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MOVING AQUACULTURE FURTHER OFFSHORE: GOVERNANCE ISSUES AND CHALLENGES

SUMMARY

This paper shares recent salient developments in offshore aquaculture, particularly in offshore mariculture* and discusses the major impediments to its development and some of their possible mitigating strategies whilst highlighting challenges ahead. Representing over 33 percent of the world's total aquatic animal production and about 35 percent of its value in 2007, mariculture has become an important contributor to food security, national economies and balance of trade of many countries. Most of it occurs in coastal sheltered waters. Costly technology and limited coastal space threaten its development. One of the mitigating strategies is to move operations further offshore. Should offshore aquaculture extend to the high seas, there would be a regulatory vacuum. While the latter could be filled by the extension of state regulatory regimes or a treaty, adaptation of existing organizations and practices in fisheries to aquaculture, a combination with the FAO Code of Conduct for Responsible Fisheries (CCRF) could be a more viable option. Technology, access to capital, increasing production costs, inadequate research and social concerns will continue to challenge open-ocean aquaculture development. Climate change and trade could also restrict this development. All these factors will require adjustments in aquaculture governance, which will have to reconcile ecological and human well-being, maintain societal harmony by protecting the interests of vulnerable groups such as small-scale farmers, without destroying entrepreneurial initiatives. The Sub-Committee is invited to revise, as appropriate, the information presented in this paper, share national experiences on the governance of offshore aquaculture and provide guidance to FAO on a suitable way forward on this issue.

* Mariculture in this document refers to culture of all aquatic organisms in the coastal and offshore areas.

INTRODUCTION

1. Over the past decade, considerable progress has been made in addressing aquaculture governance issues. FAO has especially contributed to this progress through its Code of Conduct for Responsible Fisheries (CCRF), particularly, under Article 9 of the Code. It has also published guidelines for reducing administrative burdens and for improving planning and policy development in aquaculture while assisting countries in defining adequate national aquaculture development policies, strategies and plans, and provided internet access to aquaculture legislation of more than 40 countries, which enables policy-makers to learn from others' jurisdictions.

2. Improvements in fish husbandry management have also been promoted by industry organisations with their "Best Management Practices" and by agencies with manuals on farming techniques. Individual countries have used different policies and regulations to ensure an orderly and sustainable sector development.

3. While these are laudable efforts, aquaculture governance remains an issue in many countries. Some of its manifestations include conflicts over marine sites, disease outbreaks that could have been prevented, a widespread public mistrust of aquaculture in certain countries, inability of small-scale producers to meet foreign consumers' quality standard requirements and inadequate development of the sector in certain jurisdictions despite favourable demand and supply conditions.

4. This issue is likely to become more important as the world strives to feed its ever-growing population. Recent forecasts predict that the world population will reach approximately 9.2 billion in 2050[1]. If the current average annual per capita fish consumption of 17 kg was to be maintained, about 156,400 million tonnes of fish would need to be produced to meet this demand. Assuming aquaculture maintains its current share of the world fish production of 35.8 percent, at least 56,067 million tonnes of this amount will have to come from fish farming. This implies that current aquaculture production will have to grow more than 1,114 fold.

5. That this production level is achievable is debatable. What seems certain is the low likelihood of inland aquaculture to achieve a performance of this extent and yield a production of this magnitude. Although fish from freshwater farming dominates the overall fish farming production, and there is some optimism for its expansion, especially in northern temperate regions[2], there are no credible grounds which indicate that this growth will be significant. Land and water available for agriculture, aquaculture, livestock and other uses such as human consumption are already scarce.

6. This scarcity is likely to grow even higher as the world's population expands and puts more pressure on these resources. Experts agree that the future of aquaculture is the seas and oceans; farming the oceans must play an increasingly important role in feeding humanity[3]. In fact, mariculture is occurring almost all over the world, rapidly advancing off the coast, and gradually moving further offshore.

[1] World Population Prospects: the 2008 Revision Population Database. http://esa.un.org/unpp. Accessed on 17/01/2010.
[2] Duarte, C.M., M. Holmer, Y.Olsen, D. Soto, N.Marba, J. Guiu, K. Black and I. Karakassis. 2009. Will the oceans help feed humanity? BioScience (59) (11): 967-76.
[3] Goldburg, R.J., M.S. Elliot and R.L. Naylor. 2001. Marine Aquaculture in the United States. Environmental impacts and policy options. Pew Oceans Com, Arlington, Virginia.

RECENT DEVELOPMENTS AND MAIN ISSUES IN MARICULTURE INCLUDING IN OFFSHORE AQUACULTURE

7. There is no universally accepted definition of offshore aquaculture. Perhaps, a good point of departure to understanding this concept is the meaning of mariculture.

8. Some experts define mariculture as the rearing of animals and plants in the ocean only[4]. Others describe it as a segment of aquaculture that takes place in brackish and marine environments including outside the ocean[5]. Thus, broadly speaking, mariculture includes coastal aquaculture and offshore aquaculture.

9. A fundamental distinctive characteristic of these two categories of mariculture is the degree of exposure to marine environment and their impact on the sea bottom. Coastal mariculture occurs in waters with limited exposure to oceanic environment within internal waters and territorial seas and can have a significant impact on the sea bottom. Offshore mariculture refers to open-sea aquaculture, which takes place in waters exposed to the oceanic environment including within States' Economic Exclusive Zones (EEZ) and beyond, in the High Seas. There, the impact on the ocean bottom is likely to be minimal.

10. Whether coastal or offshore, mariculture has been playing an increasingly important role in feeding humanity and contributing to countries economies worldwide. In 2007, about 16.8 million tonnes of farmed fish were produced from marine waters[6], which represents about 33.4 percent of the total aquaculture fish production. Compared to 1990, mariculture production has quadrupled and its share of the total fish production has increased by about 1.7 percent.

11. In terms of value, it brought more than 30 billion US dollars in countries' economies, which represents 34.5 percent of the total value of fish farmed. In comparison to 1990, mariculture fish farming's contribution to the world economy has more than quadrupled and its share of the value of the total fish production has increased by 5.7 percent.

12. Most mariculture operations occur in coastal sheltered waters. However, because some sites are over crowded, which increases the risks for diseases, and sheltered inshore waters are often too shallow for finfish cage farming, there is a trend for farmers towards moving to more exposed areas; the industry is continuously demanding governments to allow new operations in the open sea[7]. In other places, government policies and regulations discourage the use of inshore locations for finfish cage farming, which pushes farmers to take an early look at farming in open-sea waters. Production structures used in offshore aquaculture are either moored or floating[8].

13. While mariculture contributes significantly to food supply and to countries' economies and has the potential to help in alleviating poverty, it should also play a more important role in feeding the world in the years to come. It also has the ability to cause serious, and perhaps irreversible, harm to the environment, thereby rendering its very objective of producing food for humanity unachievable.

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[4] European Environmental Agency. http://www.glossary.eea.europa.eu/_EEAGlossary/M/Mariculture. Accessed on 23/01/2010.
[5] CBD (Convention on Biological Diversity). 2004. Solutions for sustainable mariculture: avoiding the adverse effects of mariculture on biological diversity, CBD Technical Series No.12.
[6] FAO FishStat 2009. Ryan, J. 2004. Farming the deep blue. Report submitted to the Irish Sea Fisheries Board and the Irish Marine Institute.
[7] Ryan, J. 2004. Farming the deep blue. Report submitted to the Irish Sea Fisheries Board and the Irish Marine Institute.
[8] Upton, H.F. and E.H. Buck. 2008. Open ocean aquaculture. CRS Report for Congress, Order Code RL. 32694. Washington, D.C., Congressional Research Service. 28pp.

14. This harm consists in **ecological, biological**, and **chemical** pollution, with adverse effects on consumers' **health**.

15. **Ecologically**, there are arguments that the farming of carnivorous species may put much pressure on the wild species as they may require important quantities of fish as feed. These fears stem from the technical inefficiency of some of these species; they take more fish from the wild than they produce[9]. For example, on average, and on a dry-dry basis, the production of one kilogramme of salmon requires 2 to 4 kg of wild caught fish[10].

16. Taken individually, these figures may seem negligible, but, on the aggregate, the situation is alarming. Recent estimates indicate that aquaculture consumes over 3 million tonnes of fishmeal annually[11] and uses about 5 to 6 million tonnes of low value fish as direct feed[12]. Unless new technological breakthroughs in fish nutrition are made to substitute vegetable proteins for animal proteins in these species' diet, the need for fish as feed will increase as mariculture of carnivorous species expands.

17. **Biologically**, there are widespread concerns that cultivated species could escape from their confined milieu to the sea[13]. If the farmed species is not native, the escapees can compete with endemic wild species for food and habitat[14], and, in extreme cases, replace endemic species[15]. If the species is native, the escapees can interbreed with the wild native species, thereby infecting the gene pool of the wild fish stocks, which could lead to a reduction of genetic diversity, disease resistance and adaptability[16].

18. **Chemically**, different substances including feed additives such as antibiotics, colorants and hormones, and/or pesticides are often used in mariculture. Excessive use of these chemicals can lead them into the seabed, from which they can enter benthic food webs[17], and eventually the flesh of the fish we eat. Consumption of fish contaminated with these substances can lead to unintended effects on consumers' health[18].

19. Similarly, where important quantities of artificial aquafeed are used, as is often the case in most mariculture farms, sizeable amounts of wastes[19], which consist of uneaten feed and faeces, can move into the benthos[20] or water column under the cages. In some areas, accumulation of uneaten feeds and faeces has led to a build up of nutrients (eutrophication), which, in turn, has resulted in alteration of the benthic population mix in favour of pollutant-resistant species[16]. Build up of heavy metals such as copper and zinc has also been reported near some mariculture farms[9].

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[9] Seafood Choices Alliance. 2005. Review of Major Environmental Impacts of Salmon Farming. http://www.seafoodchoices.com/resources/afishianado_pdfs/Salmon_Spring05.pdf. Accessed on 20/01/2010.

[10] Naylor, R.L. 1998. Nature's subsidies to shrimp and salmon farming. Science, 282 (1390), p883.

[11] Tacon, A. G.J. 2007. Meeting the feed supply challenges. Paper presented at the FAO Globefish Global trade Conference on Aquaculture, Qingdao, China, 29-31 may 2007.

[12] Tacon, A.G.J., M.R. Hasan and R. Subasinghe. 2006. Use of fishery resources as feed inputs for aquaculture: trends and policy implications. FAO Fisheries Circular No.1018, Rome, FAO, 99 pp.

[13] Seafood Choices Alliance. 2005. It's All About Salmon. http://www.seafoodchoices.com/resources/afishianado_pdfs/Salmon_Spring05.pdf. Accessed: 20/01/2010.

[14] Gardner, J and D.L. Peterson. 2003. "Making sense of the aquaculture debate: analysis of the issues related to netcage". For example, it has been reported that in 2004, close to 500,000 salmon and trout escaped from ocean net pens off Norway and about 600,000 around Scotland (Seafood Choices Alliance. 2005. It's All About Salmon. http://www.seafoodchoices.com/resources/afishianado_pdfs/Salmon_Spring05.pdf. Accessed: 20/01/2010).

[15] Marra, J. 2005. When will we tame the oceans? Nature 436:175–176.

[16] Mcleod, C., J. Grice, H. Campbell and T. Herleth. 2006. Super Salmon: the industrialization of fish farming and the drive towards GM technologies in Salmon production. CSaFe, Discussion Paper 5. University of Otago.

[17] Marine Biodiversity Wiki. 2008. http://www.marbed.org/wiki/Mariculture. Accessed on 17/01/2010.

[18] Holmer, M., K.Black, C.M. Duarte, N. Marba, I. Karakasis. 2008. Aquaculture in the Ecosystem. Springer.

[19] For example, a 200,000-salmon farm produces more faecal waste than a 60,000-people city (Naylor, R.L. 1998. Nature's subsidies to shrimp and salmon farming. Science, 282 (1390), p883).

[20] Bela Hieronymus Buck, B.H., G. Krause and H. Rosenthal. 2004. Extensive open ocean aquaculture development within wind farm in Germany: the prospect of offshore co-management and legal constraints. Science Direct. http://www.sciencedirect.com. Accessed on 16/01/2010.

Persistent organic and heavy metals have also been found in fishmeal and oils; they can amass into mariculture products, with detrimental human health effects[18].

20. Mariculture activities can also interfere with other economic maritime activities or compete for space with them, which can lead to serious conflicts between water resource users. There are also concerns that certain coastal mariculture structures may become negative externalities by spoiling ocean views[15].

21. One of the major social issues associated with mariculture, especially offshore mariculture, stems from the carnivorous feeding habits of cultured species; they require feeds containing fishmeal and fish oils. In addition to contributing to depleting wild stocks, **socially,** there are claims that a good part of the so-called trash fish or low-value fish used as fishmeal could be used for human consumption, especially in developing countries[11].

POSSIBLE VENUES FOR MITIGATING IDENTIFIED ISSUES

22. Different governments have adopted different governance measures to ease environmental and socio-economic issues that are associated with mariculture.

23. Some have promoted "**Best Management Practices**" (BMPs) such as the use of enclosed and recirculation systems for some species to prevent escapes and most particulate nutrients from entering natural ecosystems. Best site selection for good water exchange rates and currents that dilute the waste, and better feeding management to reduce the waste have been also used.

24. Equally important has been the promotion of producing larvae in hatcheries rather than taking them from the wild; the aim is to reduce pressure on the wild stock. Low stocking densities and probiotics reduce or prevent disease outbreaks and transmission; fixing cages on one mooring on a long line allows cages to float along a large area, thereby minimizing local sedimentation of nutrient inputs[21], and proper genetic selection programmes and other techniques such as photo period management in water help reduce the use of hormones[16].

25. Best Management Practices promoted also include "**Integrated Multitrophic Aquaculture**", which consists of incorporating species from different nutritional (trophic) levels in the same system[22]. It allows the conversion of the waste from one species into economically viable products, which reduces the risks of chemical pollution[16].

26. In addition to tackling the negative impacts of mariculture operations directly, some governments have targeted the problem of space. In this regard, a governance strategy that appears to have been successfully implemented in many countries is **Integrated Coastal Zone Management** (ICZM)[23].

27. While ICZM is the favoured governance strategy of many jurisdictions that aim at improving both the ecosystem and the democratic deficits[24], it has shown its own shortcomings. In some cases, funding has contributed to low stakeholder involvement, leading to the non-adoption of ICZM results. Participatory techniques such as consensus conferences or focus groups are expensive and long-term financing of local participation is generally not available. In other places,

[21] Goudey, C.A; G. Loverich, H. Kite-Powell and B.A., Costa-Pierce, 2001. Mitigating the environmental effects of mariculture through single-point moorings (SPMs) and drifting cages. ICES Journal of Marine Science 58, p. 497-503.
[22] Thiery Chopin, 2007. Integrated Multi-trophic Aquaculture. http://en.wikipedia.org. Accessed February 05, 2010 at 10:24.
[23] Stead, S.M., G. Burnell and P. Goulletquer. 2002. Aquaculture and its role in Integrated Coastal Zone Management. Aquaculture International, Volume 10, Number 6, pp.447-468 (22).
[24] Kaiser, M. and M. Stead. 2002 Uncertainties and values in European aquaculture; communication management and policy issues in times of "changing public perceptions" Aquaculture International. 10: 469-490.

internal conflicts as to which government entity has the authority to allocate space for mariculture have led to ICZM failure[23].

28. A technique that is emerging as a promising governance strategy in managing space related issues in mariculture is the "**Multi-functional Co-management**" (MFCM)[25].

29. An example is the integration of power generating wind farms and fish producing farms in open sea[20]. This integration has proven beneficial on two accounts. In addition to alleviating the programme of competition for space, integrated activities become economically and socially mutually supportive.

30. Economically, fish farming gets to use the energy from nearby wind farms, which it could not otherwise afford. Cheaper energy makes fish produced more competitive and enhances the long-term economic viability of the fish farming venture. Socially, wind farms may lead to fishermen loosing or having limited access to their traditional fishing grounds, which could lead to social uprising, and eventually to the closure of such facilities. Given the fact that aquaculture farms can provide alternative livelihoods for these stakeholders, they reduce potential social conflicts, enhance wind farms' social license and hence, their chances of long-term survival[20].

31. A further measure used towards lessening the spatial competition issue and the environmental and fish diseases problems associated with overcrowding is for aquaculture enterprises to **move further offshore** to waters of the continental shelves and beyond, to the open sea[26].

32. The motive is to avoid these problems by farming pristine waters, but the primary incentive is profit. When they occur near the coast, mariculture operations use relatively accessible technologies to many entrepreneurs. As these activities move further offshore, they require culture structures that can, for example, stand stronger currents, and/or minimize obstruction to navigation while allowing farming systems to remain economically competitive. Such technologies are not always readily available to all.

33. With restricted access to technology, competition is minimal and prospects for profits are high; limited access to technologies for some is a good opportunity for profits for others. The profit motivation prevails as there is a lack or limited regulation of most offshore regions. However, there is a **danger**.

34. A situation of unregulated or under-regulated access to resources may reflect on the rights of the humankind to utilize freely and unrestrictedly the sea resources. Where multiple users have had free access and unrestricted use of finite and common resource, the result has been a tragedy. Guided by selfish behaviour and motivated by self-interest, individuals have used resources to the full or near exhaustion, leading to the "**tragedy of the commons**"[27].

35. Many scholars have suggested solutions to governance issues facing the use of common resources, such as the sea.

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[25] Multi-functional Co-management consists of "the management of multiple uses, ranging from simultaneous utilization of a certain area to jointly used infrastructure and sharing of economic input by various stakeholders, to which the authorities provide support and offer mutually agreed rules and duties". (Bela Hieronymus Buck, B.H., G. Krause and H. Rosenthal. 2004. Extensive open ocean aquaculture development within wind farm in Germany: the prospect of offshore co-management and legal constraints. Science Direct. http://www.sciencedirect.com. Accessed on 16/01/2010).

[26] Ryan, J. 2004. Farming the deep blue. Report submitted to the Irish Sea Fisheries Board and the Irish Marine Institute.

[27] Hardin, G. 1994. Tragedy of the Commons. Science, 162, 1243-48.

36. One solution, which was argued for, is the **cooperation of resource users themselves to conserve the resource**. The incentive would be mutual benefit. As is the case elsewhere, this form of governance obviates the need for restrictive regulations in aquaculture; the best regulation is self-regulation. Strong corporate social responsibility of aquaculture farmers would act as social licence inducing beyond compliance behaviour[28].

37. There are benefits of this form of governance, but there are also concerns about its efficiency. Some experts contend that, in the absence of mandatory legal obligations, aquaculture industry self-regulation, especially access to resources and environmental safeguards through voluntary Codes of Practice, are ineffective forms of governance.

38. Other experts suggest the **privatization of the resources** to allow users to take over their property rights. Proponents of this policy argue that converting a common good into private property will give the owner the incentive to enforce its sustainability[29]. Opponents contend that many commons would be difficult to privatize[30]. This could be the case of the sea resources.

39. A solution that seems to attract unanimity of experts is **government regulation**. Through permit systems, government regulations have been used worldwide to limit access to and the amount of the resource available for use by any individual or entity. However, regulations have their own limitations in offshore mariculture, especially shall it extend to the high seas.

40. The main issue is the **absence of international law of aquaculture**. Aquaculture and, more specifically mariculture, is incidentally affected by a number of provisions of general international law and by treaties which were designed to deal with other problems, particularly those concerning fisheries or the marine environment. The most significant example of these provisions is the 1982 United Nations Law of the Sea Convention ("UNLOSC") which requires states to prevent, reduce or control pollution of the marine environment from a number of specified land-based sources. The impact of these legal instruments on aquaculture development can be great.

41. International law deals with fisheries and other marine activities by placing geographical areas of the sea into a number of categories, which range from internal waters to the territorial sea[31], to the Exclusive Economic Zone (EEZ)[32] and, ultimately, to the high seas[33]. The potential impact of international law on mariculture governance will vary accordingly.

42. For **internal waters**, the coastal State can exercise essentially the same rights of **sovereignty** over its internal waters as it does over land, subject to rare cases in which foreign vessels may have a historical right to pass through those waters. This provision implies that the coastal State has the same freedom to regulate mariculture operations in internal waters as it does in respect of land-based operations.

43. The principle by which the UNLOSC extends the sovereignty of a coastal State beyond its land and internal waters to its **territorial sea**[34] suggests that there is no distinction between the

[28] Lynch-Wood, G. and D. Williamson. 2007. The social licence as a form of regulation for small and medium enterprises. Journal of Law and Society. 34 (3): 321-341.
[29] Lock, J. In Tragedy of the commons. http://en.wikipedia.org/wiki/Tragedy_of_the_commons. Accessed on 03/02/2010.
[30] Ludwig von Mises. In Tragedy of the commons.http://en.wikipedia.org/wiki/Tragedy_of_the_commons. Accessed on 03/02/2010.
[31] The LOSC defines the territorial sea as the area of the sea that lies beyond a "baseline", with the baseline being best understood as the low water mark of the coastal State. Where territorial sea begins is determined by each coastal State by drawing straight baselines that follow the general trend of the coast. All waters to the landward side of the baseline are the internal waters of the coastal State (LeGresley, 1993).
[32] EEZ extends 200 miles seaward from the baseline and can be claimed by the adjacent coastal State.
[33] Areas of the sea which are beyond the EEZ.
[34] 1982 LOSC, Art.2(2).

jurisdiction of the coastal State over internal waters and its jurisdiction over the territorial sea. However, in the territorial sea, the **sovereignty** of the coastal State begins to be tempered by international obligations. Ships of all States have the right of innocent passage through the territorial sea and the coastal State has the concomitant obligation to publicise navigational hazards.

44. This restriction only limits aquaculture activities that might be a threat to navigation and, at most, it requires the coastal State to deal with the navigational aspects of aquaculture installations. The coastal State has the right to legislate in order to protect facilities and installations within the territorial sea, including aquaculture operations, but, it must give due publicity to its laws and regulations[35]. International law does not impose other general restrictions on how the coastal state manages aquaculture within the territorial sea.

45. Under the UNLOSC, the coastal State does not have sovereignty over the **EEZ**. It has only "**sovereign rights**" for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters within the EEZ[36]. In addition, it has jurisdiction over the **establishment and use of artificial islands, installations and structures**[37].

46. These sovereign rights allow the coastal State to establish aquaculture operations in the EEZ. The right to establish installations and structures comes with the right to create safety zones around them, which is sufficient for their protection. They also allow the coastal State to regulate and manage aquaculture there as it sees fit. However, the international interest in the EEZ has placed additional obligations on those regulatory and management rights. These obligations deal with the protection and preservation of marine environment (pollution control) and the management of straddling and highly migratory stocks.

47. Unlike in other categories of seawaters, coastal States have neither jurisdiction nor sovereign rights over the **high seas**[38]. They have the freedom of navigation and fishing on the high seas as well as the **freedom to construct artificial islands and other installations** permitted under international law[39]. This freedom is sufficient to permit aquaculture operations of some kind on the high seas. Aquaculture operations intrude less on the management of the high seas than artificial islands or other installations. They are also less intrusive than activities that are widely assumed to be permissible beyond the EEZ, such as those that are intended to produce or support the production, transportation or transmission of energy.

48. While it is safe to conclude that aquaculture is permitted on the high seas, it is equally important to emphasise that this right comes with a clear obligation of international law to ensure that aquaculture activities do not conflict with the rights of other States. In particular, the UNLOSC imposes many duties on states to preserve and protect the marine environment[40].

49. In this respect, aquaculture is similar to other activities, such as navigation and fisheries, in which States can exercise their rights on the high seas subject to rules derived from customary international law and treaties. Nonetheless, it differs from these activities in that it is subject to international obligations that are far less specific than the ones applicable to navigation and fisheries, which makes it more difficult to determine where the responsibility lies should

[35] 1982 LOSC, Art.21(4).
[36] 1982 LOSC, Art.56(1)(a).
[37] 1982 LOSC, Art.56(1)(b)(i).
[38] LeGresley, E. 1993. The Law of the Sea Convention. http:// dsp-psd.pwgsc.gc.ca/Collection-R/LoPBdP/BP/bp322-e.htm.
[39] 1982 LOSC, Art.87(1)(d)
[40] Kalo, 2007; 1982 LOSC, Art.192; Art.194 (1); Art.196; Art.204 and Art.206.

aquaculture on the high seas lead to a violation of one of the international obligations discussed herein[41].

OUTLOOK AND CHALLENGES AHEAD

50. This paper recalled the important role that mariculture has to play in decades ahead as the world strives to feed its growing population and argued that, in all likelihood, mariculture will have to move further offshore, perhaps even as far as the high seas if it has to meet this goal.

51. Technologically, the biggest challenge in moving offshore mariculture operations in deeper and exposed waters will be the design and installation of equipment that can withstand storm driven waves and currents while providing a safe working platform, remaining economically competitive and safeguarding the environment.

52. Economically, the challenge will be access to the required investment capital and the profitability of these operations. Already, in many countries, there is a widespread concern that offshore mariculture industry is experiencing significant problems in securing adequate investment capital and obtaining suitable insurance[7]. The physical characteristics of open-ocean environment can dramatically increase production costs. The risks associated with storms and strong currents in exposed open-ocean areas and the limited experience of fish farming in open ocean reduce the likelihood of economic success of offshore mariculture operations. Unless governments intervene with enabling policies to assist the industry in alleviating these problems, the later could restrict offshore aquaculture growth.

53. Research, particularly in fish nutrition, will be critical. As has been the case recently[42], fishmeal and fish oil prices, which are required for the high-yield and high-value carnivorous species raised in most offshore operations, are expected to rise. These concerns have already encouraged researchers and farmers to improve feeding techniques to reduce waste, modify feed formulations, utilize waste from fish-processing plants and experiment with herbivorous fish. Successful partial replacements of fishmeal by plant protein sources such as canola, algae and soybean have been reported[8].

54. For the industry to grow in a sustainable manner, governance will be equally or even more important. The most difficult challenge to address could be the governance of aquaculture in the high seas should aquaculture operations extend there.

55. The issue is that the existing applicable principles of public international law and treaty provisions provide little guidance on the conduct of aquaculture operations in these waters; they may touch on aspects of aquaculture, but only in minor ways. If the conduct of aquaculture operations involves a breach of a principle of international law or of a provision of a treaty, a state can be held liable for the acts of its nationals under the rule of state responsibility. The irony is that the law does not require aquaculture installations to register in a given state. Moreover, it is probable that any such breach will deal only with some tangential aspects of aquaculture, such as interference with navigation. The existing body of international law simply does not deal with the potential problems of aquaculture that are typically included in the national regimes. This situation suggests a **regulatory vacuum shall aquaculture activities extend from a state's Exclusive Economic Zone to the high Seas.**

[41] In navigation and fisheries ships are required to fly the flag of one state and assume the nationality of that state, which makes it is relatively easy to trace international responsibility when offences relating to these activities are detected; the responsibility for certain offences is then assigned to the flag state. In aquaculture, there is no requirement for installations such as cages or pens to register in a given state, to which it is then possible to assign responsibility for any violations of international law.

[42] FAO 2007. Aquaculture only way to fill the coming fish gap. FAO Newsroom, http://www.fao.org/newsroom/en/news/2007/1000701/index.html. Access on: 17/02/2010.

56. One of the ways of filling the vacuum could be **extension of state regulatory regimes.** In theory, although states have no jurisdiction over the high seas, they are capable of exercising their regulatory regimes over their nationals on the high seas in much the same way as they do within the EEZ. Thus, it is conceivable that a State could make some of the provisions of its aquaculture laws applicable to its nationals who carry out aquaculture on the high seas. The incentive to pass legislation of this nature could be the UNLOSC provision according to which a State is responsible for the actions of its own nationals[43].

57. In practice, however, enforcement of these regimes could be problematic. The lack of adequately trained and funded inspectorate already makes enforcement of aquaculture regulations difficult in national waters in many countries. Enforcement costs at a great distance from the State's own territory can be prohibitive, which would make enforcement even more difficult. Moreover, even if enforcement were possible, the effectiveness of the legislation would be void if non-nationals carried out the aquaculture operations; the State can enforce its regulations only against its own nationals.

58. A **treaty** is another possible option. The problem is the low likelihood of achieving this solution because of the great deal of preparation and negotiations involved in producing a final text and getting the required number of countries to agree to it. More importantly, even before contemplation of a treaty, the issue at hand must be sufficiently pressing and important to justify the international community's attention and resources. Despite the growing importance of aquaculture worldwide, it is difficult to envisage a scenario where the international community will consider aquaculture on the high seas as an appropriate subject for a treaty for many years.

59. A more promising solution seems the **adaptation of existing organisations and practices** to aquaculture. That is, to build on successful existing governance models used in other disciplines in marine environment to achieve the required level of control in aquaculture. In this regard, the field of international fisheries governance provides some of the most optimistic avenues.

60. Specifically, Regional Fisheries Organisations (RFO)[44] could be the best way forward. They have a wide geographical reach, a wide recognition as one of the most useful international bodies dealing with fisheries and a precedent in aquaculture governance. The incentive for their further intervention in aquaculture would be to prevent or minimise the potential impacts of unregulated aquaculture operations on straddling and migratory species, which they protect.

61. Another feasible solution is a **combination of the FAO Code of Conduct for Responsible Fisheries (CCRF) with the Fisheries Stocks Agreement**.

62. Because of the difficulty to enforce a voluntary code against an unwilling State, the impact of the CCRF is somewhat limited. The Code has been most effective when incorporated into national legislation. The existing legal scheme of the 1995 Fish Stocks Agreement provides an opportunity to do so through the principle that prevents States from participating in managed high seas fisheries unless they are members of a Regional Fisheries Organisation or accept its management measures. A substantial level of control over mariculture can be achieved if those management measures incorporate either the FAO CCRF or independent rules regulating mariculture. Measures set out in the Fish Stocks Agreement could supplement this level of control to deter non-parties from undermining the effectiveness of regional management measures.

63. In the event it was technically and economically feasible, and there were effective and enforceable regulations to ensure its ecological sustainability, offshore aquaculture, including in the high seas, could lead to further important socio-economic benefits to society. In addition to

[43] 1982 LOSC, Art.235 (1),(2).
[44] Created under the 1995 Fish Stocks Agreement.

on-farm employments, economic opportunities could emerge for a number of support industries such as hatcheries, feed mills, cage manufacturing, processing plants and trade. However, it could also result in socio-economic controversies, especially in developing countries, as has been the case in fisheries.

64. Since more than five decades, marine fisheries resources of many developing countries have been exploited by foreign fleets[45] in exchange for financial compensation. Yet, the socio-economic benefits accruing to the supplying countries were not always visible. Instead, in most cases, the result was over-exploitation of the resources, which led to struggling domestic fishing industries, especially small-scale fishing, and thus, loss of employment and incomes and deterioration of food insecurity for many communities[46].

65. A similar situation is happening in marine aquaculture in some places. Since the 1980's, to develop aquaculture, many governments in developing countries have adopted export-oriented policies to transform a traditionally peasant activity into an economically important industry. The major aim was to deliver high-value aquaculture products such as shrimp and prawns, to international markets, thereby earning foreign exchange. The goal was also national economic growth and employment creation. With the help of big, and generally foreign, companies, these policies resulted in a number of positive impacts including transferring technology into the host country, bringing significant amounts of foreign currency into national economies, employment opportunities and income generation for the rural poor[47]. However, there are some claims that, in addition to environmental disruption, socially, export-oriented aquaculture has disrupted the livelihoods of some rural communities and has created some growth imbalances at the local level[48].

66. The problem is likely to amplify as aquaculture moves further offshore, becomes more capital intensive and dominated by big corporations, especially foreign. While foreign investment has shown its strength in pushing the industry forward in many places, there are some concerns that these corporations may be the main beneficiaries of the advancement of the industry, not the local communities or the country owning the resources[49], especially as they concentrate to benefits from economies of scale.

67. For mariculture to develop in a sustainable manner, it must maintain a strong social licence[50]. Social licence is, will continue to be an integral part of governance and will become an increasingly critical sustainability factor, determining where aquaculture development occurs, if at all.

68. Responding to a global Delphi survey, experts expect public opposition to aquaculture to be “very detrimental” to aquaculture development in North America. In the same survey, experts from Asia and Western Europe are also concerned about “social opposition to aquaculture due to sensationalist media”[51].

[45] Mainly for export to developed countries.
[46] Alder, J. and U.R. Sumaila. 2004. Western Africa: a fish basket of Europe past and present. Journal of Environment and Development 13: 156-178.
[47] Azad, A., K.R. Jensen and C. Lin. 2009. Coastal aquaculture in Bangladesh: unsustainable and sustainable experiences. Environmental Management, 44:800-809.
[48] Pradhan, D. 2004. Communities under stress: trade liberalization and development of shrimp aquaculture in Orissa Coast, India. PhD. Dissertation, University of Victoria, Canada, 301pp.
[49] Leciak, E. (Editor). 2002. L'aquaculture en Asie; les dilemmes du développement. Univ. Michel de Montagne Bordeaux 3, Bordeaux (France). 135pp.
[50] The degree to which aquaculture is accepted by neighbouring communities, and the wider society.
[51] Hishamunda N., F. Poulain and N. Ridler. 2009. Prospective Analysis of Aquaculture; The Delphi Method. FAO Fisheries and Aquaculture Technical Paper No 521, pp93. Food and Agriculture Organisation of the United Nations, Rome.

69. To counter negative public perceptions, industry can play a role by ensuring that benefits of aquaculture accrue locally. Communications will become more important in elucidating benefits as well as environmental impacts. This should involve government policy makers as well as producers. There should be transparency over escapees, disease outbreaks and other ecological effects so that there is a credible source of information to counter misinformation. Encouraging communities to participate in decision-making is important in part because it educates the public on all aspects of aquaculture.

70. A further step to reassuring the public about the contribution of aquaculture to society could be through fees and charges. As with agriculture that needs and often charges for irrigation water, there could be demands that mariculture, especially offshore mariculture, reimburse resource rents through higher fees.

71. Besides inherent and endogenous factors to aquaculture, there could be exogenous global shocks to mariculture development, which may call for adjustments in aquaculture governance.

72. One of these adjustments could come from climate change and weather uncertainty[52]. While global warming could have some beneficial effects on aquaculture, it could have negative impacts as well. Examples include increased virulence of pathogens and animal diseases, reduced ecosystem productivity in warmer waters, and adverse impacts on livelihoods. Sea level rise could also damage on-shore facilities and cause salt-water intrusion while extreme weather conditions could destroy cages, with escapees possibly leading to loss of bio-diversity.

73. At the national level, events of this nature entail government intervention to mitigate their impacts. Mitigation of these impacts will require an ecosystem approach[53] in developing mariculture. At the regional level, climate change and extreme weather could entail reinforcement of regional institutions and structures. Increased supply volatility, and the need to reduce carbon footprints, could oblige individual producers to review supply chains and distribution outlets, encouraging more local and intra-regional trade. Global trade in commodity species such as salmon and shrimp could be jeopardized.

74. Another exogenous global shock to offshore aquaculture governance could be trade. Domestic and international trade are already globalizing hygiene and traceability standards, obliging governance of aquaculture to adapt. Globalization of food chains, expansion of supermarkets standards and the World Trade Organization, require increased traceability, ecological sustainability, and health and safety certification. Domestic consumers are also becoming more demanding. There is growing legal pressure on companies to demonstrate due diligence in food risks, and a certain sense of corporate social responsibility.

75. These requirements and pressures result in a growing uniformity of food health and safety legislation to maintain access to markets. However, there are some concerns that they are protectionist measures. Compliance for developing countries can be very difficult, jeopardizing their export opportunities.

76. Governments will have to establish enabling international marketing and trade policies to ensure fair access to international markets. They could design health and safety procedures and good aquaculture management practices in order to meet consumer demands. Further government

[52] FAO. 2008. Report of the Expert Consultation on Improving Planning and Policy Development in Aquaculture. FAO Fisheries Report No 858, pp18. Food and Agriculture Organisation of the United Nations, Rome.

[53] 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 interlinked social and ecological system". It pursues three main objectives including "insuring human well-being, insuring ecological well-being and facilitating the achievement of both, i.e. effective governance" (Soto, D., Aguilar-Manjarrez, J. and N. Hishamunda, Editors. 2008. Building an ecosystem approach to aquaculture. FAO Fisheries and Aquaculture Proceedings No. 14, FAO. Rome).

assistance could consist in export promotion, development of marketing strategies such as branding, product certification and traceability, elaboration and enforcement of regulatory frameworks for trade including tariff rates, availability and timeliness of market information to producers and exporters, processing, preservation and transport technologies, and institutional development of marketing organizations. While they involve a short-term cost, there are long-run benefits if the industry becomes more sustainable.

77. Trade brings losers and winners. Market access is already becoming difficult except for the very largest producers. This problem is likely to worsen with aquaculture becoming more capital intensive as it moves further offshore. Particularly, this move, the concentration of buyer-driven food chains and more-demanding standards are likely to continue jeopardizing small-scale producers. They will make it more difficult for them to compete internationally. Governments will have to intervene to ensure a share in the benefits of trade for these vulnerable interest groups.

78. One option is for national organizations to act as "chain up-graders," providing technical assistance for small-scale producers so that they meet international standards. Another option is to encourage nucleus farms, which would provide similar support to their satellites, as is already the case in some countries in Southeast Asia. However, the list is not exhaustive.

SUGGESTED ACTION BY THE SUB-COMMITTEE

79. The Sub-Committee is invited to:

- revise, as appropriate, the information presented in this paper;
- share national experiences on governance of offshore aquaculture; and
- provide guidance on how to proceed with the issue of governance of offshore aquaculture.