

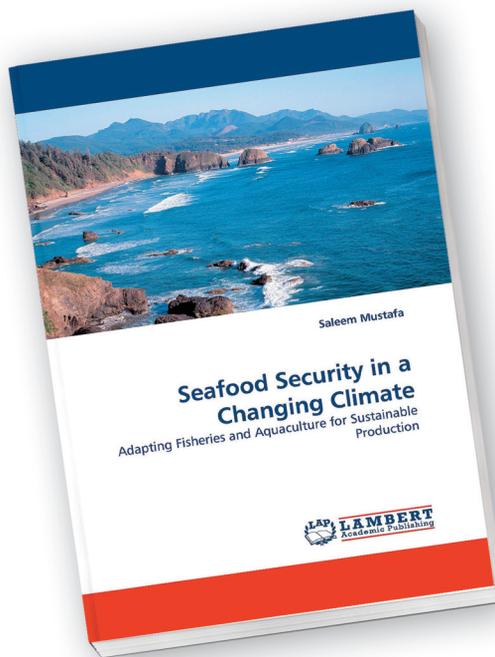
# Seafood Security in a Changing Climate

by Saleem Mustafa

'Seafood Security in a Changing Climate' is a most timely discourse on the present serious threat to seafood security from global overexploitation of the resource coupled with the effects of climate change which is seriously affecting marine ecosystems with reduction of biodiversity.

The book consists of four inter-related chapters: Seafood security in a changing climate; Resilience of marine critical habitats and sustainability of capture fisheries; Organic paradigm in sustainable aquaculture development and Growing role of biotechnology in aquaculture. The central theme of the book is to show that present aquaculture practices are not sustainable and thence to discuss how seafood security can be sustainably achieved via new aquaculture technologies involving the development of organic feed stocks. The many challenges associated with organic aquaculture are critically evaluated and a timeframe for achieving sustainable seafood security is assessed. A key aspect of the book is emphasising that sustainable aquaculture is a multi-disciplinary activity comprised of scientific, social, economic and political dimensions and that management of aquaculture practice is a multi-faceted task requiring not only knowledge of the resource and the global market but also knowledge of the marine environment and the ecosystems that comprise it.

In chapter 1, comparisons are made between sustainable aquaculture and sustainable agriculture with the latter being impeded by the move towards bio-fuel production. Present initiatives in moving towards sustainable agriculture include reducing use of fertilizers and pesticides and, in particular, reducing irrigation levels by growing less water-dependent (genetically modified) crops. By comparison moving towards sustainable aquaculture is less well entrenched despite the



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rapid growth in this industry over recent decades. At present, seafood demand exceeds the natural replenishment rates such that 60% of global fish stocks require urgent replenishment with some 28% of these being overexploited. Aquaculture can, in principle bridge this supply/demand gap but not in the short term since a balance must be effected between seafood production and marine ecosystem conservation. To achieve sustainable aquaculture requires greater integration of science and society with science influencing policy on seafood production and policy shaping scientific priorities. Further, priorities and policies related to the development of sustainable aquaculture must also embrace the many and diverse effects of climate change on the global marine environment and, particularly on the biodiversity of fish species.

Chapter 2 gives an overview of the effects of climate change on the marine environment which arise from the oceans being a natural sink for atmospheric carbon dioxide and thus the major carbon reservoir.

The reality of climate change affecting the marine environment is manifested as ocean warming and increasing acidity, deterioration of reefs and coastal erosion resulting from rising sea levels. These effects contribute to declining fish catches, deterioration of fish habitats and reduced spawning rates. Warmer aquatic environments correlate with reduced dissolved oxygen which directly affects the metabolism, growth, breeding and mortality rates of fish. Increased dissolved carbon dioxide affects phytoplankton diversity and zooplankton abundance leading to reduced calcification rates of fish with consequential detriment to marine ecosystems. Increased acidity disturbs the homeostasis and ion transport of marine organisms and fish species cannot exist outside well-defined pH ranges. It is shown that the resilience of many common and less common

fish species to all these effects is limited and that present uncontrolled fishing practices are exacerbating the current seafood security crisis. The existing strategies to address this crisis in the form of legislation are only partially effective and difficult to police. Sea ranching practices are deficient of scientific integrity and management control strategies thereof are lacking and do not account for the changing hydrodynamics of the marine environment. It is argued that the way forward in addressing the present seafood security crisis and the effects of climate change on the marine environment is to involve a larger section of society in marine conservation especially those whose livelihoods and survival depend on seafood so as to balance consumer demand with ecological stock depletion arising from degradation of fish habitats and threatened marine food webs. In short, the seafood industry must determine its own carbon footprint and devise strategies to reduce it, thereby restoring ethics to the global fishing industry.

Chapter 3 commences with a definition of aquaculture and its development over the last two decades to present supply of 36% of global stock, thereby partially addressing the supply/demand gap. It is argued that present aquaculture practice is not sustainable, the latter being defined as 'preserving environmental quality while improving production efficiency'. The many challenges associated with sustainable aquaculture are discussed, which include the development of feed stock which is not reliant on marine resources along with the culture of herbivores and low food chain species not requiring fish meal and oil and the use of high quality water as culture medium together with improved control of disease in captivity. The main theme of this chapter is a detailed discussion of 'organic aquaculture' which is the author's specialist area of research and is therefore authoritative. Organic aquaculture represents a new paradigm in aquaculture philosophy. It involves primarily the development of a plant-based food which has similar nutritional strength to animal-based foods and which is free of pathogens. Although the technology is similar to the production of organic foods, there are no universally accepted standards or accreditation criteria for the production and handling of organic aquaculture products and hence the concept of fresh seafood is ambiguous in this context. However, the growing acceptance of organic agriculture is enhancing organic aquaculture but to achieve sustainable organic aquaculture is a challenge and some guiding principles are discussed. It is argued that to achieve sustainable organic aquaculture, there is an urgent need for further research on quality control, more efficient use of water and feed, physiologically effective nourishment in captivity, disease control of stock and use of probiotics to enhance the quality of the culture medium. Also, a detailed summary of the problems caused by antibiotic use in aquaculture and the current inability to treat a range of viral infections associated with captive fish stocks, coupled with the concerns on antibiotic residues in seafood. In contrast, organic aquaculture uses bioactive compounds to treat

diseases in captive fish but this development is in its infancy. The chapter concludes with a detailed overview of the advantages and disadvantages of sustainable organic aquaculture in conjunction with the possibility of a poly-culture approach coupled with certification strategies which add market value. It is proposed that the biodynamic approach is the key to sustainable aquaculture.

Chapter 4 looks ahead towards the growing role of biotechnology in aquaculture. It is argued that the aquaculture industry needs an action plan to address the effects of climate change on it, by seriously investigating new fish farming techniques such as land-based farming systems, poly-culture and aquaponics, open ocean aquaculture, expansive sea ranching, artificial reef construction and searching for more tolerant species for captivity farming, coupled with the routine generation of carbon-neutral products. This means that the aquaculture industry will become more knowledge based overall and will adopt a holistic, multi-disciplinary approach, which combines new knowledge with well-established practice. However, this approach requires detailed knowledge of the full life cycle of fish species and recognising that 'optimum' in the wild is not coincident with that in captivity. Further, melding of biotechnological tools with organic culture requirements is not an easy task but biotechnology can assist in identifying and developing genotypes that are adaptable to environmental variations caused by climate change. The chapter concludes with a detailed analysis of what constitutes 'low carbon, green technology in aquaculture' which includes 'energy efficiency', 'water efficiency', 'waste control/re-cycling', 'organic feed', 'poly-culture' and bio-active compounds to treat disease. The importance of water quality in aquaculture is emphasised along with effective overall management strategies in the industry. It is concluded that sustainable aquaculture involves smart management of bio-resources in response to environmental challenges.

Overall, 'Seafood Security in a Changing Climate' is essential desktop reading for students, researchers, environmental managers, food economists, social scientists, bio-technologists and climatologists. It is effectively an indispensable handbook on 'state-of-the-art' aquaculture coupled with an informed projection of how sustainable aquaculture can be progressively achieved. It is very well written with concise explanations of the technical terms and language used and the essential scientific concepts are explained. The clarity and conciseness of the text together with the 150 references cited indicate the commanding depth and breadth of knowledge possessed by the author on aquaculture, much of which arising from his own research. This text confirms that aquaculture is a quantitative science with very significant social, economic, political and environmental interactions.

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