CLIMATE CHANGE VULNERABILITY AND ADAPTATION

PUBLIC HEALTH

Lebanon's Second National Communication

Ministry of Environment/UNDP

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1. VULNERABILITY AND ADAPTATION OF THE PUBLIC HEALTH SECTOR

1.1. VULNERABILITY ASSESSMENT

1.1.1. Background[1]

1.1.1.1. General Overview

The population of Lebanon is estimated at 4.29 million inhabitants in 2004[2]; 27.3% of which are under 15 years of age and 7.4% are over 65. The country is witnessing a demographic transition. The infant mortality rate has decreased from 33.5 per thousand in 1996/97 to 18.6 in 2004. This could not have been achieved without substantial reduction of the high mortality rates recorded in 1999 in the North and the Bekaa, and the lowering of regional disparities. Indicators showing the demographic transition in Lebanon between 1996/97 and 2004 are shown in Table 1-1. Life expectancy in Lebanon has been increasing and is expected to reach 76 in 2030 (WRI, 2006).

Table 1-1 Indicators of the demographic transition in Lebanon

	1996-1997	2004
Crude birth rate (per 1,000 mid-year population)	**25**	**16.9**
Crude death rate (per 1,000 mid-year population)	**7**	**4.1**
Infant Mortality Rate (per 1,000 Live Births)	**33.5**	**18.6**
Population <15 years (%)	**28**	**27.3**
Population >65 (%)	**6.5**	**7.4**
Dependency Rate (%)	**62.8**	**53.3**
Total Fertility Rate (Live Births per 1,000 women of childbearing age)	**2.5**	**1.9**
Population Growth Rate (%)	**1.8**	**1.58**

Sources: MoPH, 2009, MoPH, 2007

Health Care Status

While being in the midst of demographic transition, Lebanon is towards the end of its epidemiological transition phase: the health and financial impacts of infectious diseases are constantly declining, whereas the incidence and cost of chronic non-communicable diseases such as diabetes, hypertension and cancer are on the rise and are increasingly affecting the population (MoPH, 2009).

The changing epidemiological profile of diseases is putting the traditional health system under stress. The increasing burden of chronic, non-communicable diseases requires additional resources and health services to adapt to the emerging needs.

Health services are abundantly available in Lebanon and the majority of the population has access to an outpatient facility within a 10-minute walk, and a hospital within a 20-minute drive (MoPH, 2009).

Providers of Health Services

The role of the public sector in providing hospital care in Lebanon was subject to intense debate in the early 1990s. Private services were considered expensive and inequitably distributed, whereas public hospitals, that were part of the organizational structure of the MoPH, were inefficient.

1 The information in this section mostly relies on published MoPH figures that were extracted from the MoPH's Statistical Bulletins of 2006, 2007 and 2008, and "Health Beyond Politics" prepared by Walid Ammar in 2009.

2 This estimate was obtained through applying an annual growth rate of 1 percent to the CDR population record of 1997 that was of 4 million (CDR, 2005).

PUBLIC HOSPITALS' DEVELOPMENT

By the end of the civil war, only half of the 24 public hospitals were operational, with an average number of active beds not exceeding 20 per hospital. The Government's 1993 Reconstruction Plan aimed at rehabilitating and building public hospitals in order to have at least one in each governorate. The distribution of public hospitals in 2006 is shown in Table 1-2.

PRIVATE HOSPITALS' DEVELOPMENT

The development of the private hospital sector was relatively less affected by the civil disturbances and continued to grow both in number and capacity to represent more than 90% of the total number of hospital beds in the 1990s. This percentage decreased, with the opening of new public hospitals, to 80% (MoPH, 2009). In 2006, the total number of private hospitals in Lebanon was 189 distributed over the governorates as shown in Table 1-2.

COMMUNITY-BASED HEALTH SERVICES

- The Role of NGOs

In the period between 1975 and 1995, UN agencies played a major role in conducting essential health programs in joint coordination with NGOs.

Ever since, NGOs have been successfully providing health services by contributing to joint preventive programs carried out by the MoPH and UN agencies. Furthermore, some NGOs have been playing a meaningful supporting role in the health system by conducting surveys or training workshops, or by providing logistical support through purchasing, stocking and distributing essential medical supplies to a vast network of primary health care centers.

- The Primary Health Care (PHC) Network

Primary health care centers comprise health centers and dispensaries. In 2006, the number of such centers reached 1,085 distributed throughout Lebanon (Table 1-2).

Out of the total number, 142 health centers are affiliated to MoPH. Each health center has a defined catchment area and provides general medical care including pediatrics, cardiology, reproductive health and oral health.

The distribution of the different types of health providers by governorate is shown in Table 1-2.

Table 1-2 Distribution of health providers by governorate in 2006

	BEIRUT	MOUNT LEBANON	SOUTH LEBANON	NABATIYEH	NORTH LEBANON	BEKAA	TOTAL (100%)
Private Hospitals	21 (11%)	64 (34%)	24 (13%)	10(5%)	34 (18%)	38(19%)	189
Public Hospitals	2 (7%)	6 (20%)	4 (13%)	6 (20%)	7 (23%)	5 (16 %)	30[3]
PHC Centers	136 (12.5%)	402 (37.1)	219 (20.2%)	113 (10.4%)	63 (5.8%)	152 (14.0%)	1085

Source: MoPH, 2007

MOPH COVERAGE

With an allocation that never exceeded 4% of the total government budget (MoPH, 2009), the MoPH has to cover the hospitalization cost of uninsured patients and provide them with expensive treatments that cannot be afforded by some households. Indicators for budgetary resources for the year 2004 are presented in Table 1-3.

Table 1-3 Budgetary resources in the public health sector

INDICATOR (YEAR 2004)	AMOUNT
MoPH allocated budget (as % of total government budget)	3.67%
Public expenditure on health (as % of GDP)	2.35%
Annual MoPH budget (USD per capita)	63.97

Source: MoPH, 2005

A proportion of the MoPH's annual budget is allocated for covering uninsured patients, with the aim of ensuring universal accessibility to health services. These allocations have been growing over years with the development of the Ministry's financing function, leaving scarce resources to prevention, public health and regulation functions (MoPH, 2009). According to the National Survey of Household Living Conditions in 2004, 46.7% of the interviewed population declared being covered by one or more public or private insurance schemes (CAS, 2006). Accordingly, 53.3% of residents are not formally covered by any public or private agency, and hence, more than two million people are entitled for MoPH coverage, regardless of their ability to pay. Estimates based on the MoPH beneficiaries' database and adjusted by dependency ratios calculated from representative sampling, indicate that about 1.6 million were eligible for MoPH coverage in 2005 (MoPH, 2009). To undergo hospitalization (or tertiary treatment), an uninsured patient pays 5% of the bill in public hospitals, and 15% in private hospitals while the MoPH covers the rest of the due amount (MoPH, 2009).

Early Warning Alert and Response System (EWARS)

The EWARS was initiated in the areas that were most affected by the July 2006 war, mainly the PHC centers and the dispensaries in the South, then expanded throughout 2007 to 2009 to cover all regions in the country. The objectives of EWARS are to (WHO, 2010a):

- Establish a surveillance network for the early detection and monitoring of infectious diseases with epidemic potential or those targeted for elimination/eradication, as well as for other, new emerging and re-emerging infectious diseases;
- Enhance the role of health institutions in preventive health activities, by involving them in disease surveillance;

3 Only 23 are operational

- Strengthen the district, regional and central capacity to respond to potential outbreaks of new emerging and re-emerging diseases through the formation of rapid response teams at each level;
- Enhance communication of public health information about communicable diseases within the health system institutions and at the level of the population.

1.1.1.2. Health care and the local economy

Expenditures on health

The total expenditures on health care in Lebanon are among the highest in the world, estimated at 8.8% of total expenditures in 2004 (MoPH, 2008). The public share of total health expenditure was estimated at 43% in 2004 (Figure 1-1), entailing a heavy burden on the household income that has to ensure the rest. In fact, the share of health spending as a percentage of total household spending reached 9.23% per household in 2004 and the households' out-of-pocket direct payments were estimated at 44% of the total health expenditures by households and intermediaries in 2005 (MoPH, 2009).

On the overall, public expenditures on health, as a percentage of total expenditure (Figure 1-1), and total expenditures on health per capita in Lebanon have been increasing; they reached US $ 583 per capita in 2004 (Figure 1-2) (WRI, 2006).

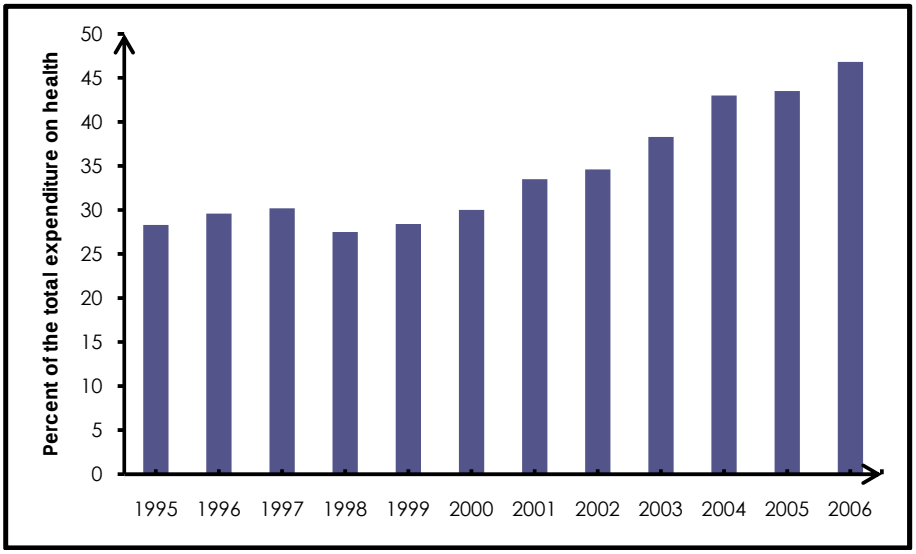

Figure 1-1 Lebanese government expenditure on health

Source: WRI, 2006

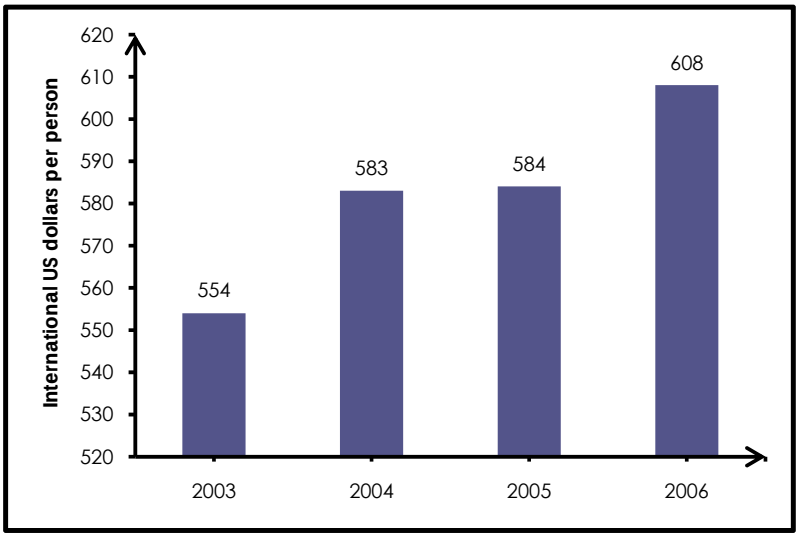

Figure 1-2 Total expenditure on health per capita in Lebanon

Source: WRI, 2006

1.1.1.3. Water and sanitation infrastructure

Water and sanitation are primary drivers of public health and once access to clean water and to adequate sanitation facilities are secured, the battle against certain communicable diseases would have been won (WHO, 2009a).

The national survey of household living conditions 2004 revealed that the public network is the most commonly used source of water supply (56.7% of primary residences). Mineral water is used by 31.8% of residences as the source of potable water, while 8.2% use artesian wells, 7.0% use purchased water tanks, 6.2% use a spring or running water, and 2.1% use private networks. Additionally, 8.4% of residences sterilize and or filter their water to make it potable (CAS, 2006). The survey also revealed that the majority of residences (67.4%) are connected to the public sanitation network, with 29.5% using septic tanks and 1.9% using open sanitation systems (CAS, 2006).

Most of the water distribution networks are old, subject to periodic cuts and present a high risk of contamination in areas where there is no sewerage network. People are exposed to water-borne diseases because of the lack of pressure in the distribution network when water is cut. This cut allows wastewater to pollute the freshwater network. Consequently, most of the water authorities use more chlorine than required, in order to fight any possible pollution through the distribution network (Jaber, 2002).

- The main sources of water pollution are: organic pollution, chemical pollution and seawater intrusion. Each type of pollution has its specific sources and impacts (Jaber, 2002).Organic pollution occurs when wastewater is mixed with the surface water or infiltrates into the groundwater through karstic limestone, thus polluting the aquifers. This may cause intestinal and hepatic diseases through drinking polluted water or eating raw green vegetables irrigated with polluted water, and even through the contact of injured skin with polluted water;
- Chemical pollution, which commonly originates from the disposal of chemicals (from industrial and agricultural practices) into public canals or the sewerage network, is toxic and may raise rates of cancer and other serious or fatal diseases when it mixes with water intended for direct or indirect human uses;

- Seawater intrusion: groundwater in coastal zones is subject to mixing with saline seawater due to over-extraction from coastal aquifers. This has occurred in some coastal areas such as Beirut, Jieh and Ghazieh. With saline seawater intrusion, aquifers become useless for drinking or even for irrigation. It could also damage sanitary equipment in houses. Most of the population in Beirut suffers from water quality problems associated with high salinity.

1.1.1.4. Disease burden

Lebanon is still in the epidemiological transition phase that started two decades ago, whereby infectious and communicable diseases remain endemic with an increase in the prevalence of non-communicable and degenerative diseases. In fact, Lebanon still reports endemic diseases such as tuberculosis, seasonal diarrhea, and zoonotic diseases such as brucellosis (WHO, 2006-2007).

The environmental burden of disease for selected risk factors and disease groups are summarized in Table 1-4.

Table 1-4 Environmental burden of disease for selected risk factors/disease groups

RISK FACTOR/DISEASE GROUP	DALYS/1000 CAP/YEAR
Water, sanitation and hygiene (diarrhoea only)	1.7
Diarrhoea	2.5
Cardiovascular disease	4.8
Asthma	1.4

Source: WHO, 2009b

1.1.2. Methodology

1.1.2.1. Scope of Assessment

Unit of Study

Climate change is expected to result in direct and indirect human health impacts causing manifold damages (World Health Summit, 2009). These are summarized below.

- The direct effects result from changing temperatures that trigger the outbreak of infectious diseases; from heat waves that can increase morbidity and mortality; and other extreme weather events and their consequences such as floods, storms, and massive fires, which can cause an increase in the number of casualties.
- The indirect effects of climate change on human health include droughts and floods affecting agriculture and leading to malnutrition; scarcity of clean water, which widely impairs hygienic conditions; and migration due to changing environments, which makes humans vulnerable to a whole host of diseases.

Spatial Frame

The assessment covers the whole country, focusing on groups that are likely to be affected by the impacts of climate change and that are designated as the "vulnerable groups[4]".

Temporal Frame

The analysis covers the whole year. In fact, temperatures and risk of droughts and floods causing the direct and the indirect effects of climate change on health are expected to vary across the seasons.

4 Groups that are vulnerable include the elderly, women, children, workers in certain occupations, population groups with low socio-economic status and refugees

The year 2004[5] was taken as a baseline year and the whole timeframe for the analysis extends until the year 2030.

1.1.2.2. Climate Factors

Human health would be adversely affected by higher temperatures and increased risk of floods. While higher temperatures may lead to alterations in the geographic range (latitude and altitude) and seasonality of certain infectious diseases including vector-borne infections and food-borne infections which peak in the warmer months, malnutrition risk and certain rodent-borne diseases are associated with flooding (WHO and UNEP, 2003).

1.1.2.3. Methods of Assessment

As a result of limited data availability, a qualitative assessment was conducted to evaluate the most vulnerable populations and regions and the most likely impacts of climate change on human health in Lebanon. It consisted of:

- Developing two baseline socio-economic scenarios to illustrate the current situation and forecast the future variation in the demographic, socio-economic and technological driving forces of the country.
- Developing a climate change scenario that indicates how climatic and climate related factors could probably change.
- Identifying vulnerable hotspots to climate change based on their social and biophysical exposure, sensitivity and their adaptive capacity to climate change.
- Setting out socio-economic indicators to define the sensitivity, adaptive capacity and vulnerability of vulnerable hotspots under socio-economic and climate change scenarios.
- Determining the likely climate change impacts through a literature review.

1.1.2.4. Data Sources and Gaps

Data included in this chapter were sourced from the following main sources:

- The Lebanese Ministry of Public Health (MoPH)
- The World Health Organization (WHO)
- The Lebanese Ministry of Environment (MoE)
- Council for Development and Reconstruction (CDR)
- Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report
- Report on the National workshop on Climate Change and Health: Impacts and Adaptation held in Beirut in November 2009[6].

Major data gaps that hindered further analysis for this chapter include:
Disease prevalence in Lebanon, particularly between the years 2000 and 2004 on the following: Cases of malaria, viral Hepatitis A, polio, cholera, dysentery, food poisoning, acute diarrhea, Typhoid fever, yellow fever, Brucellosis, Salmonella, asthma, allergic respiratory diseases, cardio-vascular diseases (heart disease, stroke, etc.), as well as the causes of death.

Moreover, data for the same years (2000-2005) has been lacking for the following parameters: proportion of the population using MoPH services and access to health care in various regions.

5 Given the lack of information, certain data and figures are given for other years as available.

6 Organized by WHO-EMRO in cooperation with the MoPH and MoE.

1.1.3. Scenarios

1.1.3.1. Human Health Sector Strategy

One strategy was devised by the NPMPLT to improve access to sanitation consequently improving public health status. Although not executed to date, this plan can cover 80% of the urban areas with primary infrastructure thus decreasing the probability of infections from water-borne disease vectors. The WHO-Lebanon and MoPH have also prepared a national framework for the health sector to alleviate impacts of climate change. Once put into action, this framework is expected to improve the adaptive capacity of public health services and mitigate potential impacts.

NPMPLT Strategy and Sanitation

The rate of connections to sewer networks and the individual practices of wastewater disposal still remain below the expected levels in almost all regions of the country (CDR, 2005). The present infrastructure for end treatment of wastewater remains incomplete. Planned wastewater treatment plants were 34 in 2005, of which one was already built and eight were in the pipeline for construction (CDR, 2005).

The NPMPLT outlined three phases in the supply of sanitation services:

- **Short-term phase** in which the priority should be given to two categories of regions:
  - Mountainous regions located in areas of extreme vulnerability, characterized by a shallow water table and/or where aquifers are being tapped by downstream villages and cities for domestic water supply. For these regions, the works should encompass collection of sewage water as well as treatment.
  - Regions with large agglomerations, where rehabilitation and extension of networks is needed. Treatment in these regions is of lower priority, except for interior agglomerations (Baalbeck, Zahle-Chtaura and Nabatiyeh), where wastewater infrastructure and treatment must constitute a top priority.
- **A second phase** will consist of endowing the isolated towns of more than 5,000 permanent residents (altogether representing around 17% of the localities) with collective treatment plants for groups of localities.
- **The last phase** that will probably come at the end of what would be possible to do until 2030 will concern towns with 2,000 to 5,000 permanent residents (25% of the localities).

National framework for health sector action to protect human health from climate change

A national workshop entitled "Climate Change and Health Impacts and Adaptations" was held in Beirut in November 2009. It outlined the elements of a national framework of action on climate change to protect the health of the population. The national framework of action was based on the WHO Framework that Lebanon has signed on its implementation. The Ministry of Public Health would lead the preparation and the implementation of the framework of action for the health component of climate change in collaboration with concerned national authorities and institutions. If implemented, the national framework of action on climate change may reduce the burden of climate-sensitive diseases/ disorders.

The objectives of the proposed national framework are summarized in Table 1-5.

Table 1-5 National framework for health sector action to protect human health from climate change

Proposed National framework for health sector action to protect health from climate change (Lebanon)
Objective 1: To ensure public health concerns and health protection from climate change are at the center of national, regional and international action on climate change. *Approaches to achieve Objective 1* ***Research national evidence*** and conduct sustained evidence-based advocacy to raise awareness, within and outside the formal health sector, of the need to protect health security from climate change. Assess the burden of disease by developing a list of indicators on which data needs to be collected and fed into registries for monitoring and surveillance of disease prevalence and incidence, and assess the magnitude of current health problems nationally. Engage effectively, as the lead sector on health, in the national processes of the United Nations Framework Convention on Climate Change. ***Form an inter-sectoral committee on which representatives from all ministries and concerned national authorities serve. The Committee shall oversee issues of climate change and health. This committee shall report to the Council of Ministers to suggest health protection measures that shall be integrated into the activities of all ministries***. In this respect, develop, in collaboration with other sectors, health protection measures and integrate them in climate change National Communications, National Adaptation Programs, and National Adaptation Plans of Action.
Objective 2: To Implement adaptive strategies at local and national level to minimize impacts of climate change on population's health. Approaches to achieve Objective 2 Undertake assessment of health vulnerability to climate change and generate a national health vulnerability profile with two explicit objectives: a) Identifying ***on the short, medium, and long term*** the additional direct and indirect threats to health from climate change; and b) ***Mapping health resources[7] available within the health system*** to cope with any additional burden of climate change on health and health systems and accordingly assessing the health system preparedness.

7 The following has been recently achieved with respect to this objective:

Mapping of human resources - Medical doctors in 2009

Hospitals Database, 2008-2009

Strengthen the health systems monitoring of the health impacts of climate change by empowering the MoPH capacity of monitoring and early warning on a specific set of indicators to be developed for surveillance systems, monitored and included in GIS[8] system on climate sensitive diseases. These indicators would include information on identified meteorological conditions and other environmental determinants related to energy, emissions, Pollution Standards Index, water security indicators, vector profile distribution and food security. Use standardized methods of data collection and reporting.

Empower and ensure sustainability for existing environmental health functions and services, within and outside the formal health sector, that already protect health from environmental risk factors, in order to respond to the additional threats of climate change. Priority threats are water security for health, water quality degradation, droughts, heat waves, food security and safety, vectors redistribution, air quality degradation, floods and other climate related natural disasters.

Based on health resources mapping and identified gaps, strengthen health systems' preparedness to cope with the additional burden of climate-sensitive health problems**.** Priority groups of diseases are water-borne diseases, food-borne disease, malnutrition associated with food insecurity, health effects of heat waves and extreme cold conditions, respiratory and other diseases associated with air pollution, vector-borne diseases and health effects of climate related disasters. ***Develop specified and standard technical units for the diagnosis such as laboratories.***

Oversee the process of undertaking interdisciplinary applied research and demonstration projects on health vulnerability to climate change and on effectiveness of health protection measures. ***Ensure translation of scientifically based applied research findings into policies, practice, and working strategies.***

Objective 3: To support "healthy" development strategies in other sectors that protect and promote health and mitigate climate change.

Approaches to achieve Objective 3

Build the capacity of health sector professionals in the identification of health impacts of development choices of other sectors (e.g. transport, energy, food, water, housing and urban development) that have bearings on health. After a burden is verified, ***capacity building shall be done based on a 3-level pyramid with Level 1 being the base of the pyramid, and Level 3 the top of the pyramid:***

GIS pharmacies, 2009

Primary Health Care centers, 2007

8 GIS: Geographic Information System

1. Level 1: Human resources and strengthening technical resources which is achieved through training workshops based on identified needs, case studies, preparedness of human resources and strengthening technical resources.
2. Level 2: Concerned authority that is engaged in the health sector and is related to the policy making process.
3. Level 3: Policy makers at the level of governmental authorities through the development of decrees and policies.

Engage health sector leaders and professionals in determining and supporting policy choices of other sectors that promote and protect health and at the same time mitigate climate change.

Establish institutional and legislative mechanisms to facilitate and mandate the health sector engagement in determination of development policies and choices in other sectors

Objective 4: To strengthen the institutional capacity of the public health systems for providing guidance and leadership on health protection from climate change.

Approaches to achieve Objective 4

Establish a national focal point on climate change and health ***who would be appointed by the Ministry of Public Health*** to enable health sector leadership and collaboration with other sectors on protecting health from climate change and to facilitate effective engagement of the health sector in the national UNFCCC processes.

- Establish a health and climate change task force within the Ministry of Public health with membership of concerned stakeholders especially those involved in preventative and protection functions and those involved in preparedness and in response to the climate-sensitive health issues.
- Strengthen the existing units in order to address the climate change impacts. Define vulnerable groups and activate epidemiological surveillance. Incorporate new health outcomes in the Epidemiological Surveillance Unit ***(***ESU***)*** that are expected to be of a great burden due to climate change. Increase and improve active reporting. At the preventive level, raise awareness on the health effects of climate change through organizing awareness ***events*** and training health care practitioners.
- Establish the institutional legislative mechanisms with the national UNFCCC focal point to mandate the health sector leadership on health protection from climate change within the national UNFCCC processes. ***MoPH as an essential stakeholder in climate change and health and a legal representative shall lead the committee and shall report to the government.***

1.1.3.2. Socio-economic Scenarios

In Lebanon, factors that define the sensitivity of human health to climate change are mainly:

- Population growth,
- Economic growth/ GDP growth,
- Preparedness/ prevention and adaptive capacity of the health care system and the population,
- Quality of/ access to health care, and
- Standards of living.

Based on the above-mentioned factors and the forecasts made by CDR in the NPMPLT (CDR, 2005), two baseline socio-economic scenarios (i.e. without climate change) can be developed to define the storylines of the public health sector in Lebanon up to 2030.

Scenario A This scenario is characterized by: ▪ Less balanced economic development ▪ GDP grows at an annual average rate of 4.2%[9] ▪ Low population growth: Population will grow, however at a decreasing rate – average of 0.35%[10] between 2010 and 2030 ▪ Low preparedness/ low prevention measures and adaptive capacity of the health care system and the population ▪ Unimproved quality of health care ▪ Current level of access of marginalized people to health care ▪ Same standards of living	This scenario assumes on one hand that the current conditions of the health care system along with the standards of living will remain the same while the size of the population barely increases. Even though the low growth in population size implies low growth in the demand for health services and low growth in hospital admissions in cases of emergency, the low GDP growth entails higher reliance on public provision of health services.
Scenario B This scenario is marked by: ▪ Balanced economic development ▪ Considerable GDP growth - GDP is assumed to grow at an annual average rate of 8.6% between 2010 and 2030 ▪ High population growth - Population will grow at a modest increasing rate with an average of 0.96%[11] between 2010 and 2030 ▪ Increased prevention measures of the health care system and higher adaptive capacity of the population ▪ Improved quality of health care ▪ Better access of marginalized people ▪ Better standards of living ~ 2.4 times higher	This scenario assumes that the current conditions of the health care system along with the standards of living will improve and that the growth in population will be high. While the high population growth implies higher demand for health care services and higher admissions in case of emergency, the high preparedness and increased use of prevention measures in the health care system allow for better health services.

The baseline socio-economic scenarios suggested above present the authors' estimation of likely developments in the provision of health services based on CDR's projected scenarios of development and demographic changes for the near future (by 2030).

9 This is an average of the actual GDP growth rate, at constant 1990 prices, between 2000 and 2004 (IMF, 2009).

10 This an average of the population growth rate in a **low-fertility scenario** as projected in the World Population Prospects: The 2008 Revision (UN, 2009).

11 This an average of the population growth rate in a **high-fertility scenario** as projected in the World Population Prospects: The 2008 Revision (UN, 2009).

1.1.3.3. Climatic Scenarios

Under the SRES A1B scenario, the annual mean warming recorded at 2.2°C between 1980 and 1999 will rise to 5.1°C between 2080 to 2099 in the Mediterranean region (Christensen et al., 2007).

Under the same scenario, it is forecasted that by 2040 temperatures in Lebanon will increase by 1°C on the coast to 2°C inland, and by 2090 the increase will be 3.5°C and 5°C higher, respectively. The projected changes of the simple daily intensity index (SDII)[12] indicate a decline in the rainfall intensity by the end of the century. The SDII decreases by six to 15 percent over three locations (Beirut, Zahle, Dahr-el-Baydar) by 2098 after an increase of six percent in Dahr-el-Baydar region by 2044.

A study by Shaban (2009) observed an increase in the number of rainfall peaks in Lebanon in the period after 1980s. Rainfall peaks represent torrential rain events, rain intensity and their behavior. High rainfall peaks increase the risk of flooding. The annual average number of rainfall peaks in Lebanon increased from 15 to 24 peaks in the period after 1980s. The average rate of torrential rain during these peaks was between 1 and 20 mm/day before the 1980s and 18-22 mm/day after that period. If the trend observed by Shaban (2009) is going to continue, where more rainfall peaks per year occur over the coming years, an increase of rainfall intensity is expected (Shaban, 2009).

1.1.4. Vulnerability Assessment

The vulnerability of a population depends on factors such as population density, level of economic development, food availability, income level and distribution, local environmental conditions, pre-existing health status, the availability and quality of health care and services and the population's accessibility to these services (WHO & UNEP, 2003). The vulnerability of a population group is the combination of its sensitivity to climate change and its ability to adapt to the projected changes in climatic factors.

1.1.4.1. Sensitivity to climatic factors

Increases in average temperatures may lead to extreme heat waves and extended dry periods during the summer while producing less extreme cold spells during the winter. This may directly affect human health. Particular segments of the population such as those with heart problems, asthma, the elderly, the very young and the homeless can be especially vulnerable to extreme heat (EPA, 2010). According to the EEWRC report, increases in temperatures would be higher in the interior than on the coast of Lebanon which leads to higher adverse health implications on the population living inland.

Other extreme weather events such as floods can also be destructive to human health and well-being by increasing event-related deaths, injuries, infectious diseases, and stress-related disorders (EPA, 2010).

1.1.4.2. Adaptive capacity

The main determinants of a community's adaptive capacity are economic wealth, technology, information and skills, infrastructure, institutions, and equity. Adaptive capacity is also a function of current population health status and pre-existing disease burdens (WHO & UNEP, 2003).

Economic resources: It is widely accepted that wealthy nations have a greater capacity to adapt because they have the economic resources to invest in adaptive measures and to afford the costs of adaptation. It is also recognized that poverty is directly related to vulnerability and that the poorest groups in the poorest countries are the most vulnerable to the health impacts of climate change (WHO

12 SDII is the annual total rainfall (mm)/number of days with rainfall ≥ 1 mm.

& UNEPA, 2003). Given that the budget allocated to MoPH never exceeded 4% of the total government budget (paragraph 1.1.1.2), the lack of economic resources could make the sector less adaptive to the projected changes in climatic factors.

Technology: Advances in technology, such as new drugs or diagnostic equipment, can substantially increase our ability to solve health problems. Generally, the availability and access to technology at the individual, local, and national levels, in key sectors such as agriculture, water resources, health, is an important determinant of adaptive capacity (WHO & UNEPA, 2003). The health sector in Lebanon is constantly improving in terms of medication supply and introduction of recent medical equipments, which enhances the adaptive capacity of the sector.

Information and skills: In general, countries with higher levels of "human capital" or knowledge are considered to have greater adaptive capacity (WHO & UNEPA, 2003). On one hand, according to the UNESCO, Lebanon has achieved close to 90% literacy (UNESCO, 2000) which enhances the effectiveness of most of health education programs relating to adaptive measures. On the other hand, the ongoing training of personnel on climate change impacts and adaptation is essential to the country's ability to formulate and implement adaptation measures.

Infrastructure: Adaptive responses to health impacts of climate change are enhanced by infrastructures specifically designed to reduce vulnerability to climate variability; such as flood control structures, air conditioning, building insulation, and stringent building codes, and general public health infrastructures; such as sanitation facilities, waste water treatment, and water supply systems. Public infrastructure such as roads, bridges, water systems and drainage, mass transit and buildings can reduce vulnerability to climate change due to improved access and outreach in the case of weather-related disasters. It also has the potential to be adversely impacted which can increase vulnerability to climate change (WHO & UNEPA, 2003). Some of these features are available in Lebanon; such as public infrastructure, health care facilities, and air conditioning, while others are not well developed; for example building insulation and codes, waste water treatment, water supply systems, flood control structures, and mass transit, thus limiting the health sector's adaptive capacity.

Institutions: Countries with less-effective institutional arrangements have a lower capacity to adapt than countries with well-established and effective institutions. Inadequate institutional support is frequently cited as a hindrance to adaptation (WHO & UNEPA, 2003). Lebanon suffers from weak institutional arrangements, conflicting mandates between public authorities as well as institutional gaps, which weaken its adaptive capacity.

Equity: It is argued that adaptive capacity will be greater if access to resources within a community or nation is distributed equitably (WHO & UNEPA, 2003). Unequal access to improved water and sanitation infrastructures and health care systems (see paragraphs 1.1.1.31.1.4.3) could adversely affect the adaptive capacity of some population groups.

Health status and pre-existing disease burdens: Population well-being is an important ingredient and determinant of adaptive capacity (WHO & UNEPA, 2003). The insufficient data on disease incidence/prevalence in Lebanon makes it hard to predict the population well-being in the country. However, the increase in prevalence of chronic diseases reduces the population's adaptive capacity.

1.1.4.3. Results of the Vulnerability Assessment

As mentioned previously, a population's vulnerability is defined as a joint function of, first, the extent to which a particular health outcome is sensitive to climate change and, second, the population's capacity to adapt to new climatic conditions (WHO & UNEPA, 2003). It is emphasized by the low

preparedness of the health care systems in countering outcomes of climate change in addition to the lack of data monitoring and surveillance of disease incidence/ prevalence.

The National Workshop on Climate Change held in Beirut in November 2009 identified the groups that are vulnerable to climate change in Lebanon as the elderly, women, children, workers in certain occupations, population groups with low socio-economic status and refugees. The sensitivity of these population groups and their adaptive capacity are summarized below.

The elderly population

Senior citizens (>65 years) represent 10.9% of the total population in Lebanon (2008). They are mostly sensitive to thermal stress during heat waves and health stress during other extreme weather events. Their vulnerability is due to their low adaptive capacity amid the lack of public safety nets such as pensions and insurance systems for this group of the population. Additionally, the elderly population can face unequal access to healthcare, as they are often unable to travel long distances to the nearest health facility.

THERMAL STRESS

Thermal stress could be risky for the elderly given that an aged body's ability to control its internal temperature decreases with time. Furthermore, their reduced fitness and nutritional status, as well as increased incidence of illness, disability, and medication use make the aged more exposed to thermal stress risk. Studies have shown that heat waves are a cause of heatstroke, cardiovascular and respiratory disease, and that heat-related mortality is highest in those over 50 years of age (Kovats, 2007).

EXTREME WEATHER EVENTS

Extreme weather events are likely to cause physiological and psychological stress due to loss of property during extreme events such as floods and injuries, mortality and displacement among the aged. Pre-existing conflicts and prevalent poverty in Lebanon will exacerbate the eventual consequences of weather events.

Women

In Lebanon women constituted 49.7% of the population in 2006 (MoPH, 2006). They are mostly sensitive to thermal stress and exposure to extreme weather events. Not having the same or direct access to the financial, technological and social resources that men have, in addition to limited participation in decision-making may have consequently made women less able to confront climate change (UNDP, 2009).

THERMAL STRESS

Studies have shown that women are at a higher risk of succumbing to heat stress, due to physiological (e.g. menopausal women) and social factors (e.g. single women) (Kovats, 2007).

EXTREME WEATHER EVENTS

The "Climate Change Connections" report prepared by the United Nations Population Fund (UNFPA) and Women's Environment & Development Organization (WEDO) (2009) reveals that women and children are 14 times more likely than men to die during natural disasters, and that a high percentage of women (single, divorced, poverty-stricken, pregnant) die in natural disasters. According to the "Gender and Climate Change" report, this is because of their social roles and because of discrimination and poverty (UNDP, 2009).

Children

Four percent of Lebanese children under 5 were moderately to severely underweight between 2000 and 2007 (UNICEF, 2004). Children are vulnerable to thermal stress and extreme weather events given their dependency and low natural resilience. Because of their relatively lower level of understanding and especially their lack of social power within family and community (Batlett, 2008), children may have difficulties in adapting to climate change implications.

THERMAL STRESS

Children are at increased risk of heat strokes, heat exhaustion and dehydration.

Children are in a rapid stage of development and are less equipped to deal with deprivation and stress, due to rapid metabolism, immature organs and nervous systems, developing cognition, limited experience and various behavioral characteristics (Barlett, 2008).

Children in conflict are also vulnerable to climate change-related events. Their sensitivity combined with their very low adaptive capacity given their displacement, homelessness and mental /emotional distress situation makes children in active conflict areas highly vulnerable.

EXTREME WEATHER EVENTS

- When faced with extreme weather events, children will face injury, surrounding death, infectious disease outbreaks following natural disasters, higher prevalence of vectors, shortage of food supplies and mental/emotional distress.

Laborers in outdoor working environments

Given their work conditions, people working outdoors are more at risk of heat strokes.

Heat waves place extra strain on the cardiovascular system through dehydration and increased blood viscosity. People on medication might be more sensitive to heat waves.

Population groups with low socio-economic status (SES)

A study on poverty, growth and income distribution in Lebanon finds that nearly 28 per cent of the Lebanese population can be considered poor and eight percent can be considered extremely poor (Laithy et al., 2008). The bulk of the poor (two-thirds of extremely poor) across the whole country is concentrated in four strata or regions: Tripoli, Akkar/ Minieh-Dennieh , Jezzine/Saida, and Hermel/Baalbek.

Given their low access to livelihoods assets, especially improved water and sanitation, the poor infrastructure of their households and their unbalanced diet, the population groups with low SES are more sensitive to infectious diseases and mental illnesses, and have limited access to medical care. In addition, less adequate types of housing among this group might increase their risk of heat-related mortality.

Refugees

In Lebanon, refugees are primarily Palestinians, Iraqis and seasonal migrants.

More than 400,000 registered Palestinian refugees live in 12 official refugee camps where living conditions are poor due to poor building structures and lack of proper public infrastructure leading to water shortages, contaminated water supplies and poor sanitation. These conditions result in a higher risk for water-borne disease transmission. Climate change may worsen the situation by threatening livelihood, food and water security of refugees.

Seasonal agricultural labor, mostly associated with Bedouins in the Bekaa valley, rely on tents for housing which increase their vulnerability to natural disasters.

The vulnerability of human health to climate change under Scenario A will be higher than in Scenario B. Even though Scenario A assumes a low growth in population size which implies a low growth in the demand for health services and a low growth in hospital admissions in cases of emergency, the low GDP growth entails an unequal access to health services leading to a lower adaptive capacity especially among the vulnerable groups. On the other hand, the improvement of the current conditions of the health care system along with the standards of living characterizing Scenario B in addition to the high preparedness and increased use of prevention measures in the health care system could allow for better health services leading to higher adaptive capacity of the population groups.

As a result of the above analysis and taking into account the two socio-economic scenarios, a summary of the assessment of vulnerable population groups is shown in Table 1-6.

Table 1-6 Vulnerability of population groups

POPULATION GROUP	SENSITIVITY TO CLIMATE CHANGE	ADAPTIVE CAPACITY	VULNERABILITY
Elderly residents	High sensitivity to thermal stress and extreme weather events	Scenario A: Very Low	Very High
		Scenario B: Low	High
Women	High sensitivity to thermal stress and extreme weather events	Scenario A: Very Low	Very High
		Scenario B: Low	High
Children	High sensitivity to thermal stress and extreme weather events	Scenario A: Very low	Very high
		Scenario B: Low	High
Laborers in outdoor working environments	High sensitivity of certain occupations to heat-related outcomes	Scenario A: Very Low	Very High
		Scenario B: Low	High
Population with low SES	High sensitivity to chronic diseases and heat stress	Scenario A: Very Low	Very High
		Scenario B: Low	High
Refugees	High sensitivity to food/water-borne diseases and extreme events (natural disasters)	Scenario A: Very Low	Very High
		Scenario B: Low	High

1.1.5. Impact Assessment

The extent and nature of climate change impacts on human health vary by region and by relative vulnerability of population groups given the extent and duration of exposure to climate change itself and society's ability to adapt to or cope with the change. Future vulnerability to climate change is determined to a large extent by the socio-economic scenarios already defined. As per the development patterns outlined in the two scenarios, it is assumed that under Scenario A, the

population will have a low adaptive capacity when confronted with the health effects of climate change. Impacts will be more severely felt under Scenario A than under Scenario B which signals a higher adaptive capacity due to public investment in the health care services.

The Fourth Assessment Report of the IPCC (Confalonieri et al. , 2007) concludes that human beings are exposed to climate change through changing weather patterns (for example, more intense and frequent extreme events) and indirectly through changes in water, air, food quality and quantity, ecosystems, agriculture, and economy. At this early stage the effects are small but are projected to progressively increase in all countries and regions (EPA, 2010).

1.1.5.1. Selected Impact Indicators

The following indicators (Table 1-7**Error! Reference source not found.**) were selected to assess the likely impact of climate change on the identified vulnerable systems under each of the two socio-economic scenarios.

Table 1-7 Indicators for analysis of climate change impacts on vulnerable groups

VULNERABLE POPULATION GROUP	INDICATOR	RELEVANCE
Elderly residents	Number of heat related deaths	Number of heat related deaths increases with increased temperature
Women	Prevalence of heat stress related diseases	Prevalence of heat stress related diseases increases with increased temperature
Children under 5 years	Prevalence of malnutrition	Prevalence of malnutrition increases with lower food availability caused by predicted higher temperatures and lower precipitation that might affect some crops
Laborers in outdoor working environments	Cases of heat stroke	Cases of heat stroke would be higher in higher temperatures
Population with low SES	Prevalence of chronic diseases	Heat exposure can aggravate chronic diseases
Refugees	Cases of water-borne diseases	Proliferation of disease-causing organisms is related to temperature Climate conditions affect water availability and quality Extreme rainfall can affect the transport of disease-causing organisms into the water supply
All groups	Lebanese government expenditure on health	Lebanese government expenditure on health increases with climatic changes
All groups	Total expenditure on health per capita	Total expenditure on health per capita increases with climatic changes

1.1.5.2. Impacts from climatic and non-climatic factors

In the Eastern Mediterranean Region EMR B which includes Lebanon, the total deaths from all causes[13] in thousands attributable to climate change for the year 2000 was estimated at 5.65/ million population and the total estimated disease burden from all causes[13] in thousands of DALYs (Disability-Adjusted Life Years) attributable to climate change for the year 2000 was estimated at 166.62/ million population (WHO, 2007a).

Direct effects of climate change on health

HEAT WAVES AND HEAT-RELATED IMPACTS ON HEALTH

Heat effects associated with exposure to extreme prolonged heat appear to be related to temperatures above those which the population is accustomed to (Nuwayhid et al., 2009). Elevated temperatures during summer months are associated with excess morbidity and mortality. Exposure to extreme and prolonged heat is associated with heat cramps, heat syncope, heat exhaustion and heat stroke (Nuwayhid et al., 2009). Increased incidence of heat waves and hot extremes affects those with existing heart problems, asthma, the elderly and the very young. Furthermore, intense short-term fluctuations in temperature can also seriously affect health, causing heat stress (hyperthermia) or extreme cold (hypothermia), and lead to increased death rates from heart and respiratory diseases (WHO, 2010b).

Under the SRES A1B scenario, it is forecasted that by 2040 temperatures in Lebanon will increase by 1°C on the coast to 2°C inland, and by 2090 the increase will be 3.5°C and 5°C higher.

Furthermore, a study conducted in Greater Beirut (El-Zein et al., 2004) covering the years 1997 to 1999 revealed a strong association between temperature and mortality, and no association between humidity and mortality (Figure 1-3). The authors concluded that heat-related mortality may constitute a significant public health concern even in temperate to warm climates. As per the study findings, a 1°C rise in temperature yielded a 12.3% increase (95% CI: 5.7–19.4%) and 2.9% decrease (95% CI: 2–3.7%) in mortality, above and below the minimum mortality temperature[14] threshold T_{MM} of 27.5°C, respectively.

Based on the findings of the climate projections for Lebanon mentioned above, an increase in mortality above T_{MM} is expected to vary between 12.3% and 24.6 %, and a decrease in mortality below T_{MM} is expected to vary between 2.9% and 5.8% by 2030. The calculated percentages when applied to the crude death rate of 4.1 per thousand of 2004 (MoPH, 2007) and the population growth figures used in Scenarios A and B reveal the following:

- For Scenario A, the average mortality above T_{MM} caused by climate change ranges between 2,483 and 4,967 extra deaths/year between 2010 and 2030.
- For Scenario B, the average mortality above T_{MM} caused by climate change ranges between 2,627 and 5,254 extra deaths/year between 2010 and 2030.

Vulnerable population groups, especially the elderly and population groups in the more socio-economically deprived areas, in semi-arid areas and in areas with lower access to health services are more at risk as a result of their high sensitivity and lower adaptive capacity.

13 All causes include: malnutrition, diarrhea, malaria, floods, and cardiovascular diseases.

14 The minimum mortality temperature or TMM is the temperature threshold above which mortality risk increases.

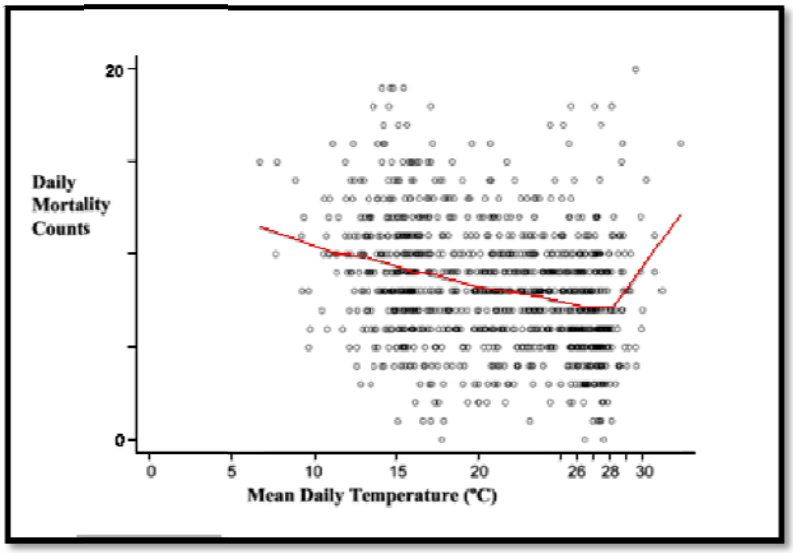

Figure 1-3: Correlation between temperature and number of deaths

Source: El-Zein, 2004

HURRICANES AND FLOODS

The effects from natural disasters can be either directly sensed through claiming the lives of many people and injuring a lot more, or indirectly through displacing people, destroying their crops, and temporarily disrupting their livelihoods. Victims of natural disasters are at a high risk of malnutrition, diarrhea and water-borne diseases caused by crowding and lack of hygiene (WHO, 2007b).

According to the NPMPLT (2005), while certain areas in Lebanon are prone to natural hazards (floods, landslides, etc.), hurricanes are unlikely to take place in Lebanon (please refer to the Human Settlements and Infrastructure section). For example, on May 16, 2007, a flood devastated several villages in the Bekaa region. As a consequence, crops were destroyed and people had to leave their houses because of high water levels (Nuwayhid et al., 2009). Injury and death could result from such natural hazards, especially in the less developed areas with weak socio-economic structures. Women, children and the elderly, especially the uninsured, would be highly affected in such events.

Indirect effects of climate change on health

The effects of climate change on existing environmental and public health problems are difficult to discern. The challenge is to identify the 'additionality', i.e., the increase in health problems that can be attributed to climate change as an additional risk factor. This requires advanced and far reaching research agendas and tools (Nuwayhid et al., 2009). The Arab world unfortunately remains one of the least published globally and, if published, in journals and reports that are not easily accessible through the Internet or recognized databases. The collection of primary data remains weak. For instance, Lebanon still lacks air quality monitoring programs, which hampers any attempt to look at trends in air pollution or to critically examine its causes (Nuwayhid et al, 2009).

The following sub-section reviews the impact of infectious diseases and air quality on health and the potential contribution of climate change to both issues.

INFECTIOUS DISEASES

Evidence on the associations between climatic conditions and infectious diseases is well established (WHO & UNEPA, 2003). Waves of infectious diseases occur in cycles; the risk of its incidence can be

higher in crowded areas and regions with depleted environmental resources. Furthermore, global travel can help pandemics cascading across continents (Epstein, 2004).

- Vector-borne and rodent-borne diseases

Vector-borne infectious diseases are transmitted by arthropods, such as mosquitoes, ticks, sandflies, blackflies and rodents. These morbidities are climate sensitive and are the most studied in terms of relation with climate change (Nuwayhid et al, 2009).

- Malaria

The number of malaria cases of malaria reported in Lebanon in 2004 was 68[15] (MoPH, 2006), but they had all originated in Africa. No data was found about the current area of distribution of the malaria vectors. Climate change is projected to influence the geographical distribution and intensity of transmission of malaria, due to changing patterns of rainfall, humidity and particularly seasonal variation of temperature (Confalonieri et al., 2007). As an example, the falciparum malarial protozoa takes 26 days to incubate at a temperature of 25°C, while at a temperature of 26°C this same protozoa takes only 13 days to incubate (Epstein 2004). Temperature thresholds limit the geographic range of mosquitoes. Transmission of Anopheline-borne falciparum malaria occurs where temperatures exceed 16°C (Epstein, 2004). Therefore, it is feared that the expected increase in temperature in Lebanon might widen the area of distribution of the vectors, favoring their growth and development over time. In that case, population groups with lower socio-economic status, no insurance coverage, and lower access to health care, as well as children and the elderly will be more vulnerable as a result of their higher sensitivity and lower adaptive capacity.

- Dengue Fever

This is an acute febrile disease caused by a flavivirus, which is transmitted by the bite of previously called Aedes mosquitoes (now named *Stegomyia aegypti*) (Nuwayhid et al, 2009). Dengue is endemic throughout the tropics and subtropics, threatening approximately one-third of the world's population. Its transmission increases with high rainfall, high temperature, and even, as some studies show, during droughts (Confalonieri, et al., 2007). Lebanon does not currently appear on the map of the countries at risk of dengue transmission as issued by the WHO in 2008 (Figure 1-4). However, with the expected increase in temperature and drought periods, dengue transmission might emerge in Lebanon.

15 The number of reported cases in this study may not be representative of the entire country and may be underestimated because of the lack of data provided by hospitals.

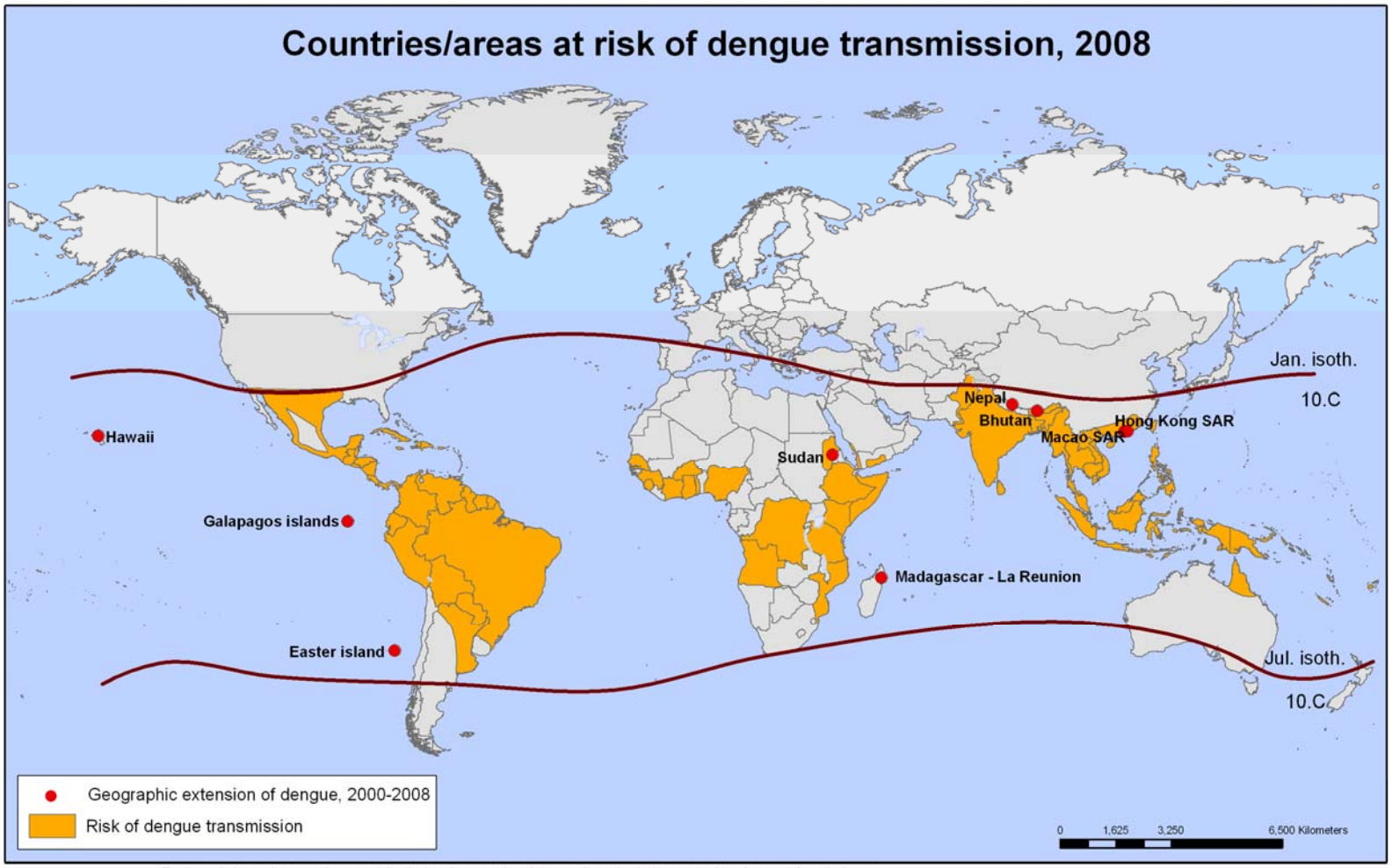

Figure 1-4 Countries/areas at risk of dengue transmission, 2008

- Other vector-borne diseases

Yellow Fever

There are two modes of transmission of the yellow fever virus, the sylvatic or forest cycle and the urban cycle. Transmission begins when vector mosquitoes (*Aedes africanus* in Africa, and several species of the genus *Haemagogus* in South America) feed on non-human primates infected with the virus. The infected mosquitoes then feed on humans travelling through the forest leading to their infection (WHO & UNEPA, 2003). No cases were reported in Lebanon for the years 2007 and 2008.

Encephalitis

The virus that causes Japanese encephalitis (JE), an infection of the membranes around the brain, is transmitted by some mosquitoes of the genus *Culex*. These mosquitoes prefer to breed in vast expanses of freshwater, and normally are associated with flooded rice fields in the early stages of the cropping cycle. Key species are C. *gelidus* and C. *tritaeniorrhynchus* (WHO, 2010c). Since rice production and pig rearing are not very common in Lebanon, the risk of Encephalitis transmission does not seem to constitute a problem in the future.

Yellow fever and Encephalitis are unlikely to become prevalent in Lebanon because dense forests, intensive pig farms, and rice paddies are not common.

Rodent-borne diseases Rodent-borne diseases are zoonoses that are transmitted directly to humans by contact with rodent urine, feces, or other body fluids (Confalonieri et al., 2007). Rodents are principle hosts for arthropod vectors such as fleas and ticks. Environmental factors that affect rodent population dynamics include unusually high rainfall, drought and introduction of exotic plant species. Rodent-borne pathogens are affected indirectly by ecological determinants of food sources that affect rodent population size (Confalonieri et al., 2007). The rodent-borne diseases that are associated with flooding include leptospirosis, tularaemia and viral hemorrhagic diseases (WHO & UNEPA, 2003). These diseases might flourish in Lebanon in case of increased floods. Other diseases associated with rodents and ticks include plague, Lyme disease, tick borne encephalitis (TBE) and Hantavirus pulmonary syndrome (HPS) (WHO & UNEPA, 2003).

- Water-borne and food-borne diseases

The implementation of CDR's plan regarding wastewater collection and treatment is expected to reduce the burden of water-borne diseases that are also at risk of resulting in outbreaks due to climate change. These diseases are cholera, typhoid, hepatitis A and diarrhea.

- Cholera

Cholera is caused by the bacterium *Vibrio cholerae*. Its outbreaks can occur sporadically in any part of the world where water supplies, sanitation, food safety and hygiene practices are inadequate. Overcrowded communities with poor sanitation and unsafe drinking-water supplies are most frequently affected. The potential contamination of drinking water supplies and disruption of sewer systems and/or wastewater treatment plants that could result from climate change could lead to an increased incidence of cholera cases. Regions with lower access to sanitation will be more exposed to water-borne diseases, and those with lower access to health care and insurance coverage, in addition to children and the elderly, will be more affected (WHO, 2010d).

- Typhoid

Typhoid and paratyphoid fevers are infections caused by the bacteria *Salmonella typhoid* and *Salmonella paratyphi* respectively which are transmitted through feces and into food and water

sources. Clean water, hygiene and good sanitation prevent the spread of typhoid and paratyphoid. Contaminated water is one of the pathways of transmission of the disease (WHO, 2010e).

Typhoid and paratyphoid fevers are common in less-industrialized countries, principally owing to the problem of unsafe drinking water, inadequate sewage disposal and flooding (WHO, 2010e). These problems might be aggravated by climate change in Lebanon, leading to an increased incidence of typhoid and paratyphoid fevers, with similar exposure and vulnerability patterns to Cholera.

- Hepatitis A

Hepatitis, a broad term for inflammation of the liver, has a number of infectious and non-infectious causes. Two of the viruses that cause hepatitis (hepatitis A and E) can be transmitted through water and food; hygiene is therefore important in their control. Hepatitis A is particularly frequent in countries with poor sanitary and hygienic conditions. Countries with economies in transition and some regions of industrialized countries where sanitary conditions are sub-standard are also highly affected (WHO, 2010f). Potential worsening of sanitary and hygienic conditions as a result of climate change is expected to increase the incidence of Hepatitis A, with similar exposure and vulnerability patterns to Cholera and Typhoid.

- Diarrhea

Diarrhea is a symptom of infection caused by a host of bacterial, viral and parasitic organisms most of which can be spread by contaminated water. More variable rainfall patterns are likely to compromise the supply of fresh water. Globally, water scarcity already affects four out of every 10 people. A lack of water and poor water quality – which are expected consequences of climate change in Lebanon – can compromise hygiene and health. This increases the risk of diarrhea (WHO, 2010g), especially in remote areas with lower socio-economic status and lower access to sanitation. Population groups with inadequate access to health care and insurance coverage, as well as children and the elderly would be most affected.

The infectious agents that cause diarrhea are present or are sporadically introduced throughout the world. Diarrhea is a rare occurrence for most people who live in developed countries where sanitation is widely available, access to safe water is high and personal and domestic hygiene is relatively good; but is widespread throughout the developing world (WHO, 2010g).

- Respiratory diseases

Respiratory disorders may be exacerbated by warming-induced increases in the frequency of smog (ground-level ozone) events and particulate air pollution (EPA, 2010).

Ground-level ozone can damage lung tissue, and is especially harmful for those with asthma and other chronic lung diseases. Sunlight and high temperatures, combined with other pollutants such as nitrogen oxides and volatile organic compounds, can cause ground-level ozone to increase. Climate change may increase the concentration of ground-level ozone, but the magnitude of the effect is uncertain. For other pollutants, the effects of climate change and/or weather are less well studied and results vary by region (Confalonieri, et al., 2007). In Lebanon, cases of asthma and chronic lower respiratory diseases have been reported and thus the proportion of the urban population with existing respiratory problems would be at a higher risk of damage to lung tissue as rising air temperatures cause a higher build-up of ground-level ozone concentrations.

Another pollutant of concern is particulate matter (PM) also known as particle pollution. Particulate matter is a complex mixture of extremely small particles and liquid droplets. When breathed in, these

particles can reach the deepest regions of the lungs. Exposure to particle pollution is the main cause of a variety of health problems in cities including f visibility impairment (haze). Climate change affects natural or biogenic sources of PM such as wildfires and dust from dry soils (EPA, 2010).

Air samples collected from several locations in Beirut revealed that Total Suspended Particulate Matter (TSP) concentrations range from 102 to 291 μ/m^3 with an average value of 166 μ/m^3 (El-Fadel & Massoud, 2000). This value is above the maximum permissible levels of TSP by the Lebanese standards (Table 1-8).

Table 1-8 Reference standards and guidelines of average ambient TSP concentration

STANDARDS	*TSP (μG/M³) (SHORT-TERM)*
EU limit values	*300*
USEPA	*75*
WHO guidelines	*150-230*
WHO guidelines for Europe	*120*
Lebanon	*120*

Source: El-Fadel & Massoud, 2000

- Malnutrition

Malnutrition causes millions of deaths each year worldwide, from both a lack of sufficient nutrients to sustain life, and a resulting vulnerability to infectious diseases such as malaria, diarrhea, and respiratory illnesses. Increasing temperatures on the planet and more variable rainfalls are expected to reduce crop yields in many tropical developing regions, where food security is already a problem (WHO, 2010b). Food security in Lebanon is also at risk, since Lebanon relies heavily on food imports. The expected reduction in crop yields to result from local climate variations would affect the most economically disadvantaged groups (please refer to the Section on Agriculture).

1.1.5.3. Summary of Impact Assessment Results

The following steps were used in assessing the likely impacts of future climatic changes on human health:

4. Socio-economic indicators that would measure changes in the vulnerable groups were chosen.
5. Changes in the indicators under each of the two socio-economic scenarios were examined (Table 1-9).
6. Changes in the indicators under the climatic scenario were examined (Table 1-9).
7. The overall change in the indicators was assessed under each of the two socio-economic scenarios and under the likely climatic change scenario, i.e. combining the results from steps 2 and 3 (Table 1-9).

The results of the impact assessment are summarized in Table 1-9.

Table 1-9 Impacts of climate change on specific indicators

VULNERABLE GROUPS	INDICATORS	NON-CLIMATIC (BUSINESS-AS-USUAL) SCENARIO		CHANGE IN CLIMATIC FACTORS	CLIMATE CHANGE SCENARIO	OVERALL IMPACT	
Elderly residents	Number of heat related deaths and injuries	Scenario A*	Moderate increase	Increase in temperature	High increase	Scenario A	High increase
		Scenario B*	Stable			Scenario B	Low increase
Women	Prevalence of heat stress related diseases	Scenario A*	Moderate increase	Increase in temperature	High increase	Scenario A	High increase
		Scenario B*	Stable			Scenario B	Low increase
Children	Prevalence of malnutrition under 5 years	Scenario A*	Moderate increase	Increase in temperature and reduction of rainfall	High increase	Scenario A	High increase
		Scenario B*	Slight decrease			Scenario B	Low increase
Laborers in outdoor working environments	Cases of heat stroke	Scenario A*	Stable	Increase in temperature and heat waves incidence	High increase	Scenario A	Low increase
		Scenario B*	Moderate decrease			Scenario B	Stable
Population with low SES	Prevalence of chronic diseases	Scenario A*	Moderate increase	Increase in temperature and flood risk	Moderate increase	Scenario A	Moderate increase
		Scenario B*	Moderate decrease			Scenario B	Stable
Refugees	Cases of water-borne diseases	Scenario A*	Moderate increase	Increase in temperature	High increase	Scenario A	High increase
		Scenario B*	Moderate decrease			Scenario B	Stable
All Groups	Lebanese government expenditure on health	Scenario A*	Stable	Increase in temperature and flood risk	High increase	Scenario A*	Low increase
		Scenario B*	High increase			Scenario B*	High increase
All Groups	Total expenditure on health per	Scenario A*	Stable	Increase in temperature	High increase	Scenario A*	Low increase

VULNERABLE GROUPS	INDICATORS	NON-CLIMATIC (BUSINESS-AS-USUAL) SCENARIO		CHANGE IN CLIMATIC FACTORS	CLIMATE CHANGE SCENARIO	OVERALL IMPACT	
	capita	Scenario B*	High increase	and flood risk		Scenario B*	High increase

*Scenario A assumes that the current status of the health care system along with the existing standards of living will remain as they currently are.

*Scenario B assumes an improvement in the current status of the health care system and the existing standards of living.

1.2. ADAPTATION MEASURES

The rebuilding and maintaining of public health infrastructure is often viewed as the "most important, cost-effective and urgently needed" adaptation strategy (IPCC, 2001) to climate change in the human health sector. This includes public health training, more effective surveillance and emergency response systems, and sustainable prevention and control programs.

Adaptive actions to reduce health impacts can be considered in terms of the conventional public health categories of primary, secondary, and tertiary prevention (WHO & UNEPA, 2003).

Primary prevention refers to an intervention implemented before there is evidence of disease or injury: avoiding hazardous exposure, removing causative risk factors or protecting individuals so that exposure to the hazard is of no consequence. Primary prevention largely corresponds to anticipatory adaptation.

Secondary prevention involves intervention implemented after a disease has begun, but before it is symptomatic (e.g. early detection or screening), and sub-sequent treatment that averts full progression to disease. Examples include enhancing monitoring and surveillance, improving disaster response and recovery, and strengthening the public health system's ability to respond quickly to disease outbreaks. Secondary prevention is analogous to reactive adaptation.

Finally, ***tertiary prevention*** attempts to minimize the adverse effects of an already present disease or injury (e.g. better treatment of heat stroke, improved diagnosis of vector-borne diseases). As the adverse health outcome is not prevented, tertiary prevention is inherently reactive.

Climate-related adaptation strategies should not be considered in isolation of broader public health concerns such as population growth and demographic change, poverty, public health infrastructure, sanitation, availability and accessibility of health care, nutrition, risky behaviors, misuse of antibiotics, pesticide resistance, and environmental degradation. All of these factors (and others) will influence the vulnerability of populations and the health impacts they experience, as well as possible adaptation strategies.

Specific measures to be taken in Lebanon include:

- Strengthen the epidemiological surveillance system and surveillance for temperature-related mortality and morbidity.
- Develop regional definitions for heat alerts/warnings which are based on public health thresholds for heat morbidity.
- Conduct a needs assessment and cost-benefit analysis of implementing an emergency heat warning system.
- Strengthen surveillance for temperature-related mortality and adverse health effects of air pollution exposure, as well as infectious diseases related to water, vector, and food borne pathogens.
- Mobilize adequate financial and human public health resources, including training, surveillance and emergency response, and prevention and control programs.
- Improve access to health care and advance a preparedness system to deal with unexpectedly occurring disasters.
- Improve access to clean water, particularly in the underserved and the most vulnerable areas.
- Improve access to proper sanitation, particularly in the underserved and the most vulnerable areas.

The recommended measures listed above are combined into adaptation strategies in Table 1-10.

Table 1-10 Adaptation Action Plan for the Human Health Sector

IMPACT	PROPOSED ADAPTATION STRATEGY	ACTIVITIES	RESPONSIBILITY	PRIORITY (ST/ MT/ LT)	INDICATIVE BUDGET (USD)	SOURCES OF FINANCING/ IMPLEMENTATION PARTNERS
Increased prevalence of heat-related impacts and infectious diseases	Enhance the Early Warning Alert and Response System (EWARS) and improve its capacity to respond to climate change impacts	Strengthen the epidemiological surveillance system by monitoring changes in vector population abundance in order to provide an early indication of the pathogen's presence in a particular area. Develop regional definitions for heat alerts/warnings which are based on public health thresholds for heat morbidity. Strengthen surveillance for temperature-related mortality and morbidity. Conduct research on climate and infectious disease linkages and couple vulnerability assessment to public health surveillance to evaluate the potential for outbreaks and for developing disease control strategies. Build the capacity to monitor dynamic changes in risk patterns at a high level of spatial and temporal resolution, in order to provide accurate information on the likely impact of a specific hazard event in a given area. Develop preparedness/response strategies based on community needs and priorities.	MoPH / Hospitals and health care centers with the collaboration of MoE, WHO and the private sector	ST	USD 500,000 to 1,000,000 to improve the performance of the surveillance system USD 1,000,000 to prepare preparedness and public communication strategies	MoPH budget WHO International agencies including: The Arab Gulf Program for United Nations Development Organizations (AGFUND) The European Investment Bank (EIB) The World Bank (WB) Canadian International Development Agency (CIDA) Italian Embassy (Cooperazione Italiana) JAPAN (embassy, JICA, JBIC) MoPWT, MoEW budgets Municipal budgets International agencies: Kuwait (KFAED) KfW

IMPACT	PROPOSED ADAPTATION STRATEGY	ACTIVITIES	RESPONSIBILITY	PRIORITY (ST/ MT/ LT)	INDICATIVE BUDGET (USD)	SOURCES OF FINANCING/ IMPLEMENTATION PARTNERS
		Develop public communication strategies to ensure that warning information and recommended response strategies are conveyed to the populations at risk. Mobilize adequate financial and human public health resources, including training, surveillance and emergency response, and prevention and control programs.				

IMPACT	PROPOSED ADAPTATION STRATEGY	ACTIVITIES	RESPONSIBILITY	PRIORITY (ST/ MT/ LT)	INDICATIVE BUDGET (USD)	SOURCES OF FINANCING/ IMPLEMENTATION PARTNERS
Increased prevalence of infectious diseases	Improve the preparedness of health care providers and sanitation status in the country	Improve water sanitation status and ensure better access to clean water, particularly in the underserved and the most vulnerable areas. Improve access to sewerage infrastructure in the underserved areas. Improve food sanitation status and ensure better control and supervision of food quality. Better equip health care providers for treating a larger number of patients during heat waves (more ambulances, equipments, etc.)	MoEW MoPWT Regional water and wastewater establishments MoPH CDR Municipalities	ST-MT	USD 500,000 to 1,000,000 for needs assessment	MoEW budget MoPWT budget MoPH budget Municipal budgets Private sector (health care facilities) World Bank EIB KfW WHO (technical assistance) UNICEF

1.3. RECOMMENDATIONS FOR FURTHER WORK

In order to improve future assessments of the vulnerability and adaptation of the human health sector, the following actions are recommended:

- Studies on the prevalence and incidence of diseases related to climate change, and relevant risk factors.
- Further national studies illustrating the relation between the changing climate factors and human health.

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