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Review Paper

INVESTIGATION OF CURRENT RISK TYPES FACED BY THE GLOBAL FISHERIES: A COMPREHENSIVE REVIEW

M. Mohsin[1], Y. Hengbin[2*], Z. Luyao[3], S. B. H. Shah[4]

[1]College of International Finance and Trade, Zhejiang YueXiu University of Foreign Languages, Shaoxing, 312000, China, [2]Marine Resource Management, School of Finance and Trade, Wenzhou Business College, Wenzhou, 325035, China, [3]Strategic Management, School of Business, Hanyang University, Seoul, 04763, Korea and [4]College of Fisheries, Ocean University of China, Qingdao, 266003, China
[*]Corresponding author's email: 20190251@wzbc.edu.cn

ABSTRACT

Although, the fisheries sector is the backbone of agriculture, however, published literature does not document current risk types faced by this sector. The primary objective of this first-time study is to identify various types of current risks faced by global fisheries in a comprehensive manner. It is envisaged that this study will not only help to understand and manage fisheries resources in a better way but it will also provide directions for further research. According to the findings of this study, global fisheries are exposed to five main types of risks, viz., natural, ecological, market, technical, and management. Typhoons, tsunamis, floods, earthquakes, accelerated beach erosion, and oceanic climate changes such as high wave action, temperature fluctuation, and high salinity are the reported natural risk factors faced by this sector. On the other hand, overfishing, aquatic pollution, habitat degradation, abundance of competitive exotic species, genetic stock structure changes, fisheries resource enhancement, and land reclamation projects are the major identified ecological risks. The market risk faced by the global fisheries includes price fluctuation, high financial risk faced by fishermen, changes in the rights to use the resources, employment loss, asymmetric market information, lack of investment, and meager loan support. Whereas, technical risk is caused by the hull or engine-related activities, low degree of mechanization, automation, and industrialization. While, work-related fatalities, loss of fishing gears, fishing mortality, lack of legally harvest strategies, unreasonable production plan of aquaculture, an insufficient supply of fishery insurance, illegal fishing, and uncertainty associated with stock assessments together constitute management risk faced by global fisheries.

Key words: fisheries, risk factors, natural risk, ecological risk, market risk, technical risk, management risk.

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INTRODUCTION

The term "risk" started to appear in fisheries management literature during the 1990s (Francis and Shotton, 1997). This term represents scarcity, uncertainty, variability, etc., faced by fisheries (Hanna, 1997; Charles, 1998). Generally speaking, the risk is a perception about some bad happening (Sethi, 2010). Thus, the term "risk" denotes that state in which the people can estimate the possible losses by using their previous experience, numerical assessment or investigation (Hirshleifer, 1992). Published literature indicates that three factors, viz., fishery collapses in the past, raising awareness of human activities on the environment and increased computing abilities triggered researchers to conduct risk management studies related to fisheries (Horwood, 1993; Walters and Pearce, 1996; Caddy and Mahon, 1995). Like other sectors, the fisheries sector is also exposed to various kinds of risks. For better management of the fisheries sector, it is essential to know these risks comprehensively. Published literature elaborates on the difference between risk and realized risk. Risk is the perception about the happening of something wrong, whereas, realized risk, on the other hand, is actually the happening of such expectation (Sethi, 2010). In order to manage natural resources more efficiently, a precautionary approach is used which is suggested by the Food and Agriculture Organization (FAO) (FAO, 1996; Punt, 2006). This approach is the straightforward approach usually employed to manage risk. This approach is basically an attempt to avoid risk (Sethi, 2010). As the name of this approach indicates, it emphasizes to take action only when that particular action is perceived harmless (Foster *et al*., 2000). According to previously conducted scientific studies, the fisheries sector is facing many types of risks. For instance, it is reported that typhoons, tsunamis, floods, earthquakes, and other kinds of irresistible natural disasters frequently occurred in the past and caused heavy losses to the fishery (Wan and Chen, 2011).

Similarly, it has been found that oceanic climate changes caused by human activities are threatening fishery resources (McKelvey and Golubtsov, 2015; Martinet *et al*., 2015). Likewise, it is considered that

some fish farming activities tend to cause ecological risks. For instance, fisheries resource enhancement may damage the genetic diversity in wild stocks (Jiang *et al*., 2014). Another plethora of published literature also describes various kinds of risks faced by the fisheries sector (Ahmed *et al*., 1993; Baxa *et al*., 2003; Dong and Xu, 2003). Although, the global fisheries sector is exposed to various kinds of risks, however, a study that comprehensively describes all kinds of risks faced by the fisheries sector is missing in the published literature. This study is the first attempt to fill this gap. The fisheries sector is exposed to five kinds of risks, viz., natural, ecological, market, technical, and management explained in detail in the coming sections of this study. Understanding different types of risks and their sources is the only way for effective fishery management (Alam *et al*., 2019; Cojocaru *et al*., 2019). The following sections of this study are arranged according to this sequence. Section 2 through light on the natural risk. Section 3 takes a brief overview of ecological risk. Section 4 comprehensively examines market risk. Section 5 presents details about technical risk. In the last section of this study, section 6 describes management risk faced by global fisheries.

Natural Risk: Typhoons, tsunamis, floods, earthquakes, and other kinds of irresistible natural disasters frequently occurred in the past causing heavy losses to the fishery (Wan and Chen, 2011). Moreover, with the recession of fisheries resources on high seas, stock depletion and sustainable production possibility of the fishery are significant risk factors in the long-run. Some countries have established fishery property rights through individual transferable quotas to avoid stock collapse. However, this condition poses a threat to the fishery (Ewald and Wang, 2010; Costello *et al*., 2008). As oceanic climate changes are poorly predictable, the harvest of some coastal fishing countries is also affected by a deteriorating oceanic climate. For instance, Jack-mackerel fishery in Chile encountered uncertainty, as threatened by *El Niño* (McKelvey and Golubtsov, 2015; Martinet *et al*., 2015). With respect to the impact of climate change, an essential point is a sea-level rise. It directly leads to the loss of mangroves. The mangrove forest is the source of fuel, wood, and food for Pakistani residents. It is also the breeding ground for 90% of local shrimps. Thus, conservation of mangrove forests is the key to retain shrimp fishery resource in Pakistan (Farooqi *et al*., 2005).

Temperature is considered the most important factor in the growth of fish. The diversity of fishery species along the coast of Pakistan is facing threats from both natural and man-made aspects. Natural factors include wave action, temperature, salinity changes, and seasonal diffusion of anoxic waters rising from depths. The man-made pressure mainly comes from the discharge of water from the Indus River and the lack of replenishment of beach sand. It results in the acceleration of beach erosion and an increase of turbidity (Haq *et al*, 1997). Almendarez-Hernández *et al.* (2015) found that the Mexican shrimp fishery encounters a great risk of economic loss under the monotonous rise of sea surface temperature, through a small amount of experimental work. Disturbance due to the presence in the area may impede fishery activities (Astles *et al*., 2009). Mathis *et al.* (2015) notice that ocean acidification poses a threat to marine organisms in Alaska intensely which also affects local commercial harvests. Hence, they used the risk assessment framework proposed by the Intergovernmental Panel on climate change to study marine chemistry. Mabon and Kawabe (2017) discuss the significant infrastructural damage caused by natural disasters, such as earthquake and tsunami, and address measures of risk governance in the post-disaster period.

Ecological Risk: Overfishing, water pollution, habitat degradation, and increasing competitive exotic species all contribute to the decline of commercial fish populations (Iqbal *et al*., 2013). Many fisheries management plans have set sustainable development goals for all the important parts of the ecosystem, including habitat, endangered species, species combination, biological diversity, and ecological processes, as well as harvested species (Ward *et al*., 2002). Huang and Perrings (2017) cite an example of the sea lice infecting wild salmon in salmon farms. Newman *et al*. (2018) assesses the situations of multi-species fishery resources and propose a plan to evade the risks. On the other hand, some studies analyze the threat of exotic species introductions, changes in genetic population structure, and effects of species interaction or ecosystem on marine fishing (Newman *et al*., 2018; Baxa *et al*., 2003).

Grafton and Little (2017) make use of environmental offsets to reduce the fishery risk of habitat degradation. Some artificial disasters, like radiation leak, also affect the quality of fishery products, as released radionuclides would find their access into the sea, sediments and marine species (Yoshida and Kanda, 2012). Holley *et al*. (2018) study the recovery of oysters in the Hudson-Raritan Estuary's enclosed waters and find that troubled water, i.e., pollution is a potential risk for aquaculture. Under the influence of pollution, the profitability of the fishery may be very low or even zero. The polluted environment has resulted in a large number of potentially dangerous inorganic fishery products. Such products caused toxicity to the consumers of aquatic products in the United States (Ahmed *et al*., 1993).

It is considered that some fish farming activities tend to cause ecological risks. For instance, fisheries resource enhancement may damage the genetic diversity in the wild stocks (Jiang *et al*., 2014). It is reported that land reclamation projects have also occupied the

traditional fishery grounds of fishermen. In addition to this, the rapid development of coastal ports and communication industries occupy large sea areas on which fishermen live (Gao, 2013). In recent years, the development of island resources also increases pressure on the coastal resources, offshore resources, and environment carrying capacity (Zhang *et al*., 2016). Marine life is affected by global warming caused by carbon dioxide and other greenhouse gas emissions. Marine man-made environmental disasters such as eutrophication, emissions of toxic substances, disposal of marine radioactive substances, oil and gas exploitation and leakage, and improper disposal of solid waste have brought a great threat to the stability and safety of marine fisheries. The content of mercury in aquatic products and health risk assessment of human exposure has always been a hot spot of research in China (Li, 2008; Yang *et al*., 2009). Pan *et al*. proposed that the emission of land pollutants has aggravated the deterioration of the marine environment and the over-exploitation of marine resources (Pan *et al*., 2014).

Market risk: Zhang and Zheng (2016) found that there were own price risk and cross-price risks in aquatic products trade, which was due to the sensitivity of fishery products towards price fluctuations. Fishermen face high financial risk, which is determined by their large annual income fluctuation (Kasperski and Holland, 2013). Moreover, cost fluctuation, alteration of resource user rights, employment loss, and asymmetric market information make market risks more dynamic by influencing the supply of fishery products (Kvamsdal *et al*., 2016; Sethi, 2010). Some studies divide the fishery risk into natural risk, technical risk, management risk, and market risk. In terms of market risk, fishery production decision-making changes relative to the market change, the asymmetric market information, and the disordered competition among the fishery producers all may bring losses to the producers (Dong and Xu, 2003).

The rising prices of fishery means of production make the risk of fishermen's production and operation increase constantly (Zhang and Jiang, 2010). The lack of investment and financing and the difficulty in circulating capital are also important factors restricting the development of aquaculture. The risk tolerance of most farmers is weak. Credit guarantee and financial institutions are difficult to provide loan support. Private capital is not willing to flow to high-risk industries. Government finance lacks a stable policy in supporting this high-risk industry (Liu and Liu, 2014).

Overexploitation, pollution, and habitat fragmentation in Pakistan have led to a decline in some important commercial fish stocks (Rafique, 2001). Concurrently, rapid industrialization and economic development have also led to increased pollution along the Karachi coast of the Arabian Sea in Pakistan. Heavy metal pollution in the sea area is aggravated by industrialization and urban activities, which directly affects the ecosystem of Karachi Port (Memon *et al*., 2015; Ahmed and Bat, 2015). Ahmed *et al*. (2015) propose that fishing operations tend to cause diverse ecological impacts, such as habitat destruction, death from lost or discarded fishing gear, pollution, and generation of marine debris. They may lead to unsustainable trends in tuna fishery development in the Arabian Sea.

Technical risk: Some habitats not only provide physical shelter for fishing activity but also play an important role in restoring the productivity of many commercial fish species. Nevertheless, unreasonable use of fishing gear can easily bring high pressure to marine habitats. For instance, the presence of demersal trawlers poses a threat to marine organisms. These trawlers have rock-hopper or bobbins on their trawls, which enable them to fish smoothly even in rough and hard ground habitats (Bax and Williams, 2001). Some scholars put forward a progressive view that equipment failure tends to increase the uncertainty of the profitability of fishing vessels (Almendarez-Hernández *et al*., 2015). Astles *et al*. (2009) explain the possibility of accidental spillage or leakage into the sea or air with the tasks involving fuel, oil or other activities related to engines and ships. This means boat maintenance and emissions may disturb fishery production activities. Moreover, the spread of infectious diseases is another common risk in aquaculture (Lafferty *et al*., 2015).

The fishermen must face both the natural risks, such as typhoons, storm surges, and red tide and the social risks including disease and management risks (Tong and Li, 2011; Dong and Xu, 2003). Yuan studied that the risk of aquaculture mainly comes from natural disaster risk, social risk, and technical risk. Invasive species or any problem of breeding techniques and methods may cause fish growth to slow down or even die (Yuan, 2012). With the expansion of the operation mode and area of marine fisheries, the lack of some fishing boat horsepower and the low quality of fishermen lead to a growing risk of marine fisheries production (Du and Yan, 2013). In recent years, aquaculture in deep water cage is developing in China, but the low degree of mechanization, automation, and industrialization restricts the transformation and upgrading of the Chinese fishery industry (Chen and Tan, 2015).

Management risk: Beddington *et al*. (2007) argued that the fishery crisis is relevant to two key stakeholders, i.e., the fishing community and the management authority. To achieve effective fisheries management, it is essential to understand the behavior of fishermen, and the lack of such knowledge is likely to lead to the collapse of several fisheries (Hilborn, 1985; Sampson, 1991). According to

the Bureau of Labor Statistics, fishing is a risky business with the highest rate of work-related fatalities and personal injury in all the US industries (BLS, 2011). Due to overfishing, the initially prosperous marine fishery may degenerate into a state of serious shrinkage of fish resources and marginal harvesting profitability in just a few years. Some scientific studies analyze the common impacts of overfishing (Jennings and Kaiser, 1998; Murawski, 2000). There are other risks, which are caused by fishing activities indirectly. For instance, contact without capture can lead to direct physical damage to habitats, and an indirect impact on the captured species due to the ecological relationship between the captured species and their habitat. In addition, the loss of fishing gear, such as part or all of the net, warp and otter board, may pose a risk to fishing activities (Astles *et al*., 2009).

Naylor *et al*. (2005) found that the escape of farm fish may lead to competition or hybridization with wild fish, which may promote the spread of pathogens, thus causing greater pressure on the reduced wild population. Jonzén *et al*. (2002) consider fishing mortality is a non-negligible risk factor of fishing activities and they refer to reduce fishing mortality substantially at the current level as the only way to avoid irretrievable ecological and socio-economic consequences of continued exploitation. Single species management is severely criticized for its low sustainable level of fish stocks and an inability to maintain the safety of marine ecosystems. Management authorities usually lack legally harvest strategies and operational errors (Gray and Hatchard, 2008). Due to limited resources, it is difficult for fisheries management agencies to solve numerous problems caused by a series of demands that stakeholders may compete with each other (Cochrane, 1999; Scandol *et al*., 2005). The uncertainty associated with stock assessments makes fishery managers have a difficult task of evaluating scientific information. Since, there are complex nutrient interactions among the ecological components in marine fisheries and those nutrients are not fully known, thus, it is a major challenge to conduct an ecological risk assessment in fisheries lacking data (Astles *et al*., 2009; Francis, 1992). Sethi (2010) lists other management risks affecting a fishery system, including failure to achieve social welfare goals through excessive and prudent harvest, and the failure to achieve ecological protection through excessive and positive harvest and fund changes. Studies suggest that fishery production risk depends upon input such as capital, fuel, and labor but it varies between different types of vessels (Asche *et al*., 2020).

Since the 1990s, because of the changes in the new international fishery order, the overfishing and the unreasonable production plan of aquaculture, improper production process or operational errors have brought losses to fishery production. The insufficient supply of fishery insurance is a serious problem. Thus, a fishery catastrophe insurance system, which is in line with the national conditions, is necessary (Li, 2012; Yang, 2012). Taking the marine fishing industry as an example, fishermen are fishing for years with wind and waves. Fisherman's casualty accident and fault of operation tools are major risks of this industry (Sun, 2006). In some parts of China, authorities have decided to restrict fishing and guide fishermen to transfer jobs, but the policy ignores the shortage of the national security system and brings more recessive risks to the fishermen's society. Some fishermen do not hesitate to take risks and are more insanely illegal fishing (Tong and Li, 2011).

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