

CHAPTER IV

Adaptation Options

In this chapter, we shall consider adaptation definitions and adaptation methods to climate change in preparation for consideration of adaptation options.

IV.1. Adaptation

Adaptation is adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climatic change and variability. Adaptation is important in the climate change issue in two ways—one relating to the assessment of impacts and vulnerabilities, the other to the development and evaluation of response options (Munasinghe, 2000)^[177]

A rigorous description of any adaptation would specify the system of interest (who or what adapts?), the climate-related stimulus (adaptation to what?), and the processes and forms involved (how does adaptation occur (UNFCCC 2007)).^[78]

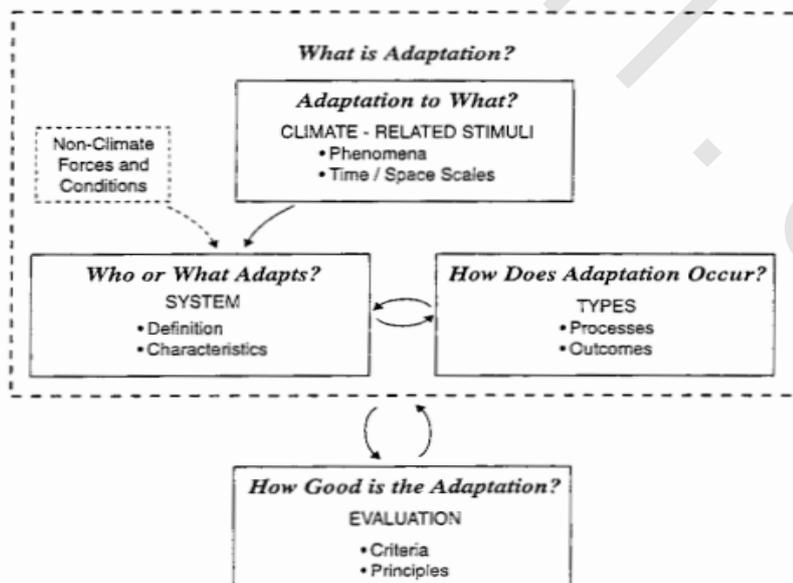


Figure (IV-1): Adaptation to Climate Change and Variability (Smit et al., 1999)^[79].

Adaptation according to Seneviratne, 2012¹¹⁰ is the process of adjusting to new conditions, stresses and natural hazards that result from climate change. Adaptation to climate change takes place in response to impacts experienced already, as well as in anticipation of expected impacts. In this sense, adaptation can be a spontaneous, autonomous process that takes place depending on existing capacity (so called ‘adaptive capacity’) and it can also be planned. Planned adaptation can take many forms and be driven by decision makers from a distance and by policies on a macro scale as well as locally by those involved.

IV.1.1 Who or What Adapts

Adaptations occur in something, called the “unit of analysis”, “exposure unit”, “activity of interest”, or “sensitive system” (Carter et al., 1994)^[80]. The terms sensitivity, vulnerability and adaptability are probably sufficient to capture the main concepts, especially if the reasons for particular adaptability characteristics are treated as underlying forces, and not included in the adaptability characterization itself. The IPCC (1995) Second Assessment Report

IV.1.2 Adaptation to what

Climatic stimuli pertinent to adaptation have been called “doses”, “stresses”, “disturbances”, “events”, “hazards”, and “perturbations” (Burton, 1997)^[81]; (Downing et al., 1996)^[82] These stimuli are expressed sometimes as climate or weather conditions (e.g., precipitation), and sometimes as the ecological effects or human impacts of the climatic conditions (e.g., drought, crop failure or income loss). Thus, the phenomena to which adaptations are made need to be specified according to the climate characteristics

IV.2 Methods for Adaptation Analysis and Evaluation

Conceptual models have been developed to outline expected relationships among stimuli, systems, adaptations and impacts (Klein et al, 1998)^[83]; (Smit et al., 1999)^[79]. These theoretical models also provide the structure and hypotheses for numerical impact assessments (Easterling et al., 1993)^[84] and (Rosenzweig et al, 1994)^[85]. Impact assessment models, whether for ecosystems, economic sectors or integrated regions, necessarily include assumptions About adaptations (or their

absence) (Tol et al., 1998)^[86]. The assumptions are reflected in estimates of likely adaptations, which are based upon the critical principle, observation or speculation. A second body of evaluative work deals with planned adaptations, mainly anticipatory undertaken or directly influenced by governments as part of their policy response to climate change. The methods are intended to evaluate the merit or utility or acceptability of potential adaptation measures or strategies (Carter et al., (1994)^[80].

IV.3 Adaptation and IPCC Assessments

Any systematic treatment of adaptation to climate change requires specification of three core elements: adaptation to what, who or what adapts, and how does adaptation occur for impact assessment, the central question is: what and when is “dangerous” anthropogenic interference in the climate system? (UNFCCC, Article 2)^[78]. The degree to which changes in climate are dangerous for ecological and human systems depends in significant part upon the nature of adaptations which are likely to occur in those systems as a matter of course, and the consequences of those adaptations. Hence, knowledge of adaptations, including an ability to predict the conditions under which they can be expected to occur in given locations and situations, is a necessary ingredient in impact assessment. For response options or policy evaluations, the central question is: what measures should be undertaken to facilitate adequate adaptation to climate change (UNFCCC Article 4)^[78]. The need here is to identify and evaluate potential adaptation measures, and ultimately put in place mechanisms for their implementation

IV.4 Disaster risk reduction

The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events (UNISDR (2009a)^[87]. Poorer developing countries are especially vulnerable to climate change because of their geographic exposure, low incomes and greater reliance on climate sensitive sectors particularly agriculture. People exposed to the most severe climate-related hazards are often those least able to cope with the associated impacts, due to their limited adaptive capacity (ADB et al., 2003)^[88].

(Stern et al., 2006)^[89]. Coastal communities, particularly those beyond Australia's capital cities are at the frontline of impending climate change impacts. Varying levels of physical exposure to shoreline erosion, storm surge, flooding, and changed weather patterns, exacerbated by sea level rise, represent significant environmental, financial, social and legal risks to coastal population while rising sea levels and increased frequency of storm surges are expected to intensify processes of shoreline recession, saline intrusion to fresh water systems, habitat shift and reduction (Steffen et al. 2009) ^[90]. Within this context, there is growing recognition of the potential role of social protection as a response to the multiple risks and short and long-term shocks and stresses associated with climate change. (Stern, 2008) ^[91]

IV.5 Climate change will affect the different regions of the world

Climate change will affect all countries, but people in the poorest countries and poor people in richer countries are more likely to suffer the most. They tend to live in high risk areas such as unstable slopes and flood plains, and often cannot afford well-built houses. Many of them depend on climate-sensitive sectors, such as agriculture and have little or no means to cope with climate change for example owing to low savings, no property insurance and poor access to public services. Climate change is expected to reduce already low incomes and increase illness and death rates in many developing countries Africa, small island states, and the Asian and Africa climate change according to the (IPCC, 2007) ^[1].

Africa is particularly vulnerable to the effects of climate change because of multiple stresses and low adaptive capacities, arising from endemic poverty weak institutions and complex disasters conflicts. Drought will continue to be a primary concern for many African populations. The frequency of weather- and climate-related disasters has increased since the 1970s, and the Sahel and Southern Africa have become drier during the twentieth century. Water supplies and agricultural production will become even more severely diminished. By 2020, in some African mega-deltas are likely to be particularly affected by countries agricultural yields could be reduced by as much as 50%. By the 2080s, the area of arid and semi-arid land in Africa will likely increase by 5-8%.

IV.6 The social dimensions of climate change – differentiated impacts

The impacts of climate change will be overlaid onto existing vulnerabilities of both the rural and urban poor and excluded, such as vulnerability to seasonality, to poor health and to market fluctuations (e.g. food and fuel price volatility). Poor communities are not homogenous however, and it is important to understand the differentiated social impacts of climate change based on gender, age, disability, ethnicity, geographical location. Livelihood, and migrant status (Tanner et al, 2008)^[92]. Include some specific examples:

A. Gender: water and climate change

Men and women have distinct roles in water use and management, leading to different needs and priorities. Climate change will increase the time taken to collect water in rural areas, a task mainly done by women and girls, due to travelling greater distances to find water. In urban areas, water collection is also an issue as women and girls may spend hours queuing for intermittent water supplies (Brody et al., 2008)^[93].

B. The Elderly: Health and climate change

The elderly are likely to be particularly vulnerable especially where social protection is limited or non-existent. They are at high risk from climate-change related impacts like heat stress and malnutrition and in rural areas can face restricted access to healthcare, as they are often unable to travel long distances to the nearest health facility (Brody et al., 2008)^[93].

C. Children: Drought and climate change.

Children are at highest health risk from inadequate water supplies and also predicted changes in vector-borne diseases. They are also at highest risk of malnutrition, with long-term implications for overall development. Children may also be at risk of early entry into work and exploitation in order to cover lost income from agriculture (Bartlett, 2008)^[94].

IV.7 Adaptation options

There are three different types of future planning or adaptation considerations for coastal properties in most cities or counties:

1. Undeveloped parcels that are considered or are zoned to be developable.
2. Existing unprotected development, including residential and commercial areas as well as infrastructure (i.e. streets, parking lots, parks, bike paths, sewer or water lines, etc.).
3. Existing development that has already been armored.

A Team should be aware of the different adaptation strategies that are available for both existing and planned future development. Some communities have highly developed coastlines, while others that have some undeveloped land could take advantage of the opportunity to address potential future issues proactively. Undeveloped land presents the easiest opportunity for planning ahead or adapting to future sea level rise when taking into account the very high probability of increased rates of coastal erosion. (Russell, 2012)^[115].

A. Principles for Sea Level Rise adaptation

Learning from others in similar situations can provide important insights on approaches worth exploring in this region. Increasingly, these experiences are possible to monitor on the internet and are being distilled in reports, surveys and guidance materials. In the adjacent box are highlights of a few local and state jurisdictions in Florida and across the nation that have begun incorporating sea level rise into their planning systems, along with the actions being taken:

the following are some key principles that should help guide communities as they build local adaptation strategies for sea level rise. these are drawn from experiences in a growing number of state and local jurisdictions.

1. **Plan early.** Early planning for the impacts of sea level rise is critical. Many communities and natural systems are already stressed. Decisions made today will have consequences for decades. In addition, many needed adaptations may take decades of gradual change.

2. **Build on existing policy tools.** Local governments have many policy tools already available to support local actions for sea level rise preparedness. While new policies will also be needed, existing tools provide the means to begin planning now.

3. **Integrate across sectors, disciplines and jurisdictions.** Adaptation planning, to be effective, cannot be done in isolation from other functions or levels of government. It is an ongoing process involving all sectors and disciplines, as well as intergovernmental coordination across local and regional entities. Building sea level rise adaptation strategies requires strength efforts to harmonize decision-making and to address potential cumulative and regional impacts, particularly where actions may affect adjacent jurisdictions or regional resilience.

4. **Build capacity to more effectively manage climate risk.** As characterized by the Pew Center for Global Climate Change, climate change adaptation is essentially is a risk-management strategy . Risk management is not a new concept; it involves assessing vulnerabilities and uncertainties, minimizing or avoiding negative effects and accepting some risk. Using different timeframes and scenarios for projected sea level rise, risk management can provide a systematic (Barbara and Lausche, 2009)^[116].

B. Local development planning

The local government comprehensive land use plan is a key entry point for mainstreaming climate change adaptation and building community resilience to sea level rise and climate change. It defines the vision and development path that the community aspires to take over the long term. As such, it can move communities beyond ad-hoc, short-term coping strategies to building successful long-term strategies for dealing with sea level rise and climate change. There are three areas that present immediate opportunities for leadership with local planning are Expand planning horizons, Incorporate adaptive response measures throughout comprehensive plans and Build partnerships with a broad range of stakeholders. (Barbara and Lausche, 2009)^[116].

C. Additional adaptation option

Before we carried out the evaluation of adaptation measures, we identified the most important options for adaptation in the vulnerable areas based on experts' discussions. These are considered below in detail

- **Beach nourishment and groins**

Beach nourishment includes depositing sand onto the open beach as well as beach scraping, building artificial dunes as storm buffers and beach sand reservoirs, and laying pipes underneath the beach to suck in the water and trap sand. Groins, which are hard structures perpendicular to the coastline, are used with beach nourishment to trap sand. The expense of this option is very low compared to other options (El Raey, 1999)^[109]

- **Breakwaters**

Breakwaters are hard structures used to reduce the wave energy reaching the shoreline. They can be set up offshore as submerged breakwaters or as riprap along the shore to absorb wave energy. This strategy is relatively very expensive. The net benefit of this option is only along the coastline, not on the social community or ecosystem. The environmental impact of this strategy is fair, but it is considered to be the best available tool for protection of lowland areas. The flexibility is good and so is the chance of success. The feasibility of implementation of this strategy is good. People staying in the coastal area need to protect themselves from coastal erosion. This strategy affects fishing processes so the fishermen need new tools and modern motor boats for fishing off shore. Breakwaters and dikes are good tools for protecting cultivated land as well as the entire infrastructure that is located in the coastal areas therefore, the farmers, industrial workers and employment in the tourism sector are not affected by this option (El Raey, 1999)^[109]

- **Public perception and awareness**

A questionnaire was prepared and administered by direct person-to-person interviews with a random sample of 150 persons representing the main stakeholders of Alexandria Governorate. Although this sample isn't statistically significant, it is considered good enough to give qualitative indications of major directions. The

questionnaire was supplemented by an explanation in Arabic of the problem in order to upgrade awareness of the vulnerable group (El Raey, 1999)^[109].

The most common solutions emerging in the adaptation for sea level rise and increased coastal erosion (IPCC.2007b)^[11] are planned retreat and beach nourishment. Sea walls, groins, dykes, levees and the reclaiming of land are other methods currently being employed around the world.

Adaptation according to (Seneviratne, 2012)^[122] is the process of adjusting to new conditions, stresses and natural hazards that result from climate change.

The main emphasis of the review is to identify methods and tools that have been designed for adaptation planning. Adaptation planning includes impact and vulnerability assessments, identification of adaptation options and prioritization / selection among those options through to their implementation. Related to these processes are risk analysis, which is used generally to address hazards, but here the focus is specifically on climate change.