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Socio-economic impact of cyclone Ockhi on fishers along the Kerala and Tamil Nadu coasts, India

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Original Article

Abstract

The tropical cyclone Ockhi which hit the Kerala and Tamil Nadu coasts of the Indian subcontinent in December 2017, was an unusual cyclone, with its rapid intensification and unpredictable path. An analysis of the impact of Ockhi on the losses in man-days, catch, and revenue indicated that in Kerala and Tamil Nadu, the estimated revenue losses due to the loss in fishing days were \$15.17 and 1.85 million, respectively. The mechanized sector had the highest revenue loss while the number of man-days lost was highest in the motorized sector. In Kerala, 3,21,495 man-days of fishers directly engaged in marine fishing activities were lost, while in Tamil Nadu, it was 1,06,250. The vulnerability of the fishermen community, as indicated by the reduction in the catch, loss in fishing infrastructure, and lives of 449 fishermen, clearly demands the need to increase the adaptive capacity of fishers by more robust early warning systems and by making satellite vessel tracking systems mandatory for fishing crafts.

Keywords*: Ockhi, economic loss, fishing community, tropical cyclones, loss in man-days, fishery*

Introduction

Climate change is considered to be one of the most prominent challenges of the present century, with a warming planet being a present-day reality rather than a potential future threat. Climate change impacts on the ocean have already affected the fisheries sector (FAO, 2018). Moreover, an increase in frequency and intensity of extreme climatic events are also reported across the globe (IPCC, 2012). Rising sea levels and stronger cyclones/hurricanes amplify the risk of flooding along the coasts (Woodruff *et al*., 2013), while heavy rainfall causes more impact in inland areas. As per World Meteorological Organization, 8835 natural disasters were reported globally during the period 1970 to 2012, and these have led to a loss of 1.94 million lives and caused economic damage of US\$ 2.4 trillion (WMO, 2014). Though extreme events were reported globally, the impact and economic loss vary from place to place. The International Monetary Fund (IMF) has found that small developing states were disproportionally affected by natural disasters, with the annual cost being much greater than in the larger countries (Cabezon *et al*., 2015). Whereas, increasing extreme climatic events will cause disruptions to fishing activities and affect the safety and efficiency of fishing operations in the sea (Vivekanandan and Jeyabaskaran, 2010; Weatherdon *et al*., 2016).

In India, the fisheries sector contributes around 1 per cent of national gross domestic product (GDP) and 5.23 per cent to agriculture GDP (Press Information Bureau, 2019). The census conducted by Central Marine Fisheries Research Institute (CMFRI) in 2010 indicated that there were about 4.0 million marine fishers along the coastline of India, indicating an increase of 14 per cent over the previous half a decade (Rao *et al.*, 2016). In India, natural disasters like cyclones and floods are known to affect the fishing community for the past several decades (Shanmugavelu *et al.*, 1979; Rao and Datta, 1982; Ellithathayya *et al.,* 1997; Shiledar *et al.,* 2013). The main devastation of extreme events in coastal areas is the damage and destruction of fishing and transport boats, engines, and the fishing gears. These also destroy common facilities like harbours and infrastructure for post-harvest processing (FAO, 2018). In addition to the craft and gear damages, fishing days are reduced owing to bad weather conditions in the sea (Toulmin, 2009; Deepananda, 2013) during cyclones. Early warnings for severe weather conditions have significantly decreased the fishing days in the Bay of Bengal (Macfadyen and Allison, 2009). An earlier analysis of destruction caused had been recorded during the cyclone which hit Andhra Pradesh in the 1970s (Venkataraman and Algaraja, 1980) and along with Gujarat in 1998 (Makadia *et al.*, 1998). Later, economic losses due to cyclone Vardah had studied by Geetha *et al.* (2016).

In this paper, the socio-economic impact of cyclone Ockhi was studied. Cyclone Ockhi was the 2nd most intense cyclonic storm in the Arabian Sea after the cyclone Megh in 2015 (Science Daily, 2017). Cyclone Ockhi originated as a low-pressure area on 28th November 2017 in the south-west Bay of Bengal. Ockhi became a very severe cyclonic storm (VSCS) over the Lakshadweep islands, where it curved and moved in a north-easterly direction and dissipated into a depression along the Gujarat coast on 6th December 2017 (Fig.1). The

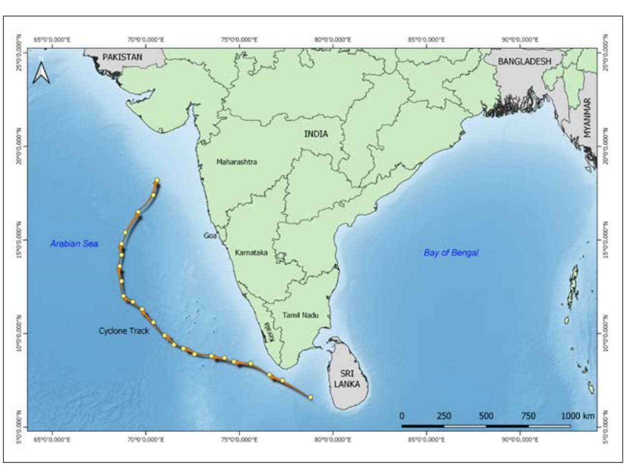

Fig. 1. The track of cyclone Ockhi-2017

cyclonic storm Ockhi reported a maximum wind speed of 185 Km/hr, and the lowest pressure recorded was 975hPa (RSMC preliminary report, 2017). India, Sri Lanka, and Lakshadweep coasts were severely affected by the cyclone, and it led to the death and disappearance of 400 fishermen from Southern states, particularly from Kerala and Tamil Nadu states (FAO and ICSF, 2019). Kerala and the southern Tamil Nadu districts such as Kanyakumari and Tuticorin were not frequently prone to cyclones as other states along the east coast of India. The sudden outburst of Ockhi during December 2017 along the southwest coast was totally unexpected. So, the coastal communities could not but refrain from fishing for several days. In this paper, a detailed analysis of how Ockhi affected the fishery and the livelihood of fishers has been done.

Material and methods

The accurate estimation of profit is an important aspect to assess the financial success of fishing activity. The financial term 'profit' can be defined in many ways based on the modes of fishing. In the present context, the term 'Net profit' is used to represent the income gained in United States dollar (USD) ($1 = INR (₹) 70.5) after deducting all expenditures incurred in the fishing activity. Operating cost per trip included the cost of fuel, crew wages, food expenses, auction charges, repair and maintenance, and other day-to-day expenditure for fishing (Geetha *et al.*, 2014). Gross revenue and Net profit were calculated using the given formula.

Gross Revenue = Quantum of Selling X Market Prize………… (1)
Net Profit = Gross Revenue – Operating Cost………… (2)

The socio-economic impact of Ockhi in Kerala and Tamil Nadu coasts (Fig.2) was assessed by working out the loss in man-days, catch, and revenue through tabular analysis. The data of operating cost, gross revenue, and net profit were collected from scientific project reports in the annual report of CMFRI, Kochi (CMFRI, 2014; CMFRI, 2017). The crew size and fishery data were collected from National Marine Fishery Data Centre (NMFDC) of CMFRI.

During the days of a cyclone, the majority of the fishermen could not go for fishing and allied activities mainly due to the bad weather conditions over sea. The loss in fishing days led to a reduction in marine fish landings, which in turn resulted in revenue loss to fishermen (Johnson and Narayanakumar, 2016). Besides this, craft and gear damages are common in cyclonic events. With this backdrop, the loss in revenue, man-days, and catch was estimated based on the data on fishery catch, effort, gross revenue, and crew size. For the analysis, selected gears were multiday trawl net (MDTN), mechanized trawl net (MTN), mechanized gill net (MGN),

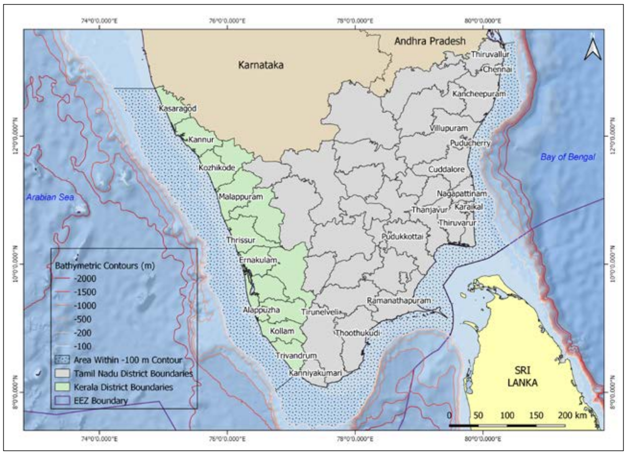

Fig. 2. Map showing the Kerala and Tamil Nadu coast with bathymetric contours

mechanized ring seine (MRS), outboard gill net (OBGN), outboard hook and line (OBHL), outboard ring seine (OBRS), outboard trawl net (OBTN) and non-motorized crafts (NM). The catch loss was estimated by multiplying the average catch and loss in fishing days. The economic loss was calculated by estimating the number of losses in fishing days and gross revenue per trip. Man days lost for fishers directly engaged in fishing activity was the product of crew size and loss in fishing days. To find the socio-economic impact of Ockhi, selected districts were Thiruvananthapuram, Kollam, Alappuzha, Ernakulam, Thrissur, Malappuram, Kozhikode and Kannur in Kerala and Kanyakumari and Tuticorin in Tamil Nadu state (Fig. 2). Finally, the estimated economic losses were mapped using the QGIS software to assess the variation of impacts on fishers.

Results and Discussion

Economic Impact of Ockhi along the Kerala and Tamil Nadu Coasts

In Kerala, the marine fisheries sector is very vibrant and provides employment for a total fisher population of 6,10,165 (CMFRI, 2011). The number of fishermen was found to vary in the nine coastal districts, with the highest in Thiruvananthapuram (1,46,326) (CMFRI, 2011). In the present study, the loss in catch, man-days, and revenue in the coastal districts of Kerala and Tamil Nadu were estimated from the loss in fishing days during Ockhi. The number of days when fishing was not conducted (loss in fishing days) due to Ockhi, bad weather conditions, and other aspects related to this cyclone were higher in Thiruvananthapuram (20 days). In other districts, it varied between seven to ten days in December 2017 (Table 2). The districts affected by cyclone Ockhi were Thiruvananthapuram, Kollam, Alappuzha, Ernakulam, Thrissur, Malappuram, Kozhikode, and Kannur. No losses in fishing days were reported in the Kasargod district.

The number of crew or fishers in a fishing craft varied depending on the type of craft. The average crew size was maximum (43 fishers) in MRS and lowest (3 fishers) in traditional crafts like NM crafts. In Thiruvananthapuram and Alappuzha districts, motorized crafts were dominant. At the same time, mechanized crafts were predominant in the Ernakulam, Kollam, and Kozhikode districts. In general, an estimated 3,21,495 man-days of fishers directly engaged in marine fishing activity were lost in Kerala due to cyclone Ockhi, and the maximum loss (30.5%; 97,871 man-days) was in Thiruvananthapuram district followed by Kollam (15%; 48,330 man-days). Sector-wise highest loss 1,62,634 (50.6%) was in the motorized sector, followed by mechanized sector, 1,39,309 (43.3%) and the least 19,552 (6.1%) in the non-motorized sector (Table 3).

The economic analysis indicated that, in Kerala, MGN sector had greater gross revenue ($2786) and net operating income

Table 2. The total loss in fishing days in Kerala and Tamil Nadu states during cyclone Ockhi-2017

District	State	loss in fishing days
Kanyakumari	Tamil Nadu	20
Thirunelveli	Tamil Nadu	14
Thiruvananthapuram	Kerala	20
Kollam	Kerala	10
Alappuzha	Kerala	7
Thrissur	Kerala	7
Malappuram	Kerala	7
Kozhikode	Kerala	7
Kannur	Kerala	7

Table 1. The average operating cost, gross revenue and net operating income for the different gears in Kerala during the period 2014-17

		Mechanized sector			Motorized sector				Traditional
	INDICATORS	MDTN	MGN	MRS	OBRS	OBGN	OBHL	OBTN	NM
1.	Average operating cost (in $)	1113	1522	551	610	63.6	82.2	44.1	7.1
2.	Average gross revenue (in $)	1765	2786	1758	1095	118	90.6	66.4	14.3
3.	Average net operating income (in $)	652	1264	1207	485	54.4	8.4	22.3	7.2

MDTN: Multiday trawl net, MGN: Mechanized gill net, MRS: Mechanized ring seines, OBRS: Outboard ring seines, OBGN: Outboard gill net, OBHL: Outboard hook and line, OBTN: Outboard trawl net, NM: Non-motorized crafts

Table 3. Sector-wise and district-wise estimated loss in man-days due to cyclone Ockhi in Kerala

	Mechanized Sector			Motorized Sector				Traditional	Total loss	
District	MDTN	MGN	MRS	OBRS	OBGN	OBHL	OBTN	NM	Man-days	Percentage
Thiruvananthapuram	-	-	6431	3900	58300	23100	-	6240	97971	30.5
Kollam	15611	-	19707	4255	5205	1301	-	2251	48330	15.0
Ernakulam	8877	650	7008	5676	1916	762	114	380	25383	7.9
Alappuzha	-	-	-	14203	7719	694	216	9503	32335	10.1
Thrissur	4055	-	6936	6589	4823	4510	2488	1178	30579	9.5
Malappuram	2510	-	20570	184	3835	-	167	-	27266	8.5
Kozhikode	10123	-	17175	753	6233	790	431	-	35505	11.0
Kannur	3713	73	15870	439	3600	112	319	-	24126	7.5
Total	44889	723	93697	35999	91631	31269	3735	19552	321495	100
Percentage	13.96	0.22	29.14	11.20	28.50	9.73	1.16	6.08	100.00	
Sector wise total Man-days	139309			162634				19552		
Sector wise percentage	43.3			50.6				6.1		

MDTN: Multiday trawl net, MGN: Mechanized gill net, MRS: Mechanized ring seines, OBRS: Outboard ring seines, OBGN: Outboard gill net, OBHL: Outboard hook and line, OBTN: Outboard trawl net, NM: Non-motorized crafts

Table 4. Sector-wise and district-wise loss in catch per trip due to cyclone Ockhi in Kerala

	Mechanized Sector				Motorized Sector			Traditional	Total loss in catch	
District	MDTN	MGN	MRS	OBRS	OBGN	OBHL	OBTN	NM	Tonnes	Percentage
Thiruvananthapuram	-	-	12.69	20	1.97	1.65	-	0.88	37.19	14.5
Kollam	12.54	-	10.17	12.63	1.95	0.90	-	0.14	38.32	14.9
Ernakulam	15.73	23.02	14.02	2.84	1.32	0.35	0.20	0.06	57.54	22.4
Alappuzha	-	-	-	7.91	1.52	1.0	0.31	0.27	11	4.3
Thrissur	2.45	-	13.25	2.51	1.84	0.08	0.35	0.12	20.6	8
Malappuram	7.68	-	10.89	24.98	1.18	-	0.35	-	45.08	17.5
Kozhikode	15.03	-	9.21	2.01	0.88	0.54	0.24	-	27.9	10.8
Kannur	3.18	8.78	3.63	3.63	0.36	0.03	0.07	-	19.67	7.6
Total	56.61	31.8	73.86	76.51	11.02	4.55	1.52	1.47	257.3	100
Percentage	22	12.4	28.7	29.7	4.3	1.8	0.59	0.57	100	
Sector wise total catch loss per trip	162.27				93.6			1.47		
Sector wise percentage	63.1				36.4			0.57		

MDTN: Multiday trawl net, MGN: Mechanized gill net, MRS: Mechanized ring seines, OBRS: Outboard ring seines, OBGN: Outboard gill net, OBHL: Outboard hook and line, OBTN: Outboard trawl net, NM: Non-motorized crafts

Table 5. Sector-wise and district-wise estimated loss in revenue (in millions) due to cyclone Ockhi in Kerala

	Mechanized sector				Motorized sector			Traditional	Total loss	
District	MDTN	MGN	MRS	OBRS	OBGN	OBHL	OBTN	NM	in millions	Percentage
Thiruvananthapuram	-	-	0.26	0.29	1.37	0.42	-	0.03	2.37	15.6
Kollam	1.97	-	0.81	0.31	0.12	0.024	-	0.01	3.24	21.4
Ernakulam	1.12	0.13	0.29	0.42	0.05	0.014	0.001	0.001	2.03	13.4
Alappuzha	-	-	-	1.04	0.18	0.013	0.003	0.05	1.29	8.5
Thrissur	0.51	-	0.28	0.48	0.11	0.08	0.032	0.006	1.5	10.0
Malappuram	0.32	-	0.84	0.014	0.09	-	0.003	-	1.27	8.5
Kozhikode	1.28	-	0.7	0.06	0.15	0.014	0.006	-	2.21	14.6
Kannur	0.47	0.014	0.65	0.032	0.09	0.001	0.004	-	1.26	8.3
Total loss in revenue (in millions)	5.67	0.14	3.83	2.65	2.16	0.57	0.05	0.097	15.17	
Percentage	37.4	1.0	25.3	17.5	14.2	3.8	0.3	0.7		
Sector wise total	9.64				5.43			0.097		
Sector wise %	63.6				35.8			0.6		

MDTN: Multiday trawl net, MGN: Mechanized gill net, MRS: Mechanized ring seines, OBRS: Outboard ring seines, OBGN: Outboard gill net, OBHL: Outboard hook and line, OBTN: Outboard trawl net, NM: Non-motorized crafts

($1264) per trip. Operating cost was high for MGN, nearly $1522 per trip. Traditional crafts like NM ones had the least gross revenue and net profit (Table 1). The total catch loss in Kerala due to loss in fishing days during cyclone Ockhi was estimated to be 257.3 tonnes per trip. Among coastal districts, reduction in catch due to loss in fishing days was higher at Ernakulam (57.54 tonnes) and Malappuram (45.08 tonnes) districts. The highest catch loss estimated in the MRS (28.7%) and OBRS gears (29.7%) (Table 4). In Kerala, the total economic loss due to loss in fishing days was estimated to be $15.17 million, which was in addition to the physical damage caused by cyclone Ockhi to fishing crafts and gears (Table 5). Based on the total economic loss, Kollam ($3.24 million), Thiruvananthapuram ($2.37 million), and Kozhikode ($2.21 million) districts were found to be more affected by Ockhi, and comparatively less economic loss was at Kannur ($1.26 million), Malappuram ($1.27 million) and Alappuzha ($1.29 million) districts. Among the different gears, MDTN had the highest revenue loss ($5.67 million; 37.4%), followed by MRS ($3.83 million; 25.3%). In sector-wise, the mechanized sector had the highest revenue loss, $9.64 million (63.6%), followed by motorized sector, $5.43 million (35.7%), and the least $0.097 million (0.6%) by the traditional non-motorized sector. The gear-wise and district-wise economic loss are presented in Table 5 and Fig. 3, and Fig. 4.

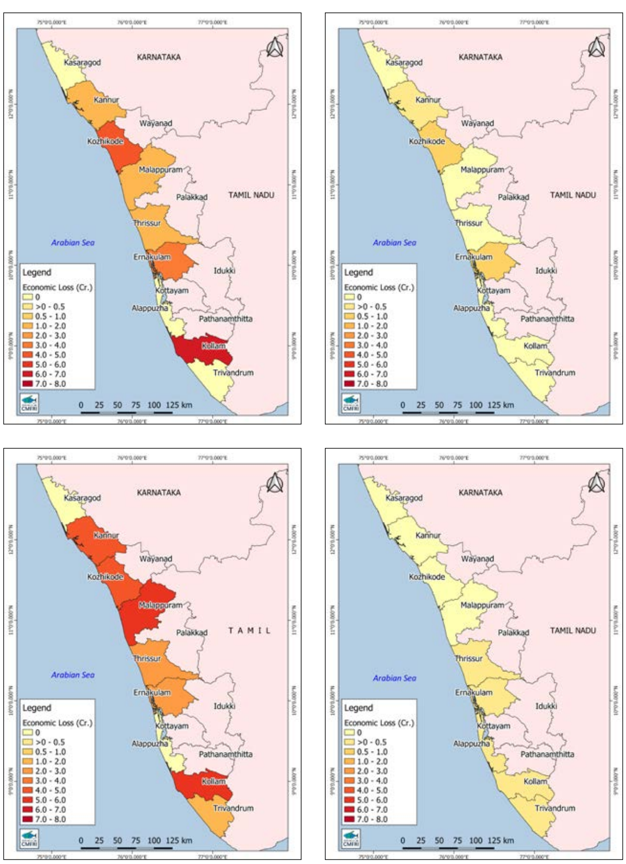

Fig. 3. Economic loss due to cyclone Ockhi along the Kerala coast in mechanized and traditional fishery sectors a) MDTN b)MGN c)MRS d)NM

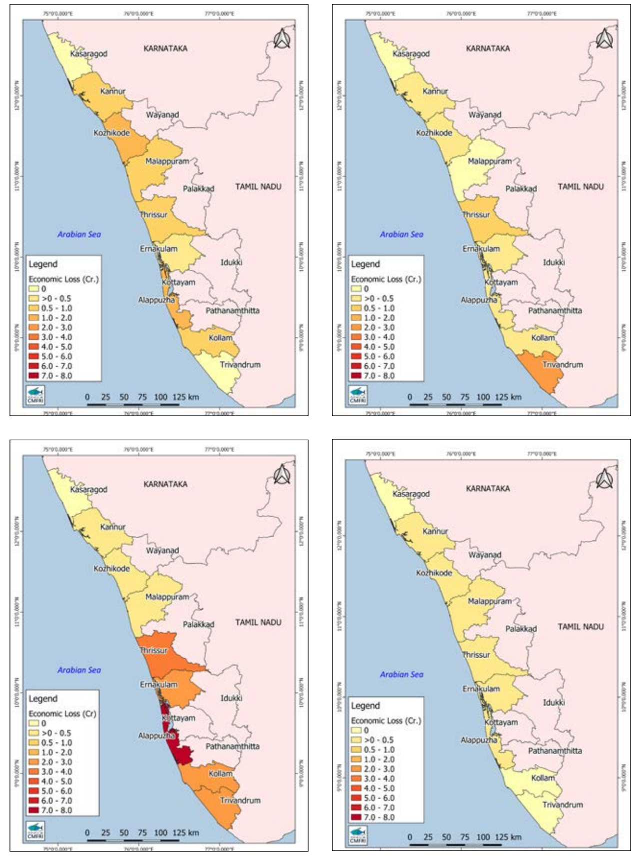

Fig. 4. Economic loss due to cyclone Ockhi along the Kerala coast in motorized fishery sector a) OBGN b)OBHL c)OBRS d)OBTN

In Tamil Nadu, the total number of fishermen families have been reported as 2,01,855 with a population of 7,95,708 (CMFRI, 2011). Ramanathapuram district has about 23.7per cent of the total fisher population. The fisherfolk population was comparatively less in the Villupuram and Thiruvarur coastal districts (CMFRI, 2011). The entire Tamil Nadu coast is divided into Coromondel, Palk Bay, and Gulf of Mannar regions based on their difference in the ecosystem, fishing ground, and fishing pattern (Sathianandan *et al*., 2012). Coromondel coast is more populated with 37 per cent of fishermen families. The various districts in Coromondel coast are Thiruvallur, Chennai, Kancheepuram, Villupuram, Cuddalore, and Nagapattinam, while in Palk Bay region, there are four districts *viz*. Thiruvarur, Thanjavur, Pudukottai and Ramanathapuram. The cyclone Ockhi affected districts in Tamil Nadu are Tuticorin, Thirunelveli, and Kanyakumari, which lie along the Gulf of Mannar coast. The operating cost, gross revenue, and net operating income for the different gears are presented in Table 6. From the given gears, MDTN had greater gross revenue ($1753) and net operating income ($550) per trip (Table 6).

Table 6. The average operating cost, gross revenue and net operating income for the different gears in Tamil Nadu

		Mechanized Sector	Motorized Sector	
	Indicators	MDTN	OBGN	OBHL
1.	Average operating cost (in $)	1203	19	25
2.	Average gross revenue (in $)	1753	34	41
3.	Average net operating income (in $)	550	15	16

MDTN: Multiday trawl net, OBGN: Outboard gill net, OBHL: Outboard hook and line

The loss in fishing days in Kanyakumari and Thirunelveli districts was 20 and 14 days, respectively (Table 1). There was no loss in fishing days at Tuticorin district. The loss in man-days is estimated as 1,06,250 (Table 7). The highest man-days lost was for the OBGN gear of Kanyakumari (75,515 man-days, 71%), followed by OBHL of the same district (13,095 man-days, 12.3%). The total catch loss in Tamil Nadu during cyclone Ockhi was estimated to be 174.57 tonnes per trip. Reduction in catch due to loss in fishing days was higher in MDTN craft in Kanyakumari (172.24 tonnes). In Tamil Nadu, the total economic loss due to loss in fishing days was estimated to be $1.85 million (Table 7). With a loss of $1.3 million (70 per cent of the total loss), the MDTN sector of Kanyakumari was the worst affected by not being able to fish during cyclone Ockhi. The estimated economic loss was comparatively less in the Thirunelveli district ($0.04 million, 2.2%). When compared to other districts, the total loss in catch and revenue was greater in the Kanyakumari district. Based on the economic loss, Kanyakumari district ($1.81 million) was the most affected district in Tamil Nadu by cyclone Ockhi (Table 7).

Unexpected natural disasters like the tropical cyclone Ockhi affected the fishers directly by destroying the fishing craft, gear, their dwellings, and also many losses in lives, leaving a more lasting impact on the fisher community (Rajya Sabha report, 2018). The loss in revenue due to the reduction in fishing days was high in Kerala. In Kerala, several fishers had lost/damaged their craft and gear, and 216 fishers lost their life (Rajya Sabha Report, 2018). Similar impacts have been observed in several nations. In December 2012, due to the tropical cyclone, Evan nearly 1700 houses in Samoa were destroyed, and more than 8000 people were affected. The artisanal fisheries sector was the worst affected, and about 27 per cent of the canoes owned by the fishers were damaged, and 50 per cent of the fishing gear was also destroyed, which affected their livelihood for nearly six months (FAO, 2018). Similarly, due to Typhoon Haiyan in 2013, in the Philippines, over one million fishermen and farmers were affected, and most of them needed assistance to restore their livelihoods, and the recovery from the impact was difficult (FAO, 2018).

In Kerala and Tamil Nadu, the overall estimated economic loss due to loss in fishing days during the Ockhi was $17.02 million (Table 5&7). Two districts Kanyakumari and Thiruvananthapuram were affected badly by the cyclone Ockhi and the recovery of fisheries was slow since several fishers had lost/damaged their craft and gear. Additionally, the loss of their other physical assets and human lives have also reduced the pace of recovery, similar to the cyclone impact on fishers of Fiji (Radway *et al.*, 2006), Bangladesh (Paul, 2014), and most small island nations

Table 7. Details of economic parameters and loss in revenue, catch and man days for important marine craft–gear combination in the cyclone Ockhi affected districts of Tamil Nadu

		Mechanized sector	Motorized sector		
	INDICATORS	KANYAKUMARI	KANYAKUMARI		THIRUNELVELI
Sl. No		MDTN	OBGN	OBHL	OBGN
1	No. of Crafts	36	539	131	92
2	Average Catch (in Kg)	8612	39	43	48
3	Crew size	12	7	5	7
4	Loss in fishing days	20	20	20	14
5	Loss in catch per trip (in tonnes)	172.24	0.79	0.86	0.68
6	Loss in revenue per Boat	35049	677	818	480
7	Total loss in revenue (in millions)	1.3	0.4	0.11	0.04
8	Percentage Gear wise loss in revenue	70.3	21.6	6.0	2.2
9	Total loss in mandays	8594	75515	13095	9046
10	Percentage mandays lost	8.1	71.1	12.3	8.5

MDTN: Multiday trawlnet, OBGN: Outboard gillnet, OBHL: Outboard hook and line

(Westlund *et al*., 2007). Total economic loss due to cyclone Vardah was $4.6 million in Tamil Nadu (Geetha *et al*., 2016), while the estimated revenue loss due to cyclone Ockhi in Kerala and Tamil Nadu was much higher. It indicates that the impact was much higher when compared to cyclone Vardah which struck the Tamil Nadu coast in December 2016.

In total, the estimated loss in man-days in Kerala and Tamil Nadu was 4,27,745, and the overall catch loss was 431.87 tonnes per trip. The loss in revenue and catch during the cyclone Ockhi were very high in the mechanized sector (Table 3, 4 & 7). After cyclone Ockhi, the Central Government provided financial assistance of $21.7 million and $79.9 million to the State Governments of Kerala and Tamil Nadu (Rajya Sabha Report, 2018). The Government of Kerala provided one-time assistance of $28.37 per person to all active fishers who couldn't venture into the sea for two weeks. In Tamil Nadu, an amount of $35.46 per family was sanctioned to provide livelihood assistance to all fisher families in the affected districts. The Government sanctioned an amount of $70.92 to the fisher families of the Kanyakumari district affected by Ockhi. In addition, the lean fishing season special allowance of $70.92 per person was provided (Rajya Sabha Report, 2018). As per the study, the compensation offered by governments was not sufficient.

The human causalities were also higher in the Ockhi affected districts. One important factor which affected the fisheries sector was the lack of preparedness of the fishing communities. Kerala state and southern part of Tamil Nadu along the west coast were usually less prone to tropical cyclones. The sudden changes in the cyclone path and the lack of facilities for communication to the fishers who are out in the sea have increased the risk to cyclones. Similarly, the lack of vessel tracking systems in the fishing boats hampered the rescue operations leading to higher casualties, and this affected the recovery of the fisheries sector from the impacts of the Ockhi cyclone (FAO and ICSF, 2019; Punya, 2019).

Among the cyclone-affected districts, economic loss was much higher in Kollam and Thiruvananthapuram districts in Kerala and in Tamil Nadu; Kanyakumari was the most affected district by cyclone Ockhi. Overall, the estimated economic loss was high in all affected coasts. So, from the present study, it was evident that extreme climatic events such as tropical cyclones had a greater impact on the marine fisheries sector. As per FAO (2015), tsunamis and storms like hurricanes and cyclones affect the fisheries sector mostly. Among the 78 disasters reviewed in FAO (2015), which created the most economic impact in Asia for the fisheries sub-sector was the 2004 tsunami, which affected India and Indonesia, causing over USD 500 million in damage and losses to the sub-sector in each country. Though the Ockhi cyclone lasted for a short period, there was a reduction in catch affecting the fisheries production. As per FAO (2015), one of the impacts of natural disasters on the fisheries sector is the decline in output. It was estimated that, due to the tropical cyclone Winston, which hit Fiji in February 2016, the damage and loss to the fisheries sector were USD 100 million, which corresponded to about 2.3 per cent of Fiji's GDP in 2015 (FAO, 2018). The frequency and intensity of cyclones are increasing owing to global warming. Also, there is a dramatic increase in exposure and vulnerability to disasters such as cyclones (Mendelsohn *et al*., 2012). The climate model projection studies revealed that the frequency of extremely severe cyclonic storms in the Arabian Sea would increase in the future (Murakami *et al*., 2017). Also, the future projections of extreme weather losses indicate an increase in losses and damages, which is completely unavoidable (Bouwer, 2019). Suitable policy interventions may help the fishing community to safeguard against and to revive from the impact of extreme events. Furthermore, fish farming integrated with agriculture and livestock production will help to get some additional income for the fishing communities, and it buffers the impacts of climatic vagaries. Whereas allied activities will nullify the income losses resulting from the loss in fishing days during extreme weather events. Micro-insurance is not generally available in the fisheries and aquaculture sectors. Access to weather-linked micro-insurance might help fishers to maintain financial resilience to external shocks. Also, it provides an opportunity to spread and transfer risk (Macfadyen and Allison, 2009).

The impact of the natural disaster on the fishing community, as indicated by the reduction in the catch, loss in fishing infrastructure and lives clearly demands the need to increase the adaptive capacity of fishers to such extreme events. Also, the preparedness for such extreme events can reduce the impact and increase the resilience of fishers. It is also recommended that improved infrastructure which can withstand the impacts of floods and cyclones need to be developed in coastal areas to increase the resilience capacity of fishers. Likewise, diversification and fostering of alternative livelihood activities can reduce the income losses during such extreme events. The study points out that there is a need to effectively implement early warning and vessel tracking systems to increase the preparedness of fishers for such unexpected extreme events. Indian space research organization (ISRO) has developed an Indian regional navigation satellite system (IRNSS) or NavIC that helps to locate fishing boats/vessels in the sea. So, the government should ensure the use of both satellite-based Automatic identification systems (AIS) and NavIC systems on fishing vessels that ensure safety and reduce the vulnerability to disasters. Also, the use of better and more seaworthy fishing vessels can reduce the risk of offshore accidents. It is advised that the fishery department should have a register that contains accurate information on boats and the number of fishermen leaving for fishing from a landing centre. It is recommended that the government should ensure the compulsory use of sea safety equipment such as lifesaving apparatus (LSA) in all fishing vessels being operated along the Indian coast.

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