in designated areas throughout the South, Bekaa and Beirut and along river banks. The rubble is mainly composed of concrete debris, sand and aggregates (refer to construction chapter). Accordingly, it may contribute to sediment loading of run-off and adjacent waterbodies especially during high-precipitation conditions.

Minimal sorting of the waste was conducted prior to disposal and thus a limited amount of household and industrial chemicals (pesticides, detergents, hydraulic fluids, lubricating oils, cooking oils, diesel, etc.) were incorporated within the debris. These chemicals if allowed to infiltrate into the soil would pollute the soil itself and also underlying and adjacent waterbodies. Such pollution could render water unusable.

The aerial extent of the heaps is mostly small with the exception of the huge pile at the Ouzaii location along the coast. The chemical impact on the adjacent waterbodies of these heaps is expected to be minor given that the limited amounts of liquid pollutants and small aerial extent of the piles.

The impact effect on water quality from construction and demolition wastes from buildings is limited and impact duration is short-term (<1year); the impact is classified as **marginal non-significant**.

Another impact of the debris piles may be a physical one in that they will act as sources of loose sediment and particulates which may be picked up by runoff water and wind and deposited onto adjacent surface waterbodies. The problem with these sediments would then be in that they cover benthic organisms and reduce light and temperature in the waterbody making it difficult for fauna and flora to live and/or reproduce.

The impact effect from sediment deposition in waterbodies is limited (localized) and of short term duration; the impact is classified as **marginal non-significant**.

9.1.2.1.4 Post-conflict Initiatives

No assessment of these damages has been reported to date.

9.1.2.2 Damaged Bridges and Overpasses

9.1.2.2.1 Location

Different sources reported 92 to 107 bridges and overpasses to have been totally or partially damaged by the conflict located in various regions of Lebanon (HRC, 2006 and GoL, 2006, respectively). About 30 permanent and intermittent water courses were possibly affected by this issue (refer to Transport chapter for additional information).

9.1.2.2.2 Potential Environmental Receptors

The main environmental receptors directly impacted by the war-inflicted damage to bridges and overlays consist of adjacent surface waterbodies. Those bridges that may have directly affected rivers and intermittent water streams are identified in the Transport chapter.

9.1.2.2.3 Impact Assessment

The concern related to demolished or damaged bridges is mainly founded upon the reconstruction works and to a lesser extent the creation of temporary diversion roads to allow traffic bypass. Two types of physical damages are foreseen. The first involves the introduction of excess sediments into the impacted streams which originate from the stream banks along which reconstruction of bridges is occurring or from dumped rubble and debris. These eroded soil particles are carried downstream depositing in rivers and at their sea outlet. This sediment usually covers the benthic regions adversely affecting fauna and flora.

The second type of damage is the constriction or total blockage of flow channels by debris or diversion roads built over stream channels to bypass destroyed bridges. The damage would be downstream of these constrictions in depriving aquatic flora and fauna of their habitat. Further damage may occur if floods develop due to blockage of flow. These floods would damage areas in the vicinity of the blockage and lead to excessive erosion and stream bank destruction. The same type of flooding would also occur if debris blocks flow in wadis and ephemeral streams.

The impact effect is considerable given the possible number of sites affected. Impact duration is short term (< 1 year); hence the impact can be classified as **critical non-significant**.

9.1.2.2.4 Post-conflict Initiatives

Reconstruction of several damaged bridges has begun. It can be assumed, based on visual observation of some sites, that necessary precautions related to stream bank erosion are not being taken.

9.1.3 IMPACT ON WATER RESOURCES FROM ENERGY SECTOR

9.1.3.1 Jiyeh Power Generation Plant

9.1.3.1.1 Location

The site is located in Jiyeh, South Lebanon.

9.1.3.1.2 Potential Environmental Receptors

The direct water receptor is the sea; coastal aquifers are possible but unlikely receptors due to the extreme proximity of the site to the sea, the fact that the reservoirs are predominantly built on fill material and the impervious nature of the terrain.

9.1.3.1.3 Impact Assessment

Fuel oil from storage facilities of the power generation which are located right on the coast, leaked to the ground and eventually to the sea. An extensive oil slick formed that eventually reached Syria. Fuel oil was deposited on many sandy and rocky coastal zones. Elevated concentrations of PAH and heavy metals could negatively affect seawater quality; however the impact is only transient based on published studies on previous oil spills (Vinas *et al.*, 2005; Page and Gilfillan, 2006).

The impact effect on seawater quality is considerable but short-term as concentrations of pollutants in the water related to the oil can return to normal values in relatively short time (within few months); the impact is classified as **critical non-significant**.

Further, some of the slick was deposited at the bottom of the sea contaminating the seabed. This portion of the fuel oil that has settled at bottom of the sea may be source of pollution to coastal aquifers that have been intruded into by sea water. The potential for such contamination is small and thus the impact on these aquifers may be considered negligible. It should be noted that the reservoirs lie directly on the Sannine Maamaltein Aquifer, which is in direct contact with the sea.

9.1.3.1.4 Post-Conflict Initiatives

Clean-up activities were initiated and are described in the biodiversity chapter. Monitoring of seawater quality is being conducted by NCMS (National Center for Marine Sciences).

9.1.3.2 Damaged Transformers from Transmission and Distribution Networks

9.1.3.2.1 Location

Multiple locations may have been affected by damaged transformers, particularly in Jounieh, Tyre, Nabatiyeh, Bint Jbeil, Wadi Al-Zineh, El-Shiyyah, and Halba based on reports from EDL.

9.1.3.2.2 Potential Environmental Receptors

The main direct receptor is the soil with adjacent waterbodies as potential indirect receptors.

9.1.3.2.3 Impact Assessment

All but one of the transformers hit was manufactured after 1979 – the cutoff year after which all transformers may be considered free of polychlorinated biphenyls. However, there is the risk that post-1979 dielectric oils manufactured in Eastern Europe, Soviet Union and China might contain PCB-based dielectric fluids. As such it may be prudent to assume the presence of PCBs at some of the targeted sites until proven otherwise. Also, there is uncertainty as to the exact number of transformers damaged, reports varying from 199 to 725; the number of potentially containing PCB-transformers could vary from a few to 240 units.

PCBs are known carcinogenic compounds and are very persistent in the environment. Their mobility in the soil is limited, however, PCBs may be transported off-site to adjacent surface waterbodies through erosion processes.

Thus until proven otherwise and given the persistence of the compounds, the impact on water resources may be limited (given its localized nature) but long-term (if soil source is not removed) and the impact is classified as **critical significant**.

9.1.3.2.4 Post-Conflict Initiatives

While most transformers have been replaced, no assessment of potential water contamination has been undertaken at possibly affected sites.

9.1.3.3 Petrol Stations

9.1.3.3.1 Location

Based on officially published values, at least 25 stations were affected (energy chapter) in Bint Jbeil, Tyre, Marjaayoun, Nabatiyeh, Saida, Jebb Jannine, Beirut, and Baalbeck. Among these, seven stations were damaged in Baalbek and were confirmed by a field survey conducted by ELARD. In the other areas, reports from local authorities indicate that up to 47 stations may have been damaged, where 22 had fuel in their underground storage tanks when hit and thus have possibly leaked and/or burned.

9.1.3.3.2 Potential Environmental Receptors

The main direct receptor is the soil with adjacent subsurface waterbodies as potential indirect receptors.

9.1.3.3.3 Impact Assessment

Not all fuel reservoirs of the targeted petrol stations were hit. However, the concussions from the explosions may have been enough to form cracks in the reservoirs causing fuel to leak. Need for clean-up would require site assessments and soil sampling to quantify level of contamination at the sites. The seven petrol stations in Baalbek were surveyed by ELARD staff and possibility of gasoline and diesel leakage was confirmed at five sites. The leaked fuel would eventually percolate into groundwater contaminating it. Groundwater pollution was identified at one of the wells present at one of the sites. The extent of groundwater contamination as well as its potential impact to the various ground water receptors needs to be evaluated. The presence of contaminated soils that constitute a continuous source of pollution needs to be assessed, and necessary measures should be taken to remove the soil source of pollution and to remediate the groundwater pollution only if found necessary (refer to action plan in soil chapter).

In the South, the stations would lie either on the Sannine Maamaltein aquifer or on the Marls and chalk of the Eocene and the Cenonian formations, which are relatively impermeable. For those stations which would lie on the Sannine Maamaltein aquifer, any contaminant would seep into the ground and possibly reach the deep aquifer (at least 100 m below surface), would likely be flushed away due to the karstified nature of the aquifer. For the stations lying on the Eocene and Cenonian formations, the likelihood of groundwater contamination is minimal due to the relatively impermeable nature of both formations.

Impact effect from fuel leakage from damaged petrol stations on water resources in Baalbeck is rated considerable, given the possible contamination of the upper aquifer and presence of potential receptors (water supply wells), and impact duration can exceed one year if source is not removed; hence impact duration is medium-term (1 to 10 years) and the impact is classified as **critical significant**.

Impact effect from fuel leakage from damaged petrol stations on water resources in the South is limited and duration is short-term (less than 1year) given the reasons above; the impact in the South is classified as **marginal non-significant**.

9.1.3.3.4 Post-conflict initiatives

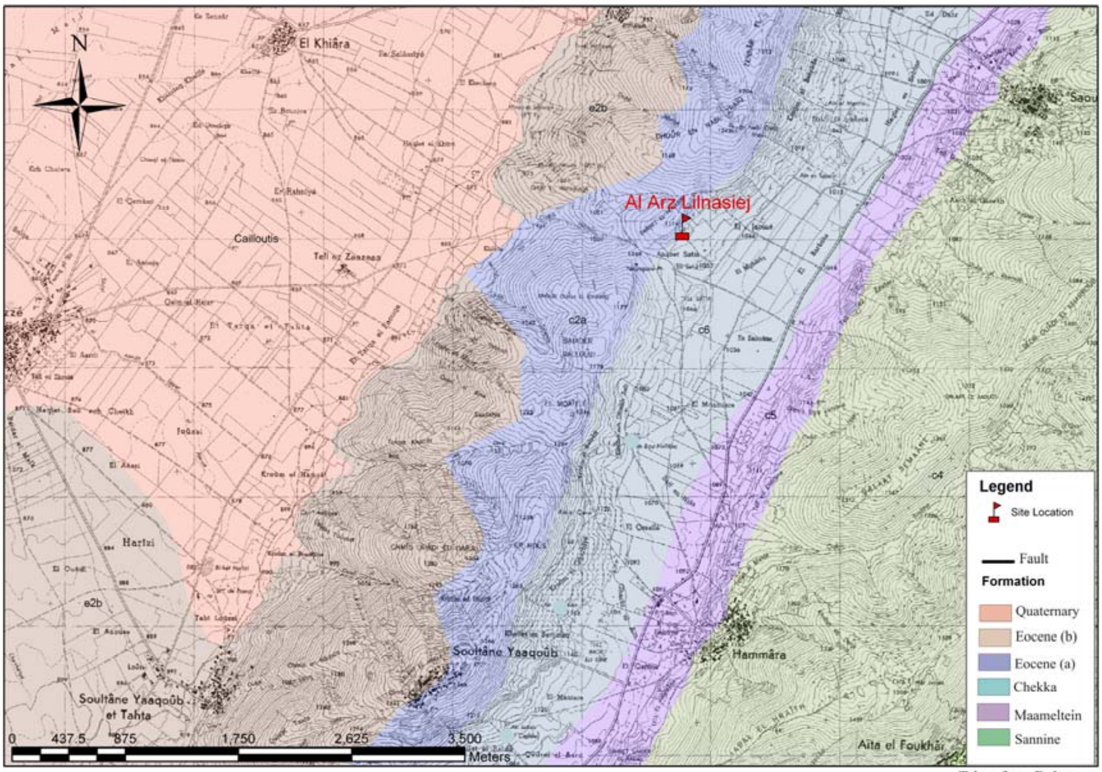
While some of the stations have already been repaired, no detailed assessment of water contamination has been made at the possibly affected sites.

9.1.4 IMPACT ON WATER RESOURCES FROM THE INDUSTRY SECTOR

9.1.4.1 Al Arz Textile Factory

9.1.4.1.1 Location

The site is located in Al Khyaray – Al Manara, Bekaa and is surrounded by agricultural lands (olive trees and vineyards). The site is shown in Figure 9.1 on a hydrogeological map.



Taken from Dubertret

Figure 9.1. Al Arz Textile Factory in Bekaa

9.1.4.1.2 Potential Environmental Receptors

The main direct receptor is the Eocene aquifer.

9.1.4.1.3 Impact Assessment

Evidence of oil leakage has been noticed at the site. Any wells located down-gradient from the site and tapping the Eocene aquifer will likely be a receptor. However due to the karstic nature of the aquifer, it is most likely that the plume shall rapidly be flushed away and get dispersed during the winter.

The impact on water resources is considered to be localized (limited) and short-term (<1year) and therefore the impact is classified as **marginal non-significant**.

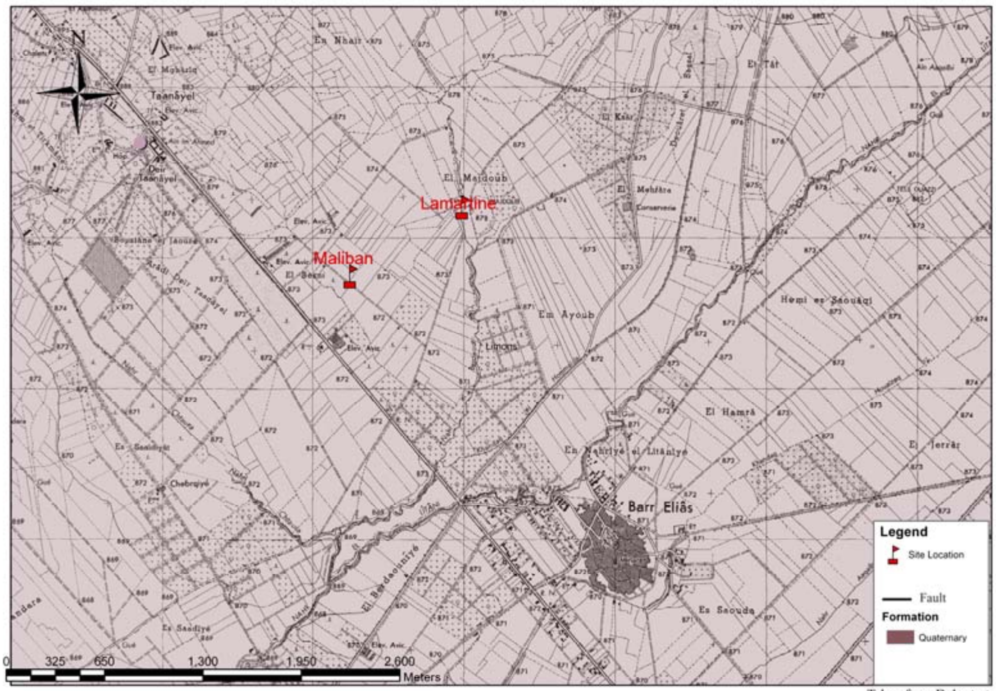
9.1.4.1.4 Post-Conflict Initiatives

UNEP post-conflict assessment team took samples of oil and water for analysis.

9.1.4.2 Lamartine Food Industries, Maliban Glass and Liban Lait

9.1.4.2.1 Location

Lamartine Food Industry and Maliban Glass Factory are located in Deir Taanayel, Bekaa. Liban Lait is located in Talia, also in the Bekaa. Figure 9.2 shows a hydrogeological map with the location of the Lamartine and Maliban sites and Figure 9.3 shows the location of the Liban Lait site.



Taken from Dubertret

Figure 9.2. Lamartine and Maliban Industries in the Bekaa

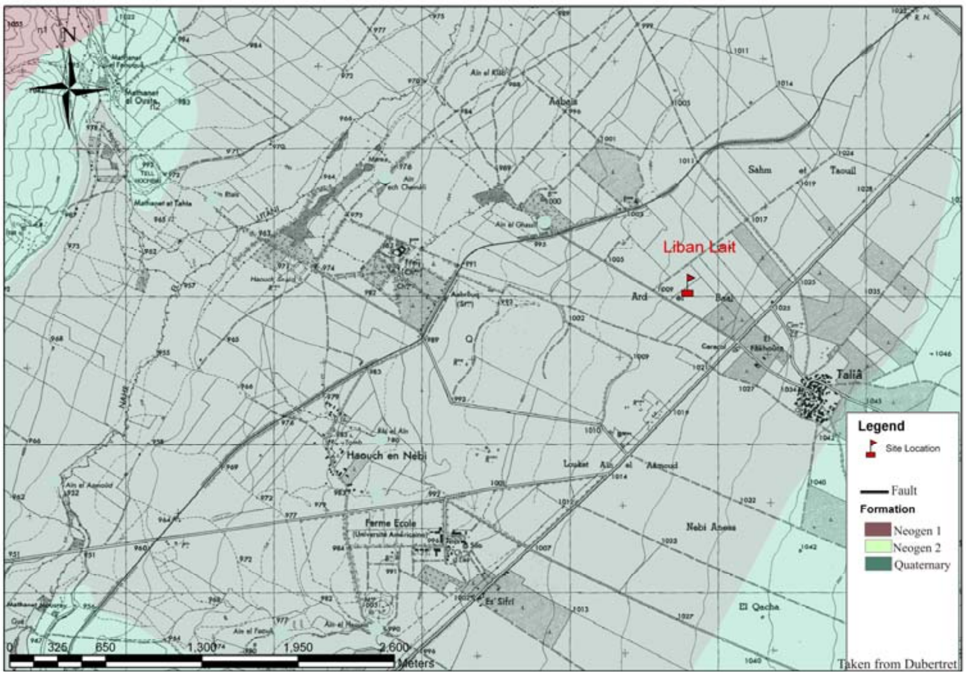


Figure 9.3. Liban Lait Industry in the Bekaa

9.1.4.2.2 Potential Environmental Receptors

The factories lie on the Quaternary-Neogene aquifer. This aquifer would be the direct receptor of any spillage from the site.

9.1.4.2.3 Impact Assessment

In case of a potential spill, pollutants will seep into the ground to reach the shallow water table (Quaternary-Neogene Aquifer System). Any potential plume would move towards the south; however there are no major springs down-gradient of the three sites. The potential receptors could be the down gradient wells tapping this aquifer that are used for irrigation and domestic purposes, if any.

At Lamartine, fuel-oil and chewing gum flavorings leakages were observed. At Maliban, heavy machinery is damaged on-site; oil spills underneath the rubbles can be noticed. At the Liban Lait site, fuel for operating electricity generators may have leaked to the soil on site.

It is therefore recommended to remove these possible sources of pollution, if found. Due to the presence of the fine materials, the downward migration of the pollution in the unsaturated zone is very slow.

There is no significant risk of contamination of the Eocene Aquifer, which lies at least several hundred meters below the surface. The overall vertical permeability of the Quaternary – Neogene aquifer should be very small due to the presence of numerous silt and clay layers over its entire thickness.

Consequently the impact on water resources is considered to be limited and impact duration is medium-term (1 to 10 years) in case a source of contamination is found; the impact can be classified as **critical non-significant**.

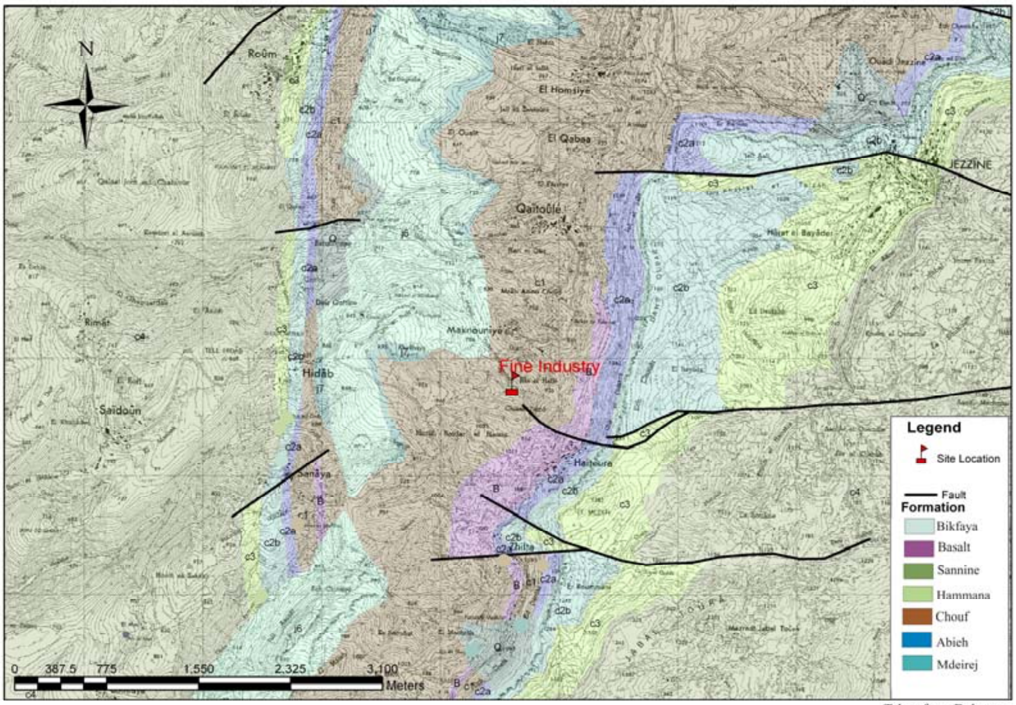
9.1.4.2.4 Post-Conflict Initiatives

UNEP post-conflict assessment team took soil samples at the sites. Results should confirm whether clean-up is needed.

9.1.4.3 Fine Tissue Factory

9.1.4.3.1 Location

The Fine Tissue Factory is located in Kfar Jarra, South. The site location is shown in Figure 9.4 on a hydrogeological map.



Taken from Dubertret

Figure 9.4. Fine Industry in Jezzine Area

9.1.4.3.2 Potential Environmental Receptors

The site lies within the Chouf Sandstone Formation of Lower Cretaceous Period.

9.1.4.3.3 Impact Assessment

The site lies within the Chouf Sandstone Formation of Lower Cretaceous Period. This formation consists of white to reddish brown very fine sands and sandstone with numerous intercalations of marl layers, thin beds of lignite and clay lenses. The formation is not considered as a major aquifer, due to the presence of the fine materials that significantly restrict the groundwater flow. Wells tapping this formation in the region generally yield less than 3 L/s and are usually private wells used for domestic purposes.

Groundwater in this formation tends to be under semi-confined conditions due to the presence of these layers of fine materials. Groundwater tends to flow westerly. No major springs were identified in the area. The presence of these layers of fine materials mitigates the downward migration of contaminants.

Due to the porous nature of this aquifer, groundwater velocity is very slow, thus any potential spill will travel very slowly, forming a plume that slowly migrates down-gradient. The potential risk of reaching down-gradient well receptors, if any, will depend on their distances from the spill. It is thus recommended to remove the source of contamination (if present).

The impact is limited and duration is medium-term (1 to10 years) in case a source of contamination is found; the impact is classified as **critical non-significant**.

9.1.4.3.4 Post-Conflict Initiatives

UNEP post conflict assessment team visited the site and took samples. Results should confirm whether clean-up is needed.

9.1.4.4 Transmed and Lebanese Co. for Carton Mince and Industry

9.1.4.4.1 Location

The sites are located in Choueifat, Mount Lebanon. The sites are shown in Figure 9.5 on a hydrogeological map.

9.1.4.4.2 Potential Environmental Receptors

The main direct receptor is the Quaternary aquifer and indirect receptors are adjacent surface waterbodies (Ghadir River).

9.1.4.4.3 Impact Assessment

Nickel-cadmium batteries were stored in Transmed facility along with other material. The batteries burned and their contents mingled with the soil on site. The site is close enough to the Ghadir river for the ash content to reach it. Cadmium and nickel are both considered carcinogenic and are considered to have detrimental ecological effect on benthic organisms if their concentrations in sediment are greater than 5 mg/kg for cadmium and 49 mg/kg for nickel. There is a direct risk of pollution of the quaternary aquifer; however likelihood of pollution of the deep Sannine Aquifer is limited. In the Lebanese Co., household chemicals could have spilled at the site.

Impact effect is considerable given the possibility of pollution of both surface and groundwater and impact duration is medium-term (1 to 10 years) given the chemical nature of the pollutants; the impact is classified as **critical significant**.

9.1.4.4.4 Post-Conflict Initiatives

Some clean-up works have begun; damaged and partially burned cleaning products are being piled up on a bare soil. UNEP post-conflict assessment team visited the site and collected samples for analysis.

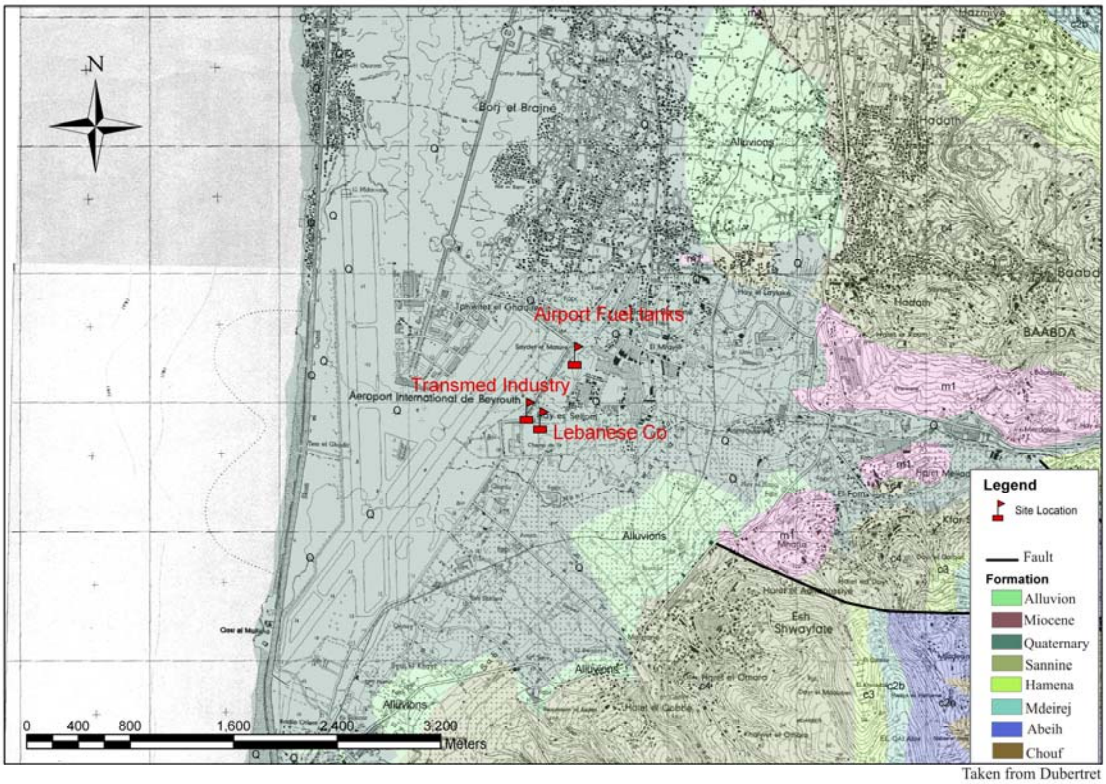


Figure 9.5. Transmed Storage and Lebanese Company for Carton Mince and Industry in Southern Beirut Area

9.1.4.5 Ghabris Detergent Factory and Saffieddine Plastic Factory

9.1.4.5.1 Location

Both sites are located at Borj Shmali, in the South. Figure 9.6 shows the sites on a hydrogeological map.

9.1.4.5.2 Potential Environmental Receptors

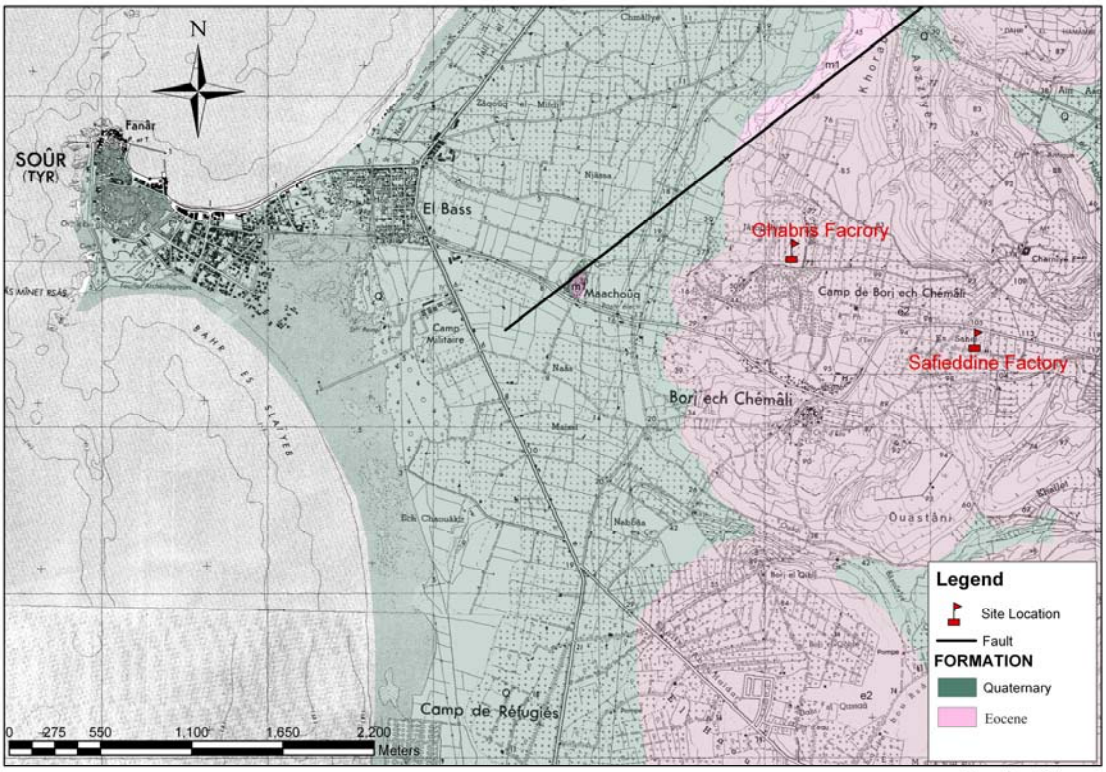
The sites lie within the Eocene Formation which is not considered as an aquifer in the region.

9.1.4.5.3 Impact Assessment

The Eocene, which consists locally of chalk and calcareous marls has a relatively low permeability. The first major aquifer beneath the two sites is the Sannine – Maamaltein Aquifer System. This aquifer, which lies at least several hundreds of meters beneath the ground, is overlain by the Chekka and Eocene formations. These formations act as an aquiclude which restrict any potential contamination, as a result of a spill, from migrating into the deep aquifer. The impact on water resources is therefore considered negligible.

9.1.4.5.4 Post-Conflict Initiatives

Clean-up of debris has been undertaken in the Ghabris site. The Saffieddine site is being cleared from UXOs.



Taken from Dubertret

Figure 9.6. Ghabris and Saffieddine Factories in Tyre Area

9.1.5 IMPACT ON WATER RESOURCES FROM AGRICULTURE SECTOR

9.1.5.1 Destruction of Storage Houses

9.1.5.1.1 Location

Storage houses in the South and the Bekaa were reported to have been damaged. Up to 170 sites were reported in the media to have been affected but no official confirmation has been published.

9.1.5.1.2 Potential Environmental Receptors

The main direct receptor is soil which acts often as a conduit to other receptors such as waterbodies, plants, animals, and other organisms residing in the soil.

9.1.5.1.3 Impact Assessment

The main concern is the movement of the agrochemicals (mainly pesticides and fertilizers) into subsurface and surface waterbodies resulting in damage to aquatic flora and fauna and rendering these waters unusable. Fertilizers such as nitrogen would readily move through the soil into subsurface waters. When nitrogen (as nitrate) is found in high enough concentrations in potable water (groundwater represents a significant source of drinking water for humans and animals), it could lead to methemoglobenemia – blue baby syndrome. This is a condition in which oxygen transport by the blood is severely restricted leading to suffocation of infants and young animals. Phosphorous from fertilizers is relatively immobile in soil and is typically carried by eroded sediments to surface waterbodies where it typically causes algal blooms which oftentimes deplete the waterbody of dissolved oxygen killing aquatic organisms.

Therefore, until proven otherwise, the impact effect of this damage is limited and impact duration is medium term (1 – 10 years) as soils saturated with the chemicals will continue to be source of pollution until treated or all the chemicals have been leached out. Consequently the impact is classified as **critical non-significant**.

9.1.5.1.4 Post-Conflict Initiatives

No assessment of water pollution in possibly damaged areas was reported.

9.1.5.2 Disposal of Animal Carcasses

9.1.5.2.1 Location

Animal carcasses were disposed of in multiple locations in the Bekaa, South and southern Beirut.

9.1.5.2.2 Potential Environmental Receptors

The main direct receptor is adjacent surface waterbodies, whenever present.

9.1.5.2.3 Impact Assessment

Animal carcasses (cows, sheep, goats, chicken, fish from fish farms, etc.) have been dumped along stream banks and in the streams themselves. The decomposing carcasses once they reach the stream would tend to take up dissolved oxygen in the affected waters to such an extent as to reduce its concentrations to levels that are detrimental to aquatic organisms.

The impact effect is limited and its duration is short term (less than 1 year) as it depends on the decomposition of the carcasses, which is often relatively rapid; the impact is classified as **marginal non-significant**.

9.1.5.2.4 Post-conflict Initiatives

No initiatives were reported.

9.1.5.3 Freshwater Fisheries Destruction

9.1.5.3.1 Location

The locations that were hit are Maallaka (dam zone of Assi under construction), Al Zoueitini Area and Assi bridge, and Al Zarka river in West Bekaa.

9.1.5.3.2 Potential Environmental Receptors

The Assi River is the main environmental receptor.

9.1.5.3.3 Impact Assessment

Two main types of impacts on the water quality of the river and its biodiversity are identified. The first is related to the increase of turbidity related to the cement material that ended-up in the river following explosions. The second is organic in nature and is related to the dead fish decomposition and depletion of dissolved oxygen, possibly leading to further impact on river fauna.

The impact effect is considerable given the extent of contamination of the surface water as visually reported in field visits but duration is short-term (less than 1 year); the impact is classified as **critical non-significant**.

9.1.6 MILITARY-RELATED IMPACTS

9.1.6.1 Explosions, Bombings and Fires

9.1.6.1.1 Location

The South and Bekaa regions were severely affected by explosions of ammunitions.

9.1.6.1.2 Potential Environmental Receptors

The main direct receptor is soil and surface waterbodies are indirectly affected.

9.1.6.1.3 Impact Assessment

Military vehicles are heavy machinery that disturb the soil greatly when moving. There are two types of impacts from these. The first is physical and involves erosion of soil and destruction of stream banks when fording streams – impacts of which were described earlier. The second is chemical and results from the leaks of hydrocarbons from these vehicles in parking/assembly locations and on roads traveled. Soil laced with fuel would erode to streams and contaminate them stressing aquatic organisms. The presence of depleted uranium, though unlikely based on NCSR and UNEP's assessments, warrants further investigation to ensure that water resources in affected areas are safe.

The impact may be considered **negligible** only due to the short duration of the activities and the limited areas impacted. The impact of white phosphorous present in some ammunitions on water resources is also considered **negligible** as the toxic material phosphine can be rapidly converted into less harmful chemicals when in contact with oxygen.

9.1.6.1.4 Post-conflict initiatives

The UNEP post-conflict assessment team is assessing impacts from weapons and ammunitions on the environment.

9.1.7 SUMMARY OF IMPACT ASSESSMENT ON WATER RESOURCES

The impacts on water resources are summarized in Table 9.1. The impacts can be classified as follows:

1. Three (3) critical significant impacts;
2. Six (6) critical non-significant impacts;
3. Five (5) marginal non-significant impacts;
4. Three (3) negligible impacts.

Table 9.1. Summary of Impacts on Water Resources from the War

Impact	Impact Effect	Duration	Severity/Significance
1. Water quality deterioration from disposal of Debris and Rubble	Limited	Short-term (less than 1 year)	Marginal Non-significant
2. Physical impact from dust generated from debris and rubble	Limited	Short-term (less than 1 year)	Marginal Non-significant
3. Impact on surface water streams from construction of bridges	Considerable	Short-term (less than 1 year)	Critical Non-significant
4. Impact on seawater quality from oil spill	Considerable	Short-term (less than 1 year)	Critical Non-significant
5. Impact on coastal aquifers from oil spill	Insignificant	Short-term (less than 1 year)	Negligible
6. Water pollution from PCB leakage from damaged transformers	Limited (localized impacts)	Long-term (10 to 50 years)	Critical Significant
7. Water pollution from fuel leakage from damaged petrol stations in Baalbeck	Considerable	Medium Term (1 to 10 years)	Critical Significant

Impact	Impact Effect	Duration	Severity/Significance
8. Water pollution from fuel leakage from damaged petrol stations in South	Limited	Short-term (less than 1 year)	Marginal Non-significant
9. Water pollution from Al Arz factory damage	Limited	Short-term (less than 1 year)	Marginal Non-significant
10. Water pollution from Lamartine, Maliban and Liban Lait factories	Limited	Medium-term (1 to 10 years)	Critical Non-significant
11. Water pollution from Fine Tissue Factory	Limited	Medium-term (1 to 10 years)	Critical Non-significant
12. Water pollution from Transmed and Lebanese Co. storage facilities	Considerable	Medium-term (1 to 10 years)	Critical Significant
13. Water pollution from Ghabresh and Saffieddine factories	Insignificant	-	Negligible
14. Water pollution from pesticides and fertilizers from damaged storage houses	Limited	Medium-term (1 to 10 years)	Critical Non-significant
15. Water pollution from disposal of animal carcasses	Limited	Short-term (less than 1 year)	Marginal Non Significant
16. Assi river impact from fisheries bombing	Considerable	Short-term (less than 1 year)	Critical Non significant
17. Chemical and physical impact from explosions, bombings, and fires	Insignificant	Short-term (less than 1 year)	Negligible

9.2 ENVIRONMENTAL ACTION PLAN

Several impacts on water resources were identified in this assessment. The oil spill impact on seawater quality is addressed in the biodiversity chapter; impacts from chemicals release from transformers, petrol stations and agriculture warehouses are addressed in the soil chapter. Impacts considered marginal or negligible are not addressed. The impacts that are addressed in this action plan are:

1. Impact on surface water streams due to bridges reconstruction activities;
2. Surface and groundwater pollution at Transmed and Lebanese Co. sites.

9.2.1 MITIGATING IMPACTS ON SURFACE WATER STREAMS FROM DAMAGED BRIDGES AND RECONSTRUCTION ACTIVITIES (DRAFT PROPOSAL)

9.2.1.1 Problem Statement and Rationale

A large number of bridges and viaducts were damaged or destroyed during the hostilities. In many cases the damage was so severe as to bring down the entire structure into the stream or wadi beneath it. Removal of the debris; provision of temporary by-passes and the reconstruction of the damaged structures are imperative for the continued livelihood of the population that uses the structure in their daily commutes. Debris resulting from destroyed buildings is often disposed of at the banks of nearby streams and rivers. These actions along with construction activities along the bridge site will cause stream bank erosion which is detrimental to the aquatic flora and fauna downstream of the site. In addition stream banks might erode back into adjacent properties destroying or damaging them. The impact of this damage has been rated critical and significant. This action plan aims at identifying measures needed to stabilize stream banks and remove constrictions at damaged sites, hence reducing the risk of erosion and flooding.

9.2.1.2 Proposed Actions

The following actions are proposed:

1. Survey the damaged bridges over the permanent and significant intermittent streams and identify critical sites based on exposure and severity of slopes, flow rates of streams, proximity of built-up areas to the river banks and sensitivity of fauna and flora;
2. Survey area in and around each critical site to assess the extent of damage and amount of disposed material/rubble and determine areas in proximity of the critical sites that are in danger of collapse due to stream bank erosion;
3. Model surface flow at the critical sites and the effects of rainfall upstream and downstream;
4. Identify and implement mitigation measures:
    a. Immediate measures to prevent flooding and erosion resulting from temporary diversions
    b. Erosion protection measures to be implemented during construction, including methods for using debris in the stabilization of the stream banks and protection of the riparian zones
    c. Post-construction measures for stabilizing stream banks and mitigate impacts on riparian zones
5. Set-up a monitoring program for each site to detect flood potential.

9.2.1.3 Legal Aspects

Need to adhere to local and international norms related to construction on rivers; local norms are deficient in this field and poorly enforced.

9.2.1.4 Institutional Aspects

The main responsible parties in this action plan are Ministry of Energy and Water, Ministry of Environment, Ministry of Public Works and Transport, CDR and local authorities.

9.2.1.5 Budgetary Estimate

The estimated budget for completing this action plan is **USD 605,000** divided into the following:

1. Survey of damaged bridges and identification of critical sites (assuming 30 sites): USD 15,000
2. Survey and assessment of critical sites (assuming 10 sites): USD 20,000
3. Modeling flow (assuming 10 sites): USD 20,000
4. Design and implementation of mitigation measures (assuming 10 sites): USD 500,000
5. Set-up and operation of monitoring program (flow measurement for 10 sites): USD 50,000

9.2.1.6 Timeframe

The expected time to complete all tasks (except post-construction measures) in this action plan is 1 year and may be divided as follows (some activities are conducted in parallel):

- Start surveys immediately to be completed within four to six weeks
- Modeling of flow: four weeks
- Rectification works: 4 to 8 months
- Set up of a monitoring program: six weeks of project start

9.2.2 MITIGATING WATER AND SOIL POLLUTION IN GHADIR AREA (DRAFT PROPOSAL)

9.2.2.1 Problem Statement and Rationale

Several industrial facilities were damaged during the hostilities. In some cases the damage was limited to structural components. But in other cases fuel, stored chemicals, and raw material were released into the environment. The resulting contamination was mostly localized to the vicinity of the damaged facility. However the mobility of some of the pollutants puts proximate waterbodies (surface and groundwater) under threat of contamination. The most critical of the impacted sites is that of Transmed - Middle East Cold Stores where, amongst others, stored nickel-cadmium batteries burned and their contents mingled with the soil on site. This facility, in addition to Lebanon Co., in the Choueifat region along the Ghadir River, have made this area a potential hotspot which may lead to contamination of areas further downstream.

9.2.2.2 Proposed Actions

To properly assess the extent of damage and remediate damaged sites, the following steps should be taken:

1. Collect all records pertaining to the facility (years in service, types of chemicals and fuel stored over years, etc.);
2. Survey area in and around the facility to assess the extent of contamination;
3. Determine the pathways from the contaminated site to the Ghadir river;
4. Collect water and sediment samples from locations near the contaminated site and downstream to complement UNEP post-conflict assessment, if needed;
5. Clean-up contaminated site while adhering to international norms;
6. Set-up a monitoring program for the facility to detect any leakage. The program should target soil and waterbodies (surface and ground water).

9.2.2.3 Legal Aspects

Depending on contaminants identified from sampling and analysis, some local standards may be lacking and international standards will have to be used.

9.2.2.4 Institutional Aspects

The main responsible parties in this action plan are Ministry of Energy and Water, Ministry of Environment, Ministry of Industry and local government.

9.2.2.5 Budgetary Estimate

The estimated budget for completing this action plan is **USD 535,000** divided into the following:

1. Sampling, modeling, clean-up and disposal: USD 500,000
2. Set-up and operation of monitoring program: USD 35,000

9.2.2.6 Time Frame

The expected time to complete all tasks in this action plan is up to 10 months and may be divided as follows:

- Start survey immediately (four weeks);
- Clean-up may be completed within six to nine months;
- Set-up monitoring program within six months of project start.

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LEBANON

RAPID ENVIRONMENTAL ASSESSMENT FOR

GREENING RECOVERY, RECONSTRUCTION AND REFORM 2006

SOIL

10.1 IMPACT ASSESSMENT

10.1.1 OVERVIEW OF IMPACTS

Soil is the medium most directly impacted by combat activities directly through bombing, vehicular movement, excavations and fortifications, and indirectly through the spillage of chemicals from destroyed industries, power stations, and fuel reservoirs. The type of damage to soils may thus be grouped into two categories, namely physical and chemical.

Physical damage is of several types including erosion, compaction, and deposition/sedimentation. Erosion occurs after soil is loosened. Runoff water and/or wind would then pick up the loosened soil particles and carry them away from impacted location. This loosening is due mainly to explosion of bombs on soil surfaces, vehicular movement, fortifications using earthen berms, excavations, and similar activities. Sedimentation is the flip side of the erosion coin. Loosened soil particles carried by runoff water and/or wind are deposited in areas some distance away from the impacted sites. These deposited materials cover existing vegetation, roadways and buildings, amongst others, thus creating at best a nuisance and in some situations might be a source of pollution and could cause harm to the health of humans and the environment in general. Compaction occurs mainly as a result of the movement of heavy vehicles on unpaved surfaces. This compaction might be shallow, i.e. within the top 10cm to 20cm but if such movement is repeated over a period of time could be deeper at depths in excess of 40cm. Also compaction may result from the impact of bombs and rockets and the depth of this varies with the type of ordinance in question.

Chemical damage to soil is in actuality pollution of the medium and not damage to its constitution and/or structure though this might occur in some cases. This pollution results from both directly exploding ordinance on soil surfaces and from the spillage and discharge of chemicals from targeted sites. Most of the commonly used ordinance has explosive material that is nitrogen-based though some do have phosphorous. Excessive amounts of these chemicals (nitrogen and phosphorous) are undesirable as they will eventually migrate into neighboring water bodies resulting in algal blooms. These eventually reduce dissolved oxygen concentrations in the receiving waters which tend to cause high mortality rates in aquatic organisms. Spilled or discharged chemicals from targeted sites could have toxic effects on soil organisms and plants at the site of spillage. These chemicals could also have detrimental effects on sites farther away. This would occur through their seepage to groundwater beneath the impacted site. The subterranean water would then transport these chemicals to locales farther away. Another means of distant contamination is through erosion. Often chemicals adsorb onto soil particles to which are loosened and then transported by water and/or wind to distant sites.

Impacts on soil were caused by all sectors damaged during the war (construction, transport, energy, industry and agriculture) and military activities; these are further described in the following sections.

With regards to soils in Lebanon, in general, most soils are described as ferruginous and calcimagnesic (i.e. high in iron, calcium and magnesium). Typically Lebanese soils have a high percentage of clay distributed between kaolinite and montmorillonite and have low organic matter content (0 - 2.8%). They are relatively alkaline with a pH ranging between 7 and 8.3. Calcium carbonate concentrations vary from high in the Bekaa to low in the North.

10.1.2 IMPACT ON SOIL FROM CONSTRUCTION AND TRANSPORT SECTORS

10.1.2.1 Debris and Rubble from Damaged Residential and Industrial Buildings

10.1.2.1.1 Location

Various sites across the country were used as either temporary or permanent disposal sites for the demolition debris generated by war-impacted regions of Dahieh, South Lebanon, Nabatiyeh and Bekaa. These sites include two main temporary storage sites in the Greater Beirut Area (Ouzaii and El-Shiyah) as well as various dumpsites scattered within the South and Bekaa regions.

10.1.2.1.2 Potential Environmental Receptors

The main direct receptor is the soil which acts often as a conduit to other receptors such as waterbodies.

10.1.2.1.3 Impact Assessment

Very large quantities of debris and rubble from damaged and destroyed residential and industrial buildings have been collected and disposed of (temporarily or permanently) in uncontained heaps in designated areas throughout the South, Bekaa and Beirut and along river banks. Little sorting of the waste was conducted prior to disposal and thus a limited amount of household and industrial chemicals (pesticides, detergents, hydraulic fluids, lubricating oils, cooking oils, diesel, etc.) may be incorporated within the debris. These chemicals if allowed to infiltrate into the soil would pollute the soil itself and as well as underlying and adjacent waterbodies. Such pollution could render water unusable. The aerial extent of the heaps is mostly small with the exception of the Ouzaii temporary storage site located on the Lebanese coast.

The impact effect on the soil of these heaps is expected to be limited given the relatively small amounts of liquid pollutants expected and limited aerial extent of the piles; impact duration is short-term (<1year) and the impact is classified as **marginal non-significant.**

10.1.2.1.4 Post-conflict Initiatives

No reports of assessment of soil contamination at debris disposal sites have been identified during this study.

10.1.2.2 Damaged Bridges

10.1.2.2.1 Location

A total of 92 bridges and overpasses were damaged in various regions of Lebanon including Beirut, Bekaa, Jbeil, Kesrwan, North, and South (HRC, 2006).

10.1.2.2.2 Potential Environmental Receptors

The main direct receptor is the soil which acts often as a conduit to other receptors such as waterbodies.

10.1.2.2.3 Impact Assessment

According to official sources, 92 bridges and overpasses were totally or severely damaged across the country (HRC, 2006). The area of concern regarding demolished or damaged bridges is their reconstruction and the diversion roads created to bypass them. The impact is mainly physical and is most likely to occur during the reconstruction phase. During reconstruction of bridges over permanent streams, the latter's banks are usually disturbed by construction machinery accessing the site leading to stream bank erosion. There are two major issues related to this erosion. The first is that eroded banks tend to be unstable and would retreat away from the river until they reach a stable slope. This retreat might erode property adjacent to the river and may lead to structural and other physical damages. Further, eroded soil particles are carried downstream as river sediment depositing in rivers and at their sea outlet. This sediment usually covers the benthic regions adversely affecting fauna and flora.

The impact effect is considerable given the number of sites affected and impact duration is short term (< 1 year); hence the impact can be classified as **critical non-significant**.

10.1.2.2.4 Post-conflict Initiatives

Reconstruction of several damaged bridges has begun. It becomes clear that the necessary precautions related to stream bank erosion should be implemented to the reconstruction process to protect this fragile habitat.

10.1.3 IMPACT ON SOIL FROM ENERGY SECTOR

10.1.3.1 Jiyeh Power Generation Plant

10.1.3.1.1 Location

The site is located in Jiyeh, South Lebanon.

10.1.3.1.2 Potential Environmental Receptors

The main direct receptor is the soil at the site and the seabed in several locations; soil up to 6 km north of the site is also potentially affected by deposition of particles and soot from burning fuel (refer to air chapter).

10.1.3.1.3 Impact Assessment

Fuel oil from storage facilities of the power generation leaked to the soil on site and eventually to the sea. A large quantity of fuel also burned.

The direct impact on the soil is mostly limited to the site itself; heavy fuel oil leaked into soil onsite and the oil slick that leaked onto the surface of the sea was carried by the sea currents and wind movement to extensive coastal tracts north of the site all the way to Syria including the Palm Island Nature Reserve (off Tripoli).

Heavy Fuel oil was deposited on several 150 km stretch of sandy, pebbly and rocky coastal zones and fishermen's wharfs (refer to affected sites in solid waste chapter). Furthermore, some of the heavy fuel oil was deposited at the bottom of the sea contaminating the seabed opposite the Jiyeh power plant. The impact of the fuel oil is widespread possibly affecting benthic organisms, fish, filter feeders (urchins, mussels, etc.) as well as reptiles and birds that utilize the coast for nesting, breeding and feeding. In addition, the portion of the fuel oil that has settled at bottom of the sea in Jiyeh may be source of pollution to coastal aquifers that have been intruded into by sea water (further addressed in water chapter).

Open burning of fuel generated contaminants such as polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, and heavy metals. These contaminants may have been largely deposited on an area up to 5 km north of the site (further addressed in the air chapter). Some of these contaminants could be trapped in the soil, and as their mobility is limited, could persist in the environment for a relatively long time.

Soil impact at the Jiyeh site is limited to the site itself (rocky section) but given the type of oil contamination, it is considered to be of medium-term duration (1-10 years) and the impact is classified as **critical non-significant**.

The impact on the littoral is catastrophic as it extends to wide areas and its duration is medium-term (1 to 10 years) and hence the impact is classified as **severe significant**.

The only confirmed site where oil has been deposited on the seabed is opposite to the Jiyeh power plant; other locations were not confirmed to date; impact on marine sediments are likely to be localized and not widespread as the oil reached the coastlines in a relatively short period time , and other processes such as volatilization and dissolution would reduce the quantities of oil that could sink and reach marine sediments; the impact on marine sediments is therefore rated as limited and is of medium-term duration (1 to 10 years). The impact is therefore classified as **critical significant**.

The impact effect from deposition of contaminants from fuel burning on soil is considerable (areas in the order of square kilometers may have been affected) and the impact duration can exceed one year and is medium-term (1 to 10 years); impact is classified as **critical significant**.

10.1.3.1.4 Post-Conflict Initiatives

The site at Jiyeh is being gradually cleaned-up, but personal communication with locals revealed that oil residues are being disposed of in the sea. The heavy fuel oil is being manually removed from the sea bed in front of Jiyeh by the Italian delegation and Bahr Loubnan. Several coastal stretches are being cleaned-up as described in the biodiversity chapter. The consultants did not identify any assessment or monitoring of soil pollution levels regarding possible impact from fuel burning.

10.1.3.2 Rafic Hariri International Airport

10.1.3.2.1 Location

The site is located in Southern suburbs of Beirut.

10.1.3.2.2 Potential Environmental Receptors

The main direct receptor is potentially the soil at the site itself as well as soil about 3 km north from the site which could be potentially affected by deposition of particles and soot from burning fuel (refer to air chapter).

10.1.3.2.3 Impact Assessment

It is estimated that 4,000 m^3 of kerosene from the fuel tanks have burned. Kerosene, a highly flammable and volatile fuel, is mobile in the soil and therefore typically does not pose long-term impacts to the medium. The anticipated small amounts that did not burn and that may have leaked are not expected to pose serious threats to soil and groundwater resources, especially given that the site is asphalted, and kerosene may have never reached the soil itself.

Soil impact at the airport site is limited to the site itself and is considered to be of short-term duration (less than 1year) given the light nature of the pollutant; the impact is classified as **marginal non-significant**.

The impact effect from deposition of contaminants from fuel burning on soil is considerable (areas in the order of square kilometers may have been affected based on air chapter) and the impact duration can exceed one year and is medium-term (1 to 10 years); impact is classified as **critical significant**.

10.1.3.2.4 Post-conflict Initiatives

On-site debris was cleaned-up. Waste disposal practice is not known. UNEP post-conflict team visited the site and took soil samples.

10.1.3.3 Damaged Transformers from Transmission and Distribution Networks

10.1.3.3.1 Location

Multiple locations may have been affected by damaged transformers, namely Jounieh, Tyre, Nabatiyeh, Bint Jbeil, Wadi Al-Zineh, El-Shiyah, and Halba (refer to Energy chapter).

10.1.3.3.2 Potential Environmental Receptors

The main direct receptor is soil at damaged sites.

10.1.3.3.3 Impact Assessment

All but one of the transformers hit was manufactured after 1979 – the cutoff year after which all transformers may be considered free of polychlorinated biphenyls. However, there is the risk that post-1979 dielectric oils manufactured in Eastern Europe, Soviet Union and China might contain polychlorinated biphenyls (PCB) based dielectric fluids. As such it may be prudent to assume the presence of PCBs at some of the targeted sites until proven otherwise. Also, there is uncertainty as to the exact number of transformers damaged, reports varying from 199 to 725; the number of potentially containing PCB-transformers could vary from a few to 240 units.

PCBs are known carcinogenic compounds and are very persistent in the environment. Their mobility in the soil is limited, however, as indicated earlier, PCBs may be transported off-site through erosion processes.

Thus until proven otherwise and given the persistence of the compounds, the impact on soils may be limited (given its localized nature) but long-term and the impact is classified as **critical significant**.

10.1.3.3.4 Post-Conflict Initiatives

While most transformers have been replaced, no assessment of potential soil contamination is believed to have been undertaken at potentially affected sites.

10.1.3.4 Petrol Stations

10.1.3.4.1 Location

Based on officially published values, at least 22 stations were affected (refer to energy chapter) in Bint Jbeil, Tyre, Marjayoun, Nabatiyeh, Saida, Jebb Jannine, Beirut, and Baalbek. Seven stations were damaged in Baalbeck and were confirmed by a field survey conducted by ELARD. In the other areas, reports from local authorities indicate that up to 47 stations may have been damaged, where 22 had fuel in their underground storage tanks when hit and thus have possibly leaked and/or burned.

10.1.3.4.2 Potential Environmental Receptors

The main direct receptor is the soil which acts often as a conduit to other receptors such as waterbodies.

10.1.3.4.3 Impact Assessment

Not all fuel reservoirs of the targeted petrol stations were hit. However, the concussions from the explosions may have been enough to form cracks in the reservoirs causing fuel to leak. Need for clean-up would require site assessments and soil sampling to quantify level of contamination at the sites. The seven petrol stations in Baalbeck were surveyed by ELARD staff and possibility of gasoline and diesel leakage was confirmed at five sites. The leaked fuel would eventually percolate into groundwater contaminating it. If un-rectified, the leaks could go on for a long period of time contaminating soil in the vicinity of the targeted sites.

Impact effect from fuel leakage from damaged petrol stations on soil, unless proven otherwise (particularly in the South villages), is limited (localized at the sites affected) but duration can be medium-term (1-10 years) as hydrocarbons may persist in the affected media, especially in the absence of oxygen, and the impact is classified as **critical non-significant**.

10.1.3.4.4 Post-conflict initiatives

While some of the stations have already been repaired, no assessment of potential soil contamination is believed to have been undertaken at potentially affected sites.

10.1.4 IMPACT ON SOIL FROM THE INDUSTRY SECTOR

10.1.4.1 Al Arz Textile Factory

10.1.4.1.1 Location

The site is located in Al Khyaray – Al Manara, Bekaa and is surrounded by agricultural lands (olive trees and vineyards).

10.1.4.1.2 Potential Environmental Receptors

The main direct receptor is the soil.

10.1.4.1.3 Impact Assessment

Evidence of oil leakage has been noticed at the site. Due to the karstic nature of the formation (refer to water chapter), any pollutant will rapidly reach the aquifer and be flushed away through the fractured system limiting impact on the soil medium.

The impact on soil is considered to be localized (limited) and short-term (<1year) and therefore the impact is classified as **marginal non-significant**.

10.1.4.1.4 Post-Conflict Initiatives

UNEP post-conflict assessment team took samples of oil and water for analysis.

10.1.4.2 Lamartine Food Industry

10.1.4.2.1 Location

The site is located in Taanayel, Bekaa.

10.1.4.2.2 Potential Environmental Receptors

The main direct receptor is the soil with limited concern regarding waterbodies.

10.1.4.2.3 Impact Assessment

Some fuel for operating the electricity generator and chewing flavoring leaked to the soil on site. The impact is limited to the site itself due the clayey nature of the soil and the presence of conglomerate formations at depths ranging between 30cm and 60cm beneath ground surface. The generally low infiltration rate of surface soils in the area is around 10cm/day and this along with the relative impermeability of the conglomerate layer would prevent or severely restrict the movement the liquid contaminants to the groundwater.

The impact on soil is considered to be localized (limited) and short-term (<1year) and therefore the impact is classified as **marginal non-significant**.

10.1.4.2.4 Post-Conflict Initiatives

UNEP post-conflict assessment team took soil samples at the site.

10.1.4.3 Liban Lait Dairy Plant

10.1.4.3.1 Location

The site is located in the Bekaa in Hosh Sneid.

10.1.4.3.2 Potential Environmental Receptors

The main direct receptor is the soil.

10.1.4.3.3 Impact Assessment

Some fuel for operating electricity generator may have leaked to the soil on site. The impact is limited to the site itself due the clayey nature of the soil and the presence of conglomerate formations at depths ranging between 30cm and 60cm beneath ground surface. The generally low infiltration rate of soils in the area is around 10cm/day and this along with the relative impermeability of the conglomerate layer would prevent or severely restrict the movement the liquid contaminants to the groundwater.

The impact on soil is considered to be localized (limited) and short-term (<1year) and therefore the impact is classified as **marginal non-significant**.

10.1.4.3.4 Post-Conflict Initiatives

UNEP post conflict assessment team visited the site and took ash samples. Otherwise debris clearing and reconstruction has taken place.

10.1.4.4 Fine Tissue Factory

10.1.4.4.1 Location

The site is located in Kfar Jarra, South.

10.1.4.4.2 Potential Environmental Receptors

The main direct receptor is the soil.

10.1.4.4.3 Impact Assessment

Fuel for operating electricity generators have leaked to the soil on site. The impact is mostly limited to the site itself. The water table is low in the area and the probability of infiltration of the fuel into it is low due to the dense nature of the fuel. Consequently the impact is local and considered to be negligible.

Dioxins may be present as a by-product of the bleaching process. Its mobility in the soil is limited; however the carcinogenic nature of the pollutant and its persistence in the environment makes its potential presence a cause of concern. The aerial extent of the potential occurrence is however limited to the site itself.

Pollution of the soil with dioxins is limited but its duration is medium-term (1 to 10 years) and the impact is classified as **critical non-significant**.

10.1.4.4.4 Post-Conflict Initiatives

UNEP post conflict assessment team visited the site.

10.1.5 IMPACT ON SOIL FROM AGRICULTURE SECTOR

10.1.5.1 Destruction of Storage Houses

10.1.5.1.1 Location

Storage houses in the South and the Bekaa were reported to have been damaged. Up to 170 sites were reported in the media to have been affected but no official confirmation has been published.

10.1.5.1.2 Potential Environmental Receptors

The main direct receptor is soil which acts often as a conduit to other receptors such as waterbodies, plants, animals, and other organisms residing in the soil.

10.1.5.1.3 Impact Assessment

The main concern is the percolation of the agrochemicals (mainly pesticides and fertilizers) as well as stored fuel into subsurface and surface waterbodies resulting in significant damage to aquatic flora and fauna and rendering these waters unusable. The aerial extent is limited and the exact number of bombed-out storage depots is still uncertain.

Therefore, until proven otherwise, the impact effect of this damage is limited and impact duration is medium term (1 – 10 years) as soils saturated with the chemicals will continue to be source of pollution until treated or all the chemicals have been leached out. Consequently the impact is classified as **critical significant**.

10.1.5.1.4 Post-Conflict Initiatives

No assessment of potential soil contamination is believed to have been undertaken at potentially affected sites.

10.1.5.2 Forest Fires

10.1.5.2.1 Location

Forest fires were reported primarily in the South and Mount Lebanon areas (refer to agriculture chapter).

10.1.5.2.2 Potential Environmental Receptors

The main direct receptor is soil.

10.1.5.2.3 Impact Assessment

The main concern is the exposure of top soil to wind and runoff water due to the destruction of vegetative cover. Eroded soil will deposit in wadi bottoms in rivers. Forest will be unable to regenerate due to the loss of the productive element of the top soil and the remaining soil would lose some of the fertility previously afforded by organic matter deposited on its surface.

The impact effect is considerable, especially on the steeper slopes where forest cover and soil regeneration are extremely slow and difficult, and impact duration is long-term unless proper measures are taken; the impact is classified as **serious significant**.

10.1.5.2.4 Post-conflict Initiatives

No initiatives addressing soil erosion related to forest fires were identified during this study.

10.1.6 MILITARY-RELATED IMPACTS

10.1.6.1 Explosions, bombings and fires

10.1.6.1.1 Location

The South and Bekaa regions were severely affected by explosions of ammunitions.

10.1.6.1.2 Potential Environmental Receptors

The main direct receptor is soil.

10.1.6.1.3 Impact Assessment

Explosions and resulting fires have a direct impact on soils. The impacts are chemical and physical.

Chemically, most explosives molecules are characterized by an aliphatic or aromatic structure with substituted nitro groups making them a source of nitrates, nitramines, and some heavy metals such as mercury and lead. Some other explosive devices are rich in phosphorous. The nitrogen based chemicals are mobile in the soil and readily leach into the subsurface waters. Phosphorous and heavy metals are much less mobile and are adsorbed onto soil particles which when eroded typically end up in receiving surface waterbodies. It is also recommended to further evaluate the contamination of water resources with depleted uranium until it is proven that it was not used.

The impact effect is rated as limited as the amount of chemicals discharged is usually not large, although large areas may have been affected, and the impact duration is short-term (<1 year), thus the overall chemical impact on soil is classified as **marginal non-significant**.

Physically the damage is related to loosening of the soil and some localized compaction at points of impact. The loosened soil is subject to erosion and the consequences have been described earlier. The impact effect is limited and duration is short-term, and the physical impact is also classified as **marginal non-significant**.

10.1.6.1.4 Post-conflict initiatives

The UNEP post-conflict assessment team is assessing the environmental impacts related to weapons and ammunitions.

10.1.6.2 Movement of Military Vehicles, Excavations, and Fortifications

10.1.6.2.1 Location

The South region is mainly affected, in particular the areas close to the international border. Agricultural lands close to the border in the villages of Ghajar, Sarada, Khiam and Kfar Kila were subject to intense military actions.

10.1.6.2.2 Potential Environmental Receptors

The main direct receptor is soil.

10.1.6.2.3 Impact Assessment

Military vehicles are heavy machinery that disturb the soil greatly when moving. There are two types of impacts from these. The first is compaction of the areas that are repeatedly trafficked. Sub-soil compaction is much more difficult to remedy than soil compaction. However no assessments of the level of compaction of the possibly affected soils was undertaken. Excessive soil compaction would lead to reduced fertility in agriculture areas and increased erosion.

The second is the loosening of the soil by tracked vehicles (tanks, armored personnel carriers, etc.) resulting in increased erosion potential. Excavations and fortifications usually disturb the soil extensively and loosen a significant amount rendering it highly erodible.

The impact is however considered to be limited and its duration is short-term, and the impact is classified as **marginal non-significant**.

In the case sub-soil compaction was caused, the impact effect would be limited with medium-term duration, and impact would be classified as **critical non-significant**. However sub-soil compaction is unlikely to have occurred.

10.1.6.2.4 Post-conflict initiatives

No initiatives are reported.

10.1.6.3 Unexploded Ordinance

10.1.6.3.1 Location

Millions of unexploded ordinance were reported to be found in the South and in some limited areas in the Bekaa and Beirut.

10.1.6.3.2 Potential Environmental Receptors

The main receptor is the soil though indirectly.

10.1.6.3.3 Impact Assessment

Once areas are identified as being unsafe due to unexploded ordinance (UXO) people would typically avoid them. This is especially true to herders who will move their sheep and goat herds to safer areas. Some of these safer areas may be of marginal lands susceptible to erosion. Even if the new areas are non-marginal and good for grazing, the limited space available for herders to shepherd their herds to will result in over grazing of those new areas leading to excessive erosion.

The impact effect may be considered to be limited but of medium-term duration, and the impact is classified as **critical non-significant**.

10.1.6.3.4 Post-conflict Initiatives

No initiatives to address this issue were identified during this assessment.

10.1.7 SUMMARY OF IMPACT ASSESSMENT ON SOIL

The impacts on soil are summarized in Table 10.1. The impacts can be classified as follows:

5. One (1) severe significant impact (related to the oil spill) and is being addressed by the Ministry of Environment (MoE) and the international community;
6. One (1) serious significant impact (related to soil erosion from forest fires);
7. Three (3) critical significant impacts;
8. Seven (7) critical non-significant impacts;
9. Six (6) marginal non-significant impacts.

Table 10.1. Summary of Impacts on Soil from the War

Impact	Impact Effect	Duration	Severity/Significance
1. Soil impact from disposal of Debris and Rubble	Limited	Short term (less than 1 year)	Marginal Non-significant
2. Stream bank erosion from construction of bridges over permanent streams	Considerable	Short term (less than 1 year)	Critical Non-significant
3. Soil impact at Jiyeh Site	Limited	Medium-term (1 to 10 years)	Critical Non-Significant
4. Littoral pollution from oil spill	Catastrophic	Medium-term (1 to 10 years)	Severe Significant Impact

Impact	Impact Effect	Duration	Severity/Significance
5. Marine sediment impact from sunken oil	Limited	Medium-term (1 to 10 years)	Critical Significant
6. Soil impact at airport site	Limited	Short-term (less than 1 year)	Marginal Non-Significant
7. Soil pollution from deposited contaminants of fuel burning at Jiyeh and airport	Considerable	Medium-term (1 to 10 years)	Critical Significant
8. Soil pollution from PCB leakage from damaged transformers	Limited (localized impacts)	Long-term (10 to 50 years)	Critical Significant
9. Soil pollution from fuel leakage from damaged petrol stations	Limited (localized impacts)	Medium Term (1 to 10 years)	Critical Non-significant
10. Soil pollution from Al Arz factory damage	Limited	Short-term (less than 1 year)	Marginal Non-significant
11. Soil pollution from Food Industries (Lamartine and Liban Lait)	Limited	Short Term (less than 1 year)	Marginal Non-significant
12. Soil pollution from Fine Tissue Factory	Limited	Medium Term (1 – 10 years) (possible presence of dioxins)	Critical Non-significant
13. Soil pollution from pesticides and fertilizers from damaged storage houses	Limited	Medium Term (1 to 10 years)	Critical Non-significant
14. Soil erosion from forest fires	Considerable	Long-term	Serious Significant
15. Chemical and physical impact from explosions, bombings, and fires	Limited	Short Term (less than 1 year)	Marginal Non-Significant
16. Soil compaction and soil loosening from military vehicle movement, excavations, fortifications	Limited	Short Term (in case of soil compaction)	Marginal Non-Significant
	Limited	Medium-term (in case of sub-soil compaction)	Critical Non-Significant
17. Over-grazing in non-affected areas by unexploded ordnances	Limited	Medium-term (1 to 10 years)	Critical Non-significant

10.2 ENVIRONMENTAL ACTION PLAN

Several impacts of varying importance were identified in this assessment. The most severe impacts are already being addressed by the authorities (oil-spill related). An action plan to address the disposal of demolition wastes is proposed in the construction chapter. Stream bank erosion is addressed in the water chapter. Soil impact at the Jiyeh and airport sites and Fine Tissue Factory are addressed by the UNEP post-conflict assessment team. Soil erosion from forest fires is addressed in the biodiversity and agriculture chapters.

It is recommended that the MoA further assesses the level of soil compaction at the agricultural areas affected by military vehicles movement along the border to verify whether sub-soil compaction has occurred and to take the necessary mitigation measures. MoA should also identify suitable areas for grazing since grazing patterns are affected in the damaged areas due to presence of unexploded ordnances.

This environmental action plan addresses the remaining impacts:

1. Soil pollution from deposited contaminants of fuel burning at Jiyeh and airport sites;

2. Overall assessment of soil pollution from damaged transformers, petrol stations and damaged agriculture storage houses.

10.2.1 MITIGATING POTENTIAL IMPACTS FROM DEPOSITION OF CONTAMINANTS FROM JIYEH AND AIRPORT FIRES IN SOIL (DRAFT PROPOSAL)

10.2.1.1 Problem Statement and Rationale

The Jiyeh and airport fires have generated large amounts of pollutants including particulate matter, PAHs, dioxins and furans among others. Preliminary air pollution dispersion simulations have shown that areas within a 5 km radius from the source (towards a north/north-east direction) are the most affected by these fires. The direct impact of plant coating and absorption of these pollutants in agriculture areas is plant phytotoxicity. Contaminants residues in plants and on soil may also affect human health. Mobility of these contaminants in soil is also generally limited, leading to a longer duration of any potential impact.

Given the toxicity and persistence of the pollutants deposited, it is important to ascertain their presence, aerial extent and level of contamination in affected regions in order to identify appropriate mitigation measures.

10.2.1.2 Proposed Actions

The following actions are proposed:

1. Conduct, in coordination with the relevant stakeholders, a sampling campaign in the agricultural lands up to 5 km to the north east of the pollution source: Jiyeh, Damour, Mechref, Aabay, Qabr Chmoun, Choueifat, Wadi Chahrour, Bdadoun with emphasis

on perennial crops (banana, tropical fruit trees, olive, almond and carob trees…) and soil and focus on the following parameters: dioxins, PAHs and heavy metals;

2. Evaluate the pollution levels by comparing with appropriate standards and identify mitigation measures if needed; if contamination is detected, further monitoring of surface water bodies should be undertaken as a follow-up;

3. Communicate the results to affected stakeholders together with the proposed actions.

10.2.1.3 Legal Aspects

Appropriate standards are not available in Lebanon to evaluate the impacts of the stated contaminants in soil and crops.

10.2.1.4 Institutional Aspects

The MoE is responsible for environmental monitoring in the country. Coordination with the MoA and the relevant municipalities will be needed to implement the survey and relay the information to the public.

10.2.1.5 Budgetary Estimate

The budgetary estimate for this intervention amounts to **USD 70,000**. Budget breakdown is as follows:

5. Monitoring activities (assuming 40 samples – soil and crops - taken and average sample cost of USD 1500 due to high dioxins analysis cost – including cost of personnel, sampling, equipment and transportation): USD 60,000

6. Design of mitigation measures and communication of results: USD 10,000

10.2.1.6 Timeframe

This assessment should be performed immediately and should be completed in 3 months.

10.2.2 CLEAN-UP NEEDS FOR SITES POTENTIALLY AFFECTED BY PCBS, PETROLEUM HYDROCARBONS AND PESTICIDES (DRAFT PROPOSAL)

10.2.2.1 Problem Statement and Rationale

Numerous sources of soil pollution have been identified but their impact magnitude and significance remains unknown. These include notably the transformers (PCB issue), petrol stations (petroleum hydrocarbons), and agricultural warehouses (pesticides and fertilizers). These sources of pollution have two commonalities: the pollution involved is persistent in the environment (especially for PCBs and some pesticides unlike hydrocarbons which could degrade rapidly provided good aerobic conditions are maintained) and the number and importance of the affected sites has not clearly identified.

While official sources point to only one transformer which could possibly include PCB, other sources note that this number could reach more than 200 transformers, in which case the impact could become significant. Also, while 5 petrol stations in Baalbeck were confirmed to have possibly leaked, another 22 stations in the South could pose local pollution problems to soil and potentially to groundwater resources. An estimated number of 170 agriculture warehouses could also have been affected by the war.

Given the types of pollutants involved and the level of uncertainty regarding their fate, it is recommended that a detailed assessment be performed, samples be taken, contaminated sites be identified, and clean-up measures be proposed and implemented. <u>One hot spot has already been defined in this assessment</u> in Baalbeck because of leaked petrol stations, and clean-up should be initiated as the upper aquifer has indicated signs of pollution.

10.2.2.2 Proposed Actions

To properly assess the extent of damage and remediate damaged sites, the following steps should be taken:

1. Conduct a survey of the possibly affected sites; list of sites can be obtained from Electricité Du Liban (EDL) for transformers, the local authorities for petrol stations and MoA for the storage houses; survey should result in a list of hot spots based on possibility of leakage or not;
2. Conduct an environmental investigation of the hot spot areas and assess the need for environmental remediation; the need for remediation should be based on potential risk to human health; environmental investigations should focus on soil and water media and pollutants to be assessed are PCBs, total hydrocarbons and pesticides, depending on source of pollution;
3. Conduct a detail remedial investigation and feasibility study for those sites that require remediation and perform a detailed design for soil remediation; contaminated soil can be treated either in-situ or after removing it; use of mobile treatment facilities can be considered; treatment should adhere to international norms and be geared towards the reuse of the soil and if possible the contaminant as well.
4. Implement remedial measures at identified locations.

10.2.2.3 Legal Aspects

Standards to assess level of contamination are not available in Lebanon for the above pollutants.

10.2.2.4 Institutional Aspects

It is recommended that the MoE, which is responsible for environmental monitoring in Lebanon, in close coordination with the Ministry of Energy and Water, EDL, MoA, local municipalities and the Syndicate of Petrol Station Owners initiate this mitigation program.

10.2.2.5 Budgetary Estimate

The budgetary estimate for this intervention amounts to **USD 400,000**. Budget breakdown is as follows:

1. Survey and assessment of sources of pollution:	USD 20,000
2. Environmental investigation on the hot spot areas:	USD 30,000
3. Remedial investigation and feasibility study (assuming 5 sites):	USD 50,000
4. Remediate contaminated soil (assuming 3 sites):	USD 300,000

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LEBANON

RAPID ENVIRONMENTAL
ASSESSMENT FOR

GREENING RECOVERY,
RECONSTRUCTION
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2006

BIODIVERSITY

11.1 IMPACT ASSESSMENT

11.1.1 OVERVIEW OF IMPACTS

The recent hostilities on Lebanon affected biodiversity both directly and indirectly. The bombing and the resultant oil spill directly impacted biodiversity "hot spots" such as protected areas and fragile ecosystems. This led to the degradation of ecosystems, deterioration of vegetation, disturbance to wildlife, and destruction of delicate habitats.

The combat also resulted in forest fires, either caused by the bombing or induced to improve visibility on the battlefields. Moreover, the bombing particularly targeted bridges, many of which overpass rivers and water canals, potentially causing damage to freshwater ecosystems and habitats.

The use of heavy artillery, such as tanks and bulldozers to clear roads during the invasion resulted in disturbance and fragmentation of ecosystems, disturbance to fauna and flora, compaction of soil, as well as eradication of marginal habitats on the sides of roads.

The sea was also significantly affected during the war and in its aftermath. The physical advance of warships (and the associated release of their waste), the direct bombing, and the oil spill were the main sources of damage. The latter was described by the Ministry of Environment (MoE) as the most significant environmental catastrophe in the history of the country. In general, the sea has been the ultimate receptor of most sources of in-land pollution caused by the war.

Indirectly, the war generated stress factors such as increased demographic pressure on resources as a result of population displacement and economic distress. Such pressures, which include the loss of an entire harvesting season for farmers and limited access to their lands, have likely promoted, in an intent for compensation, the use of unhealthy practices like drainage of wetlands for more aggressive irrigation or the extensive use of pesticides with associated detrimental impacts on natural resources namely water and birdlife. Based on IUCN assessment, abusive pumping of freshwater from Ras El Ain ponds in Tyre Coast Nature Reserve due to damages of water network has been reported.

Unfortunately, the indirect impacts of war on biodiversity can have long-lasting effects. In the aftermath of the war, ecological resources have already come under more pressure from the haphazard dumping of demolition waste, a result of the haste of reconstruction, as well as the reclamation of coastal land, wild areas, valleys, hillsides and roadsides. Practices such as dumping of demolition waste at Ouzaii near the coastline pose serious threats to marine biodiversity and habitats, especially with the risk of collapse of part of the waste mound into the sea. The country is also witnessing increased quarrying activity and arson triggered in forests by impoverished communities producing charcoal.

Cluster bombs are contributing to further destruction of forests, shrubs and bush lands. With over a million cluster bombs estimated to be scattered in the environment, it is expected that thousands of hectares of scrubland may be lost to fires. Upon late explosion by specialists, residents or by itself, unexploded ordnance is causing forest fires. The case reported from Joaya reveals that the explosion of unexploded bombs led to forest fires resulting in the damage of more than 1500 trees. Faunal assets, particularly large mammals, are also being lost or variably injured as a consequence of unexploded ordnance (UXOs) in the wild. This has been experienced and reported in many of the war zones around the world (Conachy, 1999; Blom & Yamindou, 2001; Jacobs & Schloeder. 2001; Plumptre *et al.,* 2001). The presence of UXOs is an additional stress factor on rural communities who are unable to reach their farmland and are thus increasing pressure on available resources and promoting unhealthy practices.

The arrival of foreign armies and the deployment of the Lebanese army are introducing new pressure on natural resources and their potential environmental impacts should not be overlooked. These troops enter natural areas with heavy machinery and vehicles to settle and carry out frequent patrols. Conservationists have also reported waste dumping by foreign troops coming in from the sea. Based on IUCN experts field reports, the waste was seen shored on turtle nesting beaches used by the endangered Loggerhead (Caretta caretta) and Green Turtles (Chelonya mydas).

Protected areas, wetlands, a biosphere reserve, Specially Protected Areas (SPA) and Important Bird Areas (IBAs) were all affected in one way or another during the conflict: Some of the reported impacts are:

- Direct bombing namely on Al Shouf Cedars Nature Reserve and Jabal Al Rihane threatening wildlife, habitats and entire ecosystems (IUCN reports);

- Oil from the spill posing serious threat to migrating birds, marine turtles and other fauna and flora all along the shore but specifically in Palm Islands Nature Reserve and Dammour Area as well as impacting marine life in shallow waters (OSOCC reports; PINR reports; IUCN progress reports); this includes also impact on Sand Dunes of North Lebanon shoreline and specifically PINR, knowing that sand dunes remain one of the threatened ecosystems and habitats internationally;

- Noise and dust from the bombing that forced wildlife to change migratory routes and habitat, causing additional stress;

- Drainage of water in wetlands; this effect was reported in Hima Kfarzabad, a community-driven protected area and abusive pumping of freshwater ponds in Ras El Ain in Tyre.

Other more general impacts include:

- Noise produced by military vehicles causing animals to leave these areas;

- Disposal of municipal waste in haphazard dumps especially in the South during and after the war. Proper collection points were instituted with the end of hostilities. However, the dumps were not cleaned and garbage was left to decompose eliminating original vegetation cover;

- Pressure on vegetation from increased wood extraction, among others. This is in part due to the stressful post-war economic situation and the possible absence or scarcity of supplies in the affected areas. People who collect food material to sell will tend to overexploit in an effort to increase their profits. The absence of electricity and scarcity or price of fuel products would force villagers to resort to natural resources for substitutes, thus potentially augmenting demand on firewood significantly, as is reported in many of postwar zones around the world (Conachy, 1999; Blom & Yamindou, 2001; Jacobs & Schloeder. 2001; Plumptre *et al.*, 2001).

- Pressure on the land, a result of transportation detours to disposal dumps for demolition waste, rubble and debris, garbage and other solid waste. The interruption of proper garbage collection and disposal from war-struck villages would result in large piles of waste that would end up in natural sites, degrading their vegetation.

11.1.2 IMPACT OF THE CONSTRUCTION SECTOR ON BIODIVERSITY

11.1.2.1 Impact from Disposal of Demolition Waste

More than 30,000 housing units were completely destroyed during the war and more than 100,000 housing units were partially affected (refer to construction chapter). The quantities of mixed demolition waste may have exceeded 3 million m^3 in Beirut, the South and Bekaa. While demolition wastes in Beirut were disposed of in temporary storage sites, those in the other regions of Lebanon were often dumped on hillsides, roadsides, and coastal areas (Figure 11.1).

(a) Demolition waste on roadside in the heights of Kfarshouba overlooking a valley (South L.)

(b) Demolition waste forming a mound in Dibbeen (South Lebanon)

Figure 11.1. Demolition Waste in the Environment

11.1.2.1.1 Location

Demolition waste was generated in very large quantities in the southern suburbs of Beirut, the South and the Bekaa. Some villages in South Lebanon witnessed concentrated and high levels of destruction such as the town of Khiam. The demolition waste of Khiam village in Marjayoun Caza, for example, ended up at a roadside at the beginning of the village and in a valley near the Hasbany River. Neighboring villages of Dibbeen and Kfarkila, also part of Marjayoun district, dumped their demolition waste in a pile on hillsides that are usually covered with green vegetation and fertile soil. In Beirut, a portion of the demolition waste was disposed of in a mound by the shoreline in Ouzaii, exacerbating pressure on the marine environment.

11.1.2.1.2 Potential environmental receptors

Potential receptors include floral base, fauna, soil, significant habitats, water bodies and riverbeds, as well as marine environments.

11.1.2.1.3 Impact assessment

- **Impact on floral and faunal base**

The floral base of South Lebanon is broad and comprises over a thousand species. Many of these species thrive across the affected zone as abundant or common species. Few species are localized or carry a significance of utilitarian aspect (Mouterde, 1966-1970-1983). These might exist in other unthreatened sites, however their endangered populations bear paramount local significance at different levels from ecological to socio-economic, developmental, sustainable use, and more.

The floral base of South Lebanon is significant on the national and regional scale. The flora of Lebanon comprises elements from several floristic systems, which constitutes the basis of its remarkable richness. That of the South stems from the establishment of Saharo-African elements originating in southerly floristic systems. These elements favor the dry conditions of the south, which enhances their growth and development. Their frequencies and densities vary with the prevailing conditions at the geographical locations. In general, their distribution regresses northward; some are limited to a narrow distribution zone nearing the borderline; others extend to the outskirts of Beirut. In addition, the plant associations formed by this flora are particular to South Lebanon.

The vegetation base in the South plays a key role in combating desertification. It thrives under dry conditions. The more established it is the more moderate the climatic conditions would be. The South is also characterized by fertile soil. During the Israeli occupation, it was common practice for the occupying army to steal the area's rich topsoil, a phenomenon repeatedly reported in the media.

The newly created mounds of rubble and demolition waste result in the degradation of the floral base, which may exacerbate the dryness of the system and reduce the potentials of regeneration. The mounds also disrupt the continuity of the green cover and fragment the extant ecosystems rendering them more fragile and hence enhancing their degradation. By disrupting continuity, the mounds of waste also create obstacles for free movement of wildlife, especially fauna such as the wild boar, wild cat, red fox, jackals, and striped hyenas, all observed in the South.

In summary, the extensive dumping of rubble and demolition in the wild-natured ecosystems of south Lebanon may cause:

- Partial loss of the green cover (particularly at points of dumping and downstream if dumping blocks water streams);
- Partial loss of the seeding potentials;

- Loss of soil seed bank;
- Decimation of faunal and floral populations;
- Loss of delicate and significant habitats;
- Disturbance to the ecosystem's function.

- **Impact on water bodies**

A stamping mark of this war was the destruction of bridges and culverts. Extended damage is being caused by restoration and reconstruction works; extensive areas in the vicinities of hit bridges are being altered to facilitate infrastructural works and the creation of temporary substitutes as detours or parallel dump roads. As a result, riverbanks and riverbeds, which shelter particular vegetation and water organisms from mollusks to reptiles to birds, are being covered with rubble. Rainfall and the flowing of water through the river courses would impose further threats; rubble and debris may be carried from the affected zones and variably dispersed downstream reaching the sea and threatening marine habitats. An example of this case is the demolition waste dump created in a valley in Khiam that blocked a winter water stream. With the arrival of winter, rainwater may carry this waste and pollute the riverbeds downstream (Figure 11.2).

Dumping of demolition waste was also reported in the natural ponds in Houla and Aitaroun potentially affecting freshwater organisms ranging from invertebrates to amphibians.

Figure 11.2. Demolition Waste Covering a Valley in Khiam and Blocking a Water Course

The impact of these events extends from destruction of the site to disturbance to the various natural system components. Food chains would be severely impacted where vegetation and phytoplanktonic life is killed by the covering of sites with rubble or with the deposition of silt and fine particles obstructing photosynthesis. Faunal life will also suffer from the siltation and possibly continued escape of fine particles from dumped rubble elevating the turbidity of water. Natural balance is toppled and regaining of such balance is a long-term process that requires stability. However, these sites will be in the foreseeable future exposed to more disturbance in the process of rehabilitation and reconstruction of bridges.

Impact on marine environment

Disposing of demolition waste and rubble close to the coast poses the danger of silt suffocation of benthic organisms and environmental destruction in the vicinity of the dumps. Moreover, long shore currents may carry particles for long distances thus creating a wide ranging sediment layer that adversely affects biota wherever it settles. These effects coupled with demolition wastes washed down the rivers are of utmost concern. Reef and marine life may be affected, especially sessile benthic organisms at the dumpsite in Ouzaii and north of the dump. Moreover, since the rubble is in very close proximity to the shore, the possibility of collapse is high especially when rain and waves start eroding the bottom of the small hill of rubble. Rubble falling into the sea may smother marine life and create local sedimentation problems by changing localized current directions, increasing turbulence, and reducing long shore transport. Finally, not only is the creation of mountains of demolition waste ecologically detrimental to the various ecosystems in Lebanon, but the sites are also an eyesore creating esthetic pollution affecting tourism and the local moral of the people.

Impact of demolition waste disposal on ecosystems is considerable given the spread of the impact and the possible effect on local biodiversity and impact duration is medium-term (1 to 10 years) when assuming that rubble will be removed in the short-term and affected media will recover naturally, however long term impact is expected at sites where the rubble cannot be removed and the site recovered; thus the impact can be classified as **severe significant**.

11.1.2.2 Impact of Quarrying on Natural Resources

Quarrying is a significant environmental problem in the country that is exacerbated with every new wave of reconstruction. The chaos created by the 15-year civil war facilitated uncontrolled quarrying in rocky natural systems and sand dredging from the marine environment.

As a result of the vast destruction caused by the recent hostilities, the need and demand for raw material for reconstruction has naturally risen. Estimations have indicated that reconstruction efforts may practically double the demand on local resources, mainly aggregates and sand (refer to construction chapter).

11.1.2.2.1 Location

Unless quarrying activities are organized through a proper management plan, numerous sites will be affected by increased quarrying activities.

11.1.2.2.2 Potential environmental receptors

Several receptors are at risk including mountainous ecosystems, forests, and water ecosystems.

11.1.2.2.3 Impact assessment

Quarrying eradicates biodiversity and annihilates the ecosystem in the affected sites. The losses may be irreversible; rehabilitation improves the situation but does not reproduce the natural system.

Sand quarrying from terrestrial sources endangers very sensitive ecosystems. Terrestrial sand quarrying is actually eliminating the most important filters of rainwater. It disturbs water system and eliminates impermeable stratification layers.

The vegetation and ecosystems that exist on sandy soil are very fragile and survive on a very critical balance due to the nature of the substrate and the high leaching of minerals. Extraction of sand, creation of large cavities, and exposing walls allows the drainage of the water film and soil moisture from large expanses of the ecosystem into the exposed cavities where evaporation is high. Hence the vegetation in much wider areas than the actual quarry may be subject to drought and the disturbance may ascend through the food chain to cover all dependents on the vegetation layer.

Erosion and land movement may also be exacerbated due to quarrying activities and loss of the water film.

Sand extraction from marine sources is equally destructive to marine habitats and systems.

In the wake of the heightened demand, rock quarrying will increase the pressures on mountainous ecosystems, forests and water systems leading to greater losses in habitats, flora and fauna.

Given estimates that reconstruction activities will double resource requirements, unless quarrying activities are properly planned, impact effect is estimated to be considerable and impact duration is long-term (10 to 50 years) as affected areas would need many years to be restored; this impact is classified as **severe significant**.

11.1.3 IMPACT OF THE ENERGY SECTOR ON BIODIVERSITY

11.1.3.1 Impact on Marine Biodiversity from the Jiyeh Oil spill

Bombing of the Jiyeh power plant on two occasions (13th and 15th of July) resulted in an estimated spill of approximately 15,000 m^3 of fuel into the Mediterranean Sea, contaminating 150 km of the Lebanese shoreline. The MoE described the spill as the most significant environmental disaster that ever struck the country.

The long-shore currents moving in a south-north direction transported the fuel all the way to the Syrian coast. The south-north movement of currents was accompanied by wind and wave action that carried the fuel onto the beaches and into marinas and harbors. As a result, large quantities of oil ended up in marinas, harbors, bays and caves. MoE staff intervened during the war and was on site on the second day after the first Jiyeh bombing[195]. MoE personnel tried to contain the spill and the fire by building sand dams to prevent further oil from spilling into the sea and protect the remaining fuel tanks from the heat of the raging fire. However, these efforts were undermined by the second bombing (July 15).

Burnt and un-burnt oil residue spilled into the sea and, at least at the source of the pollution in Jiyeh, the heavy fraction of the oil precipitated to the seabed bottom after light volatiles and medium molecular weight solubles had evaporated or dissolved.

The submerged oil needed to be removed soon after the spill. With time, submerged oil becomes covered with sediment and frequently goes undetected. Winter storms and wave action can normally return the oil to the water column where it tends to re-pollute coastlines that were cleaned. Also, soon after the end of hostilities, an Italian team of experts and a Lebanese NGO, “Bahr Loubnan”, worked on assessing the damage and removing the sunken oil using a remotely operated submersible, SCUBA, and the help of local divers and fishermen.

First response and clean-up actions also started during the war in pilot form in Chekka in the North and in Beirut (Sporting Beach). But effective response only started after the cessation of hostilities (33 days after the spill) when equipment and international assistance was able to arrive.

11.1.3.1.1 Location

Many point locations were significantly impacted by the oil spill. Some of these are environmentally or commercially important spots such as: Jiyeh beach and coast, Ramlet el Baida and the area around it, Fishermen’s Warf in Beirut, Movenpick Marina, Tabarja, Byblos harbor and Byblos Sur Mer area, Batroun national protected area and vermiform terraces near the marine research center, and the Tripoli coast including the PINR.

11.1.3.1.2 Potential environmental receptors: overview of Lebanon’s coastal and marine ecosystem

Available scientific literature on Lebanon’s coastal and marine ecosystem is sparse, and the present overview is not comprehensive, but is intended to provide a broad understanding of the value of marine biodiversity in Lebanese coastal waters[196].

Lebanon’s coastal and marine ecosystem is characterized as Mediterranean with sub-tropical components. The shoreline extends 220 km, and is interspersed with 3 bays, 12 prominent headlands, limestone sea cliffs, and several small river deltas. Unusual coastal habitat types include rocky terraces covered with the mollusk Vermetes and calcareous algae (Vermetid terraces), coastal springs, and coastal dunes. The Vermetid terraces / coralline reefs are an important and unique feature of the eastern Mediterranean. These wave-resistant terraces host a diverse ecosystem consisting of brown algae, calcareous algae, encrusting sponges,

[195] The Lebanese Army, staff from EDL and Jiyeh power plant, the Civil Defense, and private contractors all supported the effort
[196] Following section was summarized by R. Steiner (2006), citing multiple sources (AMWAJ, 2003; Nader & Talhouk, 2002; and Lebanon MoA / UNEP, 2003)

barnacles, scleractinian corals, bryozoans, bristle worms, nudibranchs, anemones, sea urchins, sea cucumbers, crabs, cuttlefish, various fish species, and sea turtles. The shoreline habitat of Lebanon is approximately 20 percent sandy beach, with the remainder being rock or gravel. The continental shelf is quite narrow, with the widest part at only 12 km in the north, and is intersected by several submarine canyons. Sea surface temperature varies between 16 C in winter and 30 C in summer. Tidal range is slight, averaging from 15 cm to 30 cm, with a maximum up to 50 cm.

The marine ecosystem is not particularly productive, as it is nutrient-poor, has a narrow continental shelf, and summer wind patterns inhibit nutrient replenishment through upwelling. However, the marine system is known to be rich in biodiversity and exhibits high endemism. One recent marine conservation assessment (AMWAJ, 2003) stated the following:

> <u>The Mediterranean is one of the richest seas for biodiversity in the world since it hosts 7.5 % of the marine animal taxa and 18% of the world marine flora for an area covering only 0.7% of the world oceans. The Mediterranean infralittoral and deep flora and fauna are characterized by a high ratio of endemism</u>

Although Lebanon's marine ecosystem is not particularly well studied, it is reported to host approximately 1,685 species of marine fauna, of which at least 50 species are commercially important. Much of the marine biodiversity – 1,250 species - is found in the plankton community (small plants and invertebrate animals drifting in the water column). There are reportedly more than 300 Indo-Pacific marine species that have invaded the Mediterranean from the Red Sea subsequent to the opening of the Suez Canal in 1869. These invasive species now compete with Atlantic and Mediterranean species, and are believed to have significantly altered marine communities in the region.

The phytoplankton community off Lebanon is comprised of 227 species of dinoflagellates and some 151 species of diatoms. Benthic macroalgae (sea bed algae) include some 191 species, 29 of which are endemic to the Mediterranean. But again, overall productivity as measured by chlorophyll concentration is very low relative to other coastal seas. The zooplankton community consists of at least 747 species, and both the phytoplankton and zooplankton communities exhibit significant seasonal variation in species composition, distribution, and abundance. The benthic meiofauna community is dominated by calanoid copepods, and is thought to be important to overall marine productivity. Benthic decapods (crab, shrimp, etc.) comprise important communities on rocky bottoms at 30- 50 meters depth.

The cephalopod community (octopus, cuttlefish, squid, etc.) off Lebanon is not well studied, but the Eastern Mediterranean has at least 21 species, of which the most common off Lebanon are cuttlefish (sepia), Octopus vulgaris and Octopus macropus.

There are 357 known fish species in Lebanese waters, 59 of which are Lessepsian (migrants from the Red Sea *via* the Suez canal). Fish diversity is highly correlated with rocky bottom substrate and habitats with greater substrate complexity. Commercial fisheries land only about 6,000 tons per year, and are still mostly artisanal, using small boats near shore. Much is caught at night using lamplights. Although small in comparison to other coastal fisheries, Lebanon's marine fisheries support some 30,000 fishermen and their dependents, and thus are of socioeconomic importance to the nation.

Lebanon is not an area of high bird nesting abundance, due at least in part to over hunting and habitat degradation. But lying along a north-south migration corridor, some 250 bird species are known to migrate through the coastal zone.

Two sea turtle species – Loggerhead (Caretta caretta) and Green – are known to nest on Lebanon's beaches and feed in coastal waters. There are 19 sandy beach segments along the coast that are potential sea turtle nesting sites. Sea turtles have been observed nesting in beaches heavily affected by the oil spill, namely Ramlet el Baida and PINR.

Marine mammals found in Lebanese waters include common dolphin (the most common), striped dolphin, and bottlenose dolphin. Sperm whales have been sighted offshore on rare occasions, and the critically endangered Mediterranean monk seal has been seen on rare occasions.

11.1.3.1.3 Impact Assessment

Whenever an ecosystem is known to have a high degree of endemism as well as high species diversity, this gives rise to concern that the relative impacts on individual populations / species may be higher than normal (Steiner, 2006). That is, population-level impacts may have resulted from the oil spill. Much of the short-term, acute mortality may have gone undetected offshore due to the war and air/sea blockade. Persistent ecological impacts take time to manifest and have sub-lethal but chronic and large-scale effects. For instance, in the Exxon Valdez Oil Spill in Alaska, some fish population collapses did not occur until 3 years after the initial spill (Steiner, 2006).

It is clear that much of the shoreline ecosystem that was contaminated was heavily impacted. Impacts include significant species mortality and impairment of the function of the shoreline ecosystem. Of particular concern is the impact to Vermetid terraces / coralline communities (Steiner, 2006).

The National Centre for Marine Sciences (NCMS) is currently conducting an impact assessment and sampling on different parts of the shoreline. Some of their preliminary results indicate that microscopic intertidal organisms (patella, periwinkles, mussels, oysters, algae, meiofauna) present in sandy beaches touched by the spill such as Ramlet el Baida has been 90 percent impacted. These organisms constitute the primary prey that support commercial and non-commercial fish and are expected to lead to an acute reduction in fish larvae and adults. This would reduce available fish stocks and economically impact Lebanese fishers and workers in coastal tourism sectors.

The months of July through September are the hatching seasons for the marine Loggerhead (Caretta caretta) and Green turtles (Chelonya mydas). It is likely that these endangered species have been exposed to residual oil on beaches as well as offshore waters. Such exposure may result in mortality and/or sub-lethal effects including carcinogenesis, physiological and reproductive impairment (Steiner, 2006). It is likely that slow moving and benthic species have been the highest affected fauna at the Jiyeh power plant where the most significant amount of oil sunk to the seabed.

In general, marine birds are affected by oil spills, either by being oiled, or through acute poisoning, decrease in reproduction, or damage to the food source[197].

The bird southward migration season along the coastal zone of Lebanon started in September. Some oiled birds were observed in the PINR (Jaradi, 2006). These were reported because they happened to stop in and around a nature reserve. It is expected that others could have been exposed, yet went unnoticed as they might have stopped in unmonitored areas along the shoreline.

Impact on Palm Islands Nature Reserve

The Palm Islands Nature Reserve (PINR) was impacted by the oil spill; PINR is an archipelago of three Islands that are flat and rocky with eroded limestone pavement (Palm, Sanani and Ramkine).

Palm, the main and largest of the three islands, has a sandy beach, which is a nesting site for endangered Loggerhead turtles (Caretta caretta), and a rocky shoreline, which is a nesting site for gulls, extends from the northwest to the south of the island. Its rocky shoreline is characterized by deep crevices or gutters, which collected several tonnes of oil that semi-solidified to take the shape of the gutters and have since August stabilized around the island. The other two islands, Sanani (Figure 11.3) and Ramkin, which are mostly rocky, were also contaminated with free liquid and pasty-natured oil.

The islands are rich in terrestrial and marine biodiversity. They are a Ramsar Site, Important Bird Area and a Special Protected Area (SPA) under the Barcelona Convention. The reserve is an important breeding ground for fish. The surrounding submerged area of the reserve, whether herbaceous, sandy or rocky with crevices, is considered as unique ground for spawning fish and sponges. It also represents a resting area for rare and globally endangered migratory birds such as the White-tailed Sea Eagle *Haliaetus albicilla,* Audouin's Gull *Larus audouini* and Corncrake *Crex crex*, during their passage or wintering. It also hosted in its caves the Mediterranean Monk seal *Monachus monachus*, ranked as the sixth mammal on the list of globally endangered species. As for its flora, the reserve contains medicinal plants and other rare and endemic species.

Figure 11.3. View of Sanani Island Oiled

[197] Based on a shorebird survey conducted by Harbard and Wolstencroft (1992) to assess oil spill effects from the Gulf war along the Saudi Gulf Coast, 30,000 were found dead on the shoreline. Harbard and Wolstencroft (1992) anticipated the number of dead water birds to be in excess of 100,000 they also suspected that the breeding success of oiled birds could be reduced, impacting their future population

Other characteristics of the reserve are (PINR management plan):

- PINR is the only island in the eastern Mediterranean with breeding marine birds;
- It has several endemic plants;
- It has 83 plant species that once were widespread on the continental beach but are nowadays extinct due to demographic pressure. The plants on the islands constitute the former beach flora of Lebanon and hence are considered a significant part of the natural heritage which attracts scientists, especially that half of these species are medicinal;
- It is characterized by submerged rocks with numerous holes and crevices that constitute a good breeding ground for fish;
- It is a stop-over site for 156 migrating and wintering birds, which use the reserve for resting, sheltering, and roosting. Some of these birds are globally threatened species that deserve protection;
- It is characterized by reefs originating from fossilized organic organisms, constituting an attractive site for research studies.

The oil first hit the Islands on July 30th, 2006. The Government Appointed Committee (GAC) managing the Reserve acted immediately and initiated clean-up of the sandy beach to allow turtles to lay their eggs on uncontaminated sand. However, the committee did not have the capacity to address the heavy oil covering the rocky surfaces and filling the crevices.

Aware of its fragile ecosystem, IUCN (International Union for the Conservation of Nature) in coordination with MoE assessed the reserve in mid-August (post-war) and reported that PINR was heavily impacted by the oil spill. The Union expressed concern for the rich floral and faunal biodiversity of the islands especially in regard to the endangered Loggerhead turtles (*Caretta caretta)* and the upcoming bird migration season. It assessed that the oil filling the crevices and floating around the islands posed a continuous stress for recontamination of the sandy beaches as well as for the turtles. The semi-solid oil covering the islands posed a threat to the birds.

Concerned by the damage on the wildlife inhabiting the islands, the IUCN team, through the Oil Spill Operation and Coordination Center (OSOCC) at the MoE, provided the management committee with immediate clean-up guidelines and collaborated with the GAC and the ministry on fund-raising for a complete operation. Moreover, IUCN provided a 20,000 euro fund to start a biodiversity impact assessment on and around PINR as a pilot for more general and comprehensive coastal biodiversity monitoring following the oil spill. This project is carried out in partnership with MoE and AUB.

The Swiss Agency for Development and Cooperation responded to the proposals developed by IUCN and OSOCC and funded a clean-up operation on Palm Islands as part of a larger action along the northern coast extending from Anfeh to Tripoli.

Impact on Birds

Head of the GAC and ornithologist Ghassan Ramadan-Jaradi, reported the observation of 15 oiled birds (gulls, one curlew and one pelican) in and around Palm Islands. “Three gulls in full flight over Sanani island showed black belly and chest indicating a slight pollution. One Curlew capable of flying had oiled black feet on Ramkin island,” Jaradi wrote in a recent report dated November 19, 2006. As an example, the White Pelican (Figure 11.4) was observed to have oiled legs, tails and wings. The oiling apparently prevented the bird from flying.

Figure 11.4. Oiled Pelican Observed at Palm Islands Nature Reserve

GAC members are installing deterrents for birds on the islands by fixing unusable CDs on wooden sticks to protect the resident, wintering, and migrating species from coming in touch with the oil. The Grey Herons and the gulls that usually winter on the reserve were seen on the other unprotected small islands possibly due to the presence of many workers on the three main islands of the reserve.

Impact on plants

Rocky Salicorn and sandy Euphorb plants were contaminated on Palm and Sanani islands to the extent that some were totally covered by oil (Figure 11.5). The main affected plant species on the reserve is Sea pursulane *Halmione portulacoides*, Golden Samphire *Inula crithmoides* and Glasswort *Arthrocnemum macrostachyum*. The toxins in the oil can kill the plants, which would lead to erosion. The management committee of the reserve is trying to contain the damage by clearing only polluted parts of the plants and encouraging the process of self-regeneration in relying on the roots and the shoots. The islands were the habitat of the Rock Samphire plant, which has all disappeared off the islands except for a single plant that still remains at a two-meter distance from the oil Contamination by higher waves or a storm is possible and may drive the plant to extinction in this particular habitat.

Figure 11.5. Rocky Salicorn on Sanani

Jaradi, who is monitoring the clean-up of the islands from an ecological point of view, reported oiled crabs and the disappearance of nearly all forms of life in all areas that were subject to the cleaning process. The oil therefore is considered to have also affected a large number of mollusks and invertebrates.

Given the national scale of the impact, and the sensitive ecosystems that the oil spill has affected, the impact effect is rated serious and impact duration is expected to be long-term (10 to 50 years); the impact is classified as **severe significant**.

11.1.3.1.4 Post-conflict Initiatives

Given the magnitude of the impact of the oil spill on the marine environment, a large-scale operation was launched by MoE, which lead and coordinated the effort. The following major initiatives can be reported up to November 30, 2006:

- The Ministry of Environment mobilized an oil spill emergency response team while Lebanon was still under attack. An assessment lead and coordinated by the OSOCC and involving multiple stakeholders was carried out, which resulted in the development of criteria for prioritizing the clean-up of affected sites (criteria included economic importance, contact with humans and ecological fragility). MoE also managed to mobilize resources through REMPEC as well as from national and international bodies;

- A delegation of experts from the European Commission (Danish oil spill experts) provided technical assistance to address the oil spill and training for beach clean-up;

- IUCN provided technical advice with regard to the oil spill, assisted MOE in assessing the protected areas status and in mobilizing funds for PINR clean up, participated in the OSOCC, mobilized funding for a pilot marine biodiversity monitoring project at PINR and provided communication tools (short film and 35-minute documentary) to mobilize international response to the oil spill. More than a hundred copies of a five-minute film on oil spill were distributed by the Minister of Environment at the Stockholm Conference in August and at the China UNEP conference in October; other stakeholders involved in clean-up of PINR include the Government Appointed Committee and management team, and Swiss Agency for Development and Cooperation;

- UNEP/Office for the Coordination of Humanitarian Affairs (OCHA) supported coordination of the oil spill response through OSOCC from early August to late September 2006;

- The Regional Marine Pollution Emergency Centre (REMPEC) provided technical assistance in coordination, shoreline surveys, and response through the Centre de Documentation de Recherche et d'Experimentations sur les Pollutions Accidentelles des Eaux (Cedre)[198];

- The Italian government provided assistance through coast guards and marine biologists from the Istituto Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare (ICRAM) equipped with two vessels to address underwater pollution at Jiyeh; removal of sunken oil from Jiyeh was undertaken;

- UNDP has provided financial support for clean-up activities; resources were used notably to hire local contractors to clean certain sections of the coast or to purchase equipment;

[198] Based in Bretagne, France

- The United States Agency of International Development (USAID) funded the clean-up of the shoreline from Byblos to Anfeh;
- The Swiss Agency for Development and Cooperation funded the clean-up from Anfeh to Tripoli including PINR;
- The Lebanese NGO "Bahr Loubnan" is cleaning beaches north of Jiyeh and sunken oil at Jiyeh with the help of fishermen and divers;
- A cabinet decision appointed the National Council for Scientific Research/Centre for Marine Sciences with the responsibility of assessing the impact of the catastrophe; the center has been studying the shoreline (phytoplankton, chlorophyll A, meiofauna, nutrients etc.).
- The municipality of Qolayle (South Lebanon) supported by the Society for the Protection of Nature in Lebanon (SPNL), IUCN and Euronature declared the first marine Hima (community-driven protected area) in the country a few kilometers south of Tyre including a stretch of sandy beach hosting each year on average 70 nests of endangered Loggerhead (Caretta caretta) and Green Turtles (Chelonya mydas);
- The Canadian government is funding the clean-up of beaches north of Jiyeh up to Saadyet area.

11.1.3.2 Impact on Plants and Ecosystem from Fuel Burning in Jiyeh and Airport

11.1.3.2.1 Location

Fuel oil and kerosene fires in Jiyeh and at Beirut airport, respectively, generated significant quantities of air pollutants, which may have affected the coastal areas from Jiyeh up to Damour through deposition of contaminants.

11.1.3.2.2 Potential environmental receptors

Natural vegetation, soil and ecosystems could be impacted by the by-products resulting from the burning of fuel.

11.1.3.2.3 Impact assessment

Air pollutants from fuel combustion are known to pose adverse impacts on biodiversity. Regarding the incident induced by the war, it would be difficult to assess impact from this pollution source, since similar pollutants have been depositing on plants and natural systems for years from various other sources. Besides, the heavy rains of the month of October have most likely dispersed and washed away the pollutants from plants. Those that deposited in the soil were also partly leached by the heavy rains, making the assessment of impacts imprecise.

The impact effect is considered limited and impact duration short-term (less than 1 year), and the impact is classified as **marginal non-significant**.

11.1.3.2.4 Post-conflict Initiatives

No initiatives to further assess this impact have been reported.

11.1.4 MILITARY RELATED IMPACTS ON BIODIVERSITY AND ITS CONSERVATION

11.1.4.1 Loss of Flora, Fauna, and Degradation of Ecosystems due to Fire

Forest fires are amongst the most common effects of war. They occur as a result of direct bombing or are induced to enhance visibility on the battlefield. The Israeli Defense Force (IDF) confirmed the use of phosphorous bombs known to ignite fires, and the release of around 1,800 cluster bombs containing over 1.2 million cluster bomblets[199], which now litter the Lebanese landscape are a potential source of more fires.

Fires also occurred during war due to the mismanagement of forests since July and August are fire sensitive months. There was inability of fire engines to reach the fire areas.

Villagers are also known to induce fires to detonate and thereby clear their fields of suspected UXOs. Fires induced for the production of charcoal are an additional source, particularly after the war where heightened economic pressure combined with looser regulatory enforcement encouraged such practices.

11.1.4.1.1 Location

Based on MoA assessments, more than 100 ha of forest were subject to fires in Mount Lebanon during the war, reaching to more than 900 ha after the war. In South Lebanon, more than 800 ha of forests and other wooded land were burnt in Jezzine and Nabatiyeh cazas.

11.1.4.1.2 Potential Environmental Receptors

In addition to destroying green cover and flora, fires devastate various elements of the ecosystem from insects to higher animals. The different bio-climatic regimes of Lebanon endow it with a very rich biodiversity, both in terms of its flora and fauna. South Lebanon has a particularly important role in the diversity of the fauna in Lebanon. Along the Southern border, where hunting is less severe than in other sites, animals living on the other part of the border can cross this borderline, hence enriching the faunal diversity of the country (though mines and barbed wires claim many losses).

Furthermore, millions of birds pass over Lebanon twice a year on their migratory routes between Europe and Africa. Large numbers of birds are forced to pass in limited durations of time in this geographically restricted area, making this bottleneck one of the most dynamic systems in bird migration. At present more than 250 migrant species have been recorded including several globally threatened birds.

[199] Haaretz Online, September 12, 2006

Of particular concern are also sensitive areas such as protected areas that could be affected by fire. A notable rich ecosystem that was directly affected by fire is Jabal Rihane (may potentially become a nature and biosphere reserve), which lies in the Jezzine Caza and was bombed repeatedly (Box 11.1). It was subject to several fires; the managing NGO, Green Future, is in the process of surveying the extent of the damages and the number of hectares impacted by fire.

Equally important are reforestation areas where efforts and potentials were invested to green the region. Some of these areas are reported to be struck with fires.

Box 11.1. The Proposed Jabal Rihane Biosphere Reserve (Tohme G. *et al.*, 2004)

The proposed Jabal Rihane biosphere reserve encompasses 24 globally or locally threatened plant species (such as Aborted limodore and Anatolian orchid), 44 endemic species (half of the endemic species of Lebanon), 17 rare plant species, and 273 (38% of the Rihane plants) plant species restricted to east Mediterranean area. The forest cover includes mixed evergreen and deciduous vegetation. Superb stands of large old grown oak trees and combinations of Palestine Pistachio, Sumac and Carob trees are counted among the species. The area is an important habitat of the flora of the south-eastern Mediterranean corner with many rare species, which need to be monitored to support appropriate management.

The area proposed for the reserve is rich in wildlife, due in part to the mixed nature of the forests and the varied habitats. Numerous microclimates contribute to its biological productivity. Mammals include 34 species that are known to occur at Jabal Rihane, 11 are globally and regionally threatened (Great mouse tailed bat, Greater horseshoe, Mediterranean horseshoe, Common Pipistrelle, Kuhl's Pipistrelle, Schreiber's Bat, Wolf, Marbled polecat, Striped Hyaena, Wild cat, Hyrax and Badger); 6 are significantly declining (Natterer's Bat, Wolf, Badger Striped Hyaena, Indian Porcupine and Wild cat); none is endemic but two thirds of the Rihane mammals are species that are wholly or partially limited to the Middle East region. The Hyrax appears to be only limited in its Lebanese distribution to Rihane only. Among the 33 reptile species, only the Chameleon is considered as globally threatened whereas none of them is endemic or limited to Rihane area.

The total number of recorded bird species at Rihane is 168. The globally and regionally threatened bird species are 15 (Spotted Eagle *Aquila clanga,* Imperial Eagle *Aquila heliaca* Lesser Spotted Eagle *Aquila pomarina,* White Stork *Ciconia ciconia,* among others). However, it is worthy to note that Jabal Rihane appeared to encompass several sites that are considered hotspots for roosting, sheltering and resting of migrant birds in general and globally and regionally threatened species in particular.

11.1.4.1.3 Impact assessment

Unlike other forest ecosystems, fires are not part of the natural regeneration cycle of the Lebanese forests. The nature of the soil especially in the areas affected is generally moist and favors a rich green cover and biodiversity. Exposure to fires would lead to severe loss of biodiversity and destruction of habitats. This may in turn lead to extinction of threatened and endemic species of plants, animals and birds as well as dryness. The destruction of the seed bank would also erode the potentials of regeneration and rehabilitation of the hit area.

Fires denude forests and expose the soil to such climatic factors as rain, which may results in erosion.

The impact of fire and the shock it induces into the ecological system is considerable. The whole ecological process is regressed and the natural system retreats in its evolution and succession, surely losing the current ecological status to an uncertain combination depending on the severity of the effects of fire. Natural recovery and repair of the system would certainly depend on the extensiveness of the fire and its induced effects, as well as the existing potentials to favor such recovery. Originally disturbed systems have lower recovery potentials. In conclusion, fires impose unaccountable impacts on ecosystems where the outcomes and the rehabilitation possibilities cannot be controlled with the multitudes of variables and pressures nature in Lebanon faces on regular basis.

After effect of fires as dictated in erosion of the vegetation cover, soil and ecosystem may ultimately influence climatic conditions, pushing them toward one extreme of extended dryness. Desertification is an end result of these compounded factors. The sensitivity of the affected areas is also well represented by the example of Jabal Rihane.

Given the spatial distribution of the fires and the sensitivity of the affected areas, the impact effect is considerable and impact duration is long-term (10 to 50 years); the impact of fires on ecosystems is classified as **severe significant**.

11.1.4.1.4 Post-conflict initiatives

FAO has published a report assessing impacts of the war on forests (FAO, 2006), among others, and AFDC has initiated field surveys to quantify forest areas affected by fire.

11.1.4.2 Impact on Ecosystems, Habitats, Flora and Fauna from Military Activities

In addition to causing forest fires, military activities are a source of numerous stress factors on biodiversity. Such activities include movement of heavy vehicles, bombing, commandos work and noise, among others and their consequences.

11.1.4.2.1 Location

General impacts from military activities mainly affect the South and to a lesser extent the Bekaa.

11.1.4.2.2 Potential Environmental Receptors

Ecosystems and habitats including flora, fauna and soil, of the affected areas are the main possible receptors.

11.1.4.2.3 Impact Assessment

Direct military activities impacted various components of the natural system in South Lebanon. These are complemented with the impacts generated from the various other direct and indirect threats such as fires, dumping of demolition wastes, etc. Collectively, the diverse impacts may drive an exponential trend of degradation that cannot be discerned when impacts are discussed individually. Accordingly, the underlying detailed assessment provides a summary and a holistic picture to the compounded impact of war on the natural systems of the South. The Land Use/Land Cover Map developed by MoE is useful to tailor the various impacts to specific sites when future field assessments and monitoring activities are undertaken.

- **Modification to structure of ecosystems**

Structure of ecosystems can be affected quite adversely by military activities. Their impact may be translated into cessation and loss of the existing seral stage in the history of development of the existing ecosystem and the regression of the ecological process of succession. Associated processes as energy flow and habitat development would all be damaged and degraded. Under these pressures, the ecosystem would be forced to return to lower seral stages or more primitive developmental stages in order to absorb the imposed shock. Lower seral stages promote combinations of flora and fauna that are more tolerant to disturbance but again less specialized. Therefore, the existing seral stage and its history of development may be lost for good - a situation that requires a long time (>50 years) and much stability to overcome, before the system is set back on its track of ecological development.

- **Impairment of proper functioning of ecosystem**

The physical and biological components of the ecosystems in the affected zones were variably disrupted. The extent of damage varies with the many determinant factors at the particular site (Vitousek et al. 1997, Brooks et al. 2002, McKinney 2002, Ricketts and Imhoff 2003). On the physical environment, loss of vegetation under the various threats imposed by war activities or in the remediation and recovery phases, results in more exposure of land to the sunlight allowing more evaporation of soil moisture and enhancing soil erosion. This compounded situation is described in many war-subjected zones around the world as the main cause of post-war heavily manifested aridity trends with drier climatic conditions and exacerbated desertification.

Loss of or reduction in the density of biological components from plants to animals and insects due to the disturbance factors related to military activities, directly affects food chains and energy flow in the system. Forest fires eradicate the floral base which supports the animal community on site, as a result the latter will have to migrate to other regions if possible or the lack of energy flow will force them to reduce their numbers possibly to zero. Food chains are difficult to construct, they depend on the stability of the system over long periods of time (>50 years), their disruption is devastating for all organisms hosted by the system. Breaking down of food chains manifests in local extinction of organisms.

- **Habitat destruction**

Most studies conducted in war zones state physical destruction of habitat as a consequence of the war especially due to military machinery and explosives. Marginal lands, particularly on the side of roads, though host to pioneer species, are a region of refuge for species that are competed out of densely populated and highly shaded habitats. These areas are subject to intense pressures from the various threats discussed above. Water habitats are another example of specialized habitats that were affected by the late war. Other types of habitats might be specifically endangered or disturbed. However their identification requires field visits and exploration on the ground.

Habitat restoration, both naturally and induced, requires long periods of time (10-50 years) under conditions of high stability.

Instability to ecosystems

The various forms of disturbance discussed above and their direct as well as indirect impacts exert a collective degrading force that erodes the stability of the prevailing natural systems. A learnt and established fact is that the impact of destabilization is exponential. The more disturbance a system faces, the more aggressive will be its repair measures. Restoration of balance to the system does not start from the point of disturbance and move forward; on the contrary, the natural system inflicts further degradation to its assets in order to reach a new starting point for re-stabilization whereby all components are equally receptive and apt.

While the direct impact of a threat on faunal species is readily verifiable, so is the impact on flora and woodlands; comparatively the direct impact of destabilization cannot be readily discerned because each system reacts differently depending on the many variable factors. Its manifestation is characteristically medium to long-term (few years to >50 years). However, its recovery is certainly long-term.

It is important to recognize that threats to ecosystems cannot be treated simply as local perturbations. Their influence travels across the various functions and structures of the ecosystem in an exponential mode producing more damage than the initial action. Similarly, amelioration and re-stabilization of the ecosystem cannot be effected on a local scale, but rather must address the whole ecosystem on a larger geographical scale than the directly impacted one. For example, one cannot address the fauna that migrated from the zone of bombardment without considering the zones where it found temporary refuge and the routes of its migration back. Thus, when dealing with ecosystems, large buffer zones of no hostilities have to be integrated to absorb the adverse impacts and enhance re-establishment of stability.

Impact on flora

Most of the threats from the war may result in the eradication of the floral base. The impact is evaluated at different levels:

1. As fundamental components of ecosystems;
2. As productivity and energy providers in ecosystems;
3. As floral populations; the floristic value of this plant base is in its components and their regional distribution;
4. As rare, threatened and endemic species where the South of Lebanon can provide a sanctuary;

5. As species of medicinal and economical values that support the local communities; Table 11.1 presents a list of species that are reported to be found in South Lebanon and were likely to be affected during the war (Mouterde, 1966, 1970, 1983; MoA/UNEP, 1996; El Beyrouthy, 2002; ELARD, 2006).

Table 11.1. Key Species in South Lebanon

Botanical Name	**Status**	**Comments**
Alcea setosa (Boiss.) Alef	Very common	Medicinal, ornamental
Ammi visnaga (L.) Lam.	Scarce	Medicinal
Arbutus andrachne L.	Overcollected	Ornamental species
Astragalus berytheus Boiss. & Blanche	Endemic Levantine and rare	
Calamintha incana (Sibth. & Smith) Boiss.	Localized, Overcollected, Oriental Mediterranean	Medicinal
Ceratonia siliqua L.	Common, Overcollected	Priority target species in conservation efforts in Lebanon. Economical value, medicinal and food species
Cercis siliquastrum L.	Common	Ornamental
Cichorium intybus L.	Common	Medicinal + edible
Crateagus monogyna Jacqu.	Common	Medicinal
Crithmum maritimum L.	Threatened	Edible
Eryngium creticum Lam.	Very common	Edible
Euphorbia paralias L.	Very localized	-
Foeniculum vulgare Mill.	Common	Medicinal
Glaucium flavum Crantz.	Common	Medicinal
Inula crithmoides L.	Localized	Edible and medicinal properties
Laurus nobilis L.	Common	Medicinal and aromatic species
Matthiola crassifolia Boiss. & Gaill.	Endemic to Lebanon, Localized	Ornamental
Micromeria sp.	Common + overcollected	Medicinal
Myrtus communis L.	Common	Medicinal
Nasturtium officinale R. Br.	Threatened	Edible + Immerged in water places at least at its base

Botanical Name	**Status**	**Comments**
Origanum syriacum L.	Overcollected	Medicinal
Pancratium maritimum L.	Rare, threatened at national level	Cut by local people, sandy shore species or marine habitat species
Paronychia argentea L.	Common	Medicinal
Pinus brutia Ten.	Common	-
Pinus halepensis Miller	Not very common	-
Pinus pinea L.	Common	Priority target species in conservation efforts in Lebanon. Economical value
Pistacia palaestina Boiss.		Medicinal
Quercus calliprinos Webb.	Common	Economical value, fuel plant
Salsola kali L.		Economical value
Salvia fruticosa Miller.		Medicinal
Salvia sclarea L.		Economical value
Satureia thymbra L.	Common + overcollected	Medicinal + edible
Silene sedoides Poir.	Not very common	-
Spartium junceum L.	Common	Medicinal
Styrax officinalis L.		Fish poison, economic value
Urginea maritima L.	Common, overcollected	Economical value
Vitex agnus-castus L.		Medicinal

The recovery of plant populations is a medium to long-term process depending on the extent and type of threat and the stability of ecological conditions.

Also craters resulting from the bombing expose lower substrates and bedrock, which are unsuitable for plant growth, while original soil layers are dissipated[200].

The impact on floral populations is generally reversible given the availability of temporal and conditional requirements to possibly irreversible when the genetic diversity is impaired.

200 Conachy (1999) stated that studies of war sites in Yugoslavia indicate that not only the craters are unusable, but so is the land around them. Natural regeneration of the upper layers of the soil could last thousands of years. It takes from 1,500 to 7,400 years for nature to produce a 20-centimetre thick upper layer of soil. Within 100 years, the surface layer of soil naturally grows only 0.5-2 cm

Impact on fauna

Wars have negative effects on fauna through direct bombing of fauna, the destruction of habitat, and presence of cluster bombs that limit movement among others.

In South Lebanon, since the Israeli invasion in the 80's, the land was not used intensively mainly because of the threat that people were facing due to the presence of the Israeli army which was later replaced by the Lebanese Resistance Forces that used this land as a base for their resistance against the Israelis. This situation resulted in a no-man's area and the agricultural land was transformed into a wild one providing a larger habitat for wild animals to roam around. It is expected that wildlife in that area is in a better condition than that in the other Governorates of Lebanon. However, studies or baseline surveys on the fauna in the South are rare.

On the other hand, modern wars are typically associated with detrimental effects on wildlife and wildlife habitats through direct or indirect effects. Direct effects include:

1. The use of military vehicles and tanks that enter forests and wild areas cause the destruction of habitats, dens and resting places for wild animals;
2. The use of weapons and bombing results in:
    - Death or injury of animals in their vicinity;
    - Destruction of wild habitats that the animals occupy and depend on for their survival; such as other animals and plants as their essential food requirements;
    - Outbreaks of forest fires over large areas in a short time span, leaving wild animals exposed to danger and with no shelter, which will result in abandoning the affected areas for safer regions;
    - Disturbance in the natural balance.
3. Mines and cluster bombs explode when touched or stepped on by animals, which causes injury or death;

Indirect effects would include:

1. Illegal hunting and over harvesting of wild animals due to absence of law enforcement. Many of the recorded extinctions that have occurred since 1600 were a direct result of over-kill, which is one of the most important threats to wild animals (Diamond and Case 1986, Atkinson 1989, Reid 1992, Bodmer et al. 1997, Shively 1997);
2. Conflict with people: The movement of human settlements into wild areas decreases food availability. Wild animals may turn to crops and livestock, which puts them under direct threat by people. Fearing wildlife, people may hunt the animals to the point of threatening their survival.
3. The deficiency of shelter due to forest fires which will expose the wild animals to more open areas, making them an easy target for hunting.

To address the negative impact of the direct and indirect military threats, it is important to understand that the loss of any animal means the loss of its contributions to increase or maintain its population through its reproduction over its adulthood. The recovery of its population and the potential to overcome losses requires a long time especially in animals with life spans of 10 or more years. Several generations surviving under stable ecological conditions in appropriate habitats are needed for recovery, a condition that does not exist in Lebanon especially in the South under the current situation as well as in the recovery phase.

- **Impact to avifauna**

As the conflict took place outside the breeding and migrating seasons, the impact of this is believed to be limited to migratory bird species. However resident bird populations could have been adversely affected as well.

The environmental consequences of war are most likely sensed across the damages caused to ecosystems and bird habitats. The destruction of ecosystems due to war can lead to the extinction of many species; especially those threatened, near threatened or endemic. War conflicts may have caused irreversible damages to the natural environment causing deterioration to the whole ecosystem, where inflicting harm to a certain species can influence the whole balance of an ecosystem, consequently affecting the whole food chain.

Damages caused to habitats and food resources could pose detrimental effects, either directly on the birds, or indirectly through their roosting, breeding or feeding habitats. Effects may include disruption of normal flyways, change in behavior, decrease in reproduction, or even extinction.

- **Impact on reforestation initiatives**

The South witnessed a number of reforestation campaigns under the management of the MoE. The reforested zones signify areas that were selected, prepared and forested investing efforts and finances at all levels from preparatory phases to full implementation. These areas were variably impacted, some directly but mostly indirectly. The indirect impact comprises the inability to reach the sites to water or manage or even plant the prepared seedlings. The resulting damage could be limited or exponential depending on the progress phase at the site. When seedlings could not be watered, this means the loss of the seedlings and all the preceding preparatory and growth phases from nurseries to planting.

Military activities have a serious effect on biodiversity, including ecosystems, habitats, flora and fauna and impact duration is long-term (10 to 50 years); the impact is classified as **severe significant**.

11.1.4.3 Indirect Impact on Nature Reserves and Himas

Then IUCN assessment showed that direct species impact was most pronounced at PINR, which was seriously oiled as a result of the bombing of the Jiyeh power plant and subsequent oil spill. The other reserves and Himas were mainly impacted due to the interrupted management, monitoring, and halt of activities and visits thus interrupting revenues and disrupting the community development programmes in most of them. This greatly affects the sustainability of these sites, financially and ecologically.

Management issues are critical for effective conservation especially in times of war and crises when chaos prevails and the need for law enforcement increases. Lack of management capacity may expose species living in fragile ecosystems to extinction. Two types of conservation systems are practiced in Lebanon: government run protected areas and community managed protected areas better known as Himas. Both have biodiversity importance, and hence the relevance of looking at war impacts affecting them.

11.1.4.3.1 Location

Following nature reserves and Himas were directly or indirectly affected by the war: Tyre Nature Reserve, Shouf Cedar Nature Reserve, Palm Islands Nature Reserve and Ammiq Wetland, Ehden Forest Nature Reserve, Hima Anjar / Kfar Zabad, Hima Ebel es-Saqi.

11.1.4.3.2 Potential Environmental Receptors

Lebanon's protected areas are ecologically representative of the diverse ecosystems that endow the country with diverse habitats from marine to sub-alpine. They are the last place in which there still remains a trace of the once widely existing biodiversity of insects, plants, animals and birds. Lebanon's protected areas are home to several globally threatened species. Several are internationally recognized Important Bird Areas. There is also a Biosphere Reserve, Specially Protected Area and Ramsar sites.

11.1.4.3.3 Impact Assessment

The indirect impacts of the war on Lebanon's different protected areas varied from site to site based on the reserve's habitual number of tourists and dependence on revenues from tourism and community development projects. The main impacts on the different reserves and himas are described in the following paragraphs (Palm Island was covered in previous sections).

- **Tyre Coast Nature Reserve**

The Tyre Coast Nature Reserve, a Ramsar site, falls within the war affected zone in the South of Lebanon. IUCN's rapid assessment report confirms that the reserve and its vicinity were not shelled, thus biodiversity was not directly impacted nor the natural ecosystem directly threatened. However, conservation and management activities were surely impaired and halted for about two months. The GAC was heavily involved in relief rather than conservation activities (monitoring, management) and the reserve was completely abandoned. The abandonment of the reserve, as a result of the war prevented two main activities of nesting turtle monitoring as well as tourism activities (swimming) that used to bring to the reserve considerable revenue necessary for sustainability. In this sense, the reserve lost a promising eco-tourism season as well as an important ecological monitoring season. On the other hand, it was reported that due to the damages to the water network, citizens were illegally over- pumping water from the Ras El Ain ponds of the reserve.

- **Hima Ebel es-Saqi**

Declared an IBA in 2005, Hima Ebel es-Saqi lies in the south of the country, at an altitude of 764 m on the continuation of the Rift valley, a well documented migratory flyway for soaring birds (60,000 cranes being sighted in the Spring of 2005). It consists of publicly owned unnatural coniferous woodland, scrubland with rocky outcrops, Hasbani River and its ecotone and agricultural land. 137 bird species have been recorded there, out of which 7 are globally or regionally threatened. Negative impact on soil crust and vegetation from deployment of troops and development of infrastructure were noticed. Also the war undermined motivation for conservation, impaired tourism, and management as many stakeholders deserted the village. Other impacts include:

- Excessive hunting of all species of birds
- Anti-personnel mines, and cluster bombs
- Goat grazing increased into the forest
- Firewood collected from the pine forest
- Eco-tourism especially B & B affected adversely
- Excess military presence at two sites, negative effect is (two fold):
  - B&B + eco-tourism
  - Spanish UNIFIL troops are based next to Hima Ebel es-Saqi in a very important feeding, staging and roosting site for falcons, regionally and globally threatened
- Lost harvests due to security reasons and market access (cut of roads).
- Military troops negative impact on soil crust, vegetation from deployment and development of infrastructure
- Possible disturbance to globally and regionally threatened species, because of high military presence and related activities. This is evident at the Spanish troops site next to the Hima, especially during peak migration of birds of prey migration (very important feeding and staging site)
- Affected local farmers, especially in the olive groves zone

Al-Shouf Cedars Nature Reserve

The Al-Shouf Cedars Nature Reserve and Shouf Biosphere Reserve is one of the most successful conservation areas in Lebanon with advanced programs in the area of biodiversity conservation, protected area management, co-management with local communities and livelihood projects, ecotourism and education and awareness programs for the Lebanese public and schools.

During the war the Reserve was bombed in a number of sections and management was constrained during this period. However, the main challenges facing this protected area (as in others in Lebanon) are related to survival of its key programs. The rural development program, which raises income for more than fifty families living around the reserve from hand-made naturally processed foods like jams, honey, and distilled rose water, was equally affected as the number of tourists and hence consumers of such products declined. This program raised 50 million Lebanese pounds for these families last year alone. The program not only creates jobs for the local community but also rallies their support for conservation.

IUCN also noted in its assessment that violations of accepted grazing zones occurred due to the post-war chaos and looser enforcement. The fire in the neighboring oak forest of Mazraat Bhomray is also the result of post-war chaos.

Ammiq Wetland

The wetland, and IBA and Ramsar site, falls on the outskirts of the hit zone. Ammiq wetland is the largest remaining, well preserved and managed wetland in Lebanon, lying at an elevation of 865 m on the western boundary of the Bekaa Valley, fed by springs rising from the eastern slopes of Al-Shouf Cedar Nature Reserve that borders the western limit of the Ammiq area. The wetland represents a sub-alpine habitat, hosting an astonishing array of plants and animals, and is an important staging post for breeding and migrating birds. It could be snow covered from late December well into March. So far, 246 birds and 22 mammal species have been recorded making this marshland area one of the most diverse in Lebanon, including 5 globally threatened bird species, based on data from SPNL. The war impact on the wetland is not direct, however its mobile assets from birds and fauna could have been indirectly affected by the noise of bombs and military air fighters that were almost constantly flying over the Beqaa valley. The wetland could also have constituted a shelter for fauna fleeing from the directly hit zones from the South. Conservation activities were halted during the war period, which disrupted the accumulation of data, monitoring and various inputs.

Horsh Ehden Nature Reserve

Horsh Ehden Nature Reserve is considered the most balanced Mediterranean forest ecosystem in Lebanon. It is situated at an altitude of 1,200-2,000 m on the upper northwestern slopes of Mount Lebanon. The reserve is rich in biodiversity based on its management plan (2000-2005). Studies have shown this forest to be a haven to a number of threatened bird species including Imperial Eagle among the 148 bird species recorded in this IBA. Impacts include:

- Loss in eco-tourism
- Poor enforcement (increase in hunting)
- Vehicle activities in the buffer zone
- Scientific research and monitoring disrupted

Hima Anjar/ Kfar Zabad Wetlands

The Kfar Zabad/Anjar area was declared an IBA in 2005, and is constituted of a mixture of marshland, water springs, riparian woodland, three pine woods and agricultural land, located on the east side of the Bekaa Valley at an altitude of 850 m. 123 bird species have been recorded here including 4 endangered species. Disturbance, resulting from war-related chaos such as tree cutting, to resident and migrating birds including globally threatened species such as Syrian Serin was noted. Impacts include:

- Extensive water extraction
- Increase in solid waste disposal including pesticides containers

- Increased grazing affecting resident bird populations
- Human abuse of Hima and facilities
- Increased hunting
- Disturbance to globally threatened and restricted range breeding birds such as Syrian Serin, the breeding site in Anjar. (cutting of trees)
- Displaced 120 families adding pressure on resources and families, farmers of Kfar Zabad
- Lost harvests due to security reasons and market access (affected by bombing of roads)
- Management by SPNL staff, and in the process of building capacity for local management.

Given the number of sensitive sites affected directly or indirectly by the war, the impact is considerable and its impact duration is medium-term (1 to 10 years) as impacts are mainly indirect; impact is classified as **critical significant**.

11.1.4.3.4 Post-conflict Initiatives

- PINR is drawing interest as part of the areas contaminated by the oil spill. Clean-up activities, damage assessment, and further activities are either contracted, already taking place, or provisioned;

- IUCN is trying to secure quick funds to support administrative costs mainly for Shouf Cedar Nature Reserve;

- IUCN supported Hima Kfar Zabad during and post war through mobilizing relief for the displaced populations through its member SPNL.

11.1.4.4 Impacts from War-induced Leniency in Law Enforcement and Control

Post-conflict periods generally manifest an aggravation of disturbing activities mostly due to chaos and impairment of normal functioning of institutions and in response to socio-economic pressures of the war. Infringement on natural landscape by construction and road cutting or rehabilitation, logging, firewood collection, uncontrolled grazing, charcoal production, hunting, collection of plants of particular uses are some of the activities that would induce further disturbance to ecosystems and degrade the plant base.

Several protected area managers reported that law enforcement institutions such as the internal security forces and the police are key in helping in the control of violations on natural resources. Impaired function of these institutions thus greatly threatens conservation of natural resources.

11.1.4.4.1 Location

This impact applies to the entire country.

11.1.4.4.2 Potential Environmental Receptors

Protected areas, forests and woodlands, sensitive sites, birds, mammals are all impacted by leniency in law enforcement.

11.1.4.4.3 Impact Assessment

Impact depends on the extent and magnitude of threats. The situation on the ground is proving to be extensive. Several managers of protected areas and local environmentalists reported that the post-war period was the worst in the history of over-kill and illegal hunting. In addition to uncontrolled grazing greatly, these pressures may expose fragile and threatened plant, mammal, and bird species to extinction. Both faunal and floral ecosystems and populations required very long time periods to recover.

The negative impact generated by such a surge on resources would in turn reflect negatively on the livelihood and socio-economic status of the beneficiaries from those resources. The ecological long-term benefits and sustainability of use of resources is greatly impaired.

Impact resulting from leniency in the enforcement of legislation is considerable since it affects sites all over the country and impact duration is medium-term (1 to 10 years); impact is classified as **critical significant**.

11.1.5 DIRECT AND INDIRECT IMPACTS ON CONSERVATION SITE AT MANSOURI, TYRE

The Mansouri site was selected to be included in this study given its unique model of endangered marine turtle conservation activity, which was halted because of the war. Mansouri is a village located south of Tyre that came under severe military attack during the war. Mansouri is home to an important site for the conservation of two species of marine turtles, Loggerhead *Caretta caretta* and Green *Chelonya mydas.* The site is a 1.25 km stretch of sandy beach managed by two conservationists running in parallel an eco-tourism business, a bed and breakfast facility called “The Orange House”, to financially sustain their conservation operation. The latest scientific study conducted for the population status and conservation activities on sea turtle nesting beaches in South Lebanon in 2005, conducted in collaboration with MoE, RAC/SPA, MEDASSET and MedWet, identified 51 loggerhead turtle nests in Al Mansouri (Cross *et al*., 2006). A recent survey conducted by IUCN last July reported over 70 nests, the highest recorded number even among protected areas (Tyre Coast Nature Reserve and Palm Islands Nature Reserve). Part of the beach is under the authority of Qolayle municipality, which recently declared its coastal zone (4 km) including the marine turtle nesting site, a Hima, through a municipal council decision.

The Orange House

The two women running the Orange House are marine turtle conservationists actively engaged in conservation through the protection of nests with mesh wire from foxes and other predators. They also aid hatchlings reach the sea on a daily basis during the hatching season.

11.1.5.1.1 Location

The site is located in Qolayle/Mansouri coastal area, south of Tyre.

11.1.5.1.2 Potential Environmental Receptors

The endangered Green and Loggerhead turtles are negatively affected. These species are on IUCN's Red List of endangered species.

11.1.5.1.3 Impact Assessment

Direct bombing destroyed one known marine turtle nest. Although this is not a major loss compared to the other nests unaffected by direct bombing, indirect impacts affected the conservation of these species. The turtles that succeeded to hatch may not have survived due to the spill if they headed north in the direction of the spill[201]. Moreover the Orange House was bombed five times and partially destroyed posing a greater financial burden on conservation efforts, affecting the ability to purchase equipment (mesh wire) and carry on training activities. Furthermore, the war started at the peak turtle hatching season and the conditions prevented the conservationists from going out to the beach to perform their daily job of physical protection and monitoring. The conservationists were finally forced to leave the site 10 days into the war, leaving the nests exposed to predators.

The impact is limited, given its site-specificity although the ecological importance is high and impact duration can be long-term (10 to 50 years); the impact is classified as **critical significant**.

11.1.5.1.4 Post-conflict Initiatives

IUCN, SPNL and Euronature are trying to assist the Municipality of Qolayle and the marine conservationists in the establishment of the marine Hima. However, further funds need to be mobilized.

[201] Personal communication with Mona Khalil, conservationist

11.1.6 SUMMARY OF IMPACT ASSESSMENT ON BIODIVERSITY

The impacts on biodiversity are summarized in Table 11.2 and include 8 significant impacts, 4 classified as severe and 4 critical.

Table 11.2. Summary of Impacts on Biodiversity from the War

Impact	Impact Effect	Duration	Severity/Significance
1. Degradation of floral base and ecosystems from demolition waste disposal	Serious	Medium- to long-term (1 to 50 years)	Severe Significant
2. Impact on natural resources from quarrying	Considerable	Long-term (10 to 50 years)	Severe Significant
3. Impact on marine biodiversity from oil spill from Jiyeh power plant	Serious	Long-term (10 to 50 years)	Severe Significant
4. Pollution to plants and ecosystem from fuel burning in Jiyeh and airport	Limited	Short-term (less than 1 year)	Marginal Non-Significant
5. Loss of flora, fauna and degradation of ecosystems due to fires	Considerable	Long-term (10 to 50 years)	Severe Significant
6. Impact on ecosystems, habitats, flora and fauna from military activities	Serious	Long-term (10->50 years)	Severe Significant
7. Indirect impacts on nature reserves and himas	Considerable	Medium-term (1 to 10 years)	Critical Significant
8. Impact from Leniency in law enforcement or control over disturbing activities	Considerable	Medium-term (1 to 10 years)	Critical Significant
9. Direct and indirect impact on conservation of site at Mansouri	Limited	Long-term (10->50 years)	Critical Significant

11.2 ENVIRONMENTAL ACTION PLAN

The impacts resulting from demolition waste disposal and quarrying are addressed in the construction chapter. Remaining impacts are addressed in this environmental action plan.

11.2.1 ASSESSMENT OF DAMAGE TO MARINE ECOSYSTEMS AND BIOTA, MONITORING OF RECOVERY AND PROPOSING A SET OF WATER QUALITY STANDARDS FOR POST CONFLICT LEBANON (DRAFT PROPOSAL)

11.2.1.1 Problem Statement and Rationale

During the period of July 13th – 15th 2006, approximately 15,000 m^3 of heavy fuel from the Jiyeh power plant spilled into the sea. The fuel contaminated about 150 km of coastline north of the spill site, extending well into the Syrian coast. At the source of the spill, a quantity of precipitated to the seabed following evaporative weathering of surface slicks.

Although Lebanon's marine ecosystem is not particularly well studied, it is known to be rich in biodiversity and exhibits high endemism. Approximately 1,685 species of marine fauna are reported in Lebanon of which at least 50 species are commercially important. Much of the marine biodiversity – 1,250 species - is found in the plankton community (small plants and invertebrate animals drifting in the water column). There are 357 known fish species in Lebanese waters, 59 of which are introduced. Fish diversity is highly correlated with rocky bottom substrate and habitats with greater substrate complexity. Commercial fisheries land only about 6,000 tons / year, and are still mostly artisanal, using small boats near shore. However, small as they may be in comparison to other coastal fisheries, Lebanon's marine fisheries support some 30,000 fishermen and their dependents, and thus are of socioeconomic importance to the nation.

In addition to a substantial marine faunal and floral treasure, Lebanon boasts a significant richness in birds. The country lies along a north-south migration corridor and more than 250 bird species are known to migrate through its coastal territory. Many of these spend some time during their migration on Lebanon's coastal areas and small islands. Additionally, two sea turtle species – Loggerhead (Caretta caretta) and Green – are known to nest on Lebanon's beaches, and feed in coastal waters. There are 19 sandy beach segments along the coast that are suitable for sea turtle nesting. Marine mammals found in Lebanese waters include common dolphin (the most common), striped dolphin, and bottlenose dolphin. Sperm whales have been sighted offshore on rare occasions, and the critically endangered Mediterranean monk seal has been seen on rare occasions, most recently at PINR.

The high degree of endemism as well as high species diversity gives rise to concern that the relative impacts on individual populations / species may be higher than normal. That is, population-level impacts may have resulted. Much of the short-term, acute mortality may have gone undetected offshore due to the war and air/sea blockade. Furthermore, spill ecological injuries are often sub-lethal, chronic effects that take time to manifest themselves.

It is clear that much of the shoreline ecosystem that was contaminated was heavily impacted. The impact has clearly included significant mortality and impairment of the structure / function of the shoreline ecosystem. Of particular concern with shoreline oiling is the impact to Vermetid terraces / coralline reef communities. The southward migration of birds started in September along the coastal zone of Lebanon. Some of these birds have been exposed to large amounts of oil remaining on the shoreline such as in Palm Islands.

The war months of July and August, when oil pollution was at its maximum, coincided with the hatching season for the Loggerhead (Caretta caretta) and Green turtles (Chelonya mydas) (July through September). It is likely that these endangered species have been exposed to residual oil on beaches as well as offshore waters. Such exposure may result in acute mortality and/or sub-lethal effects including carcinogenesis, physiological and reproductive impairment.

It is likely that slow moving and benthic species have been the highest affected fauna at the Jiyeh power plant where the most significant amount of oil sunk to the seabed. Moreover, reports from the National Council for Scientific Research (NCSR) indicate that impact on inter tidal organisms including patella, periwinkles, mussels, oysters, algae, terrace environments, meiofauna, etc has been significant in areas such as Ramlet el Baida, Beirut's last remaining public beach. These organisms constitute the primary prey that support commercial and non-commercial fish and are expected to lead to an acute reduction in fish larvae and adults. This will clearly reduce available fish stocks and economically impact Lebanese fishers and workers in the coastal tourism sectors.

Water pollution does not restrict its detrimental effects to marine biota. Human health was also possibly affected by the recent events. War damages affected waste disposal facilities, chemical factories, sewage treatment plants and buildings. Pollution from all these sources affects the coastal environment and will ultimately affect human health. It is imperative that the potential effects of pollutants be assessed and monitored over the short and long term to ensure the health of seafood consumers and recreational visitors to beaches as well as develop mitigation protocols for the Lebanese coastline.

Objectives of the present action plan are:

1- To study the Lebanese marine ecosystem more thoroughly to better understand coastal ecological communities and assess potential impacts of the pollutants;

2- To assess pollutant levels due to war in environment and biota. Effects include those related to the oil spill, explosive chemicals, and waste disposal, among others;

3- To design and implement a monitoring program to assess dilution, bioaccumulation and biomagnifications of pollutants resulting directly or indirectly from the war;

4- To identify additional measures required to rehabilitate the marine environment following the clean-up operations;

5- To prevent further degradation to the marine environment by remnant oil patches, demolition waste disposal and/or over exploitative fishing as fishermen try to compensate for economic loss;

11.2.1.2 Proposed Activities

The following activities are proposed:

1. Support OSOCC in evaluating the overall clean-up operation and identifying remaining sites to be cleaned to avoid risk of further environmental degradation;
2. Additional cleanup of contaminated sites in the ecosystem using bioremediation, mechanical removal, and other suitable means, of contaminants not otherwise removed during the spill response, the presence of which may impair the recovery of affected resources (the need for additional cleanup should be assessed in coordination with the OSOCC);
3. Carry out a full marine biodiversity assessment including a census of benthic, fish and mammal diversity, distribution, and abundance;
4. Identify important coastal and marine habitats and develop a map using Geographic Information Systems (GIS), relating species to their habitats;
5. Analyze and map point source pollutant influx into the marine ecosystem;
6. Conduct awareness activities with fishermen to promote sustainable fishing;
7. Build capacity of the coastal guard to enforce fishery and wildlife related regulations;
8. Find alternative economic opportunities for fishermen like ecotourism or aquaculture;
9. Develop and implement monitoring plan to evaluate long term effects of the war on ecosystem revival and toxin removal from the system;
10. Adopt coastal water quality standards (coliform counts, Vibrios, PAHs, PCBs, heavy metals, nutrients, DO, suspended solids etc.) from other countries and adapt them to Lebanese coast;
11. Design a "rapid assessment" monitoring plan that can be used by decision makers in a timely fashion to decide on beach closure, pollutant sources, and mitigation procedures;
12. Conduct risk assessment for future spills and develop a robust contingency plan for Lebanon.

11.2.1.3 Institutional Aspects

Main authorities responsible are Ministry of Environment, Ministry of Agriculture, NCSR, academic institutions; international organizations such as IUCN can play an important role in such an intervention.

11.2.1.4 Budgetary Estimate

The budgetary estimate for this intervention is **USD 1,500,000**. Budget breakdown is as follows:

1. Collect data and develop GIS map	25,000 $
2. Perform biodiversity survey and collect samples	50,000 $
3. Analyze 3600 samples @ $200/sample (all parameters included)	720,000 $
4. Develop water quality standards	5,000 $
5. Design rapid monitoring plan and instruct policymakers	15,000 $
6. Long term monitoring with lab analysis (100,000 / year for 3 years)	300,000 $
7. Support activities	385,000 $

11.2.1.5 Timeframe

Proposed timeframe is as follows:

1. 6 months to collect data and develop GIS map.
2. 1 year to analyze sites and develop monitoring plan and water quality standards.
3. 3 years of long-term monitoring

11.2.2 REMEDIATE DAMAGE TO MARINE ECOSYSTEMS AND FISHERIES: CREATING MARINE PROTECTED AREAS AND ARTIFICIAL REEFS USING WAR RUBBLE AND DECOMMISSIONED MILITARY VEHICLES (DRAFT PROPOSAL)

11.2.2.1 Problem Statement and Rationale

The recent conflict destroyed large numbers of buildings, fishing harbors, and military vehicles. Furthermore, the catastrophic oil spill at Jiyeh destroyed marine habitat and large swathes of breeding grounds for invertebrates, fish, and marine turtles. Bombs that landed in the sea killed large numbers of fish and most probably destroyed meroplanktonic stages, affecting future fisheries. All this results in two further detrimental processes: First, remaining fishermen may need to work harder to catch what is left to make a living, which takes the fishery past sustainable harvest limits. Second, some of the rubble was dumped into the sea illegally by people trying to rebuild, which spread silt and clay over large areas and may have suffocated the benthic organisms that survived the war. Past research worldwide has proven that one of the most effective tools in restoring and conserving marine resources and rejuvenating an over-exploited fishery along a coastline is to designate marine protected areas (MPAs) and construct artificial reefs in them where needed. These artificial reefs have the additional benefit of attracting tourists and divers who can observe without harvesting. These divers hire boats from fishermen, seek accommodation in local hotels, and make use of local restaurants and bars, thus helping the local economy as a whole.

The current proposal aims at using part of the war rubble and decommissioned army transporters and tanks to construct artificial reefs with potential beneficial impacts on the marine environment and specifically on fisheries. Fisheries and fishermen have been largely affected by the oil spill that originated from the Jiyeh fuel storage tanks and the bombing of harbors. Creating MPAs and artificial reefs through the use of damaged vehicles, and other wastes can be a technically sound option to mitigate a waste problem while creating an important environmental service and helping to alleviate poverty. The Lebanese army and navy, through the chief of armed forces and the head of the navy, have already given their support for such a project and may help by providing decommissioned vehicles and protection against illegal fishing in all areas that are to be designated as MPAs.

11.2.2.2 Proposed Actions

1. Environmental and socio-economic feasibility studies to assess the potential environmental & socio-economic impacts of this option and confirm its adequacy to the Lebanese context, especially given the favorable marine conditions from both physical and ecological aspects.

2. Identification of potential sites to construct artificial reefs with background information on legitimate marine activities and local/international institutional liabilities.

3. Baseline studies and data acquisition to provide benchmark data such as water depths (maximum, minimum, mean); influence on stratification; tidal period; direction and velocity of residual currents; wind and wave characteristics; etc. for the subsequent monitoring of the effects of an artificial reef on the marine environment.

4. Preparation of a national artificial reef construction program.

5. Design and implementation of a communication and awareness campaign on the positive impacts of the project. Organization of town meetings to educate stakeholders on benefits of MPAs.

6. Contracting of specialized company to collect and fully clean/process and prepare rubble and military hardware for deployment.

7. Implementation of short, medium and long-term monitoring program to verify whether the management objectives are fulfilled and the anticipated net benefits materialized:

   - The monitoring program should be aimed at establishing and assessing the environmental impacts and/or conflicts of the artificial reef construction with other legitimate uses of the maritime area or parts thereof such as transportation or fishing.

   - Monitoring of local fishery stocks, marine water quality, and movement of material used in construction of artificial reefs

   - Creel and fishery survey over several years to quantify the effect of MPAs.

11.2.2.3 Institutional Aspects

Main institutions are Ministry of Public Works and Transport, Ministry of Environment, Ministry of Agriculture (fisheries).

11.2.2.4 Budgetary Estimate

Budgetary estimate for this intervention amounts to **USD 475,000**. Budget breakdown is as follows:

1.	Environmental and socio-economic feasibility study	10,000 $
2.	Preparation of National artificial reef construction program	15,000 $
3.	Identification of sites and awareness campaign including town hall meetings with local stakeholders	50,000 $
4.	Collection and clean-up of reef material	100,000 $
5.	Program implementation (delineation and marking of reef areas, transportation and submersion of vehicles/wastes)	150,000 $
6.	Monitoring (over six years, includes pre-reef construction, fishery survey, and post construction)	150,000 $

11.2.2.5 Timeframe

The proposed timeframe is as follows:

1. 1 year for implementation
2. 2-year biodiversity monitoring
3. 3 more years for fishery survey

11.2.3 MITIGATING IMPACT OF WAR AND POST WAR THREATS ON BIODIVERSITY IN SOUTH LEBANON (DRAFT PROPOSAL)

11.2.3.1 Problem Statement and Rationale

The floral base and ecosystems in the South of Lebanon have national and regional significance that stems from their floristic origin and their importance to preserve soil and halt the advancement of desertification in a dry region. The floral base is also rich in species that have medicinal and economic virtues that would support the livelihood of the local communities especially if well managed. The ecosystems provide hosting grounds for a diversity of fauna and resting grounds for almost all of the migratory birds that cross on the migratory route southward.

Prior to the July-August war, all these natural assets were subjected to intense pressures particularly caused by prior years of wars and invasions. However, the diversity of threats generated by the recent war and the post-war restitution has aggravated degradation factors, weakening the vigor and tolerance of the natural systems and their components. This places the natural systems in the South at a critical turning point in their survival and ability to perform their functions, which becomes more crucial when envisaged with the uncertainty of future stability or suppression of threat sources. The path to react to this situation unfolds three alternatives:

A. *Do Nothing option*: proceed as prior to the war. However, Lebanon was not addressing the significance of the natural systems and biodiversity in the South, which is a must due to their national importance. Instead the natural assets were disregarded and the socio-economic benefits of their investment, which form a sustainable approach to support local communities, were wasted.

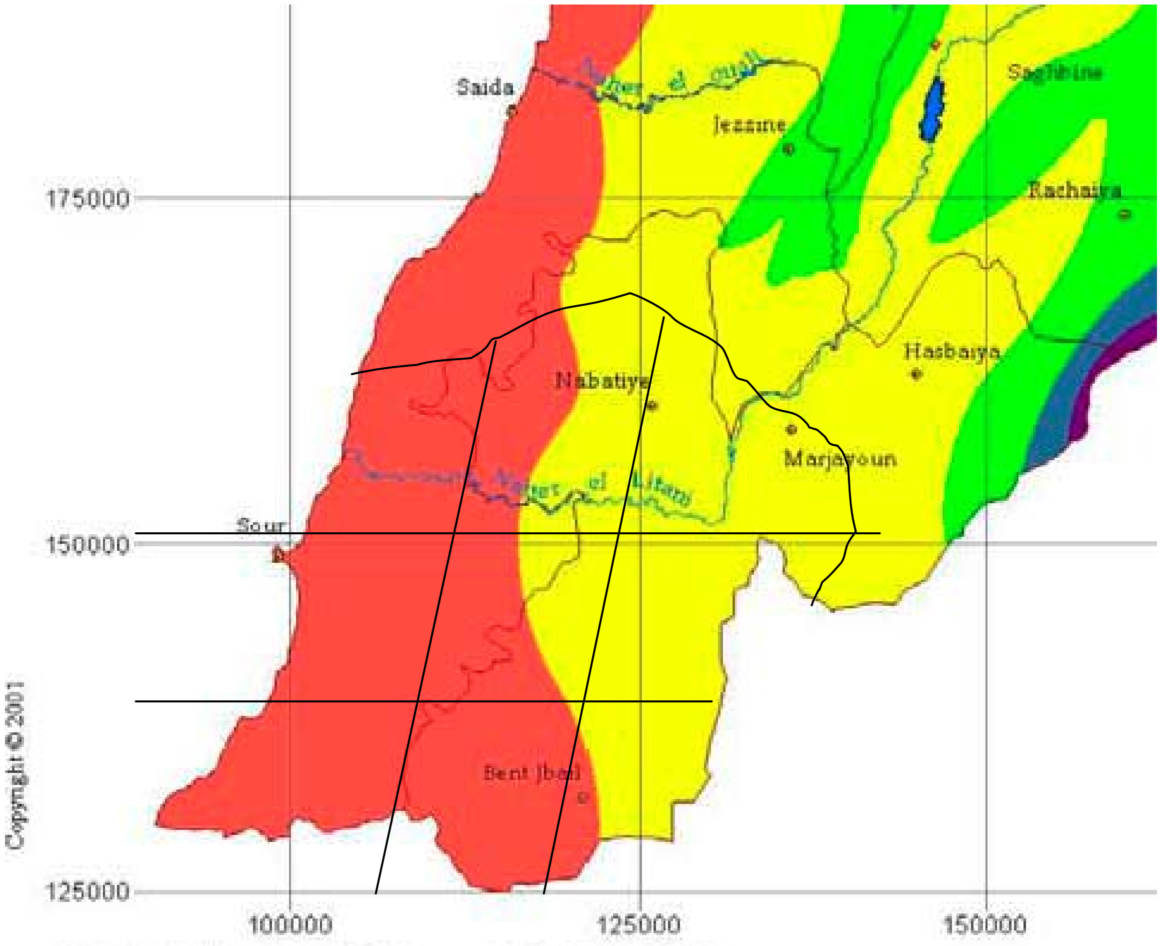
B. *Defer Action option*: whereby the importance of the natural systems is recognized but will be addressed in future plans. However, it should be realized that the lag time will exacerbate the damage and increase losses, which may become irreversible. Time is not to the advantage of biodiversity in the South; the recent war has rocked the natural systems and the post-conflict threats are augmenting.

C. *Move to Action option*: a quick reading of the situation in the field reveals a spectrum of damage from the war with one extreme characterized by undamaged, unaffected sites and the other extreme comprised of heavily damaged sites, with various levels of disturbance in between the two extremes.

The proposed intervention addresses the two extremes to help resolve the damages in between. It is based on (1) preserving the most intact and functioning ecosystems to maintain the natural assets and significant biodiversity in their current situation without further degradation and to protect them as modules and sources of viable material for future use in restoration of damaged systems whenever needed, and (2) evaluating natural recovery in the most damaged sites to guide future actions toward restoration and rehabilitation of systems and toward defining strategies to recover less damaged sites. It might prove that natural recovery is sufficient, which would relieve the burden of human-induced restoration and allow the application of similar measures on other less damaged sites.

11.2.3.2 Proposed Actions

1. Site Selection: In the light of the non-specificity of information available on damage to natural systems and its compounding effect, it is imperative to commence the actions needed with a screening of the diverse threats and their locations in order to define: the most intact systems and the most damaged areas where further action will be undertaken. GIS mapping complemented with field surveys are the tools proposed for this section. Eighteen (18) priority sites of public or municipal land will be selected for further action: 9 sites for the most intact ecosystems and 9 sites for the most damaged. The Map of Quadrates below supports the number of sites needed.



Parameters of a healthy ecosystem are as follows:

- No manifestation of diseases
- Profuse and diverse plant base
- Least damage or disturbance from war and human activities
- Host particular or sensitive habitats
- Host endangered species (of flora, fauna or avifauna)
- Is publicly owned

Field surveys involve assessing the extent of damage to animals and their habitat, and their current and prior existence. It is important to maintain this record for future restoration plans if the proposed monitoring proves the need for human intervention to speed the process.

2. Collect basic preliminary data on fauna through:

- Oral reports from people living in that area and interviews
- Newspaper reports
- Focal group discussions with elderly, local people and hunters in each area or village
- Knowledge of local people using a combination of RRA and structured questionnaire.

- Attitudes of local people towards the fauna present in their area will be conducted using a combination of RRA and structured questionnaire which will help in structuring the awareness program for wildlife conservation.

3. Capacity building of local communities, stakeholders and authorities to (1) embrace preservation where intact ecosystems are selected, and (2) refrain from further threatening the selected damaged sites. This activity includes:

- Training workshops where three workshops are proposed to address the local community, authority and stakeholders.
  - The first series of workshops centers on introducing the target group to the significance, tools and means of conservation as well as the value of their site.
  - The second series of workshops will focus on problem solving and on finding alternatives to support preservation of intact ecosystems.
  - The third series would explain the impact of the war, the significance of the selected site and following activities and engage community in refraining from inducing further damage to the sites that are under monitoring. Otherwise, monitoring would not be conclusive under constant or sporadic damage subsequent to war.

    The target groups might not be the same for the different workshops depending on the location of the selected sites.
- Training of local people on fauna identification to help in the field survey.
- Empowering stakeholder and/or local authority by responding to pertinent needs so they would effect preservation for coming 2 years.
- Regarding enforcement of preservation, it is suggested to benefit from the municipal police and forest guards assigned by the MoA at this stage until the project is expanded to cover conservation subsidies.

4. Initiate legal framework for preservation of intact ecosystems: The sites should have a status of protection in order to be effective. This can be started with a decree of preservation, and extend to an act of conservation following the legal frameworks adopted by the MoE.

5. Monitoring:

- In intact ecosystems: short-term monitoring over one year and during the four seasons is needed. At this stage, monitoring is dedicated to observe the health and progress of the natural system with all its assets from flora to fauna and avifauna.
- In damaged systems: monitor extends over 24 months with sequential visitations during the seasons. The monitoring process should discern the impact of threats on the floral base, the faunal populations and the ecosystems marking the development of flora and the stability of ecosystems and the progress of its functions. Some of the parameters to be monitored include:
  - Keystone species
  - Indicator species

- Dominant associations
- Seral stage
- Invasive species
- Endemic, rare and endangered species
- Regeneration

- Monitoring of fauna: due to hunting, animals change their behavior to adapt to human presence. They become shy, more secretive, adopt nocturnal activities, and flee when they sense human presence. This causes difficulty in finding and monitoring fauna and will be more time consuming. Accordingly, regular monitoring studies on the selected sites should be conducted over 24 months to assess impact of threats on fauna and its recovery these areas. Monitoring should stress on:
    - Species status using IUCN criteria (endangered, vulnerable...etc).
    - Indicator species
    - Umbrella species
    - Invasive species

6. Determine mitigation measures and restoration activities needed if the natural system proves to be slow or unable to recover naturally

7. Develop projects to draw funding to sustain preservation activities and long-term monitoring. The projects should address the needs of the local community and the support required to further preservation.

11.2.3.3 Legal Aspects

None identified.

11.2.3.4 Institutional Aspects

Main institutions responsible for such an intervention are the Ministry of Environment, Ministry of Agriculture and local authorities.

11.2.3.5 Budgetary Estimate

The estimated budget for this intervention amounts to **USD 634,000**. Budget breakdown is as follows

1.	GIS Mapping	20,000 $
2.	Field Survey including fauna and RR	60,000 $
3.	Capacity building	
	a. training workshops (3x9x3,000)	74,000 $
	b. training on fauna	25,000 $
	c. empowering stakeholders (9x5,000)	45,000 $
4.	Monitoring of 18 sites (8x9x2) (2x4x9)	212,000 $

5. Monitoring of fauna 80,000 $
6. Legal portfolio 6,000 $
7. Develop future projects (6x2.5) + fauna 25,000 $
8. Project Management (3 x 24) 72,000 $
9. Running expenses 15,000 $

11.2.3.6 Time Frame

The project is proposed to be realized over a period of 24 months.

11.2.4 REHABILITATION OF NATURE SITES AFFECTED BY FIRES (DRAFT PROPOSAL)

11.2.4.1 Problem Statement and Rationale

Areas subject to fires lose their vegetation layer but maintain their soil layer. It is imperative to enhance re-growth as soon as possible; the longer the soil is exposed to the adverse factors of the environment, especially rainfall, the faster it will be lost to erosion.

Fires impair the functioning of ecosystems and reduce their efficiency at moderating climatic conditions, which exacerbates desertification. They also destroy the structure of the ecosystem reducing a climax association or any seral stage to the lower levels depending on the severity of the fire. Sensitive habitats are also lost under the impact of fire. Stability of the ecosystem is degraded and the system reverts to an imbalanced state where much energy will need to be consumed in order to re-establish a stable structure before progressing forward. The regenerated composition of the vegetation will differ from the original one. Invasive species seize the opportunity to establish populations in the fire-consumed areas, which may cause the loss of the natural vegetation and might impede the redevelopment of the natural ecosystem.

Actions are needed to help the natural system re-establish itself quickly, and the natural vegetation to grow back and stabilize the soil layer.

It is important to note that this proposal does not conflict with the reforestation project proposed in the agriculture chapter for the forest fires areas. The two interventions are complementary, though *Pinus pinea* forests can be excluded from this project and devoted solely to reforestation. The aim of this proposal is to work at the level of underbrush components of ecosystems to allow quick regeneration of the vegetation that hold the topsoil and reduce erosion. Trees require a long time to establish their root network to anchor the soil; their maintenance is also more demanding. All levels of vegetation are needed to help the ecosystem develop and reconstitute its floral base. Even conifer seeds can be sown.

11.2.4.2 Proposed Actions

The total fire-affected areas assessed at the time of writing include 1,000 ha in Mount Lebanon and 800 ha in the South of Lebanon. An applicable mitigating measure would be to re-seed the area consumed by fires with seeds of wild plants in order to re-establish not only the tree cover but mainly the seed bank and lower vegetation which are faster growers than trees and would support and hold the soil sooner. Again, this would help the ecosystem restructure itself faster.

Proposed actions under this intervention are as follows.

1. Define the charred areas that need to be acted on and the neighboring areas that act as seed sources. This may be carried out through field visits to the defined areas.

2. Conduct awareness workshops with local community, stakeholders and local authorities to address the vulnerability of the burnt ecosystem, the significance of its re-establishment for the needs of the local community, and the contribution of the community to minimize damage of these sites until the system is restructured. As a result, identify seed collectors to assist in further steps.

3. Train seed collectors on the types of seeds that are required from trees and underbrush and on the ways for their collection so as not induce damage to surrounding ecosystems

4. Provide seed collectors with equipment and material to help them perform their jobs and become conservation militants in their areas.

5. Support efforts of seed collectors by providing monetary compensation on a daily basis (per diem) for seed collection and sowing

6. Monitor activities of collectors to ensure the proper progress, the absence of disturbance to seed collection sites and proper sowing in charred sites.

7. In parallel work on the legal front needed to address the problem of grazing in burnt areas. A decree or other legislation is needed to forbid grazing in burnt areas for 5 years to give the ecosystem the temporal potential to restructure its components. In reality, herdsmen prefer charred areas because after a fire the luscious green grasses and soft leaved annuals predominate, which are favored for grazing. However, their elimination reduces the productivity of the system and regresses it, enhances erosion, and jeopardizes the renewal of the system which might never be regained.

11.2.4.3 Legal Aspects

Need to forbid grazing in fire affected zones to allow vegetation to re-establish itself without further disturbance. This will help the natural system to take over and ultimately maintain the soil layer.

11.2.4.4 Institutional Aspects

Main responsible authorities are the Ministry of Environment, Ministry of Agriculture and municipalities.

11.2.4.5 Budgetary Estimate

The estimated budget for the re-seeding of 600 ha in one season is **USD 338,000 $**. Budget breakdown is as follows:

1.	Define areas of action	15,000 $
2.	Awareness workshops (20 x2)	40,000 $
3.	Field Training (20 x 1)	20,000 $
4.	Empower seed collectors (600 x 150)	90,000 $
5.	Per diem for seed collection and sowing (600 x 30days x 15$)	120,000 $
6.	Monitor activities (4x 2x2000)	16,000 $
7.	Legislation (3x3000)	9,000 $
8.	Project management (9x2000)	18,000 $
9.	Running expenses	10,000 $

The budget needed for a second season is estimated at USD 254,000. If the project runs over two years, it is estimated to require around USD 592,000.

11.2.4.6 Timeframe

The project can start immediately to benefit mainly from seeds of trees such as conifers and broadleaves. The underbrush, however, has mostly lost its seeds already for this year. Alternatively the project could be postponed till the coming spring to start the awareness and training followed by seed collection and reseeding toward end of summer. Two campaigns of reseeding over two years are needed. It is also important to ensure safety of collectors when going to the fields where the hazard of UOXs and cluster bombs remains.

11.2.5 MITIGATING INDIRECT IMPACTS ON PROTECTED AREAS (DRAFT PROPOSAL)

11.2.5.1 Problem Statement

The July-August war came at a time when protected area managers were preparing for a very good tourist season. Palm Islands and Shouf Cedar Nature Reserve managers reported that they were expecting peak numbers of visitors this year as was evident from the number of reservations. Local, regional, and international tourists were expected. Many tourists from the Gulf had reserved boats to visit Palm Islands.

The war undermined tourism at these sites that depend on this income for sustainability of conservation activities through staff rangers and scientific monitors. In addition to salaries, the income also helps cover administrative costs of patrols, marketing, and other conservation activities. Reduction of this revenue thus poses serious threat to the sustainability of conservation efforts.

The continued unstable security situation in the country discourages regional and international tourism. This is why there is a need to capitalize on internal tourism to boost revenue in protected areas.

Loss of economic opportunities from decreased tourism to remote places and protected areas is encouraging local communities to abuse resources and resort to destructive income generating activities such as overgrazing, hunting, and arson for charcoal production.

Impact assessment also demonstrated the need to spread awareness to control environmentally degrading activities. Tourism and the below proposed plan can be an effective way to implement this.

Moreover, at a time when the tourism sector needs more subsidizing, donors and institutions that were backing tourism before the war have changed strategies. One of the most prominent is USAID. In 2005 alone, USAID introduced more than $35,000,000 in rural tourism through NGOs like Mercy Corps and SRI that worked on tourism infrastructure in protected areas and the affected Hasbaya and Marjayoun cazas of South Lebanon. Post war, USAID decided to reduce and even halt its backing of tourism.

11.2.5.2 Proposed Actions

Solidarity tourism is an increasingly popular concept that is being employed in conflict struck but naturally and culturally important areas like Lebanon. In light of the fact that the tourism season is over, that international tourism is no more a reliable factor, that schools have reopened, and that the latter constitute an important base in terms of visitor number the intervention proposes that both public and private schools be the target for a solidarity tourism campaign to the benefit of protected areas and Himas in the country.

It is important to note here that a strategy that targeted schools was part of the kick off of tourism in what today is the most visited protected area, Shouf Cedar Nature Reserve.

The campaign will have the compounded effect of educating new generations on the environment and on the detrimental impacts of war on ecology as well as increasing the visitor activity to protected areas. It will also increase economic opportunities in communities surrounding protected areas hence rallying their support for conservation and discouraging unhealthy practices.

The educational aspect of the project involves connecting Lebanon's ecosystems through a visitation program over a school year introducing children to the diverse and rich ecosystems of their country. The children will learn about the different conservation methods practiced in the country through visiting Himas and government run protected areas. The visit can also link natural to environmental heritage in view of the proximity of

> On the occasion of celebrating the season of bird migration at the bird festival in Ebel es Saqi in 2005, a dialogue between children and hunters had a very positive impact whereby children seemed to be convincing hunters to practice sustainable hunting

certain sites to each other.

On the protected areas side, the program will ensure a constant flow of visitors. With over 60 schools present in the different Mohafazats of Lebanon this will constitute an important visitor base. Many environmental stakeholders are already working with schools which will facilitate the entry to the educational institutions namely SPNL and an array of eco-tour operators.

Lebanon has eight ecosystems:

- Marine – sea water, islands and shoreline –
  - Representative sites: PINR, the marine museum in Jal el Dib and Batroun Hima
  - Link to cultural sites: Tripoli city
- Freshwater – river system, lakes, wetlands, natural and artificial dams as per the definition of Ramsar Convention
  - Representative sites: Ammiq and Kfarzabad
  - Link to cultural sites: Anjar
- Coastal agricultural
  - Representative sites: Qolayle Hima/Mansouri, Naqoura and Tyre Coast Nature Reserve
  - Link to cultural sites: Oumm el Amad Phoenician site in Naqoura, Tyre ruins
- Mountainous – Pine and Oak forests
  - Representative Sites: Hima Ebel es-Saqi and Bentael
- Evergreen forests
  - Representative sites: Shouf Cedar Nature Reserve, Horsh Ehden Reserve and Tannourine Cedar Forest Nature Reserve
- Alpine
  - Representative sites: Qammoua and Mount Hermon
- Rift Valley
  - Representative sites: Western Bekaa and Qaraoun
- North Desert Ecosystem
  - Representative sites: Northern Bekaa and Hermel
  - Link to cultural sites: Baalbek Temples

Activities include:

1. Develop nature interpretation material and educational publications
2. Hold meetings with schools and relevant ministries to integrate the environment program
3. Organize exhibits to sell local products
4. Establish a pilot artistically designed environmental school bus that transports children to sites. This first pilot can be representative of one habitat such as marine ecosystem and would transport people to the Marine Museum in Jal el Dib, Palm Islands, Batroun, Tyre Coast, Qolayle Hima and Naqoura

5. Subsidize the visitation fees of public schools to the marine museum in Jal el Dib
6. Organize meetings between community stakeholders and visiting children
7. Train local protected area staff or supporters and children on nature education and interpretation, visitor management, bird identification etc.
8. Build the communication capacity of Shouf Cedar Nature Reserve. For example: develop a website and online selling capacity
9. Develop student volunteer programs in the summer to back the protected areas with human resources
10. Develop environmental games and outdoor activities
11. Back up the development of nature interpretation infrastructure (signs, panels etc.) where needed
12. Train beekeepers and women in Shouf Cedar Reserve to boost the community development program
13. Support the establishment of a local restaurant in Shouf where local food stuff could be sold

11.2.5.3 Institutional Aspects

Main institutions that can play a role are Ministry of Environment, Ministry of Education, NGOs, international organizations and private sector (eco-tour operators).

11.2.5.4 Timeframe

Total duration of the proposed intervention is 24 months.

11.2.5.5 BUDGETARY ESTIMATE

Budgetary estimate for this intervention is **USD 260,000**. The budget breakdown is as follows:

Develop nature interpretation material and educational publications	$5,000
Organize exhibits to sell local products (several regional exhibits)	$20,000
School bus with artistic design	$50,000
Subsidy for public school children to visit the marine museum	$5,000
Transportation and organization fees to support meetings between children and communities	$5,000
Training sessions	$30,000
Develop communication tools	$10,000
Design of environmental games and activities	$15,000
Nature interpretation infrastructure	$40,000
Support the establishment of environment friendly local restaurant	$40,000
Management fees	$40,000

11.2.6 MITIGATING IMPACTS ON PALM ISLANDS NATURE RESERVE (DRAFT PROPOSAL)

11.2.6.1 Problem Statement and Rationale

Palm Islands Nature Reserve (PINR) is among the nature reserves that were most affected both directly and indirectly by the war. The reserve was directly affected by the oil spill and indirectly through the loss of tourism and the severe economic impact on the fishermen, the main stakeholders of this reserve. The loss of economic opportunities for fishermen is in itself a threat as the latter would be encouraged to put additional pressures on PINR's marine environment, a known breeding site for fish.

The positive effect of this crisis, however, was that it revealed the dire need to gather marine data, strengthen management of the site, and develop sustainable tourism to increase revenues and support for conservation efforts.

The lack of marine data prevented the ability of experts to assess the extent of environmental damage caused by the oil spill in PINR and along the entire coastline. It is necessary therefore to start a full marine biodiversity assessment around PINR to better assess in case similar disasters occur in the future.

Currently there is very limited coherent, analytical information available on the biological values of MPAs in PINR (or Tyre or elsewhere) on which adequate ecotourism activities could be built. There is urgent need for the development of economic opportunities, yet with recognition that the information base for developing ecotourism activities in the marine environment is currently insufficient.

Also, since the oil spill and the war came to add to the existing threats (like non-sustainable fishing) and increase further the fragility of the reserve, it is important to strengthen the management and train existing staff to enable them to deal with the challenges and take remedial actions.

Finally, to curb the pressures posed by economically impacted stakeholders, it is important to develop tourism on site, engage the fisherman community in order to gain their support for conservation, and train them on sustainable fishing practices.

11.2.6.2 Proposed actions

1. Undertake a survey of marine habitats, biodiversity and of "snorkeling and diving experiences" values of PINR. IUCN is currently carrying out a Biodiversity Assessment and Monitoring of Palm Islands Nature Reserve in cooperation with AUB and MoE but the study needs to be complemented. There is a need to undertake a species inventory and map the underwater habitats and biodiversity with a view to assessing whether the "tourism experience" is sufficiently interesting and competitive within the country and internationally, and also as a basis to assess the willingness of divers to pay to visit the site:
   - Complete data on distribution, abundance and biology of many species
   - Develop GIS maps of habitats and lists of invasive and native species

2. Undertake a socio-economic survey of the area. Evaluation of the interactions between marine resources and the local people of this site is a central element in designing instruments for improved and sustainable resource use. Zones that maximize biodiversity conservation and others that allow for sustainable fishing will be identified based on the ecological and socio-economic information collected

3. Incorporate both marine biodiversity and socio-economic assessments into a management plan envisaged by the MoE and GAC that designates no fishing zones. Therefore the plan must be complementary to the present terrestrial management plan; developing appropriate management, financial, and monitoring for this MPA is a critical final step towards utilizing it as a fishery management tools. This will consist of workshops to allow the survey group to report back to the GAC and begin to design the boundaries of any human visitation and use of the area so that the marine management plan can proceed (snorkelers, divers, dates, frequency, moorings, no-go areas, permits, etc), and advice can be given on the potential attractiveness of the site to paying divers. This objective will include preliminary proposals for zoning (protection, multiple use, and an underwater trail for snorkelers and divers) and a draft proposal for Terrestrial and Marine Management Plan for the site

4. Design a marine research, diving, and environmental training centre on Ramkine Island; Ramkine Island, with an existing old fort, provides an excellent site and opportunity for developing a marine and visitors centre to cater for MPA monitoring, diving, and environmental education. IUCN can provide technical input on the conceptual vision of the center, logistics of establishing a marine research center, and access to best practice standards, global case studies, and appropriate experts. This centre can also be used for training and technical capacity building. Preparing and conducting training sessions for potential candidates on the management of ecotourism and marine and coastal protected areas in Lebanon is critical to the sustainability of these initiatives. Ramkine Island should act as a node for receiving all visitors who will be shuttled to the other islands, thus controlling the carrying capacity of this ecologically sensitive site.

5. Utilize the experience of the PINR as a case study to be replicated in Tyre Nature Reserve and Southern Lebanese areas of ecological significance. Although the work will take place in PINR (taking into account conservation needs), the generated information should be shared with other areas and units as well (marine and terrestrial). This objective will launch a process to identify and develop a national system of representative protected areas in Lebanon. In addition, a Geographic Information System for natural resource must be developed as it is an efficient long term, dynamic tool for planning and monitoring; and a very important instrument for data maintenance and processing. Proposed GIS work will identify “key sites” where priority intervention must be taken. The sources of data used for this purpose are a sequence of maps, statistics and field data - collected from different organizations and entities – homogenized in a unique and coherent database. This database will be used to assess affected “key biodiversity sites” and serve to develop correct measures to be taken at both the national and levels.

Proposed GIS work will focus on three main priorities:

- Ecologically important areas where conservation efforts should be focused.
- Socio-economically critical areas for users that must be considered.
- Highly impacted areas that must be addressed rapidly and rehabilitated.

6. Conduct awareness sessions with fishermen on sustainable fishing and its importance to their livelihoods

7. Train fishermen on guiding, eco-tourism and basic use of languages

8. Involve the fishermen in tourist activities and management planning for the reserve

9. Establish a marine program with fishermen that focuses on selling hand-made marine products and food stuff

11.2.6.3 Institutional Aspects

Ministry of Environment, Government Appointed Committee, Municipality of Mina, International Organizations are the main stakeholders.

11.2.6.4 Budgetary Estimate

Budgetary estimate for this intervention is **USD 705,000**. Budget breakdown is as follows:

1. Survey of marine biodiversity of the site Area mapping and delineation Identification of ecologically important areas for protection	150,000 $
2. Assessment of stakeholder-resource interactions Identifying highly vulnerable users Socio-economic assessment and stakeholder analysis	100,000 $
3. Marine center concept and services design Marine Laboratory Equipment Training of Lebanese practitioners on ecological monitoring Training of practitioners on Ecotourism and MPA Management	200,000 $
4. Zoning of PINR for different uses Designing governance systems that optimize the ecological and social values Valuation of ecosystem services	155,000 $
5. Management Fees	100,000 $

11.2.6.5 Timeframe

The duration of the proposed intervention is 30 months.

11.2.7 MITIGATING IMPACTS ON ENDANGERED MARINE TURTLES (DRAFT PROPOSAL)

11.2.7.1 Problem Statement and Rationale

War directly affected the property called "The Orange House", which is owned by two conservationists at Qolayle/Mansouri Beach. The second floor of the two-story house was hit by five rockets. This increased financial burden and reduced revenue from eco-tourism and hence indirectly conservation efforts. Moreover, the oil spill endangered the marine turtles beyond their current fragile status along the Lebanese coastline as the beaches, which are the nesting sites for the turtles, were heavily oiled (namely Ramlet el Baida). This constitutes an additional reason to support the two most active and effective marine turtle conservationists in the country.

The two ladies managing "The Orange House" and the conservation project are protecting one of the few remaining virgin sandy beaches along the Lebanese shoreline.

The 1.25 km stretch of beach they protect hosts more than 70 nests of turtles each year. The protection of these endangered species, the Loggerhead (Caretta caretta) and Green turtles (Chelonya mydas), requires equipment, full time work, and up to date know-how.

11.2.7.2 Proposed Actions

1. Support the repair of the damage caused by rockets to the eco-tourism facility
2. Develop educational material (leaflets, brochures etc.) on marine turtles
3. Develop signage
4. Provide technical assistance in zoning
5. Establish a small demonstrative waste-water recycling project for the facility
6. Establish a nearby Turtle Rescue Center
7. Finance the specialization of a local veterinary doctor in sea turtle treatment
8. Finance overseas training (Greece and Italy) on new methods in Mediterranean marine turtle conservation
9. Establish exchange programs with other marine initiatives in the country and abroad
10. Provide conservation equipment mainly mesh wire
11. Provide technical assistance from MEDASSET
12. Provide waste-water treatment solutions to the municipalities of Qolayle and Mansouri
13. Organize awareness sessions with fishermen
14. Provide incentives for fishermen to release or deliver turtles accidentally caught to the Orange House conservationists

11.2.7.3 Institutional Aspects

Responsible institutions are Ministry of Environment, Municipalities of Qolayle and Mansouri, Ministry of Energy and Water, NGOs, and International Organizations.

11.2.7.4 Budgetary Estimate

Budgetary estimate for this intervention is **USD 370,000**. The budget breakdown is as follows:

1.	Construction	40,000 $
2.	Develop educational material	10,000 $
3.	Signage	25,000 $
4.	Technical Assistance	15,000 $
5.	Demonstration of water recycling	35,000 $
6.	Turtle Rescue Center	30,000 $
7.	Training	10,000 $
8.	Fishermen Incentives (boats, nets)	25,000 $
9.	Conservation equipment	10,000 $
10.	Veterinary specialization	25,000 $
11.	Waste-water treatment	100,000 $
12.	Exchange program	5,000 $
13.	Management fees	40,000 $

11.2.7.5 Timeframe

The proposed duration of the intervention is 24 months.

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LEBANON

RAPID ENVIRONMENTAL
ASSESSMENT FOR

GREENING RECOVERY,
RECONSTRUCTION
AND REFORM
2006

CULTURAL HERITAGE

12.1 DAMAGE ASSESSMENT

12.1.1 OVERVIEW OF IMPACTS

The South and the Bekaa regions are known for the richness of their cultural heritage as they count not less than 100 archaeological sites including prehistoric sites, archaeological tells, Roman temples, and medieval castles, to name a few. As a result of the Israeli occupation of more than three decades in South Lebanon, the Lebanese authorities do not have a full comprehension of the area on the archaeological and cultural levels. The Directorate General of Antiquities (DGA) that is responsible to inventory and to classify the sites of cultural and historic value, has to cope today with serious problems: a large majority of the cultural heritage that has been targeted during this summer's war is not classified, and cannot therefore be submitted to the conditions of restorations and preservations generally imposed by DGA. At the same time, the need to rapidly rebuild the damaged villages works against the local authorities as for the sound land use planning during reconstruction.

The cultural sites of Lebanon that have been damaged during the war are up to 16 based on information available while preparing this assessment. These sites are: Byblos, Baalbeck, Bint Jbeil, Chamaa, Aita el-Chaab, Qaozah, Alma, Debl, Yaroun, Deir Mimas, Rachaya, Tebnin, Marwahin, Jbaa, Choula and Khiam. The level of damage varied from minor to severe. Some sites were completely destroyed whereas others had only some localized damage. Direct impacts include total or partial destruction of structures that were directly hit by the bombs and unearthing of archaeological structures after the destruction of upper levels. Indirect impacts include archaeological structures affected by the oil spill and weakening or deterioration of buildings or structures due to the bombardment of their vicinities.

The DGA has conducted a rapid evaluation of damages to archaeological structures and cultural sites after the conflict. UNESCO has also put in place a committee to estimate the damages undergone by the sites listed as World Heritage Sites. During the reconstruction phase, the impacts and threats on cultural assets are of extreme importance, since they could irreversibly harm the cultural character of the south, and could be prevented. The following impacts are likely to occur:

- Introducing modern elements to the original old fabric, damaging the visual aspect and genuineness of the asset;
- Unrestricted development and change in the setting and environment of a major resource, affecting its settings and visual appeal as well as the sense of the place;
- Radical destruction of cultural resources by illicit digging for archaeological material and treasures and robbing of architectural elements for use in new constructions;
- Demolition of cultural asset in order to replace with modern structure;
- Uncovering underground archaeology during reconstruction phase;
- Military presence within the resource thus preventing access and causing direct and indirect damage to the fabric;
- Dumping of trash and garbage within the cultural asset, harming its visual aspect and physical condition.

12.1.2 SITES SEVERELY DAMAGED BY WAR

12.1.2.1 Byblos

12.1.2.1.1 Historical Overview

Byblos is located 40 km north of Beirut, on the Mediterranean coast of Lebanon. Successive layers of ruins and artifacts, resulting from centuries of continuous inhabitance, make Byblos attractive to archaeologists and tourists. According to Philon of Byblos, it is the oldest city in the world. The archaeological excavations conducted on the site confirm the longevity and continuity of human settlements. The oldest remains go back to the Neolithic period (5000 B.C.). Different periods are represented on the site, to start with the Neolithic houses and the chalcolithic tombs (IV millennium). During the Bronze Age (3000 B.C.) it became a small agglomeration with an urban plan. Byblos became very prosperous due to the trade with Egypt at the beginning, and then with the Aegean world. During the Phoenician period, Byblos was eclipsed by Tyre and Sidon. Nevertheless, one of the oldest Phoenician inscriptions was found at Byblos (Ahirom sarcophagus, dating to the 10 c. B.C.). During the Persian period, the harbor kept on assuring the wealth of the city. The remains of the roman period (such as the nympheum and the theater) prove that Byblos was still prosperous. During the crusades, it was endowed with a powerful fortress.

12.1.2.1.2 Site Importance

Byblos was recognized by the World Heritage Committee of outstanding universal value and listed in the World Heritage List on November 2, 1984. It is one of the major cultural and touristical sites in Lebanon.

12.1.2.1.3 Sources of Damage

Archaeological structures in Byblos were severely affected by the oil spill from the Jiyeh power plant. Two medieval towers, that constitute the entrance to the harbor have there basement stones covered by a thick layer of fuel. Some other ancient ruins of different periods, located below the archaeological Tell, are also covered by a fuel layer. Figure 12.1 shows relevant photographs.

12.1.2.1.4 Post conflict Initiatives

During September 2006, an expert mission, sent to Lebanon by UNESCO and led by Mr. Mounir Bouchenaki has called for urgent measures to clean up the fuel from the World Heritage structures in Byblos. They declared that the most serious damage resulting from the conflict concerns the World Heritage site of Byblos. Following this mission, a draft project proposal stated that a special procedure should be applied in order to clean the archaeological remains covered by fuel. Mr. Alain Bouineau, expert in stone cleaning, recommended that these stones be cleaned manually, with a solution prepared specifically for this cleaning, and based on the components of the fuel.

(a) Byblos Medieval Tower

(b) Byblos Fish Pond

Figure 12.1. Byblos Medieval Tower and Fish Pond

Clean-up operations were estimated to cost USD 100,000. USAID has included the cleaning of the archaeological structures in its operation. It is recommended that a follow-up mission be planned in the spring to clean oil patches that could resurface during winter.

12.1.2.2 Baalbeck

12.1.2.2.1 Historical Overview

Baalbeck, eastern Lebanon, is located between the Litani and Assi rivers. Few sites of the Roman world give such an impression of gigantism, excessiveness that surprises the visitors that visit Baalbeck since the Middle Ages. This can be illustrated by the dimension of the podiums' stones, those of the neighboring careers, or the six columns height of the big temple of Jupiter. The sanctuaries of Baalbeck are one of the most extraordinary monumental wholes ever achieved by the Roman.

Although the early history of Baalbeck is almost entirely unknown, some archaeological remains indicate that it was occupied during the Bronze Age and the Hellenistic periods. The rich villas, that were uncovered in a residential district of Baalbeck, show its prosperity during the Byzantine period. During the XIIIth c., it becomes a political and strategic stake, especially in the conflict against the crusaders. The complex of the sanctuary becomes then a powerful fortress.

12.1.2.2.2 Site importance

Baalbek is known to be one of the most monumental roman sanctuaries in the World. It is listed as World Heritage since 1984, and is one of the major tourist sites in Lebanon.

12.1.2.2.3 Sources of Damage

The sanctuaries themselves were not directly damaged by the war. Nevertheless, one unstable stone has fallen from its place in the Jupiter Temple, and some cracks in the lintel of the Bacchus Temple might have widened, due to explosion pressure of repeated shelling. The most important damages occurred in the Baalbeck historical center: the Souk and the Old City. Stores belonging to the Ottoman souk, which were restored during the past years, were directly hit by bombs and completely destroyed. As for the Old City, two historical houses were targeted and partially damaged.

12.1.2.2.4 Post conflict Initiatives

The DGA has prepared a project in order to rehabilitate the historical souk isles that were damaged during the war. This plan takes into consideration the urgent actions and the long term actions that should be conducted in Baalbeck. The Stockholm Conference for Lebanon's Early Recovery specified a budget of USD 550,000 to restore the damages in Baalbeck.

12.1.2.3 Bint Jbeil

12.1.2.3.1 Historical Overview

Bint Jbeil is situated south Lebanon, few kilometers from the Israeli border. It is one of the most important villages in the south, population and development wise. Its location made of it a main commercial crossroad between Palestine, Lebanon and Syria. Moreover, the historical Bint Jbeil was directly influenced by this trade, since its architecture and decoration methods group elements of the three above mentioned regions.

12.1.2.3.2 Site Importance

Bint Jbeil's architecture was preserved during the past three decades from modern constructions and expansions. Unfortunately, the historical houses had not yet been classified by General Directorate of Antiquities and therefore can not be considered as national heritage.

12.1.2.3.3 Sources of Damage

Bint Jbeil is one of the villages in South Lebanon that was continuously targeted during the war and in which ground battles took place. The historical city center has been significantly destroyed.

12.1.2.3.4 Post conflict initiatives

The government of Qatar has declared that it will finance all the reconstruction in Bint Jbeil. It is important that the historical value of the destroyed houses be taken into consideration during reconstruction of the village. The municipality of Bint Jbeil should ask DGA for assistance during reconstruction period, in order to value and recognize the cultural heritage of the village. The village's land use plan should take this factor into consideration. *This* *recommendation is applicable to all municipalities that were damaged, especially those having recognized heritage importance.*

12.1.2.4 Chamaa

12.1.2.4.1 Historical Overview

The site's origins date back to the XIIth c. A.D. The fortress was first built and fortified by the Crusaders. During the XIIIth century, it was conquered by the Mameloukes. The site is composed of a fortification wall, an oil press, a Mausoleum of the Prophet Chamoun el-Safa and traditional houses.

12.1.2.4.2 Sources of Damage

The heritage assets of Chamaa, located in the South, are in a very poor state and extremely damaged since they were directly and massively hit by the bombardments. Apart from the north defensive wall, that has collapsed, the damages can not be evaluated before mine clearance from the site. A photograph of the site is shown in Figure 12.2.

Figure 12.2. Chamaa Cultural Heritage Site

12.1.2.4.3 Post conflict Initiatives

No specific restoration activities were initiated to date. However the Stockholm Conference for Lebanon's Early Recovery specified a budget of USD 900,000 to restore the site.

12.1.2.5 Other sites

12.1.2.5.1 Tebnin and Chqif Citadel

Chqif Citadel, located in the South, was not targeted, but the road leading to the site was hit by bombardments. As for Tebnin, it was reported that the site was occasionally hit but without incurring any major damage.

12.1.2.5.2 Aita el-Chaab, Qaozah, Alma, Debl, Yaroun, Deir Mimas, Rachaya, Marwahin, Jbaa and Choula and Khiam

All these villages of the South were targeted by the Israeli bombardments. Traditional houses, religious edifices, old districts were partially or completely destroyed. Unfortunately, there is not yet a definitive survey that states the actual damages. On the other hand, DGA can not put a hand on these cultural heritage assets, since they were not classified before the war. The only possibilities lie on the awareness of the municipalities and the inhabitants to sustain the traditional and historical value of their villages. It is recommended that DGA undertakes a comprehensive survey to classify the remaining heritage in these villages as national heritage in order to be able to make specific interventions in the future, if needed.

One notable site that was completely destroyed during the war is the Khiam Museum from World War I, which had been rehabilitated recently by the municipality and Mercy Corps with USAID funds; the damage at the site is not reparable.

12.1.2.5.3 Summary of Impacts

Most of the damaged sites have rehabilitation, clean-up or recovery plans, depending on the case, on-going. Some of these plans have already been implemented, such as in Byblos, where the clean up of archaeological structures was ended by December 2006. As for the other sites, actions are being undertaken, and budgets for rehabilitation and recovery have been set. One major impact is however related to the potential loss of the cultural heritage in affected villages that were not previously classified or assessed by DGA. The potential impact resulting from increased looting activities could also be important.

12.2 ENVIRONMENTAL ACTION PLAN

Despite the violence of the war, major cultural heritage sites were not severely affected; the sites that were affected were identified by the authorities and their restoration is either being planned or underway. Two actions are proposed in this section, the first addressing the need to survey the South region and classify heritage and the second addressing the presence of an increased number of UNIFIL soldiers which could lead to increased looting activities by local population in an attempt to find alternative sources of revenues by selling archaeological artifacts to the UNIFIL personnel.

12.2.1 SURVEY OF THE SOUTH AND CLASSIFICATION OF ASSETS AS NATIONAL HERITAGE (DRAFT PROPOSAL)

12.2.1.1 Problem Statement and Rationale

Important heritage structures were severely damaged or completely destroyed during the war. Unfortunately, many of these assets were not classified as national heritage, and therefore the role of DGA in their rehabilitation/restoration is limited. The objective of this intervention is to develop a database with all the information needed (plans, visual proofs, etc.) which would allow DGA to classify the surveyed sites. This action would give full authority to DGA to take specific interventions in the future and preserve the nature of these assets from damage. The results of the action should be shared with the Directorate General of Urban Planning (DGUP) to promote integration of results in urban planning studies of damaged villages and cities.

12.2.1.2 Proposed Actions

The following actions are proposed:

1. Conduct a survey of the South region and build a database of cultural assets;
2. Perform classification of assets.

12.2.1.3 Legal Aspects

None identified.

12.2.1.4 Institutional Aspects

DGA plays a central role in this action. Local municipalities are also important stakeholders. Coordination with the DGUP is important to integrate results in urban planning studies of damaged villages and cities.

12.2.1.5 Budgetary Estimate

This budgetary estimate of this initiative amounts to **USD 75,000**. Budget breakdown is as follows:

4. Conduct comprehensive survey (40 man-month): USD 60,000
5. Classification of structures: USD 10,000
6. Transportation and other costs: USD 5,000

12.2.2 PROTECTION OF ARCHAEOLOGICAL ARTIFACTS IN THE SOUTH (DRAFT PROPOSAL)

12.2.2.1 Problem Statement and Rationale

The Directorate General of Antiquities (DGA) anticipates that looting of archaeological sites could become a widespread practice by villagers in the South. Such behavior was experienced in Iraq during the last war, whereby local population sees foreign armies as excellent clientele for archaeological items.

The presence of 15.000 UNIFIL soldiers in the South will tempt villagers to illegally dig archaeological sites to find artifacts that could be sold to UN personnel. These actions will cause irreversible damage to archaeological sites. It is also noteworthy that UN soldiers usually leave the country without passing through Lebanese customs and artifacts can not be recovered.

The objective of this intervention is to implement an awareness campaign to UNIFIL members on the importance of archeological sites in the area, potential damages from illegal excavations, and the importance of coordinating with local authorities to prevent illegal looting to take place; last but not least, the Hague Convention of 1954 condemns such acts. While awareness to local communities could also be incorporated in this action, the campaign should be carefully designed to avoid that local communities be alerted to a previously unnoticed opportunity.

12.2.2.2 Proposed Actions

The following actions are recommended:

1. Organization of seminars to unit commanders covering:
   - "The Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict".
   - Importance of archaeological sites
   - Damages from illegal excavations
   - Value of archaeological artifacts
2. Preparation and distribution of brochures to all UNIFIL soldiers in South Lebanon (15000 copies);
3. Creation of a coordination mechanism among UNIFIL, DGA and local authorities to prevent looting from local population.

12.2.2.3 Legal Aspects

Requirements of Hague Convention need to be taken into consideration.

12.2.2.4 Institutional Aspects

DGA plays a central role in this action. Local municipalities are also important stakeholders.

12.2.2.5 Budgetary Estimate

This budgetary estimate of this initiative amounts to **USD 25,000**. Budget breakdown is as follows:

7. Development of awareness materials: USD 15,000
8. Printing of brochures (15,000): USD 7,000
9. Organization of seminars: USD 3,000

LEBANON

RAPID ENVIRONMENTAL ASSESSMENT FOR

GREENING RECOVERY, RECONSTRUCTION AND REFORM 2006

ENVIRONMENTAL LAW

13.1 INTRODUCTION

Two issues related to environmental law are presented in this chapter. First, opportunities to improve the national environmental legislation are identified and proposed. Second, an analysis of the options for obtaining compensation for environmental damage during war is presented and recommendations to the Government of Lebanon are made.

13.2 OPPORTUNITIES TO IMPROVE NATIONAL ENVIRONMENTAL LEGISLATION

Following an armed conflict, gaps in legislation, including environmental legislation, are usually unveiled. While the welfare of the environmental sector should rely first on prevention, a war constitutes a "force majeure" and the prevention principle can not always be applied. Consequently, a solid legal framework is important during the recovery period to ensure that sound environmental standards and regulations are in place to support a green recovery, reconstruction and reform.

This war provides the opportunity to improve the Lebanese environmental legal framework. This chapter highlights those aspects of the legal framework in Lebanon where (1) there is insufficient implementation and enforcement of existing laws, (2) there are gaps in relevant legislation in different sectors and (3) there is deficiency in emergency response regulations. The analysis is structured by sector or focal problem, depending on the issue at stake.

The recommendations provided in this chapter are to be taken as guidance to be used in a comprehensive legal reform that addresses the issues raised and other possible issues as deemed necessary by the decision-makers.

13.2.1 CONSTRUCTION SECTOR

The construction sector has been severely affected during the war. The following legal aspects are discussed in this section:

1. Ownership of demolition wastes;
2. Management of demolition wastes (collection, treatment and disposal);
3. Environmental standards in construction Law;
4. Provision of natural resources for reconstruction.

13.2.1.1 Ownership of Demolition Wastes

The private property in Lebanon falls under the law 3339 dated 12/11/1930 (law of land property). The provisions of this text provide that the owner of a land is by the same deed the owner of everything that overhangs this property and everything underneath it whether the material association was made naturally or artificially, subject to the laws in force (Articles 12, 13 and 15 of law no 3339).

According to this law, the construction and demolition (C&D) wastes on a private site are considered to be private property of the proprietor and should fall under the private responsibility legal status. Nevertheless, the ownership of demolition wastes retrieved from public property (roads, bridges, or public buildings for example) belongs to the public authorities. This raises two main issues:

1. Private individuals do not have the capacity and most of the time the resources to remove and properly dispose of the demolition wastes; that calls for the intervention of public authorities who shall not be considered as the proprietors of C&D wastes but only the administers.

2. Most of the time the owners of the waste have not benefited from its value, particularly related to the presence of metals and recyclable material. That raises another legal question concerning the right of the original proprietor to receive an allowance proportionate to the value of recyclable material existing in the demolition debris after the deduction of demolition, retrieval, transportation and management costs.

In principle, the competent authorities (central and local) are not to be considered as the proprietors of the debris. Their competence is limited to manage, administer and implement a technical plan regarding the removal and disposal of the retrieved debris. Such plan does not exist in the current Lebanese environmental framework and need yet to be established by the competent authorities.

13.2.1.2 Management of Demolition Wastes

There is a major gap in the Lebanese legislation regarding the management of demolition wastes. It is recommended that a comprehensive legislation (law or decree) regulating the management of construction and demolition wastes be developed. The legislation should address the following issues as a minimum:

1. Definition of a legal terminology related to all aspects of construction and demolition wastes; the definition should include the following:

   i. Construction and demolition debris refers to materials generated as a result of construction, renovation, restoration and/or demolition of a construction.

   ii. In the U.S.A. for example, construction and demolition debris can be divided into five categories: construction, demolition, excavation, roadwork and site clearance.

   iii. Special provisions should distinguish between non-toxic and toxic construction and demolition debris and specify the way to handle each category.

iv. The law should include the construction and demolition debris disposal options: recycling, landfilling, segregating hazardous construction and demolition debris.

2. Designation of adequate and technically sound sites for the treatment and disposal of construction debris in compliance with guidelines imposed by the Ministry of Environment; however expensive, expropriation of private lands remains an option if the site offers an urgent necessity for construction debris disposal. Private land lease remains a more probable, plausible and possible option.

3. Requirements that contractors that undertake construction and demolition projects shred and crush the waste on site whenever this is possible in regard to the material;

4. Management of potentially contaminated construction and demolition wastes from commercial and industrial sites;

5. Waste management requirements from contractors such as preparation and submittal of a waste management plan detailing how the waste streams will be separated and managed; responsible monitoring authority should be specified; to that the MoE according to its prerogatives stipulated in the article 2 of the law 690/2005 is competent to monitor the waste management process.

6. Imposing to a certain extent, and whenever possible, alternative demolition methods such as sawing or disassembly rather than impact demolition to limit noise production.

13.2.1.3 Green and Sustainable Construction

The construction chapter has shown the benefits of incorporating environmental standards in the reconstruction. Amendments to the construction law would be necessary to enforce green and sustainable construction as a prerequisite to begin with the building process. It should be mentioned that law 444/2002 specifies the need to prepare an EIA study for all construction projects. Yet, a post-war situation necessitating an urgent response in regard to the construction of thousands of demolished buildings does not always meet with the mentioned provision which means that the enforcement of these provisions are ought to meet an emergency plan for a post-war situation.

13.2.1.3.1 Environmental Standards in the Current Legislation

The Lebanese construction law (Law 646 dates 11/11/2004) contains several provisions regarding construction standards related in a way or another to environmental impacts:

- Provisions pertaining to delivering construction permits based on public safety, public health and environmental standards.

- Provisions pertaining to the exterior design and structure of the construction.

- Provisions pertaining to the necessity of compliance of construction works with the principles of environmental sustainability as determined in the law 444/2002.

However these provisions remain vague and are not easily enforceable.

13.2.1.3.2 Adapting the Construction Law to Post-War Necessities

The provisions of the current construction law do not respond fully to the requirements of international environmental standards. To this end, it is necessary to modify the Construction Law issued by law 646 dated 11/11/2004 and its amendments by entering new provisions addressing the following issues:

- Incorporating thermal building standards (draft standards already exist).
- Recycling concrete as a supplement to natural aggregates such as crushed stone, sand and gravel according to a minimal percentage for every demolished construction.
- Recycling steel according to a predefined percentage of recyclable steel for every demolished construction.
- Imposing to a certain limit, the use of recycled materials used in construction whenever possible.
- Creating the appropriate legal framework for efficient building practices.
- Encouraging green construction and sustainable building practices by setting construction standards dealing with water stewardship, energy efficiency standards as well as water efficient standards.
- Drawing up a list of environmentally preferable building materials and specifications.
- Considering the condition of surrounding buildings, infrastructure and utilities where appropriate to ensure its compliance with environmental national standards.
- Planning the use of waste resulting from construction works.
- Provisions dealing with sanitation, welfare and public health services.

Additional provisions with respect to noise and air pollution in construction sites can be incorporated:

- Defining environmental standards for noise levels at construction and demolition sites knowing that such standards exist in different countries (e.g. U.S.A., U.K.). The U.S. federal standards include:
    - An hourly sound level limit calculated in decibels according to the duration of activities

- Federal noise regulations through environmental noise control devices in proper working condition to ensure the compliance of construction equipments used on development sites.

- Allowing the public to file complaints regarding noise and air pollution from construction sites that should eventually lead the competent authorities to investigating the verisimilitude of the allegations.

- Reconsider the existing permitted hours for noisy construction works and operate the modifications according to environmental and public health standards and the emergency of reconstructing the homes of the displaced population.

Also economic incentives would encourage switching from polluting equipments and fuels to environment-friendly materials in construction sites particularly by encouraging the use of environmentally-friendly equipment by lowering construction tax fees for the contractor who commits to use such equipment.

13.2.1.4 Public Works and Post-War Legal Reform

The MoE in collaboration with the Ministry of Public Works and Transport and the CDR are competent to elaborate special guidelines pertaining to recycling and reusing all recyclable material.

➢ Recycling policies:

- Recycling asphalt pavement of roads and bridges that have been demolished during the war as well as demolition debris and damaged materials due to warfare.

- Creating incentives for encouraging the use of recycled material in construction:

→ Lowering the tariffs on environment-friendly imported material.
→ Waiving the locally recycled construction material from tax fees.

➢ Public works policies

Foremost, environmental guidelines need to be integrated to the global policy of public works through:

- Public projects assessment according to higher environmental standards.

→ Imposing the establishment of more green areas.
→ Implementing environmental restrictions on public land.

- The modalities of disposal of public works construction debris.

13.2.2 PROVISION OF NATURAL RESOURCES FOR RECONSTRUCTION

The construction chapter has shown that demand for aggregates and sand can double due to reconstruction needs. Besides ensuring the implementation of the existing laws and regulations relating to conditions of extraction of the construction material, it appears essential that a special post-war plan for construction material extraction be developed to face the high demand on natural resources. The plan can identify options to minimize environmental impacts from quarrying, such as by defining specific regulation and conditions required so that working and extracting permits may be given to the quarries complying with the pre-specified environmentally acceptable plans. Moreover, the said permits should be given to the quarries offering the lowest economic ratio in comparison with a high environmental quarrying and post-quarrying conditions.

13.2.3 SOLID WASTE MANAGEMENT IN EMERGENCY SITUATIONS

Generation of solid waste grew significantly and different types of wastes, including hazardous ones, were produced during the war. In the absence of a coherent solid waste management legal framework and its implementation, different problems arose:

- Disposal of wastes in existing open dumps;
- Inadequate disposal of organic wastes including animal wastes;
- Non-availability of infrastructure or even formal policies for the disposal of hazardous wastes (although local solutions could be available) and notably the oil-spill related waste.

Apart from the Basel Convention on transboundary movements of hazardous wastes ratified by act of law 387/1994, the Ministry of Environment has prepared a draft Law for integrated solid waste management in 2005. This draft Law defines responsibilities of institutions, requires the preparation of waste management plans and organizes the sector, including provisions for cost-recovery. It becomes critical that such legislation be adopted and gradually implemented so that the country is equipped with the needed infrastructure for waste management as well as the necessary policies and plans, including those in times of emergency. This obligation of self-sufficiency is also integrated to the Basel Convention. However, better implementation is needed to comply with both the Convention and environmental emergencies.

13.2.4 AGRICULTURAL SECTOR

Three main issues were identified which would require legal support: reforestation, promotion of sustainable agriculture and sustainable fisheries.

13.2.4.1 Reforestation

Large forests space was damaged during the war which raises the need of a reforestation plan in the zones hit during July war so that forests related biodiversity is recovered.

One legal issue needs to be highlighted. Conifer trees inside forests are prohibited from cutting, even when dead or burned. Fine payments and even imprisonments are possible in case of violation. This clause of law 85 dated 7 September 1991 is a major obstacle for any action to be undertaken in burned or damaged forests. By limiting the possibility of removing dead trees this law is by the same provision slowing any reforestation process to be undertaken.

Despite the exception related to public works necessity and despite the possibility of getting a special permit from the Ministry of Agriculture to cut down conifer trees by private owners, the first option, as it is clearly mentioned, remains an exception granted to public authorities while the second option requires obtaining a preliminary permit which slows down the cutting and consequently the reforestation process. The disadvantages of the existing law consist in a lack of emergency vision for many reasons:

- Considering the large areas of damaged areas, it is unlikely that the public authorities can manage this problem in a timely efficient process.

- Slowing down the reforestation process causes serious environmental consequences.

This law should be amended in order to resolve this issue and allow the prompt implementation of the reforestation plan followed by the Ministry of Environment since 2001. In the formulation of such amendments, it is recommended that relevant internationally agreed methodologies and instruments be incorporated, as deemed appropriate. Following practices can be considered:

- A limitation of responsibility should be integrated in the law regarding cutting down dead trees especially in the regions damaged by warfare.

- A clause of non penalization should be provided regarding cutting and removing dead and burned trees allowing simultaneously the reforestation.

- A person, firm or other organization should nevertheless obtain a permit exonerated from any fees before engaging in any activities that may result of:

    - → A massive removal of dead trees exceeding a certain surface estimated by acres or square meters.

    - → The perimeter of the removable surface of dead trees should be designated prior to the cutting.

    - → The ownership of the surface rights of the lands within the dead trees area should be respected.

    - → It is preferable that cutting down dead trees is made under the supervision of a forester assigned by the competent authority.

Additional requirements should include:

- The implementation of an integrated plan to combat soil erosion resulting from damaged forests within an appropriate legal frame; for instance a statement describing the best management practices and measures that will be used to minimize soil erosion and negative impacts to the media resulting from cutting and removing dead or burned trees should be established.

- Environmental impact assessments concerning damaged and burned forests could be carried out regularly. As a legal provision, this proposition is more likely to produce a mandatory obligation.

- The removal of dead trees should be exempted from taxes and any related fees.

13.2.4.2 Sustainable Agriculture

The devastation of fruit crops during the war may cause shifting from growing fruit crops to cash crops. This post-war change of agricultural habits constitutes a serious threat to the sustainability of agriculture affecting seemingly the welfare of the environment. However, the solutions to this unbalanced consequence are not only limited to developing environmental standards and regulations but also in creating economic incentives and tax-free inducements.

Sustainable agriculture policies are most certainly a necessity needed to be developed in the Lebanese legislation. Those policies should foresee the environmental consequences of crops shifting leading eventually to the excessive use of pesticides needed to grow cash crops.

Promoting sustainable cropping patterns can be ensured through para-environmental regulations such as:

- Reducing the tariff-barrier on all imported seeds related to growing fruit crops other than cash crops. This shall help maintaining both the environment and the socio-economical equilibrium.

- Encouraging sustainable cropping pattern in the damaged areas, mostly Southern Lebanon, by creating special funds dealing with promoting fruit crops by helping and supporting financially the farmers whose crops were damaged due to war. The economic aid should be limited to covering the first pre-production period following the war-damaged crops.

- An alternative solution may consist of reinforcing the already existing the Green Plan institution by integrating to it the post-war agricultural consequences along with a specific timetable forecast.

13.2.4.3 Sustainable Fish Resource Management

The need for the development of a sustainable fish resource management plan also emerged from the conflict. Such plan may be inspired from the "Upper Colorado River endangered recovery program (U.S.A.) or the "Sustainable Fish Resource management program" in Alberta (Canada), or other Mediterranean plans that could be better adapted to local conditions. The MoA should be in charge of drafting a legislation pertaining to the organization and regulation of fisheries and aquaculture farms and organize their exploitation.

Existing regulations should be strongly enforced to protect watershed management of damaged rivers and their biodiversity; these include regulations of the Ministry of Public Health (MPH) pertaining to feeding of fish with animal slaughtering by-products for food safety and public health, the banning of solid waste and sewage dumping in the river. Besides, the MoA and the MPH should be granted a common competence in addressing disease control regulations. Both should have a joint responsibility for the prevention, control and eradication of animal, plant and fish diseases.

The law should provide with creating and funding programs and incentives to promote sustainable development of aquaculture and fisheries. The management policy should consider at least the following:

- Defining the damaged marine habitat and proposing new solutions imposed by the war.
- One of the objectives of the fish resource management policy should be to set various protection measures and resource planning initiatives.
    - Habitat recovery and maintenance through sustaining or achieving a gain in the quality of fish habitat and restoring diminished fish production
    - Fish conservation by regulating fish harvest in line with the productive capacity of fish populations.
- Foreseeing any type of physical disruption to the fish habitat and be able to act rapidly to encounter the risks.
- Setting legal standards by which the fish and their habitats shall be protected from noxious substances originated from oil spill and other chemicals.
- The conditions of giving permits allowing undertaking any work taking place inside the boundaries of the predefined habitat.

Other incentives may be encouraged such as exemption from taxes for the purchase of new fishing nets and gears, especially those designed for deep fishing. Additional incentives include:

- Reducing the tariff barrier on all imported fishing items needed to accommodate with the post-war situation.

- Reducing the taxation fees on products specifically related to fishing in the conditions imposed by warfare.

13.2.5 TRANSPORT SECTOR

July war caused a great damage to Lebanon's infrastructure, mainly consisting of roads and bridges and other means of transport (Rafic Hariri int'l Airport and seaports). Bombarding transport services has also led to environmental problems which are further accentuated by heavy congestion at system bottlenecks. Moreover, rebuilding damaged or destroyed roads adds on the pressure on natural resources to secure construction materials.

Many legal texts organize the transport sector in Lebanon. However, the environmental aspects of those legal instruments are not always sufficiently emphasized especially when drawing infrastructural plans including all means of transportation. Within Chapter 9 of Agenda 21 regarding the "Protection of the atmosphere", the transport sector as a source of atmospheric pollution through emissions is specifically addressed, identifying the need for a review of existing transport systems and for more effective management of transport and traffic systems.

In 2001, new standards came into force for regulation of the transport sector by issuing law 341/2001 pertaining to lowering air pollution resulting of the transport sector and encouraging the use of less polluting fuels. However, as the post-war situation brings to light, following amendments are recommended:

- Adopting more stringent standards for construction and other off-road engines phased in a determined number of years.
- Specifying maintenance and operational requirements of construction vehicular equipment.
- Prohibition of the importation of illegal fuel should be strictly implemented and monitored.
- No use of polluting fuels should be tolerated and the standards should constantly be revised and adapted to environmental necessities and international standards.

With respect to environmental standards in the road planning decisions, land-use planning and urban development planning, adoption of the draft Strategic Environmental Assessment decree is of utmost importance and is highly recommended. Article 21 of the law 444/2002 should be further elaborated to define the projects falling under its prerogatives as of setting an Environmental Impact Assessment since the said article remains vague and unspecific.

The Directorate General for Roads and Buildings should also adapt its legal structure to meet sustainable environmental principles. (e.g. the materials used in road construction should meet environmental standards). The role of its Environmental Unit should be strengthened accordingly.

13.2.6 PROTECTION OF CULTURAL HERITAGE MONUMENTS IN WARFARE

Lebanon has signed several conventions and other international instruments dealing with the protection of cultural heritage whether it was in warfare or any other circumstances. Those international conventions are the main texts regulating the protection of historical and natural monuments. However, the obligations stipulated in those texts are not always met in national laws and that necessitates amending the law on antiquities accordingly:

The Convention for the Protection of Cultural Property in the Event of Armed Conflict done at the Hague and its First Supplementing Protocol ratified by Lebanon in 1960 includes the following obligations:

- consider marking of certain important buildings and monuments with a special protective emblem of the Convention;
- set up special units within the military forces to be responsible for the protection of cultural heritage.

However those obligations are not met in the Lebanese legislation which makes it relevant to provide with a new legislation pertaining to implementing the international instrument that Lebanon has already adhered to.

Moreover, the outdated Lebanese law on antiquities dated 1933 is believed to be no longer sufficient to ensure the protection of antiquities. That implies the necessity of amending the current law in force pertaining to antiquities so that all damaged historical monuments during warfare may be protected and restored through an emergency response plan. This means that not only the historical buildings and antiquities will be restored, but that implies the urgent and fast restoration of damaged monuments through a fast recovery procedure especially when there is a risk of non-reversible or lasting and long-term pollution consequences (e.g. oil spill and Byblos historical monument – the citadel).

13.2.7 PCBS AND STOCKHOLM CONVENTION

A relative large number of transformers were damaged during the war. This has raised the problem of possible leak of PCBs from some of the older transformers.

The Stockholm Convention allows for a phasing-out period extending to 2025 in case of use of units already operational before the ratification of the Convention (e.g. transformers, capacitors or other receptacles containing liquid stocks). The National Implementation Plan (NIP) for Persistent Organic Pollutants (POPs) including PCBs has been prepared by MoE. It is therefore highly recommended that such plan be adopted to address those environmental problems related to the release of such contaminants and to ensure that unwanted releases occur in emergency situations.

13.2.8 EMERGENCY RESPONSE POLICIES TO WAR ENVIRONMENTAL DAMAGES

Traditional legal methods are normally deficient in responding efficiently to post-war environmental consequences. Environmental welfare in times of war should be addressed under a different scope taking into account that emergency response is the most effective way to limit environmental pollution resulting from military hostilities and minimize adverse impacts to public health and the environment.

However, environmental damages in international texts are often subject to obscure standards of protection and are mainly limited to environmental protection during warfare by setting norms and characteristics pertaining to the use and transformation of environmental resources to achieve military goals (ENMOD Protocol, Geneva Conventions, the Hague Conventions).

There is no legal environmental planning in the Lebanese legislation regarding emergency preparedness and response policies. This deficiency needs to be addressed in a legal post-war reform which aim consists in preventing potential damages to the greatest extent possible through advanced planning and appropriate response.

A solid environmental emergency response policy needs to be developed and legally adopted whose application is possible during warfare and other unforeseen events. Moreover, the definitions given by the current legal texts remain deficient as the laws need to be adapted and updated by broadening their scope and object.

The legal framework will stage the stage for establishing emergency response plans and setting the appropriate standards for all potential sources or causes of pollution (e.g. a specialized coast guard should be provided to prevent, prepare for and respond to oil spills).

Appropriate and timely responses to unplanned releases or spills of polluting substances are necessary; therefore they must be regulated within a proper legal structure taking into account the different sectors that might cause potential damages to the environment.

The legal framework should call for the following activities, at least:

- Updating the inventory of hazardous and noxious materials in the country and more specifically:
    - The decree No. 22/1 dated 17/12/96 concerning the organization of plastic waste import according to the green, red and orange lists approved by the European Union
    - The 64/88 law dated 12/08/1988 on the Protection of the environment against Hazardous waste
    - The Decree 13389/2004 on Health care and medical wastes
- Establishing an environmental emergency response protocol, notification procedures, specific responsibilities, and training guidelines for all appropriate agencies and personnel.

- Reviewing the existing legal texts pertaining to the types and conditions of process or storage equipment, tanks, containers, or transportation equipment.
- Ensuring ongoing evaluation and training of workers in proper regulated material management and handling operations.
- Elaborating substitute plans for different sectors that may cause environmental degradation.

13.3 COMPENSATION FOR ENVIRONMENTAL DAMAGE FROM WAR

13.3.1 INTRODUCTION

Military conflicts lead to negative impacts on the environment, as described in the previous chapters. Environmental impacts from war generated international interest following the operation "Ranch Hand" carried out by the United States in Vietnam. Between 1962 and 1971, more than 70 million liters of defoliant containing 65 percent dioxins were spilled over 1.7 million hectares, destroying one fifth of forests and one third of the mangroves, causing a loss in biodiversity, decline in freshwater and sweater fisheries, and the long-term contamination of important natural resources such as water and soil.

In 1973, the Paris Treaty put an end to the war and introduced the principle of compensation. Claiming compensation for the environmental damages caused by military intervention is not unseemly. In fact, several international conventions adopted after 1970 confer special importance to the protection of the environment during armed conflicts.

To date, compensation claims related to environmental impacts from war have been settled either by diplomatic means (Vietnam War) or by political means, namely through a UN resolution (UN Security Council Resolution 687 - 1st Gulf war - 1991).

Environmental damages due to military intervention were never claimed before an international judicial authority.

This section provides an overview of the three methods for the resolution of international conflicts – diplomatic, judicial and political – and discusses their conditions of application, advantages and disadvantages, and provides recommendations to the Government of Lebanon.

13.3.2 STATE RESPONSIBILITY

State responsibility in an international environmental context may arise because of a breach of international obligations and treaties or as a consequence of international wrongful acts or breach of customary obligations.

State responsibility as a fundamental principle of international law is based on State sovereignty and the equality of States. The International Law Commission (ILC) has worked on this topic since 1975 and in 2001 drafted the Articles on the Responsibility of States for Internationally Wrongful Acts. This is recognized to be a progressive codification of customary laws on State responsibility. It is divided into three parts, Part I (art 1-27) on the internationally wrongful act of a State, Part II (art 28-41) on the content of the international responsibility of a State and Part III (art 42-59) on the implementation of the international responsibility of a State and dispute settlement.

There are only three recorded cases of invoking State responsibility and liability for environmental harm even though incidents of transboundary environmental harm are frequently reported in the press: the *Trail Smelter Case 1941*, the responsibility of Iraq for the environmental damages caused during the first Gulf war in 1991, the liability of the ex-USSR for damages caused by the crash of its Cosmos satellite in Canada.

Iraq's environmental liability came about through activities carried out during what was described in the UN Security Council resolution as unlawful invasion and occupation. The unlawful invasion and use of force by Iraq resulted in damage, including environmental damages, and Iraq's liability was confirmed in UN Security Council Resolution 687 (binding) imposed after the war. The Resolution was implemented and the claims were administered under the UN Compensation Commission which has processed 170 environmental claims valued at $1.8 billion (out of 2.6 million claims altogether for $250 billion) of which more than 135 have already been processed and $954 million justified and approved for payment. Thus the legal base for establishing State responsibility was the existence of an international wrongful act.

USSR's liability was based on an exceptional treaty – the Convention on International Liability for Damage by Space Objects 1972- which places absolute liability on the state of ownership of the space object.

The legal consequences of an internationally wrongful act are the cessation of that act (art 30) and remedy the breach by reparation (*Chorzow Factory Case 1928*, art 31). Reparation can take the form of restitution (rare, *Temple Case ICJ 1962,* art 35), monetary compensation for material and non-material damage (*Rainbow Warrior arbitration*, art 36) and/or satisfaction (*Rainbow Warrior Arbitration*, art 37).

The claim can be made by the injured state or by any other state entitled to have standing if the obligation is owed to a group of states or to the international community (art 48).

13.3.3 METHODS OF DIPLOMATIC SETTLEMENT

Four (4) methods of diplomatic settlement are known. These are (1) negotiation, (2) mediators mission, (3) mediation, and (4) conciliation. These methods are summarized in Table 13.1. The advantages and disadvantages of diplomatic settlement methods are described in Table 13.2.

Table 13.1. Methods of Diplomatic Settlement

Method	Comments
Negotiation	It is possible when countries accept to recognize each other.
Mediators mission	It calls upon the intervention of a third party (such as the UN or a chief of state) that informs each party of its opponent's claims and seeks to make negotiation possible.
Mediation	It requires a third party which proposes the principle of settlement in order to lead the States to negotiate a solution.
Conciliation	It is the most formal procedure. The States present their positions to a conciliation commission which examines them, then proposes to the States a solution that could potentially be accepted.

Table 13.2. Advantages and Disadvantages of Methods of Diplomatic Settlement

Advantages	Disadvantages
o Methods are flexible o Offer the only solution when the application of the law is impossible, for example when the States: ▪ Refuse to recognize each other ▪ Refuse to have judicial relations or ▪ When there is no legal rule to settle a litigation	o Methods do not lead to a compulsory legal decision; therefore the State that does not apply it would not be committing an illegal act liable of engaging its international responsibility o Rely ultimately on the good-will of the parties.

It is, however, unlikely that States would find an agreement on diplomatic grounds after 34 days of armed conflict.

13.3.4 METHODS OF JUDICIAL SETTLEMENT

There are several methods of judicial settlement. The following sections describe the procedure of arbitration before developing the conditions for resorting to international judicial authorities and national ones.

13.3.4.1 Arbitration

Arbitration is one of the earliest known methods for the peaceful settlement of conflicts. It existed before the creation of the major international judicial authorities and still persists. Its numerous advantages – mainly swiftness and low cost – make it one of the most practiced methods for settling conflicts.

Nowadays when States choose arbitration, they agree themselves on the arbitrator, the law applied to the arbitration, and the arbitration procedure.

Arbitration is a method of jurisdictional settlement. In this context, it leads to a compulsory legal solution; its violation constitutes an internationally illegal act. Upon request from the plaintiff party, the Security Council can be involved in enforcing the execution of the arbitral sentence.

Nevertheless, arbitration presents the same major disadvantage as the strictly diplomatic methods since it requires the will of the conflicting parties to resolve their disagreement. Nothing can compel a State to accept arbitration.

In the case of Israel and Lebanon, not mentioning the remote chances of the States agreeing to the terms of arbitration, it is unlikely that Israel consents to an arbitration requested by Lebanon.

However, certain conventions clearly anticipate resorting to arbitration in case of litigation on the interpretation or the application of the convention such as in the case of the Barcelona Convention (art. 28) (Box 13.1).

Box 13.1. Barcelona Convention, 16 February 1976 amended on the 10th of June 1995

The "convention for the protection of the Mediterranean against pollution" known as the Barcelona Convention was amended in 1995 and is now adopted as the "Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean". It entered into force on the 9th of July 2004. The convention was signed under the auspices of the United Nations Environment Program, by the 21 countries bordering on the Mediterranean among them Israel and Lebanon, as well as the European Union.

The convention aims to reduce pollution in the Mediterranean Sea and protect and improve the marine environment in the area thereby contributing to its sustainable development.

Nonetheless, this convention is not applied individually.

On one hand, like any framework agreement, the terms of the convention provide more incentives than constraints. It lists a number of principles that the contracting parties need to implement, such as the polluter-pay principle. Still, those recommendations are not mandatory and do not have a legal effect.

On the other hand, its field of application does not correspond to individual cases. The convention and its protocols target 4 kinds of pollution in particular:

- Pollution caused by dumping from ships and aircrafts;
- Pollution from ships;
- Pollution resulting from the exploration and exploitation of the continental shelf and the seabed and its subsoil;
- Pollution of telluric origin.

None of the additional protocols are related to the pollution cases resulting from the air raids on fuel tanks during an armed conflict.

13.3.5 THE JUDICIAL METHOD

The international judicial order is founded on the principle of the sovereignty of States. The sovereignty describes the character of the State as not being liable to any superior authority. At the same time, international powers have always sought a permanent mechanism for the jurisdictional solution of international litigations. The Permanent Court of International Justice (PCIJ), created in 1920 at the League of Nations, and the International Court of

Justice which followed with the UN in 1945 tried to conciliate between these 2 requirements: consent of the States to submit themselves to international law in their relations with other States without questioning the principle of State sovereignty.

In fact, if international judicial authorities have restricted the judicial sovereignty of States, they have nonetheless provided the countries and their leaders with efficient means for protection, including the means of eluding international law.

The 2 main international judicial authorities are the International Court of Justice and the International Criminal Court.

13.3.5.1 The International Court of Justice

The International Court of Justice is the principal judicial organ of the United Nations. Its role is "to settle in accordance with international law the legal disputes submitted to it" (Art. 38 of the Statute).

Only States may apply and appear before the Court. As for private interests, these can only form the subject of proceedings in the International Court of Justice if a State, relying on international law, takes up the case of one of its nationals and invokes against another State the facts which its national claims to have suffered.

Before examining international laws that might have been violated in the present conflict, it is necessary to establish the jurisdiction of the Court. In fact, as it was mentioned above, many conditions need to be fulfilled in order to declare the competence of the Court.

The first condition is related to the nature of the States appearing before the Court. These States should be part of the Statute of the Court. According to article 93 of the Charter of the United Nations, all member States in the UN are *ipso facto* part of the Statute of the Court. Therefore, this first condition does not pose any problem since Lebanon and Israel are both members of the UN.

The second condition is related to the consent of the States to submit their dispute to the Court. This consent is necessary. In fact, contrary to national jurisdictions, international ones are not compulsory but voluntary. This consent may be given by two (2) means: compulsory jurisdiction or optional jurisdiction.

Compulsory jurisdiction consists upon the existence of a consent granted a priori. Acceptance of the jurisdiction of the Court might be given before the emergence of any dispute, in a treaty through a jurisdictional clause. Consent may also be given through an optional declaration of compulsory jurisdiction according to article 36 § 2 of the Statute of the Court. The optional clause of compulsory jurisdiction is a unilateral declaration addressed to the Secretary General of the United Nations, through which the State concerned recognizes the jurisdiction of the Court regarding the disputes arising with another State signatory to the same declaration.

Neither Israel nor Lebanon had submitted an optional declaration of compulsory jurisdiction of the International Court of Justice.

Optional jurisdiction consists on giving consent *a posteriori*, which means after the emergence of the dispute, through a compromise – direct agreement between the States – or by the means of a forum prorogatum – implicit acceptance of the defending State to have recourse to the Court without challenging its jurisdiction. The first case ever judged by the International Court of Justice had been submitted according to this procedure (Corfu Channel, United Kingdom v. Albania – 1947-49). However, it is unlikely that Israel shall follow Lebanon in such proceedings and any unilateral request submitted to the Court by Lebanon shall not be accepted by Israel.

In conclusion, even if the rules of international law were violated during the conflict, any unilateral proceedings submitted by Lebanon to the International Court of Justice will fail. The only hypothetical strong solution depends on the acceptance, by both parties, of a compromise specifying conditions in which the States will accept to submit their dispute to the Court.

Therefore, the search for rules of international law prohibiting deliberate damages to the environment during times of war is only subsidiary.

Two international conventions deal mainly or secondarily with the respect of the environment during the war:

- **The Convention on the prohibition of military or any other hostile use of environmental modification techniques, 10 December 1976**

> ***Article 2*** *- As used in article 1, the term « environmental modification techniques » refers to any technique for changing - through the deliberate manipulation of natural processes - the dynamics, composition or structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space.*

The convention was signed in the context of the cold war when, at the height of the arms race between the Soviet Union and the United States, there were fears that one camp or the other might try to develop new weapons designed to act against the environment thereby achieving a decisive advantage.

First of all, the convention is a disarmament measure. It condemns "the techniques of deliberate manipulation of natural processes" but it does not deal with cases of damages to the environment by classical weapons.

Many countries ratified the convention. It entered into force in 1978 has never been implemented.

- **Additional Protocol to the Geneva convention of 12 August 1949 and relating to the protection of victims of international armed conflicts (Protocol I), 8 June 1977**

It contains several provisions concerning the protection of the environment:

> ***Part III.*** *Methods and means of warfare combatant and prisoners-of-war*
>
> ***Section I*** *- Methods and means of warfare*

Article 35 *- Basic rules*

1. *In any armed conflict, the right of the Parties to the conflict to choose methods or means of warfare is not unlimited.*

2. *It is prohibited to employ weapons, projectiles and material and methods of warfare of a nature to cause superfluous injury or unnecessary suffering.*

3. ***It is prohibited to employ methods or means of warfare which are intended, or may be expected, to cause widespread, long-term and severe damage to the natural environment.***

Article 55 *- Protection of the natural environment*

1. ***Care shall be taken in warfare to protect the natural environment*** *against widespread, long-term and severe damage. This protection includes a prohibition of the use of methods or means of warfare* ***which are intended or may be expected to cause such damage to the natural environment*** *and thereby to prejudice the health or survival of the population.*

2. ***Attacks against the natural environment by way of reprisals are prohibited****.*

The problem is that while Lebanon ratified the protocol on the 23rd of July 1997, **Israel never did**.

It is necessary to mention, in a subsidiary manner, that the decision of the court is certainly compulsory for the parties (art 59 of the Statute, art 94 of the Charter), however, only the Security Council of the United Nations has a coercive power to enforce the sentence. In other words, in case of non-implementation by one party, the other one may resort to the Security Council of the United Nations. But its decisions may be blocked by a veto of one of the 5 permanent States.

13.3.5.2 International Criminal Court

The creation of an International Criminal Court (ICC) by the Security Council of the United Nations in 1998 established the idea that individuals might be internationally prosecuted and condemned for serious violations of international law.

The Rome Statute establishing the Court entered into force in 2002 after 60 States had ratified it and in spite of the disagreement of the United States.

- **Who can be prosecuted?**

The jurisdiction of the Court is limited to individuals responsible for committing crimes, aiding, abetting or assisting in committing crimes falling under the jurisdiction of the Court. The Statute does not provide for the criminal prosecution of public or private legal entities.

In addition, Article 27 rules out any principle of immunity. Heads of States or Governments, members of government or parliament, elected representatives or government officials shall in no case be exempt from criminal responsibility.

Article 28 stipulates that military commanders must be held responsible for the crimes perpetrated by their subordinates. In addition, any crime within the jurisdiction of the Court committed pursuant to orders of a government or of a superior, whether military or civilian does not exempt the perpetrator from criminal responsibility (Article 33).

■ What are the violations of international law relevant to the ICC?

The ICC considers three (3) types of serious violations of international law: crimes against humanity, war crimes, and the crime of aggression. The provisions of article 8 of the treaty notably qualify of war crime the act of "intentionally launching an attack in the knowledge that such attack will cause incidental (…) damage to civilian objects or widespread, long-term and severe damage to the natural environment which would be clearly excessive in relation to the concrete and direct overall military advantage anticipated".

■ Under which conditions does the ICC have jurisdiction?

The ICC has jurisdiction if:

1- The crime was committed on the territory of a State which had ratified the treaty or

2- The crime was committed on the territory of a State which had not ratified the treaty but has made a declaration recognizing the jurisdiction of the Court or

3- The crime was committed by a national of a State which had ratified the treaty, or

4- The crime was committed by a national of a State which had not ratified the treaty but the case was submitted to the ICC by the Security Council of the United Nations, according to Chapter VII of the Charter of the United Nations.

■ Who can refer to the ICC?

The Rome Statute makes provisions for three (3) procedures for referring to the Court:

1- By a State Party

2- By the Security Council of the United Nations in accordance with chapter VII of the Charter

3- By the Prosecutor of the ICC according to information from States, international intergovernmental or non-governmental organizations.

For instance, the deliberate attack of Israel on the Jiyeh power plant on July 13 can be interpreted as a war crime. Therefore, the person or persons responsible for the decision of bombing the power plant could be subject to the International Criminal Court.

The problem is that **neither Lebanon nor Israel have ratified the treaty instituting the International Criminal Court**.

As to Lebanon, ratifying such a treaty creates a political problem knowing that this ratification would make Hezbollah internationally responsible for the following schemes: detention of Israeli citizens and soldiers, bombing Israeli civilians and using human shields.

On the other hand, Israel has signed the treaty on the 31st of December 2000 but does not intend to ratify it because of a clause which makes the transfer of civilians to occupied territories a war crime: The Hebrew State fears that the Jewish colonization in the occupied territories may be judged as such.

Therefore, unless submitted to the UN Security Council, the International Criminal Court can not pursue those responsible for the war crimes, if any, committed in Lebanon. However, this last assumption is highly unlikely since out of the 5 permanent members in the UN Security Council, only France and Great Britain have signed and ratified the treaty of the International Criminal Court. Russia has signed the treaty without ratifying it thereafter. Analysts do not expect Russia to sign the treaty before the end of the conflict in Chechnya. China and the United States do not acknowledge Court.

The incompetence of the International Criminal Court in the present conflict is unfortunate since the Court has the authority to grant the victims of these crimes indemnities and compensations (Article 75 in the Code). As such, the Court represents a balance between punitive justice and indemnities justice. This is the first time in human history that an international court has the power to order an individual to pay indemnities to another individual.

The Court has the possibility to grant an individual or collective indemnity concerning a full group of victims or a community, or both. Often, the condemned person will not receive the sum corresponding to the amount of the indemnity fixed by the Court. If the Court decides to grant a collective indemnity, it can then order that this indemnity be granted through *the Special Allocation Fund in aid of the Victims.* The indemnity can also be paid to an intergovernmental, international or national organization authorized by the Fund. This Fund was established by the Assembly of Member States in September 2002.

The Fund is supported by grants or allocations from governments, international organizations, individuals or enterprises. As of the 29th of August 2006, the Fund amounted to 1,630,237 Euros, in addition to 275,000 Euros already committed.

13.3.5.3 The International Oil Pollution Compensation (IOPC) Funds

The international convention instituting the IOPC funds on 18th of December 1971 needs to be ratified by national legislation in order to be applicable. The international convention was modified on the 27th of November 1992. The convention complements the international convention pertaining to the civil responsibility for the damages caused by hydrocarbon pollution, signed on the 29th of November 1969 and also modified on the 19th of November 1992. The system of international indemnification of damages caused by hydrocarbon pollution is based on these two conventions. However, like the Barcelona Convention, the system can only be applied to pollution resulting from hydrocarbons spilled from tankers, and not to pollution caused by damage to hydrocarbon tanks in war time.

One hundred (100) States are members of the fund, including Israel. However, Lebanon, which signed the new convention on civil responsibility in March 2006, did not ratify the new IOPC convention.

13.3.6 POLITICAL METHOD

The UN Security Council is the political organ of the United Nations. It offers a third way to settle international conflicts. With only a few exceptions, all States are members of the United Nations and by ratifying its Charter, the members of the Organization agree to accept and implement the decisions taken by the Security Council. The resolutions of the Security Council are mandatory decisions, as stipulated in Article 25 of the Charter.

In practice, many enforceable resolutions remain unfulfilled, or not completely implemented, mainly because Member States refuse to give sufficient human, material and financial resources to implement them.

Most armed conflicts and interstate aggressions are subject to a UN resolution charging the belligerents to stop hostilities or condemning the aggression. Some aggressions go even further, charging the aggressor to pay an indemnity to the attacked country.

Notably, and for the sake of illustration, the scale of the resolutions adopted after the first Gulf war exceed all others. In April 1991, following Saddam Hussein's defeat, the UN Security Council confirmed that Iraq was responsible, by virtue of the international law, for any loss and damage – *including the impact on the environment and the destruction of natural resources* – and for any other direct harm suffered by foreign States, individuals and foreign communities resulting from its invasion and illicit occupation of Kuwait (Resolution 687, the 3rd of April 1991, § 16). Consequently, the resolution stipulates the creation of an "indemnification fund for damages and harm" following the invasion of Kuwait, as well as a Compensation Commission in charge of managing the fund and receiving the indemnification requests (§ 18).

Saddam Hussein acknowledged Iraq's responsibility for the invasion of Kuwait and accepted resolution number 687. However he did not accept the procedural rules the Commission imposed upon him later.

The United Nations Compensation Commission (UNCC) for Iraq was officially established by the Security Council resolution 692 on the 20th of May 1991. Its administration board is composed of 15 Member States of the Security Council. The board decides the amount of indemnities to be paid to each plaintiff, by virtue of a report presented by three commissioners, who are experts chosen by the executive secretariat. The indemnities are deducted from 25 percent (30 percent till the end of 2000) of Iraq's annual revenues from its oil exports, a percentage Iraq is constrained to pay to the compensation fund within the framework of the UN "Oil for food" program. Only the governments can send complaints in their name or on behalf of their nationals or their communities or any other individual or legal entity residing in their territories.

The creation of a Compensation Fund by the UN Security Council is unprecedented in the United Nations history, and for several reasons. First, no compensation commission was created following other invasions declared illegal by virtue of the international law, such as Turkey invading the northern part of Cyprus (1974), Indonesia invading Eastern Timor (1976) or Israel invading the south of Lebanon (1982). However, in three cases – when Israel attacked Beirut Airport in 1968 (resolution 262, annexed), the Portuguese attack against Guinea in 1970 (resolution 290) or the attack of South Africa against Angola in 1976 (resolution 387, annexed) – the Security Council decided that indemnities should be paid to the victims, without fixing the amount thereof. In the case of Angola, the British representative in the Security Council said then: "The Security Council is not a court of justice and is not the appropriate place to decide upon indemnity requests."

Second, the UN Compensation Commission procedure for indemnity request is very simple, the Security Council's priority being to provide a fast indemnity to the victims. As such, Iraq does not have access to neither the complaints nor the experts' reports on which these complaints are based. Whenever Iraq is allowed to defend itself, it is within deadlines unrelated to the complexity of the files. Moreover, the pronounced decisions are without appeal. The UN Compensation Commission emphasizes that it is not a court and does not have these procedures. Therefore, the principles of defense acknowledged by the international law are not applicable to the Commission. Besides, in its report on the 2nd of May 1991, the UN Secretary General considered this commission as a political organ having "a quasi-judicial function".

The nature of the damages warranting indemnity is also unprecedented. Contrary to the international law, Iraq is not only forced to repair the damages it has caused, but also those caused by the allied forces. The lost revenues by enterprises, whether a multinational oil company such as Kuwait Petroleum Corporation or a regular Israeli merchant, are also considered as warranting compensation. As a result, millions of dollars were distributed to compensate lost revenues during the recession period. Finally, for the first time, paying indemnities for "damaging the environment and destroying natural resources" is expressly allowed.

However, more and more jurists, diplomats and NGOs are questioning the legality of the Compensation Commission.

The Security Council is the political organ of the United Nations and the Charter does not grant it any judicial power. Therefore, in principle it could not mandate a judicial power that it does not have to a subsidiary organ, namely the Compensation Commission. Only the international Court of justice – judicial organ of the UN system – has within its competence the ability to impose a mechanism of indemnities and compensation following an international disagreement.

If the international situation of 1991 led to the establishment of the UNCC, it is very unlikely that a similar institution could see the light again today. The United States contributed largely in imposing the UNCC in 1991. However, today the United States would probably be the first to work against the establishment of a similar institution against Israel.

Nevertheless, the three aforementioned resolutions, condemning attacks and demanding the Aggressor State to pay indemnities to the aggressed State, constitute interesting precedents.

At this point, it is necessary to mention that the 15 member States in the UN Security Council, by virtue of resolution 1701 adopted on the 11th of August 2006, have expressed their opinion with respect to the conflict between Hezbollah and Israel. The first lines of the resolution point out the aggressor responsible for the conflict, namely Hezbollah:

> *Expressing its utmost concern at the continuing escalation of hostilities in Lebanon and in Israel since Hezbollah's attack on Israel on 12 July 2006, (...)*
>
> *Emphasizing the need for an end of violence, but at the same time emphasizing the need to address urgently the causes that have given rise to the current crisis, including by the unconditional release of the abducted Israeli soldiers, (...)*

The resolution may seem very unbalanced and incomplete; however, it has become an integral part of the international law. From that moment, Lebanon's position is delicate. Although the Security Council makes the distinction between Hezbollah and the Lebanese State, Israel remains the aggressed state, not the aggressor. Therefore, the main injunctions are addressed to the Lebanese State, point 3 in particular:

> *3. Emphasizes the importance of the extension of the control of the Government of Lebanon over all Lebanese territory in accordance with the provisions of resolution 1559 (2004) and resolution 1680 (2006), and of the relevant provisions of the Taif Accords, for it to exercise its full sovereignty, so that there will be no weapons without the consent of the Government of Lebanon and no authority other than that of the Government of Lebanon;*

Moreover, not even one article condemns Israel for its disproportioned counter-attack or a fortiori for the purpose of some of its operations such as bombing the power plant in Jiyeh. However, the right for defence is well-defined in the international law and it seems very obvious that Israel has exceeded its right.

In its famous resolution on the 27th of June 1986, Nicaragua c/ United States, the International Court of justice defined the proportionality of the counter-attack:

> *237. (...) Whether or not the assistance to the contras might meet the criterion of proportionality, the Court cannot regard the United States activities summarized in paragraphs 80, 81 and 86, i.e., those relating to the mining of the Nicaraguan ports and the attacks on ports, oil installations, etc., as satisfying that criterion. Whatever uncertainty may exist as to the exact scale of the aid received by the Salvadorian armed opposition from Nicaragua, it is clear that these latter United States activities in question could not have been proportionate to that aid. Finally, on this point, the Court must also observe that the reaction of the United States in the context of what it regarded as self-defence was continued long after the period in which any presumed armed attack by Nicaragua could reasonably be contemplated.*

The drafting of resolution 1701 has been the subject of bitter negotiations inside the Security Council. A new evaluation of the legitimacy of the Israeli operations in Lebanon could lead to distinguish between the Israeli operations relative to legitimate defence and those that are illegitimate. This new evaluation of the Israeli operations and an exhaustive estimation of the damages suffered by Lebanon could lead to a redefinition of the conflict as "double aggression": Hezbollah against Israel first, then Israel against Lebanon later.

13.3.7 RECOMMENDATIONS

Table 13.3 summarizes the different methods of settlement discussed in this chapter. Whether diplomatic or judicial, there are, in theory, several methods to settle the disagreement between Lebanon and Israel. However, all these methods depend on the good will of this latter. It does not seem feasible that a diplomatic solution, an arbitration or a compromise could be reached between the two countries.

The unilateral recourse of the Lebanese State to the UN Security Council is the option left. This recourse will ask the Security Council to adopt a new, more critical resolution relative to the Israeli counter-attack, and could eventually redefine some operations such as the bombing the power plant in Jiyeh and consider it as a war crime, even though this definition is related to the international criminal law.

The new resolution should ask the parties to settle the matter of indemnity – including that for "damage to the environment and the destruction of natural resources" as in resolution 687 adopted by the Security Council – either before the International Court of Justice according to a purely judicial mode, or before an ad-hoc Commission established to compensate the States that suffered damages, through negotiations, in accordance with the international law.

Double aggression means double indemnification. If this new resolution makes a demand for indemnity of damages suffered by Lebanon, then it can not legitimately dismiss the necessary indemnification of the damages suffered by Israel resulting from Hezbollah's attacks.

The legal difficulty of this last point results from the fact that Hezbollah is not a State as defined by international law. Only States are subject to the international law. This difficulty may be solved if the Lebanese State convinces Hezbollah of the necessity to accept indemnity from damages suffered by Israel following Hezbollah's attacks, in order to secure even more important indemnities for the Lebanese population from the State of Israel.

Reaching such an agreement could be difficult. However, it must be integrated in the global negotiations relative to the implementation of the different UN resolutions concerning the "normalization" of Hezbollah, mentioned again in resolution 1701.

If Hezbollah agrees, the Lebanese State could inform the Security Council that it accepts to assume responsibility on behalf of Hezbollah.

One unknown would remain: the position of the Security Council members, in particular that of the United States, facing such a recourse showing the violations of international law by its Israeli ally. In fact, the procedure needs the unanimous agreement of the Council. However, a change in the American position is not to be excluded in the constantly changing context of events in the Middle-East.

Table 13.3. Summary of Different Modes of Settlement

Different modes of settlement	**Diplomatic**		**Judicial**			**Political**
Procedures or Proceedings	Negotiation/ mission of good offices/ mediation/ conciliation	Arbitral court	International Court of Justice	International Criminal Court	National Law	UN Security Council
Examples of Conventions		Barcelona Convention	Geneva Convention	Statutes of the International Criminal Court	FIPOL Convention	(UN Resolutions 262 or 387)
Applicability	**Not very realistic** Given the status of diplomatic relations between the two countries	**Not very realistic** Requires the will of the two parties. Barcelona Convention not applicable.	**Not very realistic** The two States did not acknowledge the obligatory competence of the Court, any recourse requires a direct agreement between the two States through compromise.	**Impossible** Neither Lebanon, nor Israel has ratified the statutes of the International Criminal court.	**Impossible** FIPOL Convention not applicable in this case. Lebanon did not ratify the convention	**Not very realistic but possible** It requires : - a global settlement of the causes and consequences of the war – Hezbollah has to pay indemnities to the Israeli victims on the basis of indemnities in return to the Lebanese population – The unanimous agreement of the Security Council

Annex 1

Resolution 262 (1968) of 31 December 1968

The Security Council,

Having considered the agenda contained in document S/Agenda/1462,

Having noted the contents of the letters of the Permanent Representative of Lebanon (S/8945),

Having noted the supplementary information provided by the Chief of Staff of the United Nations Truce Supervision Organization contained in documents S/7930/Add.107 and Add.108,

Having heard the statements of the representative of Lebanon and of the representative of Israel concerning the grave attack committed against the civil International Airport of Beirut,

Observing that the military action by the armed forces of Israel against the civil International Airport of Beirut was premeditated and of a large scale and carefully planned nature,

Gravely concerned about the deteriorating situation resulting from this violation of the Security Council resolutions,

Deeply concerned about the need to assure free uninterrupted international civil air traffic,

1. *Condemns* Israel for its premeditated military action in violation of its obligations under the Charter and the cease-fire resolutions ;
2. *Considers* that such premeditated acts of violence endanger the maintenance of the peace ;
3. *Issues* a solemn warning to Israel that if such acts were to be repeated, the Council would have to consider further steps to give effect to its decisions ;
4. ***Considers* that Lebanon is entitled to appropriate redress for the destruction it has suffered, responsibility for which has been acknowledged by Israel.**

Adopted unanimously at the 1462nd meeting.

Annex 2

Resolution 387 (1976) of 31 March 1976

The Security Council,

Having considered the letter of the Permanent Representative of Kerya on behalf of the African Group of States al the United Nations,

Having heard the statement of the representative of the People's Republic of Angola,

Recalling the principle that no State or group of States has the right to intervene, directly or indirectly, for any reason whatever, in the internal or external affairs of any other State,

Recalling also the inherent and lawful right of every State, in the exercise of its sovereignty, to request assistance from any other State or group of States,

Bearing in mind that all Member States must refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State, or in any other manner inconsistent with the purposes of the United Nations,

Gravely concerned at the acts of aggression committed by South Africa against the People's Republic of Angola and the violation of its sovereignty and territorial integrity,

Condemning the utilization by South Africa of the international Territory of Namibia to mount that aggression,

Gravely concerned also at the damage and destruction done by the South African invading forces in Angola and by their seizure of Angolan equipment and materials,

Noting the letter of the Permanent Representative of South Africa regarding the withdrawal of South African
troops,

1. *Condemns* South Africa's aggression against the People's Republic of Angola ;
2. *Demands* that South Africa scrupulously respect the independence, sovereignty and territorial integrity of the People's Republic of Angola ;
3. *Demands also* that South Africa desist from the utilization of the international Territory of Namibia to mount provocative or aggressive acts against the People's Republic of Angola or any other neighbouring African State ;
4. ***Calls upon* the Government of South Africa to meet the just claims of the People's Republic of Angola for a full compensation for the damage and destruction inflicted on its State and for the restoration of the equipment and materials which its invading forces seized ;**
5. *Requests* the Secretary-General to follow the implementation of the present resolution.

Adopted at the 1906th meeting by 9 votes to none, with 5 abstentions (France, ltaly, Japan. United Kingdom of Great Britain and Northern lreland, United States of America). One member (China) did not participate in the Voting.

14 SUMMARY AND CONCLUSIONS

The July war in Lebanon has caused severe environmental impacts, some of them being unprecedented in Lebanese and regional history, such as the impacts from the oil spill, resulting from the Israeli Air Force targeting of the Jiyeh fuel tanks. Environmental impacts resulting from the war were identified and prioritized, and specific interventions to mitigate these impacts were proposed to serve as a basis for a national environmental response program. Additional interventions that would promote the greening of the reconstruction phase are also proposed, and would serve as a first step towards leading Lebanon back to its path to sustainable development.