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Fisheries Sustainability and Sustainable Development

¹H.S. Al-Masroori and ²S. Bose

¹Department of Marine Science and Fisheries, Sultan Qaboos University, College of Agricultural and Marine Sciences, P.O. Box 34 Al-Khod, CN 123, Sultanate of Oman

²Ministry of Fisheries Wealth, Sultanate of Oman

Corresponding Author: H.S. Al-Masroori, Department of Marine Science and Fisheries, Sultan Qaboos University, College of Agricultural and Marine Sciences, P.O. Box 34 Al-Khod, CN 123, Sultanate of Oman Tel: (+ 968) 2414 1246 Fax: (+ 968) 2441 3418

ABSTRACT

Sustainability is considered necessary world-wide, as the objectives of community well-being, economic development and environmental conservation are all integrated into the concept of sustainability. The desirability of achieving sustainability is reflected in various international forums and national policy decisions. This study provides an overview of the evolution of the concept of sustainable development and reviews literature relevant to fisheries sustainability. The reviews of the growing amount of literature on the subject indicated that sustainable development has had a substantial impact on the intellectual thoughts and has, since the 1970s, infiltrated all levels of government activities from local to international.

Key words: Sustainability development, international forums, national policy

INTRODUCTION

Broadly speaking, during the past four decades or so, sustainable development has been a highly debated topic among natural and social scientists, governments and policy makers due to concern about the interaction of economic growth and natural environment. It is noted that a great deal of confusion exists in the literature regarding sustainable development's precise meaning and operational content (Morita *et al.*, 1993; Drummond and Marsden, 1995; Mitchell, 1997; Murcott, 1997; Garcia, 2000; Lele, 2000). Despite this debate and confusion, in recent years, sustainable development has been a widely accepted guiding principle for the national and international policy process.

Prior to listing some of the conceptions of sustainable development identifiable in the literature, it would worthwhile to discuss briefly the evolution of the concept of sustainable development.

In 1798, the relationship between population growth and economic development was explained by Malthus (1798) in his famous writing *Essay on the principle of population* as it affects the future improvement of society. Drawing on the concept of diminishing returns, Malthus (1798) suggested that the growth in food supplies could not keep pace with the population growth. As a result, per capita incomes would have a tendency to fall which would affect the standard of living of a population. This suggestion indicates the limit to natural capital (i.e., natural environment) by the fact that population growth, if left unchecked, has the potential to limit the sustainability of economic growth. Later, in economic development literature, this idea became

known as Malthusian population trap. Like Malthus (1798) and Ricardo and Eck (1817) also expressed his pessimistic view on the prospects of economic growth in the long-run.

In the mid 19th century, Mill (1848) in his publication Principles of political economy considered the race between technological progress and diminishing returns in examining the future prospect of economic growth and introduced the concept of stationary state, which simply indicates a stationary condition of capital and population in the economy. In other words, this condition also gave an indication of the possible limits to economic growth. However, towards the end of the 19th century an optimistic view prevailed mainly influenced by scientific and technological advances. This view dominated until the 1950.

However, despite this optimism, there was scientific evidence that indicated signs of considerable environmental damage. Since the 1960s, several publications have been written which raised concern about the extent of environmental damage caused by human activities. Publications including, The silent springs by Carson (1962), the limits to growth by Meadows (1972), a blueprint for survival by Goldsmith *et al.* (1972) and small is beautiful by Schumacher (1975) are but a few. This acute environmental concern received enormous media publicity and significant attention from the community which initiated the environmental movement in the 1960s. This movement was successful in receiving international recognition with the United Nations Conference. At this conference a milestone was reached in the development of international environmental policy which then resulted in the establishment of the United Nations Environment Program (UNEP).

The realization of the significant risks associated with the rapid and irreversible environmental changes necessitated a shift in the natural resource management paradigm to a new paradigm called sustainable development. This new paradigm called for a balance between conservation and development and shifted the focus, amongst other things, from profitability towards sustainability, from growth towards balance, from control towards integration and from domination towards harmony with nature (Clarke and Clegg, 1998).

CONCEPTUALIZING SUSTAINABLE DEVELOPMENT

To make the notion of sustainable development operational it is important to identify its precise meaning. As mentioned above, there are several views existing in literature which can be summarized as follows:

- Development that ensures the fulfillment of basic needs of both present and future generations (WCED, 1987)
- Development that ensures per capita income and consumption are non declining over time (Pearce *et al.*, 1989; Perman *et al.*, 2003)
- Development that ensures natural capital stock is non declining over time (Perman *et al.*, 2003)
- Development that ensures that the protection of the human race is maximized (Georgescu-Roegen, 1971; Daly, 1980)
- Development that protects community and community relations (Douglass, 1984)
- Development that promotes consensus building and building of institutional capacity (Perman *et al.*, 2003)
- Development that maintains biological diversity and ecological process and protects the condition of ecosystem resilience (IUCN, 1980)

The first six concepts primarily originate from social scientists (economist and sociologist), while concept seven is associated with natural scientists. There are other definitions available from

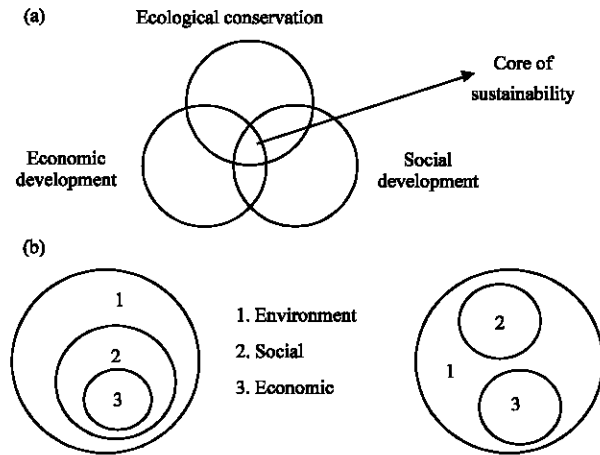


Fig. 1: (a) Scheme of sustainable development and (b) Ways of conceptualizing sustainable development

different international bodies with particular relevance to fisheries and marine resources (Appendix). It is clear that there are two distinct camps engaged in the debate in identifying the precise meaning of the concept of sustainable development. For further discussion and critical reviews on the sustainable development concept (Tisdell, 1994; Lele, 2000; Du-Pisani, 2006).

Furthermore, opposing views have also been reflected in the further debate on substitutability of man-made capital (economic) for natural capital (environment). Depending on individual views on the extent of substitutability, this debate has divided sustainability into four categories, namely: very weak sustainability, weak, strong and very strong. It is important to note that the very weak and very strong categories represent the two poles in the debate as they suggest the possibility of perfect substitution and no substitution respectively. On the other hand, the notions of weak and strong substitutability highlight the possibility of trade-off between man-made capital and natural capital (Goodland and Daly, 1996).

Although, the concept of sustainable development can be variously defined, based on a specific discipline's area, it has some common threads that bring different views together namely, that environmental quality and resource base of future generations must not be compromised, the recognition of integration between environmental and socio-economic development, preserving ecological integrity and adopting a precautionary approach in the face of scientific uncertainty (Dovers and Lindenmayer, 1997).

It is important to note that to meet the goal of sustainable development, a fulfillment of economic, social, environmental and institutional sustainability in a simultaneous fashion is fundamental (Barbier, 1987; Charles, 2001). This integration and priority towards environmental protection is shown in Fig. 1a and b. Part a of the figure indicates that the concept of sustainability is an interface between ecological conservation, economic and social development. Figure 1b highlights the facts that the environment encompasses both social and economic elements of sustainable development as the socio-economic wellbeing relies upon the health of the natural environment. By considering the changing paradigms in fisheries management, Charles (2001) postulated that through the following sustainability triangle as shown in Fig. 2, economic, social and ecological sustainability would be held together by institutional sustainability. It should be emphasized that this concept, introduced by Charles (2001) has practical application as it provides a frameworks for sustainability assessment.

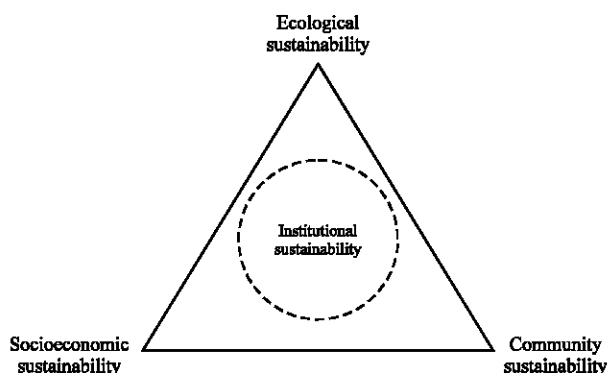


Fig. 2: The sustainability triangle for sustainability assessment (Charles, 2001)

It should be noted that in the 1970s and early 1980s, the main focus of the sustainable development campaign was on the conservation of non-living natural resources (minerals and fossil fuels) and the control of pollution. However, at the beginning of the 1980s the focus shifted towards the conservation of living resources influenced by the World Conservation Strategy (IUCN, 1980). This influence was indicated by the addition of the word ecologically to the concept of sustainable development.

It should be noted that in recent years, there has been growing recognition of the fact that religions can make a significant role in sustainable development. Religious precepts tend to influence the community's ways of making a living. Most religions teach human spiritual wellbeing through prayer or meditation or in work, as work disciplines our soul. This discipline presents itself as moral duties to make the best use of talents (human capital) and resources endowed by God. It should be noted that religion, in its modest form, is compatible with development as it is associated with a belief in experiment, in rationality, in community welfare and development, productive investment and honesty in commercial relation (Lewis, 1955; Gyekye, 1997). This crucial relationship between religion and sustainable development is highlighted for example by the existence of the Senat Al-Bahar traditional rules in Sultanate of Oman and its influence on the attitude towards community development (Al-Masroori, 2008; Al-Masroori and Shekar, 2009) Bagader *et al.* (1994) and Gottlieb (1996) and Mebratu (1998) stated that historically religious beliefs and social traditions and laws that shape a community's command for sustainability and conservation and environment.

INTERNATIONAL DEVELOPMENT AND FISHERIES SUSTAINABILITY

World conservation strategy: As mentioned above, in 1980, the World Conservation Strategy (WCS) was formed by the World Conservation Union (formerly called the International Union for the Conservation of Nature and Natural Resources, IUCN) in cooperation with the United Nations Environment Programme (UNEP), the World Wildlife Fund (WWF), FAO and UNESCO. It was developed over a three-year period with the involvement of more than 450 government agencies, international bodies and nongovernmental organizations from over 100 countries (IUCN, 1980; Saunier, 1999).

The aim of the World Conservation Strategy is to help advance the achievement of sustainable development through the conservation of living resources. Saunier (1999) stated that WCS was intended to stimulate a more focused approach to living resource conservation and to provide policy

guidance on how this could be carried out. It provided both an intellectual framework and practical guidance for the necessary conservation actions (Potter, 1985). It called for global coordinated efforts, for concerted action at national and international levels and for global solidarity to implement its programs. The WCS is considered to be the first attempt to carry the concept of sustainability beyond a simple renewable resource system (Lele, 2000).

The World Conservation Strategy identified three objectives fundamental to the ecological tier of sustainable development (IUCN, 1980; Saunier, 1999):

- Conservation of essential ecological processes and life support systems
- Preservation of genetic diversity
- Sustainable utilization of species and ecosystems

The environment debate pre-WCED focused mainly on the impact of economic growth on the environment, where the impacts of a degraded environment on development prospects were largely ignored before the emergence of the WCED (WCED, 1987; Pezzoli, 1997).

World Commission on Environment and Development (WCED): In the 1983 United Nation General Assembly (38/161), a recommendation was made to form a special commission on the environmental perspective to the year 2000 and beyond (UN, 1983; Pezzoli, 1997). After a three year period (1984-1987), the commission conducted a meeting at foreign ministers level that brought the discussion of sustainable development to literally millions of people around the world (Pezzoli, 1997). The World Commission on Environment and Development (WCED), also known as Our Common Future, was published in 1987, which alerted the world to the urgency of making progress toward economic development that could be sustained without depleting natural resources or harming the environment. The commission came to be known as the Brundtland Commission, or Report, after the Commission's chairwoman, Gro Harlem Brundtland. It developed guiding principles for sustainable development as generally understood today and defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). It outlined the condition of the global affairs in terms of environmental degradation, economic inequality and poverty and reviews the incapability of the nations to effectively secure equity for future generation. It is considered as the starting point for most of the current discussions on the concept of sustainability and sustainable development.

Therefore, the WCED Commission report has moved discussions of sustainable development from the WCS strategy of conservation to long-term environmental strategies in three major areas (Saunier, 1999): 1) Management of the commons; 2) Peace, security, the environment and development and 3) Institutional and legal changes. The key issues and common challenges the commission would investigate were population control; human resources; food security; species and ecosystem; energy; industry and the urban challenge (WCED, 1987; Segsneider, 2001).

In 1989, the report was debated in the United Nation General Assembly (44/228), in which it was decided to organize a UN Conference on Environment and Development. This decision was clearly stated in the Assembly Resolution in Article 2 as Decides to convene the United Nations Conference on Environment and Development, which shall be of two weeks' duration and shall have the highest possible level of participation, to coincide with World Environment Day, on 5 June 1992 (UN, 1989). This Assembly Resolution, which established the conference, listed around 23 objectives to be achieved by this Conference.

United Nations Conference on Environment and Development (UNCED): In 1992, more than 100 heads of state met in Rio de Janeiro, Brazil, for the United Nations Conference on Environment and Development (UNCED). The Conference met to address urgent problems of environmental protection and socio-economic development. Nearly 50,000 official observers and citizens from around the world, who met in a wide range of official and community-based councils and seminars at a Global Forum, also attended the Earth Summit. The Earth Summit or Rio Conference, as UNCED was also known, was the conclusion of two years of negotiations by four International Preparatory Committees (PrepComs) (Mebratu, 1998).

Five major agreements on global environmental issues were signed at the UNCED namely: Agenda 21; the Convention on Biological Diversity (CBD); the Framework Convention on Climate Change; the Rio Declaration and the Statement on Forest Principles.

To monitor the implementation of the above mentioned five agreements, a major institutional output of this conference was the creation of the UN Commission on Sustainable Development (CSD). Another objective for the CSD was to act as a forum for the ongoing negotiation of international policies on environment and development as a functional commission of the United Nation Economic and Social Council (UNESCO) (Saunier, 1999; UNCSD, 2006). The CSD monitoring objective is planned to be achieved through ensuring effective follow-up of UNCED; enhancing international cooperation and rationalization of intergovernmental decision-making capacity; and examining progress in the implementation of Agenda 21 at the local, national, regional and international levels (Saunier, 1999).

The convention on biological diversity: The Convention on Biological Diversity, known informally as the Biodiversity Convention was signed in 1992 and came into force in December 1993 (Yamin, 1995; CIESIN, 2006). It is an international agreement that provides a legal, institutional and normative framework for international efforts to conserve biodiversity for its 118 parties (Yamin, 1995). The CBD is considered a landmark in the environment and development field, which recognized for the first time that the conservation of biological diversity is of common concern to mankind (Pimbert, 1997).

This biological diversity of the CBD includes genetic diversity (the variation of genes within a species); species diversity (the variation of species within a region) and ecosystem diversity (the variety of ecosystems within a region) (Yamin, 1995). The CBD was signed to achieve the following objectives (CIESIN, 2006):

- To conserve biological diversity
- To promote the sustainable use of its components
- To encourage equitable sharing of the benefits arising from the utilization of genetic resources

The rio declaration on environment and development: The Rio Declaration on Environment and Development, often shortened to the Rio Declaration, is a short document produced at the UNCED. This declaration consists of 27 guiding principles intended to guide future sustainable development around the world and specifically focusing on the rights and obligations of sovereign states with respect to environment and development (Dykstra and Heinrich, 1996). One matter specifically related to the fisheries and marine resources sustainability issue in the Rio Declaration is Principle 15, which introduced the Precautionary Approach.

Agenda 21: Agenda 21 sets out actions that nations, communities and international organizations can take to contribute to the goal of global sustainability in the twenty-first century. Acting on the problems of today it also aims at preparing the world for the challenges of the next century. Agenda 21 reflects a global consensus and political commitment at the highest level on development and environment cooperation (UNSD, 1992). In sharing similar guidance responsibilities, Agenda 21 and UNCLOS set forth rights and obligations of States and provide the international basis upon which to pursue the protection and sustainable development of the marine and coastal environment and its resources (UNSD, 1992). This requires new approaches to marine and coastal area management and development at the national, sub-regional, regional and global levels and approaches that are integrated in content and are precautionary and anticipatory in ambit, as reflected in the following program areas (UNSD, 1992):

- Integrated management and sustainable development of coastal areas, including exclusive economic zones
- Marine environmental protection
- Sustainable use and conservation of marine living resources of the high seas
- Sustainable use and conservation of marine living resources under national jurisdiction
- Addressing critical uncertainties for the management of the marine environment and climate change
- Strengthening international, including regional, cooperation and coordination
- Sustainable development of small islands

Agenda 21 is divided into four main sections, or elements, including socio-economic dimension, resources conservation, community involvement and implementation measures (Gardiner, 2002). basis for action by many national and local governments. For example, over 150 countries have set up national advisory councils to promote dialogue between government, environmentalists, the private sector and the general community. Many have also established programs for monitoring national progress on sustainable development indicators. At the local government level, nearly 2000 towns and cities worldwide have created their own Local Agenda 21 plans (UNESCO, 2002). Table 1 shows details of the elements of the Agenda and it has been the Local Agenda 21 has become well embedded as a mechanism for promoting sustainable development strategies at the municipal level. Quantitative studies indicate an impressive rate of progress on strategy production

Table 1: Elements of agenda 21 (Gardiner, 2002)

Elements	Issues
Social and economic dimension	Poverty, production and consumption, health, human settlement, integrated decision making
Conservation and management of resources for development	Atmosphere, oceans and seas, land, forests, mountains, biological Diversity, ecosystems, biotechnology, freshwater resources, toxic chemicals, hazardous radioactive and solid wastes
Strengthening the role of major groups	Youth, women, indigenous peoples, non-government organizations, local authorities, trade unions, business, scientific and technical communities, farmers
Means of implementation	Finance, technology transfer, Information, public awareness, capacity building, education, legal instruments, institutional frameworks

and adoption (Selman, 1998), however, the world has not gone far enough in translating the documents into concrete actions (Wapner, 2003). Therefore, the world started to review Agenda 21 with the aim of providing more operational plans of action towards practical and secure sustainable development.

World Summit on Sustainable Development (WSSD): The 10 years era after the Rio Conference points out the paradox of how the Rio process launched a number of successful institutional processes, without, however, producing tangible global results (Sachs *et al.*, 2002). Progress in implementing sustainable development has been extremely disappointing since the 1992 Earth Summit, with poverty deepening and environmental degradation worsening (UN, 2006a).

In December 2000, the UN General Assembly decided, in Resolution 55/199, to hold the World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa (UN, 2006a). Then ten years after the Earth Summit, the WSSD, commonly known as Rio +10, was held in Johannesburg, South Africa from 26 August to 4 September 2002. It was held to review the Agenda 21 implementation and to make concrete plans of action for sustainable development (Masaharu and Akiyama, 2003).

The Johannesburg Summit brought together tens of thousands of participants, including 100 heads of State and Government, more than 10,000 national delegates and 8,000 leaders from non-governmental organizations (NGOs), businesses and other major groups. They all met to focus the world's attention and direct action toward meeting difficult challenges, including improving people's lives and conserving the natural resources in a world that is growing in population, with ever-increasing demands for food, water, shelter, sanitation, energy, health services and economic security (UN, 2002a). The WSSD resulted in a new Declaration and action plan, the Johannesburg Plan of Implementation (UN, 2002b) reaffirmed the international commitment to the goal of sustainability.

The WSSD Plan of Implementation is designed to further build on the achievements made since UNCED and to expedite the realization of the remaining goals. Critics have argued that the plan does not go far enough to securing concrete outcomes but it does make significant commitments in several key areas including oceans (Potts, 2003).

In June 2001, the United Nations Secretary called for an international work program designed to meet the needs of decision makers and the public for scientific information concerning the consequences of ecosystem change for human well-being and options for responding to those changes (UN, 2006b). This program The Millennium Ecosystem Assessment (MA), which was completed in March 2005, has involved the work of more than 1,360 experts worldwide. Their findings on the condition and trends of ecosystems, scenarios for the future, possible responses and assessments at a sub-global level are set out in technical chapters grouped around these four main themes.

The MA finds that at least one quarter of marine fish stocks are over harvested and the quantity of fish caught by humans is now declining because of the shortage of stocks since the 1980s. Numerous references support and indicate as well as strengthen the criticism of failure in securing sustainable fisheries.

World commitment toward fisheries sustainability: After the Second World War, the fleets of the Northern Hemisphere were ready to take on the world to re-establish food production (Garcia and Grainger, 1996; Pauly *et al.*, 2002). Accompanied with the rapid expansion

and progress in fisheries technology, fishing industries were discovering new fishing grounds and expanding their fishing both horizontally and vertically. Thereafter, stress in several large-scale fisheries start to appear and some fisheries, such as that of the Peruvian anchovy in 1971-1972 collapsed with global repercussions (Hannesson, 1995; Pauly *et al.*, 2002). At that time, natural causes (El Niño event) were claimed to be the reason for the Peruvian anchovy collapse, however, as claimed by Pauly *et al.* (2002) overfishing was found to be a significant factor.

Regardless of latter major collapses and stocking signals, the fishing pressure and high levels of effort continued (Potts, 2003). Pauly *et al.* (2002) stated that literature supports the claim that, historically, fisheries have tended to be non-sustainable, although not unexpectedly there is a debate about the cause for this and the exceptions. Based on an examination of historical catch and abundance data, together with experimental studies and surveys, Longhurst (2007) suggests that all sea fisheries could collapse by the middle of this century unless action is taken to prevent this from happening. In a recent study, Worm *et al.* (2006) predicted that all fisheries will have collapsed by 2048. This prediction was criticized by Branch (2008). However, literature gives many examples and different scenarios of the collapse of fisheries concluding that overall, the main cause is a failure by fisheries management to sustain fisheries resources. Therefore, as stated by Pauly *et al.* (2002) fisheries have rarely been sustainable. Rather, fishing has induced serial depletions, long masked by improved technology, geographic expansion and exploitation of previously spurned species lower in the food web. On the other hand, assuming good signs, a success in one fishery sector may be seen as a failure in another due to the conflict in objectives (Hilborn, 2007).

All the above mentioned crises of geographical spread of the fishing fleets, development in fishing technologies and stress signals in stocks, lead to maritime jurisdiction (EEZ) and evoked the idea of global fisheries management. Thereafter, different international initiatives, instruments and management approaches were initiated to unify the protection of the world marine resources especially, the shared one.

The united nation convention on the law of the sea: Triggered by the competition between governmental authority over the sea and the idea of the freedom of the sea and more specifically its jurisdiction, power, food and mineral resources, the world struggled to compile a law for the sea (Jones, 1972; O'Connell, 1982). The first official attempt to codify the law of the sea was the Hague Conference 1930 (Glasgow, 1930), which failed to reach an agreement and therefore no convention was issued (Opeskin, 2005). O'Connell (1982) claimed that the Hague Conference failed for political reasons, however, it drew some legal lines. Since then, three conferences have been convened: UNCLOS I in 1958, UNCLOS II in 1960 and UNCLOS III in 1973 (UN, 2007).

The first international collaboration in marine resources management started with the signing of the UN Law of the Sea Convention (UNCLOS) on December 10th, 1982 and came into force in 1994 (Garcia and Moreno, 2001; Potts, 2003). The UN Law of the Sea Convention marked the culmination of more than 14 years of work involving participation by more than 150 countries representing all regions of the world, all legal and political systems and the spectrum of socio/economic development (UN, 2007). From the last UNCLOS conference in 1973 to 1982, nations spent seven sessions finalizing the Law of the Sea (Opeskin, 2005). The convention comprises 320 articles and nine annexes, governing all aspects of ocean space, such as delimitation, environmental control, marine scientific research, economic and commercial activities, transfer of technology and the settlement of disputes relating to ocean matters (UN, 2007). UNCLOS is considered one of the main bases, with Agenda 21, for fisheries sustainable development.

One of the most important articles of the UNCLOS mentioned is article 87. This raises the notion of the freedom of high seas, that part of seawater that lies beyond the jurisdiction of coastal states. In this article, the rights have been granted to the nation to fish in this area (Potts, 2003). A poorly defined management regime in the high seas has been noted to contribute to the overexploitation of marine resources and resulted in a lack of incentive to conserve resources and generate minimal cooperation between states (Emerson, 1995; Potts, 2003). As an open access system (Hardin, 1968) is well known to lead to an abuse of resources, institutions such as the FAO recognized the problem and the threat to the sustainable development of resources (Potts, 2003). As an international action, the International Conference on Responsible Fishing held in 1992 has formed the United Nation Conference on Environment and Development and Agenda 21. One critical outcome from Chapter 17 of Agenda 21 (UNSD, 1992) was the recommendation to convene a conference on the issue of the management of high seas stocks, which produced The United Nation Fish Stock Agreement (UNFSA) (Potts, 2003).

The united nation fish stocks agreement: The United Nation Fish Stock Agreement (UNFSA) or the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (Anderson, 1996) was developed over six sessions between 1993 and 1995 with 148 states, UN agencies, international bodies and non-government organizations (Potts, 2003). It brought forth an agreement that was designed to address and alleviate a worldwide resource management crisis and focussed on the so-called straddling and highly migratory fish stocks (Munro, 2000). The objectives of the agreement were to agree on clarifying the responsibilities of fishing states, to provide coordination for management via Regional Fisheries Management Organizations (RFMOs) and to strengthen fisheries management on the high seas (Potts, 2003). The agreement provided measures that regulate the interaction between the RFMOs and Distance-Water Fishing Nations (DWFNs), however, instability is found to appear, which raises conflict such as the case of Northern Atlantic Bluefin Tuna Fisheries (Brasao *et al.*, 2000).

The Agreement can be broken down into four parts: general principles; measures for strengthening regional and sub-regional cooperation; measures for monitoring, surveillance and enforcement; and the settlement of disputes (Ocean-Law, 2007). According to Nandan (2005), UNFSA is built on three essential pillars, which are designed to ensure that the agreement achieves its objective of long term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks:

- To state the principles and practices on which better management of stocks should be based
- To ensure that the conservation and management measures are adhered to and complied with and that they are not undermined by those who fish the stocks
- The provision of peaceful settlement of disputes

The UNFSA declares that states should apply the precautionary approach to the conservation, management and exploitation of straddling and migratory fish stocks (Herriman *et al.*, 1997; Smith, 2000; Potts, 2003). The precautionary approach is embodied in the UNFSA to improve decision making in the face of uncertainty (Garcia, 1994; Richards and Maguire, 1998).

THE PRECAUTIONARY APPROACH

Predicting ecosystems' behavior cannot be done with absolute certainty, regardless of the amount of scientific effort invested (Panel, 1999). Therefore, uncertainty can be considered as a

fundamental characteristic of the fisheries and they can only be managed within the limits of their predicted certainty. In addition, the process of management and authority themselves suffer uncertainty, models for stock assessment are oversimplifications and errors do exist in fisheries data (Potts, 2003). As a result of such complexity in a fishery, a management concept termed as precautionary approach has emerged and gained acceptance as a basis for fishery management (Richards and Maguire, 1998). However, it should be noted that it was first incorporated into environmental policy in Germany in 1980 (Barrett, 2000).

Principle 15 of the Rio Declaration states: In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation (UN, 1992). The first part of Article 7.5 (Precautionary Approach) of the FAO Code of Conduct for Responsible Fisheries states that: States should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment (FAO, 1995).

As claimed by O'Riordan and Jordan (1995), the precautionary principle is neither a well defined principle nor a stable concept. It has become the repository for a jumble of adventurous beliefs that challenge the status quo of political power, ideology and civil rights (O'Riordan and Jordan, 1995). Smith (2000) has described the precautionary approach as a logical extension of commonsense concepts that guide daily life. It is therefore a moral and political principle, which is most often used to minimize the impact of human actions on the environment and human health when scientific facts are missing. At its core, the principle calls for preventive, anticipatory measures to be taken when an activity raises threats of harm to the environment, wildlife, or human health, even if some cause-and-effect relationships are not fully established (Smith, 2000). Kriebel *et al.* (2001) has identified four central components for the precautionary approach: taking preventive action in the face of uncertainty; shifting the burden of proof to the proponents of an activity; exploring a wide range of alternatives to possibly harmful actions and increasing public participation in decision making. Overall, the precautionary approach emphasizes guidelines intended to prevent overfishing, for rebuilding stock and therefore maintaining sustainability (Potts, 2003).

As per article 6.3b of the UNFSA, states shall determine, on the basis of the best scientific information available, stock-specific reference points and the action to be taken if they are exceeded. This article specifies the primary mechanism for applying the precautionary approach (Richards and Maguire, 1998). It is to identify and develop reference points for fisheries that identify desired states (targets) or undesirable states (limits) for a particular variable or indicator (Garcia, 1994; Potts, 2003). It should be noted that the assessment of the commercial trawling in this study is based on identifying and developing reference points as targets or limits to be achieved or avoided. Reference points have been generally defined in term of fishing mortality rate F and expressed as targets rather than limits such as with the Maximum Sustainable Yield (MSY) and Maximum Economic Yield (MEY).

Once reference points have been established, fishery management strategies shall ensure that risk of exceeding limit reference points is very low and that target reference points are not exceeded on average (Richards and Maguire, 1998). Risk assessment is also of great importance in fisheries management. To succeed in fisheries management and to maintain stable fishing communities, risk has to be managed (Hilborn *et al.*, 2001). For this purpose, different precautionary approaches were

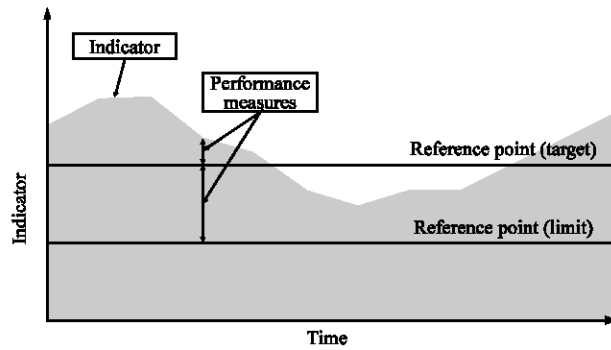


Fig. 3: The use of an indicator and reference points to define simple performance measures (Sainsbury and Sumaila, 2001)

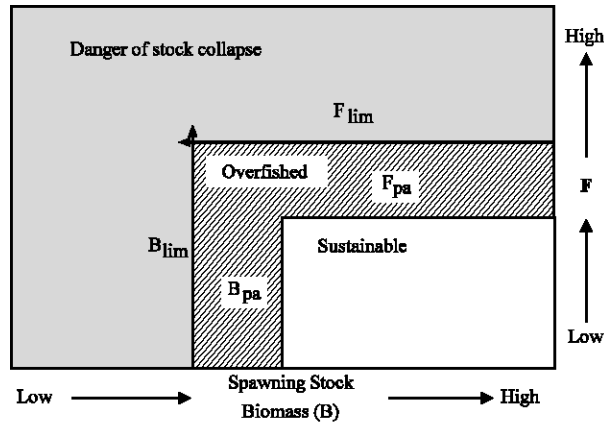


Fig. 4: ICES precautionary approach adapted from (ICES, 2007)

developed to assess risk and certainty. Figure 3 shows a simple performance measure to assess a variable over time in relation to the reference points as illustrated by Sainsbury and Sumaila (2001). Another example is the ICES 2007 precautionary approach to management (Fig. 4) (Cury *et al.*, 2005).

Uncertainties and risks can be higher in data-poor situations in the new and developing fisheries, where best information available is simply inadequate for determining meaningful reference points (Richards and Maguire, 1998). Therefore, very conservative management measures are required for such cases under the precautionary approach. For such cases and as per Article 6.6 of the FAO Code of Conduct for Responsible Fisheries, states are required to adapt as soon as possible cautious conservation and management measures. Such precautionary measures include catch and effort limits including area closure or marine protected areas and Total Allowable Catch (precautionary TAC) (Horwood *et al.*, 1998; Richards and Maguire, 1998; Saunders *et al.*, 1998; Ward *et al.*, 2002; Baelde, 2005; Jaworski *et al.*, 2006).

Most of the initial determined target and limit reference points are based on fish stock assessment models, which are inherently uncertain and based on a single species approach (Caddy and Mahon, 1995; Potts, 2003). Therefore, further conceptual development has shown the need for wide inclusion of biological diversity, ecological integrity and policy decision making and

monitoring of all context including ecological, socio-economic and institutional parameters; the principals of sustainable development. All these issues and limitations bring the world toward the implementation of an Ecosystem Approach to Management (EAM) or Ecosystem-Based Management (EBM) to focus on different management priorities and to consider the ecosystem as a whole rather than single target species (Sainsbury and Sumaila, 2001; Potts, 2003; Garcia and Cochrane, 2005; UNEP/GPA, 2006).

Ecosystem-based fisheries management: Limitation of single-species approach, target species effects on ecosystem (Pauly *et al.*, 2000, 2002), socio-economic concerns (Bowen, 1997; Potts, 2003) and human induced factors on land and in the ocean (Sherman and Muda, 1999) all are limitations in fisheries management and are threats toward the ecosystem in its holistic concept. As a result, the relatively new approach, Ecosystem-Based Management (EBM) or Ecosystem-Based Approach (EBA) (Witherell *et al.*, 2000) was then followed to achieve both ecosystems and human healthy communities. The EBM is an innovative management approach to address these challenges. It considers all ecosystem components in an interrelating mode, including humans and environment, rather than managing one issue or resource in an isolated way.

In fisheries, EBM is most commonly referred to as Ecosystem-Based Fisheries Management (EBFM) considering the considerable influence that fisheries now have on fish abundance (Christie *et al.*, 2007). EBFM is a new direction for fishery management, essentially reversing the order of management priorities to start with the ecosystem rather than the target species (Pikitch *et al.*, 2004). From 'conservation of the parts' of system, EBFM acknowledges that fisheries operates within broader ecological and socio-economic systems that influence each other (Potts, 2003). On the other hand, the study of fishing gear impacts, which is the case for this research has also moved from effect on target species toward effects on ecosystem and communities (Gislason, 2002; Hall and Mainprize, 2004). Therefore, EBFM is the interacting effect of fishery on ecosystem and of ecosystem on fishery (Sainsbury and Sumaila, 2001; Ward *et al.*, 2002; Potts, 2003).

Lackey (1998) has listed seven pillars that define and bound the concept of EBM: values and priorities, boundaries, health, stability, diversity, sustainability and scientific information. However, objectives of the EBFM will vary from one ecosystem to another and setting of conceptual objectives is important for identifying the actions required to implement the ecosystem management (Potts, 2003). Defining proper long-term, ecosystem-related objectives is one of the difficulties in developing an operational basis for a fishery ecosystem approach (Cury *et al.*, 2005). Slocombe (1998) has provided a set of procedural goals and objectives that would facilitate the development and implementation of substantive goals for ecosystem-based management. Cury *et al.* (2005) suggested that the mathematical viability concept, developed by Aubin (1991), can be used to assist in the definition, selection of and interaction among, long-term objectives at an ecosystem level. According to Pikitch *et al.* (2004), the overall objective of EBFM is to sustain healthy marine ecosystems and the fisheries they support. In particular, EBFM should:

- Avoid degradation of ecosystems, as measured by indicators of environmental quality and system status
- Minimize the risk of irreversible change to natural assemblages of species and ecosystem processes

- Obtain and maintain long-term socioeconomic benefits without compromising the ecosystem
- Generate knowledge of ecosystem processes sufficient to understand the likely consequences of human actions

Expansion from a single-species concept to a holistic approach raises questions about information, governance mechanism and the need for trans-discipline (Slocombe, 1998; Murawski, 2000; Potts, 2003). Due to the complexity of the ecosystem and therefore, great uncertainty, a precautionary approach and a wide range of objectives should be involved in this kind of management. To achieve any objective, specific practical tools and measures have to be defined (Potts, 2003) including indicators and reference points. This certainly will require a new set of reference points that cover the whole ecosystem. However, single-species targets and limit reference points are still appropriate, but will need to be modified in the context of the overall state of the system, habitat, protected species and non-target species even when there are no biological interactions between the species (Arnason, 2000; Pikitch *et al.*, 2004). Although, that fisheries management to date has not been highly successful (Schrank, 2007), there is still hope that the EBFM approach might be able to unlock some of the impediments that conventional management has experienced (Garcia and Moreno, 2001).

Ecologically sustainable development: The concept of Ecologically Sustainable Development (ESD) officially entered the Australian environmental policy lexicon in the 1980s with the formation of the ESD working groups (Australia, 1992). In 1989, following the release of the Brundtland Report, the Prime Minister released a policy statement on the environment entitled Our Country Our Future (Fletcher, 2002). Thereafter, the Commonwealth Government as well as the international community (ENRC, 2000) adopted ESD and took on board the Australian concept for Sustainable Development which emphasized the importance of the environment in sustainable development. It has been considered as a useful concept in pursuing sustainability consistent with a balanced approach in dealing with environmental, social and economic issues (ENRC, 2000; Fletcher, 2002). The term was formally transferred to the Council of Australian Governments (COAG) endorsed National Strategy of Ecologically Sustainable Development (NSES) in 1992 and now the principles are incorporated in recent environment legislation-the Environment Protection and Biodiversity Conservation Act (EPBC) 1999 (ENRC, 2000; Curran, 2003).

The National Strategy on ESD (Australia, 1992) was agreed by all Australian Governments and most states have incorporated ESD into their fisheries legislations (Whitworth *et al.*, 2002). It defines the ESD as using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life now and in the future can be increased. This definition is obviously reflecting WCD and other international conventions. The goal of the NSES is towards development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (Australia, 1992). NSES core objectives are (Australia, 1992):

- To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations
- To provide for equity within and between generations
- To protect biological diversity and maintain essential ecological processes and life-support systems

- Another fundamental element of the NSESD is a series of 'guiding principles' (ENRC, 2000), which are
- Decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations
- Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. This is a noteworthy precautionary principle and should be considered in the application of ESD principles in managing fisheries
- The global dimension of environmental impacts of actions and policies should be recognized and considered
- The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognized
- The need to maintain and enhance international competitiveness in an environmentally sound manner should be recognized
- Cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms
- Decisions and actions should provide for broad community involvement on issues which affect them

Whilst ESD has often been wrongly assumed to address only environmental issues, this set of guiding principles along with the three objectives recognize that continued development is a necessary element in meeting the overall objectives (Fletcher *et al.*, 2002). They are required to be considered as a package and no objective or principle should predominate the others. A balanced approach is required that takes into account all these objectives and principles to pursue the goal of ESD. However in practice, the objectives of optimizing economic efficiency in Australian fisheries management take precedence over social objectives.

APPENDIX

Sustainable development definitions

World conservation strategy (IUCN, 1980): For development to be sustainable it must take account of social and ecological factors, as well as economic ones, of the living resource base and of the long-term as well as short-term advantages and disadvantages of alternatives actions.

FAO committee on fisheries (FAO, 1995): The management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner to ensure the attainment and continued satisfaction of human needs for present and future generations. Such development conserves land, water, plant and genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable.

The national strategy for ecologically sustainable development (Australia, 1992): Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life now and in the future can be increased

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