

Original Research

Assessing the impact of environmental accidents and drought on the economy of fishery (case study: Iranian whitefish)

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Corresponding author:**Azadeh Shahbazian****ABSTRACT:**

The unbalanced Caspian Sea ecosystem caused by dams on rivers and the indiscriminate use of river's fresh water and contamination of fishery ponds and also factors like overfishing and excessive harvesting of river's water and loss of natural hatcheries in rivers and coastal wetlands have led to the catastrophic reduction in reserves and the economically valuable fishing of whitefish. In this study, the annual wholesale and retail prices and the production of whitefish in Iran during 2010 to 2014 were collected. Our results showed that there is a significant relation between environmental accidents and drought on the fisheries economy. In other words, by increasing the environmental accidents and drought, the whitefish's retail and wholesale price increase.

Keywords:

Whitefish, Drought, Environmental accidents, Fishery economy.

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INTRODUCTION

In Iran, Caspian Sea is an ecosystem with considerable environmental, biological, and economic conditions. The lake is brackish and closed and its coasts are divided among five countries *viz.*, Russia, Azerbaijan, Iran, Turkmenistan, and Kazakhstan. One of the major features of this lake is the unique and valuable aquatic population that includes several species of bony fishes. In recent years, on its Iranian coast, fishing companies have used different types of bony fishes in which the whitefish (*Rutilus frisii Kutum*) is the most favorite and commercially important (Valipour and Khanipour, 2009). The whitefish is a kind of Cyprinidae and indigenous fishes of Caspian Sea and also one of the valuable and economic species in Iran (Dorafshan and Heyrati, 2006). whitefish is semi-immigrant spawning in most rivers at a little distance from the estuary of the Sea. whitefish has nutritional migration and overwintering. Its lifetime is 9 to 10 years and the maximum length and weight, are reported 72 cm and 6 kg respectively. In 1950s, the maximum length and weight of this fish were reported as 67 cm and 7 kg respectively. Different ecologic conditions determine the needs and food relations and their compatibility with the environment and the density and distribution of various species (Sheldon, 1968).

The whitefish is distributed in Atrek river, located on west coast of Caspian Sea, the central Caucasus area to Turkmenistan's south coasts (Valipour and Khanipour, 2009), but the major population of whitefishes can be found in Iran (Ahmadian *et al.*, 2015). This is a river- emigrant fish spawning in aquatic plants and gravel and sand-rivers and wetlands around the Caspian Sea. A huge decrease of annual fishing of these species was reported in 1970s, which was because of their natural population decline. It was intensified due to destruction of their natural spawning beds and other factors in a way that natural reproduction of this species was restricted and consequently, Iran Fisheries Organi-

zation acted to restocking it from 1985, and annually, in order to preserve the resources of this valuable species, they produce 200 million of these finger-length baby fishes and released them in nearby rivers or even the Caspian Sea (Heyrati *et al.*, 2007). The population of whitefish in Iran reduced during the period of 1940s to 1980s due to overfishing and natural decline in spawning. But from the early 1980s onwards the reduction process stopped because of the plan of increase and release of baby fishes in Sea. Despite its natural cost, this plan played an important role in increasing the fish stocks and their management. The amount was increased from 563 tons of whitefish (*Rutilus frisii kutum*) in 1982 to 7036 tons in 2004. The highest reported amount was 10920 tons in 1991. The average fishing in the last two decades were approximately 8770 tons. Generally, the share of whitefish fishing is 54% more than bony fishes' in the Caspian Sea, in last two decades. The average price of whitefish in wholesale was more than 1 dollar and in retail was a little more than 1 dollar per kilogram, in 2004 (Cury and Christensen, 2005). It is expected that a developmental strategy to be represented by the government in order to increase the efficiency of artificial reproduction of the baby whitefishes which has a high annual economic, social, or even political value for Iran, particularly the northern cities.

The price trend of whitefish in Mazandaran province was decreasing from 2004 to 2008, whilst the price trend of crab was increasing in this period. This reduction has happened in order for a suitable volume of fishing on that period. Such that in 2008, the annual fishing amount in Mazandaran province was reported 6773 tons, while this amount was 1772 tons in 2004. The pollutions of rivers leading up to Caspian Sea and illegal fishing are among the reasons intensifying the reduction in the fish stocks of Caspian Sea (Razavi, 2008). Therefore, the aim of this paper is to assess the impact of environmental casualties and drought on the

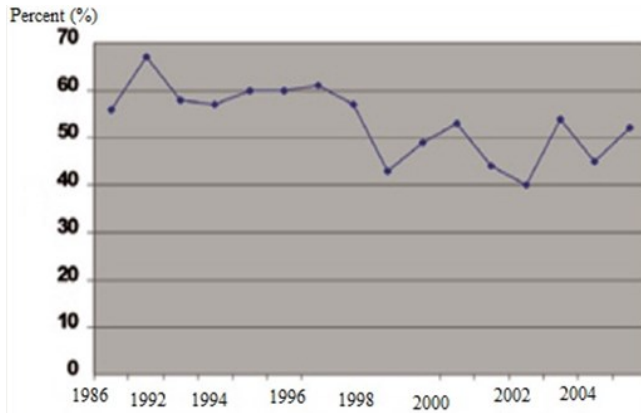


Figure 1. Proportion chart of whitefish fishing from total fishing of bony fishes in the southern part of the Caspian sea, from 1986 to 2004 (Cury and Christensen, 2005)

rivers on the economy of fishery (case study: Iranian whitefish).

Fisheries Organization of Iran started its own acts to revive the fish stocks in Caspian Sea from 1982 by releasing the baby fishes into the rivers. In the last three decades, there were more than 4.62 billion of baby fishes in the rivers and Anzali Lagoon. This had a prominent positive effect on revival and increase of fish stocks (Abdolmaleki and Ghaninezhad, 2007). Currently, the artificial proliferation and the plans for population growth are major methods of preserve and growth of the whitefishes population.

The Caspian Sea's whitefish (*R. Kutum*) is a species with high nutritional value, therefore, knowing and investigating the various populations of this fish is a great matter of attention.

Environmental and drought damages on the economy of whitefish (*R. Kutum*)

The increase of organic and inorganic pollutants and also Caspian Sea's water reduction during 1939 to 1975 have caused destruction of one of the natural habitats of bony fishes, Lagoon Anzali; so that, the amount of fishing decreased from 6000 tons in 1932 to 100 tons in 1963. Other factors such as bridge construction upon the rivers of the Sea's southern side, construction of dams, entrance of industrial, urban, and agricultural

pollution and jungle's destructions had led to the destruction of bony fish hatcheries and overfishing and illegal fishing, especially during their migration had led to reduction of natural reproduction (Abdolhaii, 1998). Unfavorable conditions of rivers don't allow the baby fishes to grow and reach the Sea in case of migration and spawn (Razavi, 2008). Besides the mentioned factors, the lack of control on fishing tools is another hurt to the stocks. Catching whitefish brood-stock by the pitfall gillnets during migration has led to the destruction of large brood-stock from the reproduction circle and reduction of size in the next generation. On the other hand, destruction of natural habitats, overfishing, construction of dams and power plant in fish migration routes, sand and gravel mining from riverbeds, petroleum, industrial, urban, and agricultural pollutions, ecological changes of rivers, decrease of the stocks of economic pieces and population and demands increased are the important factors for policy makers and development planners of aquaculture and researchers of fishery science to artificial proliferation and restocking of economic species during the recent decades (Luk'Yanenko *et al.*, 1999). In these decades, large parts of spawning habitat of sturgeon and bony fishes, the Caspian Sea and its subsidiary rivers have been destroyed. The considerable point is that the aim of all stock rebuilding projects was the revival of stocks by releasing a certain amount of baby fishes. Developments in technology of reproduction, breeding, and feeding larvae and brood-stock have caused more species of the aquatics to be ordered to reproduction. Bartley and other authors considered the release of the aquatics as a complicated action related to several technical, biological, ecological, economic, social or even political factors (Bartley, 1999).

One of the most important environmental accidents is the spread of oil slick on the surface of rivers and Seas. Therefore, evaluating the economic losses caused by oil spills are very important according to the several factors.

Table 1. The result of environmental accidents effect test on the wholesale price of Iranian whitefish

Variable	Coefficient	Standard Error	t-Statistic	Probability
SPI	996.2706	141.8690	7.022468	0.0059
AQI	957.5680	140.0351	6.838059	0.0064
R-squared	0.330660	Mean dependent var		132.0000
Adjusted R-squared	0.307547	S.D. dependent var		23.87467
S.E. of regression	7.259347	Akaike info. criterion		7.091631
Sum squared residuals	158.0944	Schwarz criterion		6.935406
Log likelihood	-15.72908	Hannan-Quinn criteria		6.672339
Durbin-Watson statistics	1.520086			

In the first place, when the people's responsibilities are in danger, it could provide predetermined answers about the amount of damages. Also, it can be mentioned as an important deciding tool for determining the optimal level of protection in the fleets' safety departments in order to avoid similar accidents in the future. In this regard, effects, transitions, and remaining time of oil spills will bring considerable economic consequences (McCluskey and Rausser, 2003). Recently, in order to compensate the financial damages caused by oil spills in international waters, it is necessary to be a reasonable degree of geographical and economic proximity between the contamination and sustained damage by the claimant (Chung, 2011). Many of the published studies showed that the oil spills affect the place directly or indirectly. Álvarez and Loureiro (2014) have studied the effects of environmental accidents on the fish price (evidence of prestige oil spilling in Galicia). In this study, the effect of environmental accidents after oil spilling in fish markets on north-west coasts of Spain (Galicia) are discussed. Specifically, it is focused on aquatic fishes showing the related market's part. The results showed that publishing media around the accident has a significant effect on the evolution of fish price. Exxon Valdez oil spill on the coast of Alaska in 1989 has contained 42000 MT of oil. This spill, particularly affected the fishing industry and especially fisheries of that area and its consequences have led to irreparable ecological damages. Economic damages on fisher-

ies sector was a great matter of importance and led to a loss of more than 155 million dollars during two years. The latest oil spill is called Deepwater Horizon, which contained 1.7 to 3 million barrels of oil and had existed from 20 April to June, 2010 on the Mexican Gulf (Brown 2010). Considering the conducted indicators about Exxon Valdez, the Deepwater Horizon losses could approximately be about 105 to 239 billion dollars which contain natural resources' losses and economic losses to the private sector (Krupnick *et al.*, 2011).

Another problem is the drought issue which is a global issue and it may happen anywhere and it could leave severe damages on human and natural ecosystem. Increasing general awareness about the issue of global climate changes has made lots of worries about its potential effects and results, and also a lot of inefficient researches have been carried out about special effects of climate changings on water resources of different areas hitherto, and so many researchers have declared that the climate changes lead to increase in dosage and everity of climatic events like drought (Saadati *et al.*, 2009).

Drought, because of the frequency of occurrence is more catastrophic than other natural phenomena and its long lasting effects are such as economic and environmental losses and intensive social effects (Álvarez and Loureiro, 2014). It is one of the most important natural accidents which could be defined as follows: less rainfall than the average annual amount and incompatible distribution of rainfall in the region along with

Table 2. The effects of environmental accidents and drought on retail price of whitefish

Variable	Coefficient	Std. Error	t-Statistic	Probability
SPI	-19.09511	15.15856	-1.259691	0.0269
AQI	18.37938	14.96260	1.228354	0.0169
R-squared	0.323170	Mean dependent variable		-2.394000
Adjusted R-squared	0.097560	S.D. dependent variable		0.816505
S.E. of regression	0.775654	Akaike info criterion		2.618954
Sum squared residuals	1.804917	Schwarz criterion		2.462729
Log likelihood	-4.547384	Hannan-Quinn criteria		2.199662
Durbin-Watson statistics	1.595661			

loss of rainfalls in a long period of time. The agricultural field, gardens, pastures, and forests which need rainfalls to supply their demanding water would be directly harmed. Shokri, (2005) examined the social, economic, and environmental effects of drought and measured the effects of rainfall reduction in Sistan and Baluchestan province. He concluded that drought has a great effect on economy (compared to the other effects such as environmental, economic and social psychology's effects), and its economic and socio-psychology effects are minor.

The effects of drought on fisheries include:

- 1- Reduction of river and fish pond's water
- 2- Increased pollution of water and aquatic environment
- 3- Increased illness risk of breeding aquatics
- 4- Bankruptcy and unemployment in the aquaculture section
- 5- Increase of fishery products' price in the market
- 6- Increased import and export of the country's currency

The mobility and life of the ecosystems are based on the circulation of material and energy in them. Among the required materials of natural ecosystems' (jungles, pastures, rivers, lakes) and artificial ecosystems (cities, villages, farms), water is the most important one, undoubtedly. Therefore, the water shortage or water pollution can face its overall structure and health with serious problems, anywhere it occurs. By decreasing the amount of water in a crucial system, if the population and activities also decrease, maybe there would not be an accident, but the fact is that an increas-

ing society demands more and more water, food and health services daily or even hourly. In such situations, the collection of natural and human environment will be affected by drought. The most important effects of drought could be divided into economic, social and environmental effects. This phenomenon has unpleasant effects and consequences for human health and life set on Earth.

During the severe drought that occurred in 1970s, annually on average, 23000 persons lost their lives and 4.24 millions of persons had various losses and damages. A large group of people were also made to leave their living places as environmental refugees. One of the most important effects of drought is the environmental effects that we mention some of the most important ones here; severe reduction of water in rivers, lagoons and lake which lead to decline in static, drying up of canals and springs which also lead to restriction of life consequences and/or death of aquatics before it could affect the vegetation and human lives. The effects of severe water reduction in these resources are intensifying especially by discharge of domestic, agricultural and industrial wastewater. The death issue of aquatics is one of the environmental difficulties which occur in the water deficit seasons in downstream.

With recent droughts, the flow of water to wetlands has been completely cut off, in a way that the surface of lagoons is covered with salt and left without any vital sign. Continuation of these conditions will un-

doubtedly accelerate the process of desertification in the region (Ranjbar and Iranmanesh, 2008).

MATERIALS AND METHODS

In this study, Annual wholesale and retail price data and the production amount of Iranian whitefish were collected from 2010 to 2014. One of the applied methods for financial value of goods and environmental services is the Hedonic Price Model (HPM). This model is related to the price of a good or product compared to each of its features (Sander and Haight, 2012).

Overall shape of the model

Equation 1 is with following condition:

$$P_i = f(x_{1i}, X_{2i}, \dots, X_{mi}) \quad (1)$$

$$P_i = d_0 + d_1X_{1i} + d_2X_{2i} + \dots + d_mX_{mi} + \epsilon_i \quad (2)$$

wherein the 'P_i' is Fish price, 'x_{1i}' is the argument of function, 'f' in expression and 'ε_i' is a random error (Lee, 2014). As in the estimation of traditional enjoy models, choosing a suitable functional linear or logarithmic half form is very important.

Linear features have a clear interpretation that the increase unit in a variable boosts the price to the index's amount, while with semi-logarithmic profile; the indexes could be averagely interpreted as a percentage of price. Basic regression model (Armstrong, 2012) is used here to estimate the equation governing the relationship between the dependent and independent variables.

RESULTS

To evaluate the effects of environmental accidents on fisheries economy; firstly, air quality index and benchmarked index during 2010 to 2014 should be considered. Then, the investigation of these indexes' effect on wholesale and retail price of Iranian whitefish is a matter of priority. The results on wholesale of the whitefish are reported in Table 1.

The significant levels for environmental acci-

dents effect test and drought are 0.006 and 0.005 respectively and since these amounts are less than 0.05 respectively, so it can be resulted that environmental accidents and drought affect the wholesale price of whitefish. The coefficient of determination for test is 0.33 and the Durbin-Watson statistic value is 1.520 which is used for independency of errors and indicates the lack of correlation between the component errors. Therefore, there is a significant relation between the environmental accidents and droughts on the fisheries' economy. In the other words, following the increase in environmental accidents and drought, the wholesale price of whitefish increases.

The significance level of environmental accidents effect test and drought are 0.0269 and 0.0169 respectively and because these are less than 0.05, it can be said that the environmental accidents and droughts affect the retail price of whitefish. The coefficient of determination, for this test is 0.32 and Durbin-Watson statistic is 1.595 which is used for recognition of errors' independency and shows the lack of correlation between the errors. Therefore, there is a significant relation between the environmental accidents and droughts with fisheries economy. In other words, with an increase in environmental accidents and drought, the retail price of whitefish increases.

DISCUSSION

Tajima *et al.* (2016) evaluated the changes of market price in the condition of Fukushima nuclear accident using the monthly data of about six types of fresh vegetables in 47 districts of Japan. Their results indicated that after the nuclear accident, the price of vegetables grown in Fukushima was 10-36% lower than which have been grown in the other areas. This was because of the risk of perceived radiation in this prefecture. Their results confirm the findings of current study suggesting the direct relationship between the environmental accidents and wholesale price of the fish.

The work of Countryman *et al.* (2016) examined the long term economic consequences of U.S. drought on beef cattle. An agricultural sector model was applied along with the observations during different seasons of the year in order to link seasonal crop with various and separate parts of livestock. Short term effects showed the increase in the cost of feed as well as cattle slaughter because of drought and subsequently decreased livestock. Accordingly, it seems that there is a significant difference between the factors affecting the prices in the fishery and livestock industries; because the study mentioned above is in contrary with our results.

Fishery is considered as one of the most important parts of agriculture. Given its role on countries' economy and considering the potential of environmental accidents and droughts, evaluation of these accidents has a great importance. Also, evaluation of the environmental effects is a greatly valuable goal on designing and realizing huge farms of aquaculture. Thus, helping the experts, consultants, and schedulers in order to apply environmental considerations in planning, design, and implementation of decisions in the fisheries sector in each organization is very important. In any field, we could reduce the damaging effect of environmental effects and accidents by proper management and accurate scheduling, and by evaluating environmental accidents and drought in this way; we could recognize the problems and solve them.

CONCLUSION

According to the results of hypotheses test, it could be mentioned that environmental accidents and droughts have a major effect on fisheries economy including whitefish. With the potential increase in such accidents, the wholesale and retail prices are increasingly influenced. Thus, by evaluating these accidents and droughts, we could make a suitable planning in this field. Finally, by considering the tests results of this

research, a new protocol must be considered for compensating environmental damages on fisheries economy.

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