Urban pressures on the Spanish Mediterranean coasts: ecotoxicological and ecological issues in marine ecosystems

Pressions exercées par les centres urbains sur les côtes méditerranéennes espagnoles : conséquences écologiques et écotoxicologiques sur les écosystèmes marins

Julián Blasco[1], Eduardo González-Mazo[2]
and Antonio Tovar-Sánchez[3]

[1]Instituto de Ciencias Marinas de Andalucía (CSIC), Campus Río San Pedro 11510 Puerto Real (Cádiz), Spain
[2]Departamento Química-Física, Facultad de Ciencias del Mar y Ambientales Universidad de Cádiz, Campus Río San Pedro, 11510 Puerto Real (Cádiz), Spain
[3]Department of Global Change Research, IMEDEA (CSIC-UIB) Instituto Mediterráneo de Estudios Avanzados, Miquel Marques nº71 07190 Esporles (Mallorca), Spain

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Abstract

Spanish Mediterranean coasts support the pressures derived for the increasing of the population. This problem is not only related to the big cities located in the coastal areas, as Barcelona, Valencia and other medium size cities (e.g. Alicante, Málaga, Almería...) but to the general increasing of the population in coastal areas, especially in the last decades. Pressures of the urban nucleus on the marine environment can negatively affect marine ecosystems. Yet some important sources, as the nearly invisible submarine groundwater discharges (SGD), that are important supplier of pollutants to the coastal habitats and ecosystems, are ignored. The identification of sources and pollutants (surfactants, metals, etc.) are key points for the assessment of the environmental quality of marine ecosystems. However, recordings of pollutants in marine ecosystems do not provide information about their effects. An integrated ecotoxicological approach should be taken account for evaluating the anthropogenic risk on the marine ecosystems.

Résumé

La côte méditerranéenne espagnole supporte la pression de la croissance démographique. Ce problème n'est pas seulement lié aux grandes villes comme Barcelone, Valence ou aux moyennes villes comme Alicante, Malaga, Almeria mais

aussi à la croissance globale de la population le long de la zone côtière, particulièrement depuis la dernière décennie. Les pressions exercées par ces centres urbains sur l'environnement marin peuvent affecter l'écosystème marin. Certaines sources importantes sont encore mal connues, comme les rejets d'eau souterraine sous-marine (submarine groundwater discharges, SGD) qui sont quasiment invisibles mais qui représentent un apport important de polluants vers les habitats et les écosystèmes côtiers. L'identification des sources de pollution et de la nature des polluants (surfactant, métaux,..) est essentielle dans l'évaluation de la qualité environnementale des écosystèmes marins. Cependant, la mesure des concentrations de polluants dans les écosystèmes marins ne donne que peu d'informations sur leurs effets. Une approche écotoxicologique intégrée doit être conduite pour évaluer les risques liés aux impacts des activités anthropiques sur les écosystèmes marins.

In Spain, 44% of the population live in littoral areas although these areas are only the 7% of the country surface. Additionally, 80% of the tourists visiting Spain (approx. 48 millions) are accommodating in coastal areas during their holidays. The movement of the population to coastal areas has increased in the last years and it has generated a "littoralization" of the territory. The Spanish Mediterranean area is specially affected by this process and 80% of the land is considered as urban or built land (MMA, 2007). As a consequence of this urban pressure the coastal ecosystem is suffering a continuous degradation. A direct effect of the increase of the population is the rising of wastewater production, with an estimated volume of 126 L/person·day (UNEP, 1996). Although all the Spanish Mediterranean big cities have wastewater treatment plants (WWTPs), the wide distribution of the population along the coast makes difficult the depuration of the whole water before discharge. The main substances entering in the coastal ecosystem due to municipal wastewater discharges are: suspended and dissolved matter, organic matter and nutrients, detergents and other contaminants (e.g. metals, organohalogen compounds, antifouling, endocrine disruptors and pharmaceuticals).

Among the above mentioned contaminants, surfactants have one of the biggest production rates and they are used in industrial processes as well as in household. In Spain, the main anionic surfactant employed is the linear alkylbenzene sulphonate (LAS) which 80-85% is employed as household detergent. In coastal waters, its concentration is found below 50 µg/L (González-Mazo et al.,1998) and in marine sediments below 2 mg/kg. However, other surfactants have been recorded in hot spots in the Spanish Mediterranean areas, this is the case of non-ionic surfactants and their degradation products: nonylphenol ethoxylates (NPEOs) and nonylphenol (NP) with concentrations ranging from 620 to 1000 µg/kg. Special concern should be taken in account with NP due to its estrogenic effect (Petrovic et al., 2002). Although NPEOs are banned or restricted in Europe, they are still being used in some countries. In order to predict their long-term fate, it is interesting to continue to monitor their distribution in the environment (González et al., 2004). Other chemicals compounds which have attracted attention are the pharmaceutically active compounds (PhACs). The main route of their entry in the

aquatic medium is discharged via wastewater, although their degradation varies widely between compounds. They can be considered as pseudo-persistent due to their continuous input. The information about the presence and discharges of these compounds in the Mediterranean coastal ecosystems is scarce. Recently, Gómez et al. (2007) analysed in the Mediterranean coast (Almería, Spain) the persistence of pharmaceuticals in the effluent of WWTPs showing that it represents a continuous input to coastal waters.

Metals are contaminants which presence in the coastal environments is well known and their inputs are associated to different anthropogenic activities. Nevertheless, the importance of other sources of metals, as submarine ground discharges (SGD) to coastal ecosystems are unknown and can represent an important input of metals to the coastal areas. Tovar-Sánchez et al. (2007) have recently evaluated the relevance of SGD in the coastal of Mallorca Island and chemically characterized the components that are diffusely supplied to the coastal waters through this pathway. The results suggest SGD could be an important source of nutrients and metals to the coast and could strongly influence the productivity and biogeochemical cycling of the coastal waters. Thus, Moore et al. (2008) estimated that submarine groundwater flux in the upper Atlantic Ocean account between more than 80% of the freshwater entering the Atlantic Ocean.

Despite persistent organic pollutants (POPs) have been identified as a group of the special concern within the Mediterranean Action Plan (UNEP/MAP, 1999a, b), information in many Mediterranean areas is scarce. Gómez-Gutiérrez et al. (2007) carried out the ecological risk assessment of POPs in the Mediterraneam sea sediments and they found that the level of toxicity for the benthic community was low and highlighted the importance of DDT contamination in the sediments.

Pollutant concentrations in the Mediterranean Sea are generally low, however hot spots can be found in coastal ecosystems, because contaminants distribution is not a homogenous process. The areas close to the big cities and population nucleus with untreated discharges are potential places where pollutant problems will be detected. Among environmental compartments, sediments are the main place for accumulation; they act as sink and reservoirs of contaminants although the changes in environmental conditions can produce their releasing and affect the benthic organisms.

The ecological risk assessment carried out in the Mediterranean basin to study the hazard induced by pollutants (Gómez-Gutiérrez et al., 2007) has identified gaps regarding the exposure and effects. There is a lack of information for specific regions and on-site ecotoxicological data. The monitoring activities should be increased and the development of the bioassay with species present in the Mediterranean area should be conducted. Hansen et al. (2007) revised the different species employed in EU to characterize dredged materials. Some of these species are present in the Mediterranean Sea and they can be useful as tools to analyze the toxicity of sediments: *Ruditapes philippinarum, Cylindrotheca closterium, Sparus aurata*. Other approaches to analyse the biological effect assessment as biomarkers have been applied in the Mediterranean basin in the framework of MEDPOL programme (MAP, 2006). However, the assessment of the environmental health of ecosystems should be carried out in the framework of weight of evidence

assessment (WOE) which can include a combination of sediment chemical analysis, sediment toxicity, community structure studies, biomagnification, biomarkers, bioaccumulation and sediment stability, called lines of evidences (LOE). This holistic approach allows getting information with a greater utility than if it was extracted from individual components (Scrimshaw et al., 2007).

Finally, the ecotoxicological approaches to measure the environmental quality of the coastal ecosystems subjected to urban pressure should be carried out in the frame of the Water Framework and Marine Strategy Directives, because both of them have as goals to get a good environmental status for coastal ecosystems.

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