AMERICAN UNIVERSITY OF BEIRUT

THE PATH TO INFORMED POLICIES: ENVIRONMENTAL HEALTH INDICATORS AND THE CHALLENGES OF SURVEILLANCE SYSTEM IN LEBANON

by

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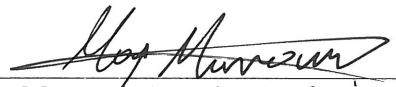

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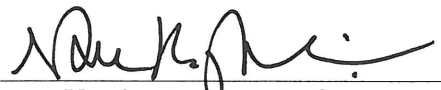

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AN ABSTRACT OF THE PROJECT OF

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Keywords: Environmental Health Indicators (EHIs), Environmental Health surveillance system (EHSS), Decision making, Prevention.

Human health is affected by multiple factors that include lifestyle, genetics, the social and physical environment, income, housing, food, access to education and health services. These factors are not the mere cause for deteriorated health conditions, but act as important risk factors. Over the years, there have been increased efforts in developed countries to bridge the gap between health and environment through adopting a monitoring system. Studies on this matter are scanty in developing countries due to several factors such as lack of funding, resources, availability of data, lack of proper legislation and political instability. As such, improved and comprehensive data is needed on the linkages between human related diseases and environmental factors to be able to inform policy and decision makers. Thus, there is a need for an environmental health surveillance system (EHSS) to monitor environmental health issues over a certain period of time, evaluate the degree of health problems in populations, detect and identify disease outbreaks or increased rates, and finally suggest and assess prevention strategies to reduce the burden of disease caused by environmental exposure to hazards. A relevant set of Environmental Health Indicators (EHIs) should be utilized to understand the relationship between health and the environment. Lebanon, like most developing countries, lacks an EHSS. Efforts have not been made in this domain due to numerous political, socio-economic, financial and technical challenges.

In order to adopt an EHSS in Lebanon we must shed light on the importance of such a system to influence policy and improve human health. Accordingly, semi-structured key informant interviews were conducted with concerned authorities and stakeholders to gather detailed information about their views and perceptions of the availability and

feasibility of collecting EHIs in Lebanon as well as their views on the development of an EHSS. Data was analyzed using the qualitative content analysis method by comparing similarities and differences between respondents, following the set objectives of the research. From the results, we were able to make a list of available and proposed EHIs for Lebanon that will be integrated in an EHSS. Challenges for developing both EHIs and EHSS were assessed and various solutions/opportunities to overcome these challenges were reported by the relevant stakeholders. Finally, from the findings, we were able to propose a framework for an EHSS that may be applicable to Lebanon taking into consideration existing indicators. This cannot be attained without certain pre-requisites such as the need for proper legislation, addressing the challenges in a wider socio-economic and political context, establishing an e-database, developing a communication and dissemination plan and finally establishing a National Council for EHSS. This study is the first detailed study of its kind in Lebanon to assess the feasibility of collecting data on EHIs that will be integrated in an EHSS and develop a framework to enhance the implementation of an EHSS that can influence policy and suggest intervention and prevention strategies.

CONTENTS

ILLUSTRATIONS

TABLES

ABBREVIATIONS

AUB	American University of Beirut
CAS	Central Administration for Statistics
CCCU	Climate Change Coordinating Unit
CDC	Centers for Disease Control and Prevention
CDR	Council for Development and Reconstruction
CH_4	Methane
CJD	Creutzfeldt-Jakob disease
CO	Carbon Monoxide
CPI	Consumer Price Index
DPSEEA	Driving Force-Pressure-State-Exposure-Effect-Action
DPSIR	Driving Force-Pressure-State-Impact-Response
DSR	Driving Force-State-Response
EHI	Environmental Health Indicator
EHSS	Environmental Health Surveillance System
EPHS	Environmental Public Health Surveillance
EPHT	Environmental Public Health Tracking
ERML	Environmental Resources Monitoring in Lebanon
GDP	Gross Domestic Product
GIS	Geographic Information System
IRB	Institutional Review Board
LEDO	Lebanese Environment and Development Observatory

MCSD	Mediterranean Commission on Sustainable Development
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoET	Ministry of Economy and Trade
MoEW	Ministry of Energy and Water
MoF	Ministry of Finance
MoI	Ministry of Industry
MoPH	Ministry of Public Health
MoT	Ministry of Transport
NCE	National Council for the Environment
NGO	Non-Governmental Organization
NO_X	Nitric Oxide
NO_2	Nitrogen Dioxide
N_2O	Nitrous Oxide
O_3	Ozone
PPP	Private Public Partnership
PM	Particulate Matter
PSR	Pressure-State-Response
SO_2	Sulfur Dioxide
SPNL	Society for Protection of Nature in Lebanon
TEDO	Tripoli Environment and Development Observatory
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USJ	University Saint Joseph

UV	Ultra-violet
WHO	World Health Organization

CHAPTER 1
INTRODUCTION

Good human health and well-being are linked to the state of the environment. Human health is affected by multiple factors that include lifestyle, genetics, social and physical environment, income, housing, food, access to education, and health services. However, these factors are not the mere cause for deteriorated health conditions, but act as important risk factors. Environmental degradation directly impacts human health and changes in the environment are contributing to an increase in human related diseases due to exposure to various biological, physical and chemical agents (Irigaray et al., 2007). Environmental factors that pose threats to human health may vary through a wide set of factors that include but are not limited to: water and air pollution, soil degradation, food contamination, ecosystems' degradation, climate change, reduction of biodiversity, ozone layer depletion, contamination by organic chemicals and industrial disasters (Gianicolo, Bruni, & Serinelli, 2010).

Over the years, there have been increased efforts in developed countries to bridge the gap between health and environment through adopting a monitoring system. This will provide decision makers with improved data on the linkages between human related diseases and factors in the environment which will influence policy at the local and national levels to prevent illnesses, injuries and deaths (Briggs, 1999; Hambling & Slaney, 2007). Thus, the development of an Environmental Health surveillance system (EHSS) might be a solution to enhance the understanding between health and environment. Environmental health surveillance is diverse; it is composed of data from multiple sources such as

agriculture, environment, health, social development, and planning. Adopting such a system is important because it allows monitoring of environmental health issues over a certain period of time. The analyzed data is used by experts and/or policy makers to provide prevention strategies. In specific, the monitoring results are used to evaluate the degree of health problems in populations, detect and identify disease outbreaks or increased rates, comprehend the natural history of diseases, and finally suggest and assess prevention strategies (Kyle et al., 2006). In this regard, environmental health should be included within public health organizations to shed light on the health impacts of environmental problems, otherwise this gap will lead to lack of coordination and fragmented responsibility among authorities (National Environmental Public Health Tracking, 2010).The significance of such a surveillance system is that it allows monitoring for long term trends instead of only tackling acute events at a specific time (Balluz, 2014). Therefore, it is most useful in tracking chronic diseases such as cancer, heart disease, stroke, and lower respiratory tract disease which are seen to be the leading causes of death in many countries. Many studies suggest that these chronic diseases may be due to hazards in the environment (Charleston, Banerjee, & Carande-Kulis, 2008).

Developing a framework for an environmental health surveillance system requires a relevant set of Environmental Health Indicators (EHIs). These indicators are important tools to better understand the relationship between health and the environment. They will eventually be integrated in an environmental health surveillance system that will allow for the ongoing collection, analysis and dissemination of information associated with disease and environment (Hambling & Slaney, 2007). An EHI can be defined as: “An expression of

the link between environment and health targeted at an issue of specific policy or management concern and presented in a form, which facilitates interpretation for effective decision making" (Hambling, Weinstein, & Slaney, 2011). EHIs can be used in monitoring progress at the national level by assessing trends and finally assist in identifying data gaps. In order for EHIs to be effective, the use of a framework is important to identify, develop and structure EHIs.

Studies reveal that developed countries faced several challenges when adopting a surveillance system. Thus, it is foreseen that developing countries will face additional problems that hinder the development of an EHSS (Abelsohn, Frank, & Eyles, 2009). Developing countries are seen to be the weakest in relation to data availability, reliability, resources and coordination among government authorities. The lack of data at both the local and national scale poses a challenge towards identifying and measuring EHIs. This in turn impedes the country's ability to make informed decisions concerning environmental exposure and human related diseases (Massoud, Basma, & Chami, 2013). In addition, the lack of financial resources leads to challenges in both monitoring and planning. Developing countries tackle short-term problems rather than addressing the long-term impacts of environmental exposure to hazards. Lack of coordination between authorities is also a waste of time and money since dispersion of roles and responsibilities does not lead to solid end results (Massoud, Basma, & Chami, 2013).

Lebanon, like all developing countries, lacks an effective surveillance system. Efforts have been made by the Ministry of Public Health (MoPH) through the development of an epidemiological surveillance unit. The main objectives of this unit are to measure and

monitor diseases burden and detect outbreaks and alerts. However, this unit is not fully-functional due to lack of proper implementation and time delay of data records (Ghosn & Saleh, 2008). Moreover, surveillance should be made more holistic and integrate all sectors that are seen to exert pressure on the environment; hence the need for an EHSS. Another initiative has been done to generate environment and development indicators for Lebanon by the Ministry of Environment (MoE) through the Lebanese Environment and Development Observatory (LEDO). This project was initiated in 2000 for a short period of time and once the project ended, so did the development of indicators. Factors such as population growth increase stress on natural resources and increase pollution of air, water and soil, thus leading to increased health diseases (MOE, UNDP, & ECODIT, 2011). In addition, a series of previous wars have led to the deterioration of many sectors in the country including the health and environment sectors. The weak control and disintegration of the public sectors are still a challenge that hinder most development initiatives in the country (USJ, MOPH, & WHO, 2012).

Furthermore, studies revealed that cancer rates are on the rise in Lebanon, specifically cancers in the lungs, bladder, larynx, breast, stomach, and blood. Researchers stipulated that a large contribution is due to environmental factors where strains on the environment have started to alter disease dynamics. Thus, there is a need for a comprehensive surveillance system for prevention and early detection of diseases (Adib et al., 1998). This study will address this issue and propose a framework to enhance the implementation of an EHSS which will eventually lead to evidence based decisions and policies concerning public health.

The specific objectives of this research project are the following:

1. Identify frameworks for selecting EHIs based on the literature.
2. Assess the availability of EHIs in Lebanon based on the stakeholder's views.
3. Investigate the feasibility of collecting EHIs in Lebanon from a legal, technical, social and financial perspective.
4. Assess the challenges for adopting and implementing an environmental health surveillance system from a political, social and economic perspective based on the stakeholder's views.
5. Propose a framework for developing an environmental health surveillance system that can be applicable to Lebanon.

This is the first detailed study of its kind in Lebanon to assess the feasibility of collecting data on EHIs that will be integrated in an EHSS. It adds to the existing literature by shedding light on the challenges of developing an EHSS. The outputs of this study will be documented in a research report, a paper or policy brief and presented to the relevant stakeholders. These findings may be used to shape decisions of policy makers on the importance of developing an EHSS taking into consideration the challenges they may encounter.

CHAPTER 2
LITERATURE REVIEW

2.1. Linking Environment and Health

Ecosystem integrity and health are seen as important elements of human well-being and vice versa. Thus, this strong interdependency reflects the fact that if the ecosystem breaks down, so does human health (Hodge & Longo, 2002; Irigaray et al., 2007). The environment can have a direct or indirect effect on human health. Direct effects on health are usually a result of a degraded ecosystem that increases the impacts of exposure to air pollution, toxic chemicals, UV radiation or even contaminated water. Additionally, the accumulation of a variety of contaminants is leading to the development of new diseases and indirectly affecting human health. This indirect effect of environmental conditions on human health is being better understood by the general public. It is also seen in the effects of climate change that result in the increased transmission of infectious diseases or even severe weather changes that can lead to increased morbidity and mortality (Hodge & Longo, 2002; Gianicolo, Bruni, & Serinelli, 2010).

Although there are still areas of uncertainty, many studies clearly reveal that new carcinogenic chemicals present in the environment, in addition to radiation and viruses, are causing cancer (Irigaray et al., 2007). A study done by Irigaray et al. (2007) reveals that life-style related factors solely are an unsuccessful diagnosis for the increasing cancer rates in western countries, but instead act as risk factors. In his study, the hypothesis proven was

that environmental factors do play a major role in cancer diagnosis and several key factors that are seen to cause cancer were taken into consideration to further strengthen this hypothesis. Life-style related factors such as alcohol consumption, tobacco smoking, obesity, genetic susceptibility and age were not seen to play a major role in increased cancer incidence. On the other hand, the environment was seen to be the most significant factor since the environment is changing over time thus, leading to the accumulation of new chemicals and carcinogens in the atmosphere. Finally, from this assessment, it can be seen that in addition to these factors, involuntary exposure to chemical, physical and biological toxins in the environment, as well as radiation, UV and microorganisms (such as viruses, parasites and bacteria) may be the reason behind the increasing rates in cancer. This proves the hypothesis being tested (Irigaray et al., 2007).

In addition, the United States population witnessed a drastic shift in the health burden from infectious diseases to other diseases such as birth defects, cancer, asthma and respiratory diseases which are associated with exposure to environmental factors (McGeehin et al., 2004). Futher technological and industrial science advances lead to the production of new chemicals that are found in the air, water and soil. At first, these chemicals were seen to be beneficial to humans, but the health effects of long-term exposure to such chemicals is still unkown. Thus, the American people strongly believe that the environment plays a major role in their health (McGeehin et al., 2004). According to a poll of voters in the United States in 2008, 92% of the people believed that exposure to environmental factors affect human health (McGeehin et al., 2008).

One of the important environmental factors that is seen to have a major impact on human health and well-being is climate change. Climate variability and extreme weather events add to the already existing burden of disease. As a result of climate change, health effects may be direct or indirect. Direct health effects include mortality and morbidity from extreme weather events such as cold, heat, droughts, storms or from changes in the quality of air and water as a result of changes in rainfall, temperature, and additional climate variables. On the other hand, indirect health effects may be due to changes in the ecology of infectious diseases that lead to the emergence of new diseases that affect human health (Hodge & Longo, 2002; Hambling et al., 2011; Pascal et al., 2012). Thus, there is a need to assess human health vulnerability to climate change in order to deal with and prevent such eventualities. This requires the use of Environmental Health Indicators (EHIs) as tools to assess and monitor human health vulnerability. Up till now, there is no program or strategy that focuses on EHIs for climate change, but it is under progress by several institutions such as the World health organization (WHO) and the United States Centers for Disease Control and Prevention (CDC) (Hambling et al., 2011). According to Pascal et al.(2012), it is important to raise the awareness of public health professionals on climate change that is affecting human health and upgrade current surveillance systems or create new ones. Thus, climate change must be considered as an input parameter for health professionals when adopting health sureviellance sysetms (Pascal et al., 2012).

2.2. Environmental Health Surveillance System (EHSS)

Environmental Health surveillance system (EHSS) may have alternative names that are used throughout the literature. Other names may include Environmental Public

Health tracking (EPHT) or Environmental public health surveillance (EPHS). All these names can be used synergistically, however, for consistency in this paper, EHSS will be used.

2.2.1. *Motivations and needs for an EHSS*

As a result of the wide and various nature of research, its complexity and uncertainties in studying the effects of environmental changes on human health, there are many research gaps present in this field. However, over the years, there have been increased efforts in developed countries to bridge the gap between health and environment through adopting a monitoring system. The basis for such a system lies in the availability and collection of data that is a powerful tool that drives decisions (Briggs, 1999; Abelsohn et al., 2009). Since human health is a central concern, all sectors such as education, commerce, research, and manufacturing must be integrated into a surveillance system. It is the same for the health and environment sectors, where accurate data is needed and will allow authorities to determine environmental hazards, disease impacts and trends in most affected geographic areas. It will also allow authorities to detect outbreaks, identify sensitive populations, and finally assess the effects of environmental exposure on human health. Thus, surveillance systems are important tools to provide data in a systematic way to decision makers (Malecki et al., 2008; McGeehin, 2008; Gianicolo, Bruni, & Serinelli, 2010).

Environmental Health Surveillance System (EHSS) is the on-going collection, integration, analysis and dissemination of data related to environmental factors/hazards, human health and exposure (McGeehin et al., 2004; Strosnider et al., 2014;

Gianicolo, Bruni, & Serinelli, 2010). In earlier times, surveillance was limited to tracking only transmittable diseases; however, in modern times, it currently encompasses tracking chronic and acute diseases (Gianicolo, Bruni, & Serinelli, 2010). Thus, continuous improvements in understanding the association between health and the environment by undergoing toxicological and epidemiologic studies will help to identify what should be tracked and how it should be tracked. Furthermore, improved integrated research, data collection, surveillance and practice will help to overcome the challenges and improve human health (Strosnider et al., 2014).

The general public understands the effects of environmental factors on human health which are seen to be aggravated in people who suffer from chronic diseases such as cancer, heart disease, respiratory disease and asthma. Thus, it is crucial to develop an environmental health surveillance system (EHSS) to better understand the risks of environmental exposure on human health (McGeehin, 2008). To be effective, such a system must be integrated, comprehensive, and systematic. Data from an EHSS will allow answering and identifying concerns related to health and the environment. This is important because environmental health data will be available to a wide range of audience including citizens, health professionals and decision makers. Moreover, it will help public health authorities to better understand the linkages between environmental exposure and health disease. In addition, it will allow them to respond to, develop, implement and assess regulations and public health actions to ultimately reduce the burden of disease on the population (McGeehin et al., 2004; Centers for Disease Control and Prevention, 2006; Abelsohn et al., 2009; Balluz, 2014). Moreover, the significance of such a surveillance

system lies in its ability to monitor long term trends instead of only tackling acute events at a specific time. Through surveillance systems, officials can trace pollutant quantities and their geographic locations over time (Balluz, 2014).

The umbrella of environmental health can be very broad and complex; thus, public health officials must be critical in determining which information is needed for the system to be effective. In this case, EHSS requires integration between different disciplines to understand the linkages between environmental hazards and health outcomes. According to Thacker et al. in 1996, EHSS requires surveillance on three major categories that include hazards, exposure and health (Abelsohn et al., 2009; Gianicolo, Bruni, & Serinelli, 2010).

Hazards may include chemical (such as lead, pesticides, or particulates), biological (such as water-borne or air-borne pathogens) or physical agents (such as noise, vibration, ionizing and non-ionizing radiation) that are found in the air, water, soil and food (McGeehin et al., 2004; Abelsohn et al., 2009). Thus, data should be standardized, collected regularly, and easily interpreted by the public to be integrated in a comprehensive EHSS. This type of data will allow public health professionals to determine which environmental hazards are causing disease and how.

The second category of an EHSS is exposure surveillance. Exposure is defined as the contact between an environmental hazard and an individual, group or population by ingestion, inhalation or skin-contact (Abelsohn et al., 2009; Gianicolo, Bruni, & Serinelli, 2010). In this case, collecting data on exposure will require the monitoring of people, communities, or populations for the occurrence of an environmental agent. This is done by

measuring the amount of contaminants in human's blood, urine or hair which is known as bio-monitoring. However, there is usually a lack of information about human exposure over a period of time. It is seen as the weakest although; it is the most important component in describing the link between hazard, exposure and disease. Thus, modeling will remain the most significant source of exposure information.

The third category of an EHSS is the collection of data about human health effects. Such data could be gathered from sources such as national statistics, annual surveys, disease registries and administrative systems such as data about hospital discharges (McGeehin et al., 2004; McGeehin, 2008; Abelsohn, Frank, & Eyles, 2009; Gianicolo, Bruni, & Serinelli, 2010). An exclusive aspect of EHSS is the integration of data among the three categories hazard, exposure and health effects. This allows for better understanding of the role of the environment in the development of many chronic diseases such as cancer, asthma, birth defects, neurologic disorders, respiratory disorders, and many others. This association between environmental contaminants and disease is more clearly shown when standardized data are integrated in an EHSS system (McGeehin et al., 2004; McGeehin, 2008).

A report on Environmental Public Health Tracking/Surveillance in Canada (2009), added a fourth category which is the assessment of policy interventions. The main goal of an EHSS is to influence public policies and practices that prevent or reduce environmental hazards, exposure or health (Abelsohn et al., 2009; Gianicolo, Bruni, & Serinelli, 2010). Nonetheless, the main goal of an EHSS is to spatially and temporally link and integrate data from various domains such as public health surveillance, environmental hazards

(chemical, physical or biological) and population exposure monitoring. Outcomes of the data associations will help to identify the link between exposure to hazards and disease, identify and monitor trends in disease burden, disseminate information to the public and finally evaluate progress towards improving human health. This will in turn influence policy outcomes by being able to identify areas or populations at risk, identify sources of exposure to a hazard or even determine the influence of environmental hazards on health within populations (Strosnider et al., 2014). Furthermore, an EHSS must generate indicators and information that work effectively on the policy platform. Continuous measurement of these indicators is crucial in monitoring the effectiveness of public health interventions and practices to be able to assess policy processes. Finally, to improve public health practices, it is required that an EHSS is developed and functional (Abelsohn et al., 2009).

A project by Morris (n.d) in Scotland highlights the need for an environmental health surveillance system (EHSS) for better decision making in environmental health. He explains that much of the data is currently available, however under-utilized. Thus, the development of a surveillance system for Scotland will help solve this problem by providing a comprehensive database that will be used to derive spatial and temporal trends in environmental health (Morris, n.d). It also integrates different disciplines and agencies working together under one common goal. Morris (n.d) identifies the weakness in policy and action related to environmental health, even though it is now widely accepted that the physical environment plays a major role in human health. He adds that many chronic diseases such as cancer, heart disease, respiratory illnesses, and mental health are shown to

have an environmental effect in addition to a wide range of interacting factors that affect well-being, he refers to as a "complex cocktail". According to Morris (n.d), environmental health is under-mined due to the lack of a proper surveillance system that collects data on health outcomes related to environmental exposure. This is needed to identify appropriate interventions for environmental health (Morris, n.d).

2.2.2. *Challenges/Requirements for an effective EHSS*

It is very difficult to indicate the link between health and environment since there is a complex relationship between exposure, environmental hazards and health effects. In addition, people may be exposed to many hazards in the environment that may be physical or chemical in a certain geographic setting and many non-environmental factors that lead to morbidity or mortality. Thus, better associations should be made between environmental exposure and human health. Responsible people must collaborate more with research institutions to decide not only on what environmental health data to track, but also on the best methods to track them (Strosnider et al., 2014). Moreover, implementing a surveillance system can allow for the generation of hypotheses regarding etiology. However, one must be cautious since confirming etiology from data linkages is not achieved easily and in most cases depends on the characteristics of the data collected and of our understanding of the linkages between hazard, exposure, and human health (McGeehin et al., 2004; Strosnider et al., 2014). Therefore, efforts should be made to integrate academia to advance the science and practice of Environmental Health Surveillance since most of the methods and tools used in an EHSS are similar to those used in environmental health research; in addition both face similar challenges. Finally, integrating researchers and practitioners in

environmental health will provide the needed research to support practitioners as well as improve the skills of the EHSS workforce (Strosnider et al., 2014).

The main goal of an EHSS is to "monitor and distribute information about environmental hazards and disease trends, advance research on possible linkages between environmental hazards and disease, develop, implement, and evaluate regulatory and public health actions to prevent or control environment-related diseases" (Malecki et al., 2008). However, there are many challenges that developed countries faced in adopting an EHSS that include gaps in information and bio-monitoring data, difficulties in tracking, complex technical and infrastructure issues and difficulties in the selection of the most appropriate EHIs. Moreover, developed countries lack a solid public health infrastructure and lack a trained staff to enforce the standards established (McGeehin et al., 2004; Abelsohn, Frank, & Eyles, 2009). Further challenges include the lack of data for the leading causes of mortality and morbidity, lack of data on hazards exposure, lack of environmental data and finally the inability to integrate and link the existing data. This data is crucial for public health authorities to make informed decisions and take actions to prevent disease, make information available to the public, promote health and influence policy makers (Strosnider et al., 2014). Moreover, information related to the spatial and temporal scales is very important otherwise data may be unsatisfactory or incomplete, or even access to data may be constrained. For example, in a study done to assess air pollution, traffic density and asthma morbidity in school children on a small spatial scale, missing data related to the child's school location, housing environment and time activity patterns resulted in exposure mis-classification. In addition, the effects of air pollution or traffic on asthma

related to children may have been underrated since data was available only for the incidence of asthma outcomes among children previously diagnosed with asthma by a doctor (Strosnider et al., 2014).

According to Strosnider et al. (2014), the challenges for developing an EHSS may be improved by several steps that public health agencies can implement once data is available to influence policies and actions on ground. Such steps include (1) improving methods and tools to use existing data in a better way that will help track the association between health and the environment over a certain period of time for small areas; (2) understanding of how the specific characteristics of data and methodological decisions impact results; (3) improving methods that deal with ecological bias, control for effect modifiers, and finally enhance exposure characterization as a result of the gaps in available data; (4) improving techniques for the data collected including identification of significant missing data as well as recommendations for creating standards for data collection and reporting. Another aspect for an EHSS to be successful is that it must integrate various stakeholders from state and local health departments, federal agencies, academic partners and non-government agencies. This holistic approach will allow implementing a nationwide surveillance system with integrated health and environment data that can drive policy makers and improve human health (Strosnider et al., 2014).

Environmental Health Indicators (EHIs) are the basis for a comprehensive EHSS. Thus, developing a framework for an environmental health surveillance system requires a relevant set of EHIs. These indicators are important tools to better understand the relationship between health and the environment and eventually be integrated in an

environmental health surveillance system. Data on its own is often confusing and provides only partial perception of the concerned issue (Hambling & Slaney, 2007; Malecki, Resnick, & Burke, 2008). EHIs allow for comparisons between local communities thus, identifying priorities in pollutant exposure which is useful information for decision makers. This data also helps to make improvements in public health by taking action to prevent disease since EHIs are needed to describe the relationships between environmental exposure and health effects. The main role of EHIs are to provide simple and useful information on environmental exposure and health disease that is understandable by policy makers, environmental health professionals and the general public (Dalbokova & Krzyzanowski, 2003; Heo & Lee, 2013). Furthermore, EHIs can be used in monitoring progress at the national level by assessing trends and finally assist in identifying data gaps (Hambling & Slaney, 2007; Malecki, Resnick, & Burke, 2008).

2.3. Environmental Health Indicators (EHIs)

In response to the National Environmental Policy Act of 1969 in the USA, the concept of EHIs gained momentum. Environmental indicators were used as tools to evaluate environmental quality and used as a foundation for guiding decision making. Similarly, at that time, health indicators were being developed by an initiative from the World Health Organization (WHO). The combination of these two concepts of indicators into "environmental health indicators" (EHIs) occurred around ten years later by an initiative also from the WHO (Tisch et al., 2014). An EHI can be defined as: "An expression of the link between environment and health targeted at an issue of specific policy or management concern and presented in a form, which facilitates interpretation for

effective decision making" (Hambling et al., 2011; Tisch et al., 2014). EHIs are used to summarize complex information into a simpler and meaningful manner that is understood by all. Moreover, they allow for comparisons across time and geographic locations.

Another major strength of EHIs is that they could be used to measure the effectiveness of previous and future decisions. This is very important to guide policy makers and the general public to choose alternatives and influence policy change (Bell et al., 2011). There are two general types of EHIs, "exposure-side indicators", which use information on exposure duration to identify degrees of health effects or "health-side indicators", which use information on health outcomes to propose attributable effects.

According to Tisch et al. (2014), EHIs serve the following key purposes (Tisch et al., 2014):

- Identify possible risks to human health by monitoring trends in the state of the environment;
- Monitor trends in health outcomes as a result of exposure to environmental hazards;
- Help influence policy formation;
- Compare and associate the environmental health status of different geographic areas in order to identify vulnerable areas and target suitable action strategies;
- Raise awareness on environmental health issues among various stakeholders (policy makers, academia, industries, public health practitioners, media etc…);
- Monitor the usefulness of policies and other practices on environmental health;

- Support in initiating further investigations to better understand the link between health and the environment, as a foundation for informing health interventions and policy.

2.3.1. Methodological framework for EHIs

There are an enormous number of environmental health indicators that reflect on the surveillance categories of hazard, exposure, and human health. Thus, public health practitioners need to be very accurate in choosing the appropriate EHIs that are scientifically sound, feasible and easily applicable (Abelsohn, Frank, & Eyles, 2009). Due to the complexity of EHIs, the use of a framework is important to identify, select, develop and structure EHIs. As such a framework offers a systematic approach for the interpretation of EHIs by highlighting the links between environment and human health. In addition, a framework helps to ensure the selection of appropriate indicators as well as organizes the ideas and concepts in a meaningful manner (Hambling et al., 2011).

Numerous frameworks have been developed in the field of environmental health with the common goal of developing EHIs to monitor the impacts of environmental exposure on human health. These frameworks will be further discussed in the coming sections.

2.3.1.1. Pressure-State-Response Framework (PSR)

The PSR framework that was developed in the early 1990s is based on a concept of causality. It is widely used, yet it is evolving. One weakness of this framework lies in its inability to differentiate between pressure and state indicators. In addition, it calls for the need to expand to deal more with sustainable development. Moreover, the PSR is based mostly on linear relationships in the human-environment interaction, which limits its use in

assessing human health linkages (Hambling et al., 2011). The PSR framework is illustrated below in Figure 1.

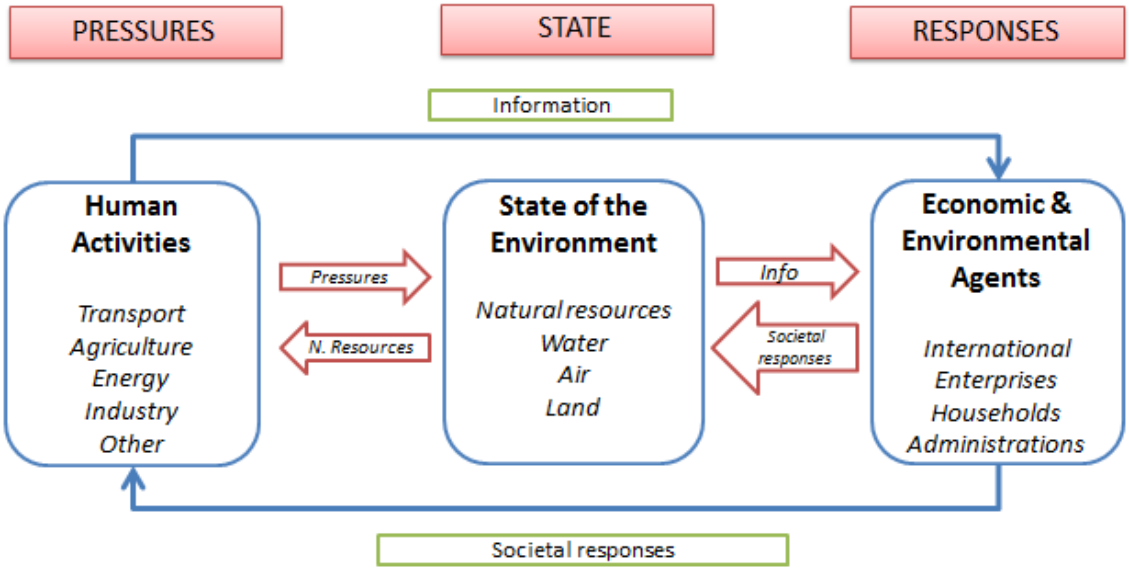

Figure 1: PSR framework adapted from Hambling et al., 2011

Human activities exert pressures on the environment and affect the quality and quantity of natural resources whether air, water or land. This is expressed in the "State" box. Next, the society responds to such changes through the establishment of societal, environmental and economic policies that are needed to prevent and reduce pressure on the environment. This is expressed as "societal responses" that forms a feedback circle to pressures through anthropogenic actions (Hambling et al., 2011).

2.3.1.2. Driving Force-State-Response (DSR) Framework

The DSR framework is a development of the PSR framework. In this case pressure is replaced by driving force to fit in better with the addition of institutional, social and economic indicators. 'Driving force' refers to human activities or processes that have an impact on sustainable development. 'State' refers to the state of sustainable development and to indicators that give a general feedback about the state of the environment. 'Response' refers to policy changes or options to respond to variations in sustainable development (Hambling et al., 2011).

2.3.1.3. Driving Force-Pressure-State-Impact-Response (DPSIR) Framework

The DPSIR framework is a further development of the PSR and DSR frameworks developed by the European Union. In contrast to the previous frameworks, the DPSIR offers a complete mechanism for analyzing environmental problems. The *Driving forces* include criteria such as transport and industry which create *Pressures* on the environment such as the polluting toxins in the air, water and soil that damage the *State* of the environment. This then lead to *Impacts* on human health and the ecosystem which causes societies to *Respond* by policy changes such as regulations, taxes or information (Hambling et al., 2011; Gianicolo, Bruni, & Serinelli, 2010).

The three frameworks discussed up till now share one common goal which is to develop indicators. However, they are weak in describing the exposure route in detail, thus not giving weight to the links between cause and effect. The DPSIR framework describes only the distal casual factors with the introduction of the driving force and pressure elements. Moreover, a common criticism between these frameworks is the fact that they display the human-environment interaction in a linear relationship which is certainly not

the case since there are multiple factors that can affect this relationship. Due to the limitations of these three frameworks, they are not considered suitable for portraying the linkages between health and the environment and do not provide the necessary information and guidance to develop EHIs (Hambling et al., 2011).

2.3.1.4. Driving Force-Pressure-State-Exposure-Effect-Action (DPSEEA) Framework

The DPSEEA framework is an improvement of the DPSIR framework with the introduction of the evaluation of health effects, translating impact into "exposure" and "effect" and the responses into "actions" (Gianicolo, Bruni, & Serinelli, 2010). Moreover, in contrast to the frameworks previously discussed, DPSEEA does not portray the environment-health relationship in a linear form. It represents the actual complexity and associations between environment and health and how this relationship symbolizes an interlinked web instead of a straight chain for environmental health problems. This cause-effect framework highlights the link between exposures and health effects as a result of many different factors. The strength of this framework is that it identifies the multiple entry points for interventions at the different levels; thus, this allows designing intervention strategies at each point as well as monitoring their performance (Hambling et al., 2011).

The DPSEEA framework was published in 2000 by the WHO and describes the events through the following (Figure 2):

- *Driving force*: anthropogenic factors that affect the environment such as population growth, economic and social development or technology;

- *Pressure*: refers to pressure on the environment that is expressed through exploitation of the environment such as consumption, waste release or ecosystems degradation;
- *State*: refers to the state of the environment;
- *Exposure*: refers to the interaction between environment and humans, when humans are exposed to environmental hazards such as pollutants or infectious agents;
- *Effect*: refers to the health effects in humans as a result of exposure to environmental hazards;
- *Action*: refers to interventions intended to reduce or prevent health effects at any point in the framework (Hambling et al., 2011; Gianicolo, Bruni, & Serinelli, 2010).

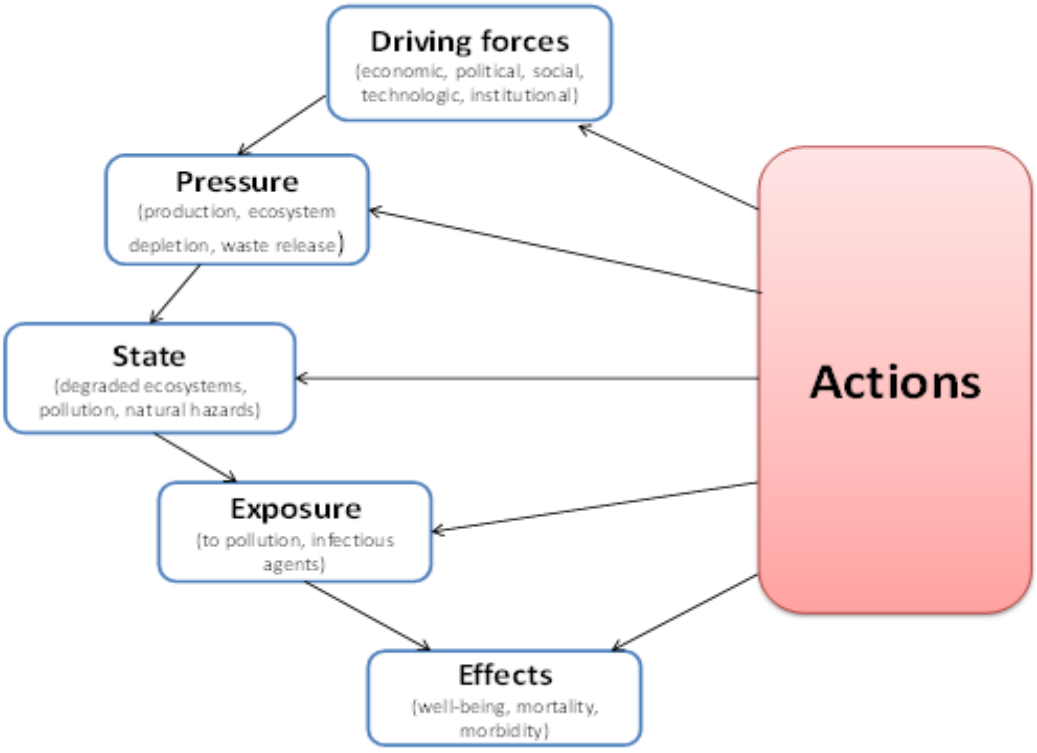

Figure 2: DPSEEA framework adapted from Hambling et al., 2011

The main goal of the DPSEEA framework is to influence policy and develop intervention strategies to reduce the burden of disease. It displays the multiple levels of action that can be carried out to reduce the impacts of environmental exposure on human health; therefore it is the most widely used framework for selecting EHIs. Moreover, the DPSEEA is known for its flexibility and applicability; thus, it can be adapted to address climate change by providing the necessary guidance to develop EHIs that measure the impacts of climate change on human health. It should be known that it is very difficult to fully assess and identify the complex relationships between climate change impacts and human health. However, the DPSEEA framework is seen as the best fit for developing

EHIs to assess the impacts of climate change on human health and identify the most suitable interventions for adaptation and mitigation (Hambling et al., 2011).

2.3.2. *EHIs in developed vs. developing countries*

To develop EHIs, they must be part of a larger scope or framework. Thus, the most widely used methodology for developing EHIs is the DPSEEA framework. For years, there has been extensive debate in developed countries for developing "rules" for EHIs, and most efforts reach duplication in trying to design and develop EHI sets. The mostly agreed upon EHIs are divided into six categories that include: water and sanitation, air quality, climate and physical environment, built environment, food safety and finally biosecurity (Hambling et al., 2011; Tisch et al., 2014):

- Water and sanitation refers to the existence of chemicals and pathogens in drinking and cleaning water that result in a variety of health effects;
- Air quality refers to exposure to both indoor and outdoor air pollutants that result mainly in the aggravation of asthma and other respiratory diseases;
- Climate and physical environment refers to changes in climate variability and other physical hazards that can lead to mortality and morbidity;
- The built environment involves buildings and spaces that are made or modified by people which encompass all the areas and spaces that people live and work. It can range from individual homes to neighborhoods to communities and cities;
- Food safety refers mainly to chemical hazards found in the air, water and soil;

- Bio-security refers to the elimination and control of risks from micro-organisms that threaten people's health, the economy and the environment (Tisch et al., 2014).

In Brazil, the Ministry of Health has established an environmental health surveillance system (EHSS) since 1998. The methodology used for the development of EHIs was the DPSEEA approach to select the appropriate indicators (Carneiro, et al., 2006). The reason behind using this framework is that it is composed of a matrix model that associates between human health, environmental exposure, economic and social dynamics. Each category encompasses a set of indicators that better explains the given problem to be able to come up with measures and interventions to deal with the complexity of each level (Figure 2). Based on this study, there are various recommendations for the development of EHIs. First, the development of EHIs should be inter-disciplinary based on a participatory approach that focuses on social, economic and environmental aspects that affect human health. Second, indicators should be developed based on priorities taking into consideration what is seen as the most important health problem to tackle. For example, water quality was seen as the major priority that needs to be addressed in Brazil. Third, the development of EHIs should integrate community-based knowledge using the inter-disciplinary and inter-sectorial approach for integrated management. Finally, government participation is crucial in the identification and development of appropriate indicators that are needed for future intervention strategies (Carneiro, et al., 2006).

Moreover, the two most widely used indicators that are common in all EHI programmes are water and sanitation and air pollution. For water and sanitation, the indicators are mainly directed towards drinking water quality, with a few related to sanitary

or recreational waters. Additionally, for air pollution most indicators are chosen for particulate matter with fewer indicators related to O_3, SO_2, NO_2 and other pollutants. However, differences exist mainly in the definition of the indicators. For example, the averaging time and thresholds of the indicator sets may differ from country to country depending on variations in standards between the different countries (Tisch et al., 2014).

The Ministry of Environment in Lebanon along with the United Nations Development Programme (UNDP) hosted a project in late 1999 called the "Lebanese Environment and Development Observatory (LEDO)" funded by the European Union. This project aims to collect and provide open access to environment and development data as well as provide a better understanding of the state of the environment and development in Lebanon. Its main goal is to establish an updated and continuous monitoring system based on environment and development indicators. This project was implemented in coordination with many national partners from private, public, academic, research institutes and non-governmental organizations. As a result, the LEDO project was able to develop 90 environment and development indicators for Lebanon; however not all were collected. These indicators were selected based on a set of 130 indicators identified by the Mediterranean Commission on Sustainable Development (MCSD) for the Mediterranean region and based on the priorities set by the national LEDO partners. The significance of such environment and development indicators was expressed in their ability to present information to decision makers and the lay public to take action at an early stage to prevent disease or injury. They also present data in a simplified way and play a major role in helping to quantify the situation, identify trends and monitor progress and change over time. Moreover, developing indicators helps guide decision makers, influence policy, and

finally ensure transparency and accountability. The indicators were developed based on the PSR (Pressure-State-Response) framework previously discussed through a participatory process. The participatory process that was used for the identification of the Environment and Development indicators was based on the following steps (LEDO et al., 2000):

- Conducting a national workshop to identify priority environment and development issues and prioritizing the issues relevant to the various sectors;
- Identifying the available data and data gaps relevant to environment and development issues and then identifying the responsible institutions for the available data;
- Assessing the feasibility of generating data when needed to fulfill data gaps;
- Developing a tentative list of indicators relevant to Lebanon;
- Conducting training sessions on the different indicator techniques;
- Finalizing the list of indicators;
- Collecting data related to environment and development and calculating indicators.

The indicators were divided into four main categories: Population and Socio-economic indicators, Economic Activities, Environment, and Sustainable Development Activities and Policies. Furthermore, each category was elaborated into different themes where the indicators fall under (Table 1) (LEDO et al., 2000).

Table 1: LEDO indicator categories and themes

Population and Socio-economic indicators:	Economic Activities:	Environment:	Sustainable Development Activities and Policies:
Demography	Agriculture	Air	Activities/Actors
Standard of Living	Industry	Water	Policies/Strategies
Consumption Production Patterns	Energy	Land/Soil	
	Services	Biodiversity	
	Transport		

To ensure consistency throughout the process, a standardized data sheet was used to collect all the necessary information related to the indicators. The set of indicators that were identified throughout the project were compiled in a database and presented on the website of the Ministry of Environment. The website contains information related to the indicator groups, along with their respective data sheets, results, graphs and relevant maps. The results were disseminated in reports and documents of public institutions as well as international organizations that deal with environment and development issues. Moreover, the users of such indicators include a wide range of institutions such as the government sector, research institutions, international organizations, civil society, academic institutions, private sector, media and finally the general public (LEDO et al., 2000).

2.3.3. Challenges of developing EHIs (collection, availability, applicability…)

Developed countries faced many challenges when developing EHIs. These challenges include difficulties in collaborating with numerous institutions for data collection and identification of indicators, organizational changes, changes in legislation

which make it difficult for communication and establishing working contacts and finally lack of human resources. A study was conducted to develop a Pan-European set of indicators which is a continuous process and requires consistent reporting on health and environmental issues. One of the challenges encountered in this initiative is the fact that indicators should be adapted at country level based on countries' prioritization. For instance, a project was conducted to develop a relevant set of indicators for Switzerland based on the Pan-European core set of environmental health indicators. However, this initiative was limited when down-scaled for policy evaluation at national level. In this case, international EHIs are only appropriate for policy evaluation at national level when they coincide with priority setting and address action taken at country level (Dalbokova & Krzyzanowski, 2003; Kahlmeier & Braun-Fahrlander, 2004).

In addition, there is no information on indicator usage which refers to the extent to which indicators are actually used. This information is important to be able to track the significances of EHI initiatives in policy formation and to highlight their effect either on decision making or health outcomes. Also, there is a need for a comprehensive assessment of the costs and benefits of EHI initiatives. Another limiting factor is the willingness of policy makers and government officials to comply with the scientific evidence provided by EHIs and influence policy (Tisch et al., 2014). Moreover, a major challenge of indicators is deciding on the appropriate definition of each indicator while taking into consideration its limitations and assumptions; otherwise this could lead to inappropriate conclusions. There is no single EHI that fully reflects the state of the environment. In fact, EHIs represent one of many ways that one can use to assess the health effects of environmental exposure. Furthermore, there is no single straightforward methodology applied for developing EHIs,

instead there are various methods used that can produce different rankings. Finally, EHIs may differ from area to area, thus some indicators are developed specifically for a certain region (Bell et al., 2011).

In contrast to developed countries, developing countries are seen to be the weakest link and are limited in data availability, reliability, resources and coordination among authorities. The lack of data at both the local and national scale poses a challenge towards identifying and measuring EHIs. This in turn impedes the country's ability to make informed decisions concerning environmental exposure and human related diseases (Massoud, Basma, & Chami, 2013). In addition, the lack of financial resources results in challenges for monitoring and planning. Developing countries tackle short-term problems rather than addressing the long-term impacts of environmental exposure. Lack of coordination between authorities is also a waste of time and money since dispersion of roles and responsibilities does not lead to solid end results (Massoud, Basma, & Chami, 2013). Further studies revealed that EHIs are not yet well developed, especially in developing countries. They are also weak in the domain of exposure-response relationships and their inability to be interpreted into a health impact. Furthermore, there is no evidence of the impact that EHIs have on decision making and influencing policy makers. Thus, there is a need to propose future priorities for further research and development of EHIs (Tisch et al., 2014). In addition, according to the LEDO project, data is compiled for short term indicators since data is available and can be analyzed regularly. However, there are many challenges in developing medium and long term indicators due to factors such as: difficulty in data collection, absence of data, scattering of data sources, lack of standardized

methodologies for the collection of information, problems of geographical coverage and finally absence of monitoring systems (LEDO et al., 2000).

CHAPTER 3
DATA AND METHODS

3.1. Study Design

This study was done following a qualitative research approach. The primary data collection method used was key informant interviews with concerned authorities and stakeholders. In this case, the researcher was flexible and analytical to be able to interpret and gather as much in-depth information as possible (Hennink, Hutter, & Bailey, 2011). There is no standardized structure for using a qualitative approach and the interviews are usually less structured however, they follow a certain guide. A semi-structured interview guide was used to allow the respondents to thoroughly express their experiences, opinions and attitudes towards developing an EHSS. Since there is gap in information regarding EHIs as well as data on environmental exposure and health effects, conducting key informant interviews allow gathering detailed information on this matter.

3.2. Recruitment of participants

Before conducting the key-informant interviews, an extensive review of the literature was done to identify EHIs and EHSSs applied in developed countries. This secondary data gave the researcher further knowledge on the subject matter. In addition, it helped to identify the potential stakeholders for recruitment in this research study. Purposive sampling was followed which is a non-probability sampling technique used to sample participants in a strategic way to fit the research objectives of the study (Bryman,

2012). Thus, a preliminary list was developed of the relevant stakeholders in the health and environment fields who were selected to take part in the key informant interviews (Table 2). The interviews were conducted with concerned stakeholders to gather detailed information about their views and perceptions of the availability and feasibility of collecting EHIs in Lebanon as well as their views on the development of an EHSS. Furthermore, during the interviews, if any additional stakeholders were recommended by the participants, they were added to the list. The interviews are intended for academic purposes only and no sensitive information related to the subject's reputation or insurability was gathered. Likewise, no information was gathered that will cause psychological harm if disclosed outside the research.

Table 2: List of relevant stakeholders for key informant interviews

Relevant Stakeholders	
Institution	**Contact person**
Ministry of Public Health (MoPH)	Epidemiological surveillance unit
Ministry of Environment (MoE)	Director General
	National Focal Point of the Lebanese Environment & Development Observatory (LEDO)
World Health Organization (WHO)	WHO Focal Point in Lebanon
United Nations Development Programme (UNDP) at the MoE	Project Manager of the United Nations Framework Convention on Climate Change (UNFCCC)
Council for Development & Reconstruction (CDR)	Head of Environment Department
Environmental NGO: Society for protection of Nature in Lebanon (SPNL)	Assistant Director
Central Administration of Statistics (CAS)	Director General
The Al-Fayhaa Union of Municipalities-Urban Observatory in Tripoli (TEDO)	Director
Lebanese Standards Institution LIBNOR	Head of Chemical Standards Department
United Nations Development Programme (UNDP) at the MoE	Project Manager of the project "Environmental Resources Monitoring in Lebanon (ERML)"

3.3. Data collection

In order to proceed with the key informant interviews, each institution was contacted by phone to get its approval in including it in the research study. The phone numbers were gathered online and any missing ones were collected from Ogero (national

phone services). Upon their approval, a meeting was arranged in which the researcher proceeded to conduct face-to-face interviews with the chosen stakeholders at their institutions. A semi-structured interview guide was used to focus the interview to meet the research objectives of the study (Table 3). The interviewer tried to gather as much in-depth information as possible by using additional probing questions. The interview was 25-30 minutes long and was carried out in the language that is most suitable for the respondent (Arabic or English). Note taking was used to be able to document the whole interview process since none of the respondents approved to be audio-taped. Moreover, the data collected from the interviews were then transcribed and analyzed.

The respondent was informed that the name and data collected from the institution will remain anonymous and that all information collected will be used only to serve the purpose of this project and will be properly controlled, managed and retained by the principal investigator. There are no perceived direct or indirect risks or benefits associated with humans' participation in the project and respondents' participation is voluntary. A written informed consent, including the project objectives and all relevant details was provided and signed by the participants prior to the start of the interview. Moreover, the study was submitted and approved by the IRB.

Table 3: Summary of the questions to be addressed linked to the objectives of the study

Objectives	**Questions**
Assess the availability of EHIs in Lebanon	What is your opinion on the available records or databases in Lebanon related to health and the environment?
	Does your institution collect any type of indicators whether related to health or the environment?
	How do you think your institution would benefit from EHIs?
Investigate the feasibility of collecting EHIs in Lebanon	How feasible is it to collect data related to EHIs in Lebanon?
	What are the tools needed to gather information on EHIs?
	Do you have the technical expertise and human resources needed to gather information on EHIs?
	Do you have the financial resources required to gather information on EHIs?
	What factors might hinder the process of data collection of EHIs?
	What EHIs can you propose that might be applicable to Lebanon? (in relation to water, air, radiation, noise etc…)
Assess challenges for adopting and implementing an environmental health surveillance system (EHSS) in Lebanon	What are the challenges of implementing an EHSS in Lebanon?
	Why do you think it is important to develop such a system in Lebanon?
	What are the solutions to overcome these challenges to sustain such a system?

3.4. Data analysis

After the data was collected from the key informant interviews, it was analyzed, summarized and tabulated by using the qualitative content analysis technique. The interviewed institutions were divided into three categories based on relevance. The first category I refers to environment-related institutions that includes six environment institutions (MoE, LEDO, UNDP/UNFCCC, UNDP/ERML, SPNL and TEDO), the second category II refers to health related institutions that includes two health institutions (MoH & WHO), and finally the third category III refers to others that includes three institutions related to execution of projects and setting standards & statistics (CDR, CAS & LIBNOR). The basic process of analysis was done by comparing similarities and differences between respondents (Bryman, 2012). Quotations were extracted from the interviews and used within the analysis. Next, the data was categorized by extracting common themes from the interviews and tabulating them to eventually come up with a list of EHIs for Lebanon. Furthermore, from the results of the analysis, the researcher was able to propose a framework that might enhance the implementation of an EHSS by taking into consideration the challenges of adopting such a system in Lebanon. In addition, to avoid subjectivity, qualitative data analysis was approached systematically and the results of the themes were reported.

CHAPTER 4
RESULTS & DISCUSSION

4.1. Availability of data/records and EHIs in Lebanon

All respondents agreed that data is not easily available and accessible in Lebanon. The reason may be attributed to the fact that data is scattered, unorganized, discontinued and not regularly updated. Moreover, the respondents added that most of the data and information is based on projects for short periods of time and not translated into a comprehensive database. Since the projects are donor driven, most of the information that is collected, analyzed and disseminated is specific to the project topic and not to country's needs. Thus, once the project ends, the studies and data collection are terminated due to lack of funding sources. A respondent from category I confirms this by saying:

"Based on our project, we have quite a lot of data; however the data collected is only for a short period of time and is difficult to be used for scientific purposes."

As a result of limited financial and human resources, data is not continuously being collected spatially and temporarily. Another reason for the limitation in data availability and accessibility is the fact that data is not easily communicated and disseminated between government institutions. This was further highlighted by a government respondent from category I who explained that:

"People do not like to share data and this is wrong because you need to use the data for it to be beneficial; otherwise it is not valuable anymore."

The problem not only lies in data availability, but in data usage and reliability that needs to be standardized. Moreover, the data collected is difficult to be used for scientific purposes and policy making. This overlaps with the findings of Jafar (2007) that highlight the gaps and challenges related to data availability in Lebanon. His findings show that most projects are donor driven and data collected or analyzed is not based on country prioritization. Jafar (2007) added that this is also due to the lack of political will at both national and international levels as well as lack of legislation requiring data collection institutions (Jafar, 2007). This gap may be due to the fact that there is no centralized entity responsible for data collection and dissemination at government level.

Furthermore, most of the stakeholders positively identified the indicators that their institutions collect which are related to health, environment, socio-economic, demography or economic activities. However, very few stakeholders responded that they do not collect any type of indicators. The reason for this is may be attributed to the fact that they have other priorities and believe it is not their role to do so. These respondents mainly belong to category III and represent institutions responsible for the execution of projects and standards. However, one of the institutions belongs to category I, which is an NGO, and added that the reason may be due to lack of skills and resources needed to develop and collect indicators. Thus, these institutions collect data, however, not in the form of indicators because there is no set of indicators for Lebanon. They added that the available information has not yet been translated into a comprehensive database.

Table 4 is a list of available indicators that were developed and collected by the different institutions. Some indicators were only developed, while others were and are still being collected by the different institutions based on the interviews. The reason for this is that some projects have already ended and thus, the indicators are not being collected anymore.

Table 4: List of available indicators

Available Indicators			**Status** **Developed/collected**
Environment indicators	-Air quality	-ambient air -concentration of particulates ($PM_{2.5}$, PM_{10})	Developed/collected
	-GHG emissions	- CO_2, N_2O, CH_4, NO_x, CO, SO_2 …	Developed/collected
	-Water	Sea water quality, industrial releases into water, water global quality index, ground water quality index, surface water quality index	Developed/not collected
	-Land/Soil	Forest area, artificialized coastline/total coastline, "arable land", ratio of land exploitation, land use change, wet land area, area affected by desertification etc…	Developed/not collected
	-Biodiversity	Forest's protection rate, protected coastal area, protection of specific ecosystems area, threatened species, burnt forest area per year etc…	Developed/not collected
Health indicators	-Communicable diseases	Acute Polio/Acute Flaccid Paralysis, Cholera, CJD, Diphtheria, Hemorrhagic fever, Novel Influenza A, Malaria, Meningitis, Measles, Neonatorum tetanus, Plague, Rabies, Rubella, Yellow fever etc…	Developed/collected
	-Water and sanitation	Access to safe drinking water	Developed/collected
	-Living environment at household level		Developed/collected
Demographic and Social Indicators	-Population	Population density, urbanization rate, urban population growth rate, life expectancy at birth etc…	Developed/not collected on a yearly basis (2004, 2007 & 2009)
	-Education	Difference between male and female school enrollment ratios, adult illiteracy rate for females and males,	Developed/not collected on a yearly basis (2004, 2007 & 2009)
	-Labor force	Unemployment rate for females and males,	Developed/not collected on a yearly basis (2004,

		distribution of GDP, income distribution etc…	2007 & 2009)
	-Health insurance and disability	Benefiting from any type of health insurance, services covered by the various health insurances, Percentages of beneficiaries from at least one type of health insurance, characteristics of beneficiaries from at least one type of health insurance, suffering from chronic diseases, disability and the characteristics of the disabled	Developed/not collected on a yearly basis (2004, 2007)
	-Children's situation	Child mortality, nutrition, child health, child development, child protection, children's living arrangements and orphan hood	Developed/not collected on a yearly basis (2009)
	-Women's situation	Reproductive health, Percentage of women aged 15-49 years currently married who are using (or whose partner is using) a contraceptive method	Developed/not collected on a yearly basis (2009)
	-Household expenditure	Household budget, average expenditure for household, household expenditures categories, household size, income categories, individual expenditures category	Developed/collected on a yearly basis up till 2012
	-International migration	Migrated individuals based on relationship with family, migrated individuals based on age and gender, migrated individuals based on education level, migrated individuals based reason for migrating, migrated individuals based on year of migration	Developed/not collected on a yearly basis (2009)
Economic Activities	-Agriculture	Use of agriculture pesticides, use of fertilizers, agriculture land, share of irrigated agricultural land, agricultural water demand per irrigated area	Developed/not collected
	-Industry	Unlicensed small & medium industries, new industrial establishments, non-categorized industrial zones,	Developed/not collected

		number of quarries and amount of quarried material produced etc…	
	-Energy	Share of production of renewable energy resource, annual energy consumption or consumption per GDP etc…	Developed/not collected
	-Services	Number of tourist hotel nights per hundred inhabitants, number of international tourist per 100 inhabitant, currency balance due to tourism, number of visitors to protected areas, number of tourism establishments on coastline etc…	Developed/not collected
Economic Indicators	-CPI: Consumer Price Index		Developed/collected on yearly basis
Gender Statistics	Women in Lebanon in figures	Use of gender statistics in education , health, economy, women's empowerment and influence	Developed/collected on yearly basis
National Accounts	-GDP in current and constant prices -Real GDP -Inflation in domestic economy		Developed/collected on yearly basis up till 2013
Sustainable Development Activities & Policies	-Activities/Actors	Number of agendas 21 adopted and implemented by local authorities, wastewater treatment rate before sea release for coastal agglomerations over 100000 inhabitants, number of wastewater treatment plants, number of fixed air/water/coastal water monitoring stations etc…	Developed/not collected
	-Policies & Strategies	Public expenditure on environmental protection as a % of GDP, development programs/projects concerning the less favored rural zones, total expenditures on protected areas, expenditure on waste management etc…	Developed/not collected

Efforts are being made to collect data and develop indicators, as shown in Table 4; however, these are not labeled as EHIs. Although all the respondents understand the importance of EHIs, efforts have not been made for their development. The reason for this may be that it is a new and challenging topic especially in developing countries such as Lebanon. Thus, institutions may have the needed information to develop EHIs, yet they lack the framework to do so. Moreover, to establish EHIs, there is a need to gather information in a continuous manner which is not an easy task in Lebanon. Most information may be old, dis-continued, overlapping and not easily accessible from the public sector due to the bureaucratic process.

According to Massoud et al. (2013), developing countries are seen to be the weakest in relation to data availability, reliability, resources and coordination among authorities. As a result, selecting and measuring indicators is a challenge due to the lack of data at both the local and national levels (Massoud, Basma, & Chami, 2013). Moreover, Jafar (2007) emphasizes the need for the presence of a legal framework necessary for the enforcement of policies for EHIs (Jafar, 2007). This requires decisions at higher governmental level.

Reference to the above results, a respondent from category I explained that,

"The main aim is not just to collect data, but to be able to analyze, use and manage it. Also, we must know how to adapt indicators to fit Lebanon and Lebanon's priorities since not all indicators can be adapted over all countries. EHIs should be developed based on country's priorities which may differ especially that developing

countries usually adopt methods from developed countries which lead to gaps in practice due to different political, socio-economic and cultural contexts."

4.2. Benefits of EHIs and EHSS

The majority of respondents considered EHIs of great importance to influence policy. One respondent did not believe that EHIs would be of any benefit to their institution. This same respondent belongs to category III and answered negatively for collection of indicators. The reason for this may be due to the fact that the institution does not have a clear understanding of the role and importance of EHIs, in addition to the fact that there is no set or framework for EHIs in Lebanon.

The stakeholders that responded positively stressed on the importance of EHIs in translating information to policy makers in an easy and simplified manner. The reason for this is that EHIs create a linkage between health and environment that is easily understandable by experts, policy makers and the general public. A member from category I added:

"From these EHIs, policy makers can assess the magnitude of a problem and act accordingly by issuing laws."

These results are complementary to the findings of Tisch et al. (2014) that highlight the importance of EHIs to influence policy formation, raise awareness on environmental health issues among various stakeholders (policy makers, academia, industries, public health practitioners, media, etc.) and monitor the usefulness of policies and other practices on environmental health (Tisch et al., 2014).

Moreover, almost all respondents agreed that developing EHIs are important to generate reports that can be used by decision makers, academic institutions and the general public. This was the case with one of the institutions belonging to category I, where the indicators established for environment and development were used to develop the State of the Environment Report at the Ministry of Environment. From these results, it is clear that all respondents understand the importance of EHIs which help bridge the gap between environment and health sectors. However, all participants agree that Lebanon faces many challenges that will further be discussed in the coming sections.

Furthermore, several respondents added that EHIs are important to be integrated in a national surveillance system to prevent injury and disease. This overlaps with the findings of Hambling and Slaney (2007) and Malecki et al. (2008), which show that EHIs are used as tools to better understand the relationship between health and the environment. Moreover, the true value of Environmental Health Indicators (EHIs) will further be attained when they are integrated in a comprehensive EHSS (Hambling & Slaney, 2007; Malecki, Resnick, & Burke, 2008).

To build on this, the majority of respondents positively agreed on the importance of developing an EHSS for Lebanon. They added that an EHSS is important to influence policy makers and to help reduce disease and injury. Some of the respondents belonging to category I added that the presence of an EHSS will help to orient research and improve preventive measures. However, the very few institutions that did not respond are the same institutions that responded negatively to collection of indicators. This may be due to the

fact that they do not really understand the importance of EHIs and an EHSS, which is a new topic and not yet developed in Lebanon.

A similar effort has been developed by the Ministry of Health through the establishment of an epidemiological surveillance system for Lebanon. However, this system is not very familiar to all and is not fully adopted on a national level. Thus, people should be made aware of the benefits of developing an EHSS on a national scale that is functional and sustainable on a long term basis.

A respondent belonging to category I added,

"Developing an EHSS is very important first because it provides information to a wide range of people and second it helps to reduce disease, thus we need the right system with the right indicators"

These results complement with the findings of McGeehin (2008), who explains that it is crucial to develop an EHSS to better understand the risks of environmental exposure on human health. He adds that environmental health data will be available to a wide range of audience including citizens, health professionals and decision makers (McGeehin, 2008). Moreover, an EHSS will allow responding to, developing, implementing and assessing regulations and public health actions to ultimately reduce the burden of disease on the population (McGeehin et al., 2004; Centers for Disease Control and Prevention, 2006; Abelsohn et al., 2009; Balluz, 2014).

4.3. Proposed EHIs that can be applicable to Lebanon

Numerous EHIs were proposed by the respondents that may be applicable to Lebanon. The proposed EHIs include the following: air quality, water and sanitation, economic indicators for environmental health, socio-economic indicators, health indicators, food safety indicators, agriculture indicators, forestry, water availability, transportation, snow and snow melt, energy resources and wastewater. The majority of the responses from the three categories were for air quality and water and sanitation that were highlighted as top priorities for EHIs. The reason for this may be that exposure to contaminated water or air pollution has a direct impact on human health. Thus, there is a direct link between environmental exposure and human health. Furthermore, it may be easier to collect data on air and water and many studies have been directed towards this domain. The other proposed EHIs are also important but come at a later stage.

These results are similar to the findings of Tisch et al. (2014), which demonstrate that the two most widely used indicators common in environmental health are water and sanitation and air pollution. For water and sanitation, the indicators are mainly directed towards the quality of drinking water, with a few related to sanitary or recreational waters. Additionally, for air pollution most indicators are chosen for particulate matter with fewer indicators related to O_3, SO_2, NO_2 and other pollutants (Tisch et al., 2014).

4.4. Challenges & Solutions for collecting EHIs and setting an EHSS

As a result of the responses of the interviews, the challenges and solutions for collecting EHIs and setting an EHSS were divided into four main themes. The four themes

are as follows: availability of tools to collect EHIs and set an EHSS, availability of technical expertise and human resources, availability of financial resources and finally administrative process. Under each theme there are various challenges and solutions that were reported by the different stakeholders.

4.4.1. Availability of tools to collect EHIs and set an EHSS

The majority of the participants responded that the needed tools to collect information on EHIs are lacking. These tools, which are referred to as the four main pillars, revolve around the availability of legal structure, technical expertise, human, and financial resources. It is crucial that all the pillars are available to have a holistic approach and influence policy. This will help ensure long term sustainability since projects are usually implemented for a short period of time and once the project ends so do the tools, methodologies and approaches. Also, there is no clear system for data collection, analysis and dissemination common between all institutions which leads to poor quality of data.

Moreover, some participants belonging to category I added that there are several tools available to collect data, however they are limited. To elaborate on this, they explained that there are certain tools used on project basis and are specific to a scope of research. For example, real time data machines are used to gather and assess information related to air quality, specifically ambient air. Additional tools that are being used to collect data are surveys or standardized forms filled out by relevant stakeholders. This tool is widely used by participants of all categories I, II & III to gather needed information. Survey structure may differ between institutions depending on the nature of information needed

and may be specific to a certain institution or project. For instance, the epidemiological surveillance unit at the Ministry of Public Health (MoPH) uses standardized forms to gather information from hospitals, clinics or other medical centers. Thus, the gathered information will be integrated in the epidemiological surveillance system to assess trends or detect outbreaks. This tool is the easiest and most efficient way to collect needed data if the stakeholders are responsive and cooperative, otherwise data collection will need to be done through field assessments, and this requires time and resources. Moreover, lab assessments and GIS mapping are two additional tools that are used by institutions belonging to category II. The reason for the former is that the institutions belong to the health sector, thus lab assessments are important tools used to assess the magnitude of a health problem as a result of environmental exposure. The latter is important to identify sensitive areas that have a high risk of health problems due to environmental contaminants. Thus, mapping will help to set priorities and propose intervention strategies.

In response to the above, solutions to overcome the challenges were proposed by the participants and the responses were recurrent among the three categories. They reported the need to establish a legal framework to develop an EHSS that is functional at national level. This will help to identify data gaps, assess trends and identify sensitive populations and areas. Moreover, most of the respondents stressed the need to institutionalize projects within the different ministries for long term sustainability even after the project has ended. This is usually lacking due to limited resources of the government. However, recent efforts are being made by the Ministry of Environment to institutionalize a project for monitoring of air quality in Lebanon. Thus, the tools, machines and indicators used will be

institutionalized within the Ministry of Environment. This will help ensure continuity and build the technical capacities of the local staff for the long term. Furthermore, the participants added the need to adopt a methodology for data collection that is standardized between all institutions. This will allow for better collection, analysis and sharing of information between all stakeholders. Thus, the available data will ensure proper selection of indicators which is needed to be integrated in an EHSS.

4.4.2. Availability of technical expertise and human resources

According to the majority of respondents, technical expertise is available. However, the participants explain that technical expertise is available only for a limited period based on the duration of the project. Thus, this is not a sustainable option since it is necessary to build the capacities of the local experts and employees. Moreover, the stakeholders added that there are several universities in Lebanon that are very knowledgeable and have the capacities to undergo scientific research and findings. Only very few institutions did not agree. They responded that technical expertise is lacking and needs further improvement. The case with most of the projects being implemented at the ministries is that international experts are employed for the period of the project and once the project ends, so do the funds along with the expertise. In this case, the government should be aware of the situation and take the needed action to benefit from such projects and share the knowledge and experience with the employees. The majority of respondents agreed that this will help build the capacities of local experts and ensure sustainability even after the project has ended.

As for the availability of human resources, which refers to the local staff or employees, all respondents agreed that this is a major challenge especially in the public sector. All governmental institutions are under-staffed; thus, they are overloaded with work commitments and deadlines. The reason for the lack of human resources may be due to the financial difficulties that the Lebanese government is facing. This also affects the pace of work being done since it is usually difficult to communicate and collaborate with other ministries which leads to delays in work. Thus, all the participants stressed the need for more recruitment of local staff and more trainings to improve the existing skills and capacities of the human resources available. They added that lack of awareness is a major problem in developing countries like Lebanon where most people do not understand the health risks of exposure to environmental hazards. Thus, it is crucial to raise awareness on the importance of EHIs and EHSS not only among public institutions, but among private institutions, government officials and the general public through awareness campaigns and capacity building trainings. This will help ensure more involvement of the civil society that should be integrated in an EHSS at national level.

4.4.3. Availability of financial resources

Availability of financial resources is a challenge in Lebanon. All the respondents from private and public institutions agreed that financial resources needed to undergo data collection, analysis and dissemination are limited. Lack of financial resources may be due to the fact that the government has other priorities to deal with in an unstable country like Lebanon that faces many political differences. Moreover, the Syrian crisis has resulted in a huge influx of refugees into Lebanon which is increasing pressure on available resources.

This is not healthy since the government relies only on short term projects instead of institutionalizing them within the government to ensure long term sustainability. These results overlap with the findings of Massoud et al. (2013) which highlight the importance of availability of financial resources and explain that lack of such resources pose challenges for monitoring and planning (Massoud, Basma, & Chami, 2013).

As a result of the financial challenges, the majority of participants responded by explaining that more commitment is needed from the government. In addition, government authorities must have the political will in order to change and influence policy at national level. Otherwise, nothing will be done and no long-term planning strategies will be put in place. Moreover, another solution that was proposed by the respondents belonging to category III was the need to enhance private public partnership (PPP). The reason for this may be that involvement of the private sector will provide more financial resources that are needed for the recruitment of human resources. Availability of these two resources is very important for any system to continue and be functional. Availability of funds will be a big support and contribute to increasing human resources. Thus, more people will be able to work together to maintain such a system.

4.4.4. Administrative process

All stakeholders agree that there are administrative challenges for collecting information on EHIs and setting an EHSS. These challenges include the lack of coordination and communication between ministries which leads to overlapping roles and responsibilities. Moreover, due to this lack of collaboration between public entities,

information and data is not easily shared and accessible. The majority of respondents added that government entities lack long term planning and focus only on short term actions and projects. This may be due to the political entourage in the country where elected ministers are motivated to work on short term projects that lead to fast outcomes and achievements. In this case, long term plans are usually delayed.

These results overlap with the findings of Massoud et al. (2013) which explain that developing countries tackle short-term problems rather than addressing the long-term impacts of environmental exposure. Furthermore, lack of coordination between authorities is also a waste of time and money since dispersion of roles and responsibilities does not lead to solid end results (Massoud, Basma, & Chami, 2013).

The most important solutions proposed by the respondents to overcome such administrative challenges were expressed by enhancing collaboration and coordination between ministries by defining clear roles and responsibilities between each institution. This can be further improved by having one central entity responsible for leading implementation and coordination with the relevant institutions. Moreover, they added the need for long-term planning which will be achieved through the establishment of an EHSS that allows for regular updating and reporting. To be able to work effectively, several respondents expressed the need for establishing a separate department or entity that deals with data collection, analysis and dissemination of indicators working in collaboration with all relevant ministries. This was recommended as a long-term solution to this problem.

Another important solution reported by a few of the respondents is the establishment a council for an EHSS. This initiative was recently established by the Climate Change Coordinating Unit (CCCU) at the Ministry of Environment (MoE) in 2012 through the *National Council for the Environment (NCE).* The NCE is used as a platform to discuss and improve climate change governance through developing national and sectoral plans to coordinate climate change initiatives by bringing together all relevant stakeholders from public and private institutions. Thus, a National Council for EHSS may be established were relevant stakeholders meet to discuss results and influence policy that will help reduce the burden of disease caused by exposure to environmental hazards.

In addition to the above common challenges, there are challenges specific for each EHIs and EHSS. For EHIs, respondents added challenges such as poor quality of indicators, lack of culture of statistics, inappropriate selection of EHIs, unreliable indicators and finally improper collection of data related to indicators. These challenges are specific to the indicators and stakeholders highlighted the importance to address them when setting a framework for selection of EHIs that will be incorporated in an EHSS.

Definitely, the challenges that face the development of EHIs will also face the development of EHSS since without EHIs there will be no EHSS. However, establishment of an EHSS faces additional challenges that were reported by the respondents. The challenges include lack of proper legislation, lack of sustainability and lack of people's motivation. It is crucial that the legal aspect is present for the system to be functional and continuous. Without proper legislation in place, the system will not be comprehensive and well-structured. Moreover, availability of resources (financial, technical and human) and

collaboration between all relevant institutions will ensure sustainability of the system for the long term. Finally, this all cannot be done without motivation from the people and their understanding of the importance of such a system to reduce or prevent disease. These results coincide with the findings of Abelsohn et al. (2009). They reveal that developing countries will face additional challenges that hinder the development of an EHSS. The challenges range from data availability, reliability and resources to coordination among authorities (Abelsohn, Frank, & Eyles, 2009).

As a result of the above challenges and opportunities, a summary table was developed that highlights how the results of the respondents were used as input for proposing a framework for an EHSS for Lebanon. Table 5 illustrates the four main themes encompassing the challenges and solutions along with their input in the framework for an EHSS. The following information from this table was used to propose a framework for an EHSS based on the stakeholder's views.

Table 5: Challenges and solutions for developing EHIs and proposing an EHSS reported by the respondents

Themes	Challenges	Solutions/Opportunities	EHSS framework
1. Availability of tools to collect EHIs and set an EHSS	Lack of four main pillars: legal, technical, financial and human resources	-Establish a legal framework for an EHSS and set priorities to be able to identify gaps and work on them	-Proper legal framework put in place through the development of an EHSS -Ensure good quality of data that will be integrated in an EHSS -Establish purpose of the system -Ensure good scientific background and evidence -Identify clear EHIs to be included in an EHSS -Prioritize EHIs based on the most important environmental hazards that are causing disease -Include reliable and measurable EHIs -Ensure that the system is sustainable for the long term (on-going process)
	Short term projects	-Institutionalize projects within ministries and public institutions	
	Absence of a clear system for data collection, analysis and dissemination resulting in poor quality data (scattered, old, dis-continued…)	-Adopt a methodology for data collection that is standardized among all institutions	
2. Availability of technical expertise and lack of human resources	Technical expertise is available only for the duration of the project	-Define proper roles and responsibilities of each stakeholder -capacity building of local staff	-Include all relevant stakeholders from public, private and academic institutions with clear roles and responsibilities -Identify target audience -Disseminate information as well as results to all people including private and public institutions, academic institutions, policy makers, media, researchers and the general public - Involvement of general public and take into consideration their concerns
	Lack of human resources especially in the public sector	-More recruitment of public employees and trainings for existing staff to upgrade skills and expertise	
	Lack of awareness on environmental health issues	-Raise awareness on importance of EHIs and EHSS among public and private institutions as well as the civil society through capacity building -More involvement of the civil society	

3. Availability of financial resources	Lack of financial resources due to other priorities of the government	-More commitment from government authorities	-Institutionalize system within the government -Allow government to take lead in developing and implementing EHSS
	Previous wars that have increased pressures and lead to financial burden, in addition to Syrian crisis	-Need for private public partnership (PPP) to make funds available	
	Political situation in the country leading to insecurity		
4. Administrative process	Lack of coordination and communication between public entities	-One leading entity responsible for implementation and coordination	-Legal framework put in place -Development of EHSS unit at MoPH -EHSS tackles long term planning through a continuous process -Development of an e-database to share information easily among institutions -Establish a National Council for EHSS to take decisions at higher level to influence policy makers -Influence policy makers -Propose intervention and prevention strategies to improve human health
	Overlapping roles & responsibilities	-Defined roles & responsibilities of each relevant stakeholder	
	Lack of long term planning	-Need for long term planning through establishment of an EHSS	
	Limited data availability and accessibility	-Continuous updating and regular reporting	
	No central entity leading and responsible for data collection and analysis	-Need for a separate entity or department responsible for data collection, analysis and dissemination	

4.5. Proposed framework for an EHSS

A framework for developing an EHSS is needed in Lebanon to be able to bridge the gap between health and the environment. After intense research, the DPSEEA framework is proposed to be the best method for developing EHIs. The reason for using this framework is that DPSEEA depicts the complexity between health and the environment. It also portrays the inter-linkages between environmental health problems unlike other frameworks that display the relationship in a linear form. Moreover, the advantage of using the DPSEEA framework is that it identifies multiple entry points at the different levels which allows for intervention and monitoring at any point.

From the results of the interviews and as a result of Table 5, a framework for an EHSS was proposed taking into consideration the various challenges/solutions that were reported. Figure 3 illustrates the proposed framework needed to develop an EHSS. This framework was developed reflecting on the inputs from numbers 1 & 2 of Table 5 and highlights four steps needed to develop an EHSS taking into consideration the stakeholder's views. The combination of all the various stakeholders throughout the process will allow for sharing of information and expertise that will be an added input in the development of an EHSS.

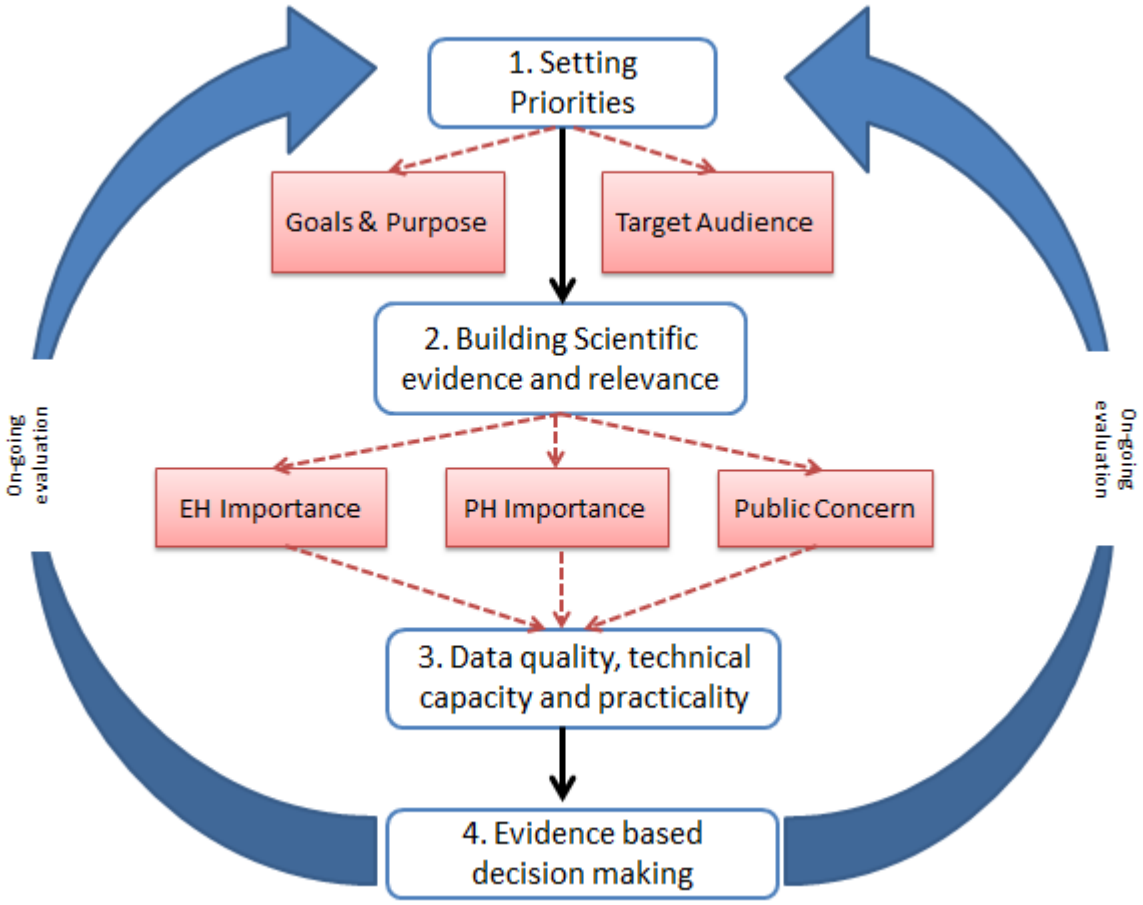

Figure 3: Proposed framework for an EHSS for Lebanon

Step 1: Setting priorities

Priority setting is required to be able to set goals, establish the purpose of the system and identify the target audience. To select EHIs, it is important to identify the most important environmental hazards that are causing disease to be integrated in an EHSS. At this stage, it is crucial that practitioners have well-established, concrete and reliable data to develop good EHIs.

The target audience may include researchers, public health practitioners, policy makers, government and non-government institutions, academic institutions and the public.

As a result of the interviews, a relevant set of available and proposed EHIs were identified. Table 6 presents the indicators that were identified by the respondents along with the stakeholder(s) that is responsible for their collection.

Table 6: Available and Proposed indicators for Lebanon

EHIs in Lebanon		Stakeholder responsible for collection
Available Indicators	-Air quality	MoE
	-GHG emissions	MoE
	-Water	MoE/MoEW/MoA/MoPH
	-Land/soil	MoE/MoA
	-Biodiversity	MoE
	-Communicable diseases	MoPH
	-Water and sanitation	MoPH/MoEW
	-Living environment at household level	MoPH
	-Population	CAS
	-Education	CAS
	-Labor force	CAS
	-Health Insurance and Disability	CAS
	-Children's situation	CAS
	-Women's situation	CAS
	-Household expenditure	CAS
	-International migration	CAS
	-Agriculture	MoA
	-Industry	MoI
	-Energy	MoEW
	-Gender statistics	CAS
	-National accounts	CAS
	-CPI: Consumer Price Index	CAS/MoET
	-Policies & Strategies	CAS/MoET/MoF/MoE
Proposed Indicators	-Air quality	MoE
	-Water and sanitation	MoPH/MoEW
	-Economic indicators for environmental health	MoET
	-Socio-economic indicators	CAS/MoET
	-Health indicators	MoPH
	-Food safety indicators	MoPH
	-Agriculture indicators	MoA
	-Forestry	MoA
	-Water availability	MoEW
	-Snow & snow melt	MoEW/MoE
	-Transportation	MoT
	-Energy resources	MoEW
	-Wastewater	MoEW

Not all the proposed EHIs are feasible to collect unless the challenges are addressed. Thus, to be more effective and efficient, it is better to start with the indicators that are already available and build on them. The list may be expanded later on.

Step 2: Building scientific evidence and relevance

After recognizing the system goals and the target audience, it is necessary that the stakeholders build scientific evidence and relevance of the environmental health issue. This assessment is based on three important components that include environmental health importance, public health importance and public concern. According to Malecki et al. (2008), it is necessary to include scientific information in an EHSS to strengthen the basis for which the system is developed and be able to identify intervention and prevention programs (Malecki et al., 2008).

First, the ***environmental health importance*** of EHIs needs to be assessed. This is done by examining what is known or not known concerning the cause-effect relationship between human exposure to environmental hazards and related health effects. Thus, it is important to prove that EHIs have an environmental health importance. Moreover, identifying gaps in the environmental health scope can help build the scientific evidence or lack that is needed for the inclusion or exclusion of a specific EHI (Malecki et al., 2008).

Second, the ***public health importance*** needs to be assessed. This is defined as the degree of the health effect related to a specific hazard or exposure accompanying the EHI. The degree can be measured in terms of three criteria including mortality, morbidity or

overall health care costs to society. Similar to the above, it is also important to prove that EHIs have a public health importance too. This is usually easier to prove than environmental health importance. Thus, environmental health importance and public health importance come hand in hand. Based on a study done by Malecki et al. (2008), many times environmental hazards may be related to health effects, however the scientific evidence provided may not be strong enough or known, thus the public health importance remains uncertain (Malecki et al., 2008).

Third, EHIs are assessed based on ***public concern***. Some EHIs are found in an EHSS simply because the public are concerned about a specific environmental health issue. The scientific evidence needed to support the environmental health importance may be missing; however, the public is the primary user of the public health sector. Thus, a public health concern or EHI will be included in an EHSS and considered important regardless of the scientific evidence. It is measured depending on risk perception and risk conditions. This was further elaborated by a case study given by Malecki et al. (2008), where a community was led to believe that the drinking water supplies are unsafe and contaminated due to outbreaks of elevated drinking water contaminants in some communities. Thus, the community switched to bottled water knowing that in reality the public water supplies are regulated on a continuous basis and programs are set in order to provide the community with safe drinking water. In addition, there is no monitoring of bottled water and the risks are unknown to the public (Malecki et al., 2008).

Step 3: Data quality, technical capacity and practicality

To be able to develop good quality EHIs, it is necessary to assess the quality of data, technical capacity and practicality/feasibility. This step is important to evaluate the availability, accessibility, collectability, feasibility, and value of the data at spatial and temporal scales. This in turn will help generate good quality data that is easy to use, estimate and assess. It also offers the opportunity to highlight areas of strength and weakness to improve EHIs.

Good quality data is easily documented and methods for data collection and analysis can be easily replicated. Moreover, sources of bias must be taken into consideration that may affect accuracy, reliability and validity and respective interpretations must be delivered (Malecki et al., 2008).

Step 4: Evidence based decision making

The final stage of the framework entails focusing on the overall goal of an EHSS which is to influence policy makers by providing evidence and implementing intervention strategies for improving human health. Thus, the development of a surveillance system should be interpreted through the implementation of prevention actions that emerge as a result of the monitoring and evaluation of key issues over a specific time. Moreover, the EHSS must be preventive, appropriate, available, easily quantifiable, cost-effective, and finally spatially and temporally scaled (Malecki et al., 2008).

It is to be noted that environmental public health priorities change over time, thus the system must be dynamic and flexible based on public health needs. Moreover,

stakeholders must be engaged throughout the development process of the surveillance system. There may not be clear decisions about what indicator sets to be included or excluded from the EHSS, however, having clear goals or priorities will assist in the final decision making.

Once the EHSS is established and functional, the administrative process must follow. The administrative framework was developed based on the results of numbers 3 & 4 in Table 5 above. Figure 4 exemplifies the administrative procedure for an EHSS following three main steps based on the inputs from the different stakeholders:

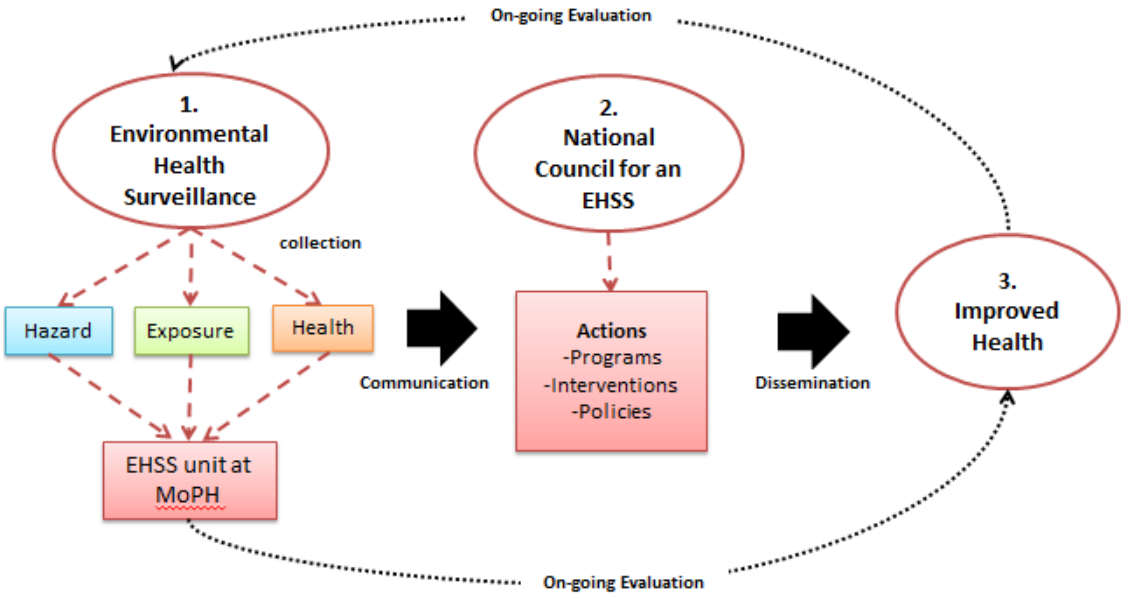

Figure 4: Administrative process for an EHSS for Lebanon

1. Environmental health Surveillance

The initial phase entails collecting data on three environmental health constituents that include hazard, exposure and health effect. After environmental health data has been collected, it will be incorporated in an EHSS and made available on an e-database. The e-database will be a shared database between all ministries that have access to the network and can easily upload and download information related to environmental health. At this stage, the data will be analyzed and interpreted. This can be done through a separate entity or department at the Ministry of Public Health (MoPH) known as "EHSS unit" that is responsible for environmental health surveillance. The MoPH has already developed an epidemiological surveillance unit that is responsible for gathering, analyzing and disseminating information related to communicable diseases. Thus, these two departments can collaborate and work together to provide information and linkages related to environmental health.

2. National Council for EHSS

Next, the analyzed data as a result of environmental health surveillance will then be communicated to the National Council for EHSS. The National Council is made up of relevant stakeholders at the decision making level. Stakeholders include academic institutions, research institutions, policy makers, health care professionals, government institutions (ministries), and NGOs. It is necessary that the National Council is made up of various members since environmental health is diverse and affects all sectors. The main role of the National Council is to come up with actions such as programs, strategies or policies that lead to improved health outcomes.

The Ministry of Environment (MoE) has already developed a similar initiative in 2012 through the National Council for the Environment (NCE). The Council is made up of members of the different private and public institutions that come together to discuss and exchange knowledge related to climate change that can later be shared under a more systematic framework. Thus, the NCE and the National Council for EHSS can collaborate to discuss environmental health issues and come up with preventive strategies and interventions.

3. Improved Health

The final stage is to improve human health which is the primary goal of an EHSS. The decisions and actions taken by the National Council at high level decision making will influence policy. Thus, intervention and prevention strategies will be set and implemented to ultimately improve health. This is an on-going process and thus data collection, analysis, interpretation, and dissemination are continuously being conducted and integrated in an EHSS to help prevent injury or disease.

A respondent from category I concluded by saying that:

"It is important that an EHSS is a continuous process involving all relevant stakeholders to ultimately influence policy at national level and improve health."

CHAPTER 5
CONCLUSIONS & RECOMMENDATIONS

From this project, we were able to identify various indicators in Lebanon that are available and feasible to collect and a list was developed. Proposed EHIs that can be integrated in an EHSS were also identified by the different stakeholders with emphasis on air quality and water and sanitation. Challenges for developing EHIs and EHSS were identified; however, the most significant common challenges include lack of collaboration and coordination between ministries, lack of political will, lack of human and financial resources, lack of awareness and finally poor quality of data available. Through interviews with various stakeholders, we were then able to identify numerous solutions/opportunities to address the challenges of developing an EHSS for Lebanon and a table was developed. The most significant solutions reported by the stakeholders consist of institutionalizing the system within the government, raising awareness of the private and public sector on EHSS, centralizing one entity responsible for leading implementation of the system, establishing a national council for EHSS and finally developing a comprehensive database. Thus, all these results facilitated the development of a framework for an EHSS. This is only a starting point that policy makers can use and build on for the future.

It is necessary to select EHIs based on country's priorities related to the most important environmental hazards that are causing disease to be integrated in an EHSS. Thus, to be more efficient, it is preferable to start with indicators that already exist in Lebanon and later on expand the list of EHIs. To develop an EHSS that is effective and functional, certain pre-requisites must first be met. Development of an EHSS must take into

consideration the need for proper legislation and address the challenges present in a wider socio-economic and political context. A comprehensive database or e-database must be developed. It will help to detect trends and assess health impacts related to environmental exposure. Furthermore, a communication and dissemination plan should be well established. The plan will help to ensure that data is easily shared with all stakeholders including private and public institutions as well as the general public. Finally, a National Council for EHSS must be developed to improve decisions at higher level and influence policy makers to implement strategies that improve human health. All these requirements need to be met to ensure a well-organized, efficient and sustainable EHSS.

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