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Cultural Eutrophication in the Coastal Ocean: A Global Context

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Editorial

Coastal eutrophication as a result of anthropogenic nutrient inputs is one of the most serious threats to the health of coastal estuarine and marine ecosystems around the world. Coastal ecosystems are projected to receive about a quarter of the anthropogenic nitrogen released in coastal watersheds.

To better understand and mitigate this hazard, researchers evaluated seven distinct coastal ecosystems exposed to a variety of riverine freshwater and fertiliser inputs. The following issues are dealt with: I how ecosystem traits minimise or amplify the impacts of anthropogenic nutrient inputs on ecosystem services; (ii) synergies among pressures (nutrient enrichment, overfishing, coastal development, and climate-driven pressures in particular); and (IV) management of nutrient inputs to coastal ecosystems [1].

This comparative analysis demonstrates that "trophic status," as characterised by the degree of primary output, is ineffective in determining the effects of anthropogenic nutrient loading. The Baltic Sea, Northern Adriatic Sea, Northern Gulf of Mexico, Santa Barbara Channel, East China Sea, and Great Barrier Reef are ranked first and second, respectively, in terms of the impact of cultural eutrophication [2].

Synergies with other pressures, such as overfishing, coastal development, and climate-driven increases in sea surface temperature, acidification, and rainfall, will exacerbate the impacts of increased anthropogenic nutrient loading (e.g., development of "dead zones," loss of biologically engineered habitats, and toxic phytoplankton events). Reducing point source inputs from sewage treatment plants is becoming more successful in terms of management. Controlling inputs from diffuse sources, on the other hand, continues to be a difficult task [3].

In the absence of successfully enforced, ecosystem-based control of both point and diffuse sources of nitrogen and phosphorus, the severity of coastal eutrophication is likely to worsen. This necessitates long-term, comprehensive research and monitoring, as well as periodic assessments of nutrient loading and effects. Continuous collaborations involving scientists, legislators, managers, and the general public must inform and guide these efforts [4].

Increased anthropogenic nitrogen (N) and phosphorus (P) inputs to coastal ecosystems via river discharge became the primary cause of eutrophication and subsequent ecosystem degradation in coastal ecosystems around the world during the twentieth century, a trend that is arguably the most widespread anthropogenic threat to the health of coastal ecosystems. Cultural eutrophication is defined by the European Union as "the enrichment of water by nutrients, particularly nitrogen and phosphorus compounds, causing an accelerated growth of algae and higher forms of plant life, causing an undesirable disturbance to the water balance of organisms present in the water and to the quality of the water concerned." Eutrophication is described by Nixon (1995) as a rise in the rate of organic matter supply [5].

Ecosystems and Services of the Coastal Zone

Healthy ecosystems provide four types of services valued by society; hence sustainable development is dependent on them. Climate control4, coastal erosion prevention, limiting the amount and impacts of coastal floods, and water quality maintenance are examples of regulating services [6].

- Provisioning (food, raw materials, and medications, for example);
- Cultural services (for example, recreational, artistic, and spiritual advantages); and
- Supporting services (for example, the availability of essential habitats5 and biodiversity, primary production of organic nutrients, oxic conditions, and appropriate nutrient cycling) that support coastal ecosystems' ability to offer regulating, provisioning, and cultural functions.

The provision of these services is threatened worldwide by coastal eutrophication. Because people are concentrated in the coastal zone, where ecosystem services are most valuable and where they are most vulnerable to convergent anthropogenic pressures, management of anthropogenic nutrient enrichment should take multiple pressures into account, particularly over fishing, coastal development, and climate-driven pressures [7].

Managing coastal eutrophication on regional to global scales requires both more comprehensive detection and monitoring of nutrient inputs and their impacts, especially, as noted in section “Global Trends and Patterns,” in the southern hemisphere [8]. In addition, efforts to reverse eutrophication and accelerate oligotrophication require more comprehensive strategies to reduce eutrophication than simply reducing nutrient inputs to coastal watersheds [9]. These begin with ecosystem-based management plans that consider watersheds and their receiving bodies of water as a whole (e.g., large marine ecosystems) and, in this context, land-use practices that integrate land-based controls to manage nutrient releases and transports to coastal ecosystems [10]. Each part of the watershed plays a role in contributing to nutrient inputs, which are modulated by soil type, land use practices and land cover. Identifying critical source areas (CSAs) for cost effective nutrient control should be part of such an integrated approach.

i) Recycle animal manure to cropland within watersheds has been shown to be an effective BMP that substantially reduces nutrient runoff;

(ii) Restore critical habitats (sea grass meadows, coral reefs, oyster reefs, mangrove forests and salt-marshes) to remove nutrients, increase

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sequestration of organic matter in benthic sediment, and increase rates of denitrification;

(iii) Establish sustainable macro algal and bivalve aquaculture systems to remove excess N and P; and

(iv) Implement ecologically sound hydrological interventions to increase flushing and reduce the residence time of nutrients.

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Conflict of Interest

None

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