Food and Agriculture Organization of the United Nations

International Collective in Support of Fishworkers

Cyclone Ockhi

Disaster risk management and sea safety in the Indian marine fisheries sector

Cover photograph: Fish landing centre, Poonthura, Kerala, India.

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Disaster risk management and sea safety in the Indian marine fisheries sector

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ABBREVIATIONS

ACWC	Area Cyclone Warning Centre
CBDM	Community Based Disaster Management
CDMA	Code Division Multiple Access
CDRRP	Cyclone Disaster Risk Reduction Project
CS	Cyclonic Storm
CWC	Cyclone Warning Centre
CWD	Cyclone Warning Division
DD	Deep Depression
DDMA	District Disaster Management Authority
DDMP	District Disaster Management Plan
DEOC	District Emergency Operations Centre
EOC	Emergency Operations Centre
DM	Disaster Management
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
ESCAP	Economic and Social Commission for Asia and the Pacific
EWDS	Early Warning Dissemination Systems
FAO	Food and Agriculture Organization of the United Nations
GMDSS	Global Maritime Distress and Safety System
GSM	Global System for Mobile communications
GTS	Global Telecommunications System
IMD	Indian Meteorological Department
INCOIS	Indian National Centre for Ocean Information Services
IUU	Illegal, unreported and unregulated fishing
KDMP	Kerala Disaster Management Plan
KSDMA	Kerala State Disaster Management Authority
KSMTF	Kerala Swatantra Matsyathozhilali Federation
MCS	Monitoring Control and Surveillance
MRCC	Marine Rescue Coordination Centre
MSW	Maximum Sustained Wind

NCRMP	National Cyclone Risk Mitigation Project
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Force
NFF	National Fishworkers' Forum
NIO	North Indian Ocean
PFD	Personal Flotation Device
RMC	Regional Meteorological Centre
RRRF	Rapid Response and Rescue Force
RSMC	Regional Specialized Meteorological Centre
SAR	Search and Rescue
SCS	Severe Cyclonic Storm
SDGs	Sustainable Development Goals
SDMA	State Disaster Management Authority
SDMP	State Disaster Management Plan
SEOC	State Emergency Operations Centre
SOP	Standard Operating Procedure
TC	Tropical Cyclone
VMS	Vessel Monitoring System
VSCS	Very Severe Cyclonic Storm
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

Cyclone Ockhi developed in the Northern Indian Ocean southwest of Sri Lanka and rapidly intensified into a cyclonic storm, killing over 350 people from southern Tamil Nadu and Kerala, India between 30 November and 3 December 2017. There were also some unidentified fishers from the north-eastern states of India who were lost at sea while working on board fishing vessels. The full force of the storm was borne by fishermen at sea, unlike previous cyclones.

Supported by the Food and Agriculture Organization of the United Nations (FAO), the International Collective in Support of Fishworkers (ICSF) Trust undertook a study to assess disaster response and preparedness in light of Cyclone Ockhi, to review cyclone warning systems and their efficacy, as well as central and state policies and plans (Tamil Nadu and Kerala) to cope with disasters and to minimise loss of human life and damage to fishery-based livelihoods, in line with the *Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication* (the SSF guidelines).

The research consisted of field interviews with survivors and the families of missing fishermen from cyclone-affected coastal fishing villages in Thiruvananthapuram, Kerala; and Kanniyakumari, Tamil Nadu. The study looked at short-haul and long-haul fishing operations–the latter undertaken in the maritime zones adjacent to states along the western seaboard up to Maharashtra and Gujarat, and the archipelagic waters around Lakshadweep Islands. Secondary research and interviews with central and state governments, fishers' associations and the scientific experts were conducted. Interviews were used to construct a timeline of events between 28 November and 6 December 2017 to identify key issues of early warning, fishing positions, disaster response and communication between various agencies.

The study recognises the need to apply disaster risk management and disaster risk reduction frameworks to reduce the vulnerabilities of coastal fishing communities. Considering the diversity of fishing communities and fishing operations, the study recommends a multipronged approach to reducing economic and social damages, including the loss of human life.

The study observes that the disaster risk management plans at the central and state levels are primarily focused on risk reduction and impact mitigation on shore where storm surges have historically led to over 90 percent of deaths. The study points out the need to integrate safety of fishing operations at sea into disaster preparedness protocols. The role and responsibilities of the Fisheries Department in monitoring fishing activity and ensuring sea safety are highlighted and the study seeks a more active role for the state fisheries departments in search and rescue operations as well as in relief, rehabilitation, reconstruction and recovery efforts.

The study reviews fisheries and sea safety legislation, rules and policy frameworks at various levels and proposes integrating disaster preparedness into fisheries management. Such integration is to be consistent with the recommendations of the SSF Guidelines, employing "relief-development continuum" and "build back better" principles and a human rights-based approach.

The study underscores the importance of developing a national legislation on fisheries for the Exclusive Economic Zone (EEZ), which integrates sea safety considerations into fisheries management and governance, and seeks greater cooperation and coordination between the littoral states, and between coastal states and the central government. The Paris Agreement, agreed under the United Nations Framework Convention on Climate Change (UNFCCC) at the 21st Conference of the Parties (COP21) in Paris (30 November to 12 December 2015), recognises the importance of averting, minimizing and addressing loss and damage caused by climate change, including extreme weather events and slow onset events, as well as of strengthening resilience and reducing vulnerability to climate change (Articles 7 and 8). The United Nations Sendai Framework for Disaster Risk Reduction 2015-2030, which India adopted in 2015, aims to achieve a substantial reduction in the loss of lives caused by natural disasters through the coordinated efforts of national and international agencies, civil society and the community.

Following are the main recommendations of the study:

1. Reconfigure the notion of the last mile in the communication of disaster warnings and include fishermen at sea.
2. Ensure constant communication between the Indian Meteorological Department (IMD) and disaster managers so as to effectively warn the coastal communities.

3. Reduce relay time between departments by using multiple channels and technologies.
4. Develop low-cost and user friendly communication technology, keeping in mind the end users, i.e. fisher families.
5. Conduct periodic awareness and training programmes in disaster preparedness guided by community-based disaster management approach, to build a culture of safety among fishermen.
6. Widen the scope of disaster management plans to include at-sea disaster and accident risks.
7. Develop the already existing national cyclone plan to include best practices from various states, based on each state's strengths and weaknesses in handling various disasters.
8. Improve coordination between various agencies in disaster management to reduce response times and more effectively collaborate during search and rescue and other mitigation measures.
9. Utilize the traditional knowledge of fishers in identifying likely fishing zones during search and rescue operations by the Indian Coast Guard and Navy. Identify experienced fishers in each village to accompany rescue teams.
10. Strengthen disaster management at the district and village levels through well-manned 24-hour control rooms, community participation and training, and ensuring the availability of technology and infrastructure to reduce damage to lives and livelihoods.
11. Integrate disaster management into fisheries management through appropriate legislation and its implementation.
12. Ensure safety of fishers at sea through free flow of information between fishers and the administration. Strengthen monitoring measures and compliance to safety norms.
13. Expand the regulatory role of the Fisheries Department to include monitoring, control and surveillance measures, reporting of all fishing activity, including accidents, and enforcement of norms for sea safety. This also includes maintaining robust, regularly updated data on fishing vessels – in total and those at sea at any given time.
14. Use new technologies for improving sea safety measures, such as mobile applications for information sharing and dissemination of alerts (e.g. Fisher Friend Mobile Application, Mfisheries or Abalobi).

Cyclone Ockhi: Disaster risk management and sea safety in the Indian marine fisheries Sector

INTRODUCTION

Cyclone Ockhi, which caused the deaths or disappearance of over 350 people and injury to over 200–almost all of them fishermen–between 30 November and 3 December 2017, left behind a scene of devastation and tragedy in southern Kerala and Tamil Nadu.[1] Yet, it did no significant physical damage to the shore. A comparative analysis of the damage caused by Ockhi and tropical cyclones in the recent past reveals that the former is at variance with the worldwide trend of continuously increasing damage to property and decreases in the loss of life (NDMA, 2008). For comparison, cyclone Phailin, which struck the coast of Odisha in October 2013, affected 1.3 million people (including 44 806 fisher families) in 18 374 villages, damaged 8 423 boats and destroyed 671 000 hectares of standing crops, whereas Ockhi affected the population of not more than 100 fishing villages in the two states and a crop area less than 14 000 hectares. Yet, not more than 50 people died in Cyclone Phailin (UNDP, 2013 and Odisha, 2013).

The point in highlighting this facet of the cyclone is not to compare the scale of tragedies; moreover, the declining trend in the loss of lives has several exceptions.[2] But the aspects of a sudden onset disaster like Cyclone Ockhi, which make it stand out from the general trend, afford planners and disaster managers the opportunity to review disaster risk reduction and management strategies, particularly in the fisheries sector.

The United Nations Sendai Framework for Disaster Risk Reduction 2015-2030 (the Sendai Framework), which India has adopted, aims to achieve a substantial reduction to the loss of life through the coordinated efforts of national and international agencies, including the central and state governments, civil society and the larger community to build resilience to natural and man-made hazards, including cyclones (UNISDR, 2015). This commitment is central to India's National Disaster Management Plan 2016, which lays out a detailed roadmap for disaster governance, so as to "build back better" from previous tragedies (NDMA, 2016). FAO draws attention to the importance of building a culture of safety and resilience at all levels in fisheries, and to identify what a disaster reveals in terms of ongoing or additional problems, such as vessel safety, during fishing operations so as to reduce future risks (Brown and Poulain, 2013).

Although disaster management plans in the past have dealt in detail with structural and non-structural measures to address the threats posed by disasters to the lives and livelihoods of coastal communities, at-sea safety measures for fishers requires greater attention. While cyclone prediction and early warning systems are highly developed in historically cyclone-prone states such as Gujarat, Andhra Pradesh and Odisha, a systematic process of warning and response needs to be standardised for all states and types of cyclones. This study addresses ways to strengthen communication to the last mile prior to and during disasters; improve sea-safety measures and compliance by all actors; and describes the best practices in disaster risk management and awareness building in the fisheries sector.

Little is known about the effects of storms on marine ecosystems; similarly, research on the risk perceptions of fishers, particularly small-scale fishers, and their behaviour during storms has been sparse. Yet, it is commonly understood that such disasters exacerbate the developmental problems of coastal communities by making fishing more dangerous, destroying craft, gear and other assets, and sometimes affecting post-harvest activities and the entire fisheries value chain. These effects are more severe in small-scale fisheries (Sainsbury *et al*., 2018). The collective learning from the experience of cyclone Ockhi in the two states underlines the need to link post-disaster relief and developmental work in the fisheries sector with disaster risk management principles and actions in order to make coastal communities more resilient. This is also in line with the Sustainable Development Goals (SDGs) – namely, to reduce casualties and build resilience of vulnerable communities to disasters (Goal 1.5), and empower small-scale fishers in the sustainable use of ocean resources (Goal 14B) – which advocate a human-rights based approach to fulfil the shared goals of states (UNGA, 2015).

The *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication* (the SSF Guidelines)–the first internationally agreed instrument dedicated to the small-scale fisheries sector–recognises the need for sea safety laws and regulations and also lays out a standard for the enactment and implementation of appropriate laws and regulations in small-scale fisheries (FAO, 2015).[3]

The disproportionate number of deaths at sea during cyclone Ockhi has led to a recalibration of disaster risk–previously understood as being limited to loss of lives and assets mainly on land–to include threats to fishers at sea.

Although the damage caused by the cyclone was limited to Kerala and Tami Nadu, the lessons from Ockhi point to the need for a national strategy to ensure the safety of fishermen. The SSF Guidelines underline the importance of integrating safety at sea into fisheries management, both through the enactment of appropriate national laws with the active participation of fishermen, and the implementation of existing mechanisms by increasing compliance, data collection and training and awareness building among fishing communities (FAO, 2015).

OBJECTIVES

Cyclone Ockhi highlights the need to incorporate disaster management and disaster risk management into fisheries policies. W hile internationally agreed instruments in the past have addressed the issue of fishermen's safety and accidents at sea,[4] the SSF Guidelines definitively addresses occupational safety in the context of disaster risks. Applying these international SSF Guidelines particularly within the framework of the FAO guidelines document for the fisheries sector on damage and needs assessments in emergencies (Brown and Poulain, 2013), the objectives of this study are:

1. To assess the emergency response and disaster preparedness, at the institutional and community level, as observed in the aftermath of Cyclone Ockhi.
2. To review storm and cyclone warning mechanisms in India and suggest interventions that benefit coastal communities, particularly fishers at sea.
3. To review the policies and plans in place at the central and state level to cope with disasters and minimise damage to lives and livelihoods of the fishing communities.
4. To evaluate the State's presence in the fisheries sector–vis-à-vis its preparedness to respond to crises and the laws governing fisheries, fishers' working conditions and rights.
5. To suggest solutions and possible linkages between various institutions and the community to develop a comprehensive disaster management framework that serves vulnerable coastal communities.

METHODOLOGY

Prior to undertaking the field study, an assessment was conducted of existing data on cyclonic events along the Indian coastline (particularly Kerala and Tamil Nadu) and domestic and multilateral interventions in disaster management in India, especially in cyclone risk mitigation. This included a review of international manuals and action plans for disaster management and disaster risk management.

The field study consisted of structured (Questionnaire in Annexure 3) and unstructured interviews with fisher families and cyclone survivors. It was essential that the field work be conducted as near to the event as possible; the villages were, therefore, chosen based on based on news reports on the disaster and on consultations with local fisher associations. Two villages were chosen from each district: Poonthura and Vizhinjam in Thiruvananthapuram, Kerala; and Chinnathurai and Vallavilai in Kanniyakumari, Tamil Nadu. The criteria for selecting villages were: a) the scale of damage, i.e., loss of lives and fishing assets; b) diversity of fishing practices and gear, safety equipment, etc., so as to have an overall picture of each group's specific vulnerabilities and emergency strategies.

Interviews were conducted with disaster managers, fisheries officials and government meteorological scientists at the central and state level. Other stakeholders including civil society groups, disaster management experts, fishers' associations and the scientific community were also consulted for this study.

Finally, the study's findings were shared with the affected community, fishworker organisations, government agencies and other stakeholders at a national-level workshop. Feedback from the workshop participants was incorporated into this report.

Map 1. Study locations

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Cartographic Section

Table 1. Population profile of study villages

State / Village		Population	Active Fishermen	Dead / Missing	Craft-wise Casualties	Survivors^
Kerala	**Poonthura**	8 871	1 584	35	32 (OBM)*, 3 (mechanised)	250 (OBM)
	Vizhinjam (North & South)	17 000	4 445	39	30 (OBM), 9 (mechanised)	180 (OBM)
Tamil Nadu	**Chinnathurai**	5 114	1 478	40	39 (mechanised); 1 (catamaran)	400 (mechanised)
	Vallavilai	6 577	1 736	33	33** (mechanised)	380 (mechanised)

* Crew sizes for *vallams* or country craft fitted with outboard motors (OBM) vary between 2-5 men; on large mechanised vessels with inboard engines, crew sizes can be up to 14 men.

** Seven Vallavilai-owned boats that sank lost 64 crew members in total. Many of these men were from Cuddalore and Thoothukudi districts. Three were from other states like Assam and West Bengal.

^ Survivors include those who returned to shore before and after the onset of the cyclonic storm

Table 2. Fishing units and safety equipment in use in the cyclone affected villages

Vessel Type*	OAL (in meters)	Engine Horsepower (hp)	Cabin	Deck	Material	Crew size	Typical Fishing Range (in nautical miles)	Length of trip	Safety / Navigation Equipment	Type of Gear
Mechanised / Deep Sea	15-20	240hp to 400hp	Yes	Decked	Wood / Steel	9-14	200-800	15-40 days	GPS, VHF Echo sounder, PFD, buoys, DAT(rare)	Long line, gillnet
Motorised Country Craft (OBM)	8-10	Twin OBM 25hp / 9.9hp	No	Undecked	Plywood / Fibre-Reinforced Plastic	2-5	20-30	1-2 days	GPS, + Echo sounder, VHF (rare)	Hook and line, boat seine, ring seine, gillnet
Motorised Small Country Craft (OBM)	5-6	Twin OBM 4hp + 2hp	No	Undecked	Plywood / Fibre-Reinforced Plastic	2-3	12	1-2 days	GPS	Hook and line, gillnet, boat seine
Non-Motorised Catamaran	3-4	None	No	Undecked	Wood	2	3-4	1 day	None	hook and line, boat seine and gillnet

[DAT: Distress Alert Transmitter, GPS: Global Positioning System, OAL: Boat Length Overall, OBM: Outboard Motor engine, PFD: Personal Floatation Device, VHF: Very High Frequency radio]

* Vessel types analysed in the study don't include larger multi-day motorised vessels (thangal vallams), which are now common in nearshore waters in the region, due to the lack of information – official or anecdotal – on the impacts of the cyclone on this category.

Table 3. Fishermen casualties in cyclone Ockhi [5]

Kerala					Tamil Nadu				
Village / District / State	Motorised		Mechanised		Village / District / State	Motorised		Mechanised	
	Dead	Missing	Dead	Missing		Dead	Missing	Dead	Missing
Adimalathura		7	-	-	Nirodi				
Kochuveli		1	-	-	Vallavilai				33
Karimkulam	-	1	-	2	Marthandanthurai				
Kochuthura	-	-	-	1	Eraviputhenthurai				
Pallom	-	-	-	3	Erayumanthurai				
Poonthura		17	-	3	Poothurai				
Poovar		4	-	-	Chinnathurai				39
Pozhiyoor		9	-	1	Thoothoor				
Pulluvila		-	-	1	Colachel				
Puthiyathura	-	-	-	3	**Kanniyakumari**				
Thumba		4	-	-	**Cuddalore**				
Valiyathura		6	-	1	**Nagapattinam**				
Vettucad		2	-	-	**Thoothukudi**				
Vizhinjam		16	-	9					
Thiruvananthapuram	51	67	-	24	**Other States**				
Kasargod	1	-	-	-	**Unidentified**				
Total	52	67	-	24	**Total**				
Total Dead + Missing	143				**Total Dead + Missing**	218			

[Source: Governments of Kerala and Tamil Nadu–verified jointly by Departments of Revenue, Home and Fisheries]

4. NATIONAL AND REGIONAL DISASTER PROFILE

A natural hazard, such as an earthquake or a cyclonic storm, is defined as a disaster when its occurrence directly or indirectly affects the local population, either resulting in the loss of lives, damage to property or socio-economic changes in the long term. Although, drought, floods and earthquakes remain the most devastating natural disasters in India, coastal fishing communities face the threat of cyclonic storms. While India's Bay of Bengal coast has a greater exposure to cyclonic storms, seasonal strong winds and high waves lead to accidental deaths and damage to fishing assets on the Arabian Sea coast, particularly in the monsoon season from June to August (KSDMA, 2016). Vulnerability to disasters is usually associated with high population densities, poor infrastructure (housing, shelters and other durable assets), inequality and poverty (FAO, 2017).

4.1 Exposure to cyclones

A cyclone is an intense vortex or a whirl in the atmosphere, which is a result of unstable convective clouds forming over a low pressure area on an ocean's surface, with winds of increasing intensity blowing outward from the system's centre. The World Meteorological Organization (WMO) defines a Tropical Cyclone (TC) as "a synoptic-scale to meso-scale low pressure system which derives its energy primarily from: 1. evaporation from the sea in the presence of high winds and low surface pressure; and 2. condensation in convective clouds concentrated near its centre." Generally, the conditions conducive for cyclogenesis – including a high mean sea surface temperature (>26°C to a depth of 60m); tropospheric humidity; deep convective cloud formation; wind shearing (differences in vertical and horizontal wind speeds); and the force of the rotation of the earth – occur between 8 degrees and 20 degrees north of the Equator, known as the inter-tropical convergence zone (WMO, 2017). The strong winds circulating around a cyclone move in an anti-clockwise direction in the Northern Hemisphere and in clockwise direction in the Southern Hemisphere (IMD, 2013).

The North Indian Ocean (NIO) occupies a prominent place in historical meteorological data as the deadliest basin for cyclone formation and impact. Of the ten cases of the world's most severe tropical cyclones in recorded history (deaths ranging from 40,000 to over 200,000), eight were in the North Indian Ocean, of which three were in India. About five to six TCs occur in the NIO annually (IMD, 2013). The 7516-km-long Indian coastline – 5400 km along the mainland, 132 km in Lakshadweep and 1900 km in Andaman and Nicobar Islands – is exposed to nearly 10 percent of the world's TCs. The Orissa super cyclone of 1999 over the Bay of Bengal was the most intense tropical cyclone to have crossed the Indian coast in recent decades (official estimates for those dead or missing are

10 000). More recent cyclones that affected India, like Phailin (October, 2013) and Vardah (December, 2016), were similar in their intensity but the loss of life was relatively small because of advances in forecasting technology and early warning systems (EWS) and the lessons in disaster management from the 1999 super cyclone and the 2004 Indian Ocean Tsunami.

Cyclones prominently occur during the pre-monsoon (March-April-May) and the post-monsoon (October-November-December) seasons. On India's east coast, storms are so common in the post-monsoon months that this period is known as the 'cyclone season'. On the other hand, TCs are less frequent over the Arabian Sea: the ratio of annual cyclone development over the Bay of Bengal and the Arabian Sea is 4:1.[6] The frequency is lower over the Arabian Sea chiefly due to colder sea surface temperatures. (IMD, 2013).

This is especially true of the Indian west coast. In the IMD's records, only 25 percent of cyclones that develop over the Arabian Sea approach the west coast (IMD, 2013). Specific to the study region, only three cyclones have developed over the Comorin area and affected south Kerala and south Tamil Nadu: two in 1912 and one in 1925. The cyclone in November, 1912 had a very similar track to Ockhi's but it crossed over southern Tamil Nadu and Kerala and then continued north-west over the Arabian Sea before curving to the north-east to again make landfall, this time over Maharashtra (IMD, 2017).

While the historic trend should not have been a cause for complacence, it also raises the question as to why the response to Ockhi from disaster management authorities was perceived to be slow, especially considering the precise operating protocol laid down for cyclone warning in India.

4.2 Climate change impacts on cyclone formation in the Arabian Sea

Climate change, understood as the changes in the earth's atmosphere as a result of greenhouse gases and sulphur aerosols accumulation caused by human activity, has had far reaching consequences on the lives and livelihoods of coastal communities, including fishing communities. Ocean warming has gradually changed composition of fisheries resources by disrupting h abitats or r edistributing fi sh po pulations. Fishing communities have themselves noted changes in the composition of catch, partly due to variations in temperatures and acidification; shoreline changes as a result of sea level rise; and unpredictable wind and rainfall, in interviews to this author as well as in previous studies (Salagrama, 2012).

Cyclonic disasters present additional challenges to these stresses already felt by coastal communities. They threaten the lives and safety of fishers at sea and adversely affect the livelihoods of all actors in the fisheries value chain, in addition to impacting the health and nutrition of populations around the world.

New research on the projected tropical cyclone activity in the Arabian Sea, which was previously less prone to such storms, predicts a continuing increase in severe cyclonic storms during the post-monsoon season in this basin, mainly as a result of warmer sea surface temperatures and variations in monsoon winds (Murakami, Vecchi and Underwood, 2017).

Predictions of potential cyclonic activity differ. Some project a decrease in cyclone formation in the Bay of Bengal and an increase in the Arabian Sea in the post-monsoon period (October to December), while others project no changes in frequency of cyclones in the overall North Indian Ocean, but an increase in the intensity of storms, with more damage expected as a result (Murakami, Sugi and Kitoh, 2013).

An increase in storms can radically impact the lives and livelihoods of fishing communities by making fishing more dangerous, displacing fish habitats and interfering with breeding cycles due to fish larval dispersal (Sainsbury *et al.*, 2018). In the study villages, fishermen and local divers reported larger quantities of marine debris, including plastics, in their nets; mollusc populations washed away by strong waves; and other damage to reefs and sea-bed ecosystems.

5. INSTITUTIONS FOR CYCLONE FORECASTING AND DISSEMINATION OF WARNINGS

Early warning and prediction of natural hazards is crucial to the disaster risk management sequence. Governments rely on a few designated forecasting agencies to ensure uniformity of prediction models and alerts, although these agencies employ multiple oceanic and atmospheric models in their analyses, including inputs from foreign agencies. Advances in satellite technology have aided India's forecasters to accurately predict recent cyclones but as the experience of Ockhi shows, early warning systems are largely designed to protect lives and assets on land. Moreover, this particular cyclone also presented fresh challenges for scientists at its very genesis and throughout its track along India's southern coast.

5.1 The Indian Meteorological Department (IMD)

The Indian Meteorological Department (IMD) three-tier system for cyclone warning consists of Area Cyclone Warning Centres (ACWCs) at Chennai, Mumbai and Kolkata and Cyclone Warning Centre (CWCs) at Visakhapatnam, Ahmedabad and Bhubaneswar. The coordination of cyclone warning operations at the national level is done by Pune's Weather Central, while the Cyclone Warning Division (CWD) at New Delhi supervises all cyclone warning activities and also functions as the Regional Specialized Meteorological Centre (RSMC) for the benefit of the World Meteorological Organization (WMO) /the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) Panel region, which includes Bangladesh, Pakistan, Maldives, Myanmar, Sultanate of Oman, Sri Lanka and Thailand.

The tropical weather outlook is issued once daily by the RSMC New Delhi throughout the year under normal weather conditions. An additional Special Tropical Weather outlook is issued again when a depression is located over the NIO region. When a system reaches the cyclonic storm stage, Cyclonic Storm Advisories are issued every three hours. Supplementary advisories may also be issued as necessitated by circumstances (e.g. change in intensity or movement).

According to protocol, when a disturbance intensifies from a low-pressure area to a depression, with the likelihood of turning into a cyclone, the IMD's Four-Stage Warning System is activated:

1. *Pre-Cyclone Watch*: The first stage, to be issued 72 hours in advance of commencement of adverse weather on a coastal area. It contains early warning about a development of a disturbance, its likely intensification and an estimate of where it will strike the coastline.

2. *Cyclone Alert* (Yellow colour coding): The second stage, to be issued 48 hours in advance of commencement of adverse weather. It contains more detailed information on location and intensity of the disturbance, districts that might be affected, and advice to disaster managers, fishermen and general public.

3. *Cyclone Warning* (Orange colour): The third stage, to be issued 24 hours in advance of landfall of the storm. It provides information on the likely point of landfall, associated rainfall, wind and storm surge and their impact on the public.

4. *Post Landfall Outlook* (Red colour): The fourth stage, to be issued at least 12 hours in advance of expected time of landfall. It gives the likely direction of movement of the cyclone after its immediate landfall.

Table 4. Criteria for classification of cyclonic disturbances over the North Indian Ocean

Type of disturbance	Associated Maximum Sustained Wind (MSW)
Low Pressure Area	31 kmph
Depression	31-49 kmph
Deep Depression	50-61 kmph
Cyclonic Storm	62-88 kmph
Severe Cyclonic Storm	89-117 kmph
Very Severe Cyclonic Storm	118-221 kmph
Super Cyclonic Storm	≥222 kmph

While the IMD employs several observational and analytical models for a holistic picture of coastal weather, cyclone analyses have traditionally been more active on the east coast. The main reason for this is that historically this coast has been more susceptible to cyclonic events. Thus, of 11 S-band radars for cyclone detection, four are on the west coast (Cochin, Goa, Mumbai, and Bhuj) and seven are on the east (Kolkata, Paradip, Vishakhapatnam, Machalipatnam, Sriharikota, Chennai and Karaikkal).

The IMD also uses Cyclone Warning Dissemination System (CWDS) stations along the Indian coast. First developed in the 1980s and employing low cost satellite technology to automatically relay warnings to district administrations, 352 stations were installed across the country. A third of these CWDS stations were in Tamil Nadu and another 101 were located along Andhra coast. These have since been phased out and the IMD has announced that 500 new Direct-To-Home-based CWDS systems are being installed. The ACWCs at Chennai, Mumbai and Kolkata and CWCs at Bhubaneswar, Visakhapatnam and Ahmedabad are responsible for originating and disseminating the cyclone warnings through CWDS.

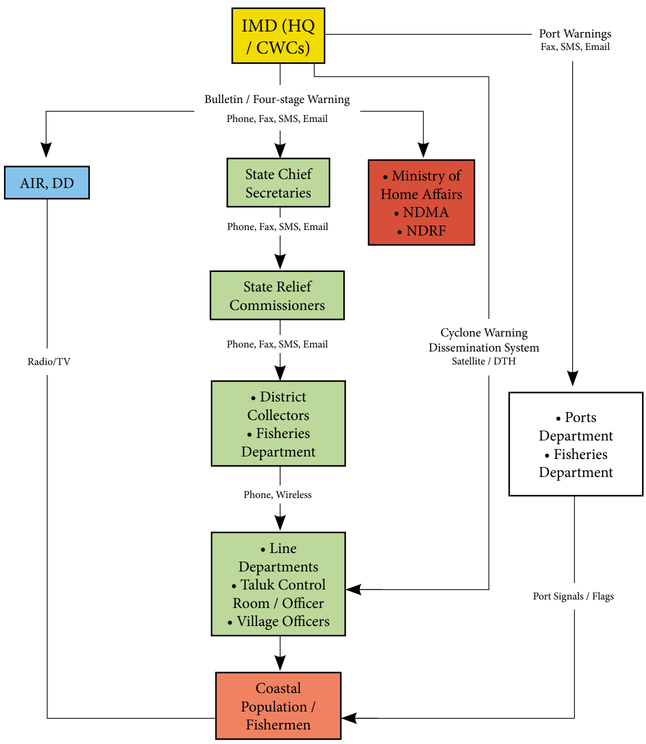
Dissemination of IMD bulletins to central and state disaster management agencies is done through fax, email and SMS and in the case of cyclone warnings, Chief Secretaries of concerned states are alerted telephonically by the ACWC/CWC about the storm's location, movement and intensity and the areas that will be affected (IMD, 2013). Previous successes in cyclone management have shown that timely communication directly between the IMD and disaster managers at the state or district levels is essential to device evacuation plans and relay the information to vulnerable communities (Nemana, 2013).[7]

5.2 Indian National Centre for Ocean Information Services (INCOIS)

Indian National Centre for Ocean Information Services (INCOIS), under the Ministry of Earth Sciences (MoES), provides ocean information for various user communities, including the shipping industry, marine scientists and fishermen through the dissemination of its Ocean Information and Advisory Services. These include potential fishing zone advisories, ocean state forecast, high wave alerts and tsunami early warnings.

INCOIS issues weather forecasts twice a day for the NIO, including the Arabian Sea and the Bay of Bengal. The data are transmitted from ACWCs in Mumbai and Kolkata. The frequency increases during tropical cyclone period. The messages are transmitted via the INMARSAT (International Maritime Satellite System) or Navigational Telex (NAVTEX), an automated distribution channel for maritime safety information, and cover wind, weather, visibility and sea state parameters. This transmission is unsuitable for the fishing community as decoding the information requires expensive technology and training.

Box I. State-level cyclone warning dissemination structure



[Source: IMD Cyclone Warning in India: Standard Operation Procedure; Gujarat, Kerala and Tamil Nadu State Disaster Management Plans]

6. EMERGENCY RESPONSE: DISASTER MANAGEMENT AUTHORITIES

The National Disaster Management Authority (NDMA) Guidelines on Cyclone Management, while recognising that "fishermen out at sea, salt pan workers and weaker sections of the coastal communities are generally caught unaware of the danger from the cyclones due to non-receipt of warnings," prescribes the timely communication of cyclone information to coastal communities as a whole (NDMA, 2008).

According to protocol, an IMD bulletin must trigger an immediate response from the state government, with information to be passed on to district collectors and the media about the position and movement of the depression, telephonically and via email, SMS and Fax. The flow of official information for all disasters, including cyclones, flows from the State Disaster Management Authority (SDMA) and the State Emergency Operations Centre (SEOC), down to the District Disaster Management Authority (DDMA) and District Emergency Operations Centre (DEOC). The EOC at the state and district levels is headed by the Chief Secretary, Revenue & Disaster Management and the District Magistrate, respectively.

States must immediately alert the Ministry of Home Affairs and the NDMA to make arrangements for deployment of Air Force, Navy or National Disaster Response Force (NDRF) on short notice, if required.[8]

The district magistrate or collector manages all disaster management activities on the ground and overseas line departments, including police, fire and rescue officers, and medical officers. The DDMA then reviews the status of preparedness of the departments at the district level and below and must give directions to take further measures as required. SEOCs and DEOCs are to function round the clock and be provided with manpower, communication and rescue equipment, and logistics support. Communication systems must remain operational round the clock. Boats for rescue and relief operation must be kept in readiness.

From the distrct magistrate, the information is supposed to pass on to the taluk and then to the village level through district and gram panchayat officials, but maintaining a trained village-level force remains a challenge in most states. In Kerala, Taluk Control Rooms are activated only in the monsoon season. The Kerala and Tamil Nadu DM plans have envisaged 65 and 284 taluk EOCs respectively in the coastal districts in their plans. The nodal officer at the Taluk level is appointed by the district collector and is usually of the rank of a deputy collector; village officers or panchayat officials are also envisaged for the last mile.

Though the Fisheries Department is not involved in relief and rescue operations, the state disaster management plan clearly delineates a crucial role for the department in the planning and warning dissemination stage (KSDMA, 2016).

Box II. Kerala State Disaster Management Plan 2016

Salient points on the management of cyclones and fishermen's safety:

Nodal Agencies

Warning: IMD

Response and Recovery: Revenue, Fisheries Departments

Role of Fisheries/Ports Department:

- Prepare a contingency plan for in sea accidents of fishermen in consultation with Land Revenue Department, Coastal Police, Coast Guard, Navy and Police
- Create a mass messaging facility for dissemination of warnings issued by KSDMA,INCOIS, IMD etc. to all sea faring fishermen
- Ensure that wind, cyclone and heavy rainfall early warnings reach all the fishermen who venture into the sea from the respective ports
- Develop early warning in all harbours based on colour flags and display boards to inform sea state to fishermen, in collaboration with INCOIS
- Ensure at least one high speed search and rescue boat in all fish landing sites for fishermen rescue through rate contract, particularly during the fishing seasons (in addition to the search and rescue boats of the department and that of Coastal Police)
- Ensure distress signal beacons in all ocean going mechanised vessels
- Ensure adequate emergency response equipment such as floating buoys with 100 m ropes attached, scuba diving gear, oxygen cylinders and first aid kits at all fish landing sites
- Develop trained civil defence volunteers from amongst the fishermen community to assist in deep diving and search and rescue with equipment provided by the department

Land-based Response Measures:

- Identification of shelters; ensure adequate supply of rations
- Identification and training of first responders and swimmers
- Four task forces established in Thiruvananthapuram City Corporation: First Aid, Shelter Management, Search and Rescue and Evacuation.

Box III. Tamil Nadu State Disaster Management Plan 2016

Salient points on the management of cyclones and fishermen's safety:

Nodal Agencies

Warning: IMD

Response and Recovery: Revenue Administration

Role of Fisheries Department:

- Aid Revenue department in informing the coastal community about the cyclone
- Issue advisories to fishermen to not venture into the sea.
- Keep track of the number of fishermen in the sea at any given time and monitor their return. Maximum efforts needed to ensure that no fishermen are out at sea 24 hours before expected landfall
- Instruct country boat fishermen to carry transistor radios and mobile phones to receive the weather forecast
- Keep a list of good swimmers at the District and Taluk level
- Keep a number of boats and catamarans equipped with nylon rope ready, with swimmers, for rescue services

Additional Measures in Cyclone Circular: (TN R&DM, 2017b)

- Strengthen cyclone prediction warning dissemination systems for ports, beaches, salt workers and fishermen
- Areas vulnerable to cyclones to be identified in advance
- Interdepartmental Zonal Teams to be formed for coordinating emergency response
- Fisheries Department to monitor fishermen out at sea with village level verification

Land-based Response Measures:

- Identification of shelters; ensure adequate supply of rations
- Swift evacuation measures and round the clock patrolling in coastal areas
- Identification and training of first responders, swimmers and their activation during cyclones

Box IV. Cyclone timeline

Nov 28 0830	**Genesis |** Low pressure system develops over southwest Bay of Bengal, off the coast of south-eastern Sri Lanka
Nov 28 1200	**First Information |** RSMC Delhi issues Tropical Weather Outlook predicting Depression formation over the next 48-72 hours
Nov 29 1150	**Bulletin 1 |** IMD Bulletin, issued when a depression is formed, forecasts the system's emergence into Comorin area and intensification into deep depression in 24 hrs. Advisory for south Tamil Nadu and Kerala fishermen not to venture into the sea. The warning doesn't reach the villages in Kerala
Nov 29 1400	**No Warning |** Poonthura *vallam* fishermen, who traditionally stay out at sea till dawn the next day, set out from their shore. Fishing range: 3-50 nmi
Nov 29 1415	**Tamil Nadu Coastal Alert |** IMD RMC Chennai warns Tamil Nadu SDMA of Depression, which relays fishermen warning to Fisheries Department, whose district officials in turn alert coastal village churches.
Nov 29 2100	**No Warning |** Mechanised boats from Kerala and Tamil Nadu continue to depart from Cochin fishing harbour in the absence of port warnings. Many left much earlier in the month, before the system's formation. Later that night, Vizhinjam vallams depart from fisheries harbour.
Nov 30 0530	**Bulletin 5 |** IMD Bulletin shows deep depression 210 km south-southeast of Kanniyakumari and predicts intensification into cyclonic storm in 12 hrs, with a movement at 18 kmph. In reality, the system had already intensified from a DD to a CS in 6 hrs and had picked up speed to over 37 kmph.
Nov 30 0830	**Cyclonic Storm |** Contrary to IMD's Bulletin 6, which predicts a CS only over Lakshadweep Islands, the cyclone lies 65 km south of Kanniyakumari and 120 km southeast of Thiruvananthapuram, much closer to the coast than the forecast track. Interviewed Kerala fishers encountered Ockhi between 08:00 and 10:00 am

Nov 30 1100	**Boats missing** | Poonthura families alert the local church when there is no sign of their men, who were expected after dawn. Priests enquire with district administration and Fisheries Department.
Nov 30 1530	**Emergency Response** | Kerala SDMA informs all collectors; requisitions Coast Guard and Navy. Mechanised boats fishing up to 100 nmi off Kerala coast encounter the storm.
Nov 30 2000	**Search and Rescue** | Coast Guard vessels pressed into search and rescue operations. Initially, rough sea conditions slow down rescue efforts. Navy soon joins SAR.
Dec 1 0600	**Severe Cyclonic Storm** | Winds upwards of 100 kmph recorded, as the system intensifies into a SCS over Lakshadweep. Interviewed Thoothoor fishers encounter biggest waves at this time. Coast Guard and Air Force aircraft start sorties limited to calmer water near Kerala coast.
Dec 1 1700	**International Safety Net** | Maritime Rescue Coordination Centre of the Coast Guard activates ISN, advising merchant ships to assist stranded fishermen. The system intensifies to a very severe cyclonic storm, centred west of Lakshadweep Islands.
Dec 2 1430	**Very Severe Cyclonic Storm** | The storm curves north-eastward and reaches peak intensity of 150-160 kmph, going in the direction of Gujarat/Northern Maharashtra.
Dec 3 1000	**300 Missing** | Expanded SAR operations succeed in rescuing 357 fishermen. 1154 more (89 boats) safely reach ports in Maharashtra, Goa, Karnataka and Lakshadweep. Villages report many more missing than initial government estimates.
Dec 6 0530	**Crossing** | Having weakened to a low pressure zone, the system crosses the south Gujarat coast between Surat and Dahanu. SAR operations continue. 105 dead and 244 missing as on 4 January, 2018.

7. CYCLONE OCKHI: 29 NOVEMBER - 6 DECEMBER 2017

Originating as a low pressure area in south-west Bay of Bengal on 28 November, BOB07, as the system was initially named, rapidly intensified from a depression into a cyclone as it skirted the coasts of southern Kerala and Tamil Nadu. Developing further into a very severe cyclonic storm (VSCS) over the Lakshadweep Islands, it curved and moved over the Arabian Sea in a north-easterly direction while gradually dissipating into a depression and then a low pressure system as it reached Gujarat's southern coast early on 6 December.

Despite sinking or damaging nearly 500 boats, leading to the deaths and disappearance of nearly 400 people in southern Kerala and Tamil Nadu, cyclone Ockhi never made landfall (PIB, 2018). This surprising fact alone should point to the need to be mindful of at-sea safety while thinking about cyclone risk mitigation measures for fishing communities.

Most fishers from the Thiruvananthapuram villages are not multi-day fishers: while Poonthura's craft went to sea on the afternoon of 29 November, those from Vizhinjam set out before dawn the next day. These communities could have benefited from a quick relay of the fishermen warning in IMD's Bulletin 1 on the morning of 29 November, which never reached them. Their vallams – 25-feet-long plywood craft fitted with outboard engines, the most common type of fishing vessels in the region – were caught in the cyclone not more than 30 nmi from the shore. Contrary to IMD's initial forecasts, the system intensified into deep depression early on 30 November and into a cyclonic storm by 08:30 IST. Moreover, the track was closer to the coasts of the two southern states than earlier estimated.

The fishermen in vallams didn't experience very strong winds on their way to the fishing grounds on the evening of the 29 November or even that night. Fishers reported heavy rains, fog and strong winds starting at 03:00 IST the next day. Many reported that their GPS readings showed the current had pulled the vallams deeper into the sea, as far as 15 nmi in some cases. Their anchors – diesel cans filled with cement or stone in most craft – were of no use against the winds and the current. The full fury of the cyclone arrived between 09:00 and 10:00 IST on 30 November, according to the interviewed survivors. The waves crashed against their craft from every direction, a phenomenon all of them said they were witnessing for the first time. According to the survivors, the waves were as high as 15 feet.

Most fishermen had given up trying to fish earlier in the morning and were struck by the cyclonic storm while attempting to return to shore. The multi-directional waves and the current, combined with the fog, made it impossible to navigate or even steady the vessels.

In Tamil Nadu, on the other hand, the SDMA was in the middle of preparations for the 2017 cyclone season. The state relief commissioner was personally alerted about the depression in the Comorin Area by the Chennai Regional Meteorological Centre of the IMD. The message was passed to the state fisheries directorate, where a meeting of all district fisheries officials was being convened at the time. The district interdepartmental zonal teams, set up according to the SDMP (Box III), were activated. As part of its dissemination strategy, the Tamil Nadu Fisheries Department had identified representatives from cooperatives, civil society and the Church. The department alerted these nodes; thus, at 14:15 IST on 29 November, the parish priest of St. Mary's Church in Vallavilai was able to warn fishermen in the village through loudspeakers placed along the shore in a 5 km radius. Over 200 vallams from Vallavilai village that go fishing at 1 am every night were thus prevented from leaving. Other villages in Kanniyakumari exercised the same caution.

Yet, several mechanised boats from this Kanniyakumari area encountered Ockhi nearly two days later, much further west and north-west of the Kerala coast (points 11 and 12, **Map 2** below). Most of these vessels depart from the Cochin Fisheries Harbour, and some from Thengapattinam in Kanniyakumari. These were the worst affected because their vessels were around the Lakshadweep Islands on 1 and 2 December, by which time the system had intensified into a very severe cyclonic storm (118-221 kmph wind speeds).

Even prior to the arrival of cyclonic winds, the para-anchors – used to hold the large vessels steady while fishing – proved insufficient. Fishers used rope, their nets and lines to tie themselves to their boats. Around the Lakshadweep region, fishers reported waves reaching higher than their wheelhouses. Some are burdened by the trauma of witnessing boats in their vicinity capsize and their friends and family members drown. They couldn't even attempt rescuing others because it was impossible to steady the boats and losing one's grip for even a moment would lead to being thrown overboard and certain death, according to the survivors. Some men were even carried off the deck of their boats by high waves, which were strong enough to tear vessels in half in some cases.

Map 1 shows the position of fishermen from Poonthura and Vizhinjam (Kerala) and Vallavilai and Chinnathurai (Tamil Nadu) relative to cyclone Ockhi's forecast track () and actual observed track () between 29 November and 3 December. [Poonthura:  markers 1,7,8,9; Vizhinjam:  markers 2,4,5,6;

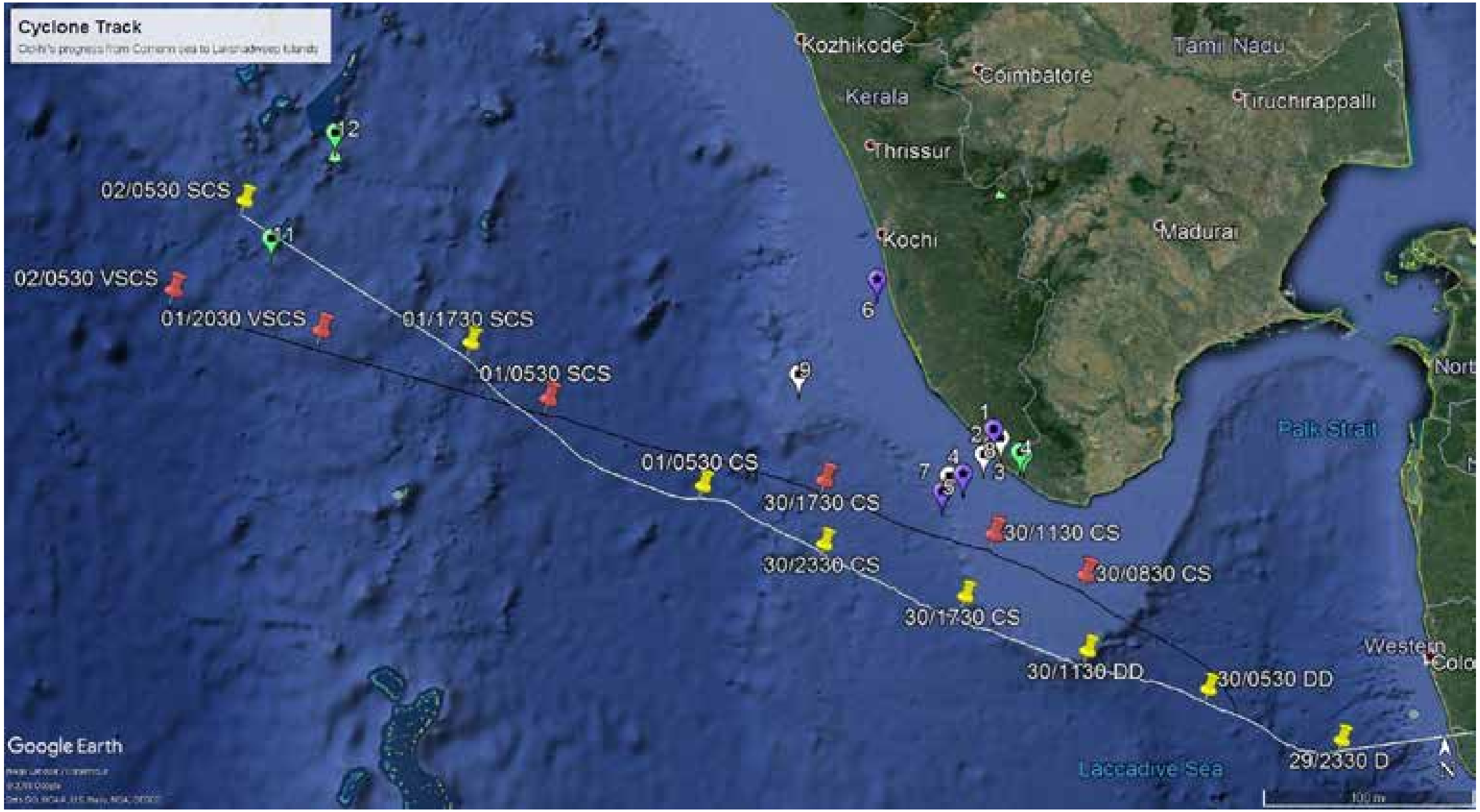
Chinnathurai markers 3,11,12: the numbers for each representing the positions of the village, fishing zone, cyclone encounter and rescue, respectively.] **Map 2** and **Map 3** show a closer view of the same coordinates.

While some of the fishermen interviewed in Vallavilai and Chinnathurai had departed from the Cochin harbour several days or even weeks before the storm, others were still at the harbour at the time of the IMD's first bulletin (11:50 IST on 29 November). There was no mechanism – neither with the government nor with the fisher families – to track the movements of or communicate the cyclone warnings to deep-sea fishing vessels from the Kanniyakumari villages. The IMD predicted a westward movement of the depression towards these vessels' fishing zones, but only the threat to the Tamil Nadu coast was acted on. Several Kanniyakumari boats that were fishing using nets closer to the coasts of Karnataka and Maharashtra (as opposed to long-lines for tuna and shark in the high seas) received news about the cyclone through the relay of Very High Frequency (VHF) radio messages and docked in these states. Others, who weren't warned, survived because the winds weren't as strong near the coastline further north.

Key

( ) Cyclone Ockhi Forecast Track
( ) Ockhi Observed Track
(**1)** Poonthura village
(**2)**Vizhinjam village
(**3)** Chinnathurai / Vallavilai villages
(**4)** Poonthura Fishing Zone
(**5)**Poonthura Fisher Cyclone Location
(**6)**Poonthura Fisher Rescue Location
(**7)**Vizhinjam Fishing Zone
(**8)**Vizhinjam Fisher Cyclone Location
(**9)**Vizhinjam Fisher Rescue Location
(**11**) Vallavilai Fisher Fishing Zone
(**12**) Vallavilai Fisher Safe Arrival

Maps 2. Cyclone track from Comorin Sea to Lakshadweep Islands

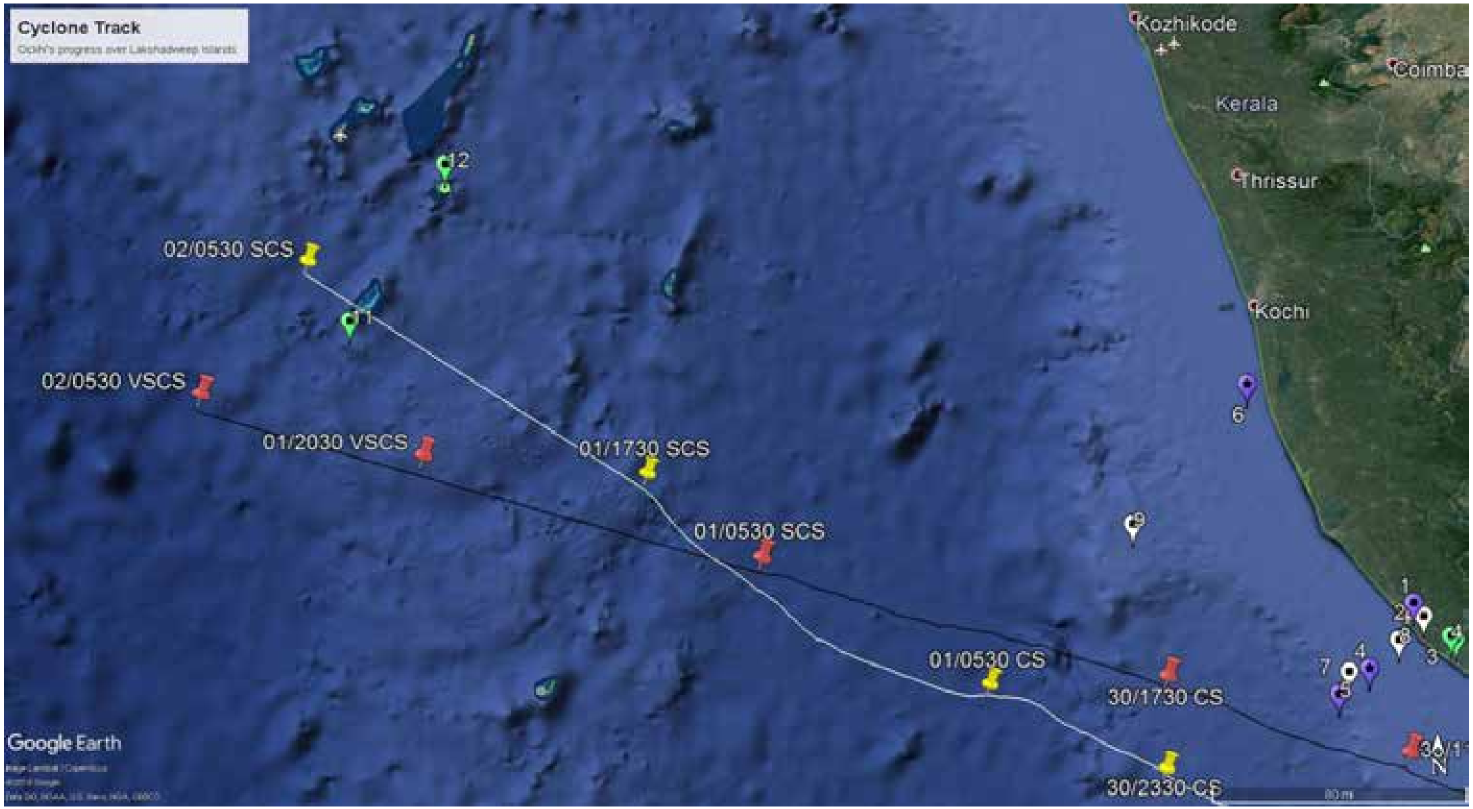


Source: Google Maps

Map 3. Position of nearshore fishers during the cyclone

Source: Google Maps

Map 4. Cyclone track over Lakshadweep Islands



Source: Google Maps

According to news reports, INCOIS's Priority Alert issued on 29 November predicted high waves of up to 3 meters till the night of 30 November along the Kerala coast from Vizhinjam to Kasargod. These readings were communicated, according to the Central Government, to state disaster management authorities along with fishermen advisories (Ilankath, 2017). Again, these alerts did not reach their ultimate recipients: the coastal villages. In Kerala, the emergency response infrastructure at the district and village levels was not activated. Previous audits of disaster management agencies, even in a state like Tamil Nadu revealed that EOCs were largely inactive at the district level.[9]

In the immediate aftermath of the cyclone, rescue operations by the coast guard, navy and the fishermen themselves saved hundreds of lives, but several hundreds were still missing – either lost at sea or landing at various location up the west coast. (The Hindu, 2017)

In both states, the use of social media platforms like WhatsApp helped coordinate the disaster response. SDMAs and DDMAs in both states communicated through WhatsApp groups, which included the police, collectors, health officials, Fisheries Department, etc. On the evening of 30 November, the Tamil Nadu and Kerala governments requisitioned the Defence Ministry to press the coast guard and Navy into rescue operations. Initially, the rough weather conditions slowed down rescue efforts, prompting the community to launch their own search operations (Kurian and IANS, 2017). On the evening of 1 December, the Maritime Rescue Coordination Centre (MRCC) of the Coast Guard activated the International Safety Net, advising merchant ships to assist stranded fishermen.

8. SEA SAFETY IN ONGOING DISASTER RISK MANAGEMENT PROJECTS

It is a positive sign that state governments are actively engaged in disaster risk reduction projects with the help of international agencies. States are now realizing the urgency of developing the awareness among coastal populations and the resilience to ward off and overcome their risks, through community-based disaster management training programmes. Moreover, a disaster management vocabulary is observable in the administration, especially in regions where extreme weather events are frequent.

Three important projects supported by the World Bank – the National Cyclone Risk Mitigation Project (NCRMP), Phase I and II; and the Coastal Disaster Risk Reduction Project (CDRRP) – were launched with the specific goal of mitigating the impacts of cyclones and related hydro-meteorological disasters in India's coastal states. While NCRMP Phase I, implemented between 2011 and 2018, focuses on reducing the vulnerability of Andhra Pradesh and Odisha coastal communities to hazards, the goal of Phase II of project is to address the same needs in West Bengal, Kerala, Karnataka, Goa, Maharashtra and Gujarat. CDRRP, started in 2013 and nearing completion, aims to increase the resilience of coastal communities in Tamil Nadu and Puducherry.

These projects cover a range of structural and non-structural measures for disaster management. Structural measures include construction of cyclone shelters, evacuation road links, power transmission networks and other infrastructure. Besides these, the projects cover early warning dissemination systems (EWDS), disaster awareness generation and capacity building programmes (World Bank, 2010, 2013). All the same, focus on at-sea safety measures and early warning systems for fishermen at sea is still inadequate.

EWDS – allowing district administrations to send communications directly to the villages using Global System for Mobile Communications (GSM) technology – is a valuable tool, provided warnings are issued in time. But, this component has limited fund allocation in both projects (World Bank, 2017). Both Tamil Nadu and Kerala governments are in the implementation stage of this component of the project.

The UNDP- GOI Disaster Risk Management Programme (2002-07), a multi-donor funded project implemented in 17 Indian states, initiated the establishment of the community based disaster risk management (CBDM) framework. The aim was to ensure community ownership of disaster management strategies – including the creation of risk and resource maps, coordinating response by establishing village level teams for early warning, shelter management, evacuation and rescue, and first aid (UNDP, 2007).

Separately, the Tamil Nadu government's 2011 scheme for "Seamless Radio Communication System" was envisioned for all 13 coastal districts, with the first phase launched in Ramanathapuram district.[10] Like with previous initiatives, it is unclear if this project has accounted for advances in technology or if it has expanded beyond the trial phase.

9. POLICY FRAMEWORK FOR FISHERMEN'S SAFETY

National disaster management guidelines, read alongside already existing laws for fisheries management, are a foundation for concerted action on risk reduction. The Indian government's Comprehensive Marine Fishing Policy 2004 envisioned programmes to improve safety at sea, the need for early weather warning system and, crucially, set the agenda for the incorporation and enforcement of sea safety measures into Marine Fishing Regulation Acts (MFRA) (GoI, 2004). The National Policy on Marine Fisheries, 2017 advocates sea safety and manning norms of fishing vessels to meet the international standards as prescribed by FAO, International Maritime Organization (IMO) and International Labour Organization (ILO) (GoI, 2017).

The marine fishing regulation acts and rules in all states, including Kerala and Tamil Nadu, specify life-saving and communication equipment as a criterion for registration of fishing vessels. In the 1980s, the Kerala government, recognising the proliferation of trawler operations and mechanised vessels, notified additional pre-requisites, including life-saving and navigational equipment and driver competency certificates, for registration of vessels over 13 meters in length.[11] It underlined the "need to avoid accident and ensure safety to life and property of fishermen."

The 1995 Code of Conduct for Responsible Fisheries, unanimously adopted in October 1995 by the FAO Conference, also laid the groundwork to seek compliance with appropriate safety requirements for fishing vessels and fishers, not just in industrial fishing activities, but also small vessels not covered by international conventions.

India's Merchant Shipping Act only governs fishing vessels of over 20 metres length; therefore mechanised vessels below 20 m OAL escape scrutiny under its relatively stricter regulations, including distress and safety communication rules, life-saving equipment and other compliance requirements.

Some discussions on the safety of fishermen in the context of Cyclone Ockhi have highlighted concerns about design, material and quality of vessels. Standardisation of vessel design and quality, through inspection and certification of boat yards; regular repairs of old vessels; and regulation of load and gear weight is still a challenge, especially in the case of traditional undecked crafts. Innovative, low-tech solutions have also been suggested, such as radar reflectors, chine rails and weather-proofing for communication equipment. New proposals to repair or replace crafts are constrained by the existing wealth and technology situation of the sector (Cattermoul, Brown and Poulain, 2014). While the fishers are sometimes found to be reluctant to invest in improved safety, they also question the proportionality of safety standards to their operations and capacity.

Box V. Disaster risk management and safety at sea in the Small-scale Fisheries Guidelines

Duties of States

- Integrate safety at sea into the general management of fisheries.
- Ensure enactment and implementation of national laws consistent with international guidelines of FAO, the ILO and the IMO for work in fishing and sea safety in small-scale fisheries
- Support accident reporting, sea safety awareness and training programmes, and increase compliance and data collection
- Promote access to information and to emergency location systems for rescue at sea
- Develop policies and plans to build resilience in small-scale fishing communities to disasters and develop strategies for mitigation of risks
- Ensure integrated and holistic approaches, including cross-sectoral collaboration, in order to address disaster risks
- Assess impact of disasters on post-harvest and trade in the form of changes in fish species and quantities, fish quality and shelflife, and implications with regard to market outlets. Provide support in the form of adjustment measures to reduce negative impacts.
- Integrate emergency response and disaster preparedness and apply the concept of the "relief-development continuum". Consider longer-term development objectives throughout the emergency sequence, including in the immediate relief phase, and rehabilitation, reconstruction and recovery should include actions to reduce vulnerabilities to potential future threats. Apply concept of "building back better" in disaster response and rehabilitation.
- Make transparent access to adaptation funds and/or culturally appropriate technologies for climate change and disaster risk adaptation available to small-scale fishing communities (FAO, 2015).

10. REGULATORY COMPLIANCE OF FISHING VESSELS

While fishing operations in territorial waters are managed by state administrations through their individual Marine Fishing Regulation Acts, it has been observed for many years that both traditional and mechanised vessels are increasingly fishing in the Indian Exclusive Economic Zone (EEZ), the latter category fishing even beyond, in the absence of national legislations regulating such operations.

The challenge of delivering timely relief and rescue to fishers at sea is complicated by two significant factors: first, the absence of a system to track fishing vessels at sea; and second, lax enforcement of mandatory sea-safety measures. Fishing accidents at sea, primarily due to men falling overboard and getting entangled in nets, causes the most deaths at sea, surpassing natural hazards. An analysis of accident compensation to fishermen in Kerala estimated that one fisherman dies at sea in Kerala every four days (Kurien and Paul, 2001). The disproportionate deaths at sea over casualties on land point to significant gaps in integrating safety at sea into fisheries management, as discussed in the SSF guidelines (FAO, 2015).

At present, the disaster managers and Fisheries Departments do not possess any data on the number of vessels out at sea at any given time. This was reflected in the widely disparate numbers presented by the government and the community – both versions appearing in the media – on the number of fishers missing after the storm. Similarly, no data exist on migrant fishers from other Indian states engaged in fishing in Tamil Nadu and Kerala. A majority of fishers from the eight villages in Thoothoor own or work on vessels operating from Cochin; the officially cited number of these vessels varies from 500-1500. Boat crews, exclusively Tamil in the past, are increasingly adding members from Assam and West Bengal.[12]

Mandatory sea-safety equipment, such as life jackets and life buoys, are missing on most vessels due to poor enforcement at the time of vessel registrations. Most fishermen interviewed for this study, with the exception of a few Kanniyakumari deep-sea fishers, either did not possess life-saving equipment or did not have them on board during the cyclone. But, most fishers agreed that such equipment would have helped the stranded individuals stay afloat while waiting for assistance.

Fisheries management plans are to include monitoring, control and surveillance (MCS) mechanisms: colour coding of all vessels, notifying landing points, maintaining a database of all boat-building yards, etc. The government fishing harbour at Cochin demands a different colour code for boats from each of the states and territories: Kerala (blue and orange), Tamil Nadu (green) and Lakshadweep Islands (white).

The Registration and Licensing of Fishing Craft (ReALCraft) project was started in 2008 to address problems such as the lack of uniformity in craft and multiple registrations (GoI, 2016). But such interventions face several hurdles on the ground: for instance, over 60 percent of Kanniyakumari deep-sea fishing vessels depart from and arrive at Cochin harbour; sometimes, they might depart from Thengapattinam but dock at Cochin, Alappuzha or Kollam, depending on the price of fish. Second, many vessels are registered in a particular state but owned by two or more individuals from different places. Moreover, MCS is easier to implement at harbours but almost all affected fishers in Thiruvananthapuram set out in vallams directly from their coastal villages.

The deep-sea vessels owned by Kanniyakumari fishers are manufactured in boat yards as far as Gujarat on the Arabian Sea coast and Thoothukudi on the Bay of Bengal coast. Although, boat registration is a centralised process, there is no system to ensure the quality, safety and seaworthiness of vessels.

Several states have a token system – issued to individual boats at harbours – but compliance is weak and a greater number of fishers – specifically those fishing in country craft and catamarans – have no access to harbours. At Vizhinjam and Kanniyakumari, fishers said the token system is not enforced. At present, the administration collects information on country vessels through its subsidy data – the number of beneficiaries availing schemes for fuel, nets, etc – but this data are unreliable in emergencies and cannot replace real-time information from individual villages or landing centres.

After Ockhi, the two state governments reiterated the importance of registration and a system of information sharing between fishers and the administration (Mariappan, 2017). In the aftermath of the cyclone, immediate measures to monitor vessel movement included the distribution of Distress Alert Transmitters (DAT) and round-the-clock control rooms at fishing harbours to register all outgoing boats, as in Cochin. Collisions are a major reason for the loss of lives of fishermen, both near harbours and in the high seas, because fishing vessels cannot be identified on the radars of merchant ships. In 2017 alone, there were seven reported incidents of collisions between ships and fishing boats near Cochin Harbour. Merchant Marine Departments have suggested several cost-effective solutions, which are valuable for other distress situations like cyclones. Several interviewed fishermen claimed that merchant ships passed close to their capsized boats without spotting them. While larger mechanised vessels, which currently use navigational light masts, can be fitted with GPS- or VHF-enabled Automatic Identification Systems (AIS), smaller country craft can have light aluminium strips or a coat of metallic paint on the hulls, in addition to radar arches near the stern.[13]

Box VI. MONITORING, CONTROL AND SURVEILLANCE: THE SRI LANKAN EXPERIENCE

In 2013, Sri Lanka's Fisheries and Aquatic Resources Act No. 2 of 1996 was amended to provide for a legal framework to manage the high seas fishing activities of its vessels. [Sri Lanka has a marine fishing vessel fleet of 50,338, of which 4,262 are classified as 'Multi-day Boats (offshore vessels)'. Of this category, 1207 have high sea fishing licences and 3055 only have licences to fish inside the country's EEZ.] (SL Fisheries, 2016 and 2018)

The main factor that necessitated such measures was the trade agreements with the European Union, the largest market for Sri Lanka's fish export. Despite these measures, Sri Lanka lost its right to export fish to the European Union in January, 2015 as a result of its seafood exports not meeting standard set against illegal, unreported and unregulated fishing activities (IUU).This created an urgent need to develop a responsible fisheries culture in the country.

The Vessel Monitoring System (VMS) was born out of this need. The system includes strict enforcement of vessel registration and inspection norms. The minimum requirements of high sea fishing vessels of length over 45 ft, include:

- VMS transponders: Satellite-based technology to monitor location of vessels in real time
- Maintain a logbook issued by Fisheries Department with a record of the fish catch of each fishing trip
- Approved Single Side Band (SSB) High Frequency (HF) radio with antenna
- Minimum sanitary facilities
- Radio call sign displayed on board vessels
- Boat construction from a supervised boat yard
- Gillnets not exceeding 2.5 km in length
- Safety equipment including life jackets, life rings, fire extinguisher
- Details of last port call and crew members, both at port of departure and on board

A separate Monitoring Control and Surveillance (MCS) Division has been established, which oversees a communication network of 11 radio stations along the coastline to facilitate communication with fishing boats. Signals or messages relating to distress, urgency, safety, etc., are communicated to the MCS station on HF international bands while individual frequencies assignment or private channels are used for private communication purpose (SL Fisheries, 2013; BOBP, 2013). The MCS Division coordinates with the Sri Lanka Navy, Air Force and Colombo Radio to rescue fishermen and craft stranded at sea.

The base stations also broadcast a special daily bulletin or radio broadcast capsule for the deep-sea fishermen. The bulletin combines weather forecasts, entertainment and market information in a concise format, designed to suit the needs of the fishermen. (Yadava, 2018)

In 2013, the estimated overall cost of radio equipment, upgradation of coastal radio stations, etc., was SLR 340 million (INR 144 million).

The MCS and VMS systems have together helped Sri Lanka regulate IUU fishing, reduce accidents and fatalities at sea and manage conflicts between various fishing operations.

11. EMERGENCY COMMUNICATION TECHNOLOGY

Mobile Phones

With the rapid expansion of telecommunications networks across India, mobile phones [Global System for Mobile (GSM) and Code-division multiple access (CDMA) technologies] have become the most common mode of communication, even in coastal villages. According to census data (MFC, 2010), 36 percent of fisher families in Kerala (17 percent in Thiruvananthapuram) and 47 percent in Tamil Nadu (25 percent in Kanniyakumari) reported the use of mobile phones (CMFRI, 2010). Field observation and anecdotal evidence suggests that mobile phone usage has significantly increased in areas visited as part of the study.

Limitations: While this noticeably decreases relay time for emergency messages from government agencies to the villages, mobile phones are relatively ineffective as a mode of communication at sea – their range is limited to 2-5 nmi. (Vizhinjam fishers claimed that SIM cards of the service provider, MTS, which is no longer operational, used to allow a range of up to 15 nmi.) Network tower density is lower near the coast and service providers have said in the past that security concerns and regulatory hurdles prevent them from increasing the range of tower signals. (BOBP, 2013)

Very High Frequency (VHF) Radio

Very High Frequency (VHF) radio is the most commonly used communication devices used at sea. Most mechanised vessels and several motorised vallams carry at least one VHF set. VHF radio operates in the 30-300Mhz band of the spectrum and allows two-way communication, making them very useful to share information on fishing grounds or the weather between boats or fleets. Nearly all mechanised trawlers and long-liners carry two VHF sets: one tuned to the international marine band (156-162 MHz, Channel 16) to communicate to nearby merchant vessels or the Navy/Coast Guard; and another band used among fishers (Channel 9 and 65), though the practice is not strictly legal (IMO, 2004). Interviewed fishers said that they often communicate with nearby merchant vessels using the marine band when in distress, or to alert the vessels about an impending collision or damage to their nets.

***Limitations*:** Nearly all Indian fishing vessels unlicensed use VHF Land Mobile Radios, and not Marine Radios, as the law demands. Marine Radios have special features, most importantly, the GMDSS, which gives each vessel a Maritime Mobile Service Identity: when a vessel turns on the distress channel, a GPS generated latitude-longitude coordinate gets captured by all vessels in the vicinity. But Marine Radios are more expensive and fishermen claim that the license is difficult to obtain. VHF radio, however, is limited to line-of-sight signals – they don't travel beyond the horizon – and therefore have a range of not more than 15-20 nmi, even when fitted to large mechanised vessels (antennae height of 5-7 meters). Big vessels like merchant ships (antennae height of 30 meters) are able to communicate as far as 65 nmi. Signal strength depends on the power output of the radio device: while handheld two-way radios have power usage between 1-5 watts, fixed-mount boat radios usually broadcast at 25 watts and need an external power source (ITU, 2015). Range enhancement is possible by constructing high towers or using repeater stations at sea – either mounted on buoys or even on coast guard vessels. This, too, enhances the range by only 25 nmi. But it is uncertain which department will be responsible for maintenance of repeater stations. (BOBP, 2013)

The smaller country craft (motorised or non-motorised) have room only for nets and other essential fishing equipment. Another concern is that the inside of the craft are also constantly damp and radio sets are easily damaged in these conditions.

High Frequency (HF) Radio

High Frequency (HF) radio broadcasts in the shortwave 3-30 MHz frequency band and therefore travels much longer distances than VHF and UHF – 250 nmi ('ground wave' propagation using the earth's curvature) to even beyond 3000 nmi ('sky wave' propagation where the radio signal bounces off the earth's ionosphere or the atmospheric layer electrically charged by solar radiation). Signal strength is dependent on multiple factors like power output, time of day, antennae height, etc.

Sri Lanka widely uses HF radio as a part of the MCS operations of its Department of Fisheries and Aquatic Resources, which allows fishers in remote locations to communicate with shore stations and also allows broadcast of fisheries-related information, entertainment content and weather bulletins for its multi-day fishers in the high seas.[14]

***Limitations*:** HF Radio is nowhere in use by Indian fishermen because licences are strictly regulated and are generally issued only to the police and public institutions. The Wireless Planning and Coordination Wing of the Department of Telecommunications oversees licensing of all radio technology in India. There is also a view that the HF signal is susceptible to interference due to sun spots because it relies on the earth's ionosphere. There is also a need for clarity on the cost of equipment and of establishing coastal radio stations.

Distress Alert Transmitters (DAT)

Distress Alert Transmitters (DAT) are small (15 kg, 30 × 23 × 20 cm) battery operated devices that work on satellite technology to transmit four types of alerts: fire, boat sinking, man overboard and medical emergency, between fishing vessels and shore stations. Once set off, the signal is received by the ISRO office in Bengaluru, which is transmitted to the appropriate coast guard station, which initiates a SAR operation. The hub for Tamil Nadu fishing operations is MRCC Chennai (BOBP, 2013). An Inter Agency Standing Committee oversees SAR operations through the National Maritime Search and Rescue Board (NMSARB), consisting of Department of Space/ISRO, the Shipping Directorate, Airports Authority of India, Indian Coast Guard and Defence services.

Limitations: Although the device costs only INR 10,000 (75 percent subsidy available through a centrally sponsored scheme), pilot projects have thus far only distributed a small number of DATs to fishermen (Indian Coast Guard, 2017: 1,853; Kerala, 2016: 5000, Tamil Nadu, 2010: 1800, Andhra Pradesh, 2015: 2000). Interviewed fishermen in Kanniyakumari acknowledged that DATs had been distributed to a few members but they had not been trained in the proper use and maintenance of these devices. Many had discarded or lost their transmitters. There were also reports of false alarms on many occasions, due to which the Coast Guard had stopped responding to distress calls, according to the fishermen.

SagarVani integrated information dissemination system

Launched in July, 2017, SagarVani is a multi-platform ocean information dissemination service developed by ESSO-INCOIS under the Ministry of Earth Sciences to provide ocean information and advisories for various stakeholders. The service will provide an integrated information system to Fisheries Departments, disaster management authorities and the community through multi-lingual SMS, voice calls, mobile apps, social media, email, GTS, Fax, radio or television broadcast units, etc. In October, 2017, INCOIS signed an agreement with the Kerala Fisheries Department to issue SMS alerts to fishermen in several languages.

Limitations: INCOIS SMSs rely on GSM or CDMA technology, which is only useful if the fishermen are on or near the shore. Moreover, fishermen have to opt in for the SMS service and only 480 fishermen had signed up for the service before the cyclone. (Ilakanth, 2017) According to the Kerala SDMA, the number has grown to over 100,000 subscribers since Ockhi.

NavIC Satellite Navigation System

Developed by the ISRO, India's regional satellite navigation system Navigation by Indian Constellation (NavIC) uses satellite waves to transmit warning signals and messages to the fishermen from the shore. The service will provide daily updates on sea state, wave height and the occurrence of extreme weather. A pilot project to fit 500 satellite-enabled communication gadgets in fishing boats and deep-sea vessels in Kerala was launched in January, 2018. But the device only has a receiver and no transmitter, thus allowing only one-way communication. The project will involve INCOIS and IMD, with a master control room at Thiruvananthapuram and six regional control rooms near main harbours such as Cochin, Kollam and Kozhikode. The service allows messages to be sent up to a distance of 1500 km (Varma, 2017).

Limitations: The technology is not yet ready for widespread use. A pilot project has been launched and the ISRO is in the process of determining the cost of commercialisation and inviting tenders to expand production.

Mobile Phone Apps

The use of Information and Communication Technology (ICT) in fisheries resource management has gained ground in recent years with widespread use of Smartphones and affordable mobile internet connectivity. Mobile applications or apps now provide the combined functions of information sharing on fishing zones, catch and fleet management (Abalobi in South Africa) and dissemination of alerts and SOS communications for local emergency response authorities (MFisheries in the Caribbean). In India, Fisher Friend Mobile Application (FFMA), developed by the MS Swaminathan Research Foundation provides real-time information to fishermen in nine Indian languages covering most coastal states. Fishermen receive messages on their mobile phones on weather, potential fishing zones, ocean state, and market related information. Most of these app suites are designed for Android phones and are free softwares, making them affordable sources of information and tools for connecting with other fishers.

***Limitations*:** While applications like FFMA are popular and have several thousand subscribers, especially among younger fishers, the technology is based on mobile network connectivity, which is very limited at sea. Although fishers can feed their GPS coordinates into the apps, real locations at the time of accidents or disasters cannot be communicated when the fishers are out of signal range. Moreover, their popularity among fishers in developing countries is limited because older, often unlettered, fishers still find it difficult to use such technology.

Television and Radio

With its near-universal reach, television presents the most effective means of disseminating emergency warnings on the shore.[15] IMD's national bulletins are transmitted to All India Radio and Doordarshan (public broadcasters), besides regular weather coverage by private radio and TV channels, as well as newspapers. During the start of Cyclone Ockhi, while the media reported on heavy rainfall on land, it missed the plight of the fishers at sea, till an alarm was raised by the fishers of Thiruvananthapuram. In addition to the existing weather reporting by the media, reporters can be trained to provide more user-oriented data and warnings. Channels can also make use of pre-recorded fishermen warnings for broadcast at the time of cyclogenesis.

Limitations: Many fishers carry transistor radios for FM (Frequency Modulation) and AM (Amplitude Modulation) broadcasts but their range is limited. Television and Radio are very useful channels to broadcast warnings but they must complement and not replace official fool-proof modes of dissemination. Without more direct communication through phone calls or press conferences, warnings in the form of emails and fax messages are often missed by news agencies, as was the case during Ockhi.

Community Radio

Community Radio (CR) can be a cheap and effective solution to the last-mile challenge in dissemination of cyclone warnings. Indian CR stations broadcast on FM radio mode, making them easily accessible to resource-poor fishermen at sea. Transistors are inexpensive and coastal tower signals have a range of up to 50 km at sea, making them very useful for nearshore craft. Locally run stations in Odisha and Gujarat provide crucial lessons for a community based disaster management approach. During the 2013 Phailin cyclone in Odisha, the state government was able to evacuate over 800,000 people from coastal villages, largely with the help of the media, particularly community radio stations like Radio Namaskar, a Konark-based coastal station. They also have multiple uses. Coastal radio stations can broadcast content developed by and for the fishing community, and cover weather forecasts, songs, discussions, and market information such as prices and new government schemes.

Limitations: FM radio has a limited range of 25-50 nmi, depending on the strength of the broadcast signal. Resource constrains prohibit the use of high towers. Community Radio alone cannot replace official and reliable modes of dissemination.

Box VII. Post-Ockhi disaster risk reduction measures

- Tamil Nadu government proposes to address communication needs of deep sea vessels through a multi-device five-boat-cluster system: Each cluster will carry one satellite phone for shore-to-vessel communication, two HF-enabled radios and two NavIC transceivers built using ISRO technology.
- Kerala government proposes a scheme to provide all deep-sea vessels with NavIC satellite-based transceivers developed by ISRO. The technology allows one-way communication of alerts from shore stations via text messages. Efforts ongoing to develop two-way communication for distress alerts.
- Kerala government has expanded its State Disaster Management Authority, employing a total of 29 full-time staff consisting of seismologists, hydro-meteorologists, computer scientists and disaster management experts.
- Tamil Nadu government recommends that the Central Government facilitate the establishment of a Satellite Radio service, like the now-defunct World Space Radio, which is a cheaper mode of communication of warnings to deep-sea vessels.
- Tamil Nadu government proposes wider coverage of Distress Alert Transmitters (DAT) among fishermen. In 2015, Central Government approved manufacture of 30,000 DATs to be provided to coastal fishermen on 75 percent central government-assisted subsidy. (Cost: INR 360 million).
- Immediately after Ockhi, the Tamil Nadu government proposed that the Central Government amend the Indian Coast Guard SAR protocol so that rescue teams can directly respond to disasters upon receipt of IMD warnings, rather than wait for state governments to request assistance from the Home Ministry.
- Kerala government plans to recruit first responders from the coastal communities, to be stationed in each fishing village. These recruits will be used during SAR operations in the future.
- Both states' Fisheries Departments have proposed amendments to marine fishing regulation acts so as to expand regulation and enforcement of safety measures on fishing vessels.

12. CONCLUSION

Threats on land vs. vulnerabilities at sea

Although information is sparse because of the lack of fleet monitoring systems, a disaggregation of data from previous disasters can shed some light on the actual number of people affected by cyclones at sea. As outlined in this report, one reason for the slow response from meteorologists and disaster managers to Ockhi was the primary focus of DRM planning on risks to life and property on land, to the exclusion of at-sea risks faced by fishermen.

Flow of emergency information

Cyclone Ockhi highlighted the need to streamline emergency communication, so that disaster warnings reach the community and a timely response is initiated. The Kerala SDMP provides for two separate protocols to factor in times when early warnings are not at hand, as in the case of Ockhi. But, here too the chain is too long, having to go through four different offices/control rooms before reaching the vulnerable community (KSDMA, 2016).

Last-mile communication

Although IMD and INCOIS bulletins reach state control rooms and district collectors are informed through SMS and email, coastal districts don't have round-the-clock emergency communication systems for emergencies, especially at the taluk and village level. At present, taluk control rooms in Kerala are operational only in the monsoon season.

Role of Fisheries Departments in disaster management

Fisheries Departments are mandated to create a sea safety plan and mass messaging facility for fishers but all responsibilities for coordinating disaster response and relief work are with the revenue and home ministries, because disaster management plans are oriented towards damage to assets on shore. Better cooperation between departments, in this case on identifying fishing zones and contacting fishers associations and community organisations, which are reciprocally in touch with fisheries officials, could have resulted in a quicker response from rescue forces.

Coordination between IMD and disaster managers

Ensuring that the response to weather warnings and bulletins is swift and effective needs training and constant vigilance at the state and district levels. This is especially true in a state like Kerala, which has historically seen fewer cyclonic events and complacency can be a problem for the community and the administration (Chari and Katakam, 2017). While the time to respond to the warning was limited by the sudden cyclogenesis and intensification in the case of Ockhi, Tamil Nadu was able to relay the depression warning to coastal districts a day before Kerala.

13. RECOMMENDATIONS

Efforts by disaster managers, civil society and the coastal community must be guided by the concept of a relief-development continuum, whereby long-term development objectives need to be considered throughout the rehabilitation and recovery sequence (FAO, 2014). The guiding principle must be to "build a culture of safety and resilience at all levels" (Brown and Poulain, 2013). An integrated approach to fisheries management must combine regulation with welfare. A free flow of information between fishers and the administration, which comes from regulatory compliance and updated monitoring systems, can have far reaching benefits for effective disaster management in the fisheries sector.

1. **Timely dissemination of IMD warnings:** Advances in forecasting technology now allow meteorologists to warn disaster managers about cyclones at least five to six days in advance in most cases. The IMD's preliminary assessment suggests that Ockhi's intensification was unusually rapid and consequently, the warning and response time was inadequate. All the same, previous successes in disaster planning and response, such as in the case of Phailin and Vardah on the Indian east coast, have benefitted from a pro-active approach from the state relief machinery: constant communication, both formal and informal, between regional meteorological centres and relief commissioners; vigilant district administrations; and regular dissemination of warnings through multiple media (Nemana, 2013; TN R&DM, 2017a)[16] Rather than wait for intensification from depression to cyclone, coastal DEOCs can issue warnings to fishing communities when low pressure conditions develop close to fishing zones.
2. **Cyclone preparedness at sea:** Cyclone Ockhi has painfully brought the urgency of cyclone preparedness and training for at-sea fishermen. The need to integrate sea safety into fisheries management and regulation is key to risk reduction. Interviews with survivors, boat owners and harbour officials revealed an overall absence of safety awareness and the need for more regular training on risk reduction among coastal communities. A widening of the scope of disaster management plans to include at-sea disaster and accident risks is necessary. This will require significant recalculations regarding warning and response times, modes

of dissemination and their effectiveness and the reorientation of the relief operations keeping all variables in mind during cyclonic events.

3. **Disaster mangement training and coordination between agencies:** Interviews with current and former disaster managers in both the affected states suggest a variance in disaster preparedness training and experience both at the planning and implementation level in the two states. Operational World Bank-assisted programmes like CDRRP and NCRMP in Tamil Nadu has ensured that its SDMA has full-time staff of trained and dedicated officers and that the disaster prevention machinery in the state is constantly active. Both states can formalise control rooms at the divisional or district level and conduct regular training programmes for its officers with the participation of the IMD and disaster experts.

4. **Reliable data on fishing operations:**The SSF Guidelines emphasize the importance of data collection and accident reporting to ensure that deficiencies in delivering safety at sea to fishermen are addressed (FAO, 2015). Coastal states must conduct a comprehensive survey of coastal villages and gather village-level data on the number of vessels actively fishing at sea. An up-to-date fishing register, maintained both at harbours and fish landing centres, and remotely (through mobile phone-enabled self-reporting) can be developed by Fisheries Departments. This will make precious data on fishing operations on any given day available to disaster planners during search and rescue operations.

   Data on migrant workers employed on multi-day fishing vessels is entirely lacking. Although larger vessels are required to maintain crew registers, the practice is rarely enforced. Interviews with fishermen and harbour officials revealed that most multi-day trawlers and long-liners operating from Cochin employed at least two migrant workers from Assam, West Bengal and other northern states on each vessel. Three migrants perished along with the 33 fishermen lost from Vallavilai but their names or identities were not known to the boat owners.

5. **Integrating national and local disaster planning:** A disaster like Cyclone Ockhi, whose effects are felt across singular state jurisdictions, underlines the need for a coordinated response to disaster risks. In keeping with the SSF Guidelines, integrating fisheries management and disaster risk management for fishermen must be a national priority. Further, any central government legislation should be made consistent with international guidelines of FAO, the ILO and the IMO for work in fishing and sea safety in small-scale fisheries (FAO, 2015). Although the most effective relief and rescue operations have involved timely,

localised efforts at the state and district level, Cyclone Ockhi presented specific jurisdictional issues, such as: a) Tamil Nadu's early dissemination of IMD's rough seas warning could not reach Kanniyakumari's multi-day fisher and fishing vessels, who are registered in their home state but operate from Kerala. b) Small country craft or vallams expected to fish within territorial waters, are increasingly venturing deeper into the Exclusive Economic Zone. This complicated search and rescue operations due to a lack of clarity on whether the state marine police or the Indian Coast Guard should conduct search operations closer to shore. The former requires more cross-sharing of information between states and the use of a combination of warning mechanisms like port signals, relayed VHF radio warnings, etc. Jurisdictional issues need to be addressed at the national level by formulating clear procedural guidelines that account for regulatory challenges in the fisheries sector.

6. **Community-based disaster management approach:** An effective disaster risk reduction strategy requires the active participation of the community and must factor in their socio-economic circumstances so as to develop cost-effective solutions. While most donor-assisted DRR programmes in the past have focused on structural measures, greater attention is needed on awareness building, dissemination of emergency warnings and ensuring at-sea safety. The aim must be to build resilience to hazards at the community level. (Muralidharan, *et al.*, 1998)
7. **Expanding the role of the Fisheries Department:** The incorporation of sea safety measures into state MFRAs can be taken up as a priority by Fisheries Departments. The departments can train and better regulate mechanised, deep-sea fishing fleets. It has been suggested that such vessels be brought under the ambit of the Merchant Shipping Act but this requires consultations with fishers associations and representatives. Alternatively, the Fisheries Departments can be more vigilant and expand their regulatory roles.
8. **Rehabilitating women and children:** In many fishing communities, women lack decision-making powers in the family and community, as a result of which they are more vulnerable, both directly and indirectly (as in the case of Ockhi) to disasters (FAO, 2017). The cyclone affected areas are no exception. In homes that have lost fishers, the wives are unable to cope due to economic pressures. Despite being better educated than their husbands, many women have never worked outside their homes, especially among the Kanniyakumari fishing households. Rehabilitation measures by the government (Annexure 2) should include vocational training and employment opportunities for women. Similarly, male children of such

households, who have traditionally followed their fathers into fishing, are left with few opportunities outside of the sector. Alongside rehabilitation measures, women and children must be included in disaster preparedness programmes, conducted through community institutions, schools and direct engagement with Fisheries Departments and the Indian Coast Guard.

9. **Assessment of environmental effects and revitalisation of marine ecosystems:** The effects of cyclonic storms on coastal and marine ecosystems have not been adequately studied (Sainsbury *et al.* 2018). Anecdotally, local fishers have noted changes to reefs, fish stocks and on fishing operations. Local divers in the region also noted how the storm dredged up marine debris in the form of plastic waste and ghost nets, which are increasingly getting caught in fishing nets off the coast of Thiruvananthapuram. In line with the Sendai Framework, post-disaster reconstruction efforts must include measures to revitalise the marine environment and ensure the conservation of fragile ecosystems– by promoting sustainable fishing practices, regulating destructive practices and managing waste treatment and disposal. Similarly, measures to mitigate cyclone risks like the conservation of mangroves and planting buffer green zones should be promoted.

Box VIII. Recommendations by the disaster affected community

a) *Emergency warnings:* Fishermen interviewed for the study showed less enthusiasm for complex and expensive technological solutions like NavIC-based transponders than to practical solutions like community radio and the use of already existing mechanisms like village loudspeakers and warnings routed through community organisations or the Church.

b) *Distress alerts:* Previous efforts like providing DATs or satellite beacons through government subsidised schemes have been ineffective because fishermen were inadequately trained to use and maintain these devices. Fisheries Departments can organise more frequent training programmes to sensitise fishermen about disasters and emergency warnings, the uses and maintenance of communication devices, etc.

c) *Consult fishers during SAR operations:* A recurring grievance among interviewed fishermen was the lack of communication between the community and the Coast Guard and Navy on SAR operations. In the immediate aftermath of a disaster such as a cyclone, rescue forces should consult fishermen on the specific locations of stranded fishing vessels, so that no time is lost and more lives can be saved.

Endnotes

1 Central government data, compiled immediately after Ockhi, on dead and missing people has since been revised after verification by state governments. This report relies on the most recent figures shared by the Kerala and Tamil Nadu governments.

2 Cyclone Nargis killed 140 000 people in Myanmar in May 2008.

3 Multiple mechanisms exist at the international level to address safety issues, like the 1968 Code of Safety for Fishermen and Fishing Vessels (since revised), the 1980 FAO/ILO/IMO Voluntary Guidelines for the Design, Construction and Equipment of Small Fishing Vessels, and the 2010 Safety Recommendations for Decked Fishing Vessels of Less than 12 meters in Length and Undecked Fishing Vessels.

4 1995 Code of Conduct for Responsible Fisheries of FAO, clause 8.2.5: "Flag States should ensure compliance with appropriate safety requirements for fishing vessels and fishers in accordance with international conventions." (FAO, 1995) Also, ILO Work in Fishing Convention, 2007, Article 31: "The prevention of occupational accidents, occupational diseases and work-related risks on board fishing vessels, including risk evaluation and management, training and on-board instruction of fishers." (ILO, 2007)

5 Statistics for the total number of casualties in Tamil Nadu were provided by the office of the State Relief Commissioner. Disaggregated district and village level data could not be obtained from the Directorate of Fisheries.

6 An analysis of the frequencies of cyclones on the east and west coasts of India during 1891-2000 show that nearly 308 cyclones (out of which 103 were severe) affected the east coast. During the same period 48 tropical cyclones crossed the west coast, of which 24 were severe cyclonic storms (World Bank, 2017).

7 Cyclone Phailin struck the coast of Odisha on 12 October, 2013. Although the IMD reported the formation of a depression on 8 October and issued its 'Orange Message' or Cyclone Watch only two days later, the CWC in Bhubaneswar had been in touch with the State Relief Commissioner since 6 October. Over 800 000 people were evacuated and housed in shelters by the day the system made landfall in Ganjam district. (UNDP, 2013; Nemana, 2013)

8 National Disaster Response Force (NDRF), established in 2006, draws its personnel from paramilitary forces like Central Reserve Police Force, Border Security Force, Indo Tibetan Border Police, Central Industrial Security Force, Sashastra Seema Bal (Armed Border Force) and Assam Rifles. It currently has a total sanctioned strength of 13 778 personnel divided into 12 battalions stationed across the country. NDRF personnel are Battalion No. 4, stationed in Arakonam, serves Tamil Nadu and Kerala. Kerala's own

100-member state disaster response force, stationed in Pandikkad, Malappuram, was renamed Rapid Response and Rescue Force (RRRF) in 2013 and its four teams are deployed in Kannur, Thrissur, Ernakulam and Thiruvananthapuram. (NDRF, 2016)

9 CAG General and Social Sector Audit Report 2011-12 (CAG, 2014)

10 The scheme was meant for both country craft and mechanised vessels. It included the setting up of base stations and distribution of subsidized VHF hand-held marine radios. (TN Fisheries, 2011)

11 Government of Kerala Fisheries and Ports Department Notification Dated 17 July, 1989 G.O.(P) 30/89/F & PD.

12 A 24-hour gate pass at Cochin harbour costs INR 15 ($0.25). Migrant workers wait near the docking stations and are called up by boat owners to fill up crew numbers.

13 Information courtesy Ajithkumar Sukumaran, Principal Officer, Merchant Marine Department, Cochin

14 Information on Sri Lankan HF Radio courtesy Dr. Y.S. Yadava, Director, Bay of Bengal Programme- Inter-Governmental Organization, Chennai; and Dr. Oscar Amarasinghe, Professor Department of Agricultural Economics, Faculty of Agriculture, University of Ruhuna, Sri Lanka (Retired).

15 Most households in Kerala (77 percent) and Tamil Nadu (87 percent) own televisions whereas radio coverage (30 percent and 23 percent, respectively) has reduced in recent years. (GoI, 2011)

16 Although the official forecast and warning for cyclone Vardah, which struck Tamil Nadu in December, 2016, was issued by the IMD only on 11 December, as a measure of caution, coastal districts were put on high alert from 8 December itself. Fishermen were also advised not to venture into the sea. (TN R&DM, 2017a)

References

Bay of Bengal Programme Inter-Governmental Organisation (2013): *Report: Strategic Workshop on Communication Needs of Marine Fishermen* (Unpublished),. BOBP IGO. BOBP/REP/143.Chennai

Brown, David and Poulain, Florence (Ed.) (2013): *Guidelines for the Fisheries and Aquaculture Sector on Damage and Needs Assessments in Emergencies*. FAO. Rome

Cattermoul, B., Brown, D., Fisheries, Poulain, F. (2014): *Fisheries and Aquaculture Emergency Response Guidance*. FAO. Rome, 2014

Comptroller and Auditor General (2014): *Audit of Disaster Preparedness in Tamil Nadu*, CAG Audit Report (General and Social Sector) 2011-12<http://iced.cag.gov.in/wp-content/uploads/2014/02/3.-PA-on-Disaster-Preparedness-in-TN.pdf>

Chari, Mridula and Katakam, Anand (2017): "World Bank assessment shows Kerala lags in coastal cyclone risk mitigation project," Scroll.in, 7 December, 2017<https://scroll.in/article/860499/world-bank-assessment-shows-kerala-lags-in-coastal-cyclone-risk-mitigation-project>

Central Marine Fisheries Research Institute (2010): Marine Fisheries Census, Department of Animal Husbandry, Dairying and Fisheries, CMFRI. Tamil Nadu <http://eprints.cmfri.org.in/9002/1/TN_report_full.pdf> , Kerala<http://eprints.cmfri.org.in/9004/1/Ker_report_full.pdf>

Government of India (2004):*Comprehensive Marine Fisheries Policy*, Ministry of Agriculture and Farmers Welfare, 2004<http://extwprlegs1.fao.org/docs/pdf/ind163860.pdf>

Government of India (2011): Census Housing, Household Amenities and Assets, 2011: Kerala<http://censusindia.gov.in/2011census/hlo/Data_sheet/Kerala/Figures_India_Kerala.pdf>; Tamil Nadu<http://censusindia.gov.in/2011census/hlo/Data_sheet/TN/HLO_Datasheet_All_indicators_Page1.pdf>

Government of India (2016):*Guidelines: Central Sector Scheme on Blue Revolution: Integrated Development and Management of Fisheries*, Department of Animal Husbandry, Dairying & Fisheries,Ministry of Agriculture and Farmers Welfare, <http://dahd.nic.in/sites/default/files/Guidelines.BR-30616.Fisheries.pdf>

Government of India (2017). *National Policy on Marine Fisheries, 2017*, Department of Animal Husbandry, Dairying & Fisheries Ministry of Agriculture and Farmers Welfare, http://dahd.nic.in/news/notification-national-policy-marine-fisheries-2017

Food and Agriculture Organization of the United Nations (1995): *Code of Conduct for Responsible Fisheries*. FAO. Rome<http://www.fao.org/docrep/005/v9878e/v9878e00.htm>

Kurien, J. and Paul, A. (2001): *Social Security Nets for Marine Fisheries: The Growth and Changing Composition of Social Security Programmes in the Fisheries Sector of Kerala State, India*. Centre for Development Studies. Thiruvananthapuram<http://www.cds.edu/wp-content/uploads/2012/10/wp318.pdf>

Murakami, H., Vecchi, G. and Underwood, S. (2017): *Increasing frequency of extremely severe cyclonic storms over the Arabian Sea*. Nature Climate Change, 7(12), pp.885-889

Murakami, H., Sugi, M. & Kitoh, A. (2013): *Future changes in tropical cyclone activity in the North Indian Ocean projected by high-resolution MRIAGCMs*. Climate Dynamics. 1949–1968

Muralidharan C.M., P. Narendrababu and B.L. Narasimha Raju (1998): *Baseline study on Training in Sea Safety Development in East Godavari District, AP*, Action for food Production for the FAO of the United Nations and Government of Andhra Pradesh, TCP/IND /6712, FAO Library No. AN 389367

Mariappan, Julie (2017): "We never sought info from fishermen, but after Ockhi we will," The Times of India, 5 December, 2017, Chennai<https://timesofindia.indiatimes.com/city/chennai/we-never-sought-info-from-fishermen-but-after-ockhi-we-will/articleshow/61922064.cms>

National Disaster Management Authority (2008):*National Disaster Management Guidelines: Management of Cyclones*. NDMA. Government of India. New Delhi<http://www.ndma.gov.in/images/guidelines/cyclones.pdf>

National Disaster Management Authority (2016): *National Disaster Management Plan*. NDMA. Government of India. New Delhi<https://ndma.gov.in/images/policyplan/dmplan/National%20Disaster%20Management%20Plan%20May%202016.pdf>

National Disaster Response Force (2016): *National Disaster Response Force: Saving Lives and Beyond*. NDRF. Government of India. New Delhi<http://ndrf.gov.in/Media/inapnacms/NewsLetter/Coffee%20Table%20Book.pdf>

Nemana, Vivek (2013): "The Great Escape," Grist Media, 22 November, 2013<https://in.news.yahoo.com/the-great-escape-103506320.html>

Press Information Bureau (2018): Damage as on 27-12-2017 due to cyclone Ockhi. 3 January 2018. Ministry of Information and Broadcasting. Government of India. New Delhi<http://pib.nic.in/PressReleaseIframePage.aspx?PRID=1515351>

Sainsbury, N., Genner, M., Saville, G., Pinnegar, J., O'Neill, C., Simpson, S. and Turner, R. (2018): *Changing storminess and global capture fisheries*. Nature Climate Change.

Salagrama, Venkatesh (2012): *Climate Change and Fisheries: Perspectives from Small-scale Fishing Communities in India on Measures to Protect Life and Livelihood*. Samudra Monograph. International Collective in Support of Fishworkers. Chennai<https://www.icsf.net/images/monographs/pdf/english/issue_121/121_Climate_Change_17May12_3_53PM.pdf >

Sri Lanka Fisheries (2016): *Fisheries Statistics 2016*, Ministry of Fisheries and Aquatic Resources Development, Government of Sri Lanka <http://www.fisheries.gov.lk/documents/c5px3hp60mxw2aqdbz8v5wks4.pdf>

Sri Lanka Fisheries (2018): Log Book Details of High Seas and EEZ Multi Day Vessels, Department of Fisheries and Aquatic Resources, Government of Sri Lanka<http://fisheriesdept.gov.lk/v3/en_US/2016/08/27/lob-book-details-of-high-seas-vessels/>

The Hindu (2017): "367 fishermen rescued so far by Coast Guard," The Hindu, 7 December 2017,Chennai<http://www.thehindu.com/news/national/tamil-nadu/367-fishermen-rescued-so-far-by-coast-guard/article21285532.ece>

Tamil Nadu Fisheries (2011): "Fisheries Department Policy Note 2011-12," Government of Tamil Nadu, <http://cms.tn.gov.in/sites/default/files/documents/fisheries_7.pdf>

Tamil Nadu R&DM (2017a): "Revenue and Disaster Management Department Policy Note 2017-2018,"Government of Tamil Nadu<http://cms.tn.gov.in/sites/default/files/documents/revenue_e_pn_2017_18.pdf>

Tamil Nadu R&DM (2017b): "Disaster Management – North-East Monsoon 2017 – Preparedness Measures for Management of Cyclone Instructions," Rc. No. N.C.I (4) / 3137 / 2017, Government of Tamil Nadu

United Nations Development Programme (2007): *Local Level Risk Management: Indian Experience*. UNDP India. New Delhi<http://www.undp.org/content/dam/india/docs/llrm.pdf>

United Nations Development Programme (2013): *Preparing for Disaster: Lessons from Phailin Response*. UNDP India. New Delhi<http://www.undp.org/content/dam/india/docs/CPR/UNDP%20-%20Preparing%20for%20Disaster%20-%20Lessons%20from%20Phailin%20Response.pdf>

United Nations General Assembly (2015): *Transforming our World: the 2030 Agenda for Sustainable Development*, UN Doc. A/Res/70.1. UN. New York< http://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf>

United Nations International Strategy for Disaster Reduction (2015): *The Sendai Framework for Disaster Risk Reduction 2015-2030*. UNISDR. Geneva<https://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf>

Varma, Vishnu (2017): "ISRO's NAVIC system to guide deep-sea fishermen from Kerala," The Indian Express, 29 December, 2017, Cochin<http://indianexpress.com/article/technology/science/isros-navic-system-to-guide-deep-sea-fishermen-from-kerala-5004155/>

World Meteorological Organization (2017): *Global Guide to Tropical Cyclone Forecasting*. WMO. Geneva <https://www.wmo.int/cycloneguide/pdf/Global-Guide-to-Tropical-Cyclone-Forecasting.pdf>

World Bank (2017): *Implementation and Results Reports*, Cyclone Disaster Risk Reduction Project<http://documents.worldbank.org/curated/en/742901498522409437/pdf/ISR-Disclosable-P144726-06-26-2017-1498522397107.pdf>

National Cyclone Risk Mitigation Project–II<http://documents.worldbank.org/curated/en/675671511993892232/pdf/Disclosable-Version-of-the-ISR-Tamil-Nadu-and-Puducherry-Coastal-Disaster-Risk-Reduction-Project-P143382-Sequence-No-09.pdf>

ANNEXURE 1

Interviews

Dr. Abhilash S., Assistant Professor, Department of Atmospheric Sciences, Cochin University of Science & Technology, Cochin

Ajithkumar Sukumaran, Principal Officer, Mercantile Marine Department, Government of Kerala, Cochin

Kamal Kishore, Member, National Disaster Management Authority, Government of India, New Delhi

P.H. Kurian, Additional Chief Secretary, Revenue and Disaster Management, Government of Kerala, Thiruvananthapuram

K.M. Lethy, Additional Director of Fisheries, Government of Kerala, Thiruvananthapuram

Dr. Mrutyunjay Mohapatra, Scientist and Director, Regional Specialized Meteorological Centre-IMD, New Delhi

Ravindran Nair, Former Executive Director, Fisheries Department, Government of Kerala, Thiruvananthapuram

Dr. Paul Pandian, Fisheries Development Officer, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers' Welfare, Government of India, New Delhi

Rajendra Ratnoo, Commissioner, Disaster Management and Project Director, CDRRP, Government of Tamil Nadu, Chennai

Dr. E. Ramesh Kumar, Joint Secretary (Fisheries), Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers' Welfare, Government of India, New Delhi

Sahadevan P., Additional Director, Department of Fisheries, Government of Kerala, Thiruvananthapuram

Dr. G.S. Sameeran, Director, Directorate of Fisheries, Government of Tamil Nadu, Chennai

Dr. K. Satyagopal, Principal Secretary, Revenue Administration, Disaster Management and Mitigation, Government of Tamil Nadu, Chennai

Dr. Sekhar L. Kuriakose, Member, Kerala State Disaster Management Authority & Head (Scientist), State Emergency Operation Centre, Thiruvananthapuram

N.A. Shah Ansari, Founder and Chairman, Radio Namaskar, Konark

Inspector General Sivamani Paramesh, Deputy Director General (Operations & Coastal Security), Indian Coast Guard, Ministry of Defence, Government of India, New Delhi

S. Sudevan, Scientist and Former Director, Regional Meteorological Centre, Thiruvananthapuram

Peter T., General Secretary, National Fishworkers Forum, Thiruvananthapuram

V.P. Thandapani, District Collector, Cuddalore (Former State Director of Fisheries), Government of Tamil Nadu, Chennai

K.G. Thara, Former Member, Kerala State Disaster Management Authority, Thiruvananthapuram

V. Vivekanandan, Advisor, South Indian Federation of Fishermen Societies and Member, International Collective in Support of Fishworkers, Chennai

Dr Yugraj Singh Yadava, Director, Bay of Bengal Programme Inter-Governmental Organisation, Chennai

ANNEXURE 2

Rehabilitation measures by the Tamil Nadu and Kerala Governments after Cyclone Ockhi:

Tamil Nadu	Kerala
• Relief assistance of INR 2 million each to the families of the deceased fishermen. A total sum of INR 54 million was given to 27 families of the fishermen who died in the cyclone.	• A one-time assistance of INR 2,000 each provided to 169,000 active fishermen enrolled in the Savings-Cum-Relief Scheme of Fisheries Department as the fishermen community could not venture into the sea for over two weeks after 30 November, 2017.
• A sum of INR 1 million each and a fixed deposit of INR 1 million each, which can be encashed after a period of 6 months, to the legal heirs of the 177 missing fishermen in Ockhi (Total INR 354 million).	• Ex-gratia of INR 2 million each (Total INR 104 million) to families of the 52 deceased fishermen.
• INR 22 million towards diesel and ration expenses to bring back 217 fishing boats and 1,754 fishermen affected during Ockhi.	• Ex-gratia of INR 2 million each to also be disbursed to families of 91 missing fishermen in Ockhi (Total INR 182 million).
• Special livelihood assistance of INR 5,000/- each (Total INR 153.7 million) disbursed to 30,756 fishermen families of Kanniyakumari district affected by Ockhi.	• Assistance of INR 500,000 each for all seriously injured individuals.
• Special livelihood assistance of INR 5000/- each (Total INR 940,000) disbursed to families of missing fishers.	• Equal compensation for both the boats and nets lost.
• Enquiry by a committee under the chairmanship of Commissioner of Revenue Administration ordered to determine relief assistance for families of missing fishers.	• Children from the families of the deceased to get free education and training in alternative livelihood.

Tamil Nadu	Kerala
• INR 500,000 each to fishermen who are permanently disabled. Further, INR 50,000/- each to meet the hospital bills of injured fishermen. Relief assistance of INR 50,000/- each has been given to the 20 injured fishermen. • INR 200 million sanctioned from State fund to the restore harbors and landing centres in Kanniyakumari damaged due to the cyclone. Tenders to be called for restoration works.	• INR 20 billion package for coastal districts in state budget 2018. [Total fisheries sector outlay: INR 6 billion; satellite communication system linking all fishing vessels and coastal villages: INR 1 billion; relocation of families residing within 50 meters of the coastline: INR 1.5 billion; completion of work on 11 fisheries harbors: INR 5.84 billion; comprehensive study and measures to protect entire coastal belt of Kerala: INR 3 billion]

ANNEXURE 3

Questionnaire for fisher interviews

1. Type of craft, gear, fishing range and description of typical fishing operations. Whether boat owner / labor.
2. Description of cyclone and steps taken to return to shore.
3. Whether Ockhi-like storms had been experienced in the past and what made the cyclone unique.
4. Perception of weather and sea conditions prior to departure – any early signs read by elderly traditional fishermen.
5. Early warning systems in place and whether warning was received during Ockhi.
6. Type of communication equipment on board and reasons why better modes not adopted.
7. Type of safety equipment in use and reasons why.
8. Fishers' experience of Search & Rescue operations and suggestions to improve response.
9. Assistance provided by the State for relief and rehabilitation and what more is needed.
10. Strategies to ensure warning dissemination and safety at sea in the future.

ANNEXURE 4 SAMPLE BULLETINS

India Meteorological Department
Earth System Science Organisation
(Ministry of Earth Sciences)

BULLETIN NO. : 01 (BOB 07/2017)

TIME OF ISSUE: 1150 HOURS IST **DATED: 29.11.2017**

FROM: INDIA METEOROLOGICAL DEPARTMENT (FAX NO. 24643965/24699216/24623220)

TO: CONTROL ROOM, NDM, MINISTRY OF HOME AFFAIRS (FAX.NO. 23093750)
CONTROL ROOM NDMA (FAX.NO. 26701729)
CABINET SECRETARIAT (FAX.NO.23012284)
PS TO HON'BLE MINISTER FOR S & T AND EARTH SCIENCES (FAX NO.23316745)
SECRETARY, MOES, (FAX NO. 24629777)
SECRETARY, DST (FAX NO. 26863847/-2418)
H.Q. (INTEGRATED DEFENCE STAFF AND CDS) (FAX NO. 23005137/23005147)
DIRECTOR GENERAL, DOORDARSHAN (23385843)
DIRECTOR GENERAL, AIR (25843825)
PIB MOES (FAX NO. 23389042)
UNI (FAX NO. 23355841)
D.G. NATIONAL DISASTER RESPONSE FORCE (NDRF) (FAX NO. 26105912)
CHIEF SECRETARY, GOVT.OF KERALA (FAX NO. 0471-2518006)
CHIEF SECRETARY, GOVT.OF TAMIL NADU ((FAX NO. 044-25672304)
CHIEF ADMINISTRATOR, LAKHADWEEP ISLANDS (FAX NO. 04896-262184)
CHIEF SECRETARY, GOVT.OF PUDUCHERRY (FAX NO. 0413-2337575)
DIRECTOR, PUNCTUALITY, INDIAN RAILWAYS (FAX NO. 23388503)

Sub: Depression over southwest Bay of Bengal off Sri Lanka Coast

Latest observations and satellite imageries indicate that a depression has formed over southwest Bay of Bengal off Sri Lanka coast. It lay centred at 0830 hrs IST of today, the 29th November, 2017 near Latitude 6.5º N and Longitude 81.8 ºE, about 80 km to the east-southeast of Hambantota and 500 km east southeast of Kanyakumari. The system is very likely to move westnorthwestwards and cross Sri Lanka coast close to northeast of Hambantota around noon of today. It would then continue to move west-northwestwards across Sri Lanka and emerge into Comorin area by tomorrow. The system is very likely to intensify further into a deep depression during next 24 hours.

Warning:

(i) Heavy Rainfall warning:

- Rainfall at most places with Heavy to very heavy rainfall at isolated places is very likely over south Tamil Nadu during next 48 hours.
- Rainfall at most places is very likely over south Kerala with heavy rainfall at isolated places during next 24 hours and isolated heavy to very heavy rainfall during subsequent 24 hours.
- Rainfall at most places with Heavy to very heavy rainfall at isolated places is very likely over Lakshadweep islands on 1st and 2nd December.

(ii) Wind warning:

- Squally winds reaching 45-55 kmph gusting to 65 kmph is very likely along and off South Tamil Nadu and South Kerala during next 48 hours and over Lakshadweep Islands and adjoining sea areas on 01st and 02nd December.

(ii) Sea condition: Sea conditions would be rough to very rough along & off South Tamil Nadu and South Kerala during next 48 hours and over Lakshadweep Islands and adjoining sea areas on 01st and 02nd December.

(iii) Fishermen Warning: Fishermen along & off South Tamil Nadu and South Kerala coasts are advised not to venture into sea during next 48 hours and along and off Lakshadweep Islands are advised not to venture into the sea on 01st and 02nd December.

The next bulletin will be issued at 1430 hrs IST of 29th November 2017.

(Neetha K Gopal)
Scientist-E, RSMC, New Delhi

Copy to: CRS, Pune/ ACWC Chennai/ MC Thiruvanathapuram/ MC Begaluru.

Spatial rainfall distribution: Isolated: <25%, A few: 26-50%, Many: 51-75%, Most: 76-100%
Rainfall amount (mm): Heavy rain: 64.5 – 115.5, Very heavy rain: 115.6 – 204.4, Extremely heavy rain: 204.5 or more.

MESSAGE

FROM: ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES
(Earth System Science Organisation, Ministry of Earth Sciences, Government of India)
(E-Mail: osf@incois.gov.in, Website: www.incois.gov.in, FAX NO. +91-40-23892910)

INCOIS-IMD JOINT BULLETIN

To: Chief Secretary, Government of Kerala
KSDMA, Thiruvananthapuram
Administrator, UT of Lakshadweep
Commandant, Indian Coast Guard, Southern Region
DNOM, Indian Navy
Reliance Foundation, Mumbai
MSSRF, Chennai
PMSSS, Puducherry
Administrator, UT Puducherry
Kamaraj College, Tuticorin
Ports in Tamil Nadu, Kerala and Lakshadweep
Chief Secretary, Government of Tamil Nadu
Chief Secretary, Government of Karnataka
Shipping Corporation of India.
T.V. & Radio channels and newspapers of relevant states/UT

Time of issue: 18:00 hours IST Dated: 01.12.2017, Bulletin No.: INCOIS/01/12/2017/4

Sub: INCOIS-IMD Joint Bulletin - Ocean State Forecast associated with Very Severe Cyclonic Storm 'OCKHI' over Lakshadweep area and adjoining Southeast Arabian Sea and Cyclone Warning for Lakshadweep Islands- RED message

The severe cyclonic storm **'OCKHI'** over Lakshadweep area and adjoining Southeast Arabian Sea continued to move west-northwestwards with a speed of 15 kmph during past 06 hours and intensified further into a **Very Severe Cyclonic Storm** and lay centred at 1430 hrs IST of today, the 01st December, 2017 over Lakshadweep area and adjoining southeast Arabian Sea near Latitude 9.1º N and Longitude 73.0º E, about 90 km north of Minicoy and 220 km south-southeast of Amini Divi. The system is very likely to intensify further during next 24 hours. It is very likely to continue to move west-northwestwards across Lakshadweep Islands during next 24 hours and then move north/ northeastwards during the subsequent 48 hours.

High Wave/Ocean State warning for Lakshadweep, Kerala, Karnataka and South Tamilnadu

1. Lakshadweep:

Table 1: Forecasted highest wave (along with time) and corresponding swell height, for locations **10 km off** Lakshadweep.

GLOSSARY*

Affected: People who are affected, either directly or indirectly, by a hazardous event. Directly affected are those who have suffered injury, illness or other health effects; who were evacuated, displaced, relocated or have suffered direct damage to their livelihoods, economic, physical, social, cultural and environmental assets. Indirectly affected are people who have suffered consequences, other than or in addition to direct effects, over time, due to disruption or changes in economy, critical infrastructure, basic services, commerce or work, or social, health and psychological consequences.

Build Back Better: The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalisation of livelihoods, economies and the environment.

Climate Change: A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Disaster: A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

Disaster management: The organization, planning and application of measures preparing for, responding to and recovering from disasters.

Disaster risk assessment: A qualitative or quantitative approach to determine the nature and extent of disaster risk by analysing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend.

Disaster risk management: The application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses

Disaster risk reduction: Disaster risk reduction is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development.

Early warning system: An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities, systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events.

Mitigation: The lessening or minimizing of the adverse impacts of a hazardous event.

Preparedness: The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.

Reconstruction: The medium- and long-term rebuilding and sustainable restoration of resilient critical infrastructures, services, housing, facilities and livelihoods required for the full functioning of a community or a society affected by a disaster, aligning with the principles of sustainable development and "build back better", to avoid or reduce future disaster risk.

Recovery: The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and "build back better", to avoid or reduce future disaster risk.

Rehabilitation: The restoration of basic services and facilities for the functioning of a community or a society affected by a disaster.

Response: Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Structural and non-structural measures: Structural measures are any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resilience in structures or systems. Non-structural measures are measures not involving physical construction which use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education.

Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

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* Adapted from definitions used by the United Nations International Strategy for Disaster Reduction (UNISDR) Sendai Framework for Disaster Risk Reduction 2015-2030; the National Disaster Management Authority of India; and the United Nations Framework Convention on Climate Change

Cyclone Ockhi: Disaster risk management and sea safety in the Indian marine fisheries sector

Between 29 November and 3 December, 2017, Cyclone Ockhi devastated hundreds of lives and livelihoods of coastal fishing communities in Kerala and Tamil Nadu, India. This study assesses the impacts of the cyclone on fishing communities and the mechanisms in place at the local, national and international levels to address disaster risks and sea safety in small-scale fisheries, using a human rights-based approach. In line with the Sendai Framework 2015-2030 and the Voluntary Guidelines for Securing Sustainable Small-scale Fisheries, the study recommends applying "relief-development continuum" and "build back better" concepts to the management of disaster risks in order to save lives and to reduce damage to fisheries as sets and livelihoods.

The study will be useful for researchers, scientists, fishworker organisations, environmentalists and anyone interested in disaster risk management, climate change and fisheries management.

ICSF is an international NGO working on issues that concern fishworkers the world over. It is in status with the Economic and Social Council of the UN and is on ILO's Special List of Non-Governmental International Organizations. It also has Liaison Status with FAO. As a global network of community organisers, teachers, technicians, researchers and scientists, ICSF's activities encompass monitoring and research, exchange and training, campaigns and action, as well as communications.

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