

## **Environmental Sustainability: The case of Nutrients and Harmful Algal Blooms in the Catalan Coast (NW Mediterranean)**

*Marta Estrada and Jordi Camp  
Institut de Ciències del Mar. CSIC  
Passeig Marítim de la Barceloneta, 37-49, 08003 Barcelona, Spain  
marta@icm.csic.es*

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### GENERAL COMMENTS

The open waters of the Mediterranean are characteristically oligotrophic. This situation prevails over most of the continental shelves, but changes dramatically in the shallow littoral areas near the continent (at distances from land <500 m). Typical surface concentrations of dissolved inorganic nitrogen (DIN), phosphate and silicate in offshore waters are, respectively, lower than 1, 0.1 and 0.5  $\mu\text{mol l}^{-1}$ ; mean values (42, 1.7 and 7.4, respectively) in shallow coastal waters are more than ten times higher (Camp et al., 2000).

The amount of nutrients in Mediterranean littoral waters is controlled by two basic factors: Inputs from land and dilution (Camp et al., 2000). The high human population density near the coast (10-100 inhabitants per meter of coast), specially in summer, results in nutrient inputs which could sustain chlorophyll concentrations of 40  $\mu\text{g l}^{-1}$  (mean) or 7  $\mu\text{g l}^{-1}$  (median). In addition, anthropogenic pressure has resulted in increased confinement of nearshore waters, through the construction of harbours (more than 40 in 400 km of coast) and other infrastructures. The effect of these physical barriers is particularly important in a marine area without significant tides.

Another relevant aspect of coastal eutrophication is the distribution of nutrient ratios. Open waters of the Mediterranean have already been considered as basically P limited. This situation is maintained in most nearshore areas, in which N/P ratios range between 20 and 50; an exception is the heavily populated region near Barcelona, in which there is no indication of P deficit (Anon., 1999; Olivos 2000). P limitation could have implications for the toxicity of harmful algal blooms (HABs). In addition, DIN/Si ratios in the Catalan coast tend to be higher than 1, in principle favouring the dominance of phytoplankton groups other than diatoms (Masó et al., 2000).

Increases in nutrient concentrations and water residence times in many nearshore areas, together with possible introduction of some species, could be associated with the relatively frequent detection, since the late 1980s, of novel types of harmful algal events in the Catalan coast (Camp et al., 2000). The results of a monitoring program based on samples from harbours and open coastal waters (Vila, 2001) have shown the existence of a significant correlation between the maximum bloom density reached in HABs and the size of the harbour (positively correlated with water residence time). In turn, confined water bodies are likely to be preferred sites of cyst deposition, compounding their influence on HAB appearance.

### CONCLUSIONS / SUGGESTIONS

The situation in the Catalan coast suggests a conceptual model in which HAB generation is associated with small scale phenomena in confined nearshore areas, both of natural or artificial origin; these limited HABs can coalesce into a mesoscale event as a result of interactions with the alongshore coastal circulation and littoral hydrographic fronts occurring under certain meteorological and

freshwater input conditions. In contrast, the formation of HABs in other areas (like upwelling regions) appears to be basically related to mesoscale circulation patterns.

In summary, one important conclusion from eutrophication and HAB studies in the Catalan coast is that the consideration of anthropogenic effects on physical properties on the environment must be integrated with that of chemical and biological factors.

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### REFERENCES

- Anon. (1999) Informe sobre l'estat del medi ambient a Catalunya. *Documents dels Quaderns de medi ambient*, núm. 3. Generalitat de Catalunya, Departament de Medi Ambient, 199 pp.
- Camp, J., M. de Torres, M. Masó and E. Garcés. (2000) Nuevas problemáticas asociadas a proliferaciones fitoplanctónicas en la costa catalana. *VI Reunión Ibérica sobre Fitoplancton Tóxico y Biotoxinas. Sevilla, 5-7 May 1999. Actas de la Reunión, pp. 291-294.*
- Masó, M., J. Camp, E. Garcés, A. Olivos and M. Vila. (2000) Nutrient ratios in the near-shore waters of the Catalan Coast: a more realistic scenario for the HABs increment in the NW Mediterranean Sea. Poster. 9<sup>th</sup> International Conference on Harmful Algal Blooms. Hobart, Tasmania (Australia).
- Olivos, A. (2000) *Nutrientes inorgánicos disueltos en aguas litorales próximas del Mar Catalán*. Ph. D. Thesis, Universitat de Barcelona, Spain.
- Vila, M. (2001) *Proliferacions algals nocives a la costa catalana*. Ph. D. Thesis, Universitat de Barcelona, Spain.

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