AQUACULTURE AND FOOD SECURITY - CAN FISH FARMING FILL THE GAP?

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ABSTRACT

While aquaculture has provided economic and nutritional benefits to millions, there are concerns that unconstrained sector expansion and intensification, coupled with its ecological and social impacts, globalization of markets, and climate change, may have undesirable impacts on the resilience of social-ecological systems. A significant part of the aquaculture expansion is expected to occur in coastal areas, where it directly affects resource systems already experiencing large pressure from human activities. Thus, there is a risk that the anticipated benefits from aquaculture may come at the expense of increased pressure on coastal ecosystem services, thus jeopardizing coastal people's food security and livelihoods. Further, intensification may also indirectly increase the dependence on marine ecosystems through usage of fish resources as feeds. The practice of intensive farming of fish and crustaceans is characterised by inputs of high quality resources and energy and release of effluents. The industry continues to improve performance through research on food development and system designs, and recent initiative, the "Aquaculture dialogue", attempts to identify sustainability criteria for a selection of cultured species. In addition FAO have recently moved beyond their earlier established "code of conducts" and are now developing a broader systematic perspective on aquaculture, i.e. "Ecosystem approach to aquaculture". This presentation will discuss how aquaculture may impact on social-ecological resilience, more broadly and also in connection to coastal aquaculture development, and specifically considers the intensification of production methods. In connection to this some recent sustainability tools/indicators will briefly be discussed out from this perspective.

Keywords:

Resilience; social-ecological systems; ecosystem approach; ecosystem services; life cycle analysis

INTRODUCTION

Today aquatic products provide nearly 3 billion people with at least 15% of their animal protein intake and fish constitute the dominant source of animal protein in many island states and poorer countries (FAO 2009, Smith et al. 2010). However, the world's growing population consumes more and more fish and stagnating catches from our oceans cannot keep up (Pauly et al. 2003). The rapid development of aquaculture has to some extent enabled us to partly meet this growing demand and currently the aquaculture sector provides half of all fish destined for human consumption (FAO 2009). However, the gap between demand and supply is increasing and the pressure is on aquaculture to develop even further. The aquaculture industry is already today the fastest growing animal production sector but the question is whether production can double by 2020 to meet the expected demand for fish products (Jacquet et al. 2009). However, as aquaculture attempts to meet this demand it will be necessary to distinguish between market demand and people's food security needs.

The continuous and strong development of aquaculture within the last few decades, growing at 6.9 percent per year, indicates aquaculture's potential to continue to play a central role for future production of aquatic products. Ninety percent of today's aquaculture production comes from Asia but other regions, e.g. whole continents such as Africa with the exception of Egypt, has despite natural endowments, including unexploited land, water, coastlines and human resources, largely remain an aquaculture backwater (Hecht 2000, FAO 2000, Brummett et al. 2008). The reasons for this have largely been identified (lack of investment and infrastructure, dissemination of best practices, lack of directed and supported national strategies, etc.) and this has spurred new initiatives for developing aquaculture in e.g. Africa (FAO 2000, Moehl, Halwart and Brummett, 2005). Thus, Africa, together with other regions where aquaculture is still underdeveloped, could play a more important role in future aquatic production and thus food security. However, climate change effects, such as e.g. sea level rise and increased storm impacts, together with water shortage caused by e.g. intensive agriculture irrigation schemes and droughts, threaten existing aquaculture production in some areas and also limit potential of aquaculture to grow. Key here is to find and develop adaptation strategies together with new culture technologies (e.g. for improving water use efficiency, etc.). Off-shore waters been suggested as next frontier for aquaculture expansion but it is difficult to see how this production could become available for the poor.

The gap

Filling the existing and future gap between production and demand does not only simply involve producing large volumes of fish. If this was the case more fish biomass could be obtained by choosing to eat fish lower in the food web, i.e. better utilisation of small pelagic fish from capture fisheries and focus on cultivating herbivorous fish species needing less high quality resources (fish and agriculture inputs). However, this would need structural and policy reforms that enable fish to reach poor people in developing countries at affordable prices. The role of aquaculture with respect to food security is much more complex than just fish biomass. The market demand also consists of a mix of high valued species aimed at developed countries, such as EU member nations, USA, etc., and also for rapidly developing economies such as those of India and China. Thus, increased production from aquaculture may need to meet multiple demands, and the production systems needed to achieve this will have the possibility to improve food security either in the form of increased availability of food fish for poor, and/or through generation of economic benefits to farmers, people involved in value-added activities as well as other interlinked businesses in developing countries.

AQUACULTURE AND THE ENVIRONMENT

While aquaculture has provided economic and nutritional benefits to millions, there is concern that negative ecological and social impacts, resulting from unconstrained sectoral expansion and intensification of production methods, together with increased globalization of markets and climate change, may prevent efficient and equitable usage of natural resources and cause undesirable impacts on the resilience of social-ecological systems. The aquaculture industry has responded to these concerns in various ways and besides the many technological innovations and improvements in husbandry, efforts also involve reaching consensus among the various stakeholders on criteria for sustainable aquaculture practices. In addition, organisations such as the FAO have recently moved beyond their earlier established “codes of conducts” to develop a broader systematic perspective on aquaculture, i.e. “Ecosystem Approach to Aquaculture”. This has been described as “a strategy for the integration of the activity within the wider ecosystem in such a way that it promotes sustainable development, equity, and resilience of inter-linked social and ecological systems". These measures are needed and form necessary steps towards a sustainable trajectory for the industry. However, it may not be enough. Thus, there is a need to further increase our knowledge about how present aquaculture production impacts on food security at various spatial and temporal scales, and also to analyze potential environmental and social implications from emerging changes in preferences and demand for seafood products

Aquaculture and Ecosystem services

Human action is increasingly changing our life-support system resulting in changes that threaten the future availability of ecosystem services, i.e. benefits that people obtain from nature (Steffen et al. 2004). The Millennium Ecosystem Assessment showed that the increased loss of services from ecosystems is a significant barrier to reducing poverty, hunger and diseases (MEA 2003). Poverty and ecosystem degradation are closely associated and exacerbate each other (Biggs et al. 2004), and the feedbacks that produce the spiral of poverty and ecosystem degradation are still incompletely understood. The development of aquaculture has directly contributed to the loss of important ecosystem functions through land and seascape transformation, and also more indirectly through e.g. pollution. Overexploitation of provisioning ecosystem services usually also degrades regulating ecosystem services that maintain air, soil, or water quality. This may decrease future yield of provisioning services, and increase vulnerability of people to environmental variability. On the other hand aquaculture has also enhanced provisioning services, both in the agriculture landscapes and in the seascape, thus leading to improved welfare. Aquaculture seems to constitute a viable substitute to today's terrestrial animal production (i.e. in providing important micronutrients and proteins), which for some sectors can be highly resource consuming and detrimental to ecosystem services. The question is how to balance the negative and positive consequences from aquaculture development. The landscape and seascape are today increasingly being managed for multiple functions and services in addition to provision of food and fiber, and this requires the integration of ecological and socioeconomic research, policy innovation, and public education. With regard to aquaculture development we still have the possibility to do it "right" from the beginning, as the industry still is fairly young. However, this window of opportunity is rapidly closing.

Looking at the diversity of farming systems it is easy to understand that the biophysical impacts of aquaculture activities, i.e. magnitude and spatial scale, vary enormously. Impacts generally vary with species, culture system, intensity of production methods and quality of management. A range of environmental and social concerns has accompanied the recent rapid expansion of intensive aquaculture, including both fish and shrimp. These include issues such as: nutrient enrichment or depletion, effects of chemicals, disturbance or replacement of local ecosystems, exotic species introductions, flow of exotic genetic material from farmed to wild populations, transmission of disease/parasites, consumption of capture fishery resources, energy and resource dependency and associated greenhouse gas emissions. Thus, each production strategy, i.e. type of aquaculture production, is characterised by a unique suite of environmental interactions at local, regional and global scales. Informed decision making for improved environmental management in aquaculture therefore requires tools which can provide multi-criteria environmental performance assessments and clarify the environmental trade-offs associated with specific aquaculture technologies and products. Not only is there a need to consider trade-offs between different aquaculture systems but also between alternative production systems (i.e. livestock, crops, etc.), as well as trade-offs with respect to the generation of ecosystem services from nature (Rodriguez et al. 2006). From a food security and livelihood perspective, the trade-off between aquaculture development and ecosystem services becomes utterly important when dealing with poor people living close to, and from, natural systems. For example, a significant part of the aquaculture expansion is expected to occur in coastal areas, where it directly affects natural resource systems already experiencing significant pressure from diverse human activities. Thus, depending on species, culture system and siting, there is a risk that anticipated benefits from aquaculture expansion may come at the expense of increased pressure on ecosystem functions and services which could lead to an overall negative impact on livelihoods. There are also trade-offs between use of services now and the use of services in the future. For example, high-densities of aquaculture production systems may decrease the oceans' or land's capacity to support aquaculture in the future. We still do not fully understand how human actions such as aquaculture affect ecosystems, or more specifically the provision of ecosystem services and also the value of those services. Many social and political challenges remain with respect to develop institutions able to reflect and consider the many social values of ecosystem services to society.

System analyzing tools

To be able to identify direct and indirect environmental and social effects from aquaculture activities a wider system perspective is needed. Thus, it is not enough to discuss the local effects of aquaculture production in an analysis of the sustainability of the industry, as trade in a globalised world connect farms to distant ecosystems (and markets). A value chain approach would capture up- and downstream activities (seed and feed production, distribution, processing, transport, etc.), and follows an "ecosystem perspective" that extends far beyond the farm border (regional to global). Life cycle analysis (LCA) is an emerging tool for studying environmental implications from aquacultures and could, if complemented with other existing and new tools, improve sustainability of the industry. Trade of final products and resources also increasingly interlink different food production systems at the global scale (Deutsch et al. 2007). This does not only have implications for supporting resource systems but volatility spill-over from e.g. agricultural or the fishery market can also have significant effects on vertically related markets such as aquaculture, resulting in increased vulnerability.

FEED RESOURCES – FOOD SECURITY AND EQUITY

Future development of aquaculture faces some challenges with respect to the input side. Despite significant progress being made on reducing inclusion of fishmeal and fish oil in feeds, and finding alternative feed ingredients (Tacon and Metian 2008), there is a net increase in total demand for fish resources in aquaculture. Today 68 and 98% of global fishmeal and fish oil, respectively, are used by aquaculture (Tacon and Metian 2008, FAO 2008). This link to fisheries through feed is important as increased consumption of some type of aquaculture species in richer countries (or richer segments within some countries) compete with consumption of cheaper fish in many poor countries (Alder 2008). This is analogous to some fisheries that channel fish away from local markets to international markets (Swartz and Pauly 2008). The conversion of more than one third of the worlds fish catch (most probably an underestimate due to lack of data, Tacon and Metian 2008) to aquafeeds (mainly fishmeal) is questionable (Nayor et al. 2000, Alder and Pauly 2006, Pauly 2009) but it is, however, not only small marine pelagic fish that are being used. Significant amounts of freshwater fish throughout Asia are being used directly as feed in many farming systems (Edwards et al. 2004, Funge-Smith et al. 2005). The landings of forage fish have declined since a peak in the mid 1990s but still account for 37% of world's total fishery. The bulk is transformed into fishmeal and fish oil, two commodities also exhibiting a downward trend in recent years (www.globefish.org). Interesting to note is that although variations between continents exist, there seems to be an upward trend of forage fish being directly consumed by humans (Alder et al. 2008). On the other hand, a comprehensive study by Delgado et al. (2003) noted that consumption of low-value fish, as a proportion of total fish consumed, decreased by 11% from 1973 to 1995 (excluding China gives 5% decrease).

CONCLUSION

Increasing aquaculture production to meet future demand may seem rational and is something that mirrors present thinking in the policy arena and ongoing development. However, there are a number of critical questions that need to be addressed before endorsing the present "aquaculture trajectory". These questions address complex issues and embrace sustainability at the highest level. In short – we need to better identify who gets to eat the fish being produced through aquaculture, and what the focus on certain species and technologies implies, especially for food security and livelihoods of resource poor people. The many negative ecological and social externalities, at various scales, that arise from some types of aquaculture need to be set against the benefits generated, and discussed beyond short-term gains and from a social-ecological resilience perspective.

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