



Economic and Environmental Crises Caused by the COVID-19 Pandemic in the Makran Coasts, Iran

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ABSTRACT

Aims: Like many other countries, Iran has been exposed to the COVID-19 pandemic and its different economic and environmental implications. So, the research studies the economic and environmental consequences of COVID-19 in the Makran Coast of Sistan and Baluchistan which supplies nearly 60 % of the demand for fish in Iran.

Materials & Methods: The research is an applied study in terms of goal and a descriptive study in terms of data collection method, which was conducted by the cross-sectional survey method.

Findings: A comparison of the period of January-June 2020 (COVID-19 conditions) versus a similar period in the year 2019 (normal conditions) in the economic sector showed that the fishermen's income, catch rate, and employment has decreased and their unemployment has increased. In the environmental sector, the pandemic and related restrictions have increased seawater pollution and waste production.

Conclusion: These changes, which have seemingly increased by the culmination of the COVID-19 pandemic, have had irreparable consequences for the fisheries sector. Governmental support from the management of demand and supply markets and its plans to support fishermen are recommended as approaches to tackling the crisis. Given the emergence of new strains of COVID-19, such as alpha, beta, gamma, delta, and omicron, it is necessary to conduct long-term studies to determine the full range of the pandemic.

Keywords: COVID-19, Economic crisis, Environmental crisis, Makran Coast of the Sea of Oman, Sistan and Baluchestan Province.

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Introduction

Since the beginning of the COVID-19 pandemic in late 2019, extensive research has been conducted in the sociocultural, medical, and economic fields to prevent and mitigate its consequences^[1]. The pandemic of the new coronavirus (COVID-19) in Wuhan, China since December 2019 has posed many challenges in different aspects throughout the world so even developed countries that claim to have advanced health systems and social security have recently encountered serious problems^[2]. The current COVID-19 pandemic has caused health and economic crises in the world– a shock that has affected the food systems across all regions of the world^[3]. The fisheries sector in Iran is one of the sectors heavily influenced by this infection in this country^[4]. Since the fisheries sector of Sistan and Baluchistan Province supplies about 60 percent of the demand for fish in Iran, this research focused on the Makran Coast in this province in the southeast of Iran. Most activities in this coastal area are related to fishing and fishery, as well as aquaculture. As the main implications of COVID-19 for the fishery of Sistan and Baluchistan Province, the sector is facing an economic and environmental crisis that has influenced fishing activities, income, profit, costs, employment, and so on. From the environmental aspect, although the virus has had positive effects on air quality and the reduction of pollutant emissions due to the reduction of human activities, the extensive disposal of bio-hygienic waste, which is mostly plastic, has negatively impacted the environment so that this pollution and the remaining wastage have had remarkable consequences for the vulnerability of fishers and consumers in the present and future.

The Gulf of Oman or Sea of Oman, also known as Gulf of Makran or Sea of Makran, is a gulf that connects the Arabian Sea with the Strait

of Hormuz, which then runs to the Persian Gulf. It borders Iran and Pakistan on the north, Oman on the south, and the United Arab Emirates on the west. The Makran Coast is less exposed to regional and international stresses as it is located outside the Persian Gulf and the Strait of Hormuz; on the other hand, it is of economic significance since the Sea of Oman is part of the route connecting the Persian Gulf and its oil-rich regions to the Indian Ocean, the Mediterranean Sea, and Europe. This region is characterized by its neighborhood with international free waters in the southern borders of Iran and its neighborhood with Pakistan and Afghanistan. Furthermore, the connection of the Gulf of Oman and the port of Chabahar on the eastern coast of Makran to the International North-South Transport Corridor will play a key role in the exchange of goods to the east of Iran and the Central Asian countries. Indeed, the access of the port of Chabahar on the Makran Coast to open waters has made the Central Asian countries, India, China, Afghanistan, and even European countries willing to use this port for the transport of their goods. So, the Makran Coast has a special place in expanding regional and international exchanges in Iran, and in the study area according to Figure 1, the cities of Chabahar, Konarak, and Dashtiari are among the important fishing areas in Sistan and Baluchistan Province and have the greatest impact from COVID-19.

Few studies have addressed the effects of COVID-19 on different sectors in the world. In this regard, Taleb Beidokhti et al. (2020)^[5] investigated the environmental effects of the COVID-19 virus. This study aims to show the direct and indirect positive and negative effects of COVID-19 on the environment. Research shows that despite the positive effects of the Coronavirus on the environment such as improving air quality, clean beaches, and reducing noise pollution, there are negative and secondary aspects

such as excessive water consumption, reduced waste recycling, and increased organic and inorganic waste. Which has led to air, water, and land pollution. Alang (2021) ^[6] investigated COVID-19 and the increase of plastic waste in the coastal and marine environment. The study found that the unprecedented increase in the production and use of masks and gloves is a new environmental challenge that has led to an increase in plastic waste in roads and marine environments. The World Health Organization estimates that approximately 89 million medical masks are required each month to respond to COVID-19. Improper disposal and disposal of these items have caused them to enter the coastal and marine environment through runoff as well as coastal visitors. Mofijur et al. (2021) ^[7] investigated the impact of COVID-19 on social, economic, environmental, and energy fields. The results showed that 72 h delay in waste, collection, and disposal of contaminated waste is very important to control viruses. Sustainable businesses at the height of the pandemic require development programs for socio-economic growth as well as a strong entrepreneurial economy. Despite these sources and research, and considering that the history of the COVID-19 pandemic dates back to less than two years, researchers have pondered the present issue from other dimensions and intend to try to enrich the subject as much as possible. This paper explores the immediate impacts of the COVID-19 pandemic on the small-scale fisheries sector of the gulf of Makran.

Materials & Methods

The research adopted a descriptive-analytical method at the theoretical level and collected data by reviewing the relevant books, articles, and theses. The selection of a proper method that is consistent with the research topic and theoretical framework

is crucial for any scientific research^[8]. Data were collected with document and library work and face-to-face or telephone interviews with fishermen and acquired through descriptive methods of reasoning, interpreting, inferring, and comparing. It also investigated the topic in question by the document method using the opinions of fishery experts and compiling additional economic and environmental information from public sources. The purpose of this research is to examine the information of the variables mentioned before (Pre-) and after (Post-) COVID-19 to make a comparison and determine the effects in general, and whether these effects are negative or positive in the fisheries sector ^[9].

Data Description

The long coastal area of Makran covers an area of over 611 km² from Bandar-e-Jask to Gwatar including coastal capes. The region can be considered to be economically important at regional, national, and international levels. It is characterized by 561 km of water borderline, its control over one of the most strategic waterways in the world, its neighboring with Afghanistan and Pakistan, and its proximity to landlocked republics in the northeast of Iran. The Makran Coast has a high potential for the expansion of regional and international trade for Iran. Indeed, 60 percent of the material for canned fish is supplied by Chabahar, Konarak, and Dashtiari. The long coasts and access to open waters are the main factors responsible for the capability of these three counties to supply fishery products and employment in the fisheries sector so that they meet almost 60 percent of Iran's demand for fish. Although most local people are employed in the fisheries sector, some are engaged in agricultural, horticultural, and animal farming activities, too (Anonymous, 2020). Figure 1 displays a general view of the Makran Coast.

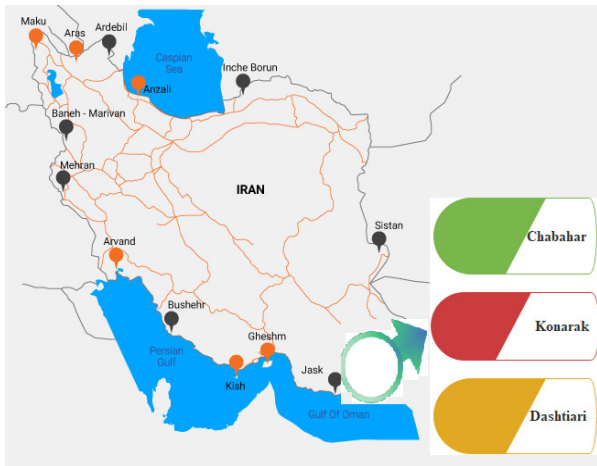


Figure 1) The map of the Makran Coast in the north-west of the Indian Ocean and (b) the SRTM-DEM of the Makran Coast.

The statistical population of this study includes fisheries, environment, and fishermen in three regions: 1- Chabahar fishing 2- Konarak and Dashtiari and the descriptive-analytical method has been used. To determine the sample size, population information was first randomly selected from each region. Then, using Cochran's formula, the required sample size of 232 (90 fishermen in Zone 1, 80 fishermen in Zone 2, and 62 fishermen in Zone 3) was randomly completed with researcher-made questionnaires (Table 1). So, the purpose of this paper was to conduct a field study of the effects of COVID-19 on fisheries sectors and sub-sectors, which surveyed fishermen, fisheries experts, and the environment. For this purpose, we used the capacity of the organizations of the fisheries sector and the real activists of this sector. The efficacy of COVID-19 was evaluated in both the past and present, with an emphasis on economic and environmental effects. The reliability of the questionnaires was assessed using Cronbach's alpha method. According to the results of this test on 30 questionnaires by pre-test method, the reliability of the assessment tool of this study was 0.88. The validity of the questionnaires has also been considered in two ways. First, an attempt was made to extract the main

indicators from a review of the literature and opinions of experts, and then it was approved by 8 relevant experts and specialists.

Table 1) Fishing ports and villages and sample size.

City	Seaport	No. of samples
Chabahar	Haft-Tir	35
	Tis	25
	Ramin	30
	Konarak	20
Konarak	Pozm	15
	tang	15
	Zarabad	15
	Galk	15
	Pasabandar	25
Dashtiari	Beris	20
	Gavater	15
	Sum	232

Table 2 presents the number of vessels sailing in the region. It is observed that almost 80 percent of the vessels are boats, and the rest are dhows and ships. Boats are mostly engaged in economically valuable commercial fishing in the bays and domestic waters and their sea trips last only one day. Dhows are, on the other hand, engaged in industrial fishing with trips of 30-60 days. They are equipped with refrigeration systems. There are also ice-equipped dhows, but their trips take from 7 to 10 days. Various benthic fish are mostly fished in this region.

The results of a survey showed that out of 232 fishermen, the minimum and maximum ages were 18 and 76 years. From the study and analysis of economic indicators (harvest, income, and employment) and environmental indicators (air pollution, waste, and sea pollution) it was found that 66 percent of Chabahar fishermen, 75 percent of Konarak fishermen, and 80.6 percent of Dashtiari fishermen believe that COVID-19 has affected their harvest rate and also 66.6 percent of Chabahar fishermen,

Table 2) Impact of COVID-19 on economic and environmental variables.

Indicator	Chabahar				Konarak				Dashtiari			
	Frequency		Percentage		Frequency		Percentage		Frequency		Percentage	
	P	N	P	N	P	N	P	N	P	N	P	N
Impact on harvest	60	30	66.6	33.4	60	20	75	25	50	12	80.6	19.4
Impact on employment	56	34	62.2	37.8	65	15	81	19	55	7	88.7	11.3
Impact on income	57	23	66.3	33.7	60	20	75	25	50	12	80.6	19.4
Impact on air pollution	57	33	36.6	63.4	20	60	25	75	18	44	29	71
Impact on waste	65	25	72.2	27.8	45	35	56.2	43.8	45	17	72.5	27.5
Impact on sea pollution	60	30	66.6	34.4	52	28	65	35	55	7	88.7	11.3

P: positive, N: negative

65 percent of Konarak fishermen and 88.7 percent of Dashtiari fishermen stated that COVID-19 and its consequences have affected seawater pollution. Because of the outbreak of COVID-19 disease, there is an increase in protective products such as masks, gloves, and other medical and plastic tools, and releasing them after consumption during fishing activities cause these substances to enter the water (Table 2).

Table 3 summarizes the fishing status, alternative livelihood opportunities, and market connectivity in the three studied communities on the Makran Coast. The regions have an almost similar fishing status. The Chabahar and Konarak regions are in a better status than Dashtiari in livelihood and access to the markets.

According to Table 4, the fishermen expressed in the interviews that they spent less time on fish processing and sales (by almost 50%) on the Makran Coast. All fishermen and fish traders agreed that the amount of fish and byproducts had decreased at the interview time versus the previous year (by 15-30%).

They also stated that due to the lack of market for fish, they were rotten or converted into fish powder for fertilization use in agriculture. According to Table 5, it can be said that the pelagic fishing rate has decreased after the pandemic versus before it to a lesser extent than the benthic fishing rate. Since pelagic fish are caught offshore and in oceans using refrigerated vessels (dhows) and since these vessels are at the sea for 60 days and they are thus not affected by social restrictions, it can be said that COVID-19 and the related restrictions have not had significant impacts on them. So, we focus on benthic fish as most fishermen and vessels work on catching them. Because the background of COVID-19 is very short and the available data is very limited, we have achieved these results through questionnaires and the opinions of experts and fishermen. On the other hand, to reduce the impact of other studies, we have made changes in the same period last year that have the least impact from other factors such as government, and macro variables, which are based on the opinions of regional experts.

Table 3) Number of vessels by region and fishing port.

County	Region/port	Number of vessels				Total
		Ice	Refrigerated	Boat		
				Authorized	Unauthorized	
Chabahar	Haft-Tir	13	64	107	642	826
	Tis	1	0	86	122	209
	Ramin	13	76	135	427	651
Konarak	Konarak	85	155	226	562	1028
	Pozm	93	49	171	279	592
	Tang	52	0	57	107	216
	Zarabad	62	8	22	75	167
	Galak	3	0	65	23	91
Dashtiari	Pasabandar	41	123	107	124	395
	Beris	70	71	284	280	705
	Gwatar	1	3	166	186	356
Total		434	549	1426	2827	5236

Since important variables in the study area that can be most affected by a shock such as COVID-19, in this study, the variables of income, employment, consumption, etc. have been used as the main indicators ^[10].

Also for the environment: due to the use of health and medical supplies such as masks, alcohol, and chemical detergents in the COVID period 19 these cases cause water, air, and waste pollution, so these variables as important indicators in considered.

Findings and Discussion

Like many other countries, the economy and society of Iran have been deeply affected by the COVID-19 outbreak, and the fishery sector is no exception. This section discusses the crises caused by COVID-19 for local fishermen. In general, important indicators in the economy include consumption, income, etc., and in the

field of environment, pollution indicators are important. Therefore, depending on the conditions of the region, these variables are more affected by natural and abnormal shocks (such as COVID-19). Therefore, in this study, these indicators were used.

Economic crises

Catch rate (production)

Figure 2 depicts an estimation of benthic catch for the period pre- and post-COVID-19. As is observed, the catch rate decreased by 16 percent during 2019-2020. Our findings imply a decrease in fishing activities in June 2020. This may be associated with the COVID-19 contract panic because fishing and fish trading usually need close contact with others. Consistent with this assumption, most families reported that they tried to avoid fishing activities in June 2020 due to the fear of COVID-19.

Table 4) A summary of fishing status, alternative livelihood opportunities, and market connectivity of the three studied communities.

	Chabahar	Konarak	Dashtiari
Description	In Chabahar Port, the fishing community is located in Haft-Tir, Tis, and Ramin, and the people there are dependent on fishing activities although they have several alternative jobs since the area is located in a free zone.	There is a fishing community in Konarak, Pozm, Tang, Zarabad, and Galak. The fishermen in this area are dependent on fishing activities and there are several industries and processing factories in this county.	The fishing community is in the Pasabander, Beris, and Gwatar areas. Livelihoods in this area are dependent on fishing activities. Besides fishing, they also engage in ranching, horticulture, and agriculture.
Fishing method	Fishing is done by dhows and boats.	Fishing is done by dhows and boats.	Worker fishing involves the use of a very limited number of small crafts (if any) and little capital and equipment per person on board, which often belongs to the family.
Alternative livelihood	Fishing is supported by other activities such as small businesses and service businesses.	Fishing is supported by other activities such as small businesses and service businesses.	Fishing is supported by other activities such as small businesses and service businesses.
Market connectivity	Local markets are connected to Iran's larger markets and even international markets and rely on local industry workers.	It is connected to the larger market in Chabahar City, Nikshahro County, and the markets outside the province.	Due to the remoteness of this county from the center, local traders buy fish from local markets and sell it to traders in Chabahar City, Konarak, whereby it is distributed to other provinces and big cities.

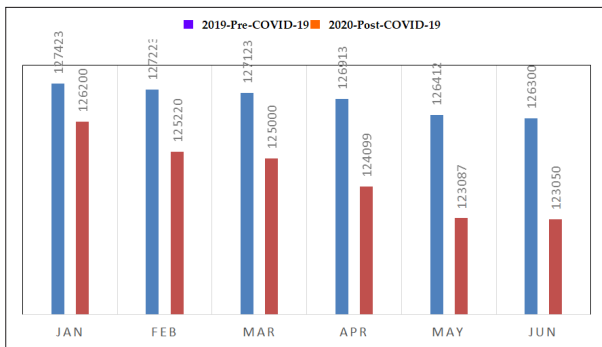


Figure 2) The catch rate of the fishermen during six months.

Income in different fishing regions

Figure 3 displays the income of each vessel in the first six months of 2020 versus the same period in 2019. The COVID-19-related crisis in the income sector for each vessel

is in thousand IRR. As is observed, data on fishermen and data analysis show that the COVID-19 pandemic has had adverse impacts on the income of farmers in the coastal area of Makran since late-February 2020.

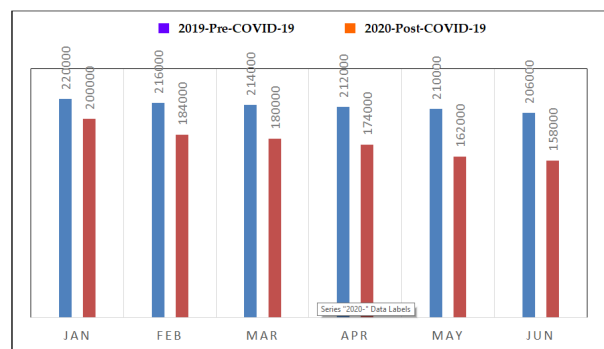


Figure 3) The income trend of the fishermen during six months.

Table 5) A comparison of benthic catches (ton) pre- and post-COVID-19 pandemic.

Species	Pre-pandemic					Post-pandemic
	2015	2016	2017	2018	2019	2020
<i>Trachinotus mookalee</i>	352	367	330	402	793	657
<i>Lethrinus microdon</i>	704	1060	880	943	1425	1033
<i>Saurida tumbil</i>	1416	1463	1445	1463	1847	1041
<i>Pampus argenteus</i>	569	710	402	444	347	96
<i>Parastromateus niger</i>	6465	8325	6341	6583	7189	6001
<i>Chirocentridae</i>	393	633	513	533	686	292
<i>Eleutheronema tetradactylum</i>	604	556	328	302	774	98
<i>Grammoplites suppositus</i>	596	827	651	400	481	139
<i>Aphareus furca</i>	1180	1804	1717	1598	2293	1804
<i>Raja erinacea</i>	3235	3071	3314	6449	5179	2693
<i>Pomadasys stridens</i>	2992	3153	2484	2321	3720	2418
<i>Acanthopagrus latus</i>	1746	1712	1478	1541	2192	1280
<i>Lethrinus crocineus</i>	1089	1532	1356	1301	2179	1574
<i>Otolithes ruber</i>	4187	5069	5410	5596	6464	3155
<i>Argyrosomus hololepidotus</i>	3036	2191	1131	1144	1191	810
<i>Argyrosomus rogae</i>	1032	1177	1571	2178	3152	7630
Total	29522					24810
Coefficient of variations						-16%

Table 6) A comparison of pre-pandemic and post-pandemic catch rates (ton).

Species	Pre-pandemic					Post-pandemic
	2015	2016	2017	2018	2019	2020
<i>Thunnus albacares</i>	34199	36356	49164	52629	49530	38662
<i>Kajikia audax</i>	17417	13010	16941	18723	15914	19009
<i>Thunnus tonggol</i>	28691	30943	30688	34242	22947	26099
<i>Katsuwonus pelamis</i>	35987	36015	47295	44281	39092	42350
Total	127483					126120
Coefficient of variations						-1.1

Employment

Figure 4 shows the employment status of fishermen in the first six months after the COVID-19 outbreak versus a similar period in 2019. As is observed, the more the number of months after the outbreak,

the higher the decrease in labor. It can be said that the low literacy and educational level of people in the studied counties can be implicated in low labor quality in these regions. Undoubtedly, labor plays a significant role in the development of

coastal areas in Makran, so the shortage of skillful and efficient labor in the region during the pandemic can destroy the capacity to achieve growth and development.

The pandemic has influenced employment in terms of both labor supply and demand. Closures and declined economic activity have led to job cuts, reduced demand for labor, and reduced supply of labor because some people have directly contracted the virus and others have reduced their working hours as a self-care measure to reduce their interactions with people. Therefore, Iran has faced a decrease in participation and employment rates in 2020 and 2021. Based on the data for labor and pandemic trends in the fisheries sector, it was found that the employment rate has decreased while the unemployment rate has increased in the autumn and winter of 2020-2021 versus the similar period in the last year. In 2018-2019, pre-COVID-19 outbreak, in addition to 2400 vessels sailing in Chabahar and 1399 vessels in Konarak, the Fishery Organization of Sistan and Baluchistan Province issued fishing licenses for 250 new boats and 16 new dhows, which significantly contributed to people's employment. But, following the outbreak of COVID-19 in February 2020, a decline happened in their activity, which reduced the employment of fishermen on this coast.

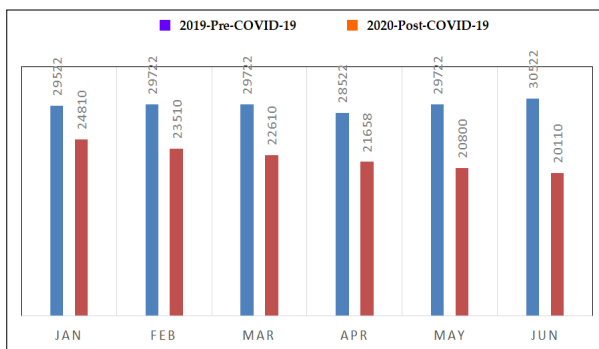


Figure 4) The employment rate of the fishermen during the six months pre- and post-COVID-19 pandemic.

Environmental crises

Like the economic sector, the environment has been influenced by the COVID-19 crisis both positively and negatively. A challenge was that people had to stay at home for a prolonged time, which resulted in the increased consumption of water, power, domestic fuel (e.g., gas), food, health products, and even medications. However, due to restrictions on commuting inside the cities, between the cities, and between the provinces, fuel was saved to a greater extent. The next sections discuss these impacts in the three areas of sea pollution, waste, and air pollution.

Water (sea) pollution

Sea pollution is the direct or indirect entry of any substance or energy into the marine environment that leads to reduced production and also reduces the growth and development of living things and has adverse effects on aquatic and human health. The corona pandemic and its limitations have caused fishermen to use more plastic equipment, masks, detergents, etc., and fishermen who go to sea to catch fish, leave this equipment in the sea, which causes increased sea and beach pollution. Figure 5 displays the results as to the mean concentrations of heavy metals. It is observed that all studied metals have high concentrations. The chromium and nickel contents are much higher than their natural levels in the seawater, which is related to the geological features of the study site (Anonymous, 2021).

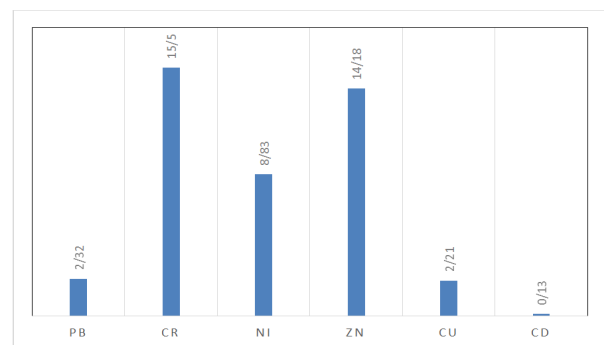


Figure 5) The average concentrations of heavy metals in water samples from the northern shores of the Makran Sea.

The results of the concentrations of heavy metals in the air are shown in Figure 6. The concentrations of all studied metals have been ascending in different sampling stations on the northern shores of the Makran Sea since February 2020.

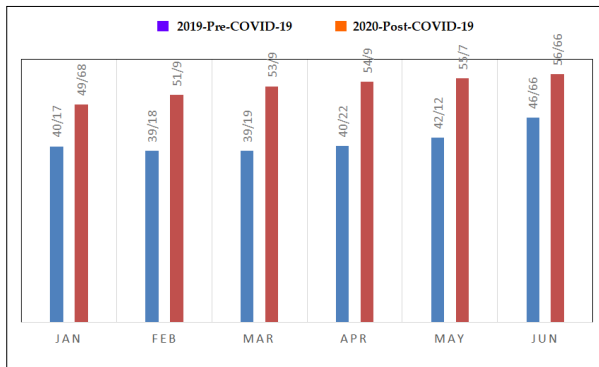


Figure 6) The variation trends of the concentrations of heavy metals in water samples of the northern coast of the Makran Sea in different months.

The investigation of the concentrations of heavy metals in the water samples from the northern shores of the Makran Sea shows that metals in the normal state have lower concentrations than the global standards. With the breakout of COVID-19, increases occurred in the concentrations of heavy metals among different stations by the discharge of heavy metals due to the presence of pollution sources related to the disposal of hospital waste, repairmen, lubricant replacement, and painting of dhows and commercial and fishing boats, the disposal of human garbage and waste in coastal areas, and the aggregation of commercial and fishery activities in the Chabahr, Konarak, and Dashtiari stations. These heavy metals have been taken up by various algae species.

Waste

According to Figure 7, the extensive use of personal protection equipment and the improper disposal of disposable products, as well as the high volume of the use of detergents and environmentally-pollutant chemicals, have

changed the primary sources of the pollution of sea beds during the COVID-19 pandemic, resulting in a potential increase in plastic pollution. During this pandemic, personal protection equipment, and disposable products have been used to a greater extent, which has, in turn, become a source of plastic pollution. The inappropriate methods of waste management and the improper disposal of personal protection equipment and other plastics have had irreparable consequences for biodiversity at sea. One problem is the increased consumption of water and detergents whose excessive use has increased sewage.

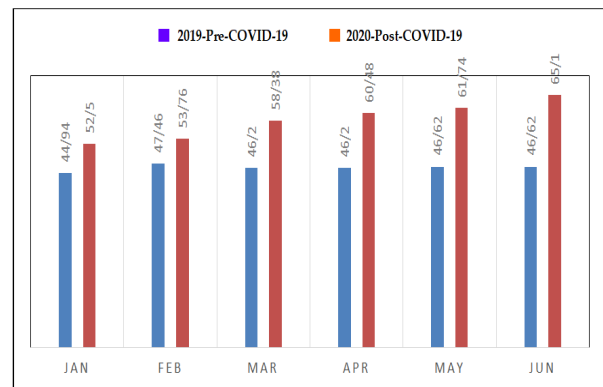


Figure 7) The trend of the average per capita waste of the fishing households.

Air pollution

One of the measures taken by governments to eliminate or reduce the effects of COVID-19 is to create restrictions and increase the distance between people, which has led to a reduction in fisheries activities, car traffic, human activities, etc., including Tangible positive environmental effects, reduction of air pollution (through reduction of vessel pollutants such as particulate matter with a diameter of 2.5 and 10 microns, Nitrogen Oxides, CO₂), reduction of greenhouse gas emissions, reduction of the river and sea pollution, reduction of noise pollution, reduction of consumption Fossil fuels and negative effects such as increasing concentrations of O₃, SO₂, increasing pollution of water resources through the pen-

etration of disinfectants, increasing the volume of hospital waste and household waste can be mentioned (Figure 8).

In general, the positive effects of the coronavirus on the environment appear to be temporary and short-lived, with little compared to the long-term consequences. Therefore, by overcoming the corona, we must focus on rebuilding a healthy society and economy, and by fully recognizing the opportunities and threats of this virus, we must consciously train environmental behaviors.

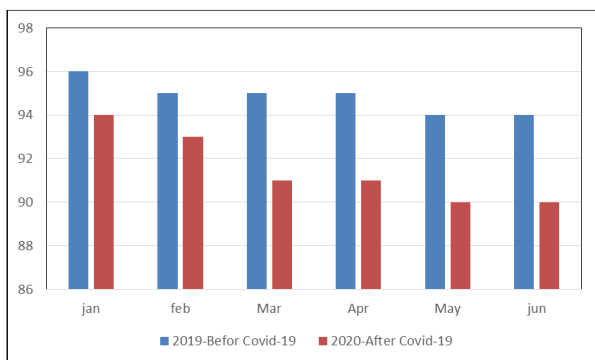


Figure 8) The variation trends of the concentrations of PM2.5 particles.

Conclusion

Based on a field study and data collected from regional Fishery and Environment Organization, the paper addressed the current state of the COVID-19 pandemic and its effects on the economy (including income and subsequently profit, employment, unemployment, and production) and environment (including seawater, waste, and sewage). The comparison of the present conditions with normal conditions (before the pandemic) in the economic sector revealed the descending trends of income and production (catch rate). In addition, employment decreased and unemployment increased in the winter and spring of 2020 versus the same months in the previous year. Regarding the environment, COVID-19 and the resulting restrictions increased the

pollution of seawater and waste (sewage) versus similar months before the pandemic. These changes, which were increased after the culmination of the pandemic, have had irreparable implications for the fisheries sector. However, it can generally be said that COVID-19 has had adverse effects on people's livelihoods and the environment. Its effects have been much graver in the economic sector than in the environmental sector. Therefore, the government is recommended to support the management of supply and demand markets and devise supportive plans for fishermen. Given the persistent outbreak of new COVID-19 strains such as alpha, beta, gamma, delta, and omicron, it is necessary to conduct long-term studies to determine the full range of this pandemic. According to our observations, imperative measures must be taken to prevent fisheries collapse in the area. Also To support vulnerable fishing communities, like those engaged in fishing and fish processing, the government of Iran should provide direct financial aid (e.g., providing cash aids in Chabahar, Konarak, and Dashtiari), food, and tax exemptions.

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Ethical Permissions

Data and information in this research did not require any ethical permission.

Conflicts of Interests

None declared by Authors.

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