

Training Module

On

Adaptation to Climate Change to
protect Human health

Table of Contents	<u>Page</u>
Chapter 1:	
Introduction.....	4
1.1 Objectives of the training module.....	5
1.2 Audience of the training module.....	6
Chapter 2: Framing Climate Change Impacts on Water and Health	
2.1 Impacts of climate change on water resources.....	7
2.2 Impacts of climate change on health.....	11
2.3 Linkages between the impact of CC on water resources and health.....	15
Chapter 3: Impact and vulnerability assessment of the Health Sector based on RICCAR outputs	
3.1 RICCAR indicators and outputs that feed into the identification of adaptation measures.....	19
3.2 Vulnerability assessment tools of the health sector.....	22
Chapter 4: Identification of adaptation measures and options (IWRM tools) for the Health Sector based on the impact and vulnerability assessment results	
4.1: Stocktaking of available Adaptation measures.....	27
4.2: Evaluation and prioritizing proposed adaptation measures and selection criteria.....	29
Chapter 5: Adaptation measures implementation matrix	
5.1 Institutional and Legislative setup analysis and assessment for adaptation implementation Plan.....	35
5.2 Identification of Barriers to adaptation to Climate change impacts.....	37
Chapter 6: Areas for Action: Suggestions for Follow-up	
6.1 Following up on adaptation programs development at the national policy level.....	45
6.2 Following up on adaptation programs development at the global policy level.....	48
Chapter VI: References and further reading.....	50
Appendix 1: Tables for group exercises.....	52

Chapter 1 Introduction

The Arab countries like many other parts of the world is expected to be strongly impacted by climate change. Climate change impacts are expected to affect quantity and quality of the region's water resources. Previous local studies in many of the Arab countries showed an increase in the magnitude and frequency of extreme temperatures, a decrease in the precipitation levels and the resulting surface runoff and ground water recharge values. The already water stressed region will even go through more water stressed conditions because of climate change.

All development sectors are expected to be negatively impacted by climate change. The sectors that expected to be significantly impacted are:

- Water
- Agricultural (and food security)
- Ecosystems
- Health, and
- Economic growth

Climate change mitigation has been in the forefront discussion and research for decades. However, it is evident now that climate change impacts are occurring already and are expected to intensify for a long period of time. Thus, most efforts need to focus on the adaptation to climate change impacts.

In order to make the necessary adaptation to the consequences of climate change, many stakeholders have to be well informed. Knowledge of the consequences of humankind's behavior on our climatic system – presented, for example, in the latest Intergovernmental Panel on Climate Change (IPCC) assessment reports – is well-founded and adequate for the people working in the field. However, more specific information is needed for the implementation of concrete measures at the local level. It has been shown that the lack of such information is one of the most significant bottlenecks to concrete action, in particular with regard to adaptation, but also for the implementation of integrated activities that would promote both mitigation and adaptation.

Climate change and its health linkages in the water sector started to receive more focused attention throughout the last few years. The reported and expected significant impacts on public health is directly affecting the economic development of countries especially those who are most vulnerable to the impact to climate change and/or those who already suffer from water stressed conditions. It is imperative to recall that public health in the water sector management and governance is a major aspect and should always be addressed when analyzing the impact of climate change on the water sector.

Climate change is expected to impact water resources in two major pathways; scarcity and the frequency and intensity of extreme events (floods and droughts).

Water scarcity will lead to a decreased access to water supplies for many categories of the population to result in less water for hygiene. Water quality deterioration that can lead to potentially increased water borne and food borne diseases incidents is also another concern that should be addressed by the water managers and planners. In addition water scarcity will lead to less water for food and cause food insecurities leading to under nutrition of the vulnerable groups of the community.

A major area that needs to be addressed concerning public health is the possible impacts of climate change on vector-borne diseases. Issues stemming from this category of impacts are:

- Changes in temperature will affect their development, reproduction, behavior and survival rates.
- Changing temperature and precipitation may shift the geographic range in which they can live and the seasonal period of disease risk, and
- Temperature also can affect pathogen development within vectors, precipitation can influence the availability of breeding sites, and climatic variables can affect the distribution and abundance of their vertebrate host species

Water-borne infectious diseases are expected to worsen with climate change impacts by the increased temperatures, flooding, and other changes in the water cycle. An example of areas of concern is the infectious diarrhea where infection is spread through contaminated food or drinking-water, or from person to person as a result of poor hygiene. In addition severe diarrhea leads to fluid loss and may be life-threatening, particularly in young children and people who are malnourished or have impaired immunity.

The increased frequency of extreme events (floods for example) is expected to impact the infrastructure of countries prone to such events. Health protection programs will directly be impacted by these events. For example flooding can directly cause a disruption of the existing wastewater treatment plants of the country and could lead to more contamination potential of all water resources to negatively impact the human health. In addition a byproduct of these events will impact the historical human settlements pattern and possible displacement events, loss of housing facilities and loss of health care facilities.

Adaptation to the impacts of climate change is required. Implementation of adaptation programmes has to be in an integrated and comprehensive manner. According to *Assessments of Impacts and Adaptations to Climate Change (AIACC) final report which released in 2007*, there are nine important lessons about adaptation to be learned, as well as, many more lessons that are specific to particular places and contexts. The general lessons, formulated as recommendations, are:

- Immediately start adaptation efforts
- Create conditions to enable adaptation
- Integrate adaptation with development
- Increase awareness and knowledge
- Strengthen institutions
- Protect natural resources
- Provide financial assistance
- Involve those at risk, and
- Use place-specific strategies

This same report also strongly stresses the role of the knowledge transfer and the strengthening of institutions in creating a robust carrying capacity that will enable different elements of the society to adapt to climate change impacts and support the vulnerable communities withstand them.

1.1 Objectives of the Training health module of the training manual

The main objective of this module is to develop the capacities of the Arab countries in the area of climate change adaptation with a specific focus on the water sector to protect Human health for professionals working in this field. The manual training manual is developed within the activities of The United Nations Development Account Project on Developing the Capacities of the Arab Countries for Climate Change Adaptation by Applying Integrated Water Resources Management Tools project seeks to assist Arab Governments to build their capacity for climate change adaptation by applying integrated water resources management (IWRM) tools. The project aims to provide a

set of regionally appropriate IWRM tools for supporting climate change adaptation in five key sectors namely agriculture, economic development, environment, health, and human settlements by deriving a training manual that includes the five modules on the selected sectors. The project is led by the United Nations Economic and Social Commission for Western Asia (ESCWA) in cooperation with the United Nations Environment Program Regional Office for West Asia (UNEP/ROWA), and is implemented in partnership with the Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD), the Arab Countries Water Utilities Association (ACWUA), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the World Health Organization Centre for Environmental Health Activities (WHO/CEHA). This UNDA project builds on the results of the Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) that is led by ESCWA and implemented by the 11 League of Arab States (LAS) and United Nations organizations.

The specific objectives of this health module are:

- Explore and identify the impacts of climate change on the water sector
- Framing the linkages between climate change, water sector, and health.
- Review the vulnerability assessment protocols and indicators in the water sector.
- Present the tools for adaptation in the water sector in order to protect human health
- Review the governance framework towards identifying the needed adaptation interventions for the sector.

1.2 Audience of the Training module:

This health module has been designed to inform the following target groups interested in learning about the different aspects of climate change impacts on water resources, the associated linkages to health and the use of Integrated Water Resource Management (IWRM) as a tool for climate change adaptation in these two sectors:

- Decision makers and technical staff in the operational water and health sectors who are concerned with the health dimensions of climate change and with developing and implementing policies, programmes or projects;
- Decision makers and technical staff in other government sectors concerned with water and health dimensions of climate-change (e.g. environment, agriculture, food, disaster risk reduction, transport, industry, labor, education, etc.);
- Stakeholders involved in the development and implementation of National Adaptation Plans (NAPs) and National Adaptation Programmes of Action (NAPAs), Nationally Appropriate Mitigation Actions (NAMAs) and National Communications;
- Representatives involved in the global UNFCCC process, such as negotiators and UNFCCC focal points;
- General health and water Sectors staff and other professionals providing water and health services;

- Non-governmental organizations (NGOs) experts active in the area of climate change and/or water and health;
- Researchers working on climate change adaptation in the water and health issues.

Chapter 2: Framing Climate Change Impacts on Water and Health

2.1 Impacts of climate change on the water resources.

Semi-arid and arid areas are particularly exposed to the impacts of climate change on freshwater. Higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution, with impacts on ecosystems, human health, water system reliability and operating costs. Climate change affects the function and operation of existing water infrastructure as well as water management practices. The negative impacts of climate change on freshwater systems outweigh its benefits.

In the last decade, climate change has emerged as an equally challenging threat to water availability in the region, whereby increased global temperatures are leading to changes in the hydrologic cycle and increased water demand. Expected biophysical and socio-economic impacts on water resources with climate change are summarized in table 1.

Table 1: Some impacts on water resources expected with changing climate (Based on El-Fadel and Bou-Zeid, 2003).

Biophysical resources	Major impacted components	Potential effects
Hydrologic resources	<ul style="list-style-type: none"> – Precipitation – Evaporation – Transpiration – Runoff – Recharge 	<ul style="list-style-type: none"> – Soil moisture changes – Reduced ground water recharge – Water shortages or surpluses – Dam failure due to floods – Dam storage loss due to sedimentation
Water quality	<ul style="list-style-type: none"> – Water temperature – Water salinity – Pollutant concentrations – Fauna and flora 	<ul style="list-style-type: none"> – Changes in chemical quality – Changes in biological quality – Changes in thermal quality
Aquatic systems	<ul style="list-style-type: none"> – Stream flows – Erosion and sedimentation – Water levels in surface water – Water levels in aquifers – Water fluxes in the subsurface 	<ul style="list-style-type: none"> – Droughts or floods – Dam failure due to floods – Dam storage loss due to sedimentation
Water supply	<ul style="list-style-type: none"> – Water demand per capita – Agricultural water demand 	<ul style="list-style-type: none"> – Water demand increase beyond projected levels
Water management systems	<ul style="list-style-type: none"> – Stream flows – Water level in surface water bodies – Water levels in aquifers 	<ul style="list-style-type: none"> – Reduced water supply – Changing loads on water treatment systems – Changing hydropower production potential

Higher temperatures and changes in extreme events, including more and more intense floods and droughts, are projected to affect water quality and exacerbate many forms of water pollution – from sediments, nutrients, dissolved organic carbon, pathogens, pesticides and salt – and also cause thermal pollution, with possible damage to ecosystems, human health, and water system reliability and operating

costs. In addition, sea-level rise is projected to extend areas of salinization of groundwater and estuaries resulting in a decrease of water availability for ecosystems and humans.

In some cases, climate change might have positive impacts such as increased growth rates and food conversion efficiencies, increased length of growing season; species range expansion, and the availability of new land due to decreased ice cover. Society should aim to understand and maximize the benefit from these positive impacts which can support adaptation, for example by using a prolonged growing season to increase the number of annual harvests.

Globally, the harm caused by climate change to freshwater systems is expected to outweigh the benefits. At the global level, by the 2050s, the area of land affected by increasing water stress caused by climate change is projected to be more than double that with decreasing water stress. Areas in which runoff is projected to decline obviously face a reduction in the value of the services their water resources can supply. Increased annual runoff in some areas is projected to lead to increased total water supply. But in many regions this benefit is likely to be counterbalanced by the damage caused by increased variability in precipitation and seasonal run-off, shifts in water supply and water quality and flood risks.

Water is central to many different sectors hence the impacts of climate change are expected to have far-reaching effects on society. Economic sectors which are projected to be most affected are agriculture (increased demand for irrigation and forestry), energy (reduced hydropower potential and cooling water availability), recreation (water-linked tourism), fisheries and navigation. Because of the importance of these sectors for national and individual welfare, climate change impacts on water have important direct and indirect effects. Serious impacts on biodiversity also loom (Table 2).

Climate change and variability and associated changes in the available water resources and their quality are also responsible for increased health risks through direct effects (e.g. drowning or trauma in floods, post-traumatic mental disorders in natural disasters) and exposure to health hazards caused by growing contamination of water (e.g. by pathogens, waste and toxic chemicals), lack of household hygiene, reduction of food safety, and an increase in the number and geographical distribution of disease-carrying vectors. These changes can result in an increase in emerging and reemerging infectious diseases. A special concern is linked to the disruption of water supply and sanitation systems during extreme events that might result in an increase in water-borne infectious diseases. Adverse effects of climate change on water aggravate the impacts of other stresses and pressures, such as changing consumption and production patterns, land use change, urbanization and population growth. Responses to climate change and other pressures may have irreversible long-term impacts, e.g. land degradation caused by inappropriate long-term irrigation.

Furthermore, the impacts vary in time and space: some impacts are on a daily/local scale (e.g. lower oxygen content), others are at longer/larger scales (e.g. changes in algal blooms over weeks or months, changes in species composition over many years, groundwater level variations and alterations to groundwater flow directions).

Current water management practices may not be robust enough to cope with the future impacts of climate change on water supply reliability, flood risk, health, agriculture, energy and aquatic ecosystems. In many locations, water management cannot satisfactorily cope with current hydrologic variability which

can lead to extensive flood and drought damage. In addition, natural changes can be exacerbated by illegal activities such as unauthorized well-drilling which underlines the need for strong management rules and their enforcement.

Table 2: Risks for water, health and other sectors through climate change (Bates et al. 2008, IPCC 2007)

PHENOMENON	EXAMPLES OF MAJOR PROJECTED IMPACTS BY SECTOR, MAINLY THROUGH WATER			
	Water resources	Agriculture, ecosystems	Health	Industry and society
Heavy precipitation events	<ul style="list-style-type: none"> – Flooding – Adverse effects on quality of surface and groundwater due to sewer overflows – Contamination of water supply – Water scarcity may be relieved 	<ul style="list-style-type: none"> – Damage to crops – Soil erosion – Inability to cultivate land due to waterlogging of soils 	<ul style="list-style-type: none"> – Increased risk of deaths, physical injuries and infectious, respiratory and skin diseases – Risk of psychological disorders 	<ul style="list-style-type: none"> – Disruption of settlements, commerce, transport and societies due to flooding, migration – Pressures on urban and rural infrastructures – Loss of property
Higher variability of precipitation, including increased droughts	<ul style="list-style-type: none"> – Changes in run-off – More widespread water stress – Increased water pollution due to lower dissolution of sediments, nutrients, dissolved organic carbon, pathogens, pesticides and salt, as well as thermal pollution – Salinization of coastal aquifers 	<ul style="list-style-type: none"> – Land degradation – Lower yields/crop damage and failure – Increased livestock deaths – Increased risk of wildfire 	<ul style="list-style-type: none"> – Increased risk of food and water shortage; – Increased risk of malnutrition; – Increased risk of water and food-borne diseases 	<ul style="list-style-type: none"> – Water shortages for settlements, industry and societies – Reduced hydropower generation potentials – Potential for population migration

EXAMPLES OF MAJOR PROJECTED IMPACTS BY SECTOR, MAINLY THROUGH WATER				
PHENOMENON	Water resources	Agriculture, ecosystems	Health	Industry and society
Increased temperatures	<ul style="list-style-type: none"> – Increased water temperatures – Increase in evaporation – Earlier snow melting – Permafrost melting – Prolonged lake stratification with decreases in surface layer nutrient concentration and prolonged depletion of oxygen in deeper layers – Increased algae growth reducing dissolved oxygen levels in the water body which may lead to eutrophication and loss of fish – Changes in mixing patterns and self purification capacity 	<ul style="list-style-type: none"> – Less water available for agriculture, more irrigation needed – Changes in crop productivity – Changes in growing season – Changes in species composition, organism abundance, productivity and phenological shifts, for example earlier fish migration 	<ul style="list-style-type: none"> – Changes in vector-borne diseases – Increase of fatalities due to heatwaves, and decreased personal productivity – Increased risk of respiratory and skin diseases due to ozone and pollen 	<ul style="list-style-type: none"> – Risk for infrastructure fixed in permafrost – Degradation of freshwater quality

The climate change impacts on freshwater resources put at risk sustainable development, economic growth, poverty reduction, production and availability of food, and the health of people and ecosystems, thus the ability to achieve the Millennium Development Goals (MDGs) and the more global Sustainable Development Goals (SDGs) is becoming hard. Countries with economies in transition and less developed countries are among the most vulnerable to the adverse effects of climate change, and widespread poverty limits their ability to adapt.

Recognizing the impacts of climate change on different regions of the world the UN has devoted Goal 13 of the SDGs to address taking urgent action to combat climate change and its impacts. The targets of this goal are to: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries, Integrate climate change measures into national policies, strategies and planning, Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning, Implement the commitment undertaken by developed-country to address the needs of developing countries in the context of meaningful mitigation actions, Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities.

Adaptation to climate change is consequently indispensable and urgent since the climate is already changing in some respects, and mitigation will take too long to show effects. Further climate change throughout this century and beyond is almost certain even if global mitigation efforts prove successful. In addition, it is more cost effective to start preparing for adaptation now.

Adaptation represents an important challenge for all countries, especially for those with economies in transition, but few have developed adaptation strategies so far. Knowledge and experience of adaptation in a transboundary context is especially lacking.

2.2: Impacts of CC on health.

Climate change poses a significant threat to public health at a global level. The Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report declared that climate change ‘contributes to the global burden of disease and premature death.

Addressing the impacts of climate change on human health is challenging because of the wide spectrum of determinants that influence health including the physical and social environment, the introduction of new technologies, and changing political landscapes that reshape social and economic conditions. Health is directly and indirectly related to the impacts of climate change. Direct impacts of climate change on human health include mortality and morbidity from extreme weather events (floods, heat waves, droughts and hurricanes) while indirect impacts on human health include longer-term climatic changes that affect the range and reproductive rates of disease vectors, extending transmission seasons, increasing the incidence of food- and waterborne diseases, and resulting in poor air quality and food insecurity (IPCC, 2007, IPCC,2014). Figure 1 provides a conceptual framework depicting the links between climate change and human health.

In a recent report, the World Health Organization (WHO) attributed 0.2 percent of annual global mortality to climate change (WHO, 2009). The same report attributes about 1.2 million annual deaths to urban air pollution, 2.2 million to diarrhea, 3.5 million to malnutrition, and 60,000 to natural disasters, all of which are climate sensitive outcomes prone to increase with a warmer and more variable climate. Despite the multiplicity of possible impacts, the threat that climate change is likely to pose to human health and security should not be underestimated (WHO/EMRO, 2008); the interactions between environment and health are complex, highly dependent on local conditions, and dynamically shaped by national, regional, and international pressures.

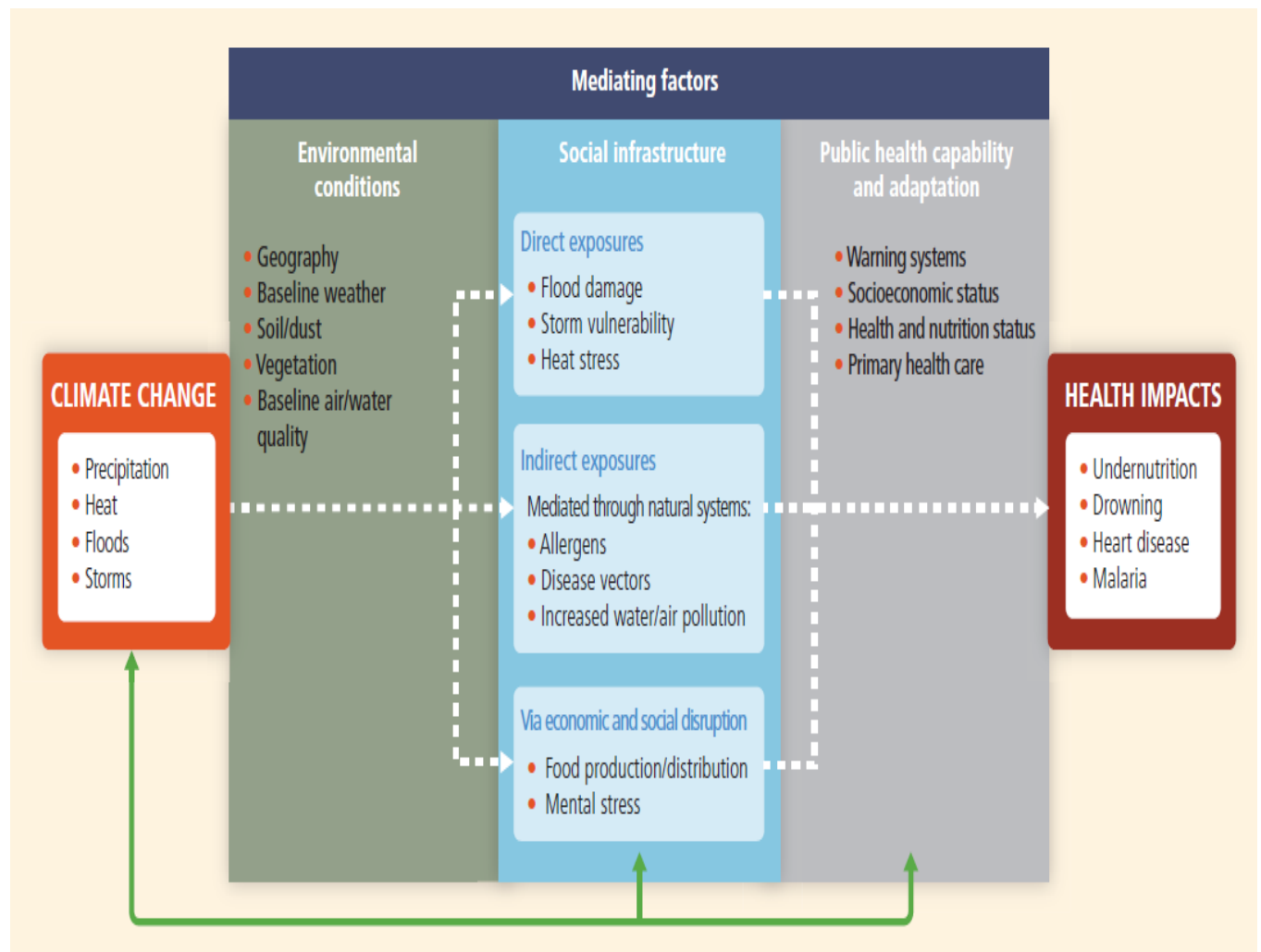


Figure 1: Conceptual diagram showing three primary exposure pathways by which climate change affects health: directly through weather variables such as heat and storms; indirectly through natural systems such as disease vectors; and pathways heavily mediated through human systems such as under nutrition. The green box indicates the moderating influences of local environmental conditions on how climate change exposure pathways are manifest in a particular population. The gray box indicates that the extent to which the three categories of exposure translate to actual health burden is moderated by such factors as background public health and socioeconomic conditions, and adaptation measures. The green arrows at the bottom indicate that there may be feedback mechanisms, positive or negative, between societal infrastructure, public health, and adaptation measures and climate change itself. (*IPCC AR5, 2014*)

Extreme weather events impacts on health

Extreme weather events including floods, droughts, storms, fires, and heat waves have had an impact on morbidity and mortality. These weather events are expected to increase and intensify as a result of global climate change (IPCC, 2007). Victims of these disasters often find shelter in inadequate housing that lack basic environmental services, increasing the risk of water-, air- and vector-borne illnesses and rising rates of hunger and malnutrition (WHO/EMRO, 2008).

Extreme weather events have been associated with a variety of psychological impacts due to loss, social disruption, displacement, and repeated exposure to natural disasters. The Centers for Disease Control (CDC) projects that, by 2050, 200 million people will be displaced by climate change-related factors worldwide (CDC, 2010).

Following natural-disaster events, geographic displacement, loss or damage of property, death or injury of loved ones and recovery efforts will exacerbate mental health problems and stress-related disorders, which include post-traumatic stress disorder, depression, anxiety, sleep difficulties, and sometimes drug or alcohol abuse (Silove and Steel, 2006). These events may impact livelihoods and socioeconomic and demographic situations, which in turn results in increased rates of violence and injuries. Some studies have shown a relation between such mental health disorders or stress resulting from climate change and other negative health effects such as blood glucose levels and cardiovascular disease (Surwit et al,2002; Black and Garbutt,2002).

Flood-related diseases

Floods disrupt basic sanitation systems, increasing probabilities of diarrheal disease outbreaks through the fecal-oral route. They also typically contaminate drinking-water sources and facilities with pathogens present in human or animal sewage, increasing the risk for outbreaks of waterborne diseases such as dysentery, hepatitis A, cholera, typhoid fever, or leptospirosis.

Floods may indirectly lead to an increase in vector-borne diseases through the expansion in the number and range of vector habitats.

Heat-wave related mortality and morbidity

Heat waves can cause death (i) directly through causing heat illnesses and (ii) by aggravating pre-existing heat-sensitive medical conditions. Additional risk factors for heat-related mortality are mediated through the additional pressure on water and electrical systems, risk-associated behavioral responses, and worsening environmental conditions, especially air quality.

Increased heat-related morbidity can occur, like mortality, through direct heat illness or through aggravation of preexisting diseases. Either of these outcomes may require primary care or hospitalization, and a proportion of this morbidity may eventually result in mortality. Though heat-related deaths are often documented as such, heat illnesses sometimes pass unnoticed or unreported in low and middle-income countries, calling for the use of proxies for baseline data when planning and designing public-health actions. Heat waves increase the risk of hyperthermia (excessive body temperature) which entails serious risks for health and may result in death. Hyperthermia may result in heat exhaustion, cramps and/or heat stroke. Furthermore, the stress from extreme weather events are associated with myocardial infarction, sudden cardiac death and stress-related cardiomyopathy. People with pre-existing illnesses such as cardiovascular and respiratory diseases are more prone to heat cramps, heat syncope, heat exhaustion, and heat stroke as a result of elevated temperature.

Indirect health consequences of climate change

The increased temperatures and more variable precipitation that have been documented over the past two decades, and which are projected to continue into the next century (IPCC,2007), have indirect effects on health. Changes in temperature, humidity and rainfall affect vector-borne disease transmission as well as

waterborne and food-borne disease. These changes also interfere with agricultural systems and affect crop yields which could create food and water shortages leading to malnutrition. The WHO estimated that in the year 2004, the world faced a total of 141,277 deaths and disease burden of 5.4 million Disability-Adjusted Life Years (DALYs) as a result of global climate change. The same report estimated that the Eastern Mediterranean Region (EMR) faced a total of 20,000 deaths and disease burden of 755,870 Disability-Adjusted Life Years (DALYs) as a result of global climate change (WHO 2004), likely to be an underestimation since the exposure was only measured in terms of carbon emissions and the outcome measures were limited mainly to diarrhea, lower respiratory infections and malaria.

Vector-borne diseases

Climate-related environmental changes such as increased temperatures, variable humidity and rainfall trends may affect the density of vector populations, their transmission patterns, and infection rates (WHO, WMO and UNEP,2003). Furthermore, rapid human developments have led to increased water demand and construction of dams and irrigation canals and have spurred changes in mosquito populations. As a consequence, vector-borne illnesses—closely associated with temperature and humidity conditions—such as malaria, dengue fever, Rift Valley fever, and West Nile virus may intensify, re-emerge in previously endemic areas, or emerge in areas not previously affected.

Water-related illnesses

Inadequate water supplies, either in quantity and quality, may lead to increased risk of waterborne illnesses such as diarrhea, typhoid, hepatitis, dysentery, giardiasis, bilharziasis, and cholera. Cholera epidemics are likely to emerge in areas experiencing warmer weather and water, such as the Arabian Peninsula.

The increasing pressure on fresh water resources has led to a rise in the use of wastewater for irrigation. But if improperly treated the use of wastewater can create increased health risks to farmers, families, and consumers (WHO/EMRO,2008).

Food-borne diseases and malnutrition

Globally about 800 million people suffer from malnutrition with 3.5 million deaths per year; (WHO 2009; WHO/EMRO,2008). Climate change affects the agricultural sector and food production and thereby threatens the basic needs of the people in the region. Increased temperature, less water available for irrigation, and more variable precipitation will reduce crop yields in some regions.

Climate change is likely to increase the occurrence of the kind of worldwide agricultural price shocks experienced in 2007–2008 and again in 2010–2011 (World Bank, 2011).

Food-borne illnesses result from the ingestion of spoiled or contaminated food such as seafood contaminated with metals or crops with pesticide residues or microbes (Interagency Working Group on Climate Change and Health, IWGCCCH 2010). Extreme weather events such as droughts encourage the proliferation of crop pests and the spread of mold that may be harmful to humans. Changes in climate may also affect environmental ocean parameters that lead to the proliferation of existing or new pathogens that are harmful to human health (Centers for Disease Control (CDC, 2010). Harmful algal blooms produce toxins that when ingested through shellfish will also cause human diseases. The increase in pests and weeds could also lead to a wider use of pesticides and a higher risk of pesticide exposure (CDC, 2010).

Other health effects

Weather conditions including temperature, humidity, and wind also affect ambient air quality which is largely determined by anthropogenic sources of pollutants. Climate-related environmental factors including dust storms, rainfall, and increases in temperature, raise the ambient concentrations of aeroallergens (including pollen and dust), ground level ozone, and suspended particulate matter, which exacerbate respiratory illnesses (IWGCCH, 2010).

Increased human exposure to toxic substances as a result of climate change-related factors may be linked to cancers in humans . For example, volatile and semi-volatile carcinogens are transferred from water and wastewater into the atmosphere as a result of higher ambient temperatures, and toxic pollutants are washed out by heavy rains and floods contaminating runoffs and ultimately water resources (Macdonald et al., 2003). However, limited evidence has been established on these transfers and their impact on people's exposure to carcinogens and ultimately their impact on cancer outcomes (IWGCCH, 2010).

Cardiovascular illnesses have been linked to climate change-related variables such as average daily temperatures (Basu and Samet 2002, Braga, Zanobetti, and Schwartz, 2002; Donaldson et al. 1998; Ebi et al, 2004). Physiological adjustments to cold and warmth are associated with changes in blood pressure, blood viscosity and heart rate, all important determinants of mortality related to cardiovascular diseases and strokes (Martens, 1998).

2.3: Linkages between the impact of CC on water resources and health.

As indicated earlier the impact of climate change on water quality and quantity is direct, evident, and been proved by an overwhelming majority of studies. Certain countries are more prone to the impact of climate change on water resources than others. The Arab countries are one of the most vulnerable countries to climate change on all sectors with a specific concern on the water sector.

The close linkage between the water quality and quantity and impacts on the public health is also very direct and clear, since water has a profound influence on human health. At a very basic level, a minimum amount of water is required for consumption on a daily basis for survival and therefore access to some form of water is essential for life. However, water has much broader influences on health and well-being and issues such as the quantity and quality of the water supplied are important in determining the health of individuals and whole communities.

The first priority must be to provide access for the whole population to some form of improved water supply. Even though access may be restricted by many reasons, climate change would come as an important factor that will aggravate the availability of water and its quality. These linkages between the water issues and health must be addressed if public health is to be protected and make it less vulnerable to the impact of climate change on water resources.

The quality of water does, however, have a great influence on public health; in particular the microbiological quality is important in preventing ill-health. Poor microbiological quality is likely to lead to outbreaks of infectious water-related diseases and may causes serious epidemics to occur.

Chemical water quality is generally of lower importance as the impact on health tend to be chronic long-term effects and time is available to take remedial action. Acute effects may be encountered where major pollution event has occurred as in the case of disaster and failure of some water utilities and sanitation infrastructure due to extreme events of droughts and floods, two elements that are expected to be increased in frequency due to climate change.

Microbiological drinking-water quality and human health

Climate change is expected to impact the microbiological quality of drinking-water due to the decrease in surface runoff and the associated increase in the level of their microbial contamination. Thus it is expected that an increase in the spread of important infectious and parasitic diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis, guinea worm and schistosomiasis can be expected as a result of climate change impact on water resources.

Many other diseases are also associated with water in other ways. Water may act positively in the control of some through its use in hygiene, and may act as a source or vector for others where contact with water is required for disease transmission or where agents of disease or insect vectors require water in which to complete their life cycle. The various relationships between water and disease are summarized in Table 3.

Table 3: Diseases related to water and sanitation

Group	Disease	Route leaving host	Route of infection
Diseases which are often water-borne	Cholera	faeces	oral
	Typhoid	faeces/urine	oral
	Infectious hepatitis	faeces	oral
	Giardiasis	faeces	oral
	Amoebiasis	faeces	oral
	Dracunculiasis	cutaneous	percutaneous
Diseases which are often associated with poor hygiene	Bacillary dysentery	faeces	oral
	Enteroviral diarrhoea	faeces	oral
	Paratyphoid fever	faeces	oral
	Pinworm (Enterobius)	faeces	oral
	Amoebiasis	faeces	oral
	Scabies	cutaneous	cutaneous
	Skin sepsis	cutaneous	cutaneous
	Lice and typhus	bite	bite
	Trachoma	cutaneous	cutaneous
	Conjunctivitis	cutaneous	cutaneous
	Diseases which are often related to inadequate sanitation	Ascariasis	faecal
Trichuriasis		faecal	oral
Hookworm (Ancylostoma/Necator)		faecal	oral/percutaneous
Schistosomiasis		urine/faeces	Percutaneous
Diseases with part of life cycle of parasite in water	Schistosomiasis	urine/faeces	Percutaneous

Diseases with vectors passing part of their life cycle in water	Dracunculiasis	cutaneous	Percutaneous
---	----------------	-----------	--------------

(Adapted from Bradley, D J, London School of Hygiene and Tropical Medicine, 1981)

Forty per cent of mortality in children under five years of age is related to diarrhoeal disease.

The above mentioned diseases are caused by the ingestion of contaminated faecal material transmitted by the transmitted by the faecal - oral route. Infectious agents of all types may be transmitted by the faecal - oral route via water, including viruses (such as infectious hepatitis, rotavirus and Norwalk agent); bacteria (such as cholera, typhoid and dysentery); and parasites (such as *Giardia*, *Cryptosporidium* and *Entamoeba*).

Faecal pollution of drinking-water may be by the lower water quantities or the pollution episodes caused by wastewater plants malfunction of destruction due to extreme events of floods.

An example of exercise on climate impacts on Water and public health and tracking climate readiness for a region/country follows: (See Tables A-1 and A-2)

This exercise offers insight into enhancing climate readiness in water safety. The exercise is divided into four parts:

1. An overview of the effects of extreme weather and climate change on the public health infrastructure;
2. Opportunities for integrating climate readiness into existing programs;
3. Tracking climate readiness; and,
4. A review of the evidence that a climate readiness approach can offer co-benefits to health, financial wellbeing, and the environment.

Activity 1: Climate Impacts

Tip for Finding Helpful Resources:

Use any country or state's climate assessment and / or action plan to identify priority climate risks and their impact on water safety.

1.a. What are the immediate and long-term effects of extreme weather and climate change on water safety in your country?

Step 1. Identify the top 1-3 climate risks to your country.

Step 2. Identify how these climate risks will impact water safety.

Step 3. List the agency or department that addresses each water safety impact identified under

Step 4. List the existing programs designed to reduce the impacts identified under Step 2.

Step 5. Based on your responses to Steps 1-4, place an asterisk next to the climate risk that would be most appropriate to prioritize for the remainder of this assessment. (Note: If two or more climate risks are equally important to address simultaneously, simply repeat the remainder of activities in this assessment for the additional risks.)

1.b. What are the potential negative health outcomes associated with the impacts of climate change on water safety?

Step 1. List the climate risk identified with an asterisk in Activity 1.a.

Step 2. In the left-hand column of the table below, list three impacts associated with this climate risk (as identified in Activity 1.a.).

Step 3. List the potential negative health outcomes associated with these impacts.

Step 4. List the populations that are particularly vulnerable to these impacts.

Step 5. List the existing public health tracking / surveillance programs, policies, and interventions designed to reduce the negative health outcomes identified under Step 3.






Step 6. List the co-benefits of the public health programs to the water safety programs outlined in Activity 1.a.

Chapter 3 Impact and vulnerability assessment of the health sector based on RICCAR outputs

3.1 RICCAR indicators and outputs that feed into the identification of adaptation measures

Vulnerability and adaptation assessments do not only improve the understanding of the linkages between climate change and health, they can also serve as baseline analysis against which changes in disease risks and protective measures can be monitored. They can also provide the opportunity for building capacity and can strengthen the case for investment in health protection.

In its attempt to carry out a vulnerability assessment to the Arab region RICCAR has selected the water, biodiversity and ecosystems, agriculture, Infrastructure and human settlements, and people as the main sector for the assessment. Figure 2 outlines these sectors and the possible impacts of climate change on these sectors. The impacts on human health were detailed within the people sector.

Sectors	Impacts	(Sub-)Vulnerability
 Water	Change in water availability	V0
 Biodiversity & Ecosystems	Change in area covered by forests	V1
	Change in area of wetlands/marshes	V2
 Agriculture	Change of water available for crops	V3
	Change of rangeland for livestock	V4
 Infrastructure & Human Settlements	Change in inland flooding area	V5
	Change in coastal flooding area	V6
 People	Change of water available for drinking	V7
	Change in health due to heat stress	V8
	Change of employment rate in the agricultural sector	V9

Source: VA-WG, adapted from adelphi, 2013.

Figure 2: RICCAR Sectors and Impacts Selected for the Arab Region Vulnerability Assessment

RICCAR has explained that water availability provides the entry point when preparing the vulnerability assessment for the Arab region.

The Issue of Public Health as discussed by RICCAR

“Water, already a scarce resource in the Arab region, may further decrease in quality and quantity which will put pressure on the availability of drinking water for the population. Climate change effects on agricultural production in already arid and semi-arid areas may lead to a loss of labor opportunities in the agricultural sector and trigger further migration to urban centers, which may in turn cause social disturbances and puts further stress on already densely populated areas”. (RICCAR, 2015)

“Increasing temperatures, decreasing rainfall as well as the increased frequency and intensity of extreme weather events, such as heat waves and dust storms will be some of the most severe challenges posed by climate change to the population in the Arab region, threatening their livelihoods and health. Higher temperatures, especially in the summer months, may have severe impacts on public health, in particular affecting the young and elderly and those working in economic sectors requiring outside work, such as agriculture, security and construction”. (RICCAR, 2015)

Thus, RICCAR identified the following three key climate change impacts on people to be included into the vulnerability assessment of the Arab region:

- Change in the availability of water for drinking
- Change in the rate of employment in the agricultural sector
- Change in the state of human health due to heat stress

RICCAR vulnerability indicators of exposure, sensitivity, and adaptive capacity indicators are detailed in the introductory chapter of the training manual. The RICCAR modeling outcome has predicted at least an increase of 2 °C within the next few decades. As far as the health sector is concerned, the people of the Arab region will then be subjected to impacts of less water availability for drinking, hygiene, and agricultural production. This will directly impact the population through the many pathways indicated in the previous chapter. The water availability decrease through decreased precipitation and increased temperature patterns will almost hit all of the Arab region especially those depending greatly on the surface water resources to cater for their agricultural production like Jordan, Syria, Tunisia, Morocco, Egypt, Sudan, etc., Heat waves have also been predicted to come on a more frequent pattern with intensity and higher durations. The direct and indirect impacts of heat waves were also discussed in chapter 2. Flooding events for the coastal and inland areas were also predicted to happen at a much increased frequency and duration. The impacts of this on the drinking and sanitation infrastructure and services and the subsequent impacts on human health and the possible spread of diseases related to this are expected to be huge. The health sectors should be prepared to deal with the more incidents of diseases (depending on the local conditions), such as Cholera; Typhoid, Bacillary dysentery, Infectious hepatitis, Giardiasis, Scabies, Skin sepsis and Ulcers, Lice, Trachoma, Dysenteries, Ascariasis, Chistosomiasis, Bilharziosis, Threadworm, Yellow fever, Dengue fever, and Malaria

3.2 Vulnerability Assessment tools of the health sector to climate change impacts

Health vulnerability assessment

A useful definition of ‘vulnerability’ in the public health context is the “the degree to which a system is susceptible to injury, damage, or harm”. This broad definition emphasizes the importance of well-functioning institutions and the accessibility to quality healthcare that safeguards individual and population health. In this module vulnerability will be defined as being a function of exposure, sensitivity, and adaptive capacity. Sensitivity encompasses (1) the ability of a community to withstand these exposures and the range of associated impacts; and (2) physiological (e.g. co-morbidities or disabilities) and socio-economic (e.g. poverty) factors that increases the susceptibility of individuals to the exposure. The concept of sensitivity also includes access to functioning infrastructure that can influence how people withstand an exposure (e.g. availability of electricity during an extreme heat event). The potential public health impact, jointly produced by exposure and sensitivity, can be offset by adaptive capacity. Adaptive capacity refers to behavioural, institutional, and technological responses and adjustments to lessen the potential impact. Typically, such adaptations limit damages, provide recovery opportunities, and enhance coping with consequences.

Protecting health from climate change: Vulnerability and adaptation assessment using WHO guidance (*Adapted from Methods of assessing human health vulnerability and public health adaptation to climate change, Health and Global Environmental Change, SERIES No. 1, 2003*)

In response to the request in 2008 from the World Health Assembly for WHO to support countries in strengthening actions to protect health from climate change, WHO built on past guidance and technical tools to outline a flexible process for vulnerability and adaptation assessment. The guidance is designed for countries to assess which populations are most vulnerable to different kinds of health effects, to identify weaknesses in the systems that should protect them, and to specify interventions to respond. Further, the resulting assessments can improve evidence and understanding of the linkages between climate and health, serve as a baseline analysis against which changes in health risk and protective measures can be monitored, provide the opportunity for building capacity, and strengthen the case for investment in health protection.

Steps in assessing vulnerability and adaptation

Assessment steps should be consistent with the risk management framework. They need to be considered in future policy development. It is worth mentioning that not all steps may be possible or desirable, and the determination of which steps are included depends on the objectives and resources available for the assessment.

1. Determine the scope of the assessment

The first step is to specify the scope of the assessment in relation to:

- The health and community security issues of concern today and of potential risk in the future;
- The geographical region to be covered by the assessment; and the time period.

Interactions between weather and climate and health are location-specific; using epidemiological evidence based on local data if they are available is therefore important. Assessments should include current vulnerability to climate variability to inform understanding of what could occur with climate change. The extent to which an assessment addresses these issues depends on the goals of the assessment and the resources available.

The national boundaries may not be the most appropriate geographical framework for the assessment. Climate, diseases and vectors do not respect national boundaries, and other countries may therefore need to be considered to assess the national risk.

The responsible national or regional health authority can identify the health outcomes to be included in collaboration with, when appropriate, (1) the authorities responsible for the social security, environmental affairs and meteorological offices; (2) the research community; and (3) other stakeholders, such as nongovernmental organizations, business and the public.

2. Describe the association between disease outcomes and climate variability and change

Once health outcomes (the climate-sensitive diseases) are identified for inclusion in the assessment, the current evidence (published literature) should be reviewed. A variety of statistical methods is available to analyze associations with exposure to weather or climate, taking into account modifying and/or interacting factors. Meteorologists can provide input into how to define and describe the important types of weather exposure; for example, the severity and recurring periods of extreme weather events.

For each chosen outcome, determining the factors that could modify its association with weather and climate variables is important. Modifying factors will vary by disease outcome and could include socioeconomic and other variables.

The current burden of the climate-sensitive diseases can be described using the following indicators and outcomes:

- the current incidence and prevalence of the disease and the trend (is the disease increasing or decreasing), which may be available from routine statistics from the appropriate national agency; and
- the attributable burden of a disease to climate and/or weather, such as what proportion of all cardiovascular deaths are attributable to high or low temperatures or the number of deaths caused by floods.

For vector-borne diseases, having a map showing the current geographical distribution of human cases and vectors may be useful. Finally, environmental and socioeconomic conditions also influence human vulnerability and need to be considered within the assessment.

3. Identify and describe current strategies, policies, and measures that reduce the burden of climate sensitive diseases

Activities and measures individuals, communities and institutions currently undertake to reduce the burden of disease should be identified and evaluated for effectiveness. Adaptation measures can be identified from: (1) review of the literature; (2) from information available from international and regional agencies and from national health and social welfare authorities (ministries of health); and (3) from consultations with other agencies and experts that deal with the impact of the health outcome of concern. Identifying successful adaptations being undertaken to address the negative effects of climate variability and those implemented in anticipation of climate change is important. For example, is an early warning system for heat waves in place?

The key questions to address for a specific health outcome include the following.

- What is being done now to reduce the burden of disease? How effective are these policies and measures?
- What could be done now to reduce current vulnerability? What are the main barriers to implementation (such as technology or political will)?
- What strategies, policies, and measures should begin to be implemented to increase the range of possible future interventions?

4. review the health implications of the potential impacts of climate variability and change on the other sectors

The impact of implemented strategies, policies and measures in response to actual or projected climate change needs to be evaluated in terms of potential health effects. For example, in cases where domestic water storage is recommended, the implementation of this measure may have implications for vector breeding and the transmission of dengue. Water development projects should be subject to environmental and health impact assessment.

5. Estimate the future potential health impact

The climate change community often chooses from the present until 2050 and until 2100 as the reference periods for projecting the impact of climate change.

This requires using climate scenarios such as those adopted by RICCAR. The time scale of the assessment depends on the scope and purpose of the assessment. However, addressing potential effects both in the near term (the next 20 years) and the long term (up to 2050 or 2080) is advisable. The focus on the near term provides relevant information within the usual planning horizon of health agencies. A further need is looking beyond the near term to develop comprehensive adaptation measures.

Models of climate change should include projections of how other relevant factors may change in the future, such as population growth, income, fuel consumption and other relevant factors. Scientists, policy-makers and the public must recognize the existence of multiple sources of uncertainty, from climate projections to the potential future public health effects. This step should be realistic about the likelihood that the uncertainty can be resolved in a meaningful

period.

Future capacity to adapt to the effects of climate change depends on the future levels of economic and technological development, local environmental conditions and the quality and availability of health care and of public health infrastructure. Social, economic, political, environmental and technological factors strongly influence health.

6. Synthesize the results and draft a scientific assessment report

Convening an interdisciplinary panel of experts with relevant expertise is one approach to developing a consensus assessment.

Assumptions that underlie any quantitative estimates should be clearly described. Quantitative estimates should be clearly identified with a climate scenario. The degree of certainty of a statement should be provided (see Chapter 4). The most vulnerable population groups should be identified.

Value judgments have to be made in summarizing the assessment. In particular, decisions should be taken about:

- how to balance near-term and long-term effects;
- how to weight the different potential effects in different population groups;
- how to balance the more certain, quantifiable potential effects with those that are less certain and not quantifiable, as well as the qualitative effects; and
- how to balance the interests of the various stakeholder groups: experts, people potentially affected and decision-makers.

7. Identify additional adaptation policies and measures, including procedures for evaluation after implementation

This step includes Identifying possible adaptation measures that could be undertaken over the short term to increase the capacity of individuals, communities and institutions to effectively cope with the weather or climate exposure of concern. These measures should be possible to institute within the population's access to material resources, technology and human and social capital. For example, if heat-related morbidity and mortality are health issues in an urban area and if an early warning system for heat-waves is not in place, then would implementing such a system be likely to benefit population health? Strengths and weaknesses as well as opportunities and threats to implementation should be evaluated and priorities set.

Every country needs to adapt to long-term climate change. The aim of this step is to identify possible measures that can be taken today and in the future to increase the ability of individuals, communities and institutions to effectively cope with future climate exposure, including extremes.

Many of the possible measures for adapting to climate change lie primarily outside the direct control of the health sector. They are rooted in areas such as sanitation and water supply, education, agriculture, trade, tourism, transport, development and housing. Intersectoral and cross-sectoral adaptation strategies are needed to reduce the potential health impact of climate change.

A policy analysis will determine the feasibility of and priorities among these options. In general, many of the policies and measures identified also promote sustainable development.

Criteria should be established in advance for evaluating possible adaptation measures. Evaluation should be an ongoing process both to identify opportunities for improving the effectiveness of the measures but also to identify maladaptation and unintended consequences as quickly as possible. The traditional public health methods for evaluating the efficacy and effectiveness of a particular intervention should be applied, with appropriate consideration of the local circumstances.

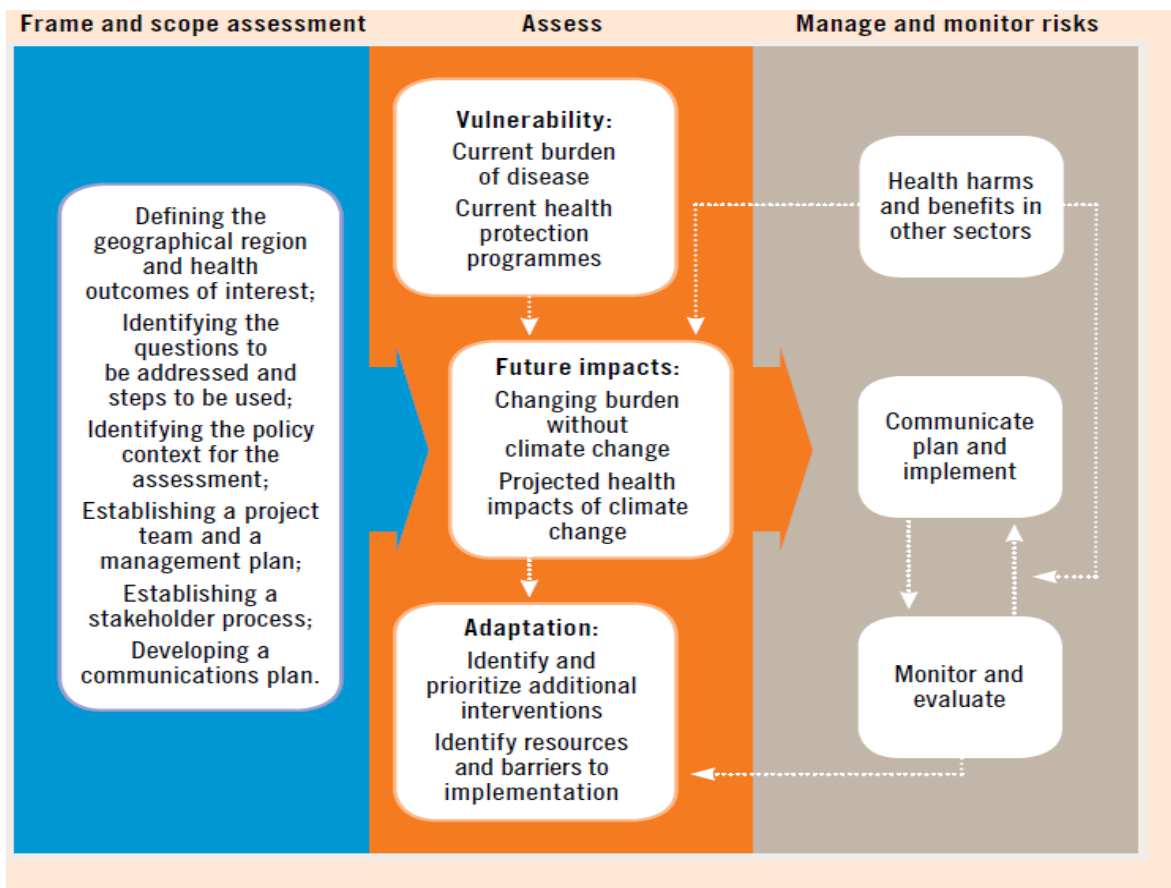


Figure 3: WHO guidance to protect health from climate change through health adaptation planning: Health within the NAP process (HNAP)

Figure 3 details the WHO guidance framework to protect health from climate change through health adaptation planning. This framework is designed to ensure that the process of iteratively managing the health risks of climate change is integrated into the overall National Adaptation Plan (NAP) process, including assessing risks; identifying, prioritizing, and implementing adaptation options; and monitoring and evaluating the adaptation process. Supported by the Least-developed Countries Expert Group (LEG), the United Nations Framework Convention on Climate Change (UNFCCC) and other relevant partners (e.g. United Nations Development Programme (UNDP), United Nations Environment programme (UNEP), WHO, development agencies and nongovernmental organizations), countries can

use the NAP process to start planning their mid- and long-term priorities to build resilience to climate change across all relevant sectors.

To achieve the goals of healthy people in healthy communities, it is critical that the health sector is properly represented in the NAP process. Not including the health sector in adaptation planning can miss critical actions to protect population health, and can result in policies and programs in other sectors inadvertently causing or contributing to adverse health impacts, thereby also undermining efforts to protect the environment.

The health national adaptation process (HNAP) should be the health component of the National Adaptation Plan (NAP), including as an output a detailed health adaptation plan designed to achieve the national health adaptation goals within a specific period of time and given available resources.

The following is an example of how to convene a methodological framework for the vulnerability assessment

In line with the official IPCC’s definition , the vulnerability of a particular system is highly contingent upon four main components: the magnitude of its exposure to climate change hazards, its degree of sensitivity to the hazard, the resulting amount of impact and its level of adaptive capacity. The relationship between these four dimensions, is commonly expressed by the following conceptual formula:

$$Vulnerability = [exposure\ to\ climate\ stimuli\ x\ Sensitivity = impact] / adaptive\ capacity$$

Following the steps of VA assessment for the health sector as outlined in section 3.2, and using the scoring scale shown in Table 4 and the vulnerability ranking scale shown in Table 5 carry out a vulnerability assessment for the health sector in one of the following countries; Jordan, Lebanon, Bahrain, and Tunisia (Select one for each group).

Table 4: Scoring scales for exposure (likelihood, geographical magnitude and confidence)

exposure factors	Score 1	Score 2	Score 3	Score 4	Score 5
likelihood	Event is not expected to occur, but it is possible (there is less than five percent probability of occurrence per year <5%)	Event or change is unlikely to occur, but not negligible (there is between 5-33% probability of occurrence per year)	Event or change less likely than not, but still possible (33-66% probability of occurrence per year)	Event or change likely to occur (66-95% probability of occurrence per year)	Event or change very likely to occur (>95% probability of occurrence per year)
Geographical magnitude	less than 5% of the area is Affected	5-33% of the area is affected	33-66% of the area is affected	66-95% of the area is affected	>95% of the area is Affected
Confidence of being correct	very low: less than 10%	low: 20% chance	Medium: about 50% chance	High confidence: 80% chance	very high confidence: > more than 90% Chance

Table 5: Vulnerability ranking scale

		Impact score					
		Score	0,1-1	1,1 - 2	2,1 - 3	3,1 - 4	4,1 - 5
Adaptive capacity	Score	Description	very low	low	Moderate	High	very high
	0.1 – 1	very low	Moderate	Moderate	Moderate	very high	very high
	1.1 – 2	low	low	Moderate	Moderate	High	very high
	2.1 – 3	Moderate	low	Moderate	Moderate	High	very high
	3.1 – 4	High	very low	low	Moderate	Moderate	High
	4.1 - 5	very high	very low	low	low	Moderate	High

Chapter 4 Identification of adaptation measures and options (IWRM tools) for the Health Sector based on the impact and vulnerability assessment results

Introduction

According to *Assessments of Impacts and Adaptations to Climate Change (AIACC) final report (2007)*, the following recommendations are to be adopted:

- Start adaptation immediately
- Create conditions to enable adaptation
- Integrate adaptation with development
- Increase awareness and knowledge
- Strengthen institutions
- Protect natural resources
- Provide financial assistance
- Involve those at risk, and
- Use place-specific strategies

The following sections will pave the way for adopting such recommendations into the development, implementation, and verification of adaptation to climate change programs in the health sector with the emphasis on the IWRM tools.

4.1 Stocktaking for available adaptation measure for national and regional needs

The literature provides many priority interventions that can be adopted by the health sector in order to adapt to the impact of climate change. The national circumstances should be reflected on the needed adaptation interventions depending on the strength and the resilience of the institutions of the different sectors and the health sector in specific. Below is a summary of the many possible adaptation measures that can be considered towards the development of a national action plan to adapt to the impacts of climate change.

Institutional and strategic Interventions

- Support “healthy” development strategies in other sectors that protects and promotes health and mitigates climate change
- Implement adaptive strategies at local and national level to minimize impacts of climate change on population’s health
- Enhancing intersectorial coordination and regional collaboration
- Mainstream public health concerns and health protection from climate change are in all national, regional and international action on climate change
- The establishment of political institutions for assistance and coordination of activities changes adaptation and climate change

Environmental Quality Monitoring and Control

- Monitoring of air and drinking water quality
- Intensifying water pollution control activities and ensuring safe reuse of wastewater
- Enhancing environmental sanitation
- Securing minimum household water requirements to maintain health.

Health Institutions Enhancement

- Maintenance and upgrading national public health infrastructure

Awareness and Capacity Development

- Review of public awareness programs about proper food handling, storage, as well as governmental food monitoring actions and integrate them into an adaptation action plan.
- Capacity building of prevention and response to disease epidemic potential
- Strengthening and expanding capacity Intervention of the different plans and national programs under the climate change;
- Strengthen the institutional capacity of the public health systems for providing guidance and leadership on health protection from climate change.

Early warning Systems

- The development of early warning systems and control programs for infectious diseases:
- The development of weather and seasonal forecasting and early warning systems, disaster planning and educational and public awareness programs
- Early warning for weather for the prevention of their effects on the population.
- Enhancing surveillance system

4.2 Evaluation and Prioritizing the Proposed Adaptation Measures and the selection criteria

The methodology for identifying the needed adaptation measures for the water sector can be implemented through the following action plans and activities:

a. Consulting with stakeholders is the first step towards identifying the adaptation measures.

The aim of such a consultation is to:

1. Have clear effective and useful opinions, comments, recommendations, and possible changes on the project work plans, actions, tasks, and methodologies adopted to fulfill the necessary objectives.
2. Foster stakeholder participation in research projects to bridge the gap between scientists, policy-makers and all other relevant parties.
3. Engage stakeholders more could streamline the flow and sharing of information, and avoid duplication of work and undue delays in taking decisions.
4. Improve understanding of local knowledge and practices and public awareness, which are essential for successfully implementing adaptation measures, avoiding mal-adaptation and unsustainable solutions.

b. Review all possible adaptation measures for water availability and water quality as well as the related health aspects adaptation measures in connection with water ones

The revision process can be achieved through detailed investigation for all possible adaptation measures outlined in literature.

The revision process will have to focus on the following issues:

1. Review all possible adaptation measures for water availability for conventional and nonconventional water as wastewater reuse, water desalination, weather modification, brackish water, industrial wastewater.
2. Review all possible adaptation measures for water demand management, residential water supply, surface water development, groundwater recharge.

3. Review all possible adaptation measures for water quality in terms of pollution, protection and management.
4. Review all possible adaptation measures for water monitoring system, measures to improve system efficiency, watershed management, urban water use, flood control, research programs, institutional reform, and irrigation water.
5. Review all possible adaptation measures related to socio-economic issues.
6. Review all possible adaptation measures related to health issues in terms of the legislative, institutional, and plans and programs.

Based on this revision, all possible adaptation measures for the health and water sectors can then be listed (an example is shown in *Appendix 4-A*).

c. Evaluate all possible adaptation measures for in term of suitability and applicability to the study area under consideration, and suggest and prioritize the best possible adaptation measures.

In order to facilitate the evaluation process, the following method can be adopted:

1. A multi criteria score based method should be used in order to derive an accurate evaluation. A set of criteria has to be selected (based on different sources like IPCC fourth assessment guideline report). An example criteria for screening the appropriate adaptation for a region are shown in table 6.
2. The score represent the sum of the weights of each sub-criteria used in the evaluation multiplied by the ratio.
3. Weights should be assigned by the experts based on the region conditions and in accordance with their importance in the evaluation, and sums up to 100% (See Table 8).
4. The ratio is the stakeholder judgment for each proposed adaptation under each sub-criteria (criterion) having a range from 1 to 5, where 1 represent the lowest level and 5 represent the high ratio level.

According to the evaluation of the opportunities, barriers, and suitability of each suggested adaptation to climate change risks will be ranked according to combination of elements from various options (decision support tool).

It is suggested that, the most feasible immediate actions should be set first especially that deals with management of existing infrastructures and the institutional frameworks that deals with those entities.

The “best” or “preferred” option involves the costs, benefits, and impacts of alternative strategies comparison.

Setting priorities requires choosing criteria to weigh different concerns. These criteria can also act as indicators of the success or failure to realize the objectives, and can be used by a monitoring-evaluation programme for the adaptation strategies, policies and measures. An excel sheet should be developed to facilitate this process through collecting the experts feedback.

The final scores can then be calculated based on averaging the scores obtained from the responded stakeholders (An example is shown in **Table A-4**). The prioritized adaptation measures based on this analysis should be summarized after including the results from all stakeholders (An example appears in **Table A-5**).

Table 6: Criteria used for evaluating the suggested adaptation measures.

Criteria	Sub-criteria	Description	Weight	Sub-weight
Sustainability	Mitigation (adaptation) benefits	Changes in the level of greenhouse gas emissions created by the adaptation measure	25	10
	Ecosystem Impact	The degree of environmental impacts on biodiversity		7
	Equity	Number of people benefiting from the adaptation - if possible disaggregated by gender, age, class		8
Effectiveness	Robustness (ability to adopt under different scenarios)	Elaborate how effective this measure could be for a diverse range of plausible future scenarios	20	5
	Reliability	Identify if this measure is untested or the effectiveness of this measure is proven		5
	Cost Effectiveness (Low-regret)	Identify if this measure will bring high relative benefits to the costs		10
Risk and Urgency	Urgency	Identify the time frame of impact occurrence from recent past, present until short- and long-term futures	15	5
	Degree of risk (potential extent of future risks)	Identify potential extent of future risks from minor and reversible until irreversible		5
	Uncertainty or Precautionary	Estimate how well the risks are understood		5
Opportunity	Ancillary benefits	Identify how this measure will contribute to other community goals	10	3
	No-regret option	Identify if this measure has benefits regardless of actual climate change impacts		3
	Window of opportunity	Identify if there is currently a window of opportunity to implement this measure		4
Implementation	Initial cost	Identify the approximate cost of implementation; you could compare these costs with cost of inaction over time	30	5
	Operating and maintenance cost	Identify the cost of operation and maintenance over time, compared to other budget expenditures		5
	Public acceptability	Elaborate on public support or opposition to this measure		5
	Funding sources	Identify availability and sources of potential funding		5
	Capacity (information, technical, staff, resources)	Estimate if current capacity is sufficient and, if not, what are lacking capacity gaps		5
	Institutional	Identify if implementation is within local control or it requires coordination with, or action by, other jurisdictions		5
Final Score	Sum of All Scores Multiplied by its Weight (Total Scores 500)		→	Divide the results by 5 to have the range out of 100

d. Develop needed mechanisms and interventions to integrate the proposed adaptation measures in national policies and action plans.

All over the world a variety of policy instruments and tools used aiming at integrating the proposed adaptation measures in national policies and action plans.

To develop the needed mechanisms and interventions to integrate the proposed adaptation measures into the national policies and action plans, the following should be considered:

- Initially, the overall goals should be determined through the issuance of environmental standards, and then they choose the means to achieve those goals through either command-and-control and/or market approaches (including environmental subsidies, taxes, deposit/refund system, and/or permit trading systems).
- Then, legislating goals and means and finally monitor and enforce those goals and means.
- All international environmental standards, policy tools and instruments related to climate change have to be reviewed.
- The most suitable combination of these instruments and tools can then be suggested.

The Cap-Net Training Manual and Operational Guide on Integrated Water Resources Management Plans (Cap-Net, 2005) presents the process in seven sequential steps. When viewing the IWRM planning process as instrumental for adaptation to changing climatic conditions, the following may be considered:

- In the 'Initiation' step, climate change impacts need to be integrated in the planning process. In advocacy towards policy makers, the argument can be brought up that this will be instrumental for decision makers to advance demand management strategies, which otherwise might be politically difficult to implement.
- During the 'vision/policy' phase, climate change adaptation is an additional element, not a replacement of IWRM goals. The overall aims of IWRM will remain the same.
- In the 'situation analysis' step, the use of climate information and impact analysis needs be incorporated. Further, the adaptation/mitigation theme can be brought out to suggest that the IWRM process should reduce the risk of adaptation options negatively impacting on the mitigation targets, and vice versa.
- In the 'strategy choice' phase, the anticipatory or 'precautionary' approach can be introduced as the basis for strategies for IWRM.
- Consider the roles of local authorities in adaptation strategies when drafting an IWRM plan.

- Legal frameworks, economics and health, and other variable conditional elements that have been analyzed from the corner stone for implementation of IWRM and are decisive in how it contributes to climate change adaptation.
- During evaluation, results must be measured against indicators, taking into consideration the adaptation measures proposed in the plan.

Throughout the process, stakeholder involvement is essential so that the results of the impacts assessment and strategic choice are owned by the implementing agencies. The range of solutions and strategies has been broadened over time by improvements in technologies. What has changed is our understanding and implementation of the integrated ensemble of water management measures that conform to modern principles and policies.

Chapter 5: Adaptation measures implementation matrix

5.1 Institutional and legislative setup analysis and assessment for adaptation implementation plan.

Assessments of vulnerability, impacts and adaptation will often seek to understand the institutional and the legislative context. This includes also political, social and economic factors that structure individual choices. Such methods are broadly categorized as institutional analysis.(Hinkel and Bisaro, 2013a). Below is a description of some approaches towards achieving this analysis:

Governance description

Governance description approaches describe the actors and institutions relevant for adaptation. These types of analyses have been done all around the world in the context of climate change. For example, Tol et al. (2008) review the institutional context for adaptation in coastal zone management in Europe, and identify three levels of decision-making: national governments, local governments and private individuals. They find that national level decisions are partly determined by EU policies, e.g. the Coastal Bathing Water Directive, the Water Framework Directive and the Habitat Directive. This type of approach requires no strong theoretical assumptions on the part of the analyst, and contributes to adaptation by providing a more comprehensive description of the policy context in which adaptation takes place.

Governance design

Governance design addresses the question of how to design effective institutions, on the theoretical assumption that the link between institutions and outcomes can be understood and predicted with some confidence. One particular kind of governance design approach that has been applied extensively in the adaptation literature is policy analysis. Policy analysis seeks to determine “which of various alternative policies will achieve a given set of goals in light of the relations between the policies and the goals” (Nagel 1999). It is applied ex-ante to improve the design of policies, programmes or projects.

A lot of literature has employed policy analysis to analyze mainstreaming of adaptation into policies. Because adaptation occurs in all sectors and at all levels of social organization, the goal of adaptation policy is generally to ensure that existing policies address relevant climate risks and to increase the capacity of individuals and societies to respond to these risks. This indicates that adaptation is not a stand-alone policy domain, but rather the task to integrate, or mainstream, the consideration of climate change risks into existing sectoral policies. The recommendations of high-level adaptation policy documents, such as the EU White Paper on Adaptation (European Commission, 2009), are illustrative, as they focus on the need to increase the consideration of climate risks across all sectors.

One focus of mainstreaming studies has been development policy where mainstreaming has been carried out through portfolio screening in order to identify climate risks which might conflict with development policy goals.

However, if climate is already being considered, the critical task is “climate proofing” the policy in question. “Proofing” policies involves addressing relevant risks early in the policy formulation process, to identify any obvious effects on other sectors or objectives. The practice of proofing policies is well-established in other sectors, such as health, and rural sectors. One example is the tool development by GIZ, the German Development agency for climate-proofing development plans. (GIZ, 2011)

Governance emergence

These methods aims at understanding and explaining governance emergence, a distinction is made between those approaches that assume that it is possible to generalize beyond a single case, and those that do not.

These approaches face the general challenge that the ratio between the number of relevant variables and the number of cases is often too high to derive statistically significant results. Nonetheless, with these limitations in mind, carefully constructed studies comparing a large number of similar cases have produced an accumulation of evidence leading to conclusions about general characteristics of social-ecological systems that can be related to desirable outcomes.

An example is the “institutional prescriptions for adaptive water governance” (Huitema et al. 2009). In relation to adaptation, these prescriptions provide input regarding institutional attributes that enhance the adaptive capacity of actors faced with climate risks. These general prescriptions need to be supplemented by contextual knowledge when implementing adaptation interventions. The fact that the prescriptions remain general and require contextualization differentiates the approach from that of policy design, which assumes that outcomes can be predicted ex ante. Table 7 describes the institutional set up methods.

Table 7: Institutional analysis methods.

Method type	Governance description	Governance emergence		Governance design	
		Understanding case	Generalizing design principles	Policy screening	Policyproofing
Task	Identifying the relevant actors and institutions for adaptation	Explaining the emergence of governance systems which enables adaptation		Identifying policies that ensure goals are not negatively affected by climate change impacts	
Adaptation situation	Vulnerability impacts and adaptation are a result of many actors interacting and making inter-related decisions			Climate change risks to policy goals are not known	Climate change risks to policy goals are known
Theoretical assumptions	None	Attributing an outcome to an institution is only possible on a case by case basis.	It is difficult to attribute outcomes to a particular institution.	There is a direct predictable relationship between policies and outcomes.	

5.2 Identification of Barriers to adaptation to Climate change impacts.

The transfer of technologies and practices that have the potential to reduce or adapt greenhouse gas (GHG) emissions and Climate Change (CC) impacts is often hampered by various constraints called “barriers” (IPCC TAR, 2000). Thus, selecting best CC adaptation measure should be based on barriers-opportunities analyses to decrease the gap between the market potential of a technology or practice and the economic, socioeconomic, or technological potential.

The IPCC AR4, 2007 definition states that; A barrier is any obstacle to reaching a potential that can be overcome by a policy, programme, or measure, while an opportunity is a situation or circumstance to decrease the gap between the market potential of a technology or practice and the economic, socioeconomic, or technological potential

According to Pierre Mukheibir report (2005), the common barriers to implementing some adaptation measures and practices are related to financial, planning, institutional and technical capacity, and social aspects. Most common barrier for adapting a climate adaptation measure were focusing on either the lack of local capacity to implement the suggested strategies, and low financial resource base to cover the capital and running costs of most of the strategies. Local government competes for nationally allocated funds for capital expenditure. Running costs are mostly covered from local revenues, which for the smaller and remote local municipalities, are insufficient to ensure water security at this level.

The Organization for Economic Co-operation and Development (OECD, 2006), has reported that the main barriers to mainstreaming adaptation to climate change are the lack of awareness of climate change within the development community and limitations on resources for implementation.

The organization also suggested that several opportunities exist for more effective integration of climate change adaptation within development activities. These include the following:

- Making climate information more relevant and usable
- Developing and applying climate risk screening tools
- Using appropriate “entry points” for climate information
- Shifting emphasis to implementation rather than developing new plans
- Encouraging meaningful co-ordination and the sharing of good practices

Kareiva et al.,(2007) have summarized the barriers and opportunities to successful implementation of climate change adaptation strategies (Table 8). Barriers and opportunities may be categorized into policies and procedures, human and financial capital, institutional coordination and collaboration, and information and tools.

Table 8: Barriers and opportunities to successful implementation of climate change adaptation strategies. Adapted from Kareiva et al. (2007)

POLICIES AND PROCEDURES	
Barrier	Opportunity
Legislation and agency policies may be highly static, inhibit dynamic planning, impede flexible adaptive responses and force a fine-filter approach to management.	Re-evaluate capabilities of, or authorities under, existing legislation to determine how climate change can be addressed within the legislative boundaries.
Seasonal management activities may be affected by changes in timing and duration of seasons	Review timing of management activities and take advantage of seasonal changes that provide more opportunities to implement beneficial adaptation actions.
Agency policies do not recognize climatic change as a significant problem or stressor.	Take advantage of flexibility in the planning guidelines and processes to develop management actions that address climate change impacts.
HUMAN AND FINANCIAL CAPITAL	
Lack of incentive to take risks, develop creative projects; reward system focuses on achieving narrowly prescribed targets; funds allocated to achieve targets encourage routine, easily accomplished activities.	Shift from a culture of punishing failure to one that values creative thinking and supports incremental learning and gradual achievement of management goals.
Little to no climate expertise within many management units at the regional and local level; disconnect between science and management that impedes access to information	Use newly created positions or staff openings as opportunities to add climate change expertise; train resource managers and other personnel in climate change science
National and regional budget policies/processes constrain the potential for altering or supplementing current management practices to enable adaptation to climate change; general decline in staff resources and capacity	Look for creative ways to augment the workforce and stretch budgets to institute adaptation practices (e.g., individuals or parties with mutual interests in learning about or addressing climate change that may be engaged at no additional cost).
INSTITUTIONAL COORDINATION & COLLABORATION	
Political boundaries do not necessarily align with ecological processes; some resources cross boundaries; checkerboard ownership pattern of public and private lands at odds with landscape-scale management	Identify management authorities/agencies with similar goals and adjacent lands; share information and create coalitions and partnerships that extend beyond political boundaries to coordinate management; acquire property for system expansion.
INFORMATION AND TOOLS	
Often no inventory or baseline information on condition exists, and nothing is in place to detect climate change impacts.	Identify existing monitoring programs for management; develop a suite of climate change indicators and incorporate them into existing programs.
Historic conditions may no longer sufficiently inform future planning (e.g., "100-year" flood events may occur more often and dams need to be constructed accordingly)	Evaluate policies that use historic conditions and determine how to better reflect accurate baselines in the face of climate change; modify design assumptions to account for changing climate conditions.
Lack of decision support tools and models, uncertainty in climate change science, and critical gaps in scientific information that limits assessment of risks and efficacy and sustainability of actions.	Identify and use all available tools/mechanisms currently in place to deal with existing problems to apply to climate-change related impacts.
Occurrence of extreme climate events outside historical experience.	Use disturbed landscapes as templates for "management experiments" that provide data to improve adaptive management of natural resources.
Stakeholders/public may have insufficient information to properly evaluate adaptation actions, and thus may oppose/prevent implementation of adaptive projects (e.g., such as those that have ground-disturbing elements like salvaging harvests after disturbance and using herbicides before revegetating). Appeals and litigation from external publics often results in the default of no action	Inform public and promote consensus-building on tough decisions; invite input from a broad range of sources to generate buy-in across stakeholder interests.

Overcoming the barriers could be achieved through:

- 1- Promoting Integrated Water Resources Management
- 2- Improving National Adaptation Programs for Action and making them transboundary
- 3- Supporting the local level and participation
- 4- Managing uncertainty by adaptive planning
- 5- Finding fresh and flexible funding
- 6- Moving water to the forefront

Progress on adaptation in different sectors will require an understanding of why and how national-level authorities and policy may not be conducive to integrating adaptation within these sectors. Similarly, identifying and capitalizing upon existing opportunities will pave the way forward.

To Strengthen national policy frameworks, five steps were proposed. Table 9 details these steps and the approach needed to implement them.

Table 9: Approaches to strengthen the national policy frameworks (based on Tearfund, 2010)

Step	Goal	Approach
1	Identify barriers and opportunities in relation to a good enabling environment for the integration of adaptation into the Health sector	<p><i>Key questions to consider are:</i></p> <p>Are there any legislative constraints or gaps that could inhibit implementation of effective adaptation?</p> <ul style="list-style-type: none"> •
2	Undertake a 'Strengths, Weaknesses, Opportunities, Threats' (SWOT) analysis (or similar) of the overall findings from Step 1, with the aim of identifying ways to overcome problems and capitalize on strengths and opportunities.	<p>SWOT analysis would form the basis of an attempt to seek ways of using the strengths to improve or overcome the weaknesses.</p> <p>As well as analyzing specific documents, plans and events, it is important to note that <i>processes are also conducive to integration</i>. For example, preparing National Communications and NAPAs, which involve the engagement of multiple stakeholders, particularly those at the national level, has been a good step forward for the integration agenda, despite the fact that NAPAs themselves are, arguably, currently too segregated from existing development planning.</p>
3	Identify any catalysts that could aid the creation of supportive or stronger enabling environments, as expressed in national policy.	<p><i>Key questions to consider are:</i></p> <ul style="list-style-type: none"> • Are there any lessons to be learned from the disaster management community's experience in raising the priority of risk reduction following disaster events? • What is public/the media's opinion on climate change impacts affecting the country? For example: how regularly is climate change mentioned in the press? Do NGOs or CBOs working among communities report an awareness or concern regarding climate risks? • Is there any recent or new scientific evidence or are there observable impacts of climate change. • How and why were the priorities expressed in a NAPA or National Communication decided upon?
4	Facilitate awareness-raising among national authorities regarding the links between climate risks and present-day conditions.	<p><i>Awareness-raising can include activities such as:</i></p> <ul style="list-style-type: none"> • National media campaigns on climate impacts. • Internal government awareness-raising on the linkages between climate change, different sectors, and the health sector. • No regrets and low regrets approaches (which as well as supporting adaptation are effective in achieving development objectives regardless of climate change).
5	a) Identify political champions to help	<p><i>Key questions to consider are:</i></p>

Step	Goal	Approach
	<p>overcome any barriers (such as lack of political will for adaptation, and lack of budgetary support) and to create and maintain high-profile momentum amid changing priorities.</p> <p>b) Develop regular contact with such key individuals as part of the ongoing multi-stakeholder dialogue on adaptation within the health sector. For example, key individuals could be asked to chair such meetings.</p> <p>c) Seek to influence national authorities and donors, drawing upon 'champions' for assistance to counteract and address clashes between sectors.</p>	<ul style="list-style-type: none"> Is there anyone who can help strengthen the link on adaptation between the health ministry and national authorities (such as the finance and planning ministries or prime minister/ president's office) to help secure political support and financing for capacity development and implementation, and aid coordination across sectors? For example, who was instrumental in the NAPA process or in the writing of National Communications to UNFCCC? Who is best placed to strengthen the links between the health ministry and the likely priority sub-national and local levels?

One experience from the Arab world was initiated by the Yemen National Adaptation Program of Action (NAPA) giving efforts to address climate change and other important environmental issues. Their report identifies the synergies and barriers to adaptation. The report was based on a general classification of adaptation barriers, potential barriers to implementation of adaptation measures including analyses and evaluation of each barrier according to their degree of severity.

Barriers were classified according to the level where they are influencing into:

- (1) Barriers at Multilateral Environmental Agreements level,
- (2) Barriers at national policy level, and
- (3) Barriers at program/project level.

Also barriers were classified based on their nature/type into: (1) Institutional barriers, (2) Political barriers, (3) Cultural barriers, (4) Economic/financial barriers, (5) Technical barriers, and (6) Social barriers. A rough assessment for each barrier was achieved according to their degree of severity and classified into three levels; High severity barriers, Medium severity barriers, and Low severity barriers. A summary of their results are presented in Table 10.

Table 10: Summary of potential barriers to implementation of adaptation measures in Yemen (based on Yemen NAPA team, 2006)

BARRIERS	Level	Type	Severity
Weak institutional structures and environmental legislations (weak inter-related, lack of executive bills, poor implementation of laws and bills, weak law enforcement)	2	1	H
The institutional arrangement for Vulnerability and assessment (V&A) studies is weak	2, 3	1	H
Lack of policies to facilitate the implementation of Yemen NAPA	2	1, 2	H
Uncertainty about effectiveness and appropriateness of adaptation options	1, 2	5	M
Lack of appropriate data (in terms of lack of adequate monitoring and collection, difficulties experienced in accessing databases, lack of technical capacity to analyze	1, 2, 3	5	H

and manipulate data for V&A and lack of quality assurance)			
Uncertainties in regional, local climate change scenarios, Socio-economic scenarios	1, 2, 3	4, 5	H
Public awareness for policy- and decision makers on the subject of V&A is inadequate (lack of knowledge on CC and V&A, lack of ability of technical personnel to convey clearer and concise information on CC and V&A issues to policy- and decision makers)	2	2, 3, 5	H
Financial support is limited (inadequate financial capacity to develop or modify existing models and methodologies, lack of financial sources to implement the adaptation measures)	3	4	H
Technical support is limited (lack of methodologies to identifying and collection of information, apply models and interpret results, inadequate technical capacity to develop or modify existing models and methodologies)	2, 3	5	H
Lack of coordination on cross-sectoral issues. Coordination and cooperation among national and technical cooperation programs/projects is very weak	3	1, 2, 5	M
Lack of awareness on vulnerability and climate change issues	1, 2, 3	4, 5	H
Little research work on the practical application of policy measures for adapting to climate change. National scientific community has not had an active role in addressing vulnerability and adaptation issues	1, 2, 3	4, 5	H
Poverty 1. Compounding problems of poor/worsening local conditions e.g. land degradation 2. Lack of community resources (financial, human, social) to enhance own resilience 3. Lack of local institutional capacity and resources to support community resilience building	1, 2, 3	4, 6	H
Low investment in environmental friendly technologies	2, 3	5	M

An example of an exercise for distribution of roles and responsibilities in the health and water sectors is given below.

Through this exercise stakeholder mapping will be conducted and the responsibilities of key actors involved in the governance of climate adaptation for health sector and the relationships between these actors will be further clarified. The exercise looks at formal and informal responsibility and identifies responsibility gaps that risk impeding climate adaptation.

Objective of the exercise:

- To rank identified key actors in terms of adaptive capacity, importance for climate adaptation, and for seizing opportunities
- To assess their degree of interaction with one another.
- To map divisions of responsibility across the key actors who are involved in identified areas or sectors. This will enhance the ability to decide how to proceed with: (i) long-term planning (ii) crisis management and (iii) seizing opportunities related to climate change.

Procedure for the exercise

The exercise consists of three parts: 1) Brainstorming actors and their responsibilities 2) Mapping interaction and 3) Discussion and Analysis.

Brainstorming actors and their responsibilities

1. Develop list of the key stakeholders.
2. Study the list. Brainstorm to determine if any key actors are missing.
3. Identify the crisis management and long-term planning role of each stakeholder.
4. If new actors are identified, they should be added to the list. Try to be as specific as possible by giving the name of the government department, section, and even contact names, if possible.
5. For each actor on the list:
 - Select a circle of appropriate color and size. The size of the planet represents its level of influence for adaptation in your case. The colors could represent different types of organizations.
 - Place the planet on the large paper and write the name of the case in the center. The closer to the middle of the paper the circle is placed the more influential you think it is for influencing adaptation to climate change.
 - Repeat for all actors.
 - In the list of stakeholders, fill in the level of influence that you think the actor has on the governance of climate adaptation.

Mapping interactions between actors

6. Draw a line between actors that currently collaborate. The thicker the line, the stronger the interaction. A thin or dotted line symbolizes that collaboration just barely exists.
7. Use another marker to draw lines to represent collaboration between actors that should exist to facilitate climate adaptation in your case but are currently missing. On each line specify the object of the collaboration.

Discussion and analysis

9. Discuss the questions below. The objective is to decide on measures to increase inter-actor collaboration and involvement of any important actors that are not already connected to your process.

Questions to facilitate the group discussion:

- What forms of collaboration are needed to seize potential opportunities generated by climate change?
- Who is responsible for what important areas? Are these actors actually exercising their responsibility in the area of climate change?

- Are there actors who have an informal responsibility? Should these actors be mobilized? Are there actors who should have more or more formal responsibility?
- Are there any responsibility gaps?
- Which of the actors have resources? Are these resources utilized efficiently?
- Are there any resource gaps, “stock-piles” (not utilized today)?
- Which of the identified sensitive activities are the hardest to handle? What actors and areas of responsibility must be included in the process to best handle these issues?

An example of an exercise on crisis management and long-term strategies within the health sector

This exercise is developed to distinguish between crisis management on the one hand and more long term strategies on the other. Experiences have shown that sometimes there is confusion between these two issues, which makes it hard to analyze division of responsibility. This group exercise will try understand difference between these two issues for the health and water sector.

(Use Table A-6 in the Appendices to understand the current cooperation among different organizations.)

1. For each stakeholder already involved in the group, fill in the process stakeholder list including:
 - Name, organization, and position
 - Area of responsibility
2. In order to determine other people that should be included, go through the prepared questions below and see what other stakeholders come to your mind.
3. Fill in the details of each stakeholder in the list.

Questions that may assist you in determining who to involve and why:

- What roles do various organizations play for local responses to CC?
- Who (function as well as person) can participate in the assessment?
- Who will be using the outcomes of the assessment of challenges and opportunities?
- Who will be the potential beneficiaries?
- Who will be adversely affected?
- Who has existing rights? Who has control over resources?

- Who is likely to be voiceless? Who can represent them?
- Who is likely to mobilize resistance?
- Who is dependent on whom?
- Who is responsible for the intended plans?
- Who has money, skills or key information?
- Whose behavior has to be changed to attain certain key goals?
- What power gaps exist between stakeholder groups? How should these be dealt with? In what way could each stakeholder be involved that will best aid the process?
- Who should be recipients of the assessment outcomes such as the final report?

Chapter 6: Areas for Action: Suggestions for Follow-up

6.1 Following up on adaptation programs development at the national policy level

In order to have in place an efficient adaptation action plan for all sectors, it is imperative that countries should carry out the following necessary steps:

a) Carrying out National assessments

National and regional national assessments of the potential health impacts of climate change must be carried out in order to provide needed information about future impacts on vulnerable areas and populations.

Health impact assessments will provide information to an integrated climate change assessments, strategies or action plans.

Key areas such as diarrhoeal disease, vector-borne disease and malnutrition should receive special attention in these assessments. However, a prerequisite to accurate assessment is to obtain accurate climate information at the local level, particularly on climate variability and extremes.

The need for standardized methods and tools for such assessments is highly needed and authorities should shy away from the ad hoc style of assessments.

b) Establishing a Monitoring process to climate change impacts on human health

Monitoring to assess climate-change impacts on health requires data gathering coupled with analytical methods for quantifying the climate-attributable part of diseases that climate change is likely to cause incremental changes in their frequency and distribution.

Standardized long-term monitoring of related indicators could provide direct evidence of climate-change impacts on health. long-term surveillance should be able to detect variables with associations between climatic changes and disease incidence.

In order to achieve this important goal, it is imperative that authorities develop standardized surveillance methods of climate-sensitive health areas in order to strengthen the already existing systems designed to detect climate change impacts on human health.

Health data and information should also be made available to all research institutions especially those with linkage to climate and determinants of vulnerability.

c) Developing effective Adaptation strategies and policies

Implementation of adaptation strategies will play an important role in reducing the adverse health impacts of climate change. However, the effectiveness of adaptation strategies will depend upon cultural, educational, managerial, institutional, and legal and regulatory practices at the national and regional levels.

The existence of a sound and broadly-based public health infrastructure (including environmental management, public education, food safety regimes, vaccination program, nutritional support, emergency services and health status monitoring) is a pre requisite to have an efficient adaptation program. Other health-directed policies in other sectors, including transport, urban planning, industry, agriculture, fisheries, energy, water management and so on are needed to complement such a program.

There is a key need for research on barriers and opportunities for enhancing adaptive capacity in order to protect human health, as well as potential interactions with ongoing development projects and programs. Research also is needed on the processes of “adaptation decision-making”, including identifying the roles and responsibilities of individuals, communities, nations, institutions and the private sector in adaptation.

d) Moving from science to policy

Policy-focused assessment is a valuable process for providing timely and useful information to policy-makers, resource managers and other stakeholders in the public health community.

Successful policy-focused assessment should have multidisciplinary assessment team to answer questions asked by stakeholders in the public health community towards evaluation of risk management adaptation options and identification and prioritization of key research gaps. They should also be able to characterize and explain uncertainties and their implications for decision-making.

In addition, authorities will also a need to:

- Assess and prioritize questions about the potential impacts of climate change on human health that have identified by the research community.
- Perform assessments of adaptation strategies to reduce the risks to public health from climate change.
- Evaluate the costs, benefits, effectiveness (in practice), barriers to implementation and risks of maladaptation for each adaptation option.
- Identify and develop a decision-support tools to help public health officials make decisions under uncertainty, given available assessment results.
- Develop needed mechanisms and interventions to integrate the proposed adaptation measures in national policies and action plans.

According to Cap-Net Training Manual and Operational Guide on Integrated Water Resources Management Plans (Cap-Net, 2005) the process of integrated adaptation plans into the policies and strategies is presented in seven sequential steps. These are:

- In the 'Initiation' step, climate change impacts need to be integrated in the planning process. In advocacy towards policy makers, the argument can be brought up that this will be instrumental for decision makers to advance climate change adaptation strategies, which otherwise might be politically difficult to implement.
- During the 'vision/policy' phase climate change adaptation is an additional element, not a replacement of health or water management goals. The overall aims of health and water strategy will remain the same.
- In the 'Situation analysis' step, the use of climate information and impact analysis need to be incorporated. Further, the adaptation/mitigation theme can be brought out to suggest that adaptation program should reduce the risk of adaptation options negatively impacting on the mitigation targets, and vice versa.
- In the 'Strategy choice' phase, the anticipatory or 'precautionary' approach can be introduced as the basis for the health and water sector strategies (IWRM).
- Consider the roles of local authorities in adaptation strategies when drafting an IWRM plan.
- Legal frameworks, economics and health, and other variable conditional elements that have been analyzed from the corner stone for implementation of IWRM and are decisive in how it contributes to climate change adaptation.
- During evaluation, results must be measured against indicators, taking into consideration the adaptation measures proposed in the plan.

Throughout the process, stakeholder involvement is essential so that the results of the impacts assessment and strategic choice are owned by the implementing agencies. The range of solutions and strategies has been broadened over time by improvements in technologies. What has changed is our understanding and implementation of the integrated ensemble of water management measures that conform to modern principles and policies.

An example of how to move from science to policy is shown below:

Instruction:

This example deals with discussion on how to utilize scientific research results to design an adaptation program in the health sector.

Uncertainty has to be discussed first and then to come up with a reasonable planning scenario for adaptation in the health sector.

The following items are discussed in this exercise:

1. Level of expected uncertainty in the research outcome (justify your answer)
2. Suggested climate change impacts on the health sector according to the research results outline in the research summary shown below.

3. Under each of the below categories detail all possible measures, plans or strategies for health adaptation of climate change to improve the resilience of the country to climate change impacts
 - governance and policy
 - health adaptation implementation
 - Financing and costing mechanisms
 - health benefits from climate change mitigation

This Morocco profile includes information related to the health sector profile as well as other related sectors are a prerequisite to this exercise.

Research Summary

Morocco's climate is very diverse, with a warm, Mediterranean climate in the northern coastal region, continental inland areas and semi-arid areas in the south. Morocco has ambitious renewable energy targets and is making political and strategic efforts to conserve biodiversity and to mitigate and adapt to climate change.

Despite positive actions, Morocco remains vulnerable to the effects of climate change. The Mediterranean coast and low-lying Moulouya River delta, with their economic and ecological importance are threatened by sea-level rise and subsequent shoreline erosion and saline intrusion. Agriculture, which represents 16% of Morocco's GDP, is endangered by decreases in annual rainfall increasing the risk of crop failures and malnutrition. Morocco could also face aggravated water scarcity; rising temperatures; severe heat waves; and increased incidence of dengue fever, malaria and schistosomiasis.

Research has predicted that under a high emissions scenario, mean annual temperature is projected to rise by about 5.5°C on average from 1990 to 2100. If emissions decrease rapidly, the temperature rise is limited to about 1.6°C.

Under a high emissions scenario, and without large investments in adaptation, an annual average of 187,400 people are projected to be affected by flooding due to sea level rise between 2070 and 2100. If emissions decrease rapidly and there is a major scale up in protection (i.e. continued construction/raising of dikes) the annual affected population could be limited to about 100 people. Adaptation alone will not offer sufficient protection, as sea level rise is a long-term process, with high emissions scenarios bringing increasing impacts well beyond the end of the century.

Under a high emissions scenario heat-related deaths in the elderly (65+ years) are projected to increase to almost 50 deaths per 100,000 by 2080 compared to the estimated baseline of just under 5 deaths per 100,000 annually between 1961 and 1990. A rapid reduction in emissions could limit heat-related deaths in the elderly to just over 14 deaths per 100,000 in 2080.

Morocco has an approved national health adaptation strategy and is currently implementing projects on health adaptation to climate change.

6.2: Following up on adaptation programs development at the Global Policy level

Health impacts of climate change can only be identified and quantified by the availability of accurate and comprehensive information and through adopting sophisticated tools and methodologies that can be used by highly specialized public health professionals with skills that will allow managing such impacts and

putting in place sophisticated and efficient adaptation programs into the health and water sector with IWRM process as the corner stone of such programs. In addition, the current research efforts to better understand climate change health impacts at the regional and global levels is by all means insufficient and the scope of this research is not wide to include all the required aspects of this dimensions.

These two points in addition to the results of the above review process would warrant the following steps to be taken and adopted:

(a) At the regional level:

- To develop climate change policies and strategies and integration of adaptation programs into the health and water policies and strategies based on their national circumstances that would include health as a focus area taking into consideration the regional vision through regional networks and committees towards developing robust regional actions plans.
- Countries of a region should establish a regional task teams to undertake the required work on climate change health vulnerability assessments and adaptation planning and include the IWRM process into the task force mandate.
- Countries of a region should use standardized tools and methodologies when undertaking assessment of vulnerability to climate change with focus on health.
- Two specific programs should be included in the regional committees mandate and to be included in the regional adaptation action plans. These are: (i) integrated environment and health surveillance; and (ii) strengthening of health systems.

a) The International bodies and agencies

- Implement technical support programs towards adopting standardized methods and tool for the assessment of climate change vulnerability focusing on health for different regions of the world.
- To facilitate the creation a network of experts for the assessment of vulnerability in the health sector due to climate change.
- To facilitate the creation of a data bank for the information related to the impacts of climate change on health in the region.
- To facilitate and support different countries establish resilience and adaptation public health objectives and targets for public health country adaptation planning.
- To develop a climate change and health vulnerability assessment and adaptation capacity building program with specific tools taking into consideration the different countries circumstances and capacities.

c) To the UNFCCC and its subsidiary bodies

- To emphasize the need to include the health issues as focus in order to reach a more resilient system of adaptation to climate change for the countries.
- To institute technical and financial assistance mechanisms for EMR countries to facilitate the achievement of resilience and adaptation of public health objectives and targets.

Chapter VI: References and further reading

References

Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds. (2008). "Climate Change and Water." Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.

Cap-Net (2009), "IWRM as a Tool for Adaptation to Climate Change, Training Manual and Facilitator's Guide." International network for Capacity Building in Integrated Water Resources, U.N.D.P..

CDC, 2010, "Assessing Health Vulnerability to Climate Change, A Guide for Health Departments, Climate and Health Technical Report Series, Climate and Health Program.

GIZ (2011): *Climate Proofing for Development: Adapting to Climate Change, reducing Risk.*

Huitema, D., E. Mostert, W. Egas, S. Moellenkamp, C. Pahl-Wostl, and R. Yalcin. 2009. Adaptive water governance: assessing the institutional prescriptions of adaptive (co-)management from a governance perspective and defining a research agenda. *Ecology and Society* **14**(1): 26. [online] URL: <http://www.ecologyandsociety.org/vol14/iss1/art26/>

IWGCCH, 2010, "A human health perspective on climate change, A Report Outlining the Research Needs on the Human Health Effects of Climate Change: Environmental Health Perspectives and the National Institute of Environmental Health Sciences.

OECD, (2006), "Progress On Adaptation To Climate Change In Developed Countries; An Analysis Of Broad Trends".

Pierre Mukheibir, Local water resource management strategies for adaptation to climate induced impacts in South Africa, Rural Development and the Role of Food, Water & Biomass: Opportunities for Development and Climate. Novotel, Dakar. 14-16 November 2005, Energy Research Centre

Tearfund, (2010), "How to integrate climate change adaptation into national-level policy and planning in the water sector: a practical guide for developing country governments"

World Bank (2011). "Middle-East and Northern Africa Water outlook." Prepared by FutureWater.

Key reading for participants

- IPCC Fourth Report, 2007
- MoEnv, Jordan, 3rd National Communication, 2014)
- The Natura 2000 network (EC, 2009 Task 2a report)

- World Bank, Health in a changing climate, 2011
- Cap-Net 2005, Integrated Water Resources Management Plans, Training Manual and Operational Guide, CAP-NET, Global Water Partnership, UNDP.
- WHO (2003). Climate Change and Human Health. Risks and Responses. <http://www.who.int/globalchange/publications/cchhbook/en/>
- Barriers, Opportunities, and Market Potential of Technologies and Practices, IPCC, TAR
- MoEnv (2007), National Capacity Self Assessment for Global Environmental Management (NCSA) – Jordan. Ministry of Environment, Amman- Jordan, January 2007.
- NAPA Team, Identifying Synergies and Barriers to Adaptation within the Framework of Yemen, NAPA, May 2006.
- National Environmental and Economic Development Study for Climate Change (2010), Jordan National Report Submitted to the United Nation Framework Convention on Climate Change, October 2010.
- The Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), 2009
- Tearfund 2010. How to Integrate Climate Change Adaptation into national-Level Policy and Planning in the Water Sector.

Appendix 1: Group Exercises Tables

Table A-1

	Impacts	Department/Agency	Programs
Climate Risk 1:			
Climate Risk 2:			
Climate Risk 2:			

Table A-2

Climate Risk				
	Health effects	vulnerable populations	programs	co-benefits to water safety program
Impact 1				
Impact 2				
Impact 3				

Table A-3: List of potential adaptation measures for health sector

	Prevention measures	Measures to improve resilience	Preparation measures	Response measures	Recovery measures
Institutional and strategic Interventions					
Environmental Quality Monitoring and Control					
Health Institutions Enhancement					
Awareness and Capacity Development					
Early warning Systems					

