

BRIEFING NOTES ON THE CIRCE COASTAL CASE STUDIES: THE GULF OF ORAN

Summary

- ▶ *The Gulfs of Oran and Arzew, in Algeria, comprise rich marine ecosystems, a fertile coastal zone, nature reserves for a wide range of species, and ancient sites of historical and cultural significance.*
- ▶ *The petrochemical industry is the backbone of the economy but is a major source of marine and atmospheric pollution in the area. The fishing industry is important but remains underdeveloped.*
- ▶ *The marine ecosystem is rich in species, but very sensitive to environmental disturbance (pollution, overexploitation, climate change, and the introduction of non-indigenous species). Integrated management of the coastal zone presents an enormous challenge which*

must become the basis for sustainable development.

- ▶ *Key research issues related to climate change include accelerated coastal zone degradation and marine system modification, and the availability and quality of water resources.*
- ▶ *Appropriate adaptation measures and policy responses might include: adjustment of development plans (tourism, fishing); integrated management of water resources; emergency plans; health preparedness; and the protection of designated coastal areas.*

1. Physical and socio-economic characteristics

Geography and history
 Located in the western part of the Algerian coast (Figure 1), the Bay of

Oran and the Gulf of Arzew constitute a coherent system with a complex morphological structure. Due to their proximity to the Straits of Gibraltar, they constitute a buffer zone (Atlantic currents and physical and biological oceanographic dynamics determine the spatio-temporal distribution of temperature and salinity). The Gulf of Oran extends from Ghazaouet in the west (32°06' N, 1°52' W) to Oued El Macta in the east (35°47' N, 0°06' W) over a distance of approximately 180 km. According to a more restrictive definition, the area extends from Falcon Cape in the west (35°46' N, 0°47' W) to the Cap de l'Aiguille (or Ferrat Cape) in the east (35°53' N, 0°28' W) over a distance of approximately 50 km (nearly 9000 km²). Oran is the primary city in the region and the second city of the country. It is located at the far end of the bay, bordering the

Mediterranean in the north, dominated by the Mountains of Aïdour and Murdjadjo in the west and hemmed in, in the south by the “Great Sebkhha”, a large salty depression. The coast-line is a fertile strip of land interrupted by low mountains and enclosed to the south by a higher range of mountains running parallel to the coast. The region’s natural ecosystems have high diversity and include some protected areas: the wetlands of Macta (approximately 45,000 ha located west of Oran) is a natural reserve for several species of animals, the

Great Sebkhha covers approximately 56,000 ha to the south of Oran. The *Habibas Islands* constitute an outstanding marine nature reserve located offshore from the small cities of Madegh and Bouzadjar to the west of Oran. Formerly an important prehistoric site, Oran was founded in 903 AD by Andalusian sailors. A large number of archaeological sites of prehistoric origin have been found, and many other sites in the sub-marine environment remain to be uncovered. Although the Algerian littoral zone contains ancient sites

from several empires, it is the Roman Empire in particular, which dominates this area. Roman sites include Portus Magnus in the area of Béthioua (ex Saint-Leu) currently occupied by the petrochemical complex of Arzew, Aïn Franin and Kristel to the east of Oran, and remains of ancient thermal baths. There are also many important Spanish archaeological remains, such as Santa Cruz on Murdjadjo Mount. The east coast has been marked by successive invasions and settlements (Roman, Arabic, Spanish, Turkish and

Figure 1:
Map showing
the case-study
location:
the Bay
of Oran,
Algeria



later French), which have progressively transformed the littoral zone through infrastructural developments, cities and harbour settlements.

Algeria has a population of 33 million inhabitants. The growth rate decreased from 2.8% in the 1990s to 1.8% in recent years. The proportion of the population that is urban increased from 52.4% in 1990 to 62.9% in 2004. The main conurbations in the study area, apart from Oran (with over one million inhabitants), are Arzew and its petrochemical complex, Gdyl and its coastal villages, Kristel and Aïn Franin, the new suburbs of Oran (e.g., Bir El Djir and Canastel), Mer El Kébir, Aïn El Turk, El Ançor/Bousfer, Beni-Saf and Ghazaouet.

Climate:

The area has a Mediterranean climate with semi-arid characteristics. The rainfall regime is mainly governed by mid-latitude disturbances and Mediterranean cyclones. Oran receives 370 mm of rainfall per year.

Characteristic of 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. Mean temperatures range from 10°C in January to 25°C in August. The main temperature extremes are heat waves (e.g., 2003) and cold snaps with snowfall. December and January are the key rainy months, with Westerlies the common wind regime. Spring is a very temperate season with mean temperatures of 18°C in March and 23°C in May. However, it is the season of the 'sirocco', a hot dry Saharan wind. Maximum temperatures are reached during summer (August), when extreme values can exceed 40°C. Sea breezes are often observed. Autumn is the beginning of the rainy season with some violent thunderstorms.

Economy:

Algeria is the second largest country in the African continent after Sudan and tenth largest in the world. The hydro-

carbons industry is the backbone of the economy. At the beginning of the Nineties, the country initiated a process of transition from a centralised economy to a market-oriented economy. Algeria's economic growth has continued to be underpinned by ongoing growth in oil and gas exports, (revenues from hydrocarbons represent 97% of export earnings from goods and non-factor services). GDP grew 3 % in 2000-02, nearly 6 % in 2003-04, and 5.1 % in 2004-05. This comfortable financial situation led the country to launch the *Plan for Support to Growth* and several focused initiatives such as the National Programme for Agricultural Development (PNDA).

Per capita GDP rose from \$1,783 in 2002 to \$3,100 in 2005 (with purchasing power parity estimated at \$7,189 in 2005), and \$3,698 in 2006. The Government continues to play a dominant role in managing the economy, though its role is diminishing and many sectors have been privatised over recent years: telecommu-

nications, maritime and air transport, agriculture, tourism, mining and energy. Agricultural development faces multiple limitations, in particular a shortage of agricultural land, insufficient output, and strong dependence on weather conditions. With 1,250 km of Mediterranean coastline, Algeria has a high potential for establishing a commercial fishing industry, a resource which has long been underestimated and unexploited. The tourism industry is being restructured.

Fishing is the main economic activity of the cities and villages of the western coast of Algeria; from east to west they are: Arzew, Kristel, Oran, Mers-El-Kébir, Bousfer, Bouzadjar, Beni-Saf, and Ghazaouet. Harbours along the western coastline are blessed with cold marine currents coming from the Atlantic which contain plankton of high quality. The fishing stock is largely comprised of small pelagic-like sardine, saurel, and anchovy which accounts for 70% of production. The fishing flotilla of the western coast consists of three

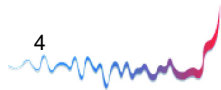
types of enterprise, trawlers, sardine boats and small-scale activities. The trawler flotilla has its hub in the harbours of Ghazaouet, Beni-Saf, Oran and Arzew.

Industrial activity is concentrated in Arzew and Béthioua (to the east of Arzew) where the petrochemical mega complex is located. It is the largest provider of employment in the region, and its exports constitute a major part of the nation's financial resources. However, it is also a major source of marine and atmospheric pollution. The industrial zone of Hassi Ameur concentrates a large number of small to medium-sized companies, is located relatively close to the coast, and specializes in the treatment of skins. A zinc electrolysis company in Ghazaouet is a major source of pollution (in particular certain types of metals) and a cement production factory in Beni-Saf is a source of atmospheric pollution. In addition, a detergents factory in the region of Aïn Témouchent is a probable source of pollution to the local river.

2. Justification

Due to its geographical position, the Algerian marine ecosystem is highly diversified. However, it is very sensitive to environmental disturbance (pollution, overexploitation of marine species, habitat deterioration, climate change, and the introduction of non-indigenous species). Integrated management of the coastal zone presents a permanent challenge which must resolve conflicts, preserve the environment, and form the basis for sustainable development.

The physical features of marine circulation which characterise the region exert a permanent dynamical force on the Western Mediterranean Sea (Mer d'Alboran) which influences the west Algerian coast eastward throughout the year. Circulation of water in the Bay of Arzew is influenced by the flow of the Atlantic water characterized by the instability of the Algerian current. This instability initiates between 0° and 1°E by meanders and succes-



sions of cyclonic and anticyclonic eddies, and is associated with coastal upwelling skirting the Algerian coasts at different space-time scales. From a biological point of view, some of these phenomena, like the anticyclonic eddies, are at the basis of intense biological activity (coastal upwelling). These circulation patterns explain the intense biological activity found in this part of the Algerian coast. Regional climate variability and the impact of anthropogenic sources of pollution on the marine ecosystem need to be analyzed in terms of biological marine indicators linked to the dynamics of the water bodies. Interrelationships between the physics and biology of the systems must first be understood in order to realise the biological, environmental and economic potential (tourism, fishing, aquaculture, etc).

This region is characterized by three important harbours (Oran, Arzew and Mostaganem). However, the pressure of population growth on the western coastal fringe

and the almost complete absence of water treatment works have negated the possibility of self-purification of domestic and / or industrial wastewater. Oran discharges 90 million m³ of wastewater annually without any treatment. The industrial zone of Arzew contains one of the biggest petrochemical complexes in Africa and constitutes a major risk of pollution (marine and atmospheric). In addition the Cheliff and Mactaâ Rivers transport high levels of nutrients (which restrict phytoplankton growth). Important consequences include: turbidity, changes in physico-chemical composition, an increase in nutrients, eutrophication and proliferation of biomass algae, modification of local and regional biogeochemical cycles and subsequent repercussions to the coastal habitat.

Research activities relevant to the case study include:

► 1994-1997: Seasonal forecasting of precipitation in the Mediterranean

► 2002: Detection of meso-scale phenomena in the Gulf of Arzew using Alsat-1 imagery

► 2005-2008: Use of remote sensing in the spatiotemporal bio-surveillance of pollution in the western Algerian coast (this research project is coordinated by ARCE in association with the European Space Agency-ESA as part of the TIGER initiative)

► 2005-2007: Integrated approach using *in situ* and remote sensing data for the evaluation of the quality of the western Algerian coastal zones. (RSE, University of Oran Es Sénia, Algeria)

► 2006: Satellite observation and *in situ* measurements for high resolution mapping of the marine biological signature in the western coast of Algeria (RSE, University of Oran Es Sénia, Algeria).

► 2004-2006: Use of biomarkers for the evaluation of spatiotemporal trends and impacts of

marine pollution in the western Algerian coastal region. (RSE, financed by the Ministry of Planning and Environment, MATE, Algiers).

3. Key Research Issues

The multidisciplinary and multi-sector approach includes *in situ* measurements (temperature, chlorophyll, turbidity, dissolved oxygen, nutrients) and the extraction of geophysical parameters from space imagery using sensors of water colour and thermal characteristics. These parameters will be used to examine the dynamics of the marine ecosystem, and the degree of its vulnerability will be assessed using high resolution mapping of the marine biological characteristics linked to the marine dynamics of the Bay of Oran and the Gulf of Arzew.

Climate issues

- ▶ Observed and future trends.
- ▶ Extreme events (heat waves, cyclogenesis).

- ▶ Climate change impacts studies.

Environmental issues

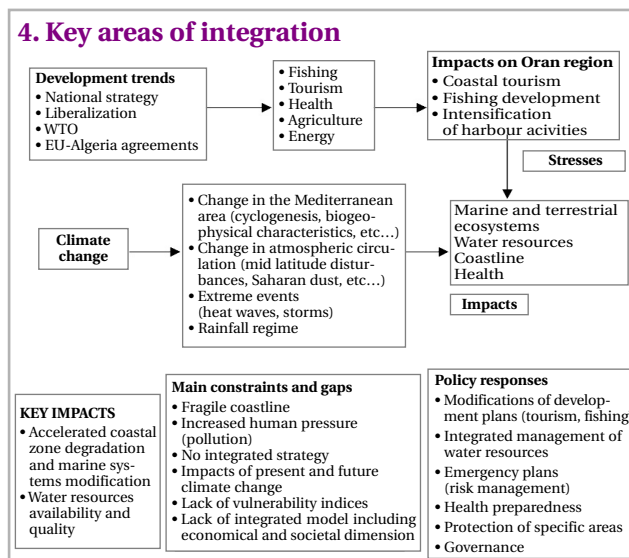
- ▶ Impacts of wastewater discharge from the city of Oran on the coastal ecosystem.
- ▶ Anthropogenic influence of the two main western Algerian rivers (Tafna and Cheliff) on the coastal zone and interrelationships.
- ▶ Vulnerability indices for the coastal zones.
- ▶ Potential risks to ecologically fragile and vulnerable zones.

- ▶ Vulnerability indices for the Algerian coastal zones.

Social issues

- ▶ Identification of zones with the potential to locate desalination stations or sites dedicated to aquaculture.
- ▶ Identification of appropriate measures of adaptation.
- ▶ Improved dissemination of information between concerned partners (Government Institutions, decision makers, NGOs, professional organisms, eco-

4. Key areas of integration



conomic stakeholders, farmers, etc.).

- ▶ Improved technical and administrative management for emergency situations (disaster and crisis management).

5. Regional stakeholders, policy makers, institutions

- ▶ Network of Environmental Surveillance (RSE) – Department of Biology, University of Oran Es Sénia, (Algeria)

- ▶ Research group on Climate and Applications to the Development (ARCE, Oran, Algeria)

- ▶ Observatory of Climate Change and Impacts (ARCE, Oran, Algeria)

- ▶ Algerian Space Agency (ASAL, Algiers)

- ▶ Ministry of Planning and Environment and Tourism (Algiers)

- ▶ Ministry of Fishing (MPRH, Algeria)

- ▶ National Met. Office (ONM, Algeria)

- ▶ Hydrometeorological Institute for Training and Research (IHFR, Oran, Algeria)

- ▶ University of Sciences and Technology (USTO, Oran), Laboratory of Environmental Modelling

- ▶ National Sanitation Office (ONA, Algeria)

- ▶ National Agency of Hydric Resources (AHRH, Algeria)

6. Data availability

- ▶ Climate data from the Algerian National Office of Meteorology: monthly data of precipitation, pressure, wind, temperature, moisture, etc. (WMO standards). Good quality.

- ▶ Collection of physical, climatic, hydrographic, oceanographic data, and information related to development indicators (population growth, health, economic activities, etc.).

- ▶ Dedicated GIS in the region of interest.

- ▶ Fieldwork campaigns: *in situ* marine measurements (temperature, pH, salinity, turbidity, dissolved oxygen) as well as laboratory analyses (of chlorophyll, nutrients, etc.).

- ▶ Satellite data (link to the TIGER Project): surface circulation of water bodies, water colour images, chlorophyll concentration, etc.

- ▶ SEDAC/CIESIN, Socio Economic and Center Application, Columbia, the USA.

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Further reading

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- ▶ Grimes et al., 2004, *Biodiversité marine et littorale Algérienne*. Ed. Sonatrach. Ed. Diwan, Alger. 362 pp.
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- ▶ ARCE, 1996, *Actes du Colloque national sur l'environnement côtier*, ARCE (Association for Research on Climate and the Environment), Oran, Algérie.

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