BRIEFING NOTES
ON THE CIRCE COASTAL CASE STUDIES: AN OVERVIEW

These notes provide an overview of the four coastal case studies chosen to assess the integrated impacts of climate change in the Mediterranean area. Separate briefing notes are available for each case study: The Gulf of Valencia (Spain), the Gulf of Oran (Algeria), the Gulf of Gabès (Tunisia), and the West Nile Delta (Egypt).

1. Justification

Coastal zones have one of the highest population densities in the Mediterranean area. They support an unparalleled concentration of uses and infrastructure in the region. They are also vital for their high biological productivity and the link they provide between terrestrial and aquatic ecosystems. Even under present climate conditions they experience high levels of hazards since they are naturally much more dynamic than inland waters or open sea, and are in conflict with the "rigid" civil engineering structures built in coastal zones. Consequently, coastal zones constitute excellent case studies to evaluate the cross-sector impacts of climate variability and change.

2. Key hazards and vulnerabilities

The main hazards for coastal zones arise from the dynamic and fragile equilibrium that exists between terrestrial, marine, riverine and atmospheric systems. A change in any one of these components, due to natural climatic variability or accelerated climate change will modify the characteristics of the coastal zone to a state which may not be compatible with present uses and infrastructures. These hazards, defined as the probability that the coastal system "fails" for an appropriate failure criterion, tend to occur from a combination of factors. A joint probability approach is therefore required to estimate their occurrence.
However, the main variables used to calculate failure "modes" (waves, sea level, river discharge and wind) are partially interdependent in probabilistic and physical terms. In addition, marine variables generally have relatively short time series spanning a few decades at most. This makes it difficult to assess joint probabilities and marginal probabilities of extreme values for the return periods normally used in civil engineering projects.

Social vulnerability is mainly related to:

- i) Low-lying urban ar-

eas with a high population density and buildings or public paths frequently exposed to direct wave action under the present climate;

- ii) Infrastructure such as roads, railways or coastal engineering structures located in the coastal zone; and

- iii) Economic activities and facilities located in the coastal zone. They include: tourism, airports, water treatment plants, energy and industrial installations, and agriculture.

Environmental vulnerability in Mediterranean coastal zones is related to i) the lack of space for coastal systems to migrate inland due to high pressures of use and population density, and ii) the uniqueness of many threatened coastal ecosystems. The low-lying deltaic areas of the Nile and Ebro are among the most vulnerable to any change in mean sea level or wave storminess and are included in the CIRCE case studies (Figure 1). They are experiencing subsidence rates and a corresponding relative rise in sea level comparable to the accelerated sea-level rise reported by the Intergovernmental Panel on Climate Change Fourth Assessment Report. Present and future coastal development is likely to further degrade water quality. In addition, an increase in mean sea level could enhance the barrier effect of capes or breakwaters and enhance the decline in water quality.

3. Case studies

3.1 Gulf of Valencia, Spain

Within the Gulf of Valencia, the Ebro Delta and Cullera Bay are examples of coastal areas vulnerable to change in environmental and climate systems. The Ebro Delta is a low-lying coastal area protecting a deltaic plain of high environmental value and intense agricultural activity. It is particularly vulnerable to sea-level rise since about half of the deltaic plain is less than 0.5 m above the mean sea level. The Ebro River has experienced an appreciable reduction in flow and sediment load, leading to increasing rates of coastal erosion, subsidence of the Ebro Delta and a decline in nearshore water quality. Cullera Bay receives high

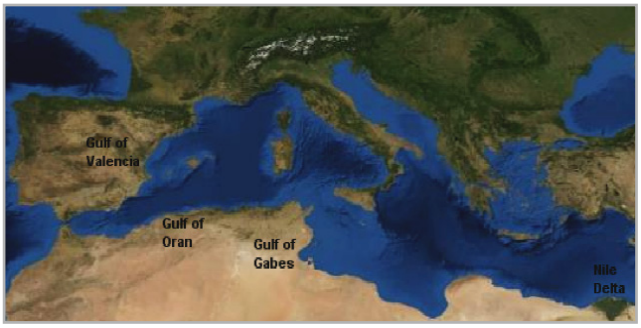

Figure 1: Location of the four coastal case studies. Modified from: MIRAVI - MERIS - Envisat - ESA (European Space Agency) http://www.esa.int

nutrient loads from the River Júcar and a marine outfall. The nearshore currents in this bay are strongly influenced by the local topography and Cullera Cape, which exerts a barrier effect on currents, propagating problems of coastal pollution. Climate change induced warming could accelerate eutrophication and further reduce water quality in this shallow bay with deleterious effects on the natural ecosystem. Sea-level rise threatens to accentuate the environmental problems of the Ebro Delta and Cullera Bay through salinisation and accelerated erosion of the coastal fringe.

3.2 West Nile Delta, Egypt

The West Nile Delta region contains many natural and cultural resources but experiences serious environmental problems. These problems include insufficient institutional capacity, widespread pollution, salt-water intrusion and a lack of environmental awareness, which makes sustainable development of the region practically impossible under the prevailing conditions. Since the building of the Aswan High Dam in 1964 there has been a rapid reduction in the amount of sediment accreted, leading to significant and rapid changes along the northern shoreline. The most vulnerable areas are the low-lying coastal districts of Alexandria (a CIRCE urban case study), an area south of Port Said, and an area near the city of Suez and the Bitter lakes. These areas are highly vulnerable to the impacts of sea level rise, which would affect the availability of fresh water, agricultural and energy resources, as well as human settlements.

3.3 Gulf of Oran

The west coast of Algeria, including the Gulfs of Oran and Arzew, acts as a buffer zone with Atlantic currents and oceanographic dynamics determining the spatio-tem-

An example of severe erosion on the Mediterranean coastline, Kerkena (Gulf of Gabès)

poral distribution of temperature and salinity. Peculiar to the Algerian climate is the extreme irregularity of rainfall, which in some years leaves the agricultural industry suffering from water scarcity and a substantially reduced harvest. Other environmental pressures are associated with harbour activities, the scarcity of urban waste water treatment, and concentrations of river nutrients and pollutants. The complexity of the shoreline and the magnitude of nutrient loads have induced significant problems of coastal pollution. The region has experienced periods of extreme warmth in recent years (e.g., 2003) which can accelerate eutrophication and further degrade water quality.

3.4 Gulf of Gabès, southeast Tunisia

A key feature of the Gulf of Gabès is the shallowness of the basin which means that nearshore waters are very sensitive to atmospheric conditions. In summer, the particularly high temperatures and salinity lead to the appearance of red algae. Another important factor is the high amplitude of the tidal range. Water in the lagoons is continuously mixed by tide oscillations preventing excessive warming in summer and cooling in winter, and is crucial for the lagoon ecosystem. The Gulf of Gabès is one of the most biologically productive zones in the eastern Mediterranean and is one of the key centres for fishing activity in Tunisia. However, this coastal zone suffers from problems related to toxic industrial discharge. The pollution affects an extensive part of the oceanic environment and has lead to the reduction and almost complete disappearance of several marine plant species. The Gulf also has a heightened vulnerability to sea-level rise due to its low elevation, particularly the low-lying islands of Kerkean, Kneis and Djerba (an important tourist resort). Severe erosion of the littoral zone has already been observed and this could accelerate with sea-level rise.

4. Main climate threats

Among the many climate threats presently experienced by coastal zones, the following will be considered:

- Increase in relative mean sea level due to a combination of subsidence and accelerated mean sea-level rise. This is considered an important threat particularly for low-lying coastal areas and beaches.
- Increase in wave storminess or changes in wave direction which could damage the equilibrium of the present shore-line configuration.
- Increase in sea-water temperature which would enhance eutrophication and algae blooms for bays with restricted water mixing due to the limited tidal range of the Mediterranean.
- Greater frequency of intense precipitation events which would accelerate erosion and increase water turbidi-

ty and the transportation of particulate matter offshore.

- Increase in UV radiation which could damage coastal ecosystems and modify social activities such as the Mediterranean sunbathing culture.

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