Egypt's National Strategy for Adaptation to Climate Change And Disaster Risk Reduction

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The formal publication of Egypt’s National Strategy for Adaptation to Climate Change and Disaster Risk Reduction is in Arabic. Any discrepancy should appear in the English version will be for reasons of translations, therefore the use and citation of this document should take this into account.

Abstract

The main objective of Egypt's National Strategy for Adaptation to Climate Change and Disaster Risk Reduction is to increase the flexibility of the Egyptian community when dealing with the risks and disasters that might be caused by climate change and its impact on different sectors and activities. It also aims at strengthening the capacity to absorb and reduce the risks and disasters to be caused by such changes.

In essence, the strategy adopts accommodation and protection as the two basic means of defence, taking into consideration systematic retreat based upon predefined plans, in case the coastal zones are exposed to cyclones, tsunamis or any other extreme event. The global concepts agreed upon in the Copenhagen Accord (2010) refer to a minimum temperature increase of no more than two degrees Celsius as well as two sea level rise scenarios of 0.5 meters and 1 meter until the end of the 21st century.

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Executive Summary

Over the past fifty years, the world has demonstrated increased concern over the climate change phenomenon. A significant number of institutions and regional and international research centers have investigated the particulars of this phenomenon with the aim of identifying how to cope with it and how to reduce its associated risks. Some countries were classified as more vulnerable to climate change and more prone to the damage it may cause, both on the short and long term. This eventually helped raise the alarm, and exposed the looming risks and imminent events. However, reality was different. Indeed, the world was shocked by the aggressive nature of the climatic conditions that hit a multitude of locations, which had never been classified as more vulnerable and threatened. A distinction was therefore made between climate change as a part of natural climatic events, and climate change caused by emissions of greenhouse gases such as carbon dioxide, methane, nitrogen oxide, and chlorofluorocarbons (CFCs) resulting from human activities and the irrational use of fossil fuel in transportation and industry.

The accumulation of greater knowledge on the complexity of climate change brought about the preparation of a large number of reports describing the phenomenon and suitable solutions for it. As a result, all parties recognized that the time scale required to tackle the problem may be short or long and that, consequently, the entire issue could necessitate an urgent, short-term, medium-term, or long-term solution. The parties also acknowledged that this problem required a strategic perspective. Some countries were able to prepare their strategies, whereas the majority merely prepared their national communication reports describing their capacities and capabilities in terms of mitigation of and adaptation to climate change.

Out of its belief in the significance of climate change and its potential impact, the Arab Republic of Egypt was among the countries of the international community which took part in most of the studies, research, conferences, seminars, and meetings addressing this phenomenon. Egypt submitted two national communication reports (first and second National Reports) under the United Nations Framework Convention on Climate Change (UNFCCC). The third national communication report is currently underway. Egypt also decided to develop a national strategy, which addresses this phenomenon at two levels according to the type of sectors affected and those affecting the climate change issue. The first level is concerned with adaptation to climate change, whereas the second level is about the mitigation of its severity. The National Strategy for Adaptation to Climate Change and Disaster Risk Reduction expresses Egypt's vision of the problem. It benefited indirectly from the strategies of countries such as: Spain, Turkey, Germany, and the United Kingdom.

The objective of the strategy is to increase the flexibility of the Egyptian community when addressing the risks and disasters resulting from climate change and its impact on various sectors and activities. It further aims at strengthening the capacity to absorb, contain, and reduce the risks and disasters caused by climate change.

The strategy primarily adopts accommodation and protection as the basis for adaptation to the risks resulting from climate change, while taking into consideration systematic retreat. This is based upon plans that are prepared in anticipation of any potential exposure of the coastal zones to hurricanes, tsunamis or any other extreme event. Action would be taken under a forecasts scenario, which requires the states to ensure that the

expected rise in temperature shall be no higher than two degrees Celsius until the year 2100. The rise of the sea level by 2100 shall be addressed under two scenarios:

- Scenario 1: sea level rise of 0.5 meter.
- Scenario 2: sea level rise of 1 meter.

In view of the scientific advances and continuous updating of studies and, in turn, the expectations of the climate change impacts and adaptation to these, it was important to lay down a flexible strategy, which would be regularly updated. Consequently, the adaptation programs addressing climate change over the next century shall be in accordance with a strategy consisting of four five-year plans (over the next twenty years), while keeping up to date with any possible changes until the end of the century.

In order to achieve Egypt's Strategy for Adaptation to Climate Change and Disaster Risk Reduction, the following determinants must be met: Political will; provision of human, financial and natural resources; reform and amendments of institutional frameworks; amendment of legislations and laws; strengthening of the national system of information dissemination; monitoring, assessment, follow up and identification of performance indicators and development of a national model for social and economic analysis and projection.

The strategy assesses the current situation in all sectors, mainly the coastal zone that intersects with other sectors: water resources and irrigation, agriculture, health, urban areas, housing, roads and tourism.

The strategy classifies and highlights the importance of coastal zones according to their potential exposure to risks and disasters resulting from climate change and the associated sea level rise.

Regarding the water resources and the irrigation sector, the strategy identifies the determinants of an integrated water management system, population increase, fragmented agricultural holdings, a free crop structure, the lack of financial resources, water pollution, and inappropriate legislations in addition to other social and economic factors.

As for the agricultural sector, there have been extensive discussions regarding the area of cultivated land, plant produce as well as animal and fish production across the country.

The strategy thoroughly describes the current situation in the health and demographic sector, defining the loss in life expectancy due to communicable and non-communicable diseases, infections compared to the rates prevailing in the entire region, rates of access to health services, the mortality rates of children under five years of age, and the development in health insurance coverage from 1994 to 2009.

With respect to urban areas and population distribution, a detailed account has been given on land reclamation projects and the impact of climate change on population, housing and roads.

On tourism, the strategy expounded on tourist demand, inbound tourism, external tourism revenues, local tourism, hotel capacity, and the key issues and challenges in the field of tourism development.

The strategy then broadly lays out the risks, disasters, and crises generated by climate change in each sector, mainly the impact on the coastal areas, water resources, agriculture, health and population, tourism. It concludes with a presentation of the risks as regards food security.

Chapter V is deemed one of the key chapters of the strategy; it examines the methods and means of adaptation to climate change and disaster risk reduction, while considering the international consensus that the temperature increase shall not exceed two degrees Celsius as well as two sea level rise scenarios of 0.5 and 1 meter until the end of the 21st century.

Accordingly, the potential exposure of Egyptian coasts to the risks of disasters resulting from sea level rise has been discussed; and direct defence and preventive methods as regards the exposure areas have been suggested.

As for water resources, the adaptation measures have been reviewed together with the factor of uncertainty in terms of the increase or decrease in the revenues of the River Nile.

In the agricultural sector, the recommended adaptation methods are mainly the establishment of an effective institutional crisis management and disaster reduction system, the conservation of biodiversity, the sound management of soil, arable land, water resources, crop irrigation, the promotion of livestock and fish resources, the adjustment and improvement of economic and agricultural systems and the improvement of the rural community's conditions.

The strategy highlights the importance and the need to promote health care efficiency in order to address climate change in the health sector, develop meteorological and seasonal forecasts and early warning systems, raise community awareness as regards the preventive health principle, encourage scientific research and field and demographic studies, and improve social and economic conditions and population characteristics.

The strategy presents several proposals for adaptation to climate change in the fields of housing, buildings, and roads. In the field of tourism, preventive, precautionary, and direct defence methods and techniques are examined.

The strategy further presents multiple measures for the incorporation of adaptation plans within sustainable development programs and plans, calling for support of economic growth to enhance the ability of adequate resilience for adaptation to climate change, promote social cohesion and reduce the risks of any internal conflict.

The strategy examines the role of civil society organizations and community participation in a manner that allows effective cooperation among the state agencies, private sector, and members of non-governmental organizations, professional associations, trade and agricultural unions, research centers, media associations, local and popular committees, sporting clubs, and cultural forums.

The strategy also discusses regional and international cooperation; initiatives underway to adapt to the climate change; and the organizations concerned with regional and international affairs where Egypt is a member. It also provides an overview on some projects that are under implementation, in collaboration with some of these organizations.

The strategy's building blocks are supported by an operational framework proposed for adaptation programs, and for the estimated investments necessary to fulfill them.

Finally, the strategy provides an outline for the efforts of monitoring, evaluation, and follow-up, at two levels: (1) efforts on the ground related to climate change phenomena, including the efforts made to handle the issue of uncertainty; and (2) monitoring, evaluation and follow up of the implementation of the strategy itself through the development of indicators for measuring and identifying the required future steps and measures.

It is necessary here to emphasize the dynamic nature of this strategy, meaning that it needs to be updated depending on the changes and developments that may occur in the

projections and potential impact. It is also necessary to emphasize that the strategy presents itself as a guide to all state institutions and the different sectors during the development of their own operational action plans.

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Preamble

The development of Egypt's National Strategy for Adaptation to Climate Change and Disaster Risk Reduction is a contribution to the world efforts in this respect. Egypt joined the global concerted efforts since the Earth Summit in Rio de Janeiro, Brazil in 1992, where 189 countries developed a framework convention on climate change that targeted the maintenance of fixed levels of emissions of greenhouse gases in the atmosphere. Egypt also participated in the conferences and negotiations that led to the signing of the Kyoto Protocol in 1998, which stipulated that the signatories shall implement the mechanisms set forth in the Protocol presented in 2005. This was followed by the Copenhagen Summit, in Denmark in 2009. One of its most prominent undertakings - though not realized - was the drafting of a new universal agreement to protect the globe against the risks of climate change. This appeared recently during the meeting in Cancun, Mexico, in 2010, which put aside some of the controversial issues between industrialized and developing countries, through an agreement which had not been reached during the Copenhagen Summit.

Egypt was represented at The World Conference on Disaster Reduction (WCDR) held in Cope, Hyogo, Japan, from 18-22 January 2005, in accordance with the resolution adopted by the United Nations General Assembly. During the Conference, the Hyogo Framework for Action 2005 - 2015: Building the Resilience of Nations and Communities to Disasters was developed to promote a strategic approach reducing vulnerabilities[1], risks and hazards[2].

The Hyogo Framework for Action included the following strategic goals:

1. The more effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction;
2. The development and strengthening of institutions, mechanisms, and capacities at all levels, in particular at the community level, which may systematically contribute to building resilience to hazards. This is determined by the capacity to learn from past disasters for better future protection and to improve risk reduction measures, especially in the rural areas that lack these capacities and where poverty may amount to 70% of the total population in need of effective integrated and comprehensive development efforts.
3. The systematic incorporation of risk reduction approaches within the design and implementation of emergency preparedness, response, and recovery programs in the reconstruction of affected communities.

Given that climate change may threaten people's lives, properties, and livelihoods, and may also compromise the achievement of their development goals, the Hyogo Framework of Action sought to: "promote the integration of risk reduction associated with existing climate variability and future climate change into strategies for reduction of disaster risk and adaptation to climate change, which would include the clear identification of

[1] Vulnerability is defined as: "The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards".

[2] Hazard is defined as:" A potentially damaging physical event, phenomenon, or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards may include latent conditions that may represent future threats and can have different origins: natural (geological, hydro-meteorological, and biological) or induced by human processes (environmental degradation and technological hazards)".

climate-related disaster risks, the design of specific risk reduction measures and an improved and routine use of climate risk information by planners, engineers, and other decision-makers".

The Second Session of the Global Forum for Disaster Risk Reduction was held in Geneva, Switzerland in June 2009 amid escalating fears of climate change, its impact, and adaptation measures. Participants unanimously agreed that dealing with the negative impacts of climate change had become a priority issue. All parties stressed the urgent need to adopt certain measures that would secure integration and harmony between disaster risk reduction and adaptation to climate change, linking them under a wider framework that includes poverty reduction and conservation of sustainable development.

The National Committee for Crisis/ Disaster Management and Disaster Risk Reduction affiliated to the Information and Decision Support Centre (IDSC) in Egypt, through its scientific advisory committee comprising of a panel of experts and professional scientists, embarked on the development of the National Strategy for Adaptation to Climate Change and Disaster Risk Reduction.

The strategy has been based on the findings of the first and second communication reports prepared within the framework of the UNFCCC. The two reports covered two phases: the first national communication from 1990 to 1999 and the second covered from 2000 to 2009. The two reports described the condition and level of greenhouse gas[1] emissions, the extent of ecosystem exposure to global warming and the related impact, and suggested adaptation and disaster reduction measures.

This strategy is specifically relevant to adaptation to climate change in different sectors as per the Second National Communication Report, namely: coastal areas, water resources, agriculture, tourism, health, population, inhabitants, and roads. It is important to stress that the energy sector, mainly used by industry and all forms of transportation, has not included as the strategy focused solely on adaptation to climate change. It also aimed at leaving the door open for the development of a special strategy on the mitigation of its impact, mainly through the reduction of emissions and limiting the process of burning fossil fuel.

The Strategy includes eleven chapters:

Chapter I introduces the goals of the strategy, which include increasing the flexibility of the Egyptian community in dealing with the climate change risks and disasters and their impact on different sectors; and their ability to absorb, contain, and reduce such risks and disasters.

Chapter II examines the strategy constraints that impede the achievement of the goals within the expected time framework, and the way to deal with such constraints.

Chapter III assesses the current situation of coastal zones and five key affected sectors, namely: water resources and irrigation, agriculture, health; rural areas, housing and roads and tourism .

Chapter IV discusses the main risks and disasters caused by climate change as regards the coastal zones and the above-mentioned sectors, including the impact of temperature increase and sea level rise.

[1] Also known as GHGs.

Chapter V lists the measures of adaptation to climate change and risk reduction, including the general frameworks and its related fundamentals relevant to the sectors and areas incorporated in the strategy .

Chapter VI aims at addressing climate change and adaptation measures as part of an integrated strategy of the Egyptian government and its sustainable development programs and plans. The planning or implementation of any project or program incorporated in the development plans would therefore take into account the impacts of climate change .

Chapter VII stresses the importance of the civil society's role and the community's participation in climate change risk reduction and mitigation of its negative impact on the community at large. In terms of adaptation to climate change, the state cannot certainly assume this role on its own without the full support of these groups .

Chapter VIII discusses the efforts of regional and international cooperation in endeavours of adaptation to climate change and reviews the current key initiatives in this respect.

Regarding the implementation of the strategy, **Chapter IX** lays out the proposed operational framework for the climate change adaptation action plans through the development of a matrix for the implementation framework and initiatives, as proposed in accordance with the key objectives of the strategy and the detailed goals for each sector. The adaptation programs are divided into four five-year plans covering the next two decades.

Given that the implementation of these adaptation programs will require substantial funding, **Chapter X** presents the estimated costs and forecasts .

The strategy concludes with **Chapter XI**, which addresses the methods of monitoring, evaluation and follow-up of the implementation process, as well as the field efforts to monitor and follow up on the climate-related features .

Few countries have developed strategies for adaptation to climate change and risk reduction, therefore, the publication of this document positions Egypt, at the regional level, as a pioneer in this field. The National Committee for Crisis/ Disaster Management and Disaster Risk Reduction submits the strategy to all climate change stakeholders in Egypt, mainly decision-makers, and all relevant regional and international organizations.

It is worth mentioning that four national adaptation strategies were monitored, specifically in the United Kingdom, Germany, Spain and Turkey, and these helped guide the Egyptian national strategy, as it benefited from the international experience in this field .

The strategy also integrates with the National Strategy for Crisis/ Disaster Management and Disaster Risk Reduction, which the IDSC issued in 2010. It addressed in detail the extreme events and consequent disasters. It is to be noted that the strategy does not provide the same level of specification .

The strategy is considerably momentous as it comes at a time when the world is moving, at an accelerated pace, towards handling the issue of climate change. However, the panel assigned to develop this strategy suggests that its theme be seen as dynamic in nature; hence, it is to be updated periodically. All estimates are based on various stages. The first five years address the urgent issues that cannot be deferred; this is synchronous with the interest in the studies and research required for future measures, followed by three five-year plans. This is all within the framework of future short- and long-term projections that may extend until the end of the century .

The panel recommends that all state institutions and sectors should consider the strategy as a guide. Every sector has to translate it into detailed action plans that would identify the methodologies to be adopted by respective agencies in order to address this important issue and how to benefit from its positive aspects and limit its negative ones.

Chapter I

National Strategy: Goals

Confronting the impact of climate change requires local, regional and international cooperation and synergy. This is a tremendous and sophisticated challenge which humanity is faced with, for the current and future generations. The government of Egypt undertakes its activities based upon the principle of common responsibilities at the domestic level. In collaboration with the international community, the government implements the key objectives, while taking into account the social and economic indicators, as well as the social dimension. The government adopts its national policies and measures, based on the fact that these are vital for the protection of existing investments, and simultaneously secures growth and sustainable development.

The National Strategy aims at achieving the following goals

1. **Increasing the flexibility of the Egyptian community in dealing with the risks and disasters caused by climate change and its impact on different sectors:** These sectors include the coastal zones, water resources and irrigation, agriculture, health; urban areas, housing & roads; and tourism. This goal can be achieved by carrying out an in-depth analysis of the current situation in different sectors of the community. These are the facilities that are available and required to raise the degree of preparedness for confrontation and flexible interaction with developments.
2. **Enhancing the capacity to absorb and contain climate-related risks and disasters:** This is attainable through the development of specialized sectorial programs and action plans to meet the needs of the community at large, and to adapt to the new conditions through various means, ranging from basic fundamentals to the use of state-of–the-art technologies. In this manner, systems are set up for adaptation to potential climate changes, namely temperature increase and water scarcity, and the adverse expectations on the increase and decrease of precipitation and sea level rise.
3. **Reduction of climate change – related disasters:** This is feasible through accurate scientific calculations; field and theoretical observation of the different sectors of the community; appropriate support of the existing projects; selection of the most convenient and appropriate locations and designs for new projects; and strengthening the infrastructure in a manner that would help reduce the disasters related to climate change.

To achieve these goals, the following measures must be taken:

1. Define the risks and crises associated with climate change, while taking into account a precise scientific handling of the state of uncertainty on the current prospective impacts and their extent in terms of geographic and time ranges.
2. Integrate the adaptation plans of different sectors in the five-year plans and national development programs.
3. Build a "Safety First" culture and raise community awareness, taking into consideration that climate change constitutes a long-term phenomenon.
4. Enhance community participation at all levels (governmental, non-governmental, popular, and civil society).
5. Promote regional and international cooperation and entrench current initiatives of adaptation to climate change.
6. Monitoring, assessment, and follow-up.

The National Strategy provides an assessment of the current situation, the real dimensions of the problem and the consequent impact; it lays down the foundation for an adaptation strategy consistent with the goals identified. Through the operational framework, it further focuses on the development of a national model for climate change. This can evolve into a realistic and scientific model for the analysis of space and time, and for projections in terms of consequent impacts and adaptation methods.

The strategy also adopts a series of proposed studies, measures, and alternatives – ranging from the basics to the state-of-the-art technologies – for adaptation and climate change disaster risk reduction.

Chapter II

National Strategy: Determinants

In order to achieve the goals of the National Strategy for Adaptation to Climate Change and Disaster Risk Reduction within the set time frame, seven determinants must be met.

1. Political will at All Levels:

Egypt is subject to so many natural disasters causing major human and financial losses. The following table (Table 1) introduces a number of statistics on losses resulting from natural disasters which Egypt experienced during the period 1987-2008.

If the decision-makers, at various levels of the state's institutional hierarchy, do not consider climate change as a matter of utmost urgency, and if they do not appreciate its short- and long-term impacts, it will be a challenging issue to handle. This would consequently lead to failure of preventing the potential detrimental impacts of climate change.

As political will is a key issue and a top priority, any flawed perceptions (at the senior levels of influential departments) could lead to the importance of climate change being undervalued. In this respect, it is imperative to separate between personal opinions and personal convictions of officials and the institutions. Since the state has signed the climate change conventions, it is imperative for all institutions to be bound by such conventions as the signature or accession to these has come to achieve national interest as well as a confirmation of Egypt's cooperation in the international community.

Hence, the mobilization of political will at all levels is primarily linked to respecting the commitments of the state to conventions, treaties and instruments. This will result in a dissemination of the rationale and notions enshrined in these conventions. Moreover, the non-objection of their content should be commensurate with the degree of adjusting the international notion to the prevailing local conditions. This would improve the potential for implementation at the domestic level, while taking into account the economic, social and political conditions of the country.

2. Availability of Human, Financial and Natural Resources:

Naturally, adaptation to climate change requires resources: human resources require professionals who have a profound understanding of the subject; financial resources are needed for the implementation of infrastructure projects or for the amendment of support plans, programs, and mechanisms; finally, the natural resources are: soil, water and air. The optimal situation for countries that do not have the means is the integration of the climate change adaptation mechanisms in the state's regular development plans and programs, in order to avoid any duplication of costs in the plan projects and adaptation projects.

The Stern Review on the Economics of Climate Change, one of the well-established studies in this respect explains: "…the costs of mitigation are small relative to the costs and risks of climate change that will be avoided. Any estimate of the costs cannot accurately include the potential impact on the social conditions like social and political instability or forced migration".

3. Reform and Adjustment of Institutional Frameworks:

Reforming and adjusting institutional frameworks does not necessarily mean establishing new ones, nevertheless enhancing the existing ones is necessary, as follows: including the

issue of adaptation to climate change in their list of assignments; amending the terms of reference and staff job descriptions in order to comply with the adaptation requirements. This is rather similar to the introduction of environmental impact studies to the projects – a matter that was unheard of in the previous decades; such studies have become one of the key prerequisites for the implementation of projects.

4. **Amendment of Legislations and Laws:**

   Existing institutions must be developed. Similarly, the prevailing legislations must also be consistent with the adaptation requirements. As previously mentioned, this is not a matter of adopting new legislations but rather developing the existing ones so that they can be in tune with the developments required for adapting to climate change.

5. **Strengthening the National Information Exchange System:**

   Given that climate change is an all-embracing issue that intersects with several national activities and systems, it is essential that the various sectors stop acting individually (in separate silos) should the desired results be achieved. Egypt is in need of a common database that all can have access to, in order to exchange information and utilize its content. One of the key elements of the strategy is to define the main structure of the proposed national climate change information system, and how individuals, groups, and institutions can make use of this system (giving and taking, adding and subtracting). Evidently, this must be carried out in a clear and transparent manner.

6. **Monitoring, Assessment and Follow-up, and Identification of Performance Indicators:**

   Rather than being static, the strategy shall be subject to continuous amendments. This will render it dynamic and ever changing in conjunction with the changes in time and space. Hence, it is vital to devise a monitoring and evaluation plan that is based on two factors: the qualitative measurement of performance indicators in all fields, and a set of proposals for the appropriate amendments based on these measurements which may remove or include some concepts as necessary, according to the conditions and criteria incorporated in the performance indicators. The operational measures shall include the proposed time frame, and the related financial expenses and costs in kind.

7. **Development of a National Model for Social and Economic Analysis and Projections:**

   The assumption is that this model should provide indicators for the general social and economic impacts resulting from climate change and the adaptation process. It should also indicate the outcomes if the implementation of the adaptation plans goes as intended, and if the process experiences full or partial negligence or disregard. Accordingly, the following steps will be necessary: development and analysis of several scenarios; identification of costs; identification of implementation agencies in case of disasters; definition of financing sources.

Chapter III

Overview and Assessment of the Current Situation

The overview and assessment of the current situation is one of the most important pillars in the preparation of the national strategy. According to the data collected through the assessment and risk analysis of disasters and crises caused by climate change or extreme events affecting natural, social and economic configurations, climate change adaptation programs will be developed with a view to mitigating the associated disasters risks.

This chapter contains an overview and assessment of the current situation in a geographical region covering the Mediterranean and Red Sea coasts of Egypt, as well as the five sectors affected by climate change, which are as follows:

1. Water resources and irrigation sector.
2. Agricultural sector.
3. Health sector.
4. Urban areas, housing and roads sector.
5. Tourism sector.

3. 1 Coastal Zone:

- **The importance of coastal zones in the Arab Republic of Egypt:**

  The Egyptian coasts stretch over 3,500 km, of which 1,200 km are on the Mediterranean Sea, extending from Saloum in the West, to Rafah in the East. Egypt's Red Sea coast, and the Gulfs of Suez and Aqaba stretch over 2,300 km (Second National Communication Report, 2010). About 15% of the total population of Egypt lives in the coastal zones.

  Egypt's coastal zones are characterized by their diverse resources and abundant development potentials in all aspects. These zones are a source of natural resources (biological and mineral), and a pivotal attraction point for many projects in the economic and social domains, as well as vital arteries for maritime transport and trade. Many important environmental resources and habitats are found in these zones, which are considered the main destination for recreation and tourism attractions. Accordingly, these zones can effectively contribute to the country's development if properly utilized on a sustainable basis.

  Some of the important coastal cities (or entire coastal governorates) are located on the country's Mediterranean and Red Sea coasts. Along the Mediterranean Sea coast are the governorates of Matrouh, Alexandria, Beheira, Kafr el-Sheikh, Dakahleyia, Damietta, Port Said, and North Sinai. The governorates of South Sinai, Suez and the Red Sea are located along the Red Sea coast.

  At varying degrees, the coastal zones are exposed to the environmental pressures resulting from irrational development and pollution from several land and marine-based sources, caused by industry, agriculture, and urban development. These zones are also exposed to coastal erosion, Nile Delta inundation, seawater intrusion, soil and underground water salinization, and similar environmental problems.

  Climate change is expected to be a source of pressure on the coastal zones of the Arab Republic of Egypt, particularly the impact of the rising sea level on low land, or the recurrence of severe storms and extreme events.

- **Definition of the coastal zone in the Arab Republic of Egypt:**

  According to Environmental Law no. 4 of 1994 and its 2009 amendments, Article 1, paragraph 39, the coastal zone is defined as: "The zone stretching over the coasts of the Arab Republic of Egypt, including territorial waters, the Exclusive Economic Zone, and the continental shelf. It also covers the inland area from the shoreline inwards including the area that affects and is affected by the maritime environment, and stretches for no more than 30 km inland, in the desert areas, unless such a distance is intercepted by topographic obstacles. In the Delta, it extends up to the level of +3 meters. Each coastal governorate determines its own coastal areas in light of its natural conditions and its environmental resources, for no less than 10 km inland from the shoreline." (The Official Gazette – ed. 9 bis. 1, March, 2009).

- **Following are the classification standards of Egyptian coasts according to their vulnerability to disasters and the potential harm resulting from rising sea level and extreme events:**

  1. The surface levels of the coastal zones (land topography), which depict high and low areas in relation to the current average sea level.
  2. Subsidence rate of coastal zones as a result of subsurface sediments compression, and/or the presence of land fissures and rifts, or both.
  3. Erosion rates (resulting from regression) and sedimentation (resulting from transgression). The latter – known as constructive coasts - are considered relatively safe and are not subject to the danger of water logging as long as the construction process continues. These coasts are often found between the projections and barriers of the Delta (Delta headlands) as the sedimentation rate exceeds that of coastal regression caused by the relative sea level rise.
  4. The relative sea level rise.
  5. The presence of natural coastal protection, whether engineered constructions, such as hard engineering structures (sea walls and barriers) or natural protection in the form of sand dunes, longitudinal limestone ridges, and coral reefs, whether submerged or emerged. All of the above function as natural barriers to sea intrusion, or the risks of its rising level.
  6. The permeability and porosity of rocks and subsurface sediments in terms of allowing seawater intrusion, leading to the salinization of the close hinterland.
  7. The presence of active torrential rain spillways or those which t may become active after sudden seasonal torrential rains, leading to the flooding and drowning of parts of the coastal plain. This is the case in the Red Sea and Arish Valley.

The Egyptian coasts can be divided into the following sections according to the above standards:

- **First: The Mediterranean coast:**

  1. **The North-West coast:**

     According to current assessments, most areas of the North-West coast, stretching from the west of Alexandria to Saloum, are considered as being safe from the impact of rising sea levels, thanks to their high altitude. It ranges between +2 and +3 meters above sea level, with the exception of low-lying areas, such as natural and artificial lakes and beaches. This is also due to the presence of continuous and parallel groups of ridges, rocky lime hills and sand dunes near the coast, with heights ranging from +5 and +10 meters above sea level. Emerged or submerged lime barriers function as natural barriers to sea water intrusion. The nature of these rocks protects the area

from seawater penetration, which leads to land salinization or the compression of sediments. The fact that no subsidence or erosion rates have been registered for these areas confirms this view. Local erosion results from construction activities in the coastal zone.

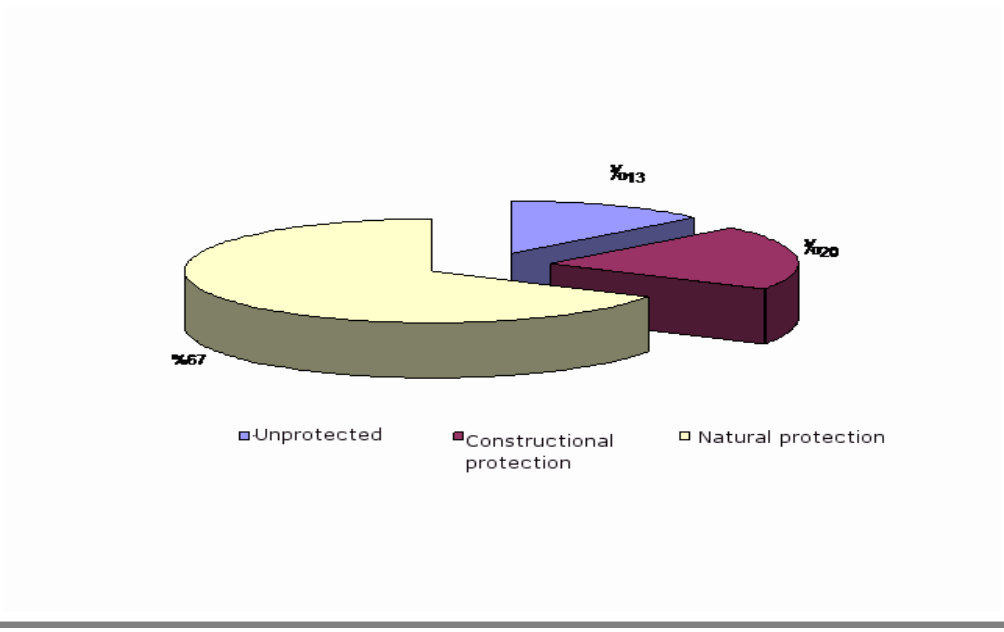
2. The coast of the city of Alexandria:

The coast of the city of Alexandria is characterized by its diverse topography. Surveys have shown that Alexandria's seafront – represented by the narrow coastal strip extending from Abu Qir to Agamy – lays on a hill or a raised barrier of limestone, ranging from +2.5 to +11 meters (on average +4 meters) above sea level. Although this barrier forms a natural shield against sea encroachment or the risks of sea level rise, there are areas at a lower altitude that may risk being submerged as a result of rising sea levels, or incidental events such as earthquakes, or high waves and extreme events accompanied by hurricanes or tsunamis (such as beaches, Lake Marriout, coastal areas, the south-eastern area neighboring the region of Al Tarh, which extends eastward towards the Delta until Kafr El Dawar, with a surface area close to 650 km^2, and bordered in the North by the wall of Mohammad Ali, which is considered the safety valve for this depression.).

According to current assessments, most of the coast of Alexandria is considered naturally safe from sea level rises, as the city is constructed on a high lime barrier. This barrier is naturally supported over a distance of 60 km, approximately 66% of the total length of the coast, with the exception of some low-lying areas. One should note that engineered protection measures are relatively few (8.2 km, about 20% of the total length of the coast). Vulnerable areas represent about 13% of the total length of the coast (Fig. 1).

Fig. 1

Protection status of the coast of Alexandria city



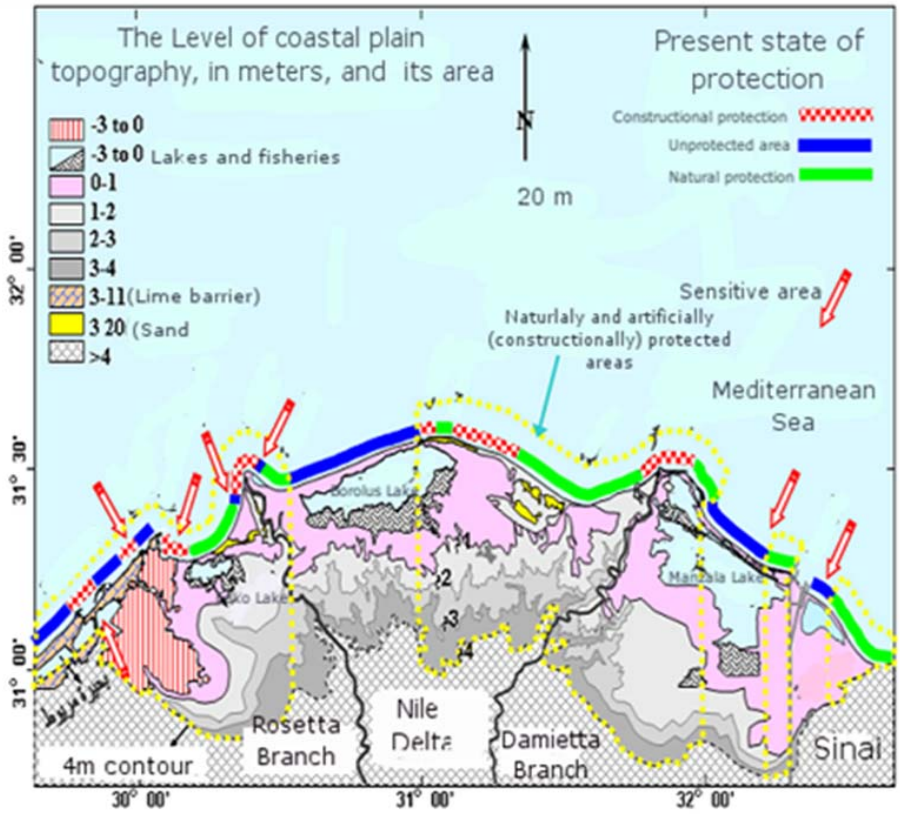
Source: Information and Decision Support Centre – Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

3. The Nile Delta coast:

The coastal area of the Nile Delta is one of the areas that are most prone to flooding as a result of expected sea level rise. This may be accompanied by soil subsidence at varying rates, depending on the conditions of each region, the topographical and geological characteristics, as well as the current protection means of each area. It is more preferable to divide this region into three different areas according to the previously stated criteria, rather than consider it as one geographical unit. Accordingly, the Delta coastal zone is divided into three sub zones depending on the degree of exposure and vulnerability to the risk of erosion and sea level rise (Fig. 2), as follows:

Fig. 2

Current natural protection of the coastal area of the Nile Delta and Alexandria (accretional beaches, sand dunes, and long limestone ridges); constructional (protective sea walls and barriers) protection areas for the Nile Delta and Alexandria coastal zone, as well as the more vulnerable areas requiring future measures of adaptation (areas indicated with the arrows).



Sources:

- Egyptian Authority for Coastal protection
- Information and Decision Support Center– Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

- **Sub-Zone one:** this includes areas that are subject to high risks. They are usually low-lying coasts or coasts that are vulnerable to subsidence or erosion at high rates. This is the case for the Manzala Lake shore, the Tarh area behind the wall of Mohammad Ali, the two areas east and west of the Rosetta City, the area between Gamasa and the port of Damietta, Al Gamiel, and the Al Tina Sahl on the Sinai coast. The Tarh area, south of

Alexandria's coastal strip and extending behind the wall of Mohammad Ali – (1,243m long) eastward between Abu Keer and the Edko outlet, till Kafr El Dawar south – is considered as one of the most vulnerable areas to the risk of inundation due to land levels falling to less than 3 meters below the current sea level. This area is, indeed, subject to inundation in the event of any natural disaster. Consequently, this would lead to the destruction – even if partially – of the wall of Mohammad Ali. The area located along the narrow sand barrier separating the Mediterranean Sea from Lake Manzala is also under threat. In this particular area, the land level is one meter above sea level only, and in addition to its potential exposure to subsidence due to the compression of its mud sediments and erosion beneath and erosion, which may in turn be caused by a sea level rise, or sea currents and waves. Studies have confirmed that the relative sea level east to this barrier, at the Port Said harbor, rises at the rate of +4 millimeters every year as a result of land subsidence and rising sea level.

- **Sub-Zone two:** the shores in this zone are relatively safe. They are not exposed to the risk of inundation, as the presence of sand dunes creates a natural defense line to the area located between Burullus, Baltiem, and West Gamasa. In addition, the majority of the accretional shores are subjected to sedimentation between the projections and headlands of the Delta at Gamasa, Abu Khashaba and the middle of Abu Qir Bay, as well as opposite the Port Said, coast where sedimentation rates towards the sea range from 3 to10 meters every year. These rates – assuming they remain stable and constant – offer natural protection to this sub-zone, being areas of sedimentation acting as a defense line.
- **Sub-Zone three:** This includes naturally and artificially protected shores. It is also comprised of shores that are protected by concrete or hard structures, for example the sea walls parallel to the shore in Baltiem, or the sea walls in Tarh, the headlands in Rosetta and Damietta, or the basaltic reinforcements at Borg Al Burullus. It should be noted that these artificial constructions and barriers contribute to the protection of about 17% of the Delta shores, where they rise about +2 - +6 meters above sea level, including the wall of Mohammad Ali.

  The current areas of the Delta coast and shores, with natural protection, (constructional shores, sand dunes, long limestone ridges) and those with artificial protection (sea protection barriers, coastal revetments), have been identified as the most vulnerable areas in need of adaptation methods for the future (Fig. 2). Also, the land level (coastal hinterland) was determined as being at a +3-meter line. Thus, the area and percentage of the main topographic units (with the aforementioned natural and artificial protection, the unprotected areas relative to the coastal area of the Nile Delta (from Alexandria to the Sahl El Tina), and south up to the + 3-meter line of the level line), is estimated to cover about 8,780 square kilometers (Table 1).

  Table 1 illustrate the surface area and percentage of the main topographic units with natural protection (constructional shores, sand dunes, long limestone ridges) and those with artificial protection (sea protection barriers, coastal revetments) estimated as a percentage of the total surface area of the coastal zone of the Nile Delta (from Alexandria to Sahl Al Tina) up to the + 3-meter line of the level line, estimated at 8,780 square kilometers.

Table 1
Surface area and percentage of naturally and artificially protected main topographic units

Level in meters (land and water areas)	Area (km^2)	Percentage of total coastal area (%)	Coast (naturally and artificially protected)		Unprotected coasts	
			Surface area of naturally and artificially protected area in (km^2)	Percentage of protected area in relation to total coastal area (%)	Surface of unprotected area (km^2)	Percentage of unprotected area in relation to total coastal area (%)
0 – 1 m	3806.92	32.42	2407.00	20.50	1399.92	11.92
1 – 3 m	4859.43	41.38	4013.52	34.18	845.91	7.20
Other levels (Nile River and water canals, drains, and small islands)	113.91	0.97	74.54	0.63	39.37	0.33

Source: Information and Decision Support Centre – Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

Table 2 and Fig. 3 show the length and percentage of naturally and artificially protected shores to the total length of the Delta shores, from Abu Qir up to Sahl El Tina, which is estimated at about 301.57 km.

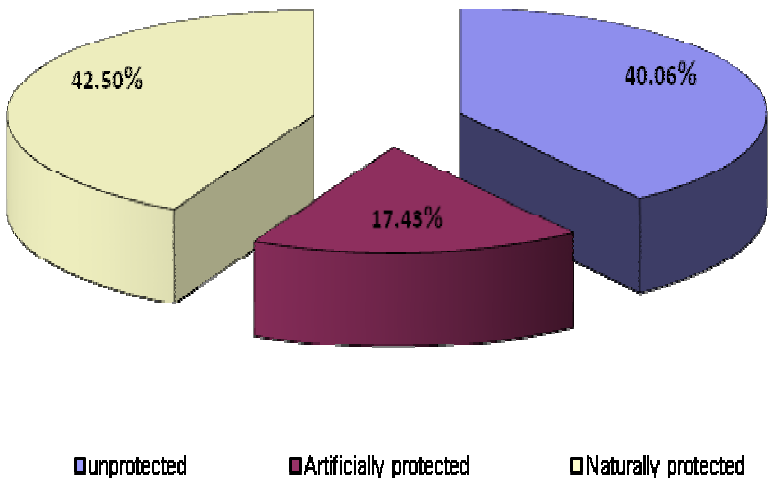
Table 2
Length and percentage of naturally and artificially Protected shores to the total length of delta shores

Length of delta coasts (km)	Length of naturally and artificially protected coasts				Length of unprotected coasts	
	Natural protection		Artificial protection			
	Km	(%)	Km	(%)	Km	(%)
301.57	128.3	42.54	52.61	17.45	120.66	40.01

Source: Information and Decision Support Centre **–** Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction**.**

Fig. 3

Percentage of naturally and artificially protected coasts and vulnerable Delta Coasts



Source: Information and Decision Support Centre – Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

4. Sinai coast

The northeastern coast of the Arab Republic of Egypt – which overlooks the Sinai Peninsula (North Sinai Governorate) and extends from Port Said to Rafah – is characterized by some natural features, which keep most of its parts far from the impact of a sea level change, as they are + 3 to +5 meters above sea level. In addition, the presence of scattered groupings of sand dunes along the coast and accretional shores along Sahl El Tina act as a natural defense line against sea encroachment or sea level rise with the exception of some areas that are below sea level, such as parts of the Sahl Al Tinah and Lake Bardawil. It should be mentioned that subsurface sediments found in this plain do not contain muddy soil or deposits, and are not compressible at all, as it is the case in the Delta lands. No subsidence rates have been recorded for these areas.

- **Second: The Red Sea Coast:**

The Red Sea coast is characterized by unique geological and compositional features. It is estimated at 0 to +20m above sea level, which prevents it from being inundated in case of a sea level rise. This makes the area safer, with the exception of the shores and areas where coral reefs were removed in order to construct artificial lakes in some tourist resorts. In addition, the coast does not subside, since the subsurface sediments that are made of rocky layers are incompressible. In spite of this, the local parts of the coastal plain – extending landwards from the shoreline to the back area mountains – are threatened by the risk torrential rains, which flow downwards through spillways which become occasionally active as a result of sudden seasonal rainfall.

Although sandy beaches in the Red Sea are limited in area, and are found in the winding coastal areas, they are of great environmental and tourism importance. Leveling at 0 to +3m above sea level, it is expected that the low shores with levels ranging between zero and + 1 meter will be inundated in case of a sea level rise as a result of climate change.

- **Resources and infrastructure of coastal areas in Egypt:** Table 3 shows the resources and infrastructure of the coastal areas in Egypt.

Table 3
Resources and infrastructure of coastal areas in Egypt

The Mediterranean Sea Coastal Area	The Red Sea Coastal Area
Industry and energy: • Many industries are concentrated in Alexandria. They include light, manufacturing, and heavy industries, as well as oil related industries. The cities of Port Said and Damietta have experienced an industrial boom. • Multiple energy resources: such as oil and natural gas.	**Industry and energy:** • Industry is concentrated in Suez. It is mostly oil related. Recently, strategic industries such as cement were established. • Energy resources: oil.
Transport and roads: • Several main commercial ports, such as Alexandria, Dekhaila, Damietta, Port Said, and Ariesh, as well as ports that serve the transport of oil and natural gas, such as Matrouh, Sidi Krair, and Damietta. Some ports have recently been constructed to serve touristic and recreational activities, such as Marina resort. • The international coastal road is considered the most important coastal corridor linking the western and eastern borders of the country. • There are airports in Alexandria, Borg Al Arab, Port Said, Matrouh, Sidi Abdel Rahman, Ariesh and Alamain. • There are airports in Alexandria, Borg El Arab, Matrouh, Sidi Abdel Rahman, Al Ariesh and Alalamein.	**Shipping and roads:** • The main commercial ports are Suez, Hurghada, and Safaga. Ports were constructed for serving touristic and recreational activities, such as yachting ports. • A coastal road links Suez in the north, with Halayeb in the south. • There are airports linking touristic destinations to countries across the world: Sharm Al Sheikh, Hurghada, and Marsa Alam.
Tourism: • The coast of the Mediterranean Sea is considered the traditional destination for domestic tourism. Alexandria being the most important location in terms of density (about 2 million visitors per year). • Recently, the northwest coast has seen extensive urban and touristic growth, as well as the coast of Matrouh. The shores of Ras Al Barr, Port Said and Ariesh are tourist destinations of medium density.	**Tourism:** • The coasts of the Red Sea and the Gulf of Aqaba (South Sinai in particular) are considered global tourist attractions because of their natural advantages, and the availability of infrastructure, making them a major economic resource. The coast of the Gulf of Suez is also a primary attraction for domestic tourism.
Agriculture: • Agricultural lands are mainly found in the coastal area of the Nile Delta. Outside this area, agriculture is seasonal, relying on rainfall and ground water.	**Agriculture:** • Agriculture is not a key resource as it is seasonal and depends on rainfall.
Natural habitats: • The Mediterranean Sea is endowed with some important natural habitats, e.g. algae, and breeding grounds for some species of fish and sea turtles.	**Natural habitats:** • The Red Sea is characterized by special important natural habitats, such as coral reefs and mangroves.

Source: Information and Decision Support Centre – Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

- **Fisheries:** In 2008, the total fish production in Egypt amounted to almost one million ton. Sea fisheries share amounted to approximately 14.5% and lakes about 12.7%. The total production of fish farms accounted for about 72.8% of the total production, as illustrated in Table 4.

Table 4
Total Fish production in Egypt in 2008

Zone	Production (in thousand tons)	Percentage as compared to total production
The Mediterranean Sea	**88.882**	**9.47%**
The Red Sea	**47.361**	**5.05%**
Total	**136.243**	**14.52%**
Total production of Northern lakes	**108.960**	**11.61%**
Total production Coastal lowlands	**5.522**	**0.59%**
Total production of Lakes connected to the Suez Canal	**4.887**	**0.52%**
Total production of lakes	**119.369**	**12.72%**
Total production of fish farms*	**683.015**	**72.76%**
Gross Total	**938.627**	**100%**

Source: General Authority for the Development of Fisheries, Fish Production Statistics Book, 2008.
* For the distribution of fish farming in the governorates in Egypt, see Table 6.

- **Population:** According to the Central Authority for Public Mobilization and Statistics (CAPMAS), the total population in Egypt reached 76.92 million in 2009. The populations of the coastal zones – as defined in Environmental Law no. 4 of 1994 and its 2009 amendments – totaled about 11.4 million, representing 14.8% of the total population. However, there is no accurate estimate for the populations vulnerable to the risks of climate change. Table 5 indicates the relative distribution indicators of the population in coastal zones according to the above mentioned law.

Table 5
Population distribution indicators in coastal areas

Population in coastal areas where the sea level is +3m or above	2009 Census at +3m sea level or above	2030 Estimates at +3m sea level or above*
1. The Mediterranean Sea		
Marsa Matrouh	321 Thousand People	475 Thousand People
Alexandria	4.315 Million People	6.465 Million People
Beheira	1.800 Million People	2.700 Million People
Kafr el-Sheikh	1.170 Million People	1.755 Million People
Dakahleyia	408 Thousand People	612 Thousand People
Damietta	720 Thousand People	1.080 Million People
Port Said	598 Thousand People	897 Thousand People
Ismailia	853 Thousand People	1.279 Million People
North Sinai	215 Thousand People	322 Thousand People
Total Population of the Mediterranean Sea	10.400 Million People	15.585 Million People
2. The Red Sea		
Suez	542 Thousand People	813 Thousand People
South Sinai	149 Thousand People	223.500 Thousand People
Red Sea	303 Thousand People	454.500 Thousand People
Total Population of the Red Sea	994 Thousand People	1.491 Million People
Grand Total	11.394 Million People	17.076 Million People

Source: General Authority for the Development of Fisheries, Fish Production Statistics Book, 2008
* Estimated figures based on an annual growth rate of 2%.

- **Environmental Pressures:**
  - **The Coastal zone of the Mediterranean Sea:**

    The coastal zone of the Mediterranean Sea is exposed to multiple environmental pressures. These are mostly due to human activities associated with urban, industrial and agricultural development, producing pollutants of land-based sources. The environmental problems related to coastal development, the alteration of the coastline and borders of the wetlands and watersheds, and the biological threats are all characteristic of this zone. Erosion is an additional problem, particularly in the Delta zone, where engineering and constructive works are constantly required as a means of protection. The coastal lakes suffer from environmental pressures as a result of land

piling, dredging, or border changing, and receiving large amounts of industrial waste and sewage.

- **The Coastal zone of the Red Sea:**

  The coastal zone of the Red Sea is exposed to various environmental pressures related to urban, touristic, or industrial development in the Gulf of Suez. The top priorities are the problems related to the alteration of the coastline and its associated activities such as dredging or land filling. The discharge of pollutants arising from activities in the oil industry is another problem. The destruction of natural habitats of the coral reefs as a result of inappropriate practices in the sport of diving or the construction of artificial lakes is considered one of the environmental pressures in this area, and an increased stress as compared to the absorptive capacity of the environment.

3.2 Sectors Affected by Climate Change:

3.2.1 Water Resources and Irrigation Sector:

The waters of the River Nile account for 96% of the water resources available in Egypt. The river flows from beyond the border, and accumulates behind the High Dam in various quantities from year to year. About 85% of the Nile River Nile water arrives from the Ethiopian Plateau and 15% percent from the Equatorial Lakes Plateau and Southern Sudan.

The total conventional water resources of freshwater that are currently available amount to 52 billion cubic meters per year. Egypt's share of the Nile River waters – according to the 1959 Agreement between Egypt and Sudan – is 55.5 billion cubic meters per year (about 95.7% of the total freshwater resources in Egypt). The remaining resources account for 4% of the total resources of freshwater in Egypt. The quantity of deep groundwater amounts to 1.1 billion cubic meters, rainfall and torrential waters water amounts to 1.3 billion cubic meters. Desalinated water amounts to 0.15 billion cubic meters per year. However, the total water requirement amounts to 72 billion cubic meters per year, divided on three main sectors: agriculture, drinking water, and industry. To bridge the shortfall between water resources and water needs – amounting to 14 billion cubic meters – agricultural, health and industrial sewage water are reused, along with groundwater, in a renewable shallow reservoir in the Valley and the Delta, and the deep reservoir in the Western and Eastern deserts and the Sinai Peninsula.

- **The most important constraints of the integrated water resource management in Egypt:**

  The integrated management of water resources is faced with several parameters associated with a range of variables that may negatively or positively affect water management. The most important parameters are as follows:

  1. **Population increase:**

     The massive population increase in Egypt has led to the reduction of the per capita share of fresh water as a result of these limited resources which hinders development plans and delays progress in all sectors.

  2. **Social and economic factors:**

     Social and economic factors significantly affect the pattern of water resources use. The lack of awareness of water users is one of the factors affecting the pattern of consumption. For example, most farmers have the tendency to make use of surface irrigation instead of up-to-date irrigation techniques. Hence, natural resources are constantly misused; malpractices of excessive water use and waste dumping in waterways are commonplace. The lack of water awareness also leads to the reluctance of users to participate in positive programs and policies (even at the lowest levels, which requires no particular expertise) that are intended to raise the efficiency of water resource management systems.

  3. **Fragmentation of agricultural tenure:**

     Despite the state's efforts to expand reclamation of new lands, the per capita share of agricultural land and cropland is constantly decreasing due to the rise of small plot owners and the fragmentation of agricultural tenure. In addition, the special water canals and passages between these small plots have had to be lengthened.

Consequently, this has created a burden on the management and distribution of water resources and increased waste in agricultural land.

4. **Free crop structure:**

   The rates of water demand by the agricultural sector were affected as a result of the implementation of the state's policy to liberalize the crop structure, with the exception of rice, which is a crop that demands high water consumption. Furthermore, farmers have refrained from planting important strategic crops, such as cotton and maize due to the low economic yield of these crops.

5. **Lack of financial resources**

   The size of investments required for irrigation and drainage development projects is great, and the burden of providing it rests on the government. Due to their low economic return, the investment environment is not yet conducive to attracting the private sector, local financiers and local financial organizations to implement irrigation and drainage sector development projects. A large percentage of the investments allocated to this sector are ensured through donors and lenders, which does not ensure financial sustainability necessary for the implementation of plans and projects in this important sector.

6. **Water pollution:**

   The increasing rate of sewage and untreated or partially treated industrial waste into water canals, as well as agricultural drainage laden with fertilizer and pesticide remains, have led to the deterioration of water quality. As a result, occasionally, the agricultural drainage water plants that provide irrigation water by mixing agricultural runaway water with fresh water can no longer function, as the water coming from agricultural drainage canals is unsuitable for mixing. This, in turn, threatens the expansion in the policy of reusing drainage water.

7. **Lack of harmonized legislations:**

   This is considered as one of the limitations hampering the application of the principles of integrated water resource management as a result of overlapping jurisdictions, weak penalties and fines related to water violations and slow litigation process. Moreover, centralized laws and decision making require the amendment of such laws in a manner that is suitable for the new variables in water resource management, and give more space to the private sector to participate in investments in this important service sector. At the same time, an institutional reform of the different state organs is necessary, in a way that is commensurate with the requirements of integrated water management.

3.2.2 Agricultural Sector:

The importance of the agricultural sector in Egypt stems from its ability to absorb 55% of the human labor force. It is the sector that consumes about 80% of total water resources, and accounts for about 14% of the Gross Domestic Product (GDP). Egyptian agriculture is particularly sensitive to climate change. The country is located in an arid and fragile environment that mainly relies on the water of the Nile River, and is vulnerable to the impact of expected climate change.

The impact on the quality, effectiveness and efficiency of agricultural inputs is the most important factor in the elaboration of the national strategy of adaptation to climate change and disaster risk reduction.

1. **Agricultural lands:**

The surface area of agricultural lands in the country amounts to 8.4 million feddans in 2007. 80% of this land is located in the Delta and the Nile Valley (old land), and 20% is located outside the valley, at the fringe of the valley and the Delta (new land).

The quality, productivity and efficiency of the agricultural land vary depending on several factors. The land is divided into four different grades (first, second, third and fourth grade). Salinity and groundwater level are the main factors in determining the efficiency of the soil. The area of arable land is expected to reach 11.5 million feddans in 2030.

2. **Plant production:**

Plant production in Egypt is characterized by its diversity as a result of multiple production seasons (winter, Nile season, summer), and diverse agricultural produce: field crops, vegetables, fruits, animal feed, oil crops, sugar crops, and other products. Although the area of land reached 8.4 million feddans in 2007, the cropping area reached 15.4 million feddans in the same year. It is expected that the cropping area will grow to 20 – 22 million feddans by 2030, as the present crops and agricultural varieties have high yield. These varieties have improved with the use of modern technology and the development of breeding programs.

3. **Water resources:**

The water resources available in Egypt are limited and fixed (see section 3.2.1: Water resources and irrigation sector). Data indicates that in 2007 the efficiency of water usage in agriculture has declined as a result of a 30% reduction in the efficiency of water transport, and a 50% reduction in field irrigation efficiency. This deterioration limits the country's potential for agricultural expansion on the short term. It also limits its ability to withstand the increase in evaporation rates resulting from the rise in temperature.

The agricultural development strategy aims at improving the efficiency of transporting irrigation water by 2030, to reach 80%. It is expected that the average share of irrigation water per feddan, per year, will drop from 6,900 to 5,565 cubic meters, and that large quantities of water will be provided and diverted to horizontal expansion projects.

4. **Livestock and Fish Production**

Livestock production in Egypt depends on buffalos, cows and sheep as the source of red meat, and poultry and fish as the source of white meat. The livestock production sector contributes about 42.9% of the total value of agricultural outlook (according to 2007 data). This demonstrates the importance of this sector in providing food security and other economic activities.

The agricultural development strategy (extending until 2030) aims to increase dairy production to 9.5 million tons, red meat to 1 million tons, poultry to 1.4 million tons, and fish to 1.4 million tons per year. This requires – among other activities – the protection of such resources from farm and common diseases.

Fish production amounts to 938.627 thousand tons per year (in 2008). Fish farming represents 72.76% of total fish production in Egypt. Table 6 shows the

distribution of fish cultivation in the different governorates of Egypt in 2008 (see Table 4 for the sources of fish production).

Table 6
Distribution of fish farming in different Egyptian Governorates in 2008

Zone	Total fish farming per zone, in tons, per year	Percentage to total
Middle Delta	**372.897 Thousand Tons**	**54.6%**
Sharqia	**129.879 Thousand Tons**	**19.01%**
Damietta	**104.495 Thousand Tons**	**15.29%**
Gharbeya	**67.076 Thousand Tons**	**9.82%**
Nile Valley	**8.476 Thousand Tons**	**1.25%**
Red Sea	**181 Tons**	**0.027%**
Aswan	**11 Tons**	**0.003%**
Total	**683.015 Thousand Tons**	**100%**

Source: General Authority for the Development of Fisheries, Fish Production Statistics Book, 2008.

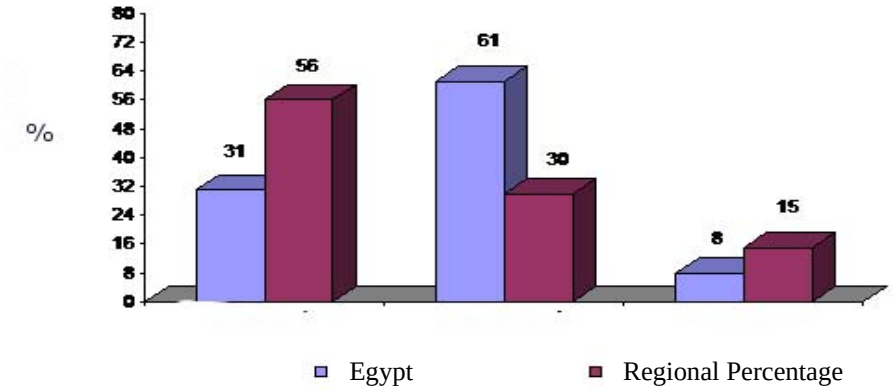
3.2.3 Health and Population Sector:

Egypt has achieved tangible success in improving the general health conditions of its citizens. Extensive investments have been allocated for building hospitals, increasing the number of hospital beds for citizens and the number of doctors and health professionals providing healthcare. A large part of the population was treated at the expense of the state. The health indicators of 2008 also show an improvement in many aspects of public health in Egypt, where the average life expectancy for males had reached 68 years, while that for females was 71 years. In 2008, child mortality rates decreased, reaching 28 per 1000 for those below the age of five, and 25 per 1000 for infants in their first year of life.

However, the health situation in Egypt is suffering from the double burden of infectious and chronic diseases. Figure 4 shows the average percentage of distribution of years of life lost due to infectious and non-infectious diseases and injuries in Egypt as compared to the regional situation.

Fig. 4

Distribution of the average percentage of years of life lost due to infectious and non-infectious diseases, and injuries in Egypt, compared with the regional situation in 2004



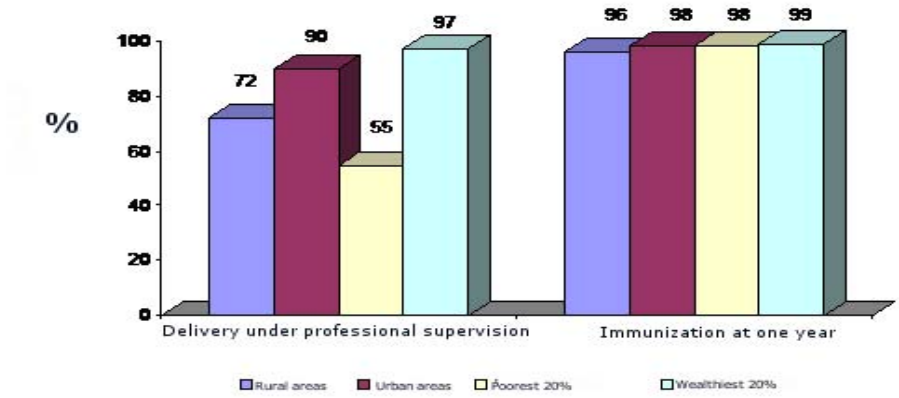
Source: World Health Organization, 2010.

Figure 5 shows the variation in benefiting from health services, while Figure 6 demonstrates the discrepancy in access to some health services, hence the health status, as reflected in child mortality rates between rural and urban areas, and between high and low economic classes. The diagram also shows the equality of access to other health services, such as vaccinations for children.

In addition, new challenges have appeared and are threatening the community (such as viral Hepatitis, and different epidemics of various influenza viruses). Other threats are present in the surrounding regional communities (such as HIV/AIDS), as well as the conditions related to varying socio-economic pressures on citizens (such as increased mortality rate due to cardiovascular diseases). All of the above leads to a greater need for treatment, especially new treatment methods and surgical procedures. This may also bring about a change in the society's attitude and behavior towards unhealthy habits.

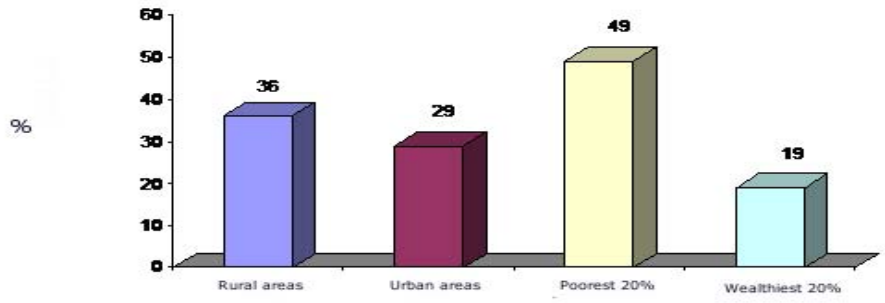
It is important to highlight that in the past decades, healthcare programs have succeeded in immunizing children, eradicating polio, and reducing the prevalence rate of Bilharziasis and other diarrheal diseases to a great extent. They have also succeeded in extending the network of primary care health services – currently 5,000 outlets – to cover the entire country.

Fig. 5
Benefiting from health services



Source: World Health Organization, 2010.

Fig. 6
Children Under Five Mortality Rate



Source: World Health Organization, 2010.

However, various challenges are still present in the field of healthcare, especially in relation to family planning programs and the provision of primary healthcare to citizens and their families. A significant amount of work is still required in order to attain equity and quality in the provision of care, and to bridge the gap between the geographical areas where a large section of the population does not yet receive sufficient services. Egypt currently spends 4.75% of its GDP on health, with a per capita share of health expenditure amounting to 566 Egyptian Pounds per year, as indicated in Table 7. Figure 7 shows that the percentage of citizens covered by health insurance in Egypt amounts to 57%.

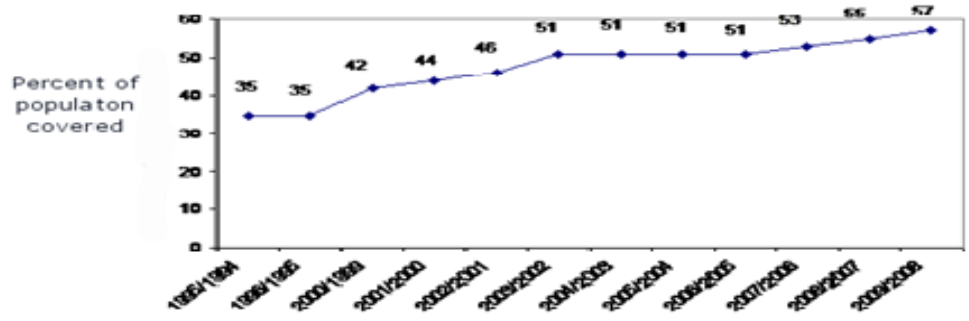
Table 7
Health expenditure in Egypt (1994 – 2008)

Item	1994/1995	2001/2002	2007/2008
Average National Income (in EGP billions)	**215.6**	**393.1**	**949.2**
Total health expenditure (in EGP billions)	**7.516**	**23.081**	**42.539**
Per capita share of total health expenditure (EGP)	**127**	**346**	**566**
Percentage of GDP spent on health	**3.7%**	**6%**	**4.75**
Percentage of out of pocket expenditure as compared to total health expenditure (%)	**51%**	**62%**	**60%**

Source: National Health Accounts, 2007 – 2008, the Ministry of Health.

Fig. 7

The development of health insurance coverage through the period of 1994-2009.



Source: National Health Accounts, 2007 – 2008, the Ministry of Health.

The population problem poses another challenge for Egypt. According to 2009 data, the country's population has reached 77 million, in addition to 4 million Egyptians living abroad. 55% of the total population lives in the rural areas. The 2009 population census indicates that the birth rate has reached 28.9 per 1000, and the mortality rate is 6.2 per 1000 of the total population. The rate of natural population increase has reached 22.7 per 1000 inhabitants. The total fertility rate has reached 2.9 children per female in 2009. The age group of less than 15 years of age accounts for 31.7% of the population.

Population growth in Egypt has reached its highest level, where it increases by 2.217 million individuals every year. The population number has come to double every 30 years, instead of every 50, as was the case through most of the past two centuries. It is expected that Egypt's population will reach 92 million by 2020, and 119 million by 2030.

The health impact that is expected to come about as a consequence to climate change will therefore increase due to the vulnerability of the social, economic and environmental characteristics of the Egyptian population. Health effects resulting from climate change are expected to affect children, the elderly, the poor, and people inhabiting rural areas the most.

The World Health Organization has classified world countries into groups according to mortality as a consequence of climate change. Egypt was ranked in the third worst group among four. The expected number of deaths as a result of climate change is between 40 – 80 deaths per million inhabitants.

3.2.4. Urban Areas, Housing and Roads Sector:

In terms of population, the Arab Republic of Egypt occupies the 16th rank internationally, the 3rd in Africa, and the 1st in the Arab World. It holds the 124th position internationally in terms of population density. Most of the population is concentrated in the Nile Valley and Delta, particularly in the Greater Cairo regions (excluding Qalyubiya) and the city of Alexandria, both housing about one quarter of the population. The majority of the remaining population lives in the Delta region and along the coast of the Mediterranean and Red Seas, and the Suez Canal cities. The total population in Upper and Lower Egypt does not exceed the number of inhabitants in Greater Cairo and Alexandria by much. Meanwhile, the number of inhabitants in the desert governorates – which cover over 90% of the country's[1] total surface area - does not exceed 2.5% of the total population. Table 8 shows the population distribution in the country's governorates. Table 9 also depicts the population distribution in the country's region and areas.

According to the last census conducted in 2009, the number of urban inhabitants accounts for 45% of the total population, while rural inhabitants make 55% of the population. The census also demonstrated that males made up 51% of the total population, while females represent 49%. Families averaged 4.2 individuals. The number of individuals holding a university degree accounted for 10% of the total population, while 29% could read and write but held no qualifications. Over 34% of the population is illiterate.

In 2009, the labor force totaled 25 million, 77.6% of whom were males, and 22.4% females. Those working in rural areas comprised 57.3% of the labor force, while those

[1] The total surface area of the Arab Republic of Egypt is 1,011,863 million km^2 (about 240.9 million acres).

working in urban areas, represented 42.7%. According to data from 2008, 13.9 million people were permanently employed, 1.6 million were temporarily employed, and 821,000 were seasonally employed. The number of those who worked intermittently was 3.6 million[1].

Table 8
Population distribution in the governorates of the Arab Republic of Egypt

No	Governorate	Population (in million)	No	Governorate	Population (in million)
1	Cairo	8.9	15	Menofya	3.5
2	Giza	6	16	Sahrkeya	5.7
3	Alexandria	4.3	17	Gharbeyia	4.2
4	Suez	0.5	18	Kafr El Sheikh	2.8
5	Ismailia	1.0	19	El Behera	5.0
6	Port Said	0.6	20	Damietta	1.2
7	Fayoum	2.7	21	Dakahleyia	5.3
8	Bani Swaif	2.4	22	New Valley	0.2
9	Menia	4.4	23	Red Sea	0.3
10	Assiut	3.7	24	North Sinai	0.4
11	Souhag	4.0	25	South Sinai	0.2
12	Qena	3.2	26	Matrouh	0.3
13	Aswan	1.2	27	Luxor	0.5
14	Qalyubiya	4.5			
Total					77

Source: The Central Authority of Mobilization and Statistics, 2009.

[1] http://www.sis.gov.eg/ar/LastPage.aspx?Category_ID=19.

Table 9
Population distribution per regions and zones of Egypt, in addition to Egyptians working abroad

Item	Number of population (in million)
Delta region	**32.2 Million People**
Greater Cairo and Alexandria region	**19.2 Million People**
Southern Upper Egypt region	**12.6 Million People**
Northern Upper Egypt region	**9.5 Million People**
Suez Canal region	**2.1 Million People**
Desert Governorates	**1.4 Million People**
Total within the country	**77 Million People**
Workers abroad	**4.1 Million People**
Grand Total	**81.1 Million People**

Source: The above data have been calculated on the basis of data contained in previous table (Table 8).

- **The strategic plan for comprehensive development in the Arab Republic of Egypt until 2050:**

  The Supreme Council for Urban Planning and Development (under the Council of Ministers) formulated a strategy for comprehensive development in the Arab Republic of Egypt until 2050 which indicated that the country's population would range between 140 and 155 million by 2050.

  The report indicated that the population distribution is not proportionate to the surface area of the inhabited regions. It outlined the country's need for an additional 40 thousand feddans every year in order to accommodate for the population increase. The report highlighted the example of the Greater Cairo province. Home to 20% of the population, its surface area is no more than 2% of that of the total country. The plan also stated that the land that is available for reclamation until 2017 is 3.27 million feddans in size, and is distributed as follows (Table 10):

Table 10
Distribution of land available for reclamation until 2017

Region	Total Area
Sinai region	**470 Thousand Feddans**
Western Delta region	**368.2 Thousand Feddans**
Center Delta regions	**61.5 Thousand Feddans**
North Coast and Western Delta region	**334.5 Thousand Feddans**
Western Delta irrigation improvement project	**285 Thousand Feddans**
Center Egypt region	**79.2 Thousand Feddans**
Upper Egypt region	**563.8 Thousand Feddans**
Tushka Southern Valley Development Project	**600 Thousand Feddans**
Scattered areas relying on ground water	**506.8 Thousand Feddans**
Total	**3.27 Million Feddans**

Source: Ministry of Water Resources and Irrigation – horizontal expansion projects until 2017, December 2011.

- **The climate change impact on the population of the Arab Republic of Egypt:**

  The 2007 -2008 World Human Development Report, issued by the United Nations Development Program, warned against the possibility that the millions of citizens inhabiting the northern part of the Delta may have to be displaced due to the floods caused by high sea waves, or seawater intrusion as a result of sea level rise.

  The report also indicated the possibility of change in rainfall rates, wind speed and direction, and an increased incidence of severe heat waves. This would lead to a higher vulnerability of slums and rural areas (as well as some urban areas) as they would be subject to floods; in particular, populated areas and constructions laid in old rain spillways which have so far seen no damage worth mentioning, due to the low rates of rainfall over the past few decades.

  - **Current situation of housing in the Arab Republic of Egypt:**

    Housing conditions are enormously varied within the country, between governorate capitals and the major cities. Prevailing modern architecture is governed by rules based on sound scientific foundation. Construction permits are issued by the competent government organs only on the basis of architectural lines and designs ensuring building safety in line with the most up-to-date international codes of construction, including protection codes against earthquakes, tremors, and wind.

    At the same time, the major cities are surrounded by slum areas whose layout defies the above-mentioned criteria and regulations. These areas are supervised and constructed by simple architectural firms that do not meet the required standards. Buildings may be constructed using materials that are not compliant

with either local or international specifications. Rural areas are divided into two parts:

I- Old buildings constructed prior to the issuance of relevant construction legislations and regulations. The majority of these buildings can be classified today as liable to collapse.

II- Buildings erected with government licenses, though in most cases construction was not supervised by any government agency. The entire process was left for landlords to handle, in accordance with their wishes and resources.

This combination of different types of housing is a proof that many fragile and old buildings are under real threat and may pose a significant hazard if the climate conditions are unstable in other words; the surrounding environment therefore remains untouched. It is clear that any unexpected climate imbalance can potentially lead to disasters that would result in many victims losing their entire families, in addition to the collapse of neighbouring houses that collectively act as a single unit. If any part collapses, this would result in the entire structure crumbling down.

Given the economic hardships experienced by most the populations living in slums and poor buildings in the villages, and due to the lack of more appropriate housing, they prefer to remain in such dwellings, despite the danger that they are exposed to.

The state cannot provide alternative housing for all those who evacuate their homes due to their potential collapse. Hence, the problem remains, and it attracts attention whenever a disaster befalls and claims victims. A group of people regarded as having been the cause of such misfortunes are then tried, but silence falls once more. No lessons are learned from these accidents and disasters so as to avoid the repetition of such mistakes and shortcomings.

Hence, the only solution is to create an inventory of buildings that are identified as structurally weak, evacuate their residents and provide them with temporary housing until their homes are strengthened or completely demolished and rebuilt, before they are allowed to return. However, this logical solution requires significant financial investments and a political will that aspires to ensure such investments. The required funding does not, necessarily, have to be made available all at once; the process can start with a small amount (subject to what is available) provided it keeps flowing until all the identified buildings have been tended.

- **Current situation of roads in the Arab Republic of Egypt**

The roads in the Arab Republic of Egypt are divided into two main categories:

I- Roads within urban areas, which include about 312 localities, cities, and districts in 27 governorates, around 3391 large villages, and over 25,515 small villages, hamlets and estates[1]. They all started as small communities, but have excessively grown and increased in population to over 50,000 in large villages, whereas the population in small villages, hamlets, or estates may reach over 5000.

[1] **Source:** The Information and Decision Support Center – Describing governorates according to data, 2010.

The inner roads extend for long distances. There is no accurate account of their full length across the country. As an example, those interconnecting the Greater Cairo districts make for over 1,319 km.

II- Open roads interconnecting urban areas; they can be divided into the following categories:

A- Agricultural roads connecting towns and villages that lie within or near the agricultural areas.

B- Desert roads between cities and villages located in the desert hinterland of the Nile Valley and Delta. They also connect cities and villages located in the eastern and western parts of the desert and the Sinai Peninsula.

C- Coastal roads stretching along the coast of the Mediterranean, and Red Seas, and the Gulfs of Suez and Aqaba with a total length of 3,500 km.

Moreover, the railroad system is of a total length of approximately 9,525 km[1]; and the underground network is currently is length of 65.5 km in length[2].

River and maritime transport (waterways) is used in transporting passengers and goods. The waterways extend along the main course of the River Nile, its branches, large tributaries and canals, and some inland and coastal lakes. The Suez Canal partly contributes to the national income through the dues levied on supertankers transiting between the Mediterranean and the Red seas.

3.2.5 Tourism Sector:

Over the past years, Egypt has achieved a notable boom in the tourism industry. The number of tourist nights has increased from around 111 million nights in 2007, to about 147.4 million nights in 2010. This was accompanied by significant touristic investments in coastal areas along the Red Sea and the north coast. This requires that the stakeholders in this sector examine the tourism industry's capability of adaptation to climate change and risk reduction. Following is a detailed analysis of the current situation of the tourism sector.

1. Tourism Demand:

Inbound Tourism:

- The number of incoming tourists to Egypt in 2010 was 14.7 million, compared with 12.5 million in 2009; a 17.63% increase. Tourist nights increased by 16.5%, amounting to 147.4 million nights in 2010, compared with 126.5 million nights in 2009.
- The number of tourists from ten countries accounted for 65% of the total number of incoming tourists in 2010. These countries are: Russia (2.9 million tourists), the United Kingdom (1.5 million tourists), Germany (1.3 million tourists), Italy (1.1 million tourists), France and Poland (0.6 million tourists each), Libya (0.5 million tourists), the Ukraine, Saudi Arabia and the United States (0.4 million tourists each).
- The global economic crisis started to have a limited impact on inbound tourism in the first half of 2009. December 2008 showed a 4.5% decline, but it later increased.

[1] The Information and Decision Support Center - governorates' describing by information, 2010.
[2] The National Authority for Tunnels: www.nat.org.eg/arb/engazat.htm

Revenue:

- Egyptian tourism revenues in 2008 amounted to US$10.9 billion, compared with US$9.5 billion in 2007; a 14.7% increase. Egyptian tourism contributed about 19.3% of the country's foreign exchange proceeds. It accounted for 11.3% of the GDP, directly and indirectly, and represented 40% of total services export.

Analysis of Tourism Demand:

- European tourism represented 74.3% of the total inbound tourism to Egypt in 2010, about 70% of tourist nights then. The average stay in 2010 was about 8.9 nights per tourist. This is below the general average of 9.2 nights per tourist. The European market is dominated by tourist groups seeking moderate prices but the seasons are distributed across the year due to multiple holidays.
- Tourists from Arab countries accounted for 14.2% of the total inbound tourism, about 19.8% of tourist nights. The average stay in 2010 was about 12.4 nights per tourist, exceeding the general average of 9.2 nights per tourist. This is a market that promises growth, although it is affected by seasonal demand, and is associated with short holiday seasons.
- North and South America and Oceania[1] represent new markets that are characterized by long stays due to the long travel time, although the traffic volume is limited.

Domestic Tourism:

There are no statistics on local tourist movement as it is not limited to hotel residents only. Most of these tourists own touristic housing units on the north coast, Hurghada, Sharm El Sheikh, Ras Sidr, and El Ein El Sokhna, making it extremely difficult to determine the number of tourist nights per visitor. However, estimates (based on intuition and guesswork rather than statistical data) indicate that the number of local tourist nights reached about 80 million nights per year in 2008, and that most of these nights were spent at tourist resorts in the above mentioned locations.

2. **Hotel Capacity:**

- By the end of 2008, Egypt's hotel capacity was about 211,000 rooms. An additional 158,000 rooms are under construction.
- Hotel capacity reached 201,642 rooms at the end of 2007, with the following distribution: about 68.3% at the Red Sea and South Sinai, 15.3% in Greater Cairo and Alexandria, and 16.4% in the rest of the country (e.g., Luxor, Aswan, the north coast, Suez Canal cities, North Sinai, the oases, the Delta, northern and middle Upper Egypt, etc).

[1] The continent of Oceania - known as the continent of Australia - is the smallest continent of the world, a group of islands totaling 25 thousand islands which is divided into three groups: Milamesia, Polynesia, Micronesia, and Australia is New Zealand is the largest and most countries of this continent.

3. **Elements of Tourist Accommodation:**

   - Accommodation is estimated that 2 million units of tourist housing in all coastal tourist areas[1].

4. **Elements of Access and Mobility**

   - There are 15 international and 8 domestic airports in the Arab Republic of Egypt. This is in addition to many seaports and border inlets.

5. **Tourism Investments:**

   - Investments in the tourism sector, in the period 1998 – 2008, amounted to about 40 billion Egyptian Pounds[2]. This increased hotel capacity from approximately 60,000 to around 211,000 rooms in the same period, in addition to an increase in the number of tourist transport coaches and service units.

6. **Average Annual Hotel Occupancy Rates:**

   - The average annual hotel occupancy during the past ten years varied between 43% in the dire years (such as the 1993 terrorist attacks), and 80 – 90% during high demand, e.g. 2008 and 2010. However, the significance of hotel occupancy is complemented by the average price for hotel and touristic services, which is calculated according to assessments made by the Central Bank of Egypt, and not as a result of a physical inventory.

     The Most Important Developmental Issues and Challenges in the Field of Tourism Development: Five main developmental issues that represent the challenges faced by Egypt's Strategy for the Development of Tourism until 2050 have been identified. They are as follows:

     - Increasing demand for products of Egyptian tourism through:
       - ❖ Expansion in the development of current international and local tourist markets, and opening new markets.
       - ❖ Increasing tourists' length of stay.
       - ❖ Developing, diversifying and integrating Egyptian tourism products.
     - Facilitating access to tourist destinations through:
       - ❖ Developing new means of tourist transport.
       - ❖ Developing the tourist circuits.
       - ❖ Increasing the current transport and transportation capacity serving international and domestic tourism.
       - ❖ Diversifying services and means of transport, connecting tourist destinations and areas in order to achieve what is known as an Integrated Tourism System (ITS).
     - Achieving communication in tourism development through:

[1] Source: Calculation estimates by Information and Decision Support Center – Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

[2] Source: Calculation estimates by Information and Decision Support Center – Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

- ❖ Taking the necessary measures and setting up the required mechanisms to prevent all forms of environmental pollution in tourist areas.
- ❖ Developing an environmental management system for tourist areas.

- Developing integrated and compatible tourist destinations within tourist regions through:
  - ❖ Coordination between the various competing usages of land in tourist regions.
  - ❖ Creating functional integration between tourist destinations within the same region, as well as with tourist destinations in neighboring regions.
  - ❖ Establishing functional and dynamic ties between the different tourism activities in tourist destinations and all types of moving tourism, e.g., yachting tourism, floating Nile hotels, safaris, train tourism, etc.)
- Upgrading the quality of tourist services through:
  - ❖ Human resources Development and training for those working in the tourist sector and its auxiliary activities.
  - ❖ Developing the tourist sector's administrative systems and structures.

Chapter IV

Risks, Disasters, and Crises caused by Climate Change

In general, the impact of risks, disasters, and crises resulting from climate change on the sectors and areas covered by the strategy is negative. It is important to highlight that these impacts will occur if no special adaptation measures are taken to reduce climate change risks, disasters and crises. Naturally, there will be a positive outcome if the necessary preventive measures are carried out.

4.1 The Coastal Zone:

- **Risks, disasters, and crises caused by climate change, sea level rise and extreme events:**
  Climate change and sea level rise are associated with direct impacts, which include the erosion and inundation of sandy beaches, and thus, the gradual regression of shorelines. Another impact is the possible recurrence of storms and hurricanes, which would have a negative impact on multiple sectors of the coastal zone. This is depicted in detail as follows:

4.1.1 The Coastal Zone of the Mediterranean Sea:

The gradual sea level rise may possibly lead to increased erosion rates of the low lying coastal zone (0 – 1m above sea level), particularly in the endangered zones. This may cause beach erosion at the narrow and low-level sand barrier - which separates the sea from the northern lakes – which will result in the gradual merging of those lakes with the sea, as is foreseen for Lake Manzala. In such cases, the environmental aspects of marine life and the natural and chemical characteristics of the lake will alter. If the shoreline recedes inwards towards agricultural land, this may increase the salinity of the groundwater, thus leading to the salinization of the agricultural land in the area. It is also probable that seawater will surround some locations by inundating low-lying areas, unless the engineered protection constructions are strengthened. These constructions function efficiently with the current sea level. Special measures should also be taken in order to anticipate the predicted climate change, given the multiple negative effects of the increasing frequency and severity of storms, hurricanes and tsunamis.

4.1.2 The Coastal Zone of the Red Sea

The coastal zone of the Red Sea is likely to be affected by climate change and the sea level rise, in particular in the low-lying areas, wetland, and beaches. Coral reef may be affected by the sea level rise, especially if the rising rate is higher than that of coral growth. The rate of coral bleaching may also increase as a result of environmental pressures. However, the rock formation of the coast - which characterizes the Red Sea, and which is slightly above sea level, 2 - 5m – is considered a natural barrier against rising sea levels in these areas. It is worth noting that frequent hurricanes and tsunamis are expected, which may cause many negative impacts.

4.1.3 Beaches

Beaches are defined as the coastal areas covered with sand and are considered as the frontline of coastal areas due to their direct contact with the sea. They are among the most important natural environments, not only as the first defence line against the aggressions of the sea, but also due their importance from the environmental, aesthetic,

and tourism standpoints. However, beaches are increasingly vulnerable to flooding and the gradual loss of their sand (by erosion); particularly if the sea level rises above the standard rate, and when impacted by the power of waves and sea currents accompanied by strong winds and storms. It is therefore expected that, according to the scenarios adopted in this strategy, all low-lying beaches with levels ranging between 0 and 1m, will be inundated. The beaches of the Mediterranean and Red Seas that are characterized by levels higher than the expected sea level will remain safe, according to the topographic characteristics of each individual area.

4.1.4 Condition of the Sea and Extreme Natural events

In general, it has been noted that the height and strength of sea and ocean waves has increased over the past decades. Climate change may double the strength of storms and hurricanes and alter their courses, hence increasing their destructive force in coastal areas. At the local level, no study has confirmed any notable imbalance of the prevailing natural events, including temperatures, winds, waves, hurricanes, and winter storms. However, many projections indicate the possibility of increased frequency and intensity of storms, hurricanes and extreme events in the future.

4.1.5 Social and Economic Structure of Coastal Zones:

There will be an evident negative impact on the social and economic aspects of the coastal zones. It is possible that the severity of this impact may decrease depending on the measures that will be taken to reduce the negative impact of climate change, and the expected rate of sea level rise. These measures may be implemented as precautionary measures, or as a rehabilitation process of some areas. Under unusual circumstances, these may be implemented to transfer some activities to areas that are less vulnerable to the negative impact of climate change and sea level rise.

- **Land:**

  If no appropriate and effective measures are taken to protect the coastal zone, lowlands will be vulnerable, at varying degrees, to inundation according to the specific nature of these areas.

- **Water resources:**

  The phenomenon of climate change is one of the most dangerous impacts on water resources, particularly the flow of the River Nile, as well as the expected decline in rainfall on coastal zones and the associated reduction in the recharging rates of coastal aquifers. Furthermore, water quality may deteriorate due to seawater intrusion.

- **Agriculture:**

  Climate change will lead to a drop in the yield of some crops and to a change of agricultural areas. It will also lead to the spread of fungal plant diseases, and will have a negative impact on the Delta's agricultural land, particularly the northern areas bordering the Mediterranean coast.

- **Fisheries:**

  The negative impact of climate change on fisheries is yet to be confirmed, due to the ability of marine organisms to gradually adapt to the rise in temperature, salinity, or strong waves and currents by changing their habitat or migration path. However, it is certain that the sea level rise may affect the breeding grounds of fish and marine

organisms, particularly in wetlands, and destabilize the food chain of marine organisms.

There is a chance that the water of the northern lakes may change, due to the rise in temperature and intrusion of the sea as a result of its level rise. This may cause the destruction and transgression of the narrow sand barrier separating the sea from these lakes, which will then lead to its gradual sinking. This may causes a change in the biodiversity of marine life and in fisheries located south of the lakes. Salinity will increase, and will gradually reach that of the open sea.

- **Ports:**

  The design of piers, barriers and port facilities takes into account the rise of high waves, storms, and hurricanes, ensuring their safety from sea level rise. However, these installations need to be reinforced in order for the ports to function efficiently in the future; particularly if the frequency and intensity of hurricanes and storms increases.

- **Health:**

  The severity of health hazards and consequences due to climate change will increase as a result of the vulnerability of Egypt's population characteristics. It is expected that this will have a stronger impact on children, the elderly, the poor, and farmers in the coastal zones.

- **Tourism:**

  Climate change may impact the tourism attraction of some of the coastal destinations of the Red Sea and South Sinai. Local tourist destinations on the Mediterranean will also be in a critical situation due to the erosion and inundation of sandy beaches.

4.1.6 Competition between Different Sectors

Coastal areas are generally attractive for various urban, tourism and industrial activities since they embrace maritime, land, and aerial communication centres related to their geographic location. In addition, many resources, such as oil, natural gas, beaches, attractive scenery, and distinguished marine habitats are present.

This has led to many bodies, authorities and individuals competing over the exploitation of coastal zones, despite the limited area. An obvious example is that the visitors of Egypt's coastal zones are not only the traditional users associated with housing, tourist, industrial and agricultural development activities. There are also activities related to maritime transport, land, energy generation, mineral wealth (oil, natural gas, and black sand), fisheries, military purposes, and public and private authorities.

This situation, apart from the problem of climate change and sea level rise, has resulted in the formation of the National Committee for the Integrated Management of Coastal Zones, under the umbrella of the Egyptian Environmental Affairs Agency (EEAA). All the ministries, authorities, bodies, and individuals relevant to coastal zones are represented in this committee in order to determine an effective mechanism to put an end to competition, and to develop the best way of exploiting coastal zones in an integrated - not a competitive - manner.

In light of the anticipated negative impacts of climate change and the sea level rise on the coastal zones, it is necessary to enhance the established institutional entity or to create a mechanism to maximize the use of coastal resources, and to reduce conflicting and overlapping prerogatives.

4.2 Affected sectors:

4.2.1 Water Resources and Irrigation Sector:

- **Vulnerability of water resources to climate change:**

  The success of the adaptation process by the water resources sector to climate change, and the ability to meet the needs of water supply for all sectors using water require knowledge of the vulnerability of water sources and resources to climate change. Therefore, we shall review in the following section, the vulnerability of the Nile sources and water resources to climate change, which can also be affected by the change in the rate and belt of rainfall and the change in evaporation rates resulting from the increase in temperature. This section also includes the impact of climate change on the water resources operating system and the rules that are currently in force for the operation of the High Dam.

A- Vulnerability of the Nile Sources and Fresh Water Resources to the Risk of Climate Change:

- **The River Nile basin:**

  A simplified analytical model of Lake Victoria (River Nile source) was developed in 2001 to demonstrate the slow response of the lake to change over an extended number of years. It was found that with the assumption that a 1% change in the lake's supply elements (less evaporation than rainfall, in addition to a flow from peripheral tributaries), there was a 7-10% change in the balance of flow by the end of the study (1 – 2 decades), indicating the extreme vulnerability of the water sources in Lake Victoria to climate change. It was suggested that a mere 1% increase in rainfall was sufficient to induce a 4-7% increase intake in all the basins of the River Nile, and a 7-11% increase in the swampy area of the dam.
  A study prepared by The Nile Forecasting Centre in 2002 on the vulnerability of Lake Victoria to regular change in the rate of rainfall – using a hydrological distribution model - showed that a 10% increase in the rate of rainfall would lead to a 5.7% increase in the lake's intake. On the other hand, a 10% increase in rainfall on the upper peripheral basins of the Blue Nile and Atbara Rivers would lead to a 34% and 32% increase, respectively, in those rivers, indicating that these peripheral basins are more sensitive to climate change than the Lake Victoria basin is. The study also showed that a 10% decrease in rainfall would reduce outflow to the Atbara River basin by 24%, to the Blue Nile basin by 24%, and to the Lake Victoria basin by 4.3%. The following table (Table 11) demonstrated the impact of the change in rainfall on the average expected intake in the peripheral basins of the River Nile.

Table 11
Expected change in flow corresponding to the regular rainfall change on the peripheral reservoir of the River Nile

Rate of change in (%) basin intake	Name of peripheral basin	Rate of change in rainfall (%)					
		- 50	**- 25**	**- 10**	**10**	**25**	**50**
	Atbara/Atbara	- 93	- 60	- 24	34	84	187
	Blue Nile/Deem	- 92	- 62	- 24	32	78	165
	Blue Nile/Khartoum	- 98	- 77	- 31	36	89	149
	Lake Victoria/Ginga	- 20	- 11	- 4.3	5.7	14	33
	White Nile/Malakal	- 41	- 28	- 11	19	48	63
	Nile/Dongola	- 85	- 63	- 25	30	74	130

Source: Sayed, M.A.A., 2004. Impacts of climate change on the Nile Flows, Ain Shams University, Cairo, Egypt.

It is clear from the table above that a 10% decrease in rainfall would lead to a reduction in the expected flow increase to the River Nile basin by 25% at Dongola, while a 10% increase in rainfall would lead to a flow increase by 30% at the same site (this is due to the dominant inflow from the Ethiopian Highland through Atbara River and the Blue Nile).

Another study published in 1996 linked the impact of rainfall and the difference in temperature at the Nile basin with the sensitivity of surface flow in the basin. See Table 12.

Table 12
The impact of rainfall and the difference in temperature at the Nile basin on the sensitivity of surface flow in the basin

Rainfall change	- 20%	- 20%	- 20%	0%	0%	20%	20%	20%
Temperature (ºC) change	0	2	4	2	4	0	2	4
Surface flow (billion m^3)	32	10	2	39	8	147	87	27
Per cent of average*	37	12	2	46	10	171	101	32

Source: Strezpek et al, 1996: Vulnerability Assessment of Water Resources in Egypt to Climate Change in the Nile Basin. Climate Research Vol. 6 No. 2.
* An average of 84 billion m3.

The above results indicate that a 20% decrease of average rainfall, with a 4°C rise in temperature above its range, would lead to a 2% reduction in surface flow below the average. A 20% increase of average rainfall, with temperatures remaining within the range, would lead to a 171% above average increase in surface flow.

Despite the lack of sufficient data on the impact of temperature on the natural flow of the River Nile, it is only logical to expect that the sensitivity of this flow to the basins of the equatorial lakes and the Gazelle Sea will be higher than the flow to the Ethiopian Highland basin, since the former basins (the equatorial lakes and the Gazelle Sea) contain vast areas of land covered with bushes, vegetation and swamps, all affected by the rise in temperature which raises evaporation and transpiration rates. In the Ethiopian Highlands, steep falls are what affect surface flow. Hence, the

natural flow of the River Nile coming from that zone has greater sensitivity to the change in the rate of rainfall, than to the change in temperature.

- **Rain and floods:**

  A distinctive characteristic of rain in Egypt is its variability and scarcity from one year to the next. Thus, rainfall is of minor importance as a water resource. This may explain the absence of studies associating climate change with rainfall in Egypt. It should be noted that the feeding of the Sinai's ground aquifers may be sensitive to variations in rainfall; however, there are no worthwhile studies regarding this matter.

- **Groundwater:**

  Groundwater is considered to be much slower than surface water in terms of its response to climate change. There are no direct feeding areas for groundwater in the eastern and western deserts, which are relatively insensitive to climate change. Groundwater in Sinai may be sensitive to changes in rainfall. However, groundwater in the Nile Delta is more sensitive to climate change, as its sources are the water leaking from the Nile and its branches, as well as the irrigation network and agricultural land which is mostly irrigated by basin irrigation methods, e.g., irrigation by inundation. The anticipated elevation of groundwater in the north coast – as an impact of the probable sea level rise – and its effect on the agricultural condition is one of the factors that must be addressed and managed.

- **Water recycling in Egypt:**

  The availability of recycled wastewater – be it for agricultural, sanitation, or industrial purposes – in sufficient quantities and adequate quality depends on the system and management of the water supply network. If an alteration in the River Nile flow leads to a change in the system and management of water supply, the quantity and quality of recycled water will also vary. Thus, the use of recycled water is sensitive to the modified management and operation of the High Dam as a result of climate change, particularly if the need to reduce water behind the High Dam ensues.

B- Water demand system:

One may say that climate change will affect water consumption, and high temperatures will lead to increased evaporation and transpiration, as long as other factors remain constant (e.g., humidity, radiation, and wind velocity). Nevertheless, the impact of other climatic factors on water consumption may alter this effect.

It is known that agriculture accounts for 80% of Egypt's total water consumption. Although this percentage is expected to decrease due to an increased demand for water in other sectors such as: drinking, manufacturing and population rise; agriculture will remain the major consumer of water in Egypt.

The use of water for household purposes is also sensitive to climate change and high temperatures (especially if it coincides with high relative humidity). This increases the demand on water for bathing, cooling and watering gardens. A study in the UK indicated that a 1.1 degree Celsius increase in temperature by the year 2025 would increase water demand by approximately 5%.

The use of water for industrial purposes is not sensitive to climate change, as it is conditional on the technologies used and their methodologies. However, cooling

requirements are affected by climate change as the increase in water temperature reduces its efficiency. Changing the current cooling technology may be necessary in order to increase its effectiveness and adaptability to climate change.

C- The climate change impact on the management and operation of the water resources system:

The operation of the water distribution network depends on the patterns of water output emerging from the High Dam, given that this water output is based on a set of regulations in accordance with the following year's flood forecasts. These regulations were established through the 1959 Nile Waters Agreement between Egypt and the Sudan. Lake Nasser is considered as the water's balancing force, since it functions as a water reservoir from year to year, and from one hydrological cycle to another. Until today, the lake has ably handled the vagaries of the River Nile's annual intake. It is expected that climate change will lead to a variation in water inflow to the lake. Hence, the current operating rules of the High Dam may need to be reconsidered, especially if any of the expected changes in the river's intake (within the framework of different climate scenarios) take place. These effects and changes always depend on the results of climate scenarios.

Numerous previous studies were interested in the implications of a change in the River Nile's output, the deviations in water demand, and the share of the country's water resources, and thus, the alteration in the economic situation, particularly with regard to the agricultural sector. These studies assumed that the 1959 Nile Waters Agreement concluded between Egypt and the Sudan took charge of the distribution of the surplus or deficit in the Nile flow. According to the agreement, the natural flow at Aswan is about 84 billion cubic meters (average of the 1900 - 1959 period). It also estimated the water lost to evaporation from Lake Nasser to about 10 billion cubic meters. The agreement stated that the remaining 74 billion cubic meters would be divided at the ratio of 3:1, with Egypt's share being 55.5 billion cubic meters (75%), and Sudan's 18.5 billion cubic meters (25%).

Assuming that the allocation ratio between Egypt and Sudan will be utilized to divide the River Nile waters under the conditions of climate change (taking into consideration that the water lost to evaporation is about 10 billion cubic meters), it is likely that, upon preparation of the water balance for 2025, there would be a 5.8 billion cubic meter deficit in a drought scenario, and an 8.8 billion cubic meter surplus in a humidity scenario.

Using the surplus and deficit percentage in calculating Egypt's share of the water, two scenarios were devised in 2004[1] to reach an amended apportionment as a result of climate change, while associating it with the expected future needs. The more optimistic scenario (a 32% increase in Egypt's share, bringing it to 73.3 billion cubic meters) assumed that implementing the expansion of the irrigation plan would be possible by 2030. This would be done in conjunction with an increase in water needs for industrial and human purposes, as a result of a higher rate of industrial development and an increasing population. Under the more pessimistic scenario (a 14% water deficit, bringing Egypt's share of the water to 48 billion cubic meters), it was assumed that under such circumstances, only 47% of the agricultural expansion plan could be implemented, along with less water

[1] A model prepared by the Hydro-meteorological Forecasting Center, the Ministry of Water Resources and Irrigation, 2004.

demand for civil and industrial purposes, due to a lower rate of industrial development and a decreasing population.

- **Current operating rules of the Aswan High Dam:**

  The Aswan High Dam is 3600m long, with a maximum height of 111m. It was constructed in 1968, at a distance of 7km from the old Aswan Dam. The amount of water stored behind it, in Lake Nasser - at the highest level borne by the dam (183m above sea level) – amounts to 169 billion cubic meters. It is equivalent to double the annual flow of the River Nile at Aswan (84 million cubic meters). Table 13 shows the characteristics of water storage areas in Lake Nasser and their water level.

Table 13
Characteristics of water storage areas in Lake Nasser and their water level

Storage area	From level (meters)	To level (meters)	Storage volume (billion m^3)	Cumulative Storage volume (billion m^3)
Dead storage	The bottom	147	31.6	31.6
Active storage	147	175	89.7	121.3
Flood control	175	178	16.2	137.5
Additional storage	178	183	31.4	168.9

Source: Ministry of Water Resources and Irrigation.

In a situation where it is expected that the water level will exceed 175m on August 1 (despite the use of operational programs designed to maintain the level below 175m on that date, in order to receive new flood intake), the excess water of Egypt's determined share can be released to the Tushka spillway, particularly when the river intake is high over consecutive years. The operating rules of the High Dam can be summarized as follows:

- The water level should not exceed 175m on August 1. This is to accommodate for the floodwater that will follow.
- Releasing water from behind the dam is determined by water demand (mainly in agriculture). This amounts to 55.5 m3 per year.
- The water level in the reservoir should not exceed 182m, and it can increase up to a maximum of 183m in emergency situations.
- If the water level exceeds 178m, water can be released into the Tushka spillway.
- The maximum secure limit that can be released from behind the Dam is 240 – 270 million m3 per day.
- If the water level in the reservoir drops – with an anticipated low flood – the water released will be reduced according to a specific percentage of the share of the water between Egypt and Sudan (This happened in 1968.).

- **Studies on the operation of the High Dam under conditions of climate change:**

  A mathematical model was implemented in 2004[1] to simulate the impact of climate change on operating the High Dam, and the change in the volume of

[1] A model prepared by the Hydro-meteorological Forecasting Center, Ministry of Water Resources and Irrigation, 2004.

water flowing to Egypt. Two scenarios were used for the year 2030: an optimistic scenario, with a 32% increase in the flow, and a pessimistic scenario, with a 14% decrease in the river flow. The scenarios relied on four Global Circulation Models (GCMs). They employed positive and negative changes on the water release in Dongola, as an outcome of a natural sequential series (1871 – 2002). The model of the High Dam was used to calculate changes in the level of Lake Nasser, and the water released into the Tushka spillway, on a comparative basis. The historical consecutive series of events was used without adjustments.

The model projected that, in the optimistic scenario, the lake's water level will not drop below 150m above sea level, therefore avoiding the occurrence of drought. However, the amount and frequency of water release to the Tushka spillway will increase, along with the risk of floods under the current operational conditions (the probability of the lake's water level exceeding 183m is 6.7%).

Under the pessimistic scenario, the number of drought years will increase. The lake's water level will reach an all-time low, more often than normal. There is also a minor possibility that the water level will drop to 174m below sea level.

In both cases, there is a need to take action in order to cope with these possibilities, although the drought situation would be more damaging. Table 14 shows the projected water levels in Lake Nasser according to different scenarios.

Table 14
Potential water levels in Lake Nasser according to different scenarios

Level (m)	Main scenario	Optimistic scenario	Pessimistic scenario
Below 147	0.00	0.00	0.64
148 - 150	0.96	0.00	12.50
151 - 155	0.77	0.00	15.90
156 - 160	2.44	0.00	19.74
161 - 165	5.64	0.00	16.54
166 - 170	14.23	0.58	11.41
171 - 175	29.92	4.10	7.95
176 - 180	40.45	56.03	13.53
181 - 182	7.63	25.96	1.79
182 - 183	0.96	6.60	0.00
Above 183	0.00	6.73	0.00

Source: Ministry of Water Resources and Irrigation, 2008.

D- Building climate scenarios:

Building regional climate scenarios, which are aimed at studying the impact of the climate, requires several steps. Each step is associated with a group of pre-set models, each one securing a certain degree of uncertainty. In 2000, the Intergovernmental Panel on Climate Change (IPCC) issued a special report on heat emission scenarios. It presented more than 40 scenarios classified into four

groups, based on different visions of the state of the world in the 21st century in terms of the use of energy resources, global, regional and local economic growth, and the building of human capacity.

Table 15 shows the extent of the impact of climate change on Egypt.

Table 15
Extent of climate change impact on Egypt

No.	Resource	Extent of certainty of impact	Degree of impact	Danger of impact	Importance of resource
1	Water resources	Moderate	Moderate	High	High
2	Agriculture (indirect impact)*	High - Moderate	Moderate - Low	High - Moderate	High - Moderate
3	Agriculture (direct impact)**	Low	Moderate - Low	Low	High - Moderate

Source: Organization of Economic Cooperation and Development (OECD), 2006.
* Indirect impact on agriculture is in the form of decreased water resources, and sea level rise.

** Direct impact on agriculture is in the form of temperature and rate of rainfall.

The first conclusion to be drawn from this table is that the direct impact of climate change – in the form of temperature change, rain and evaporation – is considered low on Egypt. It will have a higher impact temperature. The rate of rainfall will not vary considerably, and will continue to represent a secondary role in the country's water balance. There may be a more prominent impact on agriculture. Some crops will suffer from the rise in temperature, while the production of others, such as cotton, may increase. The main impact on agriculture will be indirect as a result of the decrease in the natural intake of the River Nile as well as its increased salinity.

As for the impact on water resources, due to the uncertainty of the change in the rate of rainfall on the River Nile basin, it is also difficult to be certain of change in the river's emission. However, any shift, no matter how small, will have a significant effect due to the country's reliance on that emission. It is clear from studies that the certainty of temperature change is greater than the certainty of the change in rainfall rate. High temperatures will increase water loss to evaporation from the River Nile and Lake Nasser, as well as from the lakes and rivers up the Nile basin. It will also increase the demand on water for agricultural purposes as a result of the rise in temperature, even if slight.

E- Proposed scenarios:

- Assuming the worst-case scenario, the higher flow to Lake Nasser will increase Egypt's share of the Nile water. Thus, the availability of more water for agriculture, and an increase in the area of land that can be irrigated. Under the current circumstances, one billion cubic metres is sufficient to irrigate 150 thousand feddans. This means that by 2030, cultivated land can be increased to 450 thousand feddans without affecting the current supply of agricultural land. By 2050, this will increase water irrigation for an additional 750 thousand feddans. Once the Tushka project is completed (540 thousand feddans), it will require 4 – 5 billion cubic metres of water. Hence, by 2025, the Tushka project can be run at full capacity without affecting the water share of the Nile Valley and Delta.

- The North Sinai development project covers an additional 620 thousand feddans. El Salam canal covers 220 thousand feddans, while Sheikh Gaber canal comprises 400 thousand feddans. Assuming the Tushka project gets the priority, it will be possible to supply 150 thousand feddans with water by the year 2050.
- Since the River Nile is highly sensitive to climate change, it is important to accurately monitor the river and its tributaries. The data must be confirmed and analysed. It is suggested to prepare a five-year report on the hydrological state of the River Nile basin, and preferably through the framework of the Nile Basin Initiative (NBI), thus providing an early warning against any change that may occur in the behaviour of the River Nile as a result of climate change.

4.2.2 Agricultural Sector:

The agricultural sector relies on the use of natural resources (soil, water), and biological resources (plant varieties) under a set of certain climatic data. Hence, the anticipated climate change will have a direct impact on the efficiency by which the agricultural sector achieves the required food security and agricultural industrialization.

Following are some of the direct climatic indicators with highest impact on the agricultural sector: the Mediterranean Sea level rise, temperature and drought. In addition, there are indirect impacts of climate change on genetic resources, the evaporation rates and light intensity. The following aftermaths are expected:

- Rising temperatures will increase evaporation and water consumption of crops.
- The occurrence of social and economic impacts, such as the migration of labour from marginal and coastal zones.
- A potential sea level rise and its negative impact on agricultural land and the groundwater reserves in the Delta.

In light of these anticipated conditions, it would be necessary to take action and implement programmes that would allow adaptation to the expected impact of these changes on Egyptian agriculture. There are many projections of the rate of change of both temperature and water levels in the Delta zone. The impact of a change of up to 2 degrees Celsius in temperature, and a one-meter sea level increase above current values will be further reviewed.

A- Plant Production:

The anticipated temperature increase and the change in its seasonal pattern will result in the reduced productivity of certain crops, and will bring about changes to environmental and agricultural zones. Higher temperatures will shift the production of winter cereals to the north, where the temperature will be compatible with the physiological needs of such crops. The existing areas will be transformed into agricultural ones whose climate will resemble that of the southern areas of the valley, particularly northern Khartoum in the Sudan. The move of winter cereals production to the north will add a new challenge to the producers - i.e., the difference in the length of daytime – and this will have an impact on productivity. Maintaining production in the same locations when temperature rises, and initiating the agricultural season two weeks earlier will lead to an increase in water demand or other factors.

On the other hand, the rise in temperature will lead to the spread of many fungal plant diseases, and infestation by various insects. Numerous recent researches have established the possibility of an increased prevalence of many diseases and insect infestation of main crops, such as tomato and potato late blight, wheat stem and leaf rust, which added a new challenge to maintaining agricultural productivity and other appropriate transactions.

- **Results of studies on vulnerability to climate change:**

  The basis of these results was field experiments collecting data on different models so they can be calibrated before use, ensuring their ability to accurately predict under Egyptian conditions. Simulation studies were conducted on different agricultural areas over a period of 25 – 40 years. The studies revealed the following:

  - **Wheat:** The productivity of wheat will fall by 9% if the temperature rises by 2 degrees Celsius. The water consumption of this crop will rise by 6.2%, in comparison with the situation under the current weather conditions. A 4 degree Celsius rise will increase the deficit to 18%.
  - **Maize:** Crop productivity will fall by 19% by the middle of this century if the temperature increases by 3.5 degrees Celsius, in comparison with the situation under the current weather conditions. Accordingly, water consumption will rise by 8%.
  - **Cotton:** Climate change will have a positive impact on the productivity of cotton. Production will rise by 17% if the temperature rises by 2 degrees Celsius. The water consumption of this crop will increase by 4.1 – 5.2% in comparison with the situation under the current weather conditions. If the temperature rises by 4 degree Celsius, production will increase by 31%. On the other hand, water consumption will rise by 10% in comparison with the situation under the current weather conditions.
  - **Rice:** Productivity will fall by 11% in comparison with the situation under the current weather conditions. Water consumption will increase by 16%.
  - **Tomato:** This is one of the most sensitive crops to the impact of increasing temperature, like many vegetable crops. Tomato productivity will fall by 14% if the temperature increases by 2 degrees Celsius. Water consumption of the crop will increase by 4.2 – 5.7% in comparison with the situation under the current weather conditions. The drop in productivity will reach 51% if the temperature rises by 3.5 degrees Celsius.
  - **Sugar Cane:** The results of studies on the climate change impact on the production of sugar from sugar cane indicate a 24.5% drop in productivity, and a 2.3% increase in water consumption. There will be a 25.6% drop in crop return, per unit of water.

- **Impact on water consumption of agricultural crops:**

  Results have demonstrated that by the middle of the century – under conditions of high temperature resulting from climate change – the water consumption of the majority of main crops will increase. The change in water

consumption rate will vary between -2% for barley, and +2.5% for wheat. The water consumption of summer crops will increase by 6% for sunflower, 8% for maize and millet, 10% for cotton, 15% for soybeans and 16% for rice. The water consumption of sugar cane will increase by 2.3%.

The results of the previous studies are summarized in Fig. 8, which depicts the percentage change in the productivity of some major crops under conditions of climate change (a temperature increase of 2 degrees Celsius), compared with productivity under current climate conditions. Table 16 shows the percentage change in water consumption of some major crops in Egypt under conditions of climate change (a temperature increase of 2 degrees Celsius), compared with productivity under current climate conditions.

Table 16

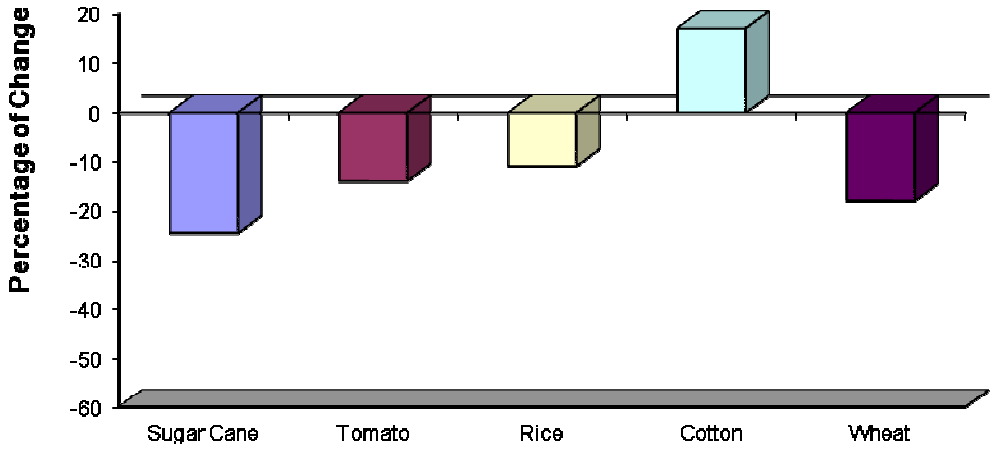
Percentage of change in water consumption of some major crops in Egypt under conditions of climate change (temperature increase of two degrees Celsius) compared to consumption under current climate conditions

Zone	Crop	Alteration (%)
Delta	Wheat	%6.2
	Cotton	%4.9
	Tomato	%4.6
Central Egypt	Wheat	%6.2
	Cotton	%5.1
	Tomato	%5.7
Upper Egypt	Wheat	%5.2
	Cotton	%4.2
	Tomato	%4.2

Source: Eid, H. M. and El-Marsafawy, S. M., 2002. Adaptation to Climate change in Egyptian Agriculture and Water Resources. 3rd International Symposium on Sustainable Agro-environmental Systems: New Technologies and Applications (AGRON 2002), Cairo, Egypt, 26–29 October.

Fig. 8

The percentage of change in the productivity of some main crops under climate change (a 2 degree Celsius increase in temperature), compared with productivity under current climate conditions



Source: Abu- Hadid, A. F., 2006. Assessment of impacts, adaptation and vulnerability to climate change in North Africa: Food production and water resources. A final report submitted to assessments of impacts and adaptations to climate change (AIACC), Project No. AF. 90.

B- Animal Production:

Temperature directly affects animal health and their ability to produce milk and meat. This differs according to the types of animals and equipment at breeding sites, with the possibility of an increased spread of diseases related to the type of water and animal feed used.

It is expected that the anticipated rise in temperature will lead to reduced milk production, and a drop in the growth rates of cattle and poultry. Among the most important diseases expected to appear are: Bluetongue disease[1] and Rift Valley fever. On the other hand, the disease distribution map will vary at the national and regional levels. There will be an increase in diseases that are common among humans and animals (zoonotic diseases), such as avian flu, foot and mouth disease, swine flu, etc. With the increasing competition for the use of land and water resources in plant production, it is expected that there will be a drop in the production of all types of feed, with an expansion in cultivating winter crops for human consumption (wheat and barley).

C- Fish Production:

Egypt produces 93% of its fish needs from different sources. They include the River Nile and its tributaries and drains, the Mediterranean and Red Seas, the northern lakes as well as fisheries north of the Delta. The high temperature will lead to the migration of fish to the North, and their movement to greater depths.

Fish farms will face competition over the redistribution of water usage, with a direct impact of temperature on the productivity of some varieties of fish. The

[1] An epidemic that affects livestock and is caused by a virus that is transmitted through insects.

likelihood of increased water salinity in the north Delta will negatively affect the productivity of fresh water fish, and increase the productivity of salt-water fish, despite the fact that many social classes rely on fresh water fish as a primary source of animal protein.

It is also expected that the rise in atmospheric and water temperature will lead to an increase in the growth rate of fish and their vulnerability in fish farms and small waterways, which are more vulnerable than fish in the sea and large water bodies.

The fish ecosystem will change as the rate of nutritional assimilation rises. This will lead to a higher need for nutrition, and increased competition between different species, thus raising the Biological Oxygen Demand (BOD).

In terms of the hydrological aspect, the Mediterranean Sea level rise – whether it is 50 cm or one meter – will have a significant impact on the rates and locations of egg hatching. The increased salinity will limit the spread of fresh water fish in the northern areas of the Delta, and alter specific mix of the fish.

D- Agricultural Land Resources:

The River Nile delta and valley are among the oldest agricultural areas with high population density in the world, with 1600 inhabitants per km2. The Nile Valley covers only 4% of Egypt's area, while the Delta covers 2.5%. The northern border of the Delta is 50km long, and 2m above sea level. It is protected by sand dunes, and is constantly subjected to erosion.

The rising water level will lead to several environmental, agricultural, economic, and social damages. The northern lakes will disappear, fresh groundwater will be polluted with salt-water, many fisheries will disappear, and land salinity will increase. With the uncertainty of the impact on the river's water resources, erosion will likely increase and some domestic tourist areas will disappear.

Studies indicate that climate change will increase sea levels due to melting ice in the polar zones. This will lead to the water logging of coastal areas that are lower than sea level. Agricultural land located in these areas will be affected. Parts of it will be inundated, while in others the groundwater level will rise to a great extent and other areas will be salinized. This will have a negative impact on the entire agricultural land.

If the sea level rises by half a meter, one million feddans of agricultural land will go out of production. This will also have an impact on environmental pollution, the spread of common diseases and insects, as well as the pressure on inner agricultural land. The peripheral agricultural land on the outskirts of the Delta will also suffer from negative effects, in addition to an increasing desertification rate.

E- Climate Change and Food Security in Egypt:

Agriculture is a major economic activity in Egypt, accounting for 14% of national income, while at the same time, 55% of the total population depends on agriculture business. The food industry represents 5% of gross national product, thus, any improvement in agricultural performance is followed by an improvement in the economic status of a large number of citizens.

Looking towards the future, agriculture requires increased productivity, and water needs to be conserved in order to meet the needs of the population increase. Water is a rare commodity, even in the absence of climate change. In the same context, agricultural activity relies on seasonal labour, and small plots of land. It also relies on small livestock breeders and fishermen who represent 80% of the workers in

the agricultural sector, and are in need of support in order to meet their basic requirements.

Over the past 50 years, transportation, power generation, industrial production, the use of fossil fuel, rice cultivation, and animal production contributed to the increase in the concentration of carbon dioxide and other greenhouse gases. The atmospheric temperature has risen between 0.03 and 0.6 degrees Celsius since the mid-20th century. It is anticipated that temperature would increase at the rate of 1.4 – 5.8 degrees Celsius until the end of the current century. The increase in temperature will be slow, but steadily on the rise.

- **Food security:**

  Food security is achieved when all members of society enjoy the natural, social and economic ability to gain access to sufficient, safe and nutritious food, which meets their nutritional needs and choices in order to fulfill an active and healthy life.

  Hence, there are four essential elements to food security:

  - Food availability: it covers production, distribution, and exchange. It is associated with the agricultural sector's ability to meet the food demand. This depends on crop productivity and the farmer's ability to meet to market's demands for agricultural products.
  - Food stability: it means the continuous availability of food that meets standard specifications. It is associated with the flexibility of community members to face the risk of being unable to provide the suitable sources in order to obtain the quantity and quality of food required. This may be due to the individual's economic status, the non-availability of food in the quantity and quality required, or the constant climate change, which in turn prevent farmers from working in order to obtain a suitable income, in the absence of insurance against such risks. The ability to obtain adequate food depends on the consumer's purchasing power, therefore income and prices.
  - Food consumption (utilization): it means nutritional value, nutritional safety, and social and health values. This is related to the safety and quality of food, to health, and to ensuring that food is free from any harmful elements. Food security does not only entail achieving it, but also that it be safe and healthy, and does not provoke any diseases.
  - Access to food: the ability to purchase, the ease of purchase, and the compatibility of the types of food required.

- **The risks of climate change on food security in Egypt:**

  The Nile Delta (Egypt's breadbasket) faces many threats resulting from climate change, which directly affect food security through the rising level of the Mediterranean Sea. This will lead to higher salinity and groundwater levels in agricultural lands. The salinity of the freshwater lakes in the north will also increase, and this will lead to:

  - The loss of areas of fertile agricultural land, and the fall of plant and animal production.
  - A change in the species and mix of fish, which is the primary source of non-animal protein in Egypt, and an important and inexpensive source of nutrition for the poor.

- The displacement of a number of inhabitants from these areas due to water logging, low fertility, and the absence of alternative employment as a source of income.

Egypt is a food importing country; it imports approximately 50% of its wheat consumption, and 90% of its oil consumption. If, in association with adaptation to climate change, suitable investments are not made in the field of technological agricultural development, it is likely that food security will be exposed to grave economic crises, which will result in a forecasted rise in the import bill, in addition to a technological crisis.

- **Adaptation of Egypt's food security to climate change:**

  There are many elements and factors that affect the improvement of adaptation opportunities in the agricultural sector to climate change, which should be examined in order to improve the chances of achieving food security. They can be summarized as follows:

  - There are many parameters that indicate the climate change impact, which the agricultural adaptation strategy is based on. This is due to the uncertainty of, and the differences and difficulties in, utilizing the available models, and the inaccuracy of determining the consequences of climate change on the Egyptian environment.
  - There is a lack of basic information, such as meteorological data, land use, and crop and livestock distribution, particularly the quality and distribution of crops grown in different areas.
  - Farmers and government policies have many alternatives for adaptation to climate change, including the replacement of existing varieties; otherwise, the government should provide highly accurate information on weather conditions for a period of 6 – 8 months. This could help farmers select the suitable crops or animal feeds that are compatible with the expected changes. The degree of climate conditions impact the agricultural sector depends on the ratio of investments in changing irrigation systems, the availability of strategic food surplus, and an environmental policy capable of dealing with such challenges.
  - Promotion of scientific research and training programs capable of coping with the anticipated changes, which, in turn, would help plant varieties use carbon dioxide more effectively.
  - Adaptation to climate change means that farmers will have the ability to maintain high productivity. However, this may require shifting agricultural production from one location to another. Agricultural policies would contribute to the identification and distribution of plant varieties according to the anticipated climate change. Moreover, agricultural policy could help farmers migrate internally, or even change their lifestyle or rehabilitate themselves.
  - Adaptation requires paying attention to productivity and social issues of target groups, although focus should not only be on agricultural labour or seasonal farmers but also on small farmers and breeders, who represent a sector that has the ability to adapt, achieve food security and develop rural communities. In the same direction, the focus on health, education and women is considered among the measures to be taken in order to activate the real role of adaptation to climate change.

- Reduction of carbon dioxide emissions in the agriculture sector. Agricultural activities contribute 14% of the greenhouse gas emissions. These emissions - mostly in the form of methane gas (80%) and nitrogen oxide - are emitted by livestock, the intensive use of nitrous fertilizers, and the hazardous handling of animal waste and rice straw. Gas emissions from agriculture amount to 6 Gigatonnes of carbon dioxide per year (mechanical equipment and agricultural machinery - mitigation).
- In light of the significant global increase in greenhouse gas emissions, the agriculture sector is required to avoid these emissions, and increase the storage of organic carbon in the soil. This process costs as little as US$20 per ton of carbon dioxide, taking into consideration intensive cultivation, land improvement, and the balance between adaptation and mitigation. However, from the scientific point of view, adaptation is considered the most important measure for protecting food security from reform.
- Continuous improvement of agricultural productivity. In order for the strategy to succeed, the information on risks that may result from climate change must be made available to all those who work in the agriculture sector. They should also be provided with the appropriate technologies, the basic environment, funding, and the sound management of water resources, land, and biodiversity.
- Upgrading the performance of agricultural extension agencies to help farmers adapt to climate change. Many available traditional technologies can be used by small farmers to distribute the risks.
- Increasing the investments aiming agricultural productivity. This is a logical measure to take, even in the absence of climate change. Investments in the development of agricultural sciences and technologies would be required to cope with global demand resulting from the anticipated population growth (about 9 billion by the year 2050) which would be mostly in developing countries, with an expected increase in their income and various nutritional needs. The climate change impact would be accompanied by a new challenge of increased demand for agricultural products. This underlines the importance of developing new agricultural techniques in order to neutralize the impacts of these new changes. This would indirectly help reduce poverty, through the creation of new jobs and reduced food prices. At the same time, rural infrastructure would be essential in case of an improvement in crop productivity. The road networks would need to be upgraded so as to improve marketing opportunities and reduce cost. Investment in improving irrigation techniques is as important, and this is where the essential role of agricultural awareness comes in to play; as well as the creation of a cooperation network between all stakeholders on the national and international levels. Breeding programs, improved varieties, reducing the ploughing rate, good fertilization, plant protection programs and marketing are all effective schemes to protect food security. Suitable agricultural machinery should be made available to farmers, along with maximizing the role of agricultural cooperatives.
- Providing funding for agricultural production requirements (seeds, fertilizers, pesticides, seasonal workers) through concessional loans.

- Partnership between nutritional agricultural industrialization and farmers' communities – through seasonal contracts – can help reduce risks and create guaranteed markets.
- An insurance system against the risks of climate change and its impact on small farmers must be in place. The purpose of this insurance system must first be to provide funds for the family's nutritional needs in case productivity deteriorates as a result of sudden climate change impacting productivity. Small farmers, breeders (in addition to agricultural workers) may be exposed to the loss of livelihood, which secures minimal living conditions for the family as a result of the negative impact of the anticipated severe changes in weather indicators. This proposed insurance system should cover a family's basic needs in case productivity drops to 50% of that under normal climatic conditions of a geographical location, provided that the farmer or breeder followed all technical recommendations. The insurance system employed in Brazil is an excellent proof of the success of this principle.

4.2.3 Health Sector

Despite the lack of studies related to the climate change impact on human health all over the world, there is a consensus about the occurrence of many negative effects. This does not preclude that some benefits may arise from climate change, such as a reduced winter mortality rate in moderate weather zones, and the increase of food production in some areas. It is quite likely that the impact on health resulting from climate change is largely negative in general. Climate change would affect the basic health requirements, clean air, drinking water, adequate food and safe shelter. As a result of climate change, human beings will be exposed to the direct impacts resulting from changes in weather patterns, such as temperature, wind, dust, sea level rise. Human beings would also be exposed to the indirect results of climate change through the alteration in the characteristics of water, air, food, soil and agricultural products. These risks will be affected by environmental conditions, society's health and social conditions, and there will also be an impact on the infrastructure of health services.

Sudden climate change in some geographical areas – floods, storms, hurricanes - will also lead to multiple injuries and forced migration together with the resulting lack of food and fresh water, creating economic and social crises. Under high population density – a characteristic of Egypt – migration will lead to further unhealthy population over density, which would increase the prevalence of infectious and non-infectious diseases, as well as death rates secondary to cardiovascular conditions, such as hypertension, strokes and heart attacks.

The direct impact of climate change can be linked to the type of changes. They include:

- The sea level rise and its effect on agricultural land, the economic and social aspects, and their reflection on health.
- The reduction in the quantity and quality of water available for different uses and its effect on reduced agricultural production and food, and the use of unsuitable substitutes for drinking water, causing various diseases.
- The change in rainfall patterns, which might help the breeding of certain species of mosquitoes, and thus spreading diseases carried by vectors.

- Torrential rains which result in floods that drown and injure humans, and drown cattle and land.
- Rain that pollutes water systems with human and animal waste.
- Thunderstorms and high humidity, which cause respiratory and cardiac diseases.
- Heat waves that cause conditions and deaths related to heat stroke.

A- Sea Level Rise:

The coastal area of the Nile Delta is considered one of the most important areas at risk from a sea level rise caused by climate change. This will have multiple effects on the populations of the coastal zone, who are exposed to economic, social and health risks. The sea level rise and extreme weather conditions may lead to the destruction of homes, medical facilities and all other essential services. People may be forced to migrate to other places, which might increase the occurrence of health hazards, ranging from mental disorders to infectious diseases. It is also anticipated that land and groundwater salinity will increase, and this in turn will negatively reflect on water resources, agriculture and fisheries in these areas. This will result in food shortages and high prices, which will lead to problems of malnutrition. The increase in salinity and water logging will trigger the breeding of insect species and disease vectors, therefore a higher prevalence of some infectious diseases.

Moreover, the possibility of hurricanes and tsunamis will lead to heavy loss of life, an increased incidence of injuries, in addition to the destruction of houses and infrastructure, thus affecting the economic and social conditions and consequently the spread of diseases.

B- Variation in Water Quantity and Decreased Quality:

Human health depends on adequate supplies of safe drinking water. Climate change may affect environmental sanitation systems, thus affecting water quality. If there is a lack in the supply of water needed for drinking and hygiene purposes, this would force people to use low-quality, unhealthy water. This would result in the spread of diarrheal and other viral, bacterial, and parasitic diseases transmitted by contaminated water, such as cholera, typhoid, etc.

C- Heat Exhaustion and Air Pollution:

It is known that hot weather – particularly if it comes in unexpected waves – increases illnesses and contributes directly to deaths from cardiovascular and respiratory diseases, particularly among the elderly. For example, more than 70 thousand additional deaths were recorded during the heat wave that hit Europe in 2003. It is expected that climate change will lead to an increase in the frequency and severity of heat waves, thus worsening the situation. As a result, urban dwellers are those most affected by heat waves as a result of an urban greenhouse effect and the formation of urban heat islands.

Air pollutants, whether chemical or organic volatile compounds, affect the respiratory system, leading to allergies and the destruction of lung cells, as they reduce the efficiency of the human body's defence mechanisms against foreign substances. They may cause cancers and aggravate heart conditions. Urban air pollution is the cause of 1.2 million deaths per year.

Health burdens arising from climate change can be divided into direct and indirect impacts:

- **Direct Impacts:**

  1. Direct Impacts of Extreme Rise in Temperature:

  Extremely high temperature contributes directly to death from cardiovascular and respiratory diseases, particularly among the elderly.
  They also increase the levels of the surface ozone, and other pollutants in the air, which worsens cardiovascular and respiratory diseases.
  The amount of pollen and other allergens in the air increase in extreme heat, and this may lead to asthma, a disease that affects about 300 million individuals worldwide. It is expected that this burden will worsen due to the continuous increase in temperature. Direct exposure to climate change leads to:

  - ❖ Sun stroke
  - ❖ Cataract
  - ❖ Skin cancer
  - ❖ Increased mortality rate among children and the elderly due to chest allergies and respiratory diseases.

  2. Direct Impacts of Natural Disasters and Change in Rainfall Pattern:

  It is expected that the sea level rise – and extreme weather events – will lead to the destruction of homes, medical facilities and all other essential services. People may be forced to migrate to other places, therefore increasing the exposure to health hazards, ranging from psychological disorders to infectious diseases. It is probable that the increasing change in the pattern of rainfall will impact fresh water supplies. The lack of fresh water may damage public health and increase the risk of infectious diseases, which may end people's lives. It is also likely that the rise in temperature and the change in the pattern of rainfall will reduce the production of basic nutrients by up to 30% by the year 2050, leading to food shortages and an increased prevalence of malnutrition diseases.
  Floods will pollute fresh water, increase the risk of waterborne infections and facilitate breeding of vectors, such as mosquitoes. Floods will also lead to drowning, physical injuries, destruction of buildings and the disruption of the delivery of medical supplies and health services.

- **Indirect impacts:**

  These are mainly associated with the shortage of water supplies, and the decrease in agricultural land, leading to a shortage of basic foodstuffs, and the emergence of malnutrition cases and diseases caused by overpopulation and forced migration. This is in addition to the increase in diseases associated with climate change, which include infectious diseases, e.g., bacterial and viral, and those transmitted by vectors such as mosquitoes. This also includes non-infectious ailments, such as cardiovascular and respiratory diseases, cancer, malnutrition and immune deficiency.

1. **Infectious Diseases:**

- **Bilharziasis:**

  Climate and environmental changes may affect the geographical distribution of Bilharziasis. The intermediate host (Bulinus and Biomphalaria snails) may change its habitat to avoid high temperature, hence altering the areas where Bilharziasis spread. In addition, as a result of climate change the anticipated water shortages will increase the need for irrigation and the expansion of irrigation networks in order to fulfill those needs, leading to the further spread of snails, and increasing the possibility of human infection with the Bilharziasis parasite.

- **Diseases transmitted by insects:**

  Many serious diseases are transmitted by insects and rodents. Epidemiological studies indicate that the elements of this group of diseases (the micro-organism causing the disease, the host that is contaminated by the microbe, whether a human, an animal or a bird, and the vector, i.e., insects and rodents) are affected by climate change. Microorganisms and insects are characterized by being sensitive to temperature, humidity, rainfall patterns, and wind. Thus the distribution and seasonality of some of these diseases may be affected by climate change. The increase in temperature shortens the vector's life cycle. It may also reduce the incubation period of pathogenic parasites or viruses. The health effects include the appearance of the disease in areas other than where it normally appears, or the prolongation of the infection season where the disease normally appears.

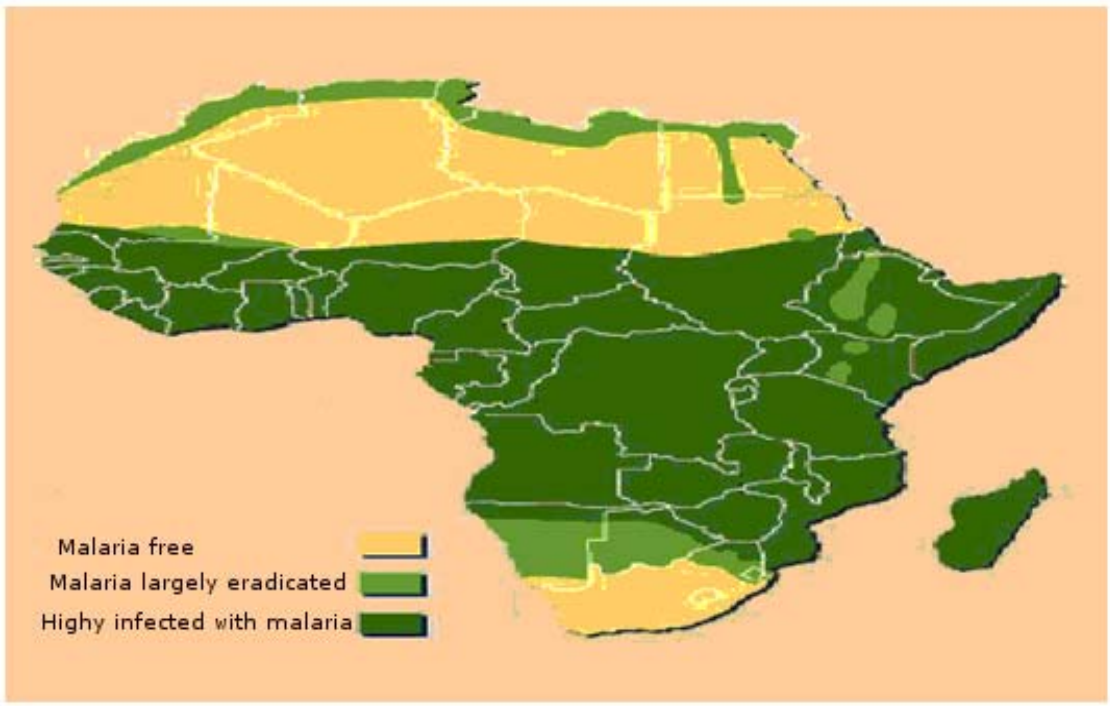
- **Malaria:**

  Malaria is one of the most serious public health problems. It was identified as the most vulnerable disease to climate change. Projections indicate the possibility of an increase in the global population at risk of being infected with malaria to 260 – 320 million, by the year 2080. Projections also indicate a significantly extended seasonal period during which the disease will spread. Egypt is currently classified in Group 1-B, which includes countries that recorded only very limited cases over the past three years, to the extent that it is considered completely free of the disease. No cases of malaria have been recorded internally since 1998, as shown in Fig. 9. In spite of this, Egypt is still at risk of the spread of malaria as the weather and environment are suitable for the reproduction of the Anopheles mosquito, which transmits the disease. In addition, people lack the necessary immunity, and epidemically infested areas in Sudan are nearby. With climate change, an increase in the incidence of the disease is anticipated, where higher temperatures and humidity will cause it to spread, extend its seasonality and strengthen the ability of the parasite to transmit the disease. The time people will spend outdoors will increase, therefore making them more vulnerable to infected mosquitoes. Water shortage accompanying climate change will lead to the spread of stagnant water, a suitable environment for the breeding of mosquitoes.

- **Filariasis:**

  Filariasis is an endemic in Egypt, Sudan and Yemen. In Egypt, Filariasis is located in the Nile Delta zone, where the disease vectors – the Culex mosquito – is often found, putting many people at risk of getting infected. With climate change, it is anticipated that the number of those at risk will increase.

Fig. 9
Distribution of malaria infection in Africa



Source: Environment Affairs Authority, 2004.

- **Rift Valley fever:**

  This is a viral disease that infects animals. However, it can infect human beings through some mosquitos' species, or when one comes in contact with meat, organs, or the blood of animals infected with the virus. Although the disease is mainly endemic in Sub-Saharan Africa, it first spread to Egypt in 1977/1978, where 18,000 cases and 598 deaths were recorded.

- **Tuberculosis:**

  Tuberculosis represents a significant problem in Egypt. The country has a moderate spread of the disease. This estimate is based on the annual prevalence of infection. Statistics and research carried out in Egypt indicate a prevalence rate of 0.21% annual incidence, i.e., 21 cases per 100,000 inhabitants (2007 estimates). In other words, the total number of new cases expected to be discovered every year is 15,000.

Egypt has made fruitful efforts in the fight against tuberculosis through the National Program for Tuberculosis Control. It includes a scientific plan to address the tuberculosis issue across the entire country. The program aims to reduce the magnitude of the problem to an extent that it does not turn into a national health issue.

- **Diarrheal diseases, and food and water borne diseases:**

  Climate change leads to noticeable changes in the quantity and quality of water available for drinking and general use. Consequently, it is expected that the incidence of diseases transmitted by food and water, especially diarrheal diseases, which affect all ages, will increase. However, elderly people and children below the age of five are the most susceptible to infection and complications, particularly dehydration, which potentially may lead to death. Other diseases include cholera, typhoid fever and paratyphoid fever. High temperature may affect the safety of stored food, leading to infection with bacteria such as salmonella and campylobacter, which cause Diarrhoea and food poisoning.

2. Non-Infectious Diseases:

- **Malnutrition diseases:**

  Climate change has a significant impact on the food security of different communities. One can focus on four main pillars of food security, which fall under the influence of climate change:

  - **Food productivity:** Current assessments of the impacts of climate change indicate that some areas suffer from diminished agricultural productivity. Moreover, the impact on the livestock, poultry, and fish resources is all factors affecting food security in case of climate change.
  - **Stability and continuity** in the provision of food: Events arising by the effect of climate change, e.g., floods, and storms, may lead to variation in the availability of different food items.
  - **Access to food:** The ability of people to obtain food in suitable quantities and quality.
  - **Benefiting from food:** Climate change creates a vicious circle of infectious diseases and malnutrition. One leads to the other, therefore increasing the severity of health impacts.

  Children under the age of five are one of the most vulnerable groups to malnutrition (particularly energy and protein deficiency), Anaemia, rickets, and delayed mental development. The lack of nutrients – particularly vitamins and minerals - also leads to general weakness, and immune deficiency, which facilitates contracting infectious diseases. It is worth mentioning that malnutrition also causes damage to other groups, such as older school children, pregnant women, and the elderly.

- **Cardiovascular diseases and diabetes:**

  About 26% of Egyptians suffer from a degree of hypertension; over 9% suffer from diabetes, while another 9% are undiagnosed. This indicates that the incidence of diabetes in Egypt is among the highest in the world.

Until 2006, Egypt ranked second in the world in terms of deaths due to diabetic complications.

Taking into account the steady increase in population – in addition to the potential impact of climate change – Egypt will suffer from an increase in the number of patients, as well as the impact of this on people's health, and on the quality of medical services provided to patients. Social and financial burdens on the Egyptian family and state resources will also increase.

- **Cancer:**

Cancer is one of the most dangerous diseases affecting humans. Thanks to scientific and technological progress, 40% of cases can be prevented, and 40% can be treated, and the symptoms of 20% of the remaining cases can be mitigated. It is expected that cancer will surpass cardiovascular diseases and accidents as a cause of death in the next 20 years. The economic burden of cancer in Egypt is estimated to be in billions. The current situation indicates the following:

- Over a hundred thousand cases of cancer are diagnosed in Egypt every year.
- The number of cases will multiply until 2020 for the following reasons:
  - Continuous population growth and the rising life expectancy of Egyptians.
  - Improved cancer diagnosis and recording methods.
  - Increased risk factors, such as smoking, obesity, pollution, and infection.
  - The defeatist approach in dealing with cancer, and the lack of social awareness of the problem.

- **Respiratory diseases:**

Weather conditions affect air pollution through transportation or polluting elements. Climate change may affect exposure to air pollutants through the following:

- A change in biological patterns (e.g., wind and temperatures). Hence, a change in the concentration of air pollution.
- Emissions.
- The distribution and type of airborne material, which cause allergies, e.g. pollen.

The respiratory system is directly affected by pollutants, through the destruction of its cells, which in turn affect the functions of the respiratory system. Pollutants also increase lung sensitivity. This may alter the human body's defence mechanisms against foreign material, thus increasing its exposure to disease.

- **Negative social impacts:**

  Negative social impacts are one of the most severe consequences of climate change. Mass migration of millions of inhabitants is expected as a result of shore erosion, coastal floods, and ceased agricultural activities. Displaced persons are the population that is most vulnerable to severe health problems caused by environmental deterioration.

- **Population groups, sectors and geographical areas most affected by climate change:**

  1. **Population groups and demographics:**

     Egypt's population vulnerability maps (developed by the United Nations World Food Programme) are considered one of the most important indicators in identifying the highly vulnerable areas. This is done through the following social and economic indicators.
     - Average income.
     - Unemployment rate.
     - Mortality rate of infants less than 1 year old.
     - Percentage of access to education.
     - Rate of illiteracy.
     - Rate of access to clean water and sewage system.

     The results of the above indicators could be used to identify the public health vulnerability of the community. These indicators are the most important determinants of an individual's health status. Governorates ranking demonstrates that some, namely Assiut, Souhag, Fayoum, Bane Sue, Menia, Qena, and Luxor, suffer a high degree of vulnerability. Thus, the governorates of Upper Egypt are a priority.

     A high index of vulnerability is a key factor in the spread of some diseases, particularly, malnutrition and different types of infectious diseases. From the standpoint of age, children and the elderly are considered highly sensitive groups in terms of vulnerability to the impacts of climate change.

  2. **Geographical regions:**

     Studies indicate that the rise in sea levels – if adaptation measures are not implemented – will lead to the inundation of large areas of the Nile Delta and the low lying coastal areas. This will result in the displacement of a large number of inhabitants, and a high impact on the economy and the state's ability to provide food for its citizens. In terms of vulnerability, the population can be divided into three groups.
     - Grade 1- population affected: This group consists of those directly affected as a result of a severe disaster, including death, injury and displacement.
     - Grade 2- population affected: Comprises those who are indirectly affected by climate change, and are located within the disaster zone.
     - Grade 3- population affected: This group includes those who are indirectly affected by climate change, but are located outside the disaster zone.

4.2.4 Urban Areas, Housing and Roads Sector:

The UNDP's 2007/2008 Human Development Report warned against the possibility of millions in the Nile Delta being displaced as a result of floods and the rising level of the Mediterranean Sea. The Intergovernmental Panel on Climate Change (IPCC) and other research institutions declared that Egypt's coastal zone was among the major risk areas that will take the largest share of the climate change impact in the world.

It is obvious that all the impacts caused by climate change on different sectors, directly or indirectly affect all the people, their homes and the roads that connect various population communities. It is expected that with the sea level rise, some homes in the coastal areas will be inundated, which calls for preventive measures, or voluntary evacuation. The roads in the coastal areas will also be severely affected by the sea level rise, particularly the International Coastal Road stretching from Rafah to Saloum.

As for the roads located beyond the coastal areas, these may be impacted by various phenomena associated with climate change, such as new, different wind speeds and hurricanes, which will affect sand movement in open land and will have a negative impact on roads. The roads may also be affected by heavy rainfall and flash floods accompanying climate change.

It is anticipated that high temperatures will directly affect road efficiency, in terms of the quality and suitability of road paving materials for high temperatures, which may increase their viscosity, causing fissures and cracks on the roads.

4.2.5 Tourism Sector:

Climate change is a challenge for the tourism sector in Egypt, as it now stands. It may change the allure of some coastal zones, which rely on moderate summer weather, and which will be subject to more heat waves, and hence lose their attractiveness to the tourism movement. This requires taking early preventive measures. The major Egyptian tourist regions relying heavily on beach tourism are along the Red Sea coast, through hotels and vacation resorts distributed across locations such as Sharm El Sheikh, Hurghada, Marsa Alam, and Taba. The attractiveness of these areas is subject to many risks, e.g. an increase in the amount and frequency of heat waves during the summer season. This change has been monitored over the past years. In such a case, tourists exposed to these heat waves, which limit their activities on the beach during their holidays, may resort to spending their vacations in other regions, or visit such locations during the spring and autumn seasons only.

On the other hand, the interconnection between the tourism sector and other sectors such as agriculture, water resources, fishing, health, and communities, lead to tourism being directly impacted by anything that befalls these sectors. For example, the anticipated decrease in water resources as a result of climate change will affect the economics of many tourism projects that rely on water desalination, which means higher investment costs in such projects.

Local tourist destinations, such as Alexandria, Port Said, Ras el Barr, Gamasa, and Baltiem, where middle-income Egyptians spend their summer vacation, are threatened as a result of the sea level rise.

The risks and crises that may arise from the anticipated climate change are diverse. However, we will concentrate on the most important ones:

- **First: Impact on coral reefs and the brightness of the sun:**

  Coral reefs are the most diverse environmental biological systems on Earth. They are a habitat for approximately 25% of marine organisms, and they represent a great economic value to tourism activities and fishing. As a result of extensive human activities on shores that are rich with coral reefs, e.g. overfishing and pollution from tourism activities, 10% of the global coral reef systems have been lost. About 15% of these systems have been lost as a result of an increased ocean surface temperature. It is projected that other types of climate change will affect the deterioration of many coral reefs across the world in the coming decades.

  In Egypt, coral reef stretches along the southern coast of the Sinai Peninsula, particularly in the Cape Tantour area and the area between Ras Nasrani and Ras Mohammad. In the Red Sea region, the coral reefs extend from Hurghada to Elba Mountain on the southern border of the country.

  Today, there are five areas declared as marine reserves containing coral reefs. They are located on the shores of the Sinai Peninsula and the Red Sea and attract deep-sea divers. The docking of diving boats along the reefs poses an extreme danger and increases the risk of their destruction. Seven other areas have been nominated for their designation as marine reserves.

  Coral reefs are considered among the most sensitive ecosystems to climate change. Coral is particularly sensitive to the rise in sea surface temperature. When subjected to stress due to climatic factors, it loses the algae which provide it with nutrition and its beautiful colours, and veers to a mottled white colour. The brightness of the sun also has a heavy impact on coral growth. The forecasted change in hours of daylight in the future and its impact on the coral reefs in the Red Sea are issues that require further study.

- **Second: Increase in relative humidity and the possible impact on archaeological sites:**

  The tombs of pharaohs, with their coloured walls and highly detailed inscriptions are the most vulnerable antiquities in terms of exposure to climate change, such as the high humidity resulting from the tourists' respiration when visiting the tombs, and the increase in carbon dioxide. Therefore, in order to reduce the negative impact, it is recommended that the microclimate[1] within these tombs be monitored, the number of visits made to the tombs be reduced during summer when relative humidity rises, and a system to manage these visits be devised. This would allow the tombs to be alternately opened for visitors. The Supreme Council of Antiquities has definite plans for preserving antiquities. The emissions sometimes directly affect the inscriptions and colours on statues, causing them to be erased. Such changes may also lead to the disappearance of the engravings on some antiquities, as is the case on the west bank of Luxor. As a result of the abundant visits of the statues of Tutankhamen and Set, all the engravings on them are beginning to be affected. In addition, the humidity in the area has also led to the appearance of different types of insects

[1] A local climate area differing from the climate prevailing around it.

and bacteria inside the archaeological site. The site is currently being restored. The Supreme Council of Antiquities has begun to restore a number of sites, which have been affected by climate change. The sea level rise, the construction of the High Dam, and the continuous irrigation in Upper Egypt and the Delta zone are sure to raise groundwater levels under some of the tombs, threatening to flood them.

- **Third: Sandstorms and the disappearance of ancient inscriptions:**

  The speed of wind loaded with sand poses another danger on open ancient Egyptian temples. They erode the engravings on the walls. Wind velocity is changing, but wind-tracing forecasts are not available in Egypt.

  It is fair to say that the antiquities will not totally disappear as a result of climate change. The Supreme Council of Antiquities examines all artefacts – whether in the desert or along the coastal area – and restores any piece that shows the slightest damage. However, the change in climate conditions, aerial currents, and sand or dust storms may provoke the erosion of some antiquities. This is what is currently taking place at the site of the Sphinx, where parts of the monument were eroded; however, it was restored. The antiquities in the desert areas differ from those that are near the coastal areas. The antiquities in the desert are subjected to more sand and dust storms. The intense heat may also lead to some ancient artefacts drying up and assuming a form that is similar to limestone. In that respect, periodical coordination takes place between the Antiquities Authority, the National Authority for Remote Sensing and Space Sciences, the National Research Institute for Astronomy and Geophysics, and the Groundwater Research Institute which provide the Antiquities Authority with instant solutions on how to deal with any archaeological site of which the contents are damaged as a result of climate change.

- **Fourth: Archaeological sites in Abu Keer, Qaitbey Citadel, Selsela (eastern harbour) in Alexandria, and the Rosetta area:**

  Some of these sites – currently above sea level - may be affected as a result of the rising sea level. The monuments that are located below sea level will not be affected as they are already submerged. The rise in sea level will further protect them from various eroding factors. Following is a more detailed overview of each site:

  1. Abu Qir Site:

  Abu Qir includes three sub-sites: Eastern Canopus, where some antiquities are submerged at a depth between 4 and 6m below sea level. It is 2km away from the shore. Some of Heraclius' antiquities are submerged at a depth between 5 and 8m, about 6km away from the shoreline. The European Institute has been carrying out excavations in the area since 1996. The policy is to first pick up the small pieces in order to save them from damage or loss, until the museum intended for submerged antiquities is constructed. Desouki's Island (Nelson's Island) is subjected to erosion and the effect of tides. No protective measures have been taken, despite the existence of a cemetery on the site, which dates back to the era of pharaohs. It is located within the island's military zone.

2. **Qaitbey Citadel:**

   This is a site where antiquities are submerged at a depth between 5 and 10m. Alexandria University's Centre for Maritime Archaeology & Underwater Cultural Heritage and the Egyptian Antiquities Authority's Department of Underwater Antiquities have been excavating on the site since 1994. A study for its protection was conducted in 1997, and recommended a double protection for the submerged site and the Qaitbey Citadel. The study took erosion factors into account, as well as sedimentation, and sea currents. As part of the study, blocks of stone were lifted off the archaeological site and moved to the north of it in order to form a wave barrier. The Citadel was surrounded by concrete blocks after suffering from the humidity.

3. **Selsela and the Eastern Harbour**

   Selsela is one of the most important underwater archaeological sites. Its inclusion among the UNESCO World Heritage sites is recommended. Excavations are being conducted since 1996 by an expedition from the European Institute of Underwater Archaeology. The Egyptian Antiquities Authority plans to construct an underwater museum on that site.

4. **Rosetta Area:**

   The Egyptian Antiquities Authority has had the area designated for archaeological excavation, although the work has not yet begun. However, as a result of increased carbon dioxide emissions – with the resulting rise in the Earth's temperature – its grave consequences are expected to impact the antiquities in that area.

- **Fifth: possible effects of the low level of the Nile:**

  Many studies point out to a potential decrease in Nile water level as a result of several types of climate change and development projects in the upstream source countries. This directly threatens the movement of floating hotels and Nile tourism in different parts of the river, particularly the Luxor – Aswan sector, where about 300 floating hotels of different sizes are located. The docking of Nile boats and floating hotels is an annual phenomenon, particularly during the winter season. It is a problem that Nile tourism suffers from due to the low water level, the appearance of islands in the river stream, and the waterway between Qena, Luxor and Aswan not being cleaned.

- **Sixth: Rising levels of the Mediterranean and Red Seas:**

  In the event that the sea level rises, coastal tourism will lose most of the sandy beaches below a one meter sea level, unless they are protected by suitable constructions. If the sandy beaches are lost, the tourism sector in the coastal areas will suffer the consequences. Beach tourism still accounts for 60% of the volume of global tourism.

- **Seventh: high temperatures in tourist areas:**

  The high temperature in tourist areas may alter the attraction of some coastal areas that rely on moderate weather during the summer season. They will be subjected to heat waves more often, and therefore lose their attractiveness for tourism. In some cases, this will lead to a slowdown or a complete halt of

tourism and travel to those affected areas. In turn, this will reflect in the weakness of the projected revenue from tourism.

- **Eighth: thunderstorms, high waves, and increased rainfall in coastal zones:**

  This includes high waves and tsunamis in the Mediterranean and Red Seas. According to some meteorological forecast research, it is likely that Alexandria and the North Coast will be hit by a severe sea storm, resembling a tsunami, which will cause significant human and financial casualties, particularly with most tourist resorts, and development projects located along the beaches of Alexandria and the North Coast. It is unlikely that those in charge of the construction of these areas based themselves on scientific studies on the ideal behaviour in the event such a storm hits. It is believed that the storm may occur after the eruption of an underwater volcano, provoking a strong earthquake, and giving rise to extremely high waves. On the other hand, waves are currently over 3m high at Marsa Alam and the southern part of the Red Sea. This represents a danger to maritime activities beyond the barrier reef.

Chapter V

Adaptation to Climate Change and Risk Reduction

Adaptation is defined as: "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities." (UNFCC Secretariat)

The ability to adapt to climate change depends on several factors, among which are the following: available infrastructure, resources, technology, information and the extent of equitable distribution of resources.

This chapter summarizes the general framework and the principles related to the adaptation to climate change and risk reduction for sectors and areas covered by the strategy. The proposed framework of the action program of adaptation to climate change will be presented in Chapter 9 of this strategy.

5.1 The Coastal Zone:

The process of selecting the appropriate approach for adaptation to and coping with the risks resulting from climate change (including extreme events such as tsunamis, expected sea level rise, high tidal waves, and repeated exposure to floods and cyclones) depends on the extent and type of potential harm to the sectors in coastal areas. These means usually include a myriad of methods of positive or precautionary defense lines accompanied by a package of preventive measures of social and economic development.

According to the Intergovernmental Panel for Climate Change (IPCC 1992), the adaptation responses to deal with sea level rise are:

- Retreat according to plans prepared in advance.
- Accommodation.
- Protection.

This strategy primarily adopts **accommodation and protection** as the basis for adaptation to the risks resulting from climate change, taking into account retreat, according to plans prepared in advance, in the event that the coastal areas are exposed to storms and hurricanes or any extreme event. Action will proceed according to the expected scenarios mentioned in the introduction of this strategy, which provide that the States should ensure that the expected rise in temperature should be no more than two degrees Celsius until the year 2100. Meanwhile, two scenarios are proposed for dealing with the change of sea level rise:

- First. A sea level rise of about 0.5m.
- Second. A sea level rise of about one meter.

In view of the scientific progress and continuous updating of assumptions on the expected impacts resulting from climate change, and in turn adaptation, it was necessary to introduce a flexible and living strategy. Accordingly, the adaptation programs of this strategy addressing climate change for the next hundred years will be dealt with according to the strategy within four-year plans only (over the next twenty years) while pursuing the developments until the end of the century.

Table (17) and (18) clarify the vulnerability and the potential harm that might affect the Egyptian coastal zone by potential disaster risks of sea level rise, which are classified under 5 degrees as follows:

1. Severe harm(+++)
2. Moderate harm(++)
3. Low harm(++)
4. Extreme events (#)
5. Safe (*)

The proposed means and programs for adaptation to disaster risks of sea level rise are covered in detail in Chapter X of this strategy.

Table (17)
Vulnerability of coastal areas and potential harm caused under sea level rise scenario (50cm)

Sector	50 cm sea level rise scenario				
	(+++)	(++)	(+)	(#)	(*)
1. **Northwest coast:**					
- Total coastal plain					
- Beaches (elevation 0 to +1m)					
2. **Alexandria:**					
- Total Coastal plain					
- Low land, e.g., Lake Marriout, south of the city (western extension El Tarh Depression).					
- Beaches (elevation 0 to +1m)					
3. **Nile Delta:**					
- El Tarh Depression.					
- West and East of Rashid extension					
- West of Damietta port.					
- Coastal lakes barrier.					
- Sand dunes.					
- Constructional protection works.					
- Sea water intrusion					
- Beaches (elevation 0 to +1m)					
4. **North Sinai:**					
- Total coastal plain					
- Sahl El Tina					
- Lake Bardaweel					
- Storm water drains					
- Beaches (elevation 0 to +1m)					
5. **The Red Sea:**					
- Total coastal plain					
- Storm water drains					
- Beaches (elevation 0 to +1m)					

Source: Information and Decision Support Center – Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

Table 18
Vulnerability of coastal areas and potential harm caused under sea level rise scenario (1m)

Sector	100 cm sea level rise scenario				
	(+++)	(++)	(+)	(#)	(*)
1. Northwest coast:					
- Total coastal plain					
- Beaches (elevation 0 to +1m)					
2. Alexandria:					
- Total coastal plain					
- Low land such as Lake Marriout, south of the city (western extension of El Tarh depression).					
- Beaches (elevation 0 to +1m					
3. Nile Delta:					
- El Tarh Depression.					
- West and East of Rashid extension					
- West of Damietta Port					
- Coastal lakes barrier.					
- Sand dunes.					
- Construction protection works.					
- Sea water intrusion					
- Beaches (elevation 0 to +1m					
4. North Sinai:					
- Total coastal plain					
- Sahl El Tina.					
- Lake Bardaweel					
- Flood water drains					
- Beaches (elevation 0 to +1m level)					
5. The Red Sea:					
- Total Coastal plain					
- Flood water drains					
- Beaches (elevation 0 to +1m					

Source: Information and Decision Support Center – Advisory Committee for Crisis/ Disaster Management and Disaster Risk Reduction.

Following is an introduction of the adaptation measures to potential disaster risks resulting from a sea level rise caused by climate change:

1. **Studies**: To conduct detailed studies on the effectiveness of the proposed adaptation measures (including methodological studies, usually conducted before building or rehabilitating the constructions for the protection of shores), in order to assess destructive factors, including extreme events, or deal with high sea levels rises, as well as meet the risks of torrential rains and floods.
2. **Rules:**
   - To develop additional rules for coastal development, covering the impact of climate change.

- To only allow the establishment of viable and accommodated small beach construction.
- To include the Environmental Impact Assessment (EIA) for projects that would be established in coastal zones (with a special section on the impact of climate change).
- To set binding limits and conditions when issuing drilling permits for the withdrawal of groundwater.

3. **Structural and architectural intervention, including:**
   - Conventional and unconventional engineering protection works (maritime walls, submersible barriers, shore coating, soil fixation, and prevention methods for seawater intrusion into land including the implementation of covered and uncovered sanitary drainage projects), and the protection of coastal buildings and constructions and electricity, water, and sanitation grids.
   - Artificial nourishment with sand to compensate for the erosion of the beach, which, if necessary, may be accompanied by the establishment of solid protection measures such as stone heads or submersible barriers, in order to increase the space, which will lead to the protection of the back shore from attacks by the sea, and address the rise of sea level.
   - Reinforcement of anti-flood protection structures and construction of new ones. These are civil constructions that would break flash floods or prevent them from reaching populated areas, and areas of economic infrastructure.
4. **Rehabilitation of installations,** such as the International Coastal Road (Rafah to Salloum), the Mohammad Ali sea wall, and the embankments of Al Salam Canal (from Damietta to Sinai), and strengthening of the existing protection structures to act as wave breakers, in addition to their regular functions.
5. **Reinforcing natural protection:** this includes:
   - Maintaining natural protection (sand dune stabilization through the cultivation of wild plants and wooden barriers).
   - Preserving natural defense lines against sea encroachment or sea level rise, i.e. rocky coral reefs adjacent to the shores of the Red Sea or limestone barriers along the northwest coast from Alexandria to Salloum.

5.2 Affected Zones:

5.2.1 Water Resources and Irrigation Sector:

Adaptation measures in the water resources and irrigation sector include the following elements:

A- Adaptation to Uncertainty:

The uncertainty in determining the climate change impact on the normal flow of the River Nile is high. This requires an elevated degree of flexibility in assessing the normal flow. Hence, in the event of an average flow scenario, adaptation options include:

- Operating the High Dam at the lowest water level in order to allow for the reception of high flows. This option was studied during the Lake Nasser Flood and Drought Control project (LNFDC). It was proven that under the current conditions – in the absence of climate change – it may be beneficial to lower the water level at the beginning of August of each year, from 175m to 170m, or even 165m above sea level, with a slight increase in the risk of drought occurring. The main benefits are: to reduce evaporation losses and water spillage to the Tushka depression; and consequently surplus water can be used to increase irrigated lands.

B- Adaptation to an Increased Flow of the River Nile:

For the high flow scenario, in addition to the options mentioned above:

- Additional storage capacities may be needed for the High Dam in order to reduce the risk of downstream spilling. The 2004 model of the Hydro Meteorological Forecast Center of the Ministry of Water Resources and Irrigation showed that the probability of the water level in Lake Nasser exceeding the 183 meters under the current operating rules was 6%, therefore, lowering the operating level (at the beginning of August) may be sufficient in some cases, but if the increased flow occupies a large area of the storage capacity, the likelihood of a problem arising due to water deficit may increase.
- Egypt has built reservoirs in upstream countries in the past; therefore the Nile Basin Initiative may be the appropriate approach to take in order to make such crucial decisions, especially if these reservoirs have mutual benefits, such as flood protection and generation of hydroelectric power.

C- Adaptation to Low Flows of the River Nile:

In the drought scenario - regardless of the low level of the natural flow of the River Nile - Egypt is bound to face water shortage, even in the absence of climate change. As a result of the increased water demand and the limited possibilities of water supply, it has therefore developed policies to address water shortages through the National Water Resources Plan issued in 2005. Water shortage resulting from climate change may exacerbate the problem, but the current water policies include many strategies that can serve as an adaptation to water shortage for any reason. Following is the list of some of the strategies developed under the 2005 National Water Resources Plan (NWRP). It can be divided into three main areas:

- Rational use of available resources.

- Addition and development of new water sources.
- Protecting water quality from pollution and improved treatment.

Regarding the use of water for drinking, household, public and industrial purposes, the implementation of water demand management would improve the efficiency of water use. In this regard, the following measures are suggested for water demand management:

1. Pricing of water use in municipal and industrial activities, and ensuring the provision of the necessary equipment for accurate measurement.
2. Launching a national campaign to raise water awareness among citizens.
3. Improving the distribution network (pipes, valves, tanks, etc.) to reduce losses caused by leakage.
4. Recycling treated wastewater.

Maximum utilization of rainfall and flash flood water:

A dry desert climate prevails over the greater part of the territory of the Arab Republic of Egypt, with the exception of some coastal areas characterized by the Mediterranean climate, where rainwater is the main source for rainfed agriculture, which contributes to the groundwater reservoirs. Rainfall in Egypt is characterized by its instability and scarcity from one year to another, accompanied by extended dry intervals as well as agricultural and pastoral farming problems. This instability could denote a wave of flash floods with devastating and undesirable environmental and social impacts. The total amount of rainfall and flash floods that could be used annually is estimated at around 1.3 billion cubic meters. This quantity can be increased to 1.5 billion cubic meters upon taking the following measures:

- Expanded construction of dams and reservoirs to collect this water and use it for drinking or agriculture directly, or for storage in groundwater reservoirs.
- Using modern techniques in the field of water harvesting, such as remote sensing and geographic information systems, in order to study the basic properties of the flood prone areas. This includes the study and analysis of surface runoff and the identification of the characteristics of the basin and soil type.
- Avoiding the risks that may result from flash floods through mapping risk assessments for each area, and taking the appropriate precautions to avoid potential risks. It is worth mentioning that the Ministry of Water Resources and Irrigation is preparing an atlas and code for flash floods in Egypt, which covers the use of water, and how to avoid risks that may arise from them.

5.2.2 Agriculture:

The development of a strategy for adaptation to climate change that is based on the general principles of crisis and disaster management and risk reduction depends on the following factors:

- Flexibility of the policy.
- Use of modern technology.
- Diversity in the proposed systems.
- Development of a system for the management of risks and crises.
- The strengthening of systems protecting agricultural productivity and rural communities against negative impacts of climate change.

Given the expected impact on agricultural production and rural environment, and considering the objectives that have been suggested for capacity strengthening,

there are nine key areas of capacity development for adaptation to climate change, as follows:

A- Building an Effective Institutional System for Crisis and Disaster Management: to follow-up on climate change at the national or regional levels. Policy flexibility relies on the follow up of changes in climate indicators of direct impact (temperature, evaporation, sea level rise), as well as the consequences of these impacts on the agricultural environment and rural community; this necessitates:

- Strengthening the capacity of monitoring, forecasting, analysis and dissemination, in current and future agricultural areas (horizontal expansion zones), through the creation and installation of monitoring stations for climate impact indicators on productivity (temperature, greenhouse gases, relative humidity, change in groundwater quality, change in organic and inorganic nutrients content of the soil, fish migration, plant and animal biodiversity and micro-organisms, agricultural productivity, intrusion of sea water into the Delta lands, and others).
- A program for monitoring and follow-up of the vulnerability index and risk assessment of different agricultural environments for each of the agricultural sectors (plant, animal and fish production, land resources, farm irrigation and rural community).
- Development of an effective system for exchange of information on climate change at the regional and international levels.
- Building dynamic expert systems to provide information, analysis and recommendations on any climate indicators changes related to agricultural productivity for the farmers, decision-makers, specialists, researchers and the general public.

B- Biodiversity:

- Biodiversity, both on the level of genetics, species or ecosystems, leads to an increase in the capacity of the agricultural sector to maintain production efficiency under various climatic and expected conditions. All programs of the production of crop varieties, and programs aimed at improving the capacity of the livestock sector, or the introduction of new crop or animal varieties, depend on the existence of programs that preserve biodiversity, as follows:
- Estimation of vulnerability index and risk assessment for the items of biodiversity that are exposed to different ecosystems.
- Feeding the national database with biodiversity records of the most vulnerable ecosystems
- Conservation and development of the use, exchange and classification, of biodiversity items in the most vulnerable ecosystems, both *in-situ* or *ex-situ*, by making use of the relevant international conventions, including the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and others.
- Strengthening the capacity of the National Genes Bank and other biodiversity banks in the more vulnerable areas, the most important of which are desert areas.
- Expansion of natural protectorate systems with the development of their performance to become centers of excellence participating in the

improvement and development of the productive agricultural sector, through genetic species or ecosystems, which have the capacity to adapt to climate change.

C- Plant Production:

The strategy on the adaptation of plant production to the expected changes in various climate indicators is based on the expansion of genetic diversity of the plant varieties that are available to farmers. It is also based on the expanded use of new species and plant traits (according to the results of the vulnerability index and risk assessment); hence the importance of genetic modification programs, through the strengthening of specialized gene banks, as well as the interim modification of the agricultural practices policies. Multiple studies have been conducted in this regard. Thus, it was possible to overcome the productivity shortfall problem of crops that have been adversely affected by these changes, or at least mitigate them.

The most important specialized adaptation programs proposed include the following:

- Determination of the vulnerability index and risk assessment facing the plant production sector.
- Introduction of breeding programs for important plant varieties of field and horticultural crops that are capable of adapting to the expected changes in climate indicators, including: gradual temperature increase up to two degrees Celsius, high salinity of the soil, relative dryness (reduced on farm water duties up to 50%), resistance to insect diseases, resistance of new microbiological and pathological species likely to spread with increased humidity, and higher rates of evaporation and temperature.
- Improvement of plant programs with the objective of developing a map for the observation of plant diseases and their causes, their prevalence in different agricultural environments and major crops as a result of changes in climate indicators, and assisting plant breeding programs in developing priorities on how to combat pathogens, and how to neutralize their impact on the efficiency of production.
- Strengthening plant protection programs to follow up on the changes in the biological diversity (species and varieties) of insects, and its association with trends in the relevant climate change indicators. Identifying how to maintain a positive balance which benefits agricultural production in different environments.
- Development of new varieties of crops with short growing seasons to reduce their water requirements.
- Expansion of cultivation of crops of economic importance, which can adapt to climate change (e.g. rice), while taking into account the use of new farming systems to adapt to changing expectations in water supply and the gradual replacement of sugar cane by sugar beet.
- Gradual modification of agricultural practices polices every five years, in order to adjust to the forecasts and analysis of climate indicators that are monitored by regional and international agro-meteorological stations.

D- Soil and Agricultural Land Management:

Soils are considered as the most important and fundamental element of agricultural production. Adaptation to projected climate change requires the increase in soil's ability to neutralize the expected changes in climate indicators.

The most important adaptation programs are:

- Determination of vulnerability index and risk assessment of agricultural soils as a result of climate change.
- Building an integrated information system for agricultural land (in terms of mineral and biological fertility, topographic, hydrological, climatic elements and uses).
- Increasing the content of soil organic matter, which helps conserve the build-up of resistance against flooding or droughts.
- Soil amelioration programs based on reducing soil salinity and alternating the uses of land in the northern Nile Delta in agricultural activities (rice) or otherwise (fish farms).

E- Management of Water Resources and Farm Irrigation:

The changes in climate indicators expected until the year 2100 will have a direct impact on water requirements of crops and their current characteristics. This will lead to reduced water use efficiency; water requirements are consequently expected to increase from 5% to 13%, with higher temperatures and increased evaporation and transpiration rates.

Adaptation to the above expectations requires the following:

- The use of breeding programs to modify the genes of plant varieties, including high osmotic water pressure, attributed to either a reduced moisture rate in soil layers surrounding roots, or high osmotic pressure due to high salinity.
- The use of new irrigation techniques based on Precision Farming.
- The increase of irrigation water efficiency to 75%. This requires an improved efficiency of farm irrigation in old lands.
- Higher concentration of organic matter to improve soil ability in order to retain moisture against increased evaporation or higher temperatures on the surface layer.

F- Livestock Production:

- Determination of vulnerability index and risks assessment of the components of livestock production as a result of climate change.
- Relying on biodiversity to improve livestock production against climate change, especially in terms of species, and the extent of their adaptability to the gradual temperature.
- Mapping of animal pathogens, its association with changes in climate indicators, their impact on the productivity of dairy and meat coming from different types of livestock, and the development of prevention and immunization programs.
- The support and development of serum and vaccine technologies and industry for diseases that are expected to appear and spread with the change in climate indicators, including common diseases between animals and humans.

- Reliance on biodiversity in the introduction of new fodder as a source of energy, fiber and protein.

G- Fish Wealth

- Estimation of the vulnerability index and assessment of the risks facing fish stocks as a result of climate change.
- Conservation of biological diversity and reducing the rate of losses in different species.
- Conservation of the density of fish growth in terms of quality and economic importance.
- Protection of the components of the ecosystem for fish farming, which contributes to the growth and diversity of fish catch.
- Protection of fish resources from pathological infections and diseases resulting from the environmental change of components (temperature, water quality, vegetation structure, food sources).
- Protection of fish communities against new species, which affect the biological and environmental balance of fish wealth in Egypt.

H- Modification and improvement of agricultural economic systems:

- Development of flexible agricultural economic systems, as well as new structures for crop management, fish farming and livestock production. Such policies are to be applied in light of the ongoing climate changes; they include:
  - Participation in economic risk assessment studies of climate change in different agricultural areas.
  - Joint management of scarce agricultural resources (land and water).
  - Government support and insurance against the risks of climate change.
  - Economics of fish farming and alternative uses of water logged lands in the north of the delta wetlands.
  - Economics of staple crops and improvement of food security and crop combinations.
  - Agro-industry and marketing of agricultural products and price forecasts.

I- Rural Community:

In order to assist it in adapting to climate change, rehabilitation of the rural community depends on the following:

- Studies and descriptions of the current status of the rural community, its traditional knowledge, and ability to cope (vulnerability index and risk assessment).
- Identification of the best methods and programs necessary to support the capacity of small farmers in adapting to climate change through the multi-stakeholder approach (farmers, civil society, agricultural extension, agricultural cooperatives and others).
- Capacity development of rural communities to participate in the management of their resources (soil, water, fertilizer and outputs), as well as participate in decisions related to and consistent with the expected changes in climate indicators, and their impact on the productivity of the rural family.

- Capacity development of rural communities to participate in the development and implementation of national policies in the field of adaptation and disaster and crisis risk reduction.

5.2.3 Health Sector:

Capacity building is considered the key step for an adaptation strategy in the field of health, including: education, training, awareness-raising, and creating an enabling environment for decision-makers to make judgments based on knowledge, in order to achieve long-term benefits for the community.

A- Raising the efficiency of the health care sector to deal with climate change:

Climate change is of such a high importance that it is essential to be placed as one of the priority themes in the plans and projects of the Ministries of Health and Population. Health reform programs, particularly the basic benefit package and the health insurance programs, should include methods of prevention and treatment of health hazards resulting from climate change. Therefore, the health problems and negative effects of the short- and long-term consequences of disregarding these problems must be clearly identified. Thus, it is also necessary to give climate change top priority in research and scientific studies in all specializations.

The state offers integrated programs for primary care based on availability and justice for all citizens, so that the poor and marginalized segments would not bear the cost of care. The state covers the expenses of developing primary healthcare units throughout rural and urban areas. It also provides free vaccinations and preventive programs against infectious diseases. More than 98% of the population is covered and as a result many infectious diseases have been successfully eradicated.

It is essential that the strategy aim at improving the efficiency of the healthcare units, and enhancing the quality of service so that the impact of climate change can be managed (either communicable or non-communicable diseases) in upper and lower Egypt, and in urban and rural areas alike. This goal could be achieved through the following measures:

- Completing the development of an infrastructure for health service delivery units.
- Developing a surveillance system for infectious diseases and disease vectors.
- Developing vaccination programs and increasing the budget allocated to vaccine research and production.
- Establishing an integrated database for diseases associated with climate change, and making it available to all concerned parties: government, private sector, civil society including NGO's, with a program for information exchange between these various entities.
- Training technical teams on medical methods and means for dealing with the phenomena associated with climate change.
- Raising the efficiency of emergency departments to receive (and care for) injuries caused by sudden and extreme events such as hurricanes and floods.

Malaria control strategies can be used as a model, given that it is one of the most serious diseases expected to spread as a result of climate change. The model can be used as an example for dealing with other diseases. Strategies for

malaria control include: early diagnosis, prompt treatment, preventive and specific measures including the ongoing control of mosquitoes that transmit the disease, and prevention or containment of the epidemic. The strategies also include building local capacity in basic and applied research so that the malaria status in the community can be continuously assessed; particularly the epidemiological, social and economic determinants of the disease. The progress in mapping malaria, through the use of satellite data, which are verifiable ground surveillance data, will help achieve the goal of controlling the disease. Table 19 depicts the types and the degree of importance of the adaptation strategies for malaria and the levels at which they are carried out as recommended by the World Health Organization (international, regional, national, local, individual).

The strategies are divided into four levels of importance as shown below:

1. Very important strategy (+++).
2. Important strategy (++).
3. Unimportant strategy (+).
4. No strategy (-).

Table 19
Strategies for adaptation to malaria at different levels

Level	Mosquito control	Vaccine development	Procurement of anti-malarial drugs	Preventive measures, such as mosquito nets and house design	Epidemiological prediction	Environmental management
International	++	++	+++	+	-	-
Regional	++	-	++	+	-	-
National (state level)	+++	-	+++	+	+++	+
Local (society level)	++	-	+	++	++	+++
Individual	+++	-	+	+++	+	++

Source: World Health Organization, 2004.

B- Developing weather and seasonal forecast and early warning systems:

It is important to provide citizens with weather forecasting information through weather forecast technology and modern hydro-meteorological systems, in order to give them the opportunity to take appropriate measures at the right time, and hence reduce injury, sickness and deaths. Air conditioners, fans, and ventilators must be made available, particularly in public and crowded areas.

C- Raising awareness on pro-active health measures:

In line with the main objective of the national strategy, which is to increase community awareness on the means of limiting risks and confronting crises and disasters, this can be accomplished on two levels:

- Political and strategic level: activating the role of the media and civil society, and coordinating efforts carried out by the Ministry of Health and other relevant ministries.
- Executive level: raising citizens' awareness and promoting changes in health behavior that would limit any harm resulting from exposure to climate change.

To this end, it is important to define the following elements:

- Target groups, with a special emphasis on health and social care for marginalized groups who are more susceptible to health hazards caused by climate change.
- A general framework of messages delivered, which should include the identification of possible health hazards and methods of prevention for infectious diseases, chronic diseases, malnutrition, or health hazards resulting from direct exposure to heat or sunlight. The messages should also advocate the principles of proactive health through:
  - Raising awareness about the importance of vectors, parasites and micro-organisms that grow with rising temperature.
  - Raising awareness about the means of maintaining food safety.
  - Raising awareness about preventive measures in case of extreme events such as floods and severe storms and hurricanes.
  - Raising awareness about the coordination and distribution of responsibilities between government agencies and non-governmental organizations.
  - Supporting volunteer programs and encouraging NGOs to promote active participation.
  - Providing appropriate methods and tools to deliver messages in an attractive and convincing way in order to achieve the intended goals, most notably through the use of mobile phones.
  - Introducing any necessary change in target groups and indicators to measure and evaluate the success in achieving objectives, particularly behavioral changes.

D- Promotion of scientific research

The promotion of scientific research and field and demographic studies for the areas and population groups that are most vulnerable to climate change are the most important means for supporting the adaptation process. The results of researches and studies are the simple way to obtain the necessary information for coping with the impacts of climate change.

Attention must also be directed towards domestic and international coordination in the fields of scientific and demographic research, in order to assess the present situation, identify the strong points and weaknesses in the research policies and capabilities, and bridge the gap between what is available and what is required.

The information required in the field of health is mainly related to the accurate determination of the epidemiological trends of the health problems expected to occur, and a clearer understanding of pathogens and factors that lead to their occurrence. This will help precisely identify the risks, and develop methods and

strategies appropriate for the prevention and reduction of health risks. This requires the following interventions:

- Special epidemiological studies related to the life cycle of pathogens and vectors, as well as methods of prevention of epidemic diseases, especially through vaccination.
- Special studies on the movement and migration pattern of disease vectors (particularly mosquitoes) and the effect of this on the occurrence of the disease.
- Scientific studies on the biological means of controlling disease vectors.
- Studying and developing available systems to monitor pathogens and disease vectors.
- Develop methods of early detection of various diseases.
- Open channels of communication at the regional and international levels to identify and classify pathogens and methods of infection and prevention.

E- Improvement of social and economic conditions and population characteristics:

In order to properly deal with the expected effects of climate change it is important to identify the current social and economic situation and needs. This will help ensure that the allocation of resources and services is in accordance with the actual needs. More focus should also be concentrated on the population issue and the programs aiming to reduce population density, improve the quality of life, and raise awareness, in particular on how to deal with the elderly and children.

5.2.4 Rural Areas, Housing and Roads Sector:

In the sector of urban areas, housing and roads, there are two means of intervention for adaption to the climate change impacts:

- Soft interventions: These include community awareness, changing administrative policies and procedures, including emergency measures that guarantee the prohibition or halt of some activities until the picture becomes clearer, and preventing the exacerbation of any possible negative effects of climate changes.
- Hard interventions: These include the physical identification of the size of the affected population, and the processing of alternative sites and communities in the case of involuntary displacement. It is also worth mentioning how, today, urban centers in Egypt suffer from hot air resulting from the use of energy in buildings, i.e. heat islands. The increase in global temperature, resulting from climate change, aggravates the situation.

Moreover, orienting buildings in the streets will have a strong and effective impact on energy saving and should limit the amount of emissions coming out of those buildings. The emission rate from the buildings is also dependent on the external color of the building. Dark colors are good emitters, while light colors are weak emitters.

Adaptation measures to climate change include the following:

A- Adaptation in the Field of Housing and Buildings:

The Egyptian Council for Green Architecture was created in January 2009 – under the chairmanship of the Minister of Housing, Utilities and Construction Development – with the aim of disseminating and implementing the idea of green architecture. The idea is based on directing city and village planning, and architectural and constructional design towards meeting the requirements of green architecture. This includes:

- Efficient energy utilization. Most of the energy used in buildings goes to electric lighting. Certain conditions and factors pertaining to the design of windows in a way that would increase natural light must be taken into consideration in building design. This will reduce Greenhouse Gas (GHG) emissions.
- Transfer and localization of the latest technology in the generation of new and renewable energy.
- Rationalization of water use through the improvement of domestic tools (taps, toilet flushing boxes, etc), separating the drainage network of kitchens and bathrooms, from that of toilets, and reusing gray water.
- Transfer and localization of the latest technology in the field of water recycling.
- Environmental compatibility of buildings.
- The use of environmentally friendly construction material.
- Recycling of agricultural or industrial solid waste, and using this waste in the manufacturing of construction materials or compost[1].
- Inventing and devising new environmentally friendly construction methods and systems.
- Issuing a green architecture code.
- Establishment of a national authority for green buildings using the Leadership in Energy and Environmental Design (LEED), and Building Research Establishment Environmental Assessment Methods (BEREAM).
- Adoption of an energy code. The National Center for Housing and Construction Research – of the Ministry of Housing, Utilities and Construction Development – issued a code pertaining to energy in residential and commercial buildings.
- Natural ventilation. This can save 10% – 30% of the electricity used for air-conditioning in houses, and help in reducing excessive heat emitted from buildings.
- The efficiency of national educational institutes. Educational curricula in many universities include teaching climate change programs in the environment, architecture, architectural design and urban planning, and civil engineering departments. They address energy saving in buildings, the inefficient use of energy in modern architecture, and the basics of green architecture. These programs need to be more effectively disseminated in order to raise awareness about climate change and the means of adapting to it (Second National Communication).

[1] Compost is plant or organic remains, or a mixture of both, that have undergone total decomposition. It is rich in important nutritious matter needed for healthy plant growth.

B- Adaptation in the Field of Roads:

- The use of bitumen1 with a certain degree of hardness commensurate with the high temperature of the road network, in road construction or in maintenance work.
- The use of alternative of transportation must be taken into consideration. Public transportation must be developed in order to reduce the use of private cars.
- Redirection of floodways away from roads.
- Construction of obstructive dams to slow down the flow of floods, and protection and diversion dams to direct floods to the main drainage basins.
- Construction of bridges over waterways to allow floodwater to flow unimpeded.
- Study the movement, speed and direction of wind and the movement of sand dunes to protect desert roads as well as railways running through the desert areas against coverage by sand.
- Review of the road network to determine potential areas vulnerable to flooding in coastal areas, as well as review of new projects proposed in the low-lying areas (Second National Communication Report).

C- Adaptation in the Field of Housing:

- It is important to immediately initiate the voluntary evacuation of some inhabitants in the areas that will without doubt be inundated with water – even if the sea level is not rising – and provide them with alternative housing. This includes preparing proper means of living for them, i.e., agricultural, industrial or commercial activities.
- Instigate the replacement and renovation of old houses in urban and rural areas, which are liable to collapse rather than wait for the occurrence of extreme weather events that may lead to their destruction.
- Conduct a large-scale campaign to remove all homes located in floodways, determine the safety margin for each floodway, and prevent any encroachment on that margin in any form. This includes the River Nile, its branches, all canals, drains, irrigation and drainage installations and works across the country.
- Educate farmers on all information related to climate change and the diseases that may be transmitted to them or their livestock, and the methods of prevention.
- Secure factories and private and public buildings that are expected to be affected by sea level rise. If the need arises, they should be moved to safe locations and alternative housing and employment should be organized for the workers.
- Observe all of the measures mentioned in this strategy – which concerns the population in all sectors – and apply these measures to them.

5.2.5 Tourism Sector:

The process of selecting the means and methods of adaption to and coping with risks that could result from climate change and its expected impacts on the areas of

[1] A mixture of black, highly viscous and organic liquids. It is used in paving roads (with asphalt), and as an insulator.

touristic development in particular, as well as on the tourism sector in general, includes a combination of protective and precautionary measures, and other direct and positive defense measures.

- **Preventive and precautionary measures:**
  - **Proclamation of marine and wildlife protectorates**: This is one of the effective adaptation measures for environmentally vulnerable areas within tourist sites, which are most vulnerable to risks according to the criteria governing the selection of protectorates.
  - **Implementation of integrated environmental management systems in touristic sites**: The Tourism Development Authority has already submitted a proposal for an integrated environmental management system for the coasts of the Red Sea – funded by the Global Environment Facility (GEF) – which included several suggestions that are considered as efficient adaption means.
  - **Assessing the degree of fragility and vulnerability to risk of touristic sites and sites of archaeological value**: This assessment should be carried out in accordance with effective standards, as a method of adapting to the impacts of climate change.
  - **Orienting tourism growth away from environmentally sensitive areas and areas that are most at risk to less sensitive and vulnerable ones**: The objective is to deal with adaptation to climate change on the planning level in a protective and precautionary manner, through the orientation of expected tourism growth away from environmentally sensitive areas and the areas that are most vulnerable to climate change. The outcome should be that tourism will be directed towards areas that are less sensitive and less vulnerable to these risks, by adapting to the expected changes before they actually occur.
  - **Developing a monitoring system for the expected impacts of climate change in touristic sites**: This includes the determination of specific measurable indicators and criteria that assess the various effects of climate change which are detected in touristic locations. The assessment results and different indicators must be exchanged in order to ensure an effective and speedy response, and to finally propose suitable adjustments to the strategy. This will trigger the establishment of the requested database.
  - **Analyzing the effectiveness of the enforcement of environmental protection laws, and their development over the past years, since the approval of the protectorates law in the early 1980s, before environment laws and regulations were issued in 1994**: Many concepts and ideas have arisen since then. Some are associated with the degree of enforcement of these laws, while others are associated with the possibility of using the laws as one of the adaptation measures to climate change, through the identification of the shoreline, storm water spillways and their limits, as well as all other measures that support the adaptation measures.
  - **Encouraging and supporting civil society organizations to participate in applying strategic operational policies**: Any proposed methods for the adaptation to climate change will rely on different operational mechanisms and policies for their implementation. At the forefront comes the reliance on the participation and support of the local civil community and its various organizations in touristic locations. These include local, regional and

national tourism investors' associations, and civil societies that are interested in the matter, along with local universities and others.

- **Direct positive defensive measures:**
  These measures cover engineering constructions such as the protection of shores in coastal zones, especially the Nile Delta and Alexandria. Figure 2 lays out the current locations of natural (constructive shores, sand dunes, and longitudinal limestone barriers) and artificial (protective seawalls and barriers) protection. It also shows the more vulnerable areas that need future adaptation measures (see arrows). The figure depicts dry land levels, as well as the areas as low as -3m below and as high as +4m above sea level.
  In the case of the Red Sea, many studies show the continuous parting of its shores as a geological rift. There is a controversy over the impact of its water level rise. Storm water spillways on its shores are also controversial. They extend across mountain chains east to the Red Sea. Thus, questions are raised as to the impact of the increase or decrease of the water level. The answer to such questions can only be reached by carrying out further studies and mathematical models in order to determine the extent of the effects resulting from the rise or fall in water level.

Chapter VI

Integration of Adaptation Plans to Climate Change in the Programs and Plans for Sustainable Development

The purpose of this chapter is to deal with the phenomenon of climate change and adaptation, as part of an integrated strategy for the Egyptian government's programs and plans for sustainable development. This is based on the premise that throughout the process, the planning or implementation of any project or program that is part of the country's development plans should never be initiated without taking the effects of climate change into account. In addition it is essential to take all necessary measures and precautions in order to reduce the risks of expected climate change.

It is natural to determine the plan's projects without regard to climate change, and later select the projects necessary for adaptation to climate change, then find the appropriate integration formulae between the two types of projects. Hence, any gaps that might exist between the two may be filled. It is also natural for such programs and projects to include the following factors:

- Land and water resources, land degradation resulting from water scarcity, desertification, increased recurrence and intensity of extreme events such as floods, droughts, tropical storms and hurricanes, sand storms and inundation at low-lying levels and the displacement of inhabitants.
- Agriculture in the territory of the Valley and Delta, reclaimed lands, national projects and desert land, the lack of productivity of some crops, insects and the prevalence of infection, increased risk of fire, erosion and soil erosion, water logging and salinization of soil and water.
- The set of shores and coastal environments, and rising sea levels and the possibility of the occurrence and recurrence of hurricanes and storms.
- The set of lakes and ponds, fishing zones and fish farms, and low rates of planktons, of marine and river fish, poor growth and economic returns .
- Industry, mining and energy and the impact on them as a result of the disrupted demand for fuel (low demand for heating and high demand for cooling) and the impact on trade and transport, as well as pressure on infrastructure, industrial, and power outages .
- Cultural and archaeological tourism and entertainment, conferences, car rallies, sports, adventures, safaris, bleaching of the coral reefs and changing tourism rates, and the presence of alternatives to transit the Suez Canal.
- Public health, increased risk of deaths and infection as a result of the spread of waterborne and nutrition diseases, drowning and other health effects due to flooding, negative effects of migration, the increased risk of mortality among the elderly, the chronically ill and children (due to high temperatures), an increasing risk of death from infectious diseases, and respiratory and skin diseases caused by food shortages and malnutrition.
- Population, housing and roads: power outages, which lead to a disruption of water supply systems, sanitation and irrigation water in rural areas and household appliances all over the country and the exposure of asphalt roads to cracking as a result of high temperatures

and the movement of sand dunes, which could lead to the closure of roads and the disruption of railway and air transport.

That said, several reports highlight the importance of integrating climate change policies - which include the economy, society, environment and all sectors – and incorporating climate change into economic and sustainable development, and poverty reduction plans and policies. These reports also refer to the necessity to support economic growth in order to enhance the ability to adequately withstand the adaptation to climate change while promoting social cohesion and reducing the risk of any internal conflict.

Chapter VII

The Role of Civil Society Organizations and Community Participation

There is no doubt that the role of civil society in the developing countries has not yet reached the desired level, especially after the transformations that have led to globalization; which, in turn, have downplayed the role of the central nation state, expanded the markets, and broken down - or rather erased - the borders between states. Globalization has also led to the collapse of the concepts and policies of economic protectionism, customs and taxation among states, the rule of law and market mechanisms. Civil society plays a weak role and is resistant to advancement in many southern countries. A possible reason could be that some civil society organizations often get engaged in exchanging criticism and monitoring errors and violations. Also, the financial transactions of some of these organizations are far from being above suspicion.

However, civil society, especially after the developments that have taken place since the end of the 1990's, is no longer the subject of national debate in terms of its roles in social and cultural rights. In fact, it has become a necessity for the promotion of development processes, especially in raising community awareness, to the extent that it allows an effective partnership between the state and its various organs, the private sector with its financial and human potential, as well as with citizens from other sectors, including NGOs, labor and farmer trade unions, academies, universities, research centers, audio-visual media and the press, local councils, popular sports clubs, youth centers and cultural forums.

The state alone can certainly not fully undertake the role of implementing the process of adaptation to climate change. At the same time, one must recognize that this process entails the implementation of construction and engineering structures, which require resources that only the state can provide; either from the state budget or through the participation of the beneficiaries from such interventions. Many of these interventions, both small in size and modest in level, can be carried out by individuals or groups of citizens. Civil society organizations can easily undertake the soft interventions. These are any other non-structural interventions, which do not entail engineering works but are limited to administrative and organizational aspects and can direct the masses towards the general good for all.

There is no doubt that each of the above-mentioned sectors can exercise a special role through its activities, considering that they form a cornerstone in the transfer and delivery of information and ideas to the largest number of citizens, and can raise their awareness on the realities of the problem.

In collaboration with civil society, the state needs to plan and implement an effective and consistent national strategy on climate change and build the capacity to do so. If climate change exacerbates the scarcity of natural resources and leads to the occurrence of crises in local food, or increased natural disasters to the point of becoming a strain on the state's abilities, the establishment of a comprehensive program for capacity building for individuals and institutions would become a national necessity. Moreover, strengthening people's participation, empowering the vulnerable and marginalized, and engaging them in all planning, decision-making and implementation phases are a must.

Each sector of the civil society should have a role within an integrated system, under the umbrella of the state. The state will be the main engine, distributing the roles of each sector, monitoring their movements and evaluating their performance.

One could mention a few examples of the tasks that can be carried out by civil society in the field of climate change disasters and crises, and the ways and means of adaptation, to then integrate these programs into development plans.

It is known that the local awareness of the inhabitants of different areas can be quite useful in the identification of historical events associated with the climate or with climate change. It can also help in determining how the previous generations have dealt with climate change, what interventions were carried out, and how to reduce the risk, the number of victims and the loss of property. Such cumulative knowledge and information might be valuable to those responsible for the preparation of climate change adaptation plans. This information can also be included in national development plans and programs. The main task of civil society organizations is to disseminate this knowledge among citizens, raise awareness of the risks of climate change, how to face them and adapt to them, and how to develop their own programs with government agencies. In addition, these organizations can also demonstrate how to take advantage of these programs in the national development plans, and thereby reduce the financial cost. They can also avoid the creation of separate adaptation plans to climate change, as well as supplementary budgets of their own, and additional work to integrate into the general development plan.

Civil society organizations can also be useful in identifying priority actions in the area of adaptation to climate change, and program development and implementation. This is thanks to their accumulated knowledge (to a greater extent more than others) of the needs throughout the stages of various projects and interventions. Then, the role of civil society comes into play in monitoring, control, evaluation and follow-up of the implementation of climate change adaptation programs, and in connecting with the people to identify their point of view and convey these trends to the executive bodies for action.

In this scope it is important to deal with vulnerable groups, which have modest capabilities and means (especially the inhabitants of slums) in a manner that is adequate to the masses of citizens of these areas.

Furthermore, universities and scientific research centers all being the main pillars of civil society, should intensify their studies and research in the field of climate change and adaptation.

Following are some examples of the proposed roles of civil society organizations in dealing with the issue of climate change for some sectors, and the ways and means to adapt to this phenomenon:

In the field of water resources and irrigation, it is important to mention the significant role the water users' associations can play in water extension activities and public awareness raising on the risks resulting from a drop in the flow of water for the entire country, due to Earth's high temperature; especially in the areas of the Nile sources. One must also highlight their role in raising awareness about the confusion that could occur as a result of temporal and spatial variation of the rainfall on the Mediterranean coast, or the deterioration of groundwater quality in the north of the Delta due to seawater intrusion, which is expected to rise when the sea water level rises.

In agriculture, the role of the agricultural extension worker - which traditionally was to convey information on fertilizers, pesticides, seeds, etc. to the farmer - could be enlarged to define the phenomenon of climate change, and the potential of changing the composite

crop or start dates for growing each crop. The agricultural supervisor should monitor the irrigation techniques used, recommend the use of modern techniques, and work on educating the farmer on the rational use of water and energy.

As for the coastal areas, the role of civil society can be focused on dealing with the most vulnerable areas threatened by the sea level rise, and on defining what living in these areas would entail, the risks they could be exposed to, and how to deal with them in the short and long term.

In the area of housing, the civil society's role is to spread the concept of green development, the use of clean energy and new and renewable energy, the rational use of natural resources and sound waste management and the protection of biodiversity.

In the medical and health sector, the main role of civil society is to educate the citizens - especially vulnerable and marginalized communities – on how to protect themselves from diseases resulting from climate change, and the methods of treatment for these diseases if infection were to occur.

Chapter VIII

Regional and International Cooperation and Ongoing Initiatives to Adapt to Climate Change in the Arab Republic of Egypt

It is common knowledge that the issue of climate change emerged on the international arena only a few decades ago. However, the attention that it has brought – at country and regional levels, and even globally – demonstrates that everyone realizes the impact of these hazardous phenomena on the living conditions of all the beings on Earth, today and in the future.

Nevertheless, the great discrepancy in the degree to which every country is exposed in terms of the risks arising from climate change has led to the accumulation of a large amount of knowledge in the countries that are exposed to greater risks. People who are vulnerable to those risks, but are less exposed to them, are less aware of them than those in other states are.

The nature of these phenomena is that they are more likely to occur in poor countries that cannot afford the expense of mitigating their effects or adapting to their development. These countries are not necessarily among the top users of fossil fuels - the main cause of the changes. This specific condition leads to discords between countries where the burning of fossil fuels, i.e. oil and coal, is at its highest degree - mostly rich industrial countries, and countries that can be directly or indirectly affected by the results of these phenomena, most of which are poor and seldom contribute to the causes of global warming and excessive heat.

While rich countries demand that all nations of the world commit to reducing the current rate of energy use, poor and developing countries claim that their energy needs are increasing because their current consumption is low by all standards, and is incomparable with that of the rich consuming nations; particularly when one compares the per capita share of energy consumption. It is natural that the inhabitants of rich industrial countries should enjoy the lion's share, not only by benefiting from all modern equipment at home, offices, schools, and factories, but also by receiving the biggest share of industrial production that, in most instances, is earmarked for export to poor countries that do not consume energy at an individual or national level, as the wealthy countries do.

In addition, the entire world – which became aware of the development of the climate change issue over the past six decades – has gained a great deal of experience across many countries, which represents a significant amount of accumulated information at the regional level. This has enabled the Intergovernmental Panel on Climate Change to collect an abundance of global knowledge on these important phenomena.

In this spirit, addressing the climate issue cannot be accomplished at an individual state level. It is necessary that countries with similar issues share their experiences among one another, and how they deal with such problems when they occur. This is followed by the exchange of information at the level of regional networks. Regional networks are then interconnected to transfer knowledge across all parts of the world .

The roles that can be carried out by different countries are concentrated around the transfer of information and experience from those that are most knowledgeable about climate change phenomena and their causes, on how to adapt to them and mitigate their effects, to the less experienced ones. This can also be done through the cooperation between regional organizations and bodies, which include all these states. Then comes the role of specialized

committees - at the local, regional or international levels - in disseminating knowledge and providing studies and research to those who need them.

The matter does not end at exchanging information and benefiting from the experience of others. It extends to providing the help that certain countries need in the field of mitigation and adaptation to climate change, and training cadres that can play an active role in this field.

Cooperation at the regional and international levels begins by identifying all the available expertise through the World Wide Web, and collecting lists of information and experience that the various countries can provide in various fields. This is followed by a bilateral communication between similar organizations in different countries. The degree of cooperation can be raised to the level of relevant ministries in both countries. This form of cooperation continues to create regional groups that transform into international groups .

The funding of such activities may come from the participation of different countries, both in kind and in money. Countries of higher financial means can contribute a greater share of the expenses, while those with lesser capabilities can pay less.

It is obvious that the past period has witnessed the movement of international organizations – at the top of which are the United Nations Development Programme (UNDP), the United Nations General Assembly and Security Council, the World Bank, the International Monetary Fund, the Global Environment Facility, the World Food Program, the World Meteorological Organization, World Health Organization (WHO), the International Strategy for Disaster Reduction, and others – to organize many conferences, training courses, round table discussions, and seminars that helped raise the awareness of the international community in terms of these important phenomena, how to deal with them, and attempt to defuse their risks and adapt to their requirements in all fields, across many countries, zones, and regions, and the world at large.

The United Nations World Tourism Organization could be considered as an example. The organization cooperates with member states, the Arab Republic of Egypt being one of them, in building their technical capabilities and supporting public awareness programs. In 2003, in its first circular, the organization announced the possible impact of climate change on the international tourism sector, particularly the greenhouse effect, along with the Davos and Copenhagen Accords, announced in the city of Djerba, in Tunisia.

At the regional level, the current assembly in which the Arab Republic of Egypt participates – the Council of Arab Ministers of Tourism – has limited its interest to developing and promoting tourism between Arab countries. However, the issue of coordination between Arab countries in the field of adaptation and monitoring of the impacts of climate change on the tourism sector in member states can be included in the agenda.

A successful example of the role of international and regional cooperation is the World Health Organization, and the United Nations Children's Fund (UNICEF) in the field of addressing climate change. The organizations cooperate with member states in exchanging information, providing technical support and assisting in the provision of financial and technical support to those countries.

The Arab Republic of Egypt benefited from international cooperation in the adaptation to climate change by obtaining the necessary funding for some projects. These include, though are not limited to, the following:

1. The Nile Delta adaptation project to climate change and sea level rise through the integrated management of coastal regions. The Ministry of Water Resources and

Irrigation participates in the project with the UNDP, and the Global Environment Facility. The project started in April 2010. It aims at achieving adaptation to climate change by raising the efficiency of the bodies dealing with the phenomena of erosion and precipitation, and increasing the efficiency of cooperation and coordination between those bodies. It also aims at introducing and enhancing benefits from the prevailing natural conditions as an alternative protective method to highly expensive constructional works, and developing, designing and implementing practical examples of such methods. The project extends over a period of five years, with a total funding of US$16.2 million.

2. The project on climate change adaptation and preparedness for natural disasters in the coastal cities of North Africa. It is mainly concerned with the protection of 60 million people currently living in such cities – this may reach 90 million by 2030 – from the effects of climate change. The most important impacts are sea level rise, and soil and groundwater pollution resulting from seawater intrusion on low-lying land on the Mediterranean coast. This study covers four cities: Alexandria, Tunis, Casablanca, and Morocco's Wadi Bour Greg. The study begins by examining the current situation of the areas, followed by developing plans to improve the potential of adaptation to climate change and prepare for natural disasters. The result of the study will then be published for those who may benefit from it; they will be included in the decision-making process. Participants on the Egyptian side include the Environment Affairs Authority and the Alexandria Governorate. At the regional level, the Arab Academy for Science, Technology and Maritime Transport, under the authority of the Arab League also took part in it. The project, which lasts for 18 months, is funded by the World Bank, with each participating country receiving US$600,000.
3. Monitoring the risks of climate change and sea level rise above that of groundwater and agriculture in the Nile Delta. The project is funded by the United Nations Food and Agriculture Organization (FAO). It aims at developing the decision making system for prediction and mitigation of the climate change impact on agriculture and the environment along the Delta coast. It creates a monitoring network to identify the impact of sea level rise on groundwater and the soil. The project has a budget of US$337.2 thousand provided by the FAO, and extends over 18 – 24 months.
4. Pilot project on assessment and development of a strategy to address the impact of sea level rise on human movement in Egypt. It was initiated by the International Organization for Migration, in cooperation with the Ministry of Manpower and Migration, in February 2010, to support the Egyptian government's efforts in enhancing the endeavors made to address the challenges posed by climate change. It includes migration and human security in the development of policies and planning, with technical aid from the most important governmental and non-governmental partners. The technical working group is made up of: representatives of the International Organization for Migration, the Ministry of Manpower and Immigration, the Environment Affairs Authority, the Ministry of Water Resources and Irrigation, Alexandria University, Friends of the Environment Society in Alexandria, and the United Nations International Strategy for Disaster Reduction.

Chapter IX

Proposed Operational Framework for the Climate Change Adaptation Program

This chapter includes the development of a matrix for the operational framework and initiatives proposed, in accordance with the key objectives of the national strategy for adaptation to climate change and disaster risk reduction, as well as detailed milestones for each sector within the framework of overall objectives.

Hence, the adaptation programs / targets for tackling climate change, for the next hundred years, will be dealt with according to the strategy within the four-year plans (over the next twenty years) as follows:

1. First Five-Year Plan: 0 - 5 years.
2. Second Five-Year plan: 5-10 years.
3. Third Five-Year Plan: 10-15 years.
4. Fourth five-year plan 15-20 years.

The operational framework proposed for the climate change adaptation programs has been built on what was laid out in the earlier chapters, however the main pillars are linked to what was covered in Chapter III: Presentation and Assessment of the Current Situation, Part IV: Risks, Disasters and Crises Caused by Climate Change, and Part V: Adaptation to Climate Change and Risk Reduction.

It is worth mentioning that the operational procedures related to regions or sectors included in the strategy have adopted common measures in the First Five Year Plan (zero - 5 years), as follows:

- Develop a national model for climate change and future prospects.
- Develop a national model for the analysis and prediction of spatial and temporal scale of the effects of climate change and adaptation.
- A comprehensive assessment of the anticipated costs for the adaptation to climate change, including damages and losses, and an estimate of the cost-benefit analysis.

The following tables detail the proposed operational framework for adaptation programs. It is divided into four five-year plans (tables from No. 20 to No. 26). Chapter X addresses the estimated costs expected for the proposed actions for the adaptation to climate change.

Table 20
Proposed Operational Framework for Climate Change Adaptation Programs in the field of research and studies

Main Goal	Proposed implementation measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. Preparation of projects, research programs and studies in various sectors	• Negative impact of climate change on health sector.				
	• Climate change impact on coastal zones and water resources .				
	• Identifying sectors that are most susceptible to climate change .				
	• Studying features threatening water resources, as a result of climate change.				
	• Studying the impact of seawater intrusion on shallow groundwater wells close to the shore.				
	• Studying climate change impact on the productivity of main crops.				
	• Studying climate change impact on methane emissions from rice cultivation and livestock and animal waste.				
	• Identifying urgent issues of Egyptian agriculture.				

Table 21

Proposed operational frame work for Climate Change adaptation programs in the field of monitoring, planning and follow up*

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. Monitoring, planning, and follow up.	• Creation of national database to compile all data and information on climate change, adaptation plans and risk reduction measures.				
	• Development of indicators necessary for the implementation of programs and activities of the National Strategy for Adaptation to Climate Change.				
	• Coordination amongst all ministries and bodies concerned with the implementation of requirements of the strategy for adaptation to climate change and its associated disaster risk reduction and to ensure their incorporation into development plans.				
	• Review of plans, programs and scenarios of all ministries and bodies concerned with the implementation of the National Strategy for Adaptation to Climate Change, ensuring their integration into the development plans .				
	• Follow up on the development of mechanisms for monitoring and early warning in the areas of climate change and disaster impact reduction.				
	• Preparation of periodic reports on progress made in the implementation of the Strategy				
	• Preparing programs for raising community awareness in the field of climate change and risk reduction.				
	• Coordinating to ensure the integration of governmental, civil society and private sector inputs.				
	• Periodic review and updating of the Strategy, in coordination with relevant ministries, taking into consideration international and regional scenarios and predictions.				
	• Coordination with regional and international bodies and organizations concerned with adaptation to climate change and disaster risk reduction, foremost among which is the International Strategy for Disaster Reduction (ISDR), the UNDP, the FAO, etc.				

*** The Information and Decision Support Centre of the Cabinet / Technical Secretariat of the National Committee for Crisis/ Disaster Management and Disaster Risk Reduction is responsible for the implementation of climate change adaptation programs in the areas of monitoring, planning and follow up.**

Table 21 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
2. Research and Studies.	• **Preparation of a comprehensive study of the economic and social impacts of climate change.**				

Table 22
Proposed Operational Framework for Climate Change adaptation programs in Coastal Zones

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. Reduction of Climate Change associated risks and disasters.	• **Making available relevant information for effective planning and implementation:**				
	– Development of GIS Data Base on coastal zones with special focus on population, economy, infrastructure and vulnerable areas …etc.				
	– Creation of a national network to monitor sea level rise and changes in physical measurements.				
	• **Scientific Handling of uncertainty**:				
	– Enhancement of technical and scientific capacities to develop and apply methodologies ensuring assessment of weaknesses and vulnerabilities to climate change, including upgrading of monitoring and assessment capabilities.				
	– Development of a national set-up for climate change and future predictions including Regional Climate Model (RCM).				
	– Development of a national format for spatial and temporal analysis and prediction of climate change impact and adaptation.				
	– Comprehensive assessment of expected costs of adaptation to climate change including: damages, losses and cost benefit analysis.				
	– Periodic mapping and updating of vulnerable areas in light of the success of adaptation measures.				
	• **Preparation and Rehabilitation of Infrastructure for adaptation to climate change Impact: systems (dunes, barriers, etc.).**				
	– Preparing studies to assess the effectiveness of current coastal zones protection measures and to identify weaknesses and special needs for support and rehabilitation.				

Table 22 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. Reduction of Climate Change associated risks and disasters.	– Reinforcing or rehabilitating current coastal protection works (Mohammad Ali Sea Wall, the banks of coastal lakes, shore protection works, etc).		■	■	
	– Preparing studies on the requirements for a full and complete protection of vulnerable coastal zones, particularly for the Delta.	■			
	– Supporting engineering constructions for the protection of ports against cyclones.		■		
	– Implementing full protection works for coastal zones vulnerable to the impact of sea level rise.			■	■
	– Rehabilitating some constructions built for dual usage in such a way as to perform their original function as well as that of protection, such as the International Coastal Road along the Mediterranean, particularly in the eastern part of the Delta, and the northern bank of El Salam Canal.			■	■
	– Preparing plans for retreat and evacuation in the event of extreme climatic conditions, such as cyclones and floods.	■			
	– Enforcing and constructing fortifications against floods in the areas vulnerable to flood risks of coastal zones. (Red Sea and Mediterranean Sea).		■	■	
	– Studying the effectiveness of natural protection systems (dunes, barriers, etc.).	■			
	– Rehabilitation and support of natural protection methods.		■	■	
	– Undertaking engineering and preventive works necessary to prevent or control sea water intrusion.		■	■	■

Table 22 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
2. Contribution to sustainable development and the Millennium requirements.	– Incorporating management of climate change crises and disaster & risk reduction into development plans and policies at all levels, including poverty reduction strategies.				
	– Supporting the National Mechanism for Climate Change Risk Reduction as to ensure full coordination at all levels among all national sectors.				
	– Supporting the General Authority for Shore Protection and the Institute of Shore Research in their efforts on climate change risk reduction.				
3. Capacity Building of Egyptian community for adaptation to climate change and its associated crises and disasters.	– Capacity building and strengthening to create an early warning system for extreme events associated with climate change, such as cyclones, floods, and tsunamis.				
	– Identifying clear-cut priorities for the implementation of adaptation programs, at all phases in order to allocate the resources necessary for implementation.				
	– Formulating adequate national legislations that would enable climate change risks reduction.				
	– Development of additional regulations for coastal development that would be proportionate to the predicted climate change impacts.				
	– Assessment of available human resources at all levels, and development and implementation of capacity building programs in response to future requirements.				

Table 22 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
4. Enhancing national partnership in the management of climate change associated crises and disasters and in risk reduction.	– Enhancing the role of the media in motivating the community to adopt a culture addressing climate change associated crises and disasters and in taking part in awareness raising campaigns and consultations.				
	– Enhancing a national partnership between public and private sectors and civil society with the aim of promoting participation by all sectors in the completion of adaptation measures.				
	– Disseminating user friendly information on climate change associated risks, particularly in coastal zones, and on prevention measures, especially for populations in vulnerable areas.				
	– Incorporating knowledge on climate change risk reduction in the relevant curricula at all levels.				

Table 23
Proposed Operational Framework of Climate Change Adaptation Programs in the Field of Water Resources and Irrigation

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. Building a culture of safety first, while raising community awareness.	– Raising awareness on climate change issues, and associating them to the need for consumption rationalization.				
2. Considering adaptation to climate change and disaster risk reduction a primary national priority.	– Preparing an effective institutional program with relevant monitoring and follow-up to address climate change crisis and impacts on water resources.				
3. Scientific Handling of the issue of uncertainty.	– Widening and deepening Tushka spillway to accommodate high flood run off, in addition to widening the main Nile stream and large canals.				
	– Updating and developing the rules and regulations governing the High Dam operation in light of potential changes (drought or floods).				
	– Continued monitoring of rainfall and runoff and their trends and adaptation strategies, and preparing an early warning system against any change in the Nile River flow due to climate change.				
	– Studying the impact of sea intrusion - in case of sea level rise - on groundwater on the northern shore of the Delta and programs for reducing groundwater level and preserving its quality.				
	– Pursuing scientific research to ascertain results.				
	– Managing climate change risks and designing a regional mathematical model to simulate climate change in the Nile Basin region.				
4. Researches and studies.	– Predicting changes in the Nile River flow, and relevant adaptation programs.				
	– Studying the development of unconventional water resources (water freshening).				

Table 24
Proposed Operational Framework for Climate Change Adaptation Programs in the Agriculture Sector

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. Building an effective institutional system for managing crises and disasters resulting from climate change at national and regional levels.	• **Monitoring, Estimating Vulnerability index and risk assessment for different agricultural environments:**				
	– Enhancement of capabilities for monitoring, prediction, analysis, and dissemination in present and future agricultural areas.				
	– Building an effective information exchange system on climate change at regional and international levels.				
	– Building expert dynamic systems for dissemination of information, analyses, and relevant recommendations.				
2. Building genetic diversity in terms of plant species and varieties capable of achieving maximum productivity and neutralizing change in climate indicators.	• **Estimating vulnerability index and risk assessment for items of biodiversity exposed to in different ecosystems:**				
	– Estimating vulnerability index and risk assessment facing plant production.				
	– Supporting the capabilities of the National Genes Bank and other genetic diversity banks in more vulnerable areas (the desert).				
	– Maintaining, developing, utilizing, exchanging, and classifying items of biodiversity.				
	– Feeding the national database with data on biodiversity in the most vulnerable ecosystems.				
	– Expanding the protectorates system.				
	– Focusing on programs for cultivation of new types of important field and horticultural crops capable of adapting to expected changes: temperature rise of up to 2 degree Celsius, soil salinity, and relative dryness.				

Table 24 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
2. Building genetic diversity in terms of plant species and varieties capable of achieving maximum productivity and neutralizing change in climate indicators.	– Follow up on plant pathogens and neutralizing their effect on the efficiency of production inputs.				
	– Plant Protection programs to preserve the positive biological balance that is beneficial to agricultural production.				
	– Devising new types of crops that have a short growth season.				
	– Expanding the cultivation of crops capable of adapting to climate change.				
	– Amendment of agricultural practice policies.				
3. Achieving biological diversity in all elements of animal, fish and poultry production for their protection and for ensuring food security for the society.	• **Programs for Monitoring and estimating the vulnerability index and risk assessment facing livestock production:**				
	– Maintaining biodiversity and improving animal production herds.				
	– Monitoring animal health, disease prevention and immunization.				
	– Supporting and developing vaccine and antidote production technology against shared and expected diseases.				
	– Relying on biodiversity for the introduction of new feeds as a source of energy, fibers and protein.				
	– Joint Management of scarce agricultural resources (land and water).				
	– Governmental support and protection against climate change risks.				

Table 24 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
4. **Development of new flexible agro-economic systems and structures to manage crops, fish farming, and animal production that are flexible enough to be applied under climatic changes**	– The economics of fish farming and alternative use of wetland north of the Delta.				
	– The economics of improving main crops and food security , crop mix, industrialization, marketing and price forecasting.				
	– Agricultural industrialization and marketing, and price forecasting.				
5. **Increasing the efficiency of irrigation water use, while maintaining crop productivity and protecting land from degradation.**	• **Monitoring and estimating the vulnerability index and risk assessment faced by field irrigation:**				
	– Using new irrigation methods that rely on Precision Farming.				
	– Raising the efficiency of utilizing irrigation water and improving field irrigation to 75%.				
6. **Reviewing policies of land use (new and old) and agricultural expansion programs commensurate with trends of land degradation, in the Delta and elsewhere, resulting from Mediterranean Sea level rise.**	• **Monitoring and estimating the vulnerability index and risk assessment facing agricultural soil:**				
	– Land improvement programs based on lowering salinity.				
	– Creating information systems concerning land suitability for agricultural use (natural, chemical and biological fertility of the land).				
	– Protecting fish wealth from new species that affect the biological and environmental balance of the fish wealth in Egypt.				
	– Preserving biodiversity and reducing the rate of losing species.				
	– Building the structure of the fish farming ecosystem.				

Table 24 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
6. Reviewing policies of land use (new and old) and agricultural expansion programs commensurate with trends of land degradation, in the Delta and elsewhere, resulting from Mediterranean Sea level rise.	– Protecting fish wealth from infections and diseases resulting from a change in environmental parameters (temperature, water quality, vegetation structure, nutritional sources).				
	– Preserving the density of fish growth (economically important types).				
7. Developing systems, programs and policies to protect rural community and support its capabilities to adapt to the expected trends of change in land use, plant and animal production, and internal migration because of change in climate indicators.	– Studying, classifying and following up on the present condition of the rural community, traditional knowledge, and the ability to adapt (estimating vulnerability index and risk assessment of risks facing different rural communities).				
	– Determining programs to support small farmer's ability to adapt to climate change.				
	– Supporting the capabilities of rural communities to manager their resources and output, and participate in relevant decision-making.				
	– Strengthening capacity of rural communities to participate in determining and implementing national policies in the field of adaptation to and coping with disasters and crises.				

Table 25
Proposed Operational Framework for Climate Change Adaptation programs to climate change in the Health Sector

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. **Identification of health risks expected to occur as a result of climate change.**	• **Providing information for effective planning and implementation:**				
	– Creating a database for the health status in the ARE covering the present prevalence of diseases, risk factors, and the availability of preventive measure..				
	– Providing information on health risk expected to occur as a result of climate change				
	• **Encouraging scientific research, field and demographic studies:**				
	– Determining the main issues that need further information through research and studies.				
	– Local and international coordination in the field of scientific and demographic research in order to assess the present situation, and determine points of strength and weakness of research policies and capabilities.				
	– Placing climate change at the top of the priority list for scientific research and studies in the field of health and population.				
2. **Raising community awareness about climate change risks and means of adaptation.**	– Conducting advocacy activities at the political and strategic levels by activating the role of the media and civil associations, and coordinating the efforts of the Ministry of Health and other relevant different ministers, and bodies.				
	– Raising people awareness and encouraging health behavioral changes that would limit damages resulting from exposure to climate change.				
	– Coordinating with civil society organizations to play an active role in educating the community.				

Table 25 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
	– Placing health hazards resulting from climate change among priority issues on the Ministry of Health list of plans and projects.				
	– Incorporating necessary measures of prevention and control of health hazards arising due to climate change within health development programs, particularly, the basic benefit package, and health insurance programs.				
	– Increasing the efficiency of health units and improving the quality of service provided in order to adapt to climate change effects, whether infectious or non-infectious diseases, both in Upper and Lower Egypt, and in rural and urban areas alike through:				
3. Increasing the efficiency of the healthcare sector and improving the quality of health services in dealing with climate change.	o Completing the development of the infrastructure of healthcare provision outlets.				
	o Developing a surveillance system for detecting infectious diseases and vectors.				
	o Upgrading the vaccination programs and increasing allocations for vaccine research and production.				
	o Building a comprehensive database for diseases associated with climate change, and making it available to all those concerned, e.g., governmental bodies private sector and civil or nongovernmental sectors, together with a program for information exchange among all various bodies.				
	o Training medical teams on means and ways of dealing with the hazards accompanying climate change.				
	o Raising the efficiency of emergency departments for better receiving and dealing with injuries resulting from unexpected and extreme events, such as torrential rain, storms, and floods.				

Table 25 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
4. Supporting the efforts of the Ministry of Family and Population to improve the social and economic status and population characteristics.	– Determining the present situation and the social and economic needs.				
	– Increasing interest in the field of population and population control programs.				

Table 26
Proposed Operational Framework for Climate Change Adaptation programs to climate change in rural areas, the population and roads sector

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. **Envisaging a basic scenario for the optimal regional distribution of population and economic activities within the geographical boundaries of Egypt in 2100, taking into consideration the climate change.**	• **Economic recovery program:**				
	– Start with the necessary economic activities for the recovery:				
	o Individual and family income.				
	o Services and main life arteries.				
	o Productive activities in affected sectors.				
	• **Precautionary programs / Reconstruction:**				
	– Stopping the issuance of construction permits in threatened areas.				
	– Introducing insurance companies so as to cover affected clients, thus banks would not be affected.				
	– Determining inhabitants, their activities, and their services in threatened areas, and arranging for alternatives now.				
	– Transferring the inhabitants of unsafe shantytowns to other safe areas.				
	– Reclaiming land to replace agricultural land, and transferring those affected to it.				
	– Preparing investment plans to transfer heavy constructions, such as industrial zones, in case of evacuation and transference.				

Table 26 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
2. Envisaging a basic scenario for the optimal regional distribution of population and economic activities within the geographical boundaries of Egypt in 2100, taking into consideration the climate change.	– Preparing alternative sites for coastal establishments. Harbors, and petrol and natural gas transfer stations perform services in case of disaster.				
	– Preparing a plan for the transfer and migration of the inhabitants of threatened areas and providing resources.				
	• **Houses and constructional communities:**				
	– Assessing the state of the houses and their suitability for resisting climate change impact (coastal area houses, shantytowns, etc).				
	– Reviewing present construction codes and developing them to be compatible with climate change (energy, temperature, water, etc).				
	– Employing developed codes.				
	• **Roads:**				
	– Assessing the efficiency of main, secondary and peripheral roads to serve under abnormal climate conditions.				
	– Employing heat resistant material for paving roads.				
	– Adopting suitable engineering designs for new roads, and implementing them.				

Table 26 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
2. Envisaging a basic scenario for the optimal regional distribution of population and economic activities within the geographical boundaries of Egypt in 2100, taking into consideration the climate change.	– Habilitating newly constructed and old roads.				
	– Habilitating the International Coastal Road, particularly along the Delta and coastal lakes, to function as a wave barrier during storms and in case sea level rises.				
	– Habilitating newly constructed and old roads.				

Table 27
Proposed Operational Framework for Climate Change Adaptation programs to climate change in touristic sector

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
1. **Reducing climate change risks in touristic areas.**	– Developing necessary plans to address risks.				
	– Assessing the vulnerability index and the susceptibility of touristic sites and locations of archeological value to risks .				
	– Guiding touristic growth away from environmentally sensitive areas and most vulnerable to risks.				
	– Calling upon the private sector to implement adaptation plans related to touristic projects.				
2. **Engaging users in supporting the proposed strategy.**	– Developing legal entities for user classes.				
	– Determining adaptation projects for private sector participation.				
	– Involving users in periodical monitoring and follow up programs.				
	– Implementing joint adaptation plans.				
3. **Supporting periodical monitoring and follow up bodies**	– Setting monitoring and follow up criteria and systems, and creating databases for different touristic areas.				
	– Implementing periodic monitoring systems.				
	– Reassessing and developing monitoring and follow up systems.				

Table 27 - Continued

Main Goal	Proposed operational measures	Execution phases for proposed adaptation programs/year			
		0 - 5 Years	5 - 10 Years	10 - 15 Years	15 - 20 Years
4. Raising environmental awareness.	– Launching an environmental awareness campaign on the impact of climate change.	■			
	– Implementing the campaign.		■		
	– Assessing the effect and effectiveness of the campaign.			■	
	– Re-implementing the campaign.				■
5. Cooperation with international bodies.	– Preparing a detailed study of the impact of climate change on the tourism sector.	■			
	– Implementing plan projects according to their phases.		■	■	■
6. Incorporating disaster risks within Egypt's sustained tourism development plans.	– Reassessing the ministry of tourism plans and bodies.	■			
	– Preparing detailed plans for developing and activating tourism, with the merging of adaptation programs.		■		
	– Periodic reviewing, reassessing and developing of plans.			■	
7. Enhancing the capabilities of local communities in touristic areas.	– Determining expected risks and the capabilities of different communities.	■			
	– Preparing a plan for the requirements to enhance local capabilities.		■		
	– Providing needs according to plan.			■	
	– Periodic reviewing, reassessing and developing of plans.				■

Chapter X

Anticipated Cost Estimates for the Adaptation to Climate Change and the Role of Insurance

Although in Chapter IX the strategy has identified the actions and measures required for adaptation to climate change through four five-year plans, while taking into account what can be imposed by events during the course of the century, the calculation of investment cost estimates for these actions is not an easy task, as the nature of the intervention that can be inflicted by future conditions is difficult to predict at times. Consequently, it is challenging to provide an accurate calculation of the costs of construction structures, or even the costs of soft interventions, which include management and planning techniques, design and others.

However, the indicators that are related to the cost estimates of the actions required should enable leaders and decision-makers to include such appropriations in the financial budgets, and recommend supportive potential funding sources and mechanisms.

Life and property insurance for citizens (against the potential outcomes of climate change disasters, which could endanger lives and destroy properties) is a significant issue. What makes it even more important is the fact that extreme events could strike suddenly, such as: an abnormal variation in temperature rise or fall, a high rate of rainfall leading to floods or rainfall drop leading to water shortage, drought and water scarcity, an unexpected rise of waves and associated cyclones, as well as aftershocks of earthquakes and tremors in the sea, and other such extreme events. All of the above can cause disasters and losses, usually covered by regular insurance systems.

As the gradual rise in air temperatures - and the accompanying gradual rise in sea levels - may take many years until they eventually cause serious events, the long-term consequences can be predicted. In this case, this will make the task of insurance easier than traditional insurance systems .

It is known that in low-income countries, natural disasters can cause an increased number of victims; they also constitute a financial burden on the budgets of these countries. Hence, the Framework Convention on Climate Change adopted by the United Nations, calls upon developed countries to increase aid to those that are threatened by climate change, in order for the latter to reduce the level of these threats and raise the level of adaptation to such changes. The Bali Plan of Action, adopted by the Conference held in Bali in 2000, calls upon decision makers to include the necessary insurance schemes, as one of the themes of any strategy for adaptation to climate change.

It is of common knowledge that insurance gives vulnerable countries the right to deal with the aftermath of extreme events in a manner that preserves their dignity and pride, without the need to ask for a helping hand from others. It is also known that insurance can be used to combat poverty, by taking preventive actions well before the occurrence of a disaster.

Hence, the term "numerical evidence based insurance" has been developed to encourage countries to implement such preventive measures. The insurance requirements

might exceed the capabilities of some countries with limited resources, individually. Yet, the grouping of a number of countries, with similar conditions, under one umbrella of insurance will make the insurance costs for each of these countries more affordable and feasible.

It is clear from the above that, due to the difficulty of estimating the costs and assigning a pivotal role to insurance, many reports and publications that cover this subject have been inspiring in the preparation of the financial costs contained in this chapter[1].

The financial estimates were developed in reference to numbers from the Second National Communication, issued by the Ministry of the Environment in May 2010. In summary, the cost estimates of the adaptation to climate change (which will be provided later) are mere indicators, and are neither conclusive nor definitive. The final cost can only be determined once a decision is actually taken to carry out certain works on a certain date and complete them within a certain period of time, particularly since most construction work is done using materials, supplies, equipment and devices, of which the prices vary from day to day on the world market .

Following are the tables providing detailed cost estimates for adaptation to climate change in the different sectors addressed by the strategy..

[1] Among these sources, the following are examples:

- Natural Hazards, Unnatural Disasters: The Economics of Effective Prevention. The World Bank, 2010.
- Climate Change and Extreme Events: What Role for Insurance. International Institute for Applied Systems Analysis (IIASA), December 2009.
- Global risks 2010, A Global Risk Network Report. World Economic Forum, January 2010.
- Assessing the Costs of Adaptation to Climate Change – Review of the UNFCCC and Other Recent Estimates", Imperial College London, UK, Grantham Institute for Climate Change, August 2009.
- Handbook for Estimating the Socio-economics and Environmental Effects of Disasters, UN Economic Commission for Latin America and the Caribbean (ELAC).

Table 28
Investment cost estimates of adaption projects: research and studies projects and programs

Axis	Project/Program	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian Pounds)
		1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
Health	• **Negative impact of climate change on the health sector.**	16	4	2	2	24
Coastal Zones	• **Climate change impact on coastal zones and water resources.**	24	6	3	3	36
Water Resources and Irrigation	• **Identifying most vulnerable sectors to climate change.**	24	6	3	3	36
	• **Studying the threatening components resulting from climate change to water resources.**	12	3	3	2	20
	• **Studying the impact of seawater intrusion into shallow groundwater wells close to the shore.**	12	4	2	2	20
Agriculture	• **Studying the climate change impact on the productivity of main crops.**	24	6	3	3	36
	• **Studying the climate change impact on methane emissions from rice cultivation and cattle and animal waste.**	24	6	3	3	36
	• **Identifying hot issues in Egyptian agriculture.**	6	2	2		10
Investment Cost Estimates for Research Programs and Studies						**EGP 218 million**

Table 29

Investment cost estimates of adaption projects: Monitoring, planning, and following up*

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian Pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
A- Monitoring, planning, and following up:					
• **Creation of a national database for all climate change related data and information, relevant adaptation plans and measures to reduce its risks.**	1	1	1	1	4
• **Identification of the indicators necessary for the implementation of national strategic programs and plans for adaptation to climate change.**	1	0.5	0.5	0.5	2.5
• **Coordination with all relevant ministries and bodies concerned with the implementation of the strategy for adaptation to climate change and disaster risk reduction, in order to ensure its incorporation within development plans.**	0.5	0.5	0.5	0.5	2
• **Review of plans, programs and scenarios of all relevant ministries and bodies concerned with the implementation of the strategy for adaptation to climate change and disaster risk reduction, ensuring its incorporation within development plans.**	1	1	1	1	4
• **Follow up on the development of monitoring and early warning mechanisms in the field of climate change and disaster risk reduction.**	1	1	1	1	4
• **Preparation of periodic reports on the progress achieved in implementation of the Strategy..**	1	1	1	1	4

* Egyptian Cabinet, Information and Decision Support Centre is the Technical Secretariat of the National Committee for Crisis/ Disaster Management and Disaster Risk Reduction, and responsible for implementing climate change adaptation programs from the monitoring, planning and follow up aspects.

Table: 29 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian Pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
• **Launching community and cultural awareness-raising programs in the field of climate change and disaster risk reduction, through different media.**	2	1	1	1	5
• **Coordination to ensure integration of the government's efforts with those of civil society and the private sector on climate change adaptation and disaster risk reduction.**	0.5	0.5	0.5	0.5	2
• **Periodic Strategy review, in coordination with relevant ministries, taking into consideration global and regional scenarios and predictions.**	0.5	0.5	0.5	0.5	2
• **Coordination with regional and international bodies and organizations concerned with adaptation to climate change and disaster risk reduction, foremost among which are the International Strategy for Disaster Reduction (ISDR), UNDP, FAO, etc.**	0.5	0.5	0.5	0.5	2
B- Researches and studies:					
• **Preparation of a comprehensive study on the economic and social impacts of climate change.**	1				1
Investment cost Estimates of research and studies projects and programs					**EGP 32.5 million**

Table 30
Investment cost estimates of adaption projects in the sector of coastal zones

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian Pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
A- Reduction of Climate change and Disaster Risks:					
1. Providing information for effective planning and implementation:					
- Creation of Geographical Information System (GIS) and databases on coastal zones that mainly gathers information on: population, economy, infrastructure, vulnerable areas, etc.	3				3
- Creating a national network to monitor sea level rise and changes in physical measurements.	2	2	2		6
2. Dealing scientifically with uncertainty issues:					
- Promotion of technical and scientific capacity to develop and apply methodologies, studies and models to assess vulnerabilities and risks related to climate change, including improved monitoring and evaluation capacities.	10	10	10	10	40
- Preparing a national model for climate change and future predictions, including the preparation of RCM.	3				3
- Formulating a national model of spatial and temporal analysis and predictions of the resulting impacts of climate change and adaptation to it.	2				2
- A comprehensive assessment of anticipated costs for adaptation to climate change, including damages and losses, estimated revenues and Cost Benefit Analysis.	2				2
- Mapping of vulnerable areas and periodic updating in light of the success of adaptation measures.	4	3	2	1	10

Table: 30 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian Pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
3. Equipping and rehabilitating infrastructure for adaptation to the climate change impact.					
- Conduct studies to evaluate the effectiveness of current methods of protection of coastal zones and to identify vulnerabilities and needs for support and rehabilitation	2				2
- Strengthening or rehabilitating coastal protection structures (wall of Mohammed Ali, bridges, lakes, coastal protection works shores ... etc.).		500	500	250	1250
- Conduct studies on the requirements for full protection of the vulnerable places of the coast and in particular the coast of the Delta.	5				5
- Supporting engineering constructions for the protection of ports, to render them capable of coping with cyclones.		100			100
- Implementing full protection works for coastal areas vulnerable to the impact of sea level rise.		2000	2000	1000	5000
- Rehabilitation of some constructions of dual function to perform their original one, in addition to protection, such as the International Coastal Road along the Mediterranean, particularly in the eastern part of the Delta, and the northern bank of El Salam Canal.	500	500	250	250	1500
- Preparing withdrawal and evacuation plans in facing extreme events, such as storms and floods.	1				1
- Reinforcing and constructing flood-resisting structures in areas vulnerable to flood risks in coastal zones. (Red and Mediterranean seas).		75	75		150
- Studying the effectiveness of natural protection systems (dunes, barriers, etc.).	1				1

Table: 30 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian Pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Rehabilitating and supporting natural protection methods.		15	15		30
- Studying subsurface sea intrusion in the Delta and its impact on groundwater and soil salinity, and means of preventing or controlling the intrusion.	1				1
- Engineering and preventive works necessary to prevent or control sea water intrusion.		100	100		200
B- Participating in achieving sustained development and the requirements of the millennium:					
- Incorporating crises and disaster management and associated risk reduction within development and plans and policies at all levels, including poverty reduction strategies.*	-	-	-	-	-
- Supporting the national mechanism for climate change risk reduction in such a way as to enable coordination at all levels and among all national sectors.*	-	-	-	-	-
- Supporting the General Authority for Shore Protection and the Institute of Shore Research in their effort to reduce the risks resulting from climate change.	25	25	25	25	100
C- Building up the Egyptian community's capability to adapt to climate change and to address crises and disasters associated with it.					
- Build and support capabilities to create an early warning system for extreme events associated with climate change, such as cyclones, floods, and tsunamis.	10	10			20
- Determine clear priorities for the implementation of adaptation programs, at various phases, so as to allocate the resources necessary for implementation.*	-	-	-	-	-
- Formulating national legislations that would enable climate change risk reduction.*	-	-	-	-	-

* The cost of these activities is not included because they are included in other activities or because they do not add any new financial burdens.

Table: 30 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian Pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Adding regulations to coastal development in accordance with the impacts predicted and associated with climate change.*	-	-	-	-	-
- Assessing the capabilities of human resources available on all levels, and developing and implementing programs to support and build capabilities in response to future requirements.	10	10			20
D- Enhancing national partnership in crisis and disaster management and risk reduction due to climate change.					
- Enhancing the role of the media to encourage the community to embrace a culture of climate change associated crises and disasters management and to participate in awareness raising campaigns and consultations.	10	10	10	10	40
- Enhancing the creation of a national partnership between public and private sectors and civil society with the aim of improving the participation and partnership by all sectors in completing adaptation measures.*	-	-	-	-	-
- Providing user friendly information on the risks associated with climate change, particularly in coastal areas, and on preventive measures, especially for populations of vulnerable areas.	5	5	5	5	20
- Incorporating information on climate change disaster risk reduction within relevant curricula at all levels.	25	25	25	25	100
- Providing user friendly information on climate change risks, particularly in coastal zones, and on preventive measures, especially for populations in vulnerable areas.	5	5	5	5	20
Total estimated investment cost for the touristic areas sector					**EGP 8.606 billion**

* The cost of these activities is not included because they are included in other activities or because they do not add any new financial burdens.

Table 31
Investment cost Estimates of adaptation projects in the water resources and irrigation sector

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
A- Building a culture of safety first, along with raising community awareness:					
- Raising awareness on climate change issues in association with consumption rationalization.	50	50	50	50	200
B- Considering adaptation to climate change and associated disaster risk reduction a primary national priority:					
- Preparing an effective institutional program to address crises resulting from climate change and its impact on water resources, monitoring and follow up on relevant programs.		50	50	50	150
C- Dealing scientifically with the issue of uncertainty:					
- Widening and deepening Tushka spillway to accommodate high flood run off, in addition to widening the main Nile stream and large canals.		100	200	200	500
- Updating the rules and regulations governing the operation of the High Dam in light of possible changes (drought or floods).	50	100	150		300
- Continued monitoring of rainfall and run off and their trends and adaptation strategies, and the creation of an early warning system on any change in the Nile River flow that may result from climate change.	100	100	200	200	600
- Studying the impact of sea water intrusion - in case of a sea level rise - into groundwater in the northern shore of the Delta and elaboration of programs to reduce groundwater level and maintain its quality.		200	200	200	600
- Pursuing scientific research to ascertain the results .	100	100	150	150	500
- Managing climate change risks and designing a regional mathematical model to simulate climate change in the Nile Basin region.	50	150			200

Table: 31 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
D- Researches and studies:					
- Studying predicted change in the Nile River flow, and adapting to it.		50	50	50	150
- Studying the development of unconventional water resources (water freshening).		50	50	50	150
Total investment cost estimates for the water resources and irrigation sector					**EGP 3.350 billion**

Table 32
Estimated investment cost of adaptation projects in the agricultural sector

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
A- Building an effective institutional system for managing crises and disasters resulting from climate change on the national and regional levels:					
- Monitoring and estimating vulnerability index and risk assessment for different agricultural data.	5	5			10
- Strengthening the monitoring, prediction, analysis capabilities, and their spread in current and future agricultural areas.	50	50	25	25	150
- Building an effective information exchange system on climate change at regional and international levels.		50	25	25	100
- Creating expert dynamic systems to provide information and analyses, and to make special recommendations.			50	50	100
B- Building genetic diversity on the level of plant varieties and species capable of realizing maximum productivity and neutralizing the change in climate indicators:					
- Estimating vulnerability index and risk assessment of biodiversity components exposure in different ecosystems.	5	5			10
- Estimating vulnerability index and risk assessment facing plant production.	5	5			10
- Strengthening the capability of the National Genes Bank and other genetic diversity banks in more vulnerable areas (the desert).	80	40			120
- Maintaining, developing, utilizing, exchanging, and classifying items of biodiversity.		100	100		200

Table: 32 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Feeding the national database with data on biodiversity in the most vulnerable ecosystems .			30	20	50
- Expanding protectorates systems .				200	200
- Focusing on programs of cultivation of new types of important field and horticultural crops capable of adapting to expected changes: temperature rise of up to 2 Degree Celsius, soil salinity, and relative dryness.	300	100	100	100	600
- Following up on plant pathogens and neutralizing their effect on the efficiency of production intake.		90	30	30	150
- Protecting plants in such a way as to preserve the positive biological balance that is beneficial to agricultural production.		90	30	30	150
- Devising new types of crops that have a short growth season			50		50
- Expanding the cultivation of crops with high capability of adaptation to climate change.				100	100
- Adjusting agricultural practices policies.				50	50
- Monitoring and assessing the vulnerability index and risks for animal production.	5	5			10

Table: 32 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
C- Achieve specific and biological diversity of animal, fish and poultry production to protect them and to achieve food security for the community:					
- Maintaining Biodiversity and improving livestock production.	300	100	100		500
- Monitoring animal health, protection and vaccination.		150	50		200
- Developing vaccine and biological preparations production technology to combat zoonotic and expected diseases.		240	80	80	400
- Relying on biodiversity for the introduction of new feeds as a source of energy, fibers and protein.			70	30	100
- Joint management of scarce agricultural resources (land and water).	60	40			100
- Providing governmental support and insurance against climate change risks.		20	480		500
D- Developing new agricultural economic systems and structures to manage crops, aquaculture and animal production that are flexible enough to be implemented under climate change:					
- The economics of aquaculture and alternate use of wetlands north of the Delta.		50			50
- The economics of improving main crops and securing food, crop mix, industrialization, marketing and price forecasting.			15	10	25

Table: 32 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Agricultural industrialization and marketing, and price forecasting.			25		25
E- Increasing the efficiency of irrigation water use, maintenance of crop productivity and land protection against degradation.					
- Monitoring and assessing the vulnerability index and risks facing irrigation:	5	5			10
- Using new irrigation methodologies that rely on Precision Farming.		120	80		200
- Raising the efficiency of irrigation water use and improving field irrigation to 75%.			250	250	500
F- Reviewing policies of land use (new and old) and agricultural expansion programs according to land degradation trends in the Delta and elsewhere, resulting from the Mediterranean Sea level rise:					
- Monitoring and assessing the vulnerability index and risks of agricultural soil.	5	5			10
- Land improvement programs based on lowering salinity.	400	300	300		1000
- Creating information systems concerning land suitability for agricultural use (physical, chemical and biological fertility of the land).	200	100	100		400
- Protecting fish collections from new species that affect the biological and environmental balance of the fish wealth in Egypt.		200	100		300

Table: 32 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Conserving biodiversity and reducing the distinction of species.		150	100		250
- Building a structure for the aquaculture ecosystem.			200		200
- Protecting fish wealth from infections and diseases resulting from a change in environmental parameters (temperature, water quality, vegetation structure, nutritional sources(			150	50	200
- Conserving the density of fish growth (economically important types).				150	150
G- Develop systems, programs and policies to protect the rural community, support its capabilities to adapt to expected trends in climate change in association with: land use, plant and animal production, and internal migration resulting from climate indicators:					
- Studying, classifying and following up on the present condition of the rural community, traditional knowledge, and the ability to adapt (assessing vulnerability index and risks facing different rural communities).	40	30	30		100
- Identifying programs that would enable small farmers to adapt to climate change.		150			150
- Strengthening the capabilities of rural communities to manage their resources and output, and to participate in relevant decision-making.			200	100	300
- Empowering rural communities to participate in determining and implementing national policies of adaptation to and coping with disasters and crises.			120	80	200
Total investment cost estimates for the agricultural sector					**EGP 7.93 billion**

Table 33
Estimated investment cost of adaptation projects in the health sector

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
A- Determining health risks expected to occur as a result of climate change:					
1. Providing information for effective planning and implementation:					
- Creating a database on the health status of the ARE including the current prevalence of diseases, risk factors, and the availability of preventive measures.	100*				100
- Providing information on health hazards expected to occur as a result of climate change					
2. Encouraging scientific research and field and demographic studies:					
- Determining the main issues which the provision of information requires through research and studies.	20	20			40
- Coordinating scientific and demographic research at both local and international levels of to assess the present situation and determine the strong and weak points of research policies and capabilities.					
- Placing climate change at the top of priorities in terms of scientific research and studies in the field of health and population.					

* This item is included in enhancing and supporting the national plan for developing information technology.

Table: 33 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
B- Raising Community awareness about climate change risks and means to adapt to it:					
- Launching awareness raising activities at both political and strategic levels by activating the role of the media and civil society, and coordinating the efforts of the Ministry of Health and other relevant different ministries and bodies.	20	20	30	30	100
- Raising citizens' awareness and encouraging healthy behavioral changes that would reduce damage resulting from exposure to climate change.					
- Coordinating with civil society organizations to take an active role in educating society.					
C- Increasing the efficiency of the healthcare sector and improving the quality of health services in dealing with climate change:					
- Placing health hazards resulting from climate change among the priority issues of the Ministry of Health plans and projects.	5	5			10
- Listing the necessary means of prevention and treatment of health hazards arising from climate change in health development programs, particularly, primary health care package, and health insurance programs.	10	10			20

Table: 33 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Increasing the efficiency of health units and improving the quality of service provided to adapt to climate change impact, in terms of infectious or non-infectious diseases, both in Upper and Lower Egypt, and in rural and urban areas alike through:					
▪ Completing the development of the infrastructure of healthcare outlets.	100	100	150	150	500
▪ Developing a system for detecting infectious diseases and vectors.	10	10	15	15	50
▪ Developing vaccination programs and increasing the budget for research and vaccine production.	10	10	15	15	50
▪ Creating a comprehensive database for diseases accompanying climate change, and making it available for all those concerned, such as governmental bodies, private sector and civil or nongovernmental organizations, with a program for information exchange among all these various bodies.*.					
▪ Training medical teams on ways and means of dealing with the phenomena accompanying climate change.	25	25			50
▪ Raising the efficiency of hospital emergency rooms in receiving and handling injuries resulting from unexpected and extreme events, such as torrential rains, storms, and floods.		150			150

* This item is included in enhancing and supporting the national plan for developing information technology.

Table: 33 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
D- Supporting the efforts by the Ministry of family and population to improve the social and economic status and population characteristics:					
- Determining the current situation and the social and economic needs.	20	20	25	25	90
- Increasing the interest of the population and population control programs.					
Total investment cost estimates for the health sector					**EGP 1.160 billion**

Table 34
Estimated investment costs of adaptation projects in rural areas, population and roads sector

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
A- Envisage the optimal regional distribution of population and economic activities within the geographical boundaries of Egypt in 2100, while taking climate change into consideration:*					
1. Economic recovery program:					
- Start with the economic activities required for recovery:					
▪ Individual and family income.	1000				1 billion Egyptian pounds
▪ Services and main life arteries.	2000				2 billion Egyptian pounds
▪ Production activities in affected sectors.	2000				2 billion Egyptian pounds
2. Precautionary programs/ Reconstruction:					
- Stop issuing construction permits in threatened areas.	1000				1 billion Egyptian pounds
- Allowing insurance companies to cover affected clients, so that banks would not be affected.	1000				1 billion Egyptian pounds
- Identifying the population, their activities, and their services in threatened areas, and arranging for alternatives now.	1000				1 billion Egyptian pounds
- Transferring the inhabitants of unsafe shantytowns to other safe areas.	2000	1000	500	500	4 billion Egyptian pounds
- Land Reclamation to replace agricultural lands, and transferring those affected to it.	1000	500	300	200	2 billion Egyptian pounds
- Developing investment plans to transfer heavy constructions, such as industrial zones, in case of evacuation.	2000	1000			3 billion Egyptian pounds

* This item is limited to only costs listed on the terms of prevention of climate change risks, including governmental and private spending.

Table: 34 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Land Reclamation to replace agricultural lands, and transferring those affected to it.	1000	500	300	200	2 billion Egyptian pounds
- Developing investment plans to transfer heavy constructions, such as industrial zones, in case of evacuation.	2000	1000			3 billion Egyptian pounds
- Preparing alternative sites for coastal establishments. Ports, and petrol and natural gas transfer stations perform services in case of disaster.	5000	3000			8 billion Egyptian pounds
- Elaborating a plan for the transfer and migration of the inhabitants of threatened areas and ensuring resources.	1000	1000			2 billion Egyptian pounds
3. Houses and constructional communities:					
- Evaluating the condition of houses and their suitability to resist climate change impact (houses in coastal areas, shantytowns, etc).	1000	1000	1000	1000	4 billion Egyptian pounds
- Reviewing present construction codes and developing them to be compatible with climate change. (Energy, temperature, water, etc).	50				50 million Egyptian pounds
- Employing up-to-date codes.	50				50 million Egyptian pounds
4. Roads:					
- Assessing the efficiency of main, secondary and peripheral roads to serve under extraordinary climatic conditions.	50	50			100 million Egyptian pounds
- Employing heat resistant materials for paving roads.	25	25	25	25	100 million Egyptian pounds

Table: 34 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Adapting and implementing suitable engineering designs for the new roads.	25	25	25	25	100 million Egyptian pounds
- Habilitating newly constructed and old roads.	100	100	100	100	400 million Egyptian pounds
- Rehabilitating the International Coastal Road, particularly along the Delta and coastal lakes, to act as a wave barrier during storms and in case of sea level rise.*.	-	-	-	-	-
Total investment cost estimates for the rural areas, housing and roads sector					**EGP 31.800 billion**

Table 35
Estimated investment costs of adaptation projects in the tourism sector

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
A- Climate Change Risk Reduction in tourism areas:					
- Developing the necessary plans to address risks.	5				5
- Assessing the vulnerability index and the range of exposure of touristic sites and locations of archeological value to risks .		10			10
- Guiding touristic growth away from environmentally sensitive areas and from areas most vulnerable to risk.			5		5
- Calling upon the private sector to implement adaptation plans as listed in its touristic projects.				1	1
B- Engage users in supporting the proposed strategy:					
- Creating legal entities for user's classes.	1				1
- Identifying adaptation projects for private sector participation.		7			7
- Involve users in periodical monitoring and follow up programs.			1		1
- Implementing joint adaptation plans.				10	10
C- Support periodic monitoring and follow up bodies:					
- Determining monitoring and follow up criteria and systems, and databases for different touristic areas.	15				15

Table: 35 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Implementing periodic monitoring systems.		3		3	6
- Reassessing and developing monitoring and follow up systems.			4		4
D- Raising environmental awareness:					
- Preparing for an environmental awareness campaign on climate change impact.	3				3
- Launching the campaign.		5			5
- Assessing the impact and effectiveness of the campaign.			2		2
- Re-launching the campaign.				5	5
E- Cooperation with international bodies:					
- Conducting a detailed study on the climate change impact on the tourism sector.	5	5			10
- Implementing planned projects according to their phases.			20	20	40
F- Taking into Consideration disaster risks in Egypt's sustained tourism development plans:					
- Reassessing the plans of the Ministry of Tourism and other relevant bodies.	5				5
- Preparing detailed plans for developing and activating tourism, while incorporating adaptation programs.		10			10

Table: 35 (cont.)

Activity / Project	Investment cost estimates (in millions of Egyptian pounds)				Total (in million Egyptian pounds)
	1st Five - year plan	2nd Five - year plan	3rd Five - year plan	4th Five - year plan	
- Periodic review, reassessment and development of plans.			5	5	10
G- Enhancing the capabilities of local communities in touristic areas:					
- Determining expected risk as well as the capabilities of different communities.	5				5
- Planning the prerequisites for the enhancement of the capabilities of local communities.		5			5
- Providing prerequisites according to plan.			30		30
- Periodical review, reassessment and development of plans.				5	5
Total investment cost estimates for the tourism sector					**EGP 190 million**

Chapter XI

Monitoring, Assessment and Follow-Up Procedures

This section addresses the efforts of monitoring, assessment and follow-up on two levels; the first level consists of monitoring, assessment and follow-up efforts on the ground of the phenomena related to climate change, as well as efforts to address the problem of uncertainty through realistic measurements to determine the risks of climate change, and later develop adaptation programs. The second level is the monitoring, assessment and follow-up of Egypt's national strategy for adaptation to climate change and disaster risk reduction, through the development of indicators to measure and monitor the implementation of the strategy and identify actions and future steps necessary to do so.

A- Monitoring, assessment and follow-up of climate change related phenomena:

Uncertainty, as far as climate change is concerned, leads to the reluctance of many decision-makers to approve the allocation of funds to the adaptation to this phenomenon. The reason for this uncertainty is that most of the studies and research available rely on regional or international mathematical models and satellite images, as well as other means. However these do not represent realistic measurements, which one can trust for their accuracy or soundness.

For example most recycling models, commonly used in all countries of the world, are based on the same theory, which demonstrates that the direct cause of global warming is the emission of greenhouse gases and the high concentration of carbon dioxide in the atmosphere. However, the assumptions and inputs underlying any of these models differ from one model to another, and thus the outputs and results for each of them are different. Hence, the decision makers are confused when offered results which are inconsistent, to say the least, and they are therefore unable to make the right decision which will lead to the implementation of steps and funding plans that require the expenditure of large sums of money.

On the other hand, most studies on the sea level rise phenomenon are based on satellite images and other models that convert these images to levels of numerical value, of which the degree of accuracy may not match the extreme sensitivity of this phenomenon. In other words, the degree of accuracy in digital elevations is in meters, while it is common knowledge that the expected annual average rise in sea and ocean levels may not exceed a few centimeters. Hence, the discrepancy which leads to some difficulty in decision making and in implementing them.

Most of the organizations and stakeholders interested in climate change have therefore stressed the need for continuous monitoring of all the variables that can aid in understanding this phenomenon, its mitigation, and adaptation. This cannot be achieved through intermittent surveys. It rather requires continuous and long term monitoring, followed by the immediate evaluation of all the data that has been obtained and the introduction of necessary amendments to the methods and elements of monitoring and follow-up.

Although Egypt has a long history in dealing with natural meteorological observations - given the country's dependence on the River Nile and the agricultural activities that require access to data for much of the climate change phenomena, such as rainfall and natural flow of the Nile – the recent developments and the fact that Egypt is

considered as one of the countries most affected by climate change in the world, dictate the need to intensify meteorological observations in different areas and the development of other observations in the areas that may not be of interest to the competent authorities at present.

In order to identify whether any elements need to be increased or additional ones created, following are some of the activities undertaken in Egypt in terms of monitoring, assessment and follow-up.

In the field of meteorology, since 1933 the General Authority for Meteorology has been operating through a network of 112 ground stations and air stations to monitor air pollution and cosmic radiation. 26 meteorological stations for monitoring agricultural climate are connected to international networks, and 32 of these stations operate through automatic and manual systems together. The General Authority for Meteorology is currently renovating 15 stations, and constructing 15 new stations, bringing the number of stations that operate automatically to 47 stations.

At the same time, the Environmental Affairs Agency is operating 47 stations to monitor air pollution in Cairo, Alexandria and the capitals of the governorates of the Delta, Upper Egypt and Central Egypt as well as the major cities. Greenhouse gases are not part of the elements of pollution monitored by these stations, except ozone gas, which is monitored by a limited number of stations.

Furthermore, the Institute for Higher Studies on the Environment, in the University of Alexandria, monitors the shores of the Mediterranean Sea, while the National Institute of Oceanography and Fisheries monitors the shores of the Red Sea. The Faculty of Science in Ain Shams University controls the quality of samples analyzed by both agencies, including the bacteriological and physical, chemical and trophozoite[1] elements. The Environmental Affairs Agency publishes this data on a special website related to all elements including the temperature of the sea water surface.

The National Authority for Remote Sensing and Space Sciences has been monitoring the earth since 2007 through Egypt's Satellite "Egypt Sat 1", which has recently disappeared in space for unknown reasons. Ongoing search is underway to return it to its original orbit. A database of meteorological data that was obtained from the satellite during the period of operation has been developed.

The National Authority for Remote Sensing has also set up a station to receive data coming from satellites of the U.S. National Oceanic and Atmospheric Administration (NOAA), the French earth observation satellites (SPOT), and others.

In the field of agro-climatic meteorology, the Ministry of Agriculture and Land Reclamation oversees the operation of 26 agro-climatic stations as well as two environmental meteorological stations, but most of these stations need maintenance and calibration. The number of stations does not meet the real needs of the country, which requires three times that number.

As regards to wave height monitoring, the setup of relevant measurement devices began in the port of Alexandria in 1944, the mouth of Rasheed Branch in 1964, Lake Burullus in 1972, the mouth of the Damietta branch in 1990, the port of Abu Qir in 1992 and the port of Damietta in 1997. An electric power-generating station was established in 1998 in El-Arish. Additionally, a device was set up to measure the height of the waves on the Red Sea, and 11 automatic measuring devices were installed along the Suez Canal.

However, Egypt's almost entire dependence on the Nile water makes identifying the rainfall on the Nile basin on a continuous and consistent basis a necessity. Although

[1] They indicate the presence of water rich in mineral and organic material, which encourages the presence of plant life, particularly algae, which reduces dissolved oxygen, most likely leading to the extinction of other living organisms.

what hinders this process is the lack of stations that measure rainfall at the basin level, the weak cooperation and coordination among countries of the basin, and the difficulty of sharing information amongst them; especially over the recent period, during which five of the Nile basin countries signed the Framework Convention separately from the other countries, and without their agreement.

The lack of information on the movement of groundwater within the Nile Basin is even greater than that on surface water. This is due to the fact that many countries of the basin do not have the energy required to pump this water, and most of them lack the financial capacity to import fuel from abroad.

The Nile Basin Initiative took some positive steps in acquiring knowledge about water quality, and this should end the ambiguity that prevailed. However, despite the continuation of the initiative which started a few months ago, the future is unclear.

It has become clear from the above that the action strategy for development in Egypt depends on obtaining data on the evolution of sea level rise on the Egyptian coast, temperature rise, rainfall, surface flow of the Nile waters and the amount of water that could reach the country as a natural flow of the River Nile. All of these activities require the constant monitoring of many aerial and ground variables, which may be within the country or abroad, particularly in the Nile Basin countries.

B- Monitoring, Assessment and Follow-Up on the Implementation of the National Strategy for Adaptation to Climate Change and Disaster Risk Reduction:

The operational framework for the adaptation to climate change contains a set of actions and activities that are consistent with the main objectives of the strategy and execution phases. It is expected that the implementing agencies would separately identify and describe their roles and responsibilities in full. They would also prepare an action plan, in order to achieve the strategic objectives within the limits of their competence. It is important that this be followed through monitoring and evaluation so as to improve the procedures of implementation, planning and resource allocation. A results report should then be submitted to the concerned authorities. The implementation is to be carried out according to a plan to monitor and evaluate the procedures taken in implementing the strategy. The objectives of this plan are as follows:

1. Ensuring the implementation of a package of measures and activities that are consistent with the main objectives of the strategy according to implementation phases, and that all stakeholders are assuming their implementation responsibilities with the relevant bodies.
2. Emphasizing on the integration between state bodies and civil society in the implementation of the strategy.
3. Identifying and addressing weaknesses in the implementation mechanisms in order to overcome the shortcomings in the early stages.
4. Reviewing the objectives and implementation mechanisms to allow for a dynamic evolution of the strategy. Considering that all estimates are based on phases, it should be updated periodically, if need be. The first five years mainly appertain to the urgent phenomena that cannot be postponed, and in parallel they focus on the studies and research that are necessary for future actions. This is followed by a ten-year plan as well as a plan covering the next twenty years. All of the above integrates in a framework of a vision for the distant future, which would cover the period from now until the end of the century.
5. Providing constant feedback in order to improve the performance of stakeholders in the implementation process, with a view to achieve the following:

Within the context of achieving those goals, the following actions must be carried out:

- Conduct baseline assessments of the status of disaster risk reduction resulting from climate change. Results should be published periodically through scientific studies that are codified according to specific performance indicators in order to monitor the implementation of the plan of action. If necessary, share this information with the local, regional and international organizations and citizens.
- Follow up (or create) institutional systems that are responsible for operational procedures, and provide periodic data at the required speed and quality.
- Follow up on integrating risk reduction associated with climate change (current and future) in the development plans, and ensure that the risk management associated with natural events and climate is taken into account.
- Monitoring and follow-up on education and awareness-raising programs in different geographic locations, with an emphasis on evaluation and follow-up on the extent of responses by influential stakeholder groups, such as decision makers, as well as by the most vulnerable groups, such as children, women and the elderly.
- Dissemination of success stories of disaster risk reduction related to climate change, which should include cost benefit analysis systems, and the ongoing monitoring and evaluation of vulnerabilities and risks, especially in regions exposed to the dangers of climate change.
- Conduct a comprehensive review of community risk assessment (population and health .... etc.) as well as national projects, and industrial and agricultural projects, water and tourism, etc. to ensure compliance with safety standards, which must be available to reduce the risk of disasters related to climate change.

Performance indicators:

Performance indicators are measurements of the inputs, procedures, results and impact of the implementation of programs and strategies. It is one of the effective means to measure progress. Similar to an early warning system, the performance indicators identify the problems associated with implementation, in order to facilitate the actions that may need to be taken in order to modify the course. However, ill-defined indicators will fail to measure the extent of success achieved.

The recommended indicators[1] for monitoring, assessment and follow-up on the implementation of the strategy include the following elements:

- Indicators related to the institutional and legislative structure and national commitment.
- Indicators related to risk reduction.
- Indicators related to the condition of the environment and the community.

Progress indicators proposed by the International Strategy for Disaster Reduction (ISDR) in 2008, for the implementation of the Hugo framework of Action, may be used as a guide to assess the performance indicators in relation to the progress made by the National Strategy for Adaptation to Climate Change and Disaster Risk Reduction, as shown in Table 35.

[1] The indicators recommended for monitoring implementation must be subject to measurement and checking. They must also provide measuring and verification means.

Table 35
Guiding proposal to assess performance indicators

Sector					
Degree of progress in implementing measures	**1st Degree No progress**	**2nd Degree: Slight progress and no clear commitment**	**3rd Degree: Institutional commitment and slow progress**	**4th Degree: Policy commitment and insufficient funding**	**5th Degree: Full implementation and sustained commitment**

Source: Information and Decision Support Center.

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List of Abbreviations

BOD	**Biological Oxygen Demand**
BEREAM	**Building Research Establishment Environmental Assessment Methods**
CAPMAS	**Central Authority for Public Mobilization and Statistics**
CFCs	**Chlorofluorocarbons**
EEAA	**Egyptian Environmental Affairs Agency**
EIA	**Environmental Impact Assessment**
FAO	**Food and Agriculture Organization**
GIS	**Geographical Information System**
GCMs	**Global Circulation Models**
GEF	**Global Environment Facility**
GHG	**Greenhouse Gas**
GDP	**Gross Domestic Product**
IDSC	**Information and Decision Support Centre**
ITS	**Integrated Tourism System**
IPCC	**Intergovernmental Panel on Climate Change**
IIASA	**International Institute for Applied Systems Analysis**
ISDR	**International Strategy for Disaster Reduction**
LNFDC	**Lake Nasser Flood and Drought Control project**
LEED	**Leadership in Energy and Environmental Design**
NBI	**Nile Basin Initiative**
NGO's	**Non Governmental Organizations**
RCM	**Regional Climate Model**
ELAC	**Economic Commission for Latin America and the Caribbean**
UNICEF	**United Nations Children's Fund**

UNDP	**United Nations Development Programme**
UNEP	**United Nations Environment Program**
UNFCCC	**United Nations Framework Convention on Climate Change**
WCDR	**World Conference on Disaster Reduction**
WHO	**World Health Organization**