BIOPHYSICAL AND SOCIO-ECONOMIC IMPACTS OF CLIMATE CHANGE ON WETLANDS IN THE MEDITERRANEAN

SUMMARY

Wetlands evokes generally water and water resources or water systems which evokes water cycle which evokes ultimately climate. They provide globally significant social, economic and environmental benefits, into the extent that they have been subject to increasing human pressure over the time, leading to loss and degradation of valuable resources.

Climate change has been also identified as a notable factor contributing to loss and degradation of wetlands, but there has been little attention given so far by policy-makers to the relationship between climate change and the wise use of wetlands.

Within the framework of the implementation of the UNFCCC, the projected changes in climate are likely to affect wetlands significantly, in their spatial extent, distribution and functions. Indeed, since the IPCC SAR, various investigations have led to greater confidence in the ability of models to project future climate, which allowed the TAR to confirm many established facts observed over the 20th century, and to confirm the role of effect of GHG emissions and aerosols due to human activities in altering the atmosphere in ways that are expected to affect the climate. Thus, under the IS92a scenario, the projected changes in climate are likely to cause a globally averaged surface temperature increase by 1.4 to 5.8°C over the period 1990 to 2100, and a globally mean sea level rise by 0.09 to 0.88 metres between 1990 and 2100 for the full range of SRES scenarios.

As far the Mediterranean region is concerned, **sub-regional climate change scenarios** have been derived from the global and regional ones constructed under different emission scenarios using various models and leading methodologies. The results under both SRES and IS92a emissions scenarios, which were then assessed for inter-model consistency, suggest that the warming will be is in excess of 40% above the global average, that for Precipitation , in spite of disagreement between scenarios, there is a consensus about the presumption of a greater contrast of the climate: In the South, the risk of a more arid climate during the XXIst century, and in the North, climate will be more contrasted, rainier in winter and dryer and more irregular in summer, and that for Sea level change, the rate of local sea level rise in the 21st century is projected to be greater than in the 20th century at the great majority of coastal locations.

Water and wetlands in the Mediterranean: water either as a resource or as an environment, is at the heart of interactions and tenseness, even conflicts, between the environment and the development, particularly within the Mediterranean region. **As a resource** water, which refers to total freshwater renewable resources, is rare, more and more solicited and submitted to anthropogenic pressures and it is very prone to climate change effects and consequences. Furthermore, during the 21st century, the projected differences in the demographic increase of Northern and the Southern countries will sharpen water shortage within the less supplied countries such as Algeria, Morocco and Tunisia.

Water as an environment refers to all marine/coastal and terrestrial natural wetlands, as well as to artificial water reservoirs. Within the Mediterranean basin, water is a valuable, but a fragile environment, which has been taped over time for various purposes. In addition, the Mediterranean Sea itself, which is a common patrimony for most of the surrounding countries, determines largely the climatic characteristics of terrestrial and coastal biotopes and ecosystems.

Mediterranean wetlands are defined and determined by three main environmental factors: (i) The Mediterranean climate that acts through regional and sub-regional variations, in particular the great year-to-year variation in the timing and quantity of rainfall; (ii) Topography and geology in through the existence of coastal plains and lowland. In fact, most of wetlands occur on these coastal plains and within interior drainage basins and (iii) Marine tides which are of limited importance within the sub-region and which occur along the Gulf of Gabès at the eastern coast of Tunisia.

In spite of various common factors with the Mediterranean countries, the sub-region shows many specific characteristics that are of a huge importance for the sustainability of wetlands, of which:

- Local variability of the climate:
- Water resources: Freshwater resources are scarce as their availability don't exceed $1000m^3$/inhabitant in the North Africa. The off take index of freshwater resources is very high for most of the southern countries where more than 80% of freshwater off take are used for agriculture production.
- Demography, which is a major dominant factor of the socio-economic and environmental development within the sub-region. It is expected that it will be of a major concern for further development during the 21^{st} century, in particular with regard to water resources scarcity.
- Socio-economic development: The prevailing constraints to development process will be further exacerbated by the demographic increase and the scarcity of freshwater resources and desertification.
- Desertification, which affects livelihood of rural population in arid and dry sub-humid areas of the sub-region is opposing a major constraint to development efforts. Thus, climate change might exacerbate desertification and, conversely, desertification aggravates carbon dioxide emission from cleared land and reduces their carbon sequestration potential.

North African wetlands show two main groups according to their functions: The first one includes wetlands having various functions, including the productive function, while the second includes wetlands having other functions than the productive one, mainly ecological and or scientific functions.

Very few national works have been done on wetlands. There is no systematic updated inventories as most of the available information are out of date. Presently, North African wetlands are experiencing either intensive anthropoid interventions or simply the lack or absence of interventions; most of wetland are not protected nor managed and valuable wetlands have been almost drained for agriculture or impacted by national water management schemes.

Because of the characteristics of water resources within the sub-region, **wetlands are very prone to climate change effects** and consequences. Indeed, Biophysical effects will appear as a result of Climate change impact on water balances and their variability over time as well as on hydrological drought frequency. It is also expected that climate change will impact coastal wetlands as a result of the interactive effects of sea level rise, warming, and decrease in precipitation.

Then, climate change impacts on water resources and coastal/marine ecosystems will in turn induce effects biophysical effects on wetlands, mainly:

- Loss of the specific biodiversity within various coastal wetlands leading to the decrease of their productivity which could be balanced, into some extent, by the formation of new wetlands on salt marshes and sebkhets.
- Disturbance of flora distribution and habitat for fauna together with a decrease of the carrying capacity of wetlands; which effect is likely to be balanced by a limited development of aquatic biodiversity.

Given the specific problems characterising the Maghreb countries in particular with regard to water resources scarcity, the reliance of rural livelihood on natural resources, desertification hazards, demography pressure, climate change, etc., will likely have various adverse socio-economic impacts which, in turn, would affect wetlands. Socio-economic impacts of climate change will be generated by biophysical effects on freshwater resources as well as by the biophysical impacts of sea level rise. These impacts are likely to affect indirectly wetlands through: (i) Increased anthropoid pressure on major productive coastal wetlands; (ii) Increased freshwater demand for domestic use and agriculture, which will exacerbate water resources problems leading to more pressure on freshwater and its diversion from natural systems and wetlands; (iii) The magnitude of sea level rise impacts on coastal infrastructures, together with desertification processes, will be a major concern with regard to social costs involved to cope with such impacts that will burden socio-economic development efforts placing environmental issues, such as wetlands, on a second hand priority .

In order to cope with such effects, adaptations should involve integrated adjusting measures primary, on the institutional framework at national levels in order to adjust the relationship between

the human element and the regarded ecosystem and Secondly, on the international environment in order to help within the preparation and the implementation of adjusting measures at national levels through financial co-operation, technology transfer, capacity building, monitoring and evaluation, etc.. these adaptations should address :

Biophysical effects through: (i) The improvement of the knowledge of wetlands; ((ii) The review of national strategies in connection with water resources management in the context of climate change; (iii) The review of national land use planning and management strategies as to integrate climate change and sea level rise issues.

Social adaptations through the development of an enabling environment which should: (i) Allow the development of ways and means as to reduce sensitivity of the rural production systems to climate stimuli; (ii) Enhance the development of alternative livelihood opportunities for rural population, which involve the strengthening of infrastructures, diversification of the economic settings, human resources development, etc. (iii) Reduce social an economic vulnerability to extreme events such as drought, floods, storm waves, and other natural disaster;

With regard to climate change mitigation, North African wetlands don't bear interesting potential mitigation options. Mitigation potential options should be sought in connection with energy and transportation sectors as they reflect opportunities for energy efficiency improvements and evenly in the rural sector where forests, agricultural lands, and other terrestrial ecosystems offer significant carbon mitigation potential, mainly through land use change and, into some extent, through afforestation and forest integrated management schemes.