Extreme Events and Resilience in the times of Pandemic: A Case Study

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For the last thirty years or so, the world is increasingly looking at environmental extremes, many of which are triggered by climate change. Scientists, though divided over the extent and likely damages to be caused by global warming, are unanimous about the need to build in mitigating and adaptive measures in local, national and global policies. However, another likely impact of climate change had remained out of focus till 2020 – the potential for contagious diseases going 'viral' and spreading pan-world. COVID19, as we know it, changed all that and globally interest has surged in this area too over the last few months. A handful of researchers are also underlining the threat of multiple shocks attacking a country or society simultaneously and the likely impact of such contagion effect. Using a case study, this paper tries to discuss how resilience to climate extreme events is affected by health extreme events like pandemic and what lessons we can draw from these. The paper starts with a background on extreme events, resilience, damage costs and avoidance costs. Thereafter it looks into the fundamentals of resilience planning and how cyclone management policies have evolved in India over the last two decades. Finally, it examines how the prevalent pandemic has affected resilience activities during a recent severe cyclonic storm in eastern India – bringing to limelight the problems faced during multiple extreme events. The issues discussed have serious implications for future resilience planning and implementation policies across the globe.

Keywords: Climate Change; Extreme Events; Resilience; Pandemic; Multiple shocks; COVID19; Amphan;

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EXTREME EVENTS AND RESILIENCE IN THE TIMES OF PANDEMIC: A CASE STUDY

For the last thirty years or so, the world is increasingly looking at environmental extremes, many of which are triggered by climate change. Scientists, though divided over the extent and likely damages to be caused by global warming, are unanimous about the need to build in mitigating and adaptive measures in local, national and global policies. However, another likely impact of climate change had remained out of focus till 2020 – the potential for contagious diseases going 'viral' and spreading pan-world. COVID19, as we know it, changed all that and globally interest has surged in this area too over the last few months. A handful of researchers are also underlining the threat of multiple shocks attacking a country or society simultaneously and the likely impact of such contagion effect. Using a case study, this paper tries to discuss how resilience to climate extreme events is affected by health extreme events like pandemic and what lessons we can draw from these. The paper starts with a background on extreme events, resilience, damage costs and avoidance costs. Thereafter it looks into the fundamentals of resilience planning and how cyclone management policies have evolved in India over the last two decades. Finally, it examines how the prevalent pandemic has affected resilience activities during a recent severe cyclonic storm in eastern India – bringing to limelight the problems faced during multiple extreme events. The issues discussed have serious implications for future resilience planning and implementation policies across the globe.

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I. INTRODUCTION

A spec on the meteorological radar appeared on 13th of May, 2020 when a low pressure system developed over Bay of Bengal in the North Indian Ocean region, about a thousand kilometres southeast of the Indian coastline city of Visakhapatnam (aka Vizag) in the state of Andhra Pradesh. It was a fairly common event for the region given the season, but little did one know at that time that this would in a week develop into the costliest cyclonic storm in recorded history (Sud & Prema, 2020). Over the next few days it went through some favourable transformations, aided largely by the exceptionally warm sea surface temperature, and by 19th of May it had developed into a 'Very Severe Cyclone' according to the categorisation by Indian Meteorological Division (IMD) and was christened 'Amphan'[1,2]. Next afternoon it made landfall near Bakkhali (part of Indian Sunderbans) in the Indian state of West Bengal with gusting winds over 150 kmph. It weakened as it moved over land, but nevertheless left a trail of devastation and death. Such cyclones have become more frequent

in recent years and scientists claim that this is due to global warming and climate change which are causing sea surface temperature to become very high in the region. For this reason the low pressure system intensified from a Category-I storm in the Saffir-Simpson scale to a Category-V storm in just 18 hours (Koll, 2020)[3]. This region clocks an average of five cyclones every summer season and preparedness remains generally high. But this year was different. By the time 'Amphan' was detected, India, like most parts of the world, was already reeling under 'Lockdown' to combat the spread of the biological hazard COVID19[4]. The lockdown that was in place since 24th of March was a strict lockdown with movement of people and vehicles completely prohibited, factories and shops closed and shuttered, and Indian Railways – the largest rail network in the world – suspending all regular passenger trains for the first time since independence. This exacerbated the process of both preparations and rescue operations when the cyclone struck and brought to fore the absence and the urgency of having policies to deal with simultaneous multiple shocks. In this paper we discuss these issues in detail to identify the missing elements in policy protocol in India in particular, and in developing countries in general, while facing compound hazards. The paper has five sections. The next section outlines the basic facts about global warming and climate change and their relationship with extreme events – both environmental and biological. In the third section we deal with the concept of resilience and the costs of shocks and their prevention. In the fourth section we describe how resilience towards cyclonic storms was compromised due to a simultaneous occurrence of another shock – the biological hazard. In the final section we outline the lessons learned from this experience and the policy response that may be put in place to deal with such situation – which looks to become increasingly regular in near future.

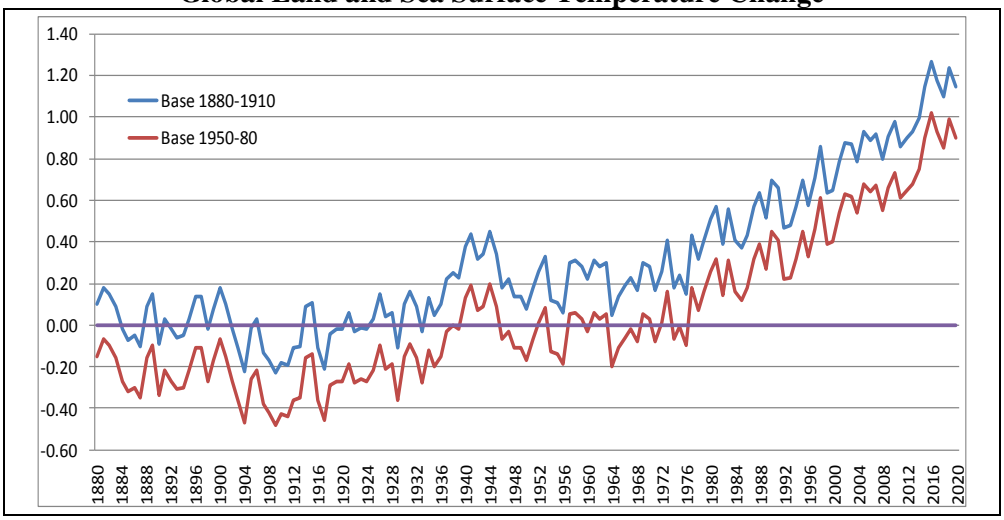
II. GLOBAL WARMING AND EXTREME EVENTS

1. Global Warming

The atmosphere of the earth envelopes and protects it from the harmful effects of sun's radiation. Some gases present in the atmosphere allows light rays to come in during daytime, but absorbs long waves of heat radiated out by earth during night. This heat is reflected back to earth, keeping it warm and habitable. This is akin to the capture of heat in glasshouses to grow plants in colder climates and was named greenhouse effect by French polymath Jean-Baptiste Fourier in 1827. By end of that century, Svante Arrhenius and P C Chamberlain had independently written about the effect of building up of Carbon-dioxide in the atmosphere and the possibility of global warming. After a lull of half a century, the issue came up in a big

way in 1957 when US oceanographer Roger Revelle warned that humanity is conducting a "*large-scale geophysical experiment*" on the planet by releasing greenhouse gases (Revelle and Suess, 1957). Since then world has woken up to warmer days every year and global warming is now a reality. Human activities, mostly related to our quest for *development* since the days of *First Industrial Revolution*, has abetted the situation to a large extent. Our development trajectory has been propelled by profligate burning of fossil fuel, massive deforestation, concretisation of built environment, and trying to overturn the forces of nature. All of these led to increased stock of greenhouse gases in the atmosphere, which enhances the heat-capture phenomenon and artificially warms up the earth.

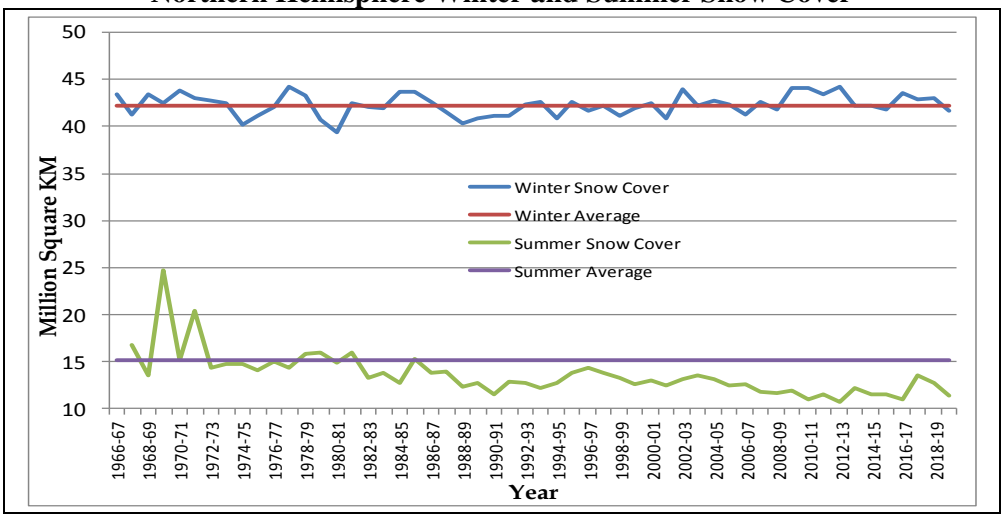
Figure 1
Global Land and Sea Surface Temperature Change



Source: GISTEMP Team (2020), Lenssen et al. (2019)
Notes: Temperature changes are measured as difference of individual year mean temperature over the average of mean temperature of (a) 1880-1910 period, and (b) 1950-80 period.

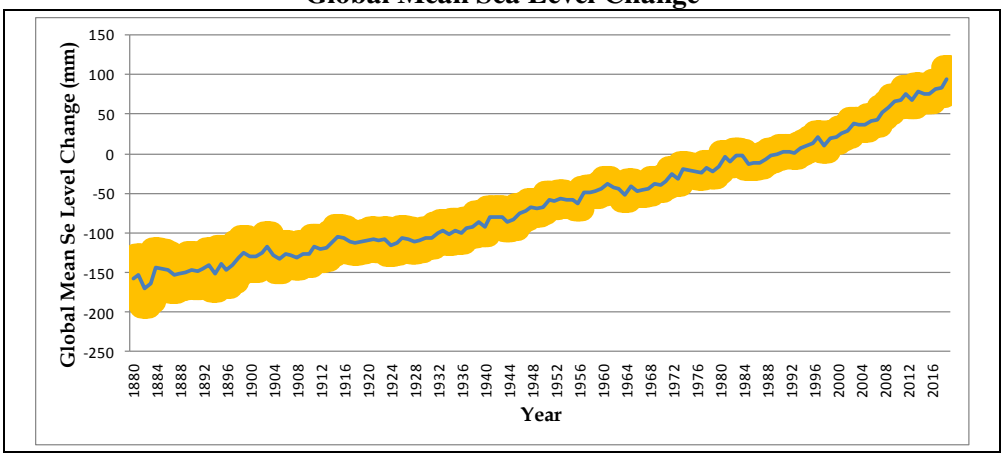
There is scientific consensus that global average surface temperature is rising since the beginning of the twentieth century, with a period of slight cooling during 1940-70 (Figure 1). This has been accompanied by a drop in number of cold days and nights and a rise in warm days and nights in a year. Precipitation patterns have changed as warmer sea-surface temperature has led to more water vapour in the atmosphere, and frequency of heavy rain/snowfall have increased even in places where total precipitation has decreased. This warmer climate has led to consistent reduction of area under snow-cover in the higher latitudes and melting of glaciers. A clear indication of the warming is observed from the declining trend of summer snow cover in the northern hemisphere (Figure 2). Summer snow cover has not reached the 1985-86 level ever after in last 35 years.

Figure 2
Northern Hemisphere Winter and Summer Snow Cover



Source: RUGSL (2020)
Notes: Averages are for 1967-1990 period; Summer consists of April-August months while Winter consists of November-March months

Figure 3
Global Mean Sea Level Change



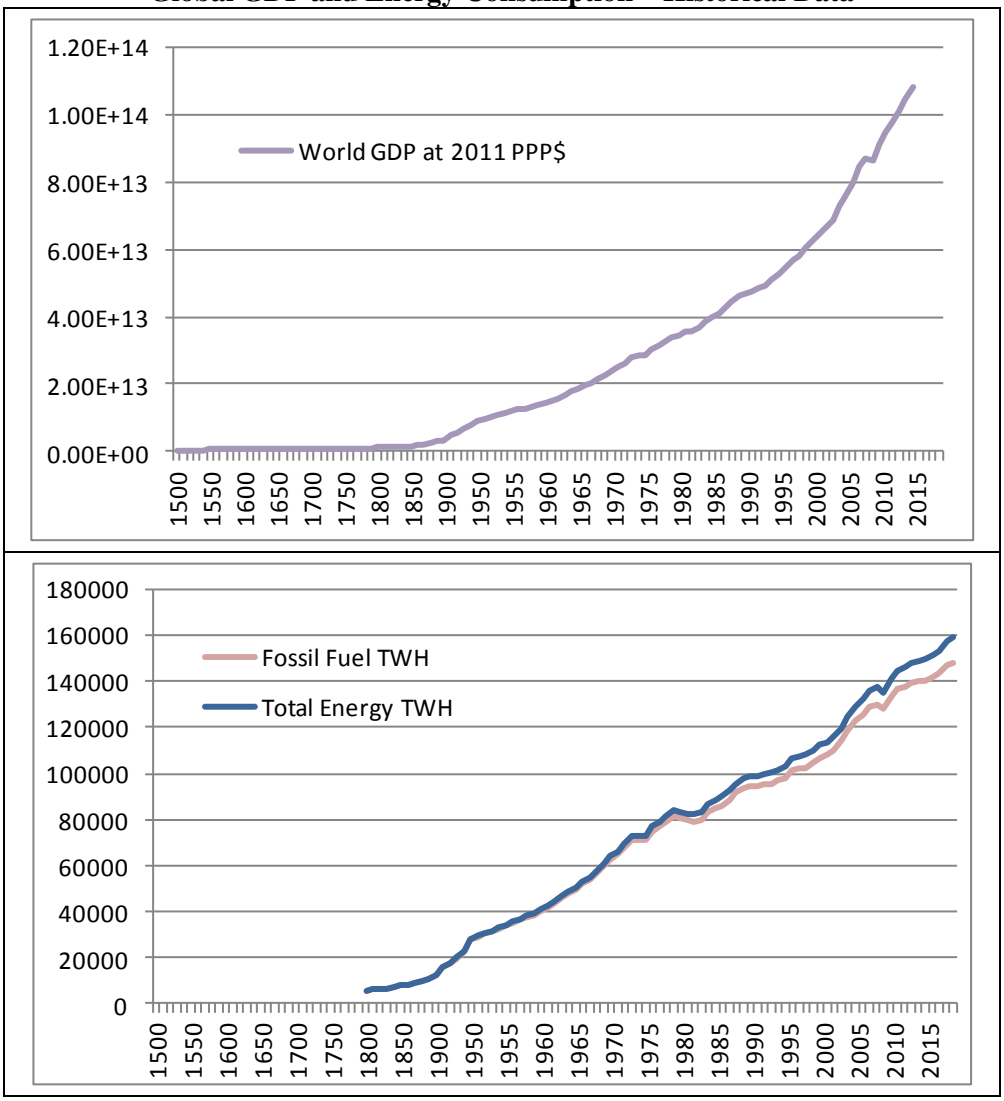
Source: Based on CSIRO (2020), updates of Church and White (2011)
Notes: Data are reported as changes relative to 1990 global average and are annual averages. Shaded area shows annual variance / uncertainty.

Mean sea level is rising due to both melting of land ice (more water being drained into seas and oceans) and expansion of sea water due to warmer temperature (Figure 3). This has serious implications for coastal communities and island countries, many of which will simply be wiped off the face of the earth if the rising sea level continues for another 50 years.

All these markers roughly match with the period of fast economic growth in the history of mankind and the race towards 'industrialisation' accompanied by a humungous rise in energy consumption, most of which have been fossil fuel (Figure 4). Such a consistent change in average weather parameters over a long period across the globe is different from year-on-year or regional variations in weather parameters, and is the marker of Climate Change. Climate Change, among other things are leading to a rise in frequency and intensity of extreme events

or shocks to the human society and economy. Here we seek to link climate change with two types of shocks – Tropical Cyclones and Infectious Diseases and how their juxtaposition is making matters complex.

Figure 4
Global GDP and Energy Consumption – Historical Data



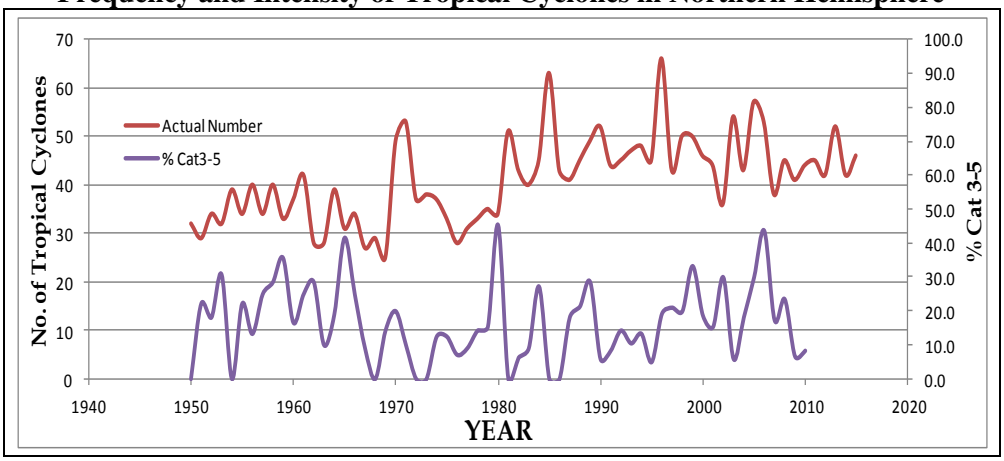
Source: Based on Bolt et al. (2018), Vaclav (2017), BP (2017); obtained from OWID (2020)

2. *Climate Change and Tropical Cyclones*

Tropical Cyclones are tropical weather systems in which intense low pressure areas develop in the atmosphere near to earth's surface leading to winds equal to or exceeding 'gale force' (i.e. 34 knot or 62 kmph). These are extreme weather events and are characterised by destructive winds, storm surges and very heavy rainfall. They are considered as one of the most harmful natural disasters which affect an average of more than 20 million people worldwide every year and leads to an economic cost of US$29 billion in direct damages (Guha-Sapir, 2017). Cyclones are devastating because of the destruction they cause to houses, power and communication towers, roads & bridges, and other essential structures like

hospitals, food storage houses, standing crops, etc., due to high velocity winds and flooding following heavy rainfall and storm surges in coastal areas. They lead to a massive loss of life, livestock, productive assets and livelihood. Their formation are aided by warm sea surface temperature; high relative humidity in the atmosphere; and atmospheric instability that encourages the formation of massive vertical cumulus clouds, among others. All these are favourably affected by global warming. Thus it is not surprising that over the last fifty years or so, frequency of tropical cyclones has shown a rising trend (Figure 5). In addition, proportion of high intensity cyclones (Category 3-5) have increased, even in basins where total number of cyclones has shown a mild declining trend.

Figure 5
Frequency and Intensity of Tropical Cyclones in Northern Hemisphere



Source: Based on Knapp et al. (2010, 2018) and NOAA's IBTrACS data 2020
Notes: Data are reported as changes relative to 1990 global average and are annual averages. Shaded area shows annual uncertainty

3. Climate Change and Diseases

The link between Climate Change and Diseases, both human and of other animals, have been studied for quite some time now. Scientific evidences confirm that global warming has the potential to encourage increased transmission of diseases. First, infectious agents (e.g. malarial parasites in the mosquito) develop more rapidly in warmer climate. Second, warmer climate means that vectors like mosquitoes now have a longer active season. Third, warming up also means extension of the tropical climate beyond the tropics and therefore extends the geographic range of vectors like mosquitoes and birds. Fourth, global warming and associated climate change has been associated with behavioural changes in vectors, e.g. changing pattern of migration among birds. All these lead to different groups & breeds of animals coming in contact with one another, which otherwise would have remained separated. As a result the pathogens (or viruses as we call them) get a chance to 'jump' from one host animal to another, mutate, and finally combine with human virus to end up in

humans. In addition, factors that drive global warming and climate change also trigger such epidemics. For example, deforestation leads to global warming and at the same time cause loss of habitat for a large number of animal species. So they migrate and come in contact with human beings[5]. At the same time, declining habitat leads to fall in supply of animals that humans eat, and humans, being what they are, experiment with eating new animals that are considered exotic or venture into virgin forests in search of animals. This increases the chances of humans contacting viruses from animals which may prove catastrophic. Massive concentration of domesticated animals around the world, fast urbanisation that leads to densely packed cities where diseases are easily transmitted from person to person, and air travel that allows germs to travel around the globe in less than a day are some of the other factors that has increased our vulnerability to pandemics (Bernstein, 2020). Another factor that is linking global warming with disease transmission is that with warming climate, more and more people are cooped in closed air-conditioned spaces for long periods, increasing chances of human to human transmission of viruses. Before the COVID19 spread and devastated the globe, several instances of flu pandemic had hit headlines in this century, in addition to growing spread of other infectious diseases like Lyme disease, malaria, dengue, etc.

COVID19 is a form of pneumonia, a contagious respiratory illness like Influenza (commonly known as the Flu). While pneumonia spread is infrequent, spread of flu is most common among infectious diseases. 'Flu' is a zoonotic disease caused by a constantly varying RNA virus originating from birds and lower animals like pigs and other mammals. Thus continuous surveillance is needed to identify and isolate the specific sub-type of the virus and update human vaccines likewise (Webster, 2002). It has also been argued that most of the influenza pandemics of the twentieth century, including the 'Spanish Flu' of 1918 that killed 50 million people worldwide, were of avian origin (Horimoto et al., 2005; Taubenberger et al., 2005). Some scientists claim that climate changes influence wild water bird habitat, their migration pattern and range, and stopover sites. This in turn determines the global distribution of avian virus agents and possibly the emergence of a new pandemic influenza strain (Curseu et al., 2010).

Apart from aiding the transmission mechanism, climate change is making humans more vulnerable to pandemics like COVID19 in another way. It is widely accepted that the susceptibility and fatality to respiratory illness in general, and corona virus in particular, is higher in places with poor air quality like metro cities (Hai-Dong Kan et al., 2005). Hence

fossil fuel burning, air pollution, and climate change increases the propensity to be affected by such diseases.

III. SHOCKS AND RESILIENCE

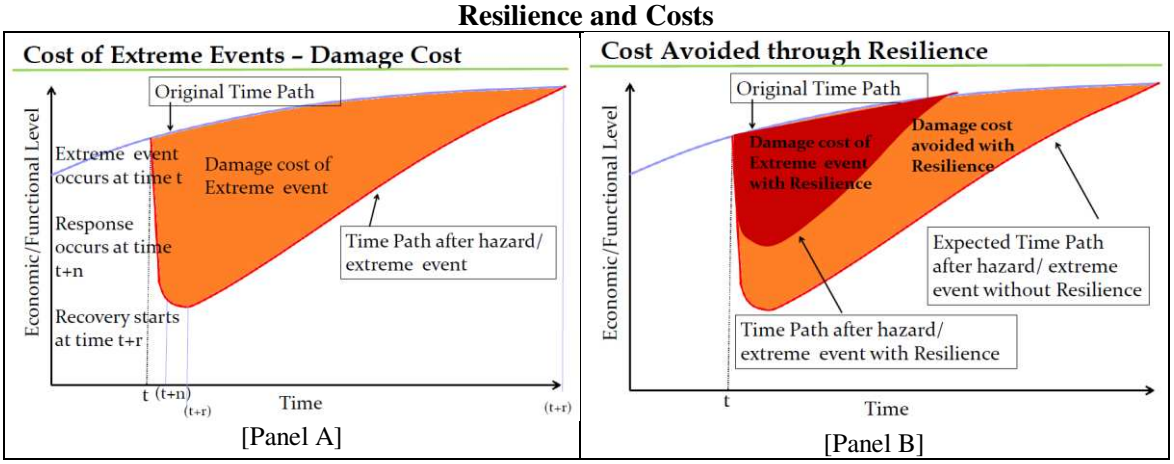
1. Extreme Event, Damage Cost and Resilience

To combat shocks human society must take measures to - (a) avoid the shocks as far as possible by taking preventive measures; and (b) minimize the negative impact by taking remedial measures. The power of a society to combat shocks is called Resilience. As the IPCC puts it, Resilience is:

> "The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation." [IPCC, 2014]

Thus there are four key elements of a resilient society. The first one is how it prevents hazards to happen in the first place. The second element is planning so that in case of an unavoidable extreme event, the impact on our built environment is minimum. The third element is to maintain functionalities as much as possible. The fourth element is to restore the normal functionality of the society and economy and get back to the pre-shock level as early as possible. Thus a resilient society can reduce the cost of damages arising out of an extreme event or a shock. Figure 6 helps us in understanding this further.

Figure 6
Resilience and Costs



Source: Author's representation

In Panel-A, we draw the likely time path of a society/economy which faces a shock at time t. The blue line is the normal time path without shock. As the extreme event (or hazard or shock) strikes at period t, immediately the functional level of the economy nosedives from its normal time path (shown by the red line). Response actions that arrest the declining functionality start at time (t+n) and the sharp decline is checked. Recovery starts at period

(t+r) when the society takes a U-turn and starts bouncing back towards its normal level once more. Finally, at (t+s) period the society comes back to its pre-shock time path. Thus the shaded area is the loss in functionality (or economic loss, if measured in terms of GDP etc) or Damage Cost due to the extreme event.

In Panel-B we superimpose the pathway followed by a resilient society on the earlier time path. A resilient society follows the dark red line. It is obvious that with resilience initial damage/loss is smaller and response is quicker. As a result the U-turn comes earlier and the rate of recovery is also faster. So the society reaches the normal time path, or the blue line, much earlier than what would have happened without any resilience. The damage cost now is the area shaded dark red. It is thus clear that Damage Cost is lower with Resilience. The area shaded light red in this panel is a measure of the Damage Cost Avoided due to Resilience.

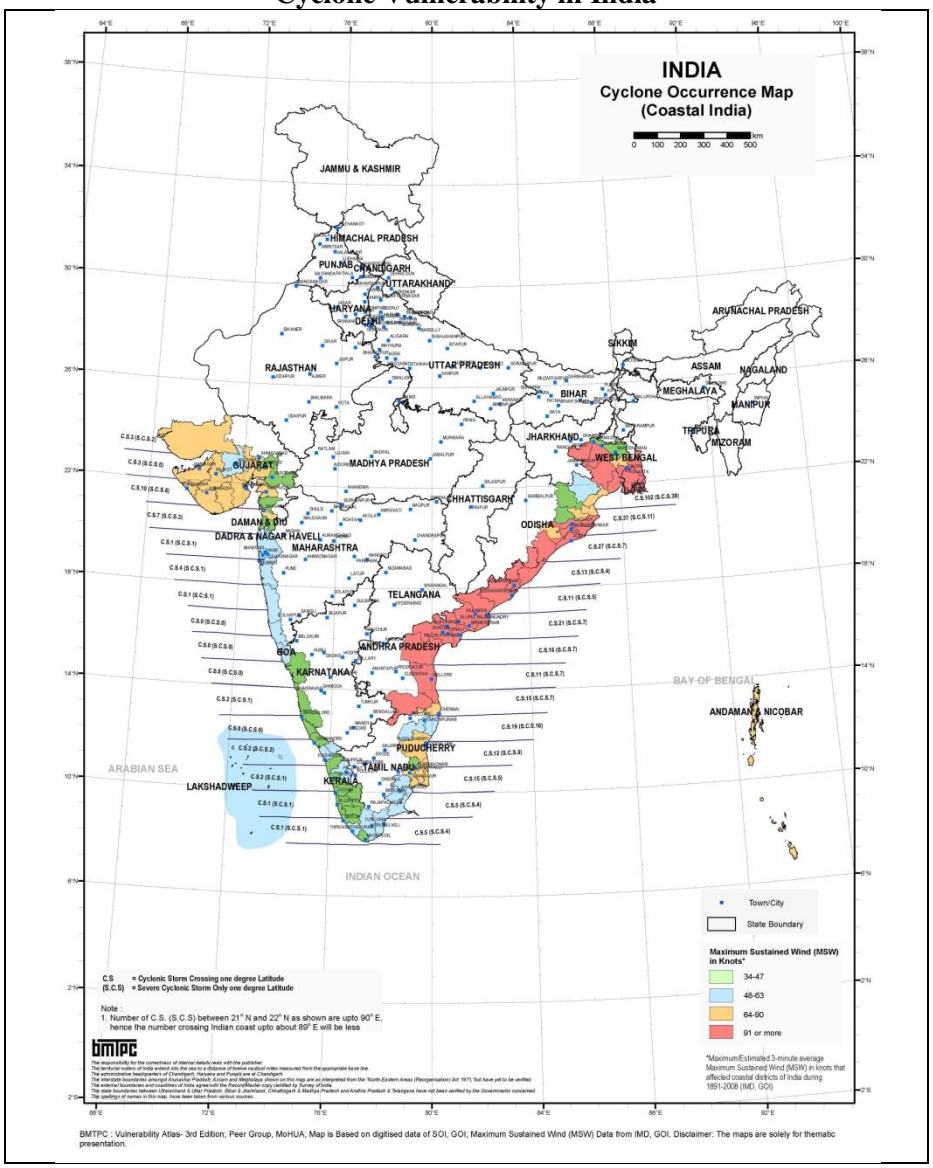
The response time, recovery time and the recovery rate are dependent on the degree of resilience of the society. If resilience is low, response will be late, recovery time will be long and recovery rate will be slow. As a result Cost Avoided will be low. On other hand, a highly resilient society will have a fast response, short recovery period, and fast recovery rate. So it will get back to its normal path quite quickly (and may even surpass that). Avoided cost in this case will be high. It is thus clear that there is a trade-off between investment in resilience (also called Avoidance Cost) and Damage Cost – to reduce Damage Cost later, one has to spend more on Avoidance Cost now. The dilemma for developing countries is that being short of resources they cannot spend on resilience in an unconstrained manner and hence has to balance between resilience and damage costs. This, because of high marginal utility of money and high time discount factor in the developing societies, typically leads to low investment in resilience building in these countries.

2. Resilience Planning for Cyclones

Resilience planning, specifically for environmental extreme events like Tropical Cyclones, is an extensive long run phenomenon. The actionables can be divided into two broad categories – Pre-event or Pre-emptive Actions, and, Post-event or Restorative Actions. Pre-emptive actions include Hazard Mapping & Monitoring, Warning systems & Forecast, Building Codes, Awareness & Insurance, Response Training, Evacuation Planning, and Stocking Essential Commodities including Food and Medicines. Restorative actions include Ensuring Drinking & Sanitation Services, Health Management, Restoring Critical Infrastructural Services, Recover /repair damaged assets, Rehabilitation of people, Restart economic activities, and, Fast insurance pay-outs. For large countries like India, this planning has to

happen not only at the macroeconomic level but also at the State and Local level. Another important aspect is coordination of such actions across geographical boundaries and jurisdictions of several agencies[6]. It is generally observed that the pre-emptive actions are mostly capital intensive in nature and involve investment in environmentally resilient infrastructures and buildings, capacity building for relocation and shelters, investment in scientific and technological breakthrough for advanced monitoring and warning, and maintaining stocks of essential commodities including medicines. Most of the restorative actions are, on the other hand, labour intensive in nature and involves transport & distribution of essentials, repair & restoration of infrastructures, and rehabilitation of people. As already mentioned, resilience planning in developing countries are generally poor because of capital shortages and lack of foresightedness.

Figure 7
Cyclone Vulnerability in India



Source: BMTPC (2019)

3. Resilience against Tropical Cyclones in India

Tropical Cyclone has always been a scourge for the Indian subcontinent. They start as low pressure areas or depressions in the North Indian Ocean. Cyclones develop in the Arabian Sea generally during the months of May-June and October-December and strike the western coast of India. Cyclones develop in the Bay of Bengal mostly during the months of April-December and strike the eastern coast of India / Bangladesh coast (Figure 7). Number of cyclones formed in the Bay of Bengal is on an average four times of that in the Arabian Sea, though proportionately more intense cyclones are formed in the latter basin. Between 1891 and 2006, 308 cyclones crossed the east coast, out of which 103 were severe. During the same period, 48 cyclones crossed the west coast, out of which 24 were of severe intensity.

The oldest recorded cyclone in the subcontinent is the 1737 cyclone which hit the Bengal delta killing approximately 3 Lakh people and devastating Kolkata (the then Calcutta). It was accompanied by a 12 metre high storm surge and a violent earthquake coinciding with this storm enhanced the destruction (IMD, 2020). The Rameswaram Cyclone of 1964 wiped out the village of Dhanuskodi in Rameswaram Island and a passenger train was washed off by the storm surges drowning nearly all the passengers. Since then, 21 of the 23 major cyclones worldwide (in terms of loss of lives) have occurred over the Indian subcontinent.

Tropical cyclones have several adverse effects on the life and society of the region. High velocity winds damage structures (houses & factory sheds); lifeline infrastructure (power & communication towers, hospitals, food storages, roads, bridges); and standing crops. They are generally accompanied by exceptionally heavy rainfall & storm surge which causes flooding in low-lying and coastal areas resulting in loss of life and destruction of property. Ingress of sea water due to high tides makes soil infertile due to salinity and reduces future period crop yield also. These impacts are higher in the coastal areas, especially the eastern coastal plains because of the low flat coastal terrain, high density of population, and concentration of economic activities along the coast.

Following extensive damage caused by two cyclones that struck Andhra Pradesh in 1969, Government of India constituted a Cyclone Distress Mitigation Committee (CDMC) in 1970. The recommendations of the CDMC included Installation and upgrading of warning system; Demarcation of vulnerable areas; Relief preparedness (drinking water/food/tarpaulin); Standard Operating Protocol for Restoration of damaged infrastructure; Construction of cyclone shelters and embankments; Creating awareness; Evolving coordination mechanism

between agencies; and, Build a calamities fund for relief/ex-gratia payment. A timeline of the major initiatives in this regard is provided in Table 1.

Table 1
Cyclone Management in India

Year	*Initiatives*
1979	National Committee of Science and Technology (cyclones)
1990	World Bank-assisted Cyclone Emergency Reconstruction Project (CERP), GoAP
1999	Orissa State Disaster Mitigation Authority & Orissa Disaster Rapid Action Force
2005	(after 2004 tsunami) National Disaster Management Authority
2006	National Cyclone Risk Mitigation Project (NCRMP) with World Bank assistance
2008	National Disaster Response Force
2009	State-of-the-art cyclone Early Warning System
2010	District Disaster Management Authorities in 84 coastal districts; National Disaster Communication Infrastructure connecting with Operation Centres

Source: GoI (208a, 2008b, 2015, 2019a, 2019b).

What emerges from the timeline is that cyclone management in India has transformed from being a predominantly restorative and rescue operation in the initial years to more a pre-emptive action based on early warning and tracking of monsoons and evacuation, in later years. These steps helped in building resilience against cyclones in the country through enhanced preparedness, early evacuation, clear SoP & communication chain, and fast relief & rehabilitation. However, there were some missing components which were not followed up. For example, the strict building standards and Coastal Zone Regulations were not adhered to because of economic reasons and the hotelier-tourism-construction lobby. In addition, climate induced sea level rise, tidal erosion and widespread poverty meant that many of the regulations for economic activities in coastal zones were transgressed more often than obeyed. Another missing component was regular mock drills regarding evacuation and relocation involving all stakeholders.

Table 2
Impact of some recent Cyclones in India

Year	*Event*	*Loss of Life*	*Estimated Economic Damage*
1999	Odisha Super Cyclone (250-275 kmph)	9,658	US $ 2.5 billion (0.54% of GDP)
2009	Severe Cyclone (110-120 kmph)	149	US $ 1.2 billion (0.10% of GDP)
2019	Very Severe Cyclone 'Fani' (185-210 kmph)	64	US $ 2.4 billion (0.09% of GDP)
2019	Severe Cyclone 'Bulbul' (130-150 kmph)	16	US $ 3.7 billion (0.15% of GDP)
2020	Very Severe Cyclone 'Amphan' (185-210 kmph)	88	US $ 11.5 billion (0.54% of GDP)

Source: GoI (208a, 2008b, 2015, 2019a, 2019b).

Even then, there was considerable progress on the science and technology front with the IMD providing very early and fairly accurate warning of cyclones and predicting their intensity

and pathway. Awareness and information dissemination was also satisfactory by involving school children for awareness building and HAM radio & mobile short messaging services for information dissemination. The National Disaster Management Authority (NDMA) and the National Disaster Response Force (NDRF) that were formed and deployed in 2005 and 2008 respectively, have also considerably improved disaster management including cyclone management in India. As a result damage from cyclones had decreased considerably during the last two decades (Table 2). But as we have mentioned earlier, this year was different because of the second monster, COVID19.

IV. BETWEEN THE DEVIL AND THE DEEP SEA

1. Pandemic & Lockdown

To understand how the dual shocks of Pandemic and Cyclone affected the society, especially how the former compromised the resilience towards the latter, we have to outline briefly the time path of the pandemic and Indian responses.

Cases of unidentified strain of pneumonia emerged in Wuhan province of China in December 2019 (Spiteri et al. 2020) and through close contact and inter-country travel spread worldwide over the next couple of months. By first week of March 2020 it had spread to close to two hundred countries, recorded cases had shot up to just over 115 thousand and resulted in 4263 deaths, a mortality rate of 3.7 per cent and on 11th march, WHO had declared it to be a pandemic (WHO 2020b)[7]. Since the disease is caused by a novel strain of the virus, no vaccine or proven therapy is available and so the only way to combat is through containment so that people do not get infected. Since the virus spreads mainly through oral/nasal discharges of droplets, physical distancing and preventing people from coming to close proximity to one another is the only way to reign in the spread of the disease. Globally this is the method followed and countries have imposed curfew like regulations (called as *Lockdown* in global media) at different times for different duration and in different degrees. The steps involve isolating confirmed cases, tracing the persons with whom they had come in contact in recent past and quarantining them, testing extensively and forcing people to stay away from each other as much as possible. In India, the first case was reported on 30th January, 2020, and by 15th March close to one hundred cases were recorded. Government of India, in a bid to contain the disease, followed the global cue and imposed nationwide *lockdown* on 24th March for 21 days, which was later extended three times to extend till 31st May.

People were prohibited from stepping out of their homes and all transport services were suspended. The century old Epidemic Diseases Act (1897) was invoked and orders were

given to arrest persons who violated the lockdown orders. The only exceptions were fire, police and emergency services, transportation of essential goods, banking services, and petrol pumps. However, with no public transport available and commuting & migrant workers accounting for close to half of India's workforce, there were no staffs to run the exempted services. This, effectively, brought the country to a standstill since end-March.

2. Lockdown & Cyclone Management

As mentioned, when the cyclone struck on 20th May, India was already suffering from two months of lockdown. This compromised the planning and restoration activities to a large extent.

a) Preparedness & Evacuation

Preparedness of cyclone depends mostly on weather forecasting and dissemination of warning to the villages. Thereafter, depending on severity of the cyclone, evacuation is done to move people from vulnerable areas and structures to safe shelters. The warning and forecasting was on target, but this year, due to the prevalent lockdown situation, dissemination of warning suffered. Officials could not move extensively among the hinterland as public transport was shut down. Distribution of leaflets through school children, as usually done in such cases, did not happen as schools were closed. Announcements over Public Address System could only cover smaller areas, and that too, only up to a limited distance from District and *Taluka* headquarters. The only arrangement that functioned was warning via SMS over the mobile telephone network. However in a country with significant rural illiteracy, these messages did not serve the full purpose.

Most of the cyclone shelters were already being used as Quarantine Centres for COVID19 (Barik, 2020; TNIE, 2020a). As a result, it was difficult to arrange for shelters for people to be evacuated. Maintaining distancing protocols in the shelters implied that most of the available shelters operated below capacity, some even housed one-tenth of what they could under normal circumstances (Nandi & Thakur, 2020; BBC, 2020; Brackett, 2020; Singh, 2020). It was reported that in Bengal, the operating capacity of cyclone shelters were half of the official capacity because of the pandemic (Westcott et al., 2020). Officials also had tough time in urging people to move to the shelters as people were afraid of contracting the disease because of close proximity to others. In addition, essential items could not be stocked in adequate quantity due to lockdown.

b) Communication and Standard Operating Protocol

There exists a clear Standard Operating Protocol for Cyclone Management in India, designed by the National Disaster Management Authority. This is followed by the State and District Disaster Management Authorities to oversee and coordinate evacuation and restoration / rehabilitation activities in case of cyclones. However this time the situation was different. There was an acute shortage of field staff as the continued lockdown for the previous two months had resulted in most staff being cooped in their homes, many in distant districts, and even when they were called for duty they could not report because of two reasons – lack of public transport to reach their place of work from their residence, and, lack of staying facilities under the distancing protocol. This hampered the rescue and rehabilitation operations to a large extent. Absence of decision making officials on site could have been managed through telecommunication. But the cyclone had destroyed almost all communication and power infrastructure in its wake and restoration of electricity and mobile telephone connections took more than three days, and that too only partially. As a result, the communication between field staff and administrative decision makers broke down, and rescue, repair and restructuring operations sometimes became unsystematic and less effective.

c) Relief and Rehabilitation

Relief and rehabilitation in case of cyclone has three major components – (a) immediate relief in the form of food, health & sanitation services; (b) repairing damaged infrastructure including homes to relocate people from shelters to homes; and, (c) provide financial support to restart economic activities. The lack of field staff hampered these operations too. Adequate relief materials could not be procured and whatsoever could be arranged could not be properly distributed due to lack of men and break down of transport and communication network. Relocation of the evacuees from the shelters back to their homes was slow[8]. Back home it was difficult to repair their houses since only tarpaulin was distributed by the authorities as relief material to reconstruct homes, and as markets were closed, building materials were hard to get. People had to register themselves with authorities with proof of damage for getting ex-gratia or compensation and there were long queues in government offices throwing all distance protocols out of the way (HT, 2020).

But what proved to be the hardest roadblock was restarting economic activities. An economy that was ‘closed’ for a period of two months had little activity going even before the cyclone struck. It now found itself completely ruined. Rural productive activities were at a standstill and there was no active demand in the economy. The supply chain had broken down in

absence of transport facilities and people to drive vehicles, casual workers were unemployed for long and had no cash income, standing crops that could not be harvested earlier due to the lockdown (and lack of manpower) now stood drowned in knee-deep water, orchards and plantations were mowed down by the swirling winds, and there was a feeling of despair all round. The only way the situation could be salvaged was by pumping money into the hands of the rural folk and ease some of the restrictions on economic activities and transport. But the government was severely cash-strapped. Since economic activities were at standstill, there was no revenue for the government since April and on top of that substantial amount of money was being spent to tackle the pandemic (for example, Yadav, 2020; Seth, 2020; among others). As a result economic activities could not be restarted with the vigour that could propel things forward.

d) Summary

It thus appears that the pandemic severely crippled the resilience of the society against the environmental hazard and cyclone management operations were compromised due to the restrictions that were imposed on production and movement of goods, movement of people, communication breakdown, and because of insufficient funds with the government. Though we have studied the impact of '*Amphan*' that struck the east coast, barely a fortnight later cyclone *'Nisarga'* came up the Arabian Sea and made landfall at Alibaug in Maharashtra near India's commercial capital Mumbai, on June 3 with a wind speed of 100-110 kmph, gusting to 180 kmph. Maharashtra has recorded the highest COVID19 cases among Indian states and Mumbai the third highest among Indian metros. While Mumbai narrowly missed being in the direct firing line of the cyclone, nobody can underestimate the potential danger from such hazards given that the mangrove cover along the city's coastline is under constant threat from the 'developmentalists'. Mumbai and Kolkata have also been named as the two Indian metro cities that are most vulnerable due to climate change – running the risk of being battered by frequent cyclones and submerged due to sea level rise. A large number of developing countries in the tropics share the environmental, economic and climate conditions that characterised the shocks and responses discussed in this paper. The case we studied here is thus applicable to not only our country, but tropical developing countries in general.

V. LESSONS TO BE LEARNT

Juxtaposition of multiple extreme events shows us that we are ill prepared to tackle the complex situation. Since scientists warn us of such compound events occurring more frequently in near future, we must overhaul our disaster management plans accordingly. The

first thing that needs to be done is to integrate biological hazards into our disaster management and risk reduction strategies. The Epidemic Diseases Act (1897) is more than a century old and the provisions thereof do not cover the realities of today's society – spatially scattered production activities, movement of essentials across long distances, frequent (international and domestic) air travel, commuting to work being a regular and common feature, colossal mass of migratory workforce, and rapid urbanisation. The Acts and Regulations needs to be revised and appropriately redesigned to align with ground realities and overall disaster management plan. The Standard Operating Protocol in this regard must be also revised so that field staff are trained and empowered to take appropriate decisions even if communication with Operation Centre breaks down. Each NDRF team should be able to do its assigned task based on ground realities without guidance from higher officials

Natural disaster shelters must now be built keeping in mind the distancing protocols and hence their numbers and capacity must at least be quadrupled. These structures, instead of lying idle for most of the time, may be innovatively used (as congregation halls, vocational training centres, festival houses, etc.) to maintain their upkeep. Essential commodities must be stocked at local level to be easily accessible in times of emergency and minimising needs for transport.

The lax attitude shown towards public training must be done away with. There are specific tasks that each household must be taught – things that they must do in case of a natural disaster even without guidance or goading – and mock drills must be held regularly so that people do not forget those steps (Roy, 2020). Building up local capacity would enable critical evacuation and rescue operations to function even if specialised teams are unavailable due to transport breakdown or biological hazards. Resilience should not be relegated to the 'recovery' phase only and must prioritise 'readiness' and 'adaptation'. Downgrading resilience activities just because the probabilistic models attach small possibility to an extreme event should not be the norm as human activities and climate change are affecting these uncertainties as well and 'rare' weather events are becoming 'frequent' (see Bhatia et al., 2017 for some of these related issues).

It is to be noted that South Asia has emerged as a global hotspot for disaster related displacement in recent times. The region recorded 9.5 million new displacements associated with disasters in 2019, compared to an average of 6.5 million people per year during the earlier decade (IDMC, 2020). The economic impacts of such shocks are also humungous. ADB estimates that Asian economy will contract by 0.7 per cent during 2020-21 (ADB, 2020). The negative impact will be higher in South Asia, and the regional GDP is

apprehended to shrink by 6.8 per cent, and Indian economy still higher by about 9 per cent. Globally the loss, in a moderate case scenario, will be about $156 billion, or 0.2 per cent of global GDP. Apart from the macroeconomic losses, there are huge employment and consumption losses at micro level, slowing down the transition from poverty.

With increasing cases of extreme events possibly staring us in the face, it is high time to recalibrate our policies and protocols. Just as the hazards interplay and multiply the shocks of each other, we can use the same interplay to leverage our fight against the shocks simultaneously. And in this battle, environmental protection is the key. Combating environmental degradation, pollution, carbon emission, and global warming involve steps (like afforestation, preserving natural biospheres, protecting ecosystems, etc.) that would not only bring down possibilities of tropical cyclones becoming more severe and more frequent, but also bring down chances of future pandemic triggered by animal-to-human jump of pathogens. With increased urbanisation, creating green & healthy cities will create healthy citizens, and improve their capacity to fight against health hazards while the green cities will themselves act as buffer against environmental hazards. Just as the extreme events are coming together, we have to fight them together in a comprehensive way.

As WHO says:

> "Attempting to save money by neglecting environmental protection, emergency preparedness, health systems, and social safety nets, has proven to be a false economy – and the bill is now being paid many times over. The world cannot afford repeated disasters on the scale of COVID-19, whether they are triggered by the next pandemic, or from mounting environmental damage and climate change."
>
> [WHO, 2020c]

It is time we embrace a new normal in its truest sense where Nature comes first, where we truly believe that Nature is supreme and we, *homo-sapiens*, are just one of the zillions of biological organisms that thrive on this earth. We may have conquered the earth through our intelligence, but as *Mufasa* famously told young *Simba* in The Lion King:

> "When we die, our bodies become the grass, and the antelope eat the grass. And so, we are all connected in the great Circle of Life……Everything you see exists together in a delicate balance. As king, you need to understand that balance and respect all the creatures, from the crawling ant to the leaping antelope....."
>
> [from the film *The Lion King*, 1994, Walt Disney Pictures]

If we forget that lesson, there will only be a dreadful *Scar* on this earth.

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Notes

[1] In 2000, World Meteorological Organisation under United Nations Economic and Social Commission for Asia and the Pacific, decided to start naming cyclones in the region to facilitate easy identification of individual cyclones, awareness building regarding its development and movement, rapid dissemination of warnings and removing confusion when multiple cyclonic storms originate in a region. Names are provided by Bangladesh, India, Maldives, Myanmar, Oman, Pakistan, Sri Lanka, Thailand, Iran, Qatar, Saudi Arabia, United Arab Emirates and Yemen and a list is drawn up in advance by WMO/ESCAP Panel on Tropical Cyclones. Cyclones originating in the region are named from the list consecutively. This cyclone was named by Thailand.

[2] Any tropical cyclone that develops in the North Indian Ocean is monitored by the IMD on a 7-scale category based on 3-minute sustained wind speeds. The lowest category with windspeeds between 31–49 kmph are labelled as Depressions. Further classifications are: Deep Depression (50–61 kmph); Cyclonic storm (62–88 kmph); Severe Cyclonic Storms (89–117 kmph); Very Severe Cyclonic Storms (118–166 kmph); Extremely Severe Cyclonic Storms (166–220 kmph); and the most severe being Super Cyclonic Storm (over 222 kmph).

[3] The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating of the intensity and damage potential of tropical cyclones in the Western hemisphere or hurricanes, based on highest average wind speed over a 1 minute time span. Thus they are not strictly comparable to the IMD classifications of North Indian Ocean tropical cyclones in Eastern hemisphere. A Category 1 hurricane has a one-minute maximum sustained winds of at least 74 mph (119 kmph). The most severe in the scale, Category 5 hurricane has winds over 156 mph (251 kmph).

[4] COVID19 is the acronym given to Novel Corona Virus Disease 2019, a viral pneumonia that was first detected in November 2019 and spread fast across the globe. Since this is a new strain of the virus, there are no proven vaccine or treatment protocol. The only effective action to fight the disease is to contain its spread by minimising person-to-person contact. Countries adopted a 'Lockdown' strategy to keep people indoors and contain the disease. Till 28 October 2020, 43.34 million people have been affected with a fatality of 1.16 million (WHO, 2020a)

[5] The recent Ebola epidemic in West Africa probably occurred in part because bats, which carried the disease, had been forced to move into new habitats as the forests they used to live in had been cut down to grow palm oil trees (Bernstein, 2020).

[6] For example, in the Indian context any cyclone that hits the eastern coast affects three states – Andhra Pradesh, Odisha, and Bengal. Similarly, any preventive and restoration activities are to be shared across Minstries and Departments of Irrigation, Public Works, Power, Communication, Health, Education, Railways, Food Supply, Defense, etc.

[7] Up to 22 October, global cases have soared to 41.3 million with 1.13 million deaths. Cases in India crossed the 10 thousand mark in mid-April with mortality rate spiking to 3.4 per cent and crossed 1-lakh mark in mid-May. Cummulative number of cases crossed the Million mark in mid-July when mortality rate had come down to 2.6 per cent. As on 22 October, India has reported more than 7.7 million cases with more than 116 thousand fatalities.

[8] This had secondary impact on the pandemic. As people stayed longer in close quarters of the shelters, possibilities of contact and spread of the virus increased (TNIE, 2020b; Singh, 2020; Dasgupta, 2020).

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