Journal of Aquaculture Research & Development

Lenzi. J Aquac Res Development 2011, 2:2
DOI: 10.4172/2155-9546.1000104e

Editorial Open Access

Resuspension of Sediment as a Possible environmental Management Method for Coastal Lagoons and Aquaculture Ponds

Mauro Lenzi

Lagoon Ecology and Aquaculture Laboratory (LEALab),Orbetello Pesca Lagunare srl,V. G. Leopardi 9, 58015 Orbetello, Italy

Coastal lagoons are highly productive environments where extensive aquaculture, based on juvenile fish entering from the sea, is conducted with excellent results in many parts of the world. In some cases, production is incremented by introduction of juvenile, prawns and molluscs of commercial value [1,2].

In the last 30 years, coastal areas, including lagoons and ponds, have been subject to man-made eutrophication [3, 4]. This process has devastated coastal communities of organisms, favouring opportunistic species, reducing species diversity and often causing die-offs of natural communities and cultivated species [3,4].

Although efforts have been made to reduce nutrient loads from civil wastewater treatment and industry (including land-based fish-farms), many lagoons still have serious environmental problems. The solutions usually used for remediation or to counteract the effects of eutrophication are often expensive and have a heavy impact on the lagoon and surrounding environments. They include earth-moving operations, excavation of channels and openings to the sea, deviation of rivers and drainage channels in farmland [5-15]. Not only do they denature lagoon characteristics and alter the coastal belt, but their cost/benefit ratio may be high and their effects short-lasting. For example, underwater channels excavated to improve internal water circulation in lagoons may silt up in a few years and require frequent costly maintenance. In the case of algal blooms, harvesting and disposal are often tried [16-22], but these operations are costly and frequently conducted with inappropriate methods and timing. Contrary to theory, the disposal of harvested algae is difficult and industrial uses of this material are rarely found.

As an alternative solution for the management of lagoon eutrophication, recent field experiments have been conducted to evaluate the efficacy of resuspension of surface sediments [23,24]. The surface layer of sediment accumulates bioavailable organic matter and with the intervention of microbes, provides nutrients for the development of opportunistic vegetation. Superficial sediment subject to frequent disturbance may undergo an increase in the oxidative mineralization rate of organic matter [25]. Oxidation accelerates nitrification and leads to predominance of nitrates over reduced forms, increasing denitrification (which occurs in anoxic microhabitats in an oxidative milieu), with the result that part of the nitrogen is lost as gases [26]. Resuspension may lead to oxidation of sediment iron to ferric oxides, which adsorb orthophosphates, removing them from interstitial water and the water column [27]. By virtue of the geo-chemico-physical effects it produces, resuspension leads to selection of microbial, plant and animal populations, in the opposite direction to the selection produced by eutrophication and dystrophy. Opportunistic macroalgae suffer phosphorus limitation and seagrasses that take up nutrients directly through their roots can recolonize the substrate [28]. Frequent disturbance of sediment does not have significant negative effects on the water column, such as increase in pH and nutrients or decrease in dissolved oxygen [23,24].

Resuspension of superficial sediment can therefore be used as a method to mitigate the effects of eutrophication and to manage eutrophic lagoons, especially shallow atidal lagoons with little water exchange. It is not always possible to completely restore such lagoons, once they become eutrophic. The reasons include historical deposition of nutrients in sediments and the difficulty of completely stopping external inputs of nutrients in heavily settled coastal areas. Resuspension can be effective if performed with the appropriate frequency and timing for a particular environment. It is economical in terms of investments and running costs, unlike all other methods of environmental remediation and management.

Resuspension can also be applied to aquaculture, especially in land-based earth ponds, to maintain good farming quality. The fish themselves also disturb the sediment to some extent, improving their aquaculture environment [29], but it may be necessary to artificially increase disturbance every 24-48 h, depending on the type of fish and the size of the pond, to favour the development of aerobic bacteria [30]. This could be particularly useful for peneids raised on fresh feed in relatively large earth ponds. In this case, sediments resuspended periodically by rotation in different parts of the pond could avoid processes of putrefaction and the development of disease.

Resuspension of sediment has been regarded with scepticism by coastal management bodies, where there is the widespread belief that sediment should never be disturbed because it could damage communities and stir up contaminants. However, occasional resuspension by strong winds or occasional human activity occurs in any case, and we know that benthic communities decline when dystrophic processes are frequent. As regards contaminants, it is necessary to determine their presence and type, but anoxic conditions in sediment are known to promote the bioavailability of certain contaminants [31].

I propose extending this solution for mitigation of eutrophication to fish farms. I hope this proposal arouses interest and debate. Often the results of research remain isolated, especially if restricted to research environments or journals with relatively limited circulation. The great advantage of an open-access journal, like Aquaculture Research & Development, lies in the fact that it can go everywhere and reach everyone, without the economic constraints posed by most scientific journals. Open access has triggered an even bigger cultural revolution than expected, enabling ideas, hypotheses and results to travel as never before. It is accelerating progress (and perhaps also democracy) everywhere.

***Corresponding author:** Mauro Lenzi, Lagoon Ecology and Aquaculture Laboratory (LEALab),Orbetello Pesca Lagunare srl,V. G. Leopardi 9, 58015 Orbetello, Italy, E-mail: lealab1@gmail.com

Received March 22, 2011; **Accepted** April 10, 2011; **Published** May 09, 2011

Citation: Lenzi M (2011) Resuspension of Sediment as a Possible Environmental Management Method for Coastal Lagoons and Aquaculture Ponds. J Aquac Res Development 2:104e. doi:10.4172/2155-9546.1000104e

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