Impact of large coastal Mediterranean cities on marine ecosystems

Impact des grandes métropoles côtières méditerranéennes sur les écosystèmes marins

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Abstract

Large coastal cities represent nowadays a threat to marine ecosystems and a real challenge for sustainable development in the Mediterranean Sea due to their rapid development -particularly in the southern and eastern areas- and the many pressures that they exert on the environment. Because of the large harbours and transport infrastructures (roads, airports, etc.) to which they are linked, coastal metropolises are complex systems where multiple interactions take place. A better understanding of the impacts engendered by these urban areas is crucial to ensure that the good ecological status of the sea and its capacity to contribute to social well being be preserved. To this extent, special attention should be devoted to further investigate: i) the inputs of chemical pollutants and litter from diffuse sources into the sea, as well as their faith and impact on marine habitats and trophic chains; ii) the impact of coastal structures on the seafloor and coastal habitats; iii) the extent (regional and/ or local) of the ecological disturbance zone around large coastal cities.

Regional, north-south cooperation was recognized as a key factor to properly face these pressing issues. The will to cooperate in the domains of research and the environment is encompassed in the idea of a common Mediterranean space for science. This regional partnership must rely on the acquisition of harmonized, consistent, and easily accessible data, thereby converging with the objectives of the Barcelona Convention and the EU initiative Horizon 2020, which aims at the de-pollution of the Mediterranean Sea. New knowledge should be accompanied by a reinforced dialogue among scientists, decision makers, stakeholders, urban managers, and the large public. This participative approach represents a *sine qua non* condition to raise awareness and reduce pressures liable of harming the marine environment.

Résumé

Compte tenu de leur développement rapide, en particulier sur les rives sud et est du bassin, et des pressions multiples qu'elles exercent sur l'environnement, les métropoles côtières représentent aujourd'hui une menace pour les écosystèmes marins et un réel enjeu pour le développement durable en Méditerranée. Les grandes villes maritimes méditerranéennes sont associées à des ports importants et à des infrastructures de transport (voies routières, aéroports…) qui en font des objets complexes, lieux de multiples interactions. Pour mieux comprendre les perturbations causées par ces espaces urbains au milieu naturel, préserver le bon état des écosystèmes marins et leur capacité à rendre des services à la société, une attention particulière doit être portée au développement des connaissances sur : i) les apports diffus en polluants chimiques et en déchets solides à la mer, ainsi que sur le devenir et l'impact de ces rejets sur les habitats marins et les réseaux trophiques marins ; ii) l'impact des structures côtières artificielles sur les fonds et les habitats littoraux ; iii) l'étendue (régionale et/ou locale) des perturbations engendrées par les métropoles côtières sur les écosystèmes.

La volonté de coopération régionale nord-sud dans les domaines de la recherche et de l'environnement est très forte. Ce partenariat régional doit s'appuyer sur l'acquisition de données harmonisées, fiables et facilement accessibles. La

production de connaissances nouvelles devra s'accompagner d'un renforcement du dialogue entre scientifiques, instances de décisions, acteurs économiques et le public, cette approche participative étant une condition nécessaire pour faire évoluer les comportements et réduire les atteintes portées à l'environnement marin.

PREAMBLE

The present document reflects the input and results of interactive discussions of some 35 multidisciplinary, "large coastal cities" experts (i.e., scientists and stakeholders) from Mediterranean bordering countries and relevant International Organizations gathered in Alexandria from 10 to 12 February 2009 on the invitation of ASRT (Academy of Scientific Research and Technology, Egypt), CIESM (Mediterranean Science Commission), IAEA/MEL (International Atomic Energy Agency/ Marine Environment Laboratories), Ifremer (French Research Institute for Exploitation of the Sea, France), NIOF (National Institute of Oceanography and Fisheries, Egypt), and UNEP/MAP-MED POL (United Nations Environment Programme/Mediterranean Action Plan – Mediterranean marine pollution assessment and control programme).

SCOPE

On a general basis, this workshop and future synergies aim to promote the sharing of experiences and tools between main Mediterranean actors so as to better manage the marine environment, improve the quality of marine waters, sediments and marine biota communities in the vicinity of major cities, and enhance a more effective control of anthropogenic pressures.

INTRODUCTION

Mediterranean cities, the cradle of major civilizations, have contributed to the prosperity of the communities and the people of the region. However, modern large coastal cities exert strong pressures on the environment as a whole and especially on marine ecosystems. They also represent complex systems and hot spots that require special attention.

In this respect, Mediterranean cities need to be reinterpreted as unique systems which encompass the marine and land domains, together with the human activities carried out therein. Yet, the impact of coastal metropolises on the environment is still not fully assessed and understood, as vital data are lacking.

Many of the marine problems related to big cities stem from a lack of adequate knowledge regarding natural fluxes of, and human intervention on waters and

sediments, major inputs of material and energy as well as marine ecosystem functioning.

Problems are further aggravated by the attitudes of citizens who live in these overcrowded and disturbed environments, mostly unaware of their negative impact on the environment and the fact that, at the same time, they are victims of their own behaviour.

A number of recent initiatives, *e.g.*, ICZM[(1)] protocol, MSFD[(2)], and H2020[(3)], may help in formulating efficient policies to address these problems. The present document attempts to contribute to the fulfilment of these efforts.

The discussions have employed the DPSIR[(4)] (Drivers, Pressure, State, Impact, Response) model and the results are presented briefly herewith.

Drivers

Major drivers linking to pressures in large Mediterranean cities are population growth, particularly in the southern and eastern areas, and increasing -in number and intensity- anthropogenic activities, such as human settlements, big infrastructures, transport, energy production, and tourism.

The growth of urban settlements is difficult to stop. Often, Mediterranean cities are trapped between mountains and the sea. Consequently, they tend to expand along the coastline and towards the sea, reclaiming wetlands and the often narrow, shallow marine areas. This inevitably affects the distribution of sediments and coastal ecosystems.

People have some knowledge of their coastal lands, but know virtually very little about their marine environment, the associated threats and the functioning of its ecosystems. As a result, the general public is less prepared and equipped to defend the sea space in comparison to coastal land areas.

Furthermore, the rapid increase in the consumption of natural resources exacerbates anthropogenic pressures on coastal and marine systems.

Pressures

Pressures exerted by big cities include: material and energy inputs from domestic heating, transport (both on-land and off-road), energy production facilities, industries, urban runoff (episodic events), urban waste (from, *e.g.*, incinerators, landfills, waste water treatment plants, sewers), small rivers (*e.g.*, watershed and agriculture), coastal structures (*e.g.*, groins and beaches), and desalinisation plants. Many cities are linked with big harbours, which are specific or particular systems *per se,* and the activities carried out therein, such as shipyard operations, ballast waters handling, and dredging.

Other activities related to cities include: fisheries, structures in the open sea (which entail changes in water circulation), off-shore natural resources (*e.g.*, oil, gas, sand, and gravel) extraction, spill accidents (oil and Hazardous and Noxious Substances, HNS), ship-based pollution, *etc*.

State

As of today, most of the existing data and work carried out in the Mediterranean marine environment focus on coastal areas, many of which are directly affected by coastal cities. Despite the fact that we have started collecting these data more than 30 years ago, major gaps persist along with a general lack of connection between physical, chemical, biological and geological data on one hand, and emissions, other pressures, and socioeconomic aspects on the other. In the recommendation section of this document, basic prerequisites for a more efficient monitoring approach are listed.

Impact

A large amount of evidence is available on the important impacts of direct and indirect pressures exerted by cities on the Mediterranean marine environment and ecosystem. These include: the dramatic decline in fish stocks and biodiversity, the diminished resilience of the ecosystem to external stressors such as the intrusion of alien species, changes in physicochemical characteristics of water bodies, and the dramatic alteration of the position of the intermixing zone between fresh and saline waters. The link between impact drivers and responses needs to be further studied and a number of recommendations are included in the relevant section.

Response

Most of the responses until now are based on regulations and *ad-hoc* management which are poorly linked to long-term planning and monitoring of the effectiveness of the measures proposed and/or applied. Part of the failure is due to the minimum involvement of various actors, lack of coordination, and low awareness of the general public.

WORKSHOP RECOMMENDATIONS

Overarching approach

Integrated approaches and methodologies should be developed to evaluate the impact and the relative contribution of anthropogenic activities carried out in large urban areas on the marine environment and ecosystems.

Specific attention should be devoted to:

Scientific research

- Producing necessary information/data (status) on chemical pollution and marine litter.
- Evaluating the total fluxes of pollutants and investigating their pathways of transfer from all point and diffuse sources (including emissions from transportation, both inland and off-road) that are linked with anthropogenic activities in, and nearby coastal cities (via e.g. atmosphere, water, and sediment) to their final fate, including in organisms.

- Evaluating the extent of the areas (regional and/or local) under the effects of pressures.
- Assessing the state and the functioning of pelagic and benthic ecosystems affected by urban pressures, especially as regard eutrophication, Harmful Algal Blooms (HABs), diversity/quality of habitat, and food webs.
- Evaluating the impact of coastal structures, urban artificial beaches and outfalls on littoral morphodynamics, sea floor integrity, habitats, as well as socioeconomic activities.
- Evaluating the impact of complex activities associated with large harbours on the marine environment.

Impacts and responses could be studied through scenarios. Scenarios need to be built for complex coastal systems including coastal cities in an integrated way. Research should be performed to develop agreed methodologies so as to reduce uncertainties and increase comparability and coherence. Coupling of ecological and socio-economic aspects as well as the use of modelling are among the critical elements for the development of such scenarios, which requires an enhanced knowledge of hydrodynamics and sediment transport processes near large urban and harbour areas.

Management

- Impact on ecosystems must be addressed before and after response interventions.
- The cost of inaction should be compared with the value of goods and services provided by unharmed ecosystems.
- The effectiveness of response should be monitored by means of environmental, ecological, socio-economic, and cultural aspects and results made available to policy makers, local administrations, and the general public.
- Coastal and offshore monitoring programmes should be established, improved and sustained according to national/regional needs and commitments.
- The awareness of targeted groups of stakeholders and the general public should be raised, whilst keeping in mind that appropriate education should be based on comprehensive analysis and scientific methodologies.
- Free flow of information as well as data accessibility by all relevant parties should be ensured, at least at national level.
- Opportunities to construct synergies between sectorial activities in a preventive approach (for instance professional fishery and tourism) should be explored.
- Methodologies to produce decision-making tools to assess citizens' choices, thereby contributing to social well being and/or ecosystem health, should be developed.

- Advanced ways of governance based on public participation and involvement of stakeholders, urban managers, and scientists in decision making should be promoted.
- Demonstration projects should be developed and good practices disseminated in order to carry out targeted capacity building actions (see, e.g., the IAEA Technical Cooperation Programme), which aim at promoting a sound management of the impacts of Mediterranean cities on marine ecosystems.

Prerequisites for proper description of the state of the environment

- Existing data should be better gathered, quality controlled, harmonized and evaluated at national and international levels.
- Regional cooperation should be enhanced particularly as it concerns data for offshore waters and characteristics of sub-regions according to EU Marine Strategy Framework Directive (MSFD) and UNEP/MAP Ecosystem Approach.
- New measurements should address emerging needs (e.g climate change, species migration and intrusion of alien species).

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