Smart-Review on Disaster and its Prevention Management in India

Mr. Subhankar Sarkar

Member -West Bengal Civil Defence and Disaster Management, Murshidabad. West Bengal. India

elinksuvankar.sarkar@gmail.com

Abstract: *Both disaster and disaster management are important to us, Disasters can occur suddenly both naturally and unnaturally. In this paper, I will discuss several issues including disaster, and post-disaster management in India. I am trying to discuss how prepared our country is to deal with disasters or how it deals with disasters, how it has dealt with disasters before, or what measures are being taken to deal with this disaster in the coming days. Our beloved Motherland India is the seventh largest country in the world and the first in South Asia. India is a country of about 140 crores Peoples. Our country India is a naturally harmonious country, and our country is riverine as well as has mountains and forests and is even surrounded by sea on three sides. Due to its size, the number of disasters in our country is also high, be it Natural or man-made. As our country has blessed us with open arms, the crops have grown green. Just like natural disasters or man-made disasters happening in our country, normal life has been hit again and again. Again, the people of our country and the government of our country have come together hand in hand to overcome this disaster. I will try to discuss in this paper, disaster and post-disaster management and also any new schemes introduced by the government to deal with disasters. And I will try to discuss if any improvement can be made in post-disaster management by improving the technology.*

Keywords: Disaster, Losses, Disaster Management, Preparedness, Technological Solution

I. INTRODUCTION

Disaster-First need to know what the disaster is. Disaster means any unfortunate event or unexpected occurrence, It can happen naturally or unnaturally, but the consequences are devastating. In other words, a disaster is an unexpected unfortunate event that disrupts the normal way of life of people, in many cases causing loss of life to humans and other animals, economic loss, and environmental damage, and takes some time to overcome. According to the International Federation of Red Cross Societies "Disaster" can be defined in one line, that line is- **Disaster = (Vulnerability + Hazard)/Capacity.** That is, if a disaster occurs in a place, it will have multiple effects including economic, political, cultural, and general communication systems in that area.Also, after several effects, they are stated through the following few points.

- A disaster is something that completely disrupts normal life.
- This affects the emergency system very badly.
- When disasters occur, food shortages occur, habitats are destroyed, and health systems are affected.
- Normal needs are greatly disrupted.

If the severity of the disaster is high, then the effects of the disaster fluctuate. We can also identify Disaster as a Hazard.

Hazard- One good thing about India is that when the intensity of the disaster is high, many voluntary organizations and common people also join hands with the administration to deal with the disaster. The danger is the terrible situation that is created as a result of the disaster, that is the danger. Risks such as injury, illness, property damage, environmental damage, or complete destruction of a site are examples of hazards.

Risk-Risk is an outcome of a disaster or the possibility of a disaster risk is an outcome of a disaster or the possibility of a disaster, which may have a negative impact on the entire system.

Vulnerability: Vulnerability refers to the delay in response or rescue when a hazard occurs the hazard caused by a disaster, or the inability to respond when a disaster occurs.For example, people living in earthquake-prone areas are more at risk than people living on plains.

Types of Disaster

We can divide disaster into two categories one is Natural Disaster and second is Unnatural Disaster or Man-Made Disaster. Whether it is a natural disaster or an unnatural (man-made) disaster, we can divide the disaster into two categories according to the severity of the disaster, one is Minor and one is Major.Some examples of natural disasters and unnatural disasters are given below.

Natural Disaster	Unnatural Disasters (Manmade)
Major	**Major**
Flood	Chemical
Cyclone	Nuclear
Drought	Biological
Earthquake	Fires
Volcanic eruptions	Deforestation
Land Slides	Pollution due to prawn cultivation
Minor	Terrorist Attack.
Cold wave	Wars
Thunderstorms	Betting factory explosion
Heat waves	**Minor**
Mudslides	Road/train accidents, riots
Storm	Food poisoning
Avalanche	Industrial disaster
	Environmental pollution crisis.

Disaster Management- it is a matter of measures taken by the government or the general public or in some cases both to deal with the disaster and to normalize the public life (be it natural or unnatural disaster) when a disaster occurs. It is called disaster management. Disaster management is the measures that are taken after a disaster before a disaster or in advance to deal with the disaster. Different countries of the world including India have various teams like Disaster Management to deal with disasters, Indian Disaster Management has different teams like NDMA- NDRF/ SDRF, FIRE BRIGADE, CIVIL DEFENCE, etc. The task of disaster management is to prepare for any disaster deal with the Disaster assess the severity of disaster impacts and conduct relief rehabilitation rescue operations. The good thing about India is that when the intensity of the disaster is high, many voluntary organizations, Student organizations Like NSS-National Service Scheme, NCC-National Cadet Crops, and common people also join hands with the administration to deal with the disaster.

As disasters have increased in the present era, new technologies have come into disaster management.I will discuss in detail the various natural and man-made disasters and risks that have happened in India along with the damages.For those who are involved in dealing with these disasters, I will try to give an idea through this paper whether any technical improvement can be made to deal with disasters in keeping with modern technology, and if any new schemes are brought by the Government of India to deal with disasters. Also, this paper will highlight how an engineering student can play a role in disaster response.

II. LITERATURE REVIEW

Disaster Preparedness, Response, and Prevention Management in India. Pallem Srikanth1, Immanent Ajay Kumar Mainly shown in this review paper Concept of natural disasters and disaster management in India is given. This paper also discusses the effects of global climate change on nature and the resulting disasters. The paper also highlights the need for a multi-disciplinary and multi-sectoral approach. Also, Preparedness, Early Warning systems (Cyclone,

Flood), Disaster Response techniques, and Disaster Recovery (Rehabilitation and Reconstruction methods are discussed. Also, this paper has a systematic discussion on disaster mitigation and the impact of disasters on public health.

A Review Paper on Disaster Management- Dr. Ashok Gupta, Neha Vashistha, Dr. Abhimanyu Upadhyay. In this review paper, mainly shows disaster and disaster management. This paper highlights the disasters that are happening in India due to climate change. Natural calamities in India such as floods, droughts, cyclones, earthquakes, and landslides have been discussed in detail along with the various magnitudes, losses, etc. An overview of disasters and disaster losses in India and post-disaster management in India is given. Also, what measures can be taken to reduce the risk of disaster are discussed here. An analysis of disasters occurring at different times is done here, Several projects undertaken by India's National Disaster Management Authority or NDMA working on disaster mitigation were also discussed like Cyclone Risk Management Project, the School Safety Project, the Decision Support System, and others.

An overview of disaster management in India by A. J. Shah In this paper, India is said to be a vulnerable country in South Asia and it is also said that due to its vulnerability, events like floods, droughts, landslides, hurricanes, cyclones and snow storms occur regularly every year. The most dangerous disasters are alkaline, earthquakes, and floods the occurrence of these disasters is reducing agricultural productivity in India, hampering development, and causing considerable financial infrastructure damage. Also, the Government of India has taken a plan to deal with disasters The paper also discusses the adoption and implementation of these schemes at the state and central levels, In addition, this paper highlights the lack of public awareness in dealing with disasters as an important point. The paper highlights the adoption of disaster management plans in different parts of India and the different states and problem-solving and reactive disaster management. A number of case studies are done in this regard and then importance and information are given and reinforcement, disaster preparedness, response, and rehabilitation management, are also discussed.

Disaster Management In India: Prevention, Mitigation & Preparedness Dr.LMalleswara Rao, J Rama Mohan. India has traditionally and geo-climatically experienced natural disasters every year and is prone to these natural disasters. Also, according to the data of National Disaster Response, the disasters that occur in India every year and the damages caused by them have been presented in the form of a study such as 40 million hectares of land in India are flooded (12% of total area), 68% of the land is drought-prone, landslides and avalanches, 58.6% of earthquakes are prone to earthquakes, tsunamis and cyclones are common in 5,700 km of coastline. Between 1970 and 2009, India experienced 371 natural disasters, resulting in 1.51,000 deaths and 1.86 billion people. a frequent occurrence in India, with 52 percent of them being catastrophic, followed by hurricanes (30 percent), landslides (10 percent), earthquakes (5 percent), and droughts (2 percent). Apart from this, important things like post-disaster warning systems, evacuation, relief rescue work, as mentioned here, rehabilitation and damage compensation, and reconstruction are also discussed in this paper. Preparedness in disaster mitigation and prevention as mentioned as well as initiatives taken by the Central Government and State Governments were also discussed constructively.

Disaster Management in India by Pramod Patil In this paper, it is stated that India is vulnerable to natural disasters due to geo-natural and climatic factors. Floods Droughts Cyclones Earthquakes Landslides These occur repeatedly as a developing country, India has a huge impact, resulting in financial, environmental, and livelihood losses. The paper also discusses the importance of realizing the need for multi-responsibility, and to mitigate risks, in various development plans after cyclones, earthquakes, or other natural disasters. Apart from this, the country's policy infrastructure to deal with disasters is highlighted in this paper.

Disaster and losses in India:

Some natural or unnatural disasters that have happened in India are described here.

Natural Disaster:

Flood: Our India has been a riverine country since ancient times. India has a geographical area of 329 million hectares (mha) Out of that, the flood-prone area is 40 million hectares(mha). So, it can be said that India is a flood-prone country.India experiences floods almost every year and the damage is increasing every year floods cause damage to livelihoods, property, infrastructure, and public utilities. The causes of floods are respectively- Firstly, Global warming, secondly, reduction in river depth, and thirdly, urbanization in riverine areas. Fourth, Construction of

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dams on the river. Apart from these reasons, there are several other reasons that can cause flooding now, when there is excess rain, the water enters the river and as a result, the drainage system of the river cannot hold more water, resulting in overflowing of both banks of the river. Besides, the sudden release of excess water from the dam can cause flooding. Melting ice and snow also causes flooding.

According to other data *(Wikipedia),* only in the state of Assam in India, between April 2022 and October 2022, the death toll from floods exceeded 197. and 103 308 hectares of land were affected. In financial terms, it is a loss of about 1.2 billion dollars. Also observed was the dire situation of floods in several states including Delhi, Uttarakhand, and Assam in India this year.
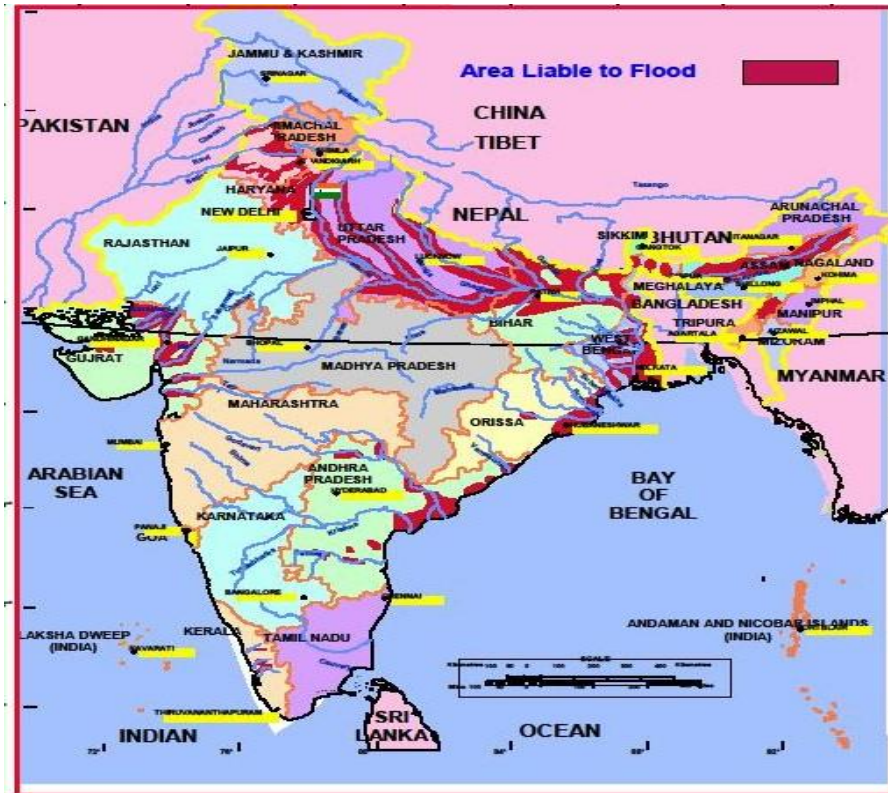

Fig. 1 Area Liable to flood (India)

Earthquakes: Earthquake is the second worst natural disaster after flood, and earthquakes are usually very destructive and usually happen without warning in most cases. Earthquake not only India but the whole world can face a dire situation. This earthquake can destroy a land or a region forever. That is, we can say that the layer of the earth where humans, animals, or plants live, when that layer shakes naturally or unnaturally, is called an earthquake. or when a vibration occurs inside the earth due to natural or unnatural reasons, it is called an earthquake. There are several reasons that cause earthquakes in the world, let's look at the natural causes of earthquakes.

First, because of the moving plates - Earthquakes occur when the moving plates inside the Earth collide with each other or try to slide up on top of each other.

Second, volcanic eruptions - that is, when an excessive amount of volcanic lava is produced from inside the earth through volcanoes, due to the compression of lava inside the earth, earthquakes can also occur in the earth.

Thirdly, the interior contains a variety of rocks that can cause earthquakes when they crack or crack. Fourthly, when landslides occur in mountainous areas when a huge rock or a piece of soil comes down, it suddenly hits the ground, and earthquakes can occur in mountainous areas. Apart from these factors - when the water in the river rises, earthquakes also occur due to the high water pressure. Apart from these, earthquakes can also occur when a large meteorite hits the Earth. Earthquakes can also be caused by a number of cosmic causes, including the gravitational pull of the Moon approaching the Earth, or the slowing down of the Earth's rotation.

Now let's look at some of the unnatural or man-made causes of earthquakes- First of all, earthquakes occur when experimental nuclear explosions occur inside the earth or when nuclear explosions occur during war or when a large bomb explodes. Second, if a large reservoir is created in a weak part of the crust, earthquakes can occur even under the strong pressure of the reservoir. Also, for commercial purposes, explosives of various sizes are used to demolish parts of mountains, which can also cause temporary earthquakes. In addition, small earthquakes can also occur during the construction of tunnels by cutting mountains. And earthquakes are measured on the Richter scale and generally, if the magnitude of an earthquake exceeds magnitude five on this scale there is a possibility of loss of life or property.

This time, we will know the date, magnitude, extent, and death toll of earthquakes in India and its adjoining areas- (Earthquake losses from 1999 to 2023)

Date	Region	Depth	Magnitude	Deaths
06/13/2023	Kashmir (Kishtwar)	10 km	5.0	0
04/28/2021	Assam	34 km	6.0	2
07/24/2019	Maharashtra (Palghar)	10 km	3.8	1
02/01/2019	Maharashtra (Palghar)	5 km	3.6	1
09/12/2018	West Bengal	10 km	5.3	1
01/03/2017	Ambasa(Tripura); Bangladesh	8 km	5.7	3
01/03/2016	Impahl	27 km	6.7	13
06/28/2015	Kokrajhar	56 km	5.3	0
08/02/2013	Kashmir (Kishtwar)	7 km	5.2	0
05/01/2013	Kashmir (Doda, Kishtwar, Ramban)	13 km	5.7	3
10/18/2012	Deurala, Jaisinghnagar, Kotma, Sarai	27 km	5.0	0
05/11/2012	Assam (Kamrup, Guwahati)	35 km	5.4	0
11/21/2011	Assam	42 km	5.8	0
10/29/2011	Sikkim	55 km	3.5	2
10/20/2011	Gujarat	34 km	5.0	0
09/18/2011	Sikkim	51 km	6.9	111
09/07/2011	Delhi	18 km	4.3	0
06/22/2010	Tauli	10 km	5.2	0
06/18/2010	Andaman Islands (Diglipur)	31 km	5.9	0
06/12/2010	Little Nicobar Island	50 km	7.5	0
05/01/2010	Chamoli	29 km	4.5	0
03/30/2010	Andaman Islands (Diglipur)	46 km	6.7	0
12/12/2009	Maharashtra (Satara)	25 km	5.1	0
08/10/2009	Andaman I	35 km	7.5	0
05/19/2009	Kashmir	48 km	4.9	0
04/09/2009	Jaisalmer	58 km	5.2	0
03/26/2009	Chaibasa	11 km	4.1	0
09/16/2008	Maharashtra	14 km	5.0	1
06/06/2008	Manpur	33 km	3.8	0
03/09/2008	Gujarat	41 km	4.5	0
02/06/2008	West Bengal	40 km	4.3	1
11/25/2007	Badaun, Meerut, Noida, Rewari	17 km	4.7	0
11/06/2007	Gujarat	5 km	5.1	1
08/20/2007	Maharashtra (Satara)	53 km	4.4	0
07/22/2007	Uttarkashi, Chamoli, Muzaffarnagar	14 km	4.3	0
12/24/2006	Rajasthan	26 km	4.2	0
04/06/2006	Gujarat	16 km	5.5	0

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03/07/2006	Gujarat	46 km	5.5	0
02/14/2006	Sikkim	25 km	5.3	2
12/14/2005	Jausari, Chamoli, Nandprayag	54 km	5.3	1
08/30/2005	Maharashtra (Ambeghar, Dicholi, Kisrule)	17 km	4.7	0
08/16/2005	Uttaranchal (Uttarkahi)	54 km	4.4	0
08/14/2005	Maharashtra	32 km	4.4	0
07/24/2005	Andaman Islands, Nicobar Islands	6 km	7.2	0
03/15/2005	Maharashtra (Dhebewadi)	6 km	4.3	0
03/14/2005	Maharashtra (Kolhapur, Ratnagiri, Satara)	49 km	4.9	0
02/15/2005	Khaspur	11 km	5.1	0
12/09/2004	Hailakandi, Cachar		5.4	0
09/13/2002	Andaman Islands (Rongat, Diglipur, ariel Bay)	29 km	6.5	2
01/26/2001	Gujarat (Bhuj, Ahmadabad, Rajokot;)	40 km	7.7	20005
01/03/2000	Maheshkhali	12 km	4.6	0
03/28/1999	Chamoli, Rudraprayag, Tehri Garhwal	11 km	6.6	100

Note: Also, according to other data, India loses 9.8 billion dollars every year due to various types of disasters. And of this, only earthquake damage accounts for 58.6 percent. And so far the most powerful earthquake in India happened on 15/8/1950 in a region of India and China and measured **8.6** on the Richter scale and the source of the earthquake was 30 km below the surface. About 1530 people died in it.
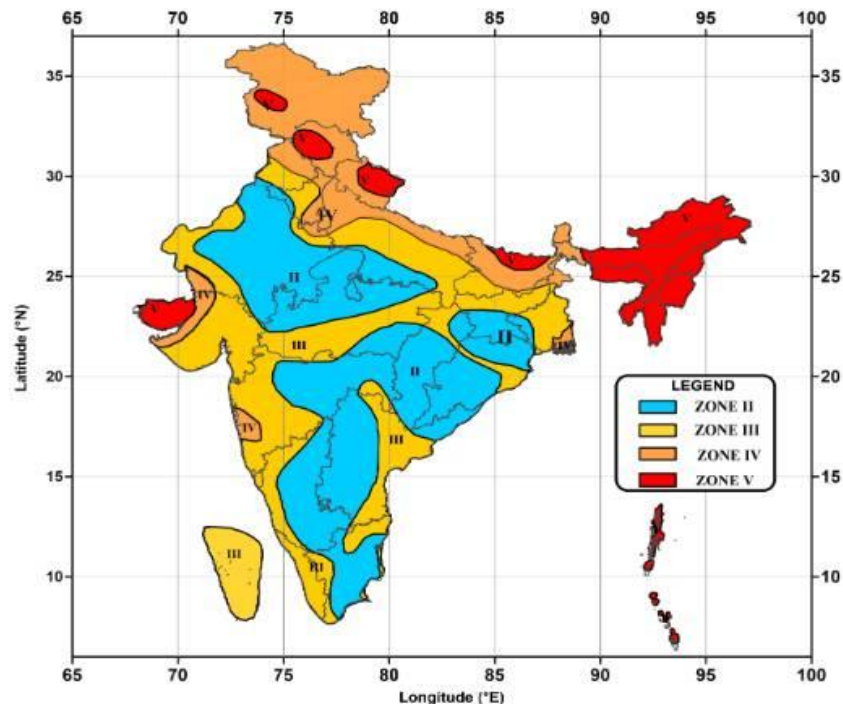

Fig. 2 Earthquake Zone India.

Cyclone: If there is a natural disaster after earthquakes and floods, it is the cyclone. And since India is surrounded by sea on three sides (Arabian Sea, Indian Ocean, and Bay of Bengal), that is why the sub-tropical regions of India are very vulnerable to cyclones. Climate change and sea level warming are increasing the number of cyclones that are currently a cause for concern in the Indian subcontinent. A cyclone is typically a tropical storm that forms over warm open water. The center of this storm is called the eye, Not only this, the eye can extend up to 50 kilometers and cyclones can usually last from a few hours to a few weeks in open water. Cyclones usually form after formation and

move forward in either a clockwise or anti-clockwise direction and cause destruction depending on intensity. Cyclones in India can be classified into various categories such as according to the strength of the associated wind or according to the intensity of the storm or storm and according to the occurrence of rainfall with the exception of waves etc. These cyclones are given different names in different regions of the world such as typhoons in the China Sea and tropical cyclones in the Indian Ocean. Besides, according to the information of the Indian Meteorological Department, In the case of storms or cyclones, storm intensity or wind intensity is usually measured in two categories, one in kilo-kilometers per hour, (Km/h). and the other in knots. Note here-

1 knot=1.85 Km/h. The depressions or cyclones occurring in the Indian Ocean, Arabian Sea and Bay of Bengal are divided into several categories according to the intensity and velocity of the rain, they are respectively –

Type of Disturbances	Wind Speed in Km/h	Wind Speed (Knots)
Low Pressure	Less than 31	Less than 17
Depression	31-49	17-27
Deep Depression	49-61	27-33
Cyclonic Storm	61-88	33-47
Severe Cyclonic Storm	88-117	47-63
Super Cyclone	More than 221	More than 120

Table 2.Cyclones or storms are named according to their intensity/speed.

Also given is a list of several storms/ Cyclones that have occurred in the Indian subcontinent: (2019-2023)-

Storms/ Cyclones Name and Timing	Details	Affected area/regions
Fani April 25 to May 4, 2019	Region: Bay of Bengal Wind speed: Max. 213 km/h On land: Max. 194 km/h Diameter: Max. 185 km Eye: Max. 56 km Air pressure: below 932 mbar	Eastern Area Odisha- Puri. West Bengal and others state.
Vayu June 8-18, 2019	Region: Arabian Sea Wind speed: Max. 148 km/h on land: Max. 41 km/h Diameter: Max. 185 km Eye: Max. 37 km Air pressure: Below 970 mbar	The southern and Western parts of India.
Maha October 28 to November 11, 2019	Region: Arabian Sea Wind speed: Max. 185 km/h on land: Max. 74 km/h Diameter: Max. 185 km Eye: Max. 56 km Air pressure: Below 956 mbar	The southern and Western parts of India.
Bulbul October 28 to November 11, 2019	Region: Bay of Bengal Wind speed: Max. 139 km/h on land: Max. 130 km/h Diameter: Max. 704 km Air pressure: Below 976 mbar	Andaman and Nicobar Islands Eastern Northeastern India
Amphan May 15-21, 2020	Region: Bay of Bengal Wind speed: Max. 241 km/h Diameter: Max. 644 km Eye: Max. 56 km	*Southern Eastern North Eastern*

	Air pressure: Below 920 mbar	
Nisarga May 31 to June 4, 2020	Region: Arabian Sea Wind Speed: Max. 111 km/h Diameter: Max. 574 km Eye: Max. 74 km Air pressure: Below 984 mbar	*Southern* *Western* *Central*
Nivar November 22-27, 2020	Region: Bay of Bengal Wind speed: Max. 120 km/h Diameter: Max. 815 km Air pressure: Below 982 mbar	*Southern*
Burevi November 29 to December 5, 2020	Region: Bay of Bengal Wind speed: Max. 83 km/h on land: Max. 74 km/h Diameter: Max. 926 km Air pressure: Below 996 mbar	*Southern*
Tauktae May 13-19, 2021	Region: Arabian Sea Wind speed: Max. 185 km/h Diameter: Max. 741 km Eye: Max. 74 km Air pressure: Below 950 mbar	*Southern* *Western* *Northern*
Yaas May 23-27, 2021	Region: Bay of Bengal Wind speed: Max. 139 km/h Diameter: Max. 796 km Air pressure: Below 970 mbar	*Andaman and Nicobar Islands Eastern*
Gulab shaheen September 23 to October 4, 2021	Region: Arabian Sea Wind speed: Max. 111 km/h on land: Max. 83 km/h Diameter: Max. 556 km Air pressure: Below 984 mbar	*Southern* *Eastern* *Central* *Western*
Jawad November 30 to December 6, 2021	Region: Bay of Bengal Wind speed: Max. 74 km/h Diameter: Max. 926 km Air pressure: Below 1000 mbar	*Andaman and Nicobar Islands Southern Eastern*
Asani May 7-11, 2022	Region: Bay of Bengal Wind speed: Max. 119 km/h on land: Max. 100 km/h Diameter: Max. 130 km Air pressure: Below 976 mbar	*Southern*
Sitrang October 23-24, 2022	Region: Bay of Bengal Wind speed: Max. 83 km/h Diameter: Max. 1222 km Air pressure: Below 994 mbar	*Eastern* *North Eastern*
Mocha May 11-14, 2023	Region: Bay of Bengal Wind speed: Max. 256 km/h Diameter: Max. 259 km Air pressure: Below 918 mbar	*Southwest of Saiha in North Eastern.*
Biparjoy *June 6-16, 2023*	Region: Arabian Sea Wind speed: Max. 194 km/h	*Western*

	on land: Max. 180 km/h Diameter: Max. 567 km Air pressure: Below 945 mbar	
Cyclone Remal May 24 - May 28, 2024	Region: Bay of Bengal Wind speeds of 110-120 kmph Gusts reaching 135 kmph	Odisha
Cyclone Asna Aug 25 - Sep 3, 2024	Northeast Arabian Sea Wind Speed: 85 km/h (50 mph) Pressure: 988 hPa (mbar)	*Madhya Pradesh*
Cyclone Dana Oct 24 - Oct 25, 2024	Wind speeds of 100-110 kmph, gusting up to 120 kmph Diameter 200- 500 (Approx)	Odisha, West Bengal

Table 3 Most violent cyclones in India.

The nomenclature is coined by several countries to name the cyclones that form in theNorthern Indian Ocean Names - Arabian Sea and the Bay of Bengal.The names of those countries are- India, Bangladesh, Iran, Maldives, Myanmar, Oman, Pakistan, Qatar, Saudi Arabia, Sri Lanka, Thailand, United Arab Emirates, and Yemen.
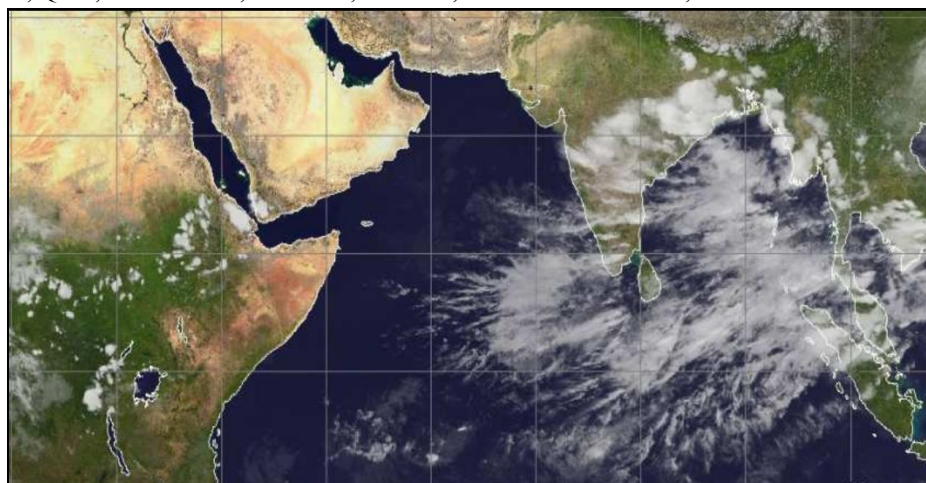
Fig. 3 Satellite image of Cyclone area of Northern Indian Ocean Names - Arabian Sea and the Bay of Bengal.

India has been facing a lot of damage due to cyclones. It is almost impossible to describe it with only a list. But an idea can be given as According to the World Meteorological Organization (WMO) the death toll in India exceeded 130 in Cyclone Amphan (2020) alone and the loss of about 14 billion US dollars was incurred by India.

Land Slides

Our India has mountain ranges everywhere from north to south. And most of these mountains in India are fragile mountains also located inland in Asia, the collision of the Indian plate with the Eurasian plate causes continuous stress on the rocks of most mountains. This makes most mountains brittle and increases the risk of landslides and earthquakes. Also during monsoons when water rises especially in mountain rivers, the soil becomes soft and loose as a result of water absorption. Landslides also occur due to soft soil or rock falling down the mountain slopes. Also, Bhumi Dasa can occur due to various reasons apart from this, landslides can occur in the mountains as a result of excessive rainfall, and landslides also occur due to earthquakes. Landslides can also occur due to unscientific excavation of hills or dynamite explosions used to collect rock chips. Landslides are found in north-west and north-east parts of India Landslides occur every year in several states of India, including Uttarakhand, Sikkim, West Bengal, Assam, and Tripura, with loss of life and disruption of communications. Landslides can cause severe damage such as: Landslides can destroy townships in hilly areas. Loss of life may occur, communication systems especially road systems may be completely disrupted. etc. Several landslides occur in the northeastern part of India and in the state of Kerala in the

south. According to the information provided by Times of India, 3782 landslides have occurred in India in the last 7 years. (up to 2015-2022) and the Death toll is over a thousand.
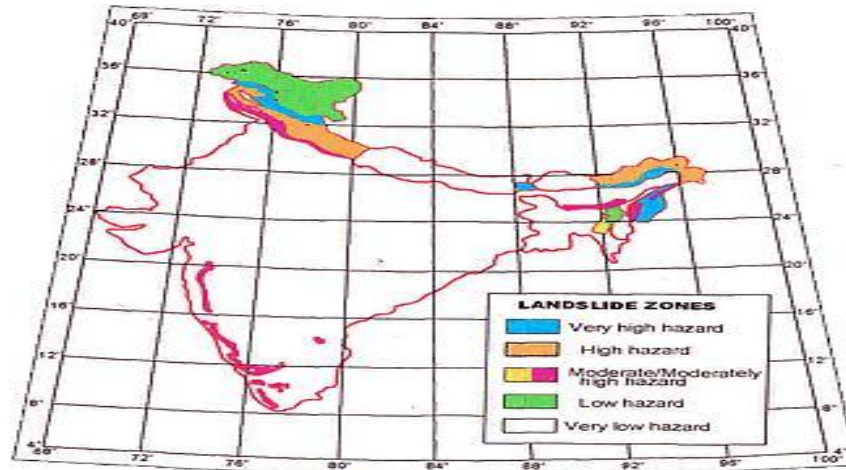

Fig. 4 Land Slide Area Map in India.

Tsunami: Tsunamis can generally be said to be a result of undersea earthquakes Tsunami refers to a series of natural phenomena including earthquakes or landslides or sometimes volcanic eruptions under the sea, and as a result, the sea level rises and it hits the coastal areas in the form of high-velocity waves and wreaks havoc on the coastal areas. When the water level or waves created by a tsunami hit a coastal area, it has a speed of about 800 kilometers per hour (500 miles per hour). Under these conditions, the water level can rise up to about 100 feet. If an earthquake above magnitude 6 occurs under the sea, a large tsunami is likely to occur. India is surrounded by sea on three sides, tsunamis can occur. However, compared to other natural disasters, the tsunami damage rate is much higher due to the delay in getting advanced predictions. We still haven't forgotten the 8.6 magnitude earthquake that hit the Sumatra Islands on December 26, 2004, and the devastating tsunami that it generated and hit the Indian subcontinent.

Fig.5 After Tsunami effects in India.
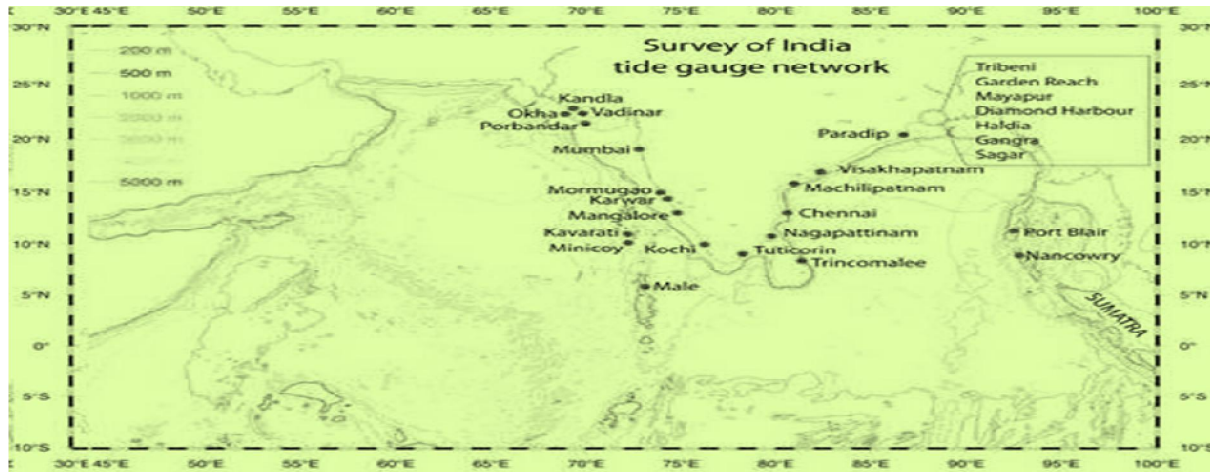
According to the data provided by the Government of India, about 10749 people died and 5640 people went missing as a result of the tsunami in the Indian Ocean in 2004. And not only thousands of people were rendered homeless, but several hectares of agricultural land were also damaged by seawater. The Indian Ocean Tsunami in 2004 caused a loss of around Rs 12,000 crore in Indian currency. Among the worst affected states in India were the Andaman and Nicobar Islands, Pondicherry, Tamil Nadu, and Kerala.

Drought

Drought refers to when a region experiences an abnormal increase in temperature due to climate change, a decrease in rainfall, a decrease in groundwater, and an increase in soil moisture. In other words, drought is when there is a chronic shortage of natural water supply in an area, then the area is declared drought, and not only that the drought lasts for one to one and a half months or sometimes even a year. Natural ecosystems and agricultural lands are severely damaged by drought. Droughts are increasing in India due to irregular rainfall or climate change, which is one of the causes of concern for environmental scientists and agriculturists. This time we will know about several causes of drought The causes of drought are: The first and main cause of drought is climate change. Secondly, one of the reasons is the abnormal rate of groundwater depletion. The third reason is the lack of adequate rainfall. The last reason is that excess temperature is found. This time we see the results of the drought first, Due to drought, the rivers and ponds dry up, and as a result, the ecosystem and other aquatic animals and plants are severely damaged. Secondly, as a result of drought, Agricultural land is severely damaged thereby affecting food crops including vegetables, and leading to loss of food crops. Food prices rise. In addition, increasing droughts lead to depletion of groundwater levels and widespread drinking water problems. Not only that, drought threatens people's livelihoods and increases the risk of disease and death.
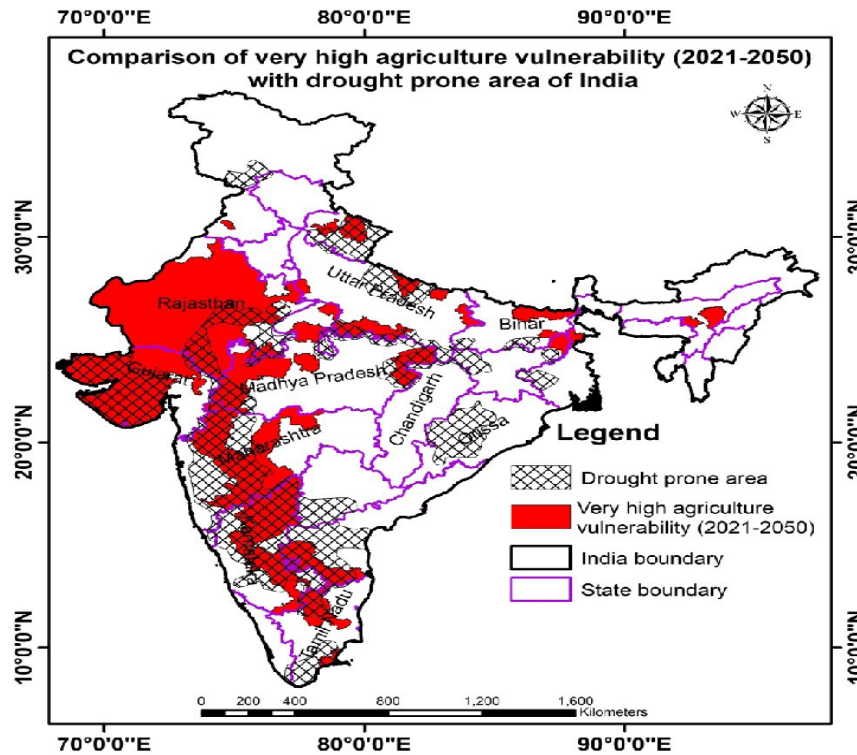

Fig. 7 Draught.

Fig. 8 Very high agriculture vulnerability vs. drought-prone area of India.

According to the UN Report- Droughts are increasing every year due to extreme weather in India and causing losses of almost eighty-seven billion dollars every year. And nearly one-third of India's districts are facing drought.

Heat waves

A heat wave is a condition in which higher-than-normal summer temperatures persist for a longer period and is called a heat wave. A heat wave is a condition in which higher-than-normal summer temperatures persist for a longer period and is called a heat wave. The heat flow period usually occurs between March and June but currently, it is seen to increase from around July to August. As a result of this heat flow, people are affected, there is water shortage, rivers dry up and where heat wave occurs, it has a great impact on people, animals, other animals, and various trees, and heatstroke can occur in severe burns, sometimes even death. According to the India Meteorological Department, if the temperature exceeds 40 degrees Celsius in the plains and 30 degrees Celsius in the hilly areas and the temperature lasts for a long time, then it is a heat wave warning. That is, when the temperature is four to five degrees above normal and lasts for a long time, a heat wave warning is issued. During this heat flow, it is seen in the plains or in the case of various plateau regions, the very hot wind blows in the afternoon called the Lu wind. Which has a very harmful effect.

The causes of heat waves are Climate change can increase heat wave, deforestation can increase heat waves, overpopulation can increase heat waves, and solar radiation can increase heat waves. Apart from this, heat waves can also occur due to the growth of factories, and excessive use of vehicles can also cause heat waves. The effects of heat waves on the human body are weakness, headache, vomiting, dehydration, etc. In some cases, even death occurs. But the biggest damage, if any, is currently happening to nature as glaciers melt and sea levels rise. As a result, several towns or big cities may go under seawater in the coming days.
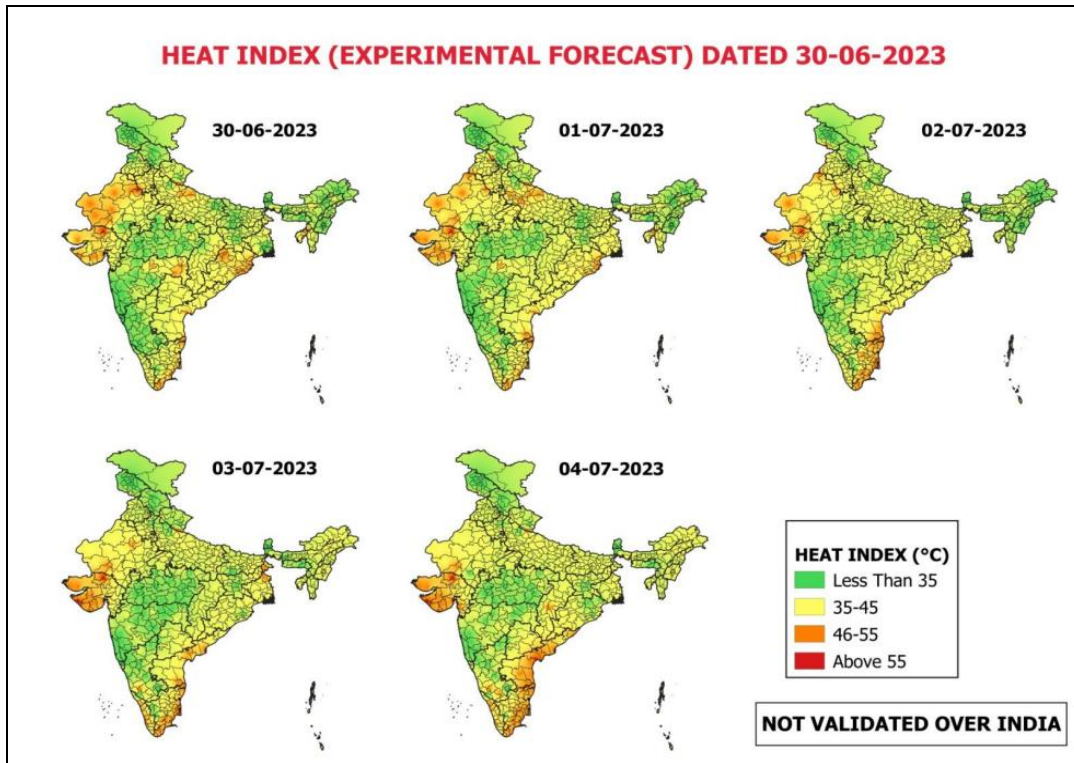
Fig.9 Temperature Status and Heat Wave Warning in India (June-July 2023)

Apart from the major and minor disasters described above, other facts, and their scope and damage, more natural and minor natural disasters occur in India. like Cold waves, Thunderstorms, Mudslides, storms, avalanches, etc.

Man-Made Disaster

This time we will know about unnatural disasters or manmade disasters and among them some major disasters and their damages.

Chemical disaster

Among the natural disasters, chemical disasters are one of the most destructive and severe. A chemical disaster occurs when a toxic chemical substance is intentionally or unintentionally released into the environment and causes harm to humans, animals, or the environment. Chemical disasters cause property damage and casualties depending on the severity and impact of the chemicals released. That is why chemical exchange occupies an important place for disaster management. Chemical accidents occur due to various reasons viz Accidents can occur if there is a safety failure in the chemical system or due to inadvertent human error or technical error or even complete management failure. Apart from these, these chemical disasters occur due to the release of gases due to various natural disasters or from various types of transportation lightning materials or during the disposal of hazardous lightning or terrorist attacks. Currently, the most important risk areas for chemical disasters are industrial areas, where toxic chemicals can be released, and spills can occur. An example of this chemical accident is the Bhopal gas accident in India in 1984. And it can be said that the Bhopal gas accident was the most devastating chemical accident in history. Which will remain an example of a terrible chemical accident to India as well as to the whole world. According to Indian government information, toxic gas methyl isocyanate (MIC) was accidentally released from a chemical factory in Bhopal, killing more than a thousand people and livestock instantly. Various people were admitted to hospitals with symptoms of multiple diseases, pains, and injuries, and townships, arable land were damaged. Apart from this, according to the information given by the NDMA, even after the Bhupal gas accident, more than 130 chemical accidents have been recorded in India in the last decade and about 259 people have died and about 550 people have been seriously injured.

Biological disasters

A biological disaster is defined as when a disaster occurs in the environment due to bacteria, viruses' micro-organisms, or toxins. Although this disaster can happen due to natural or unnatural reasons. Bio-disasters can cause loss of life or severe damage to health and not only affect livelihoods. Even the environment is damaged. Examples of biological disasters are respectively- animal plagues and infestation, epidemic diseases, plant or animal contagion, etc. Biological disasters have two important categories namely epidemics and pandemics. An epidemic is when a disaster spreads within a certain area and affects a large number of people disproportionately. For example malaria, Cholera, Dengue, Plague, Japanese Encephalitis, etc. This time we will learn about the pandemic, the pandemic is a disaster that is not confined to a specific place and spreads globally it can be across the district or state or across the country or sometimes it can cross country boundaries and spread across the globe. An example of this is influenza. Incidentally, we have already seen such a pandemic in 2019, 2020, and 2021, which originated in China and spread to different continents of the world including India. The whole world has to face a difficult situation like a lockdown to deal with the novel coronavirus. India also saw the world's biggest lockdown in 2020. From 2019-2020, the Nobel Coronavirus was spread all over the world and According to WHO's Information the number of people affected by this virus was 695286674 and the number of deaths was 6915532 respectively. And the number of infected with this coronavirus in India was **44,997,975** and the number of dead was **531,930**, and about **44,465,415** people recovered from this virus infection. The Indian government and the people of India joined hands to deal with this coronavirus, not only that, along with the lockdown in India, there was also an adequate rationing system for free which was arranged by the government to send the affected people home. Even though doctors gave their lives, they were engaged in fighting this virus, several government departments including the police, army, fire department, and Department Civil Defence of India took a positive role in fighting this virus by risking their lives, their contribution to fighting the covid epidemic is not to be forgotten, also India is the world's largest vaccination against this coronavirus.

Nuclear and Radiological Emergency

Nuclear and radiological disasters are among the unnatural disasters. As a country moves forward in keeping pace with technology, energy needs require the application of nuclear science technology in power generation, the pharmaceutical, industry or research, or sometimes for defence. For energy needs in India, the use of nuclear energy is increasing day by day. And due to some neighboring countries of India being nuclear-powered - India is at risk of nuclear and radiological radiation.The various types of nuclear accidents or nuclear hazards that can occur are: As a result of the experimental explosion of the atomic bomb sometimes as a result of an accidental accident in a nuclear reactor or sometimes as a result of the use of an atomic bomb in war field but it all depends on the size of the atom according to its intensity and level of radiation. India has several atomic power plants, most of which are located in the north-west and south-west of India. And from all these power plants, maximum safety measures are taken to avoid any accidents. The administration is always alert even at the local level to reduce accidents or risks. It is pertinent to mention that the Bangladesh government has constructed an atomic thermal power plant in Kushtia district, a short distance from Nadia and Murshidabad districts on the eastern border of India. In the coming days, if any accidental incident occurs at this atomic power plant and there is radiation or other damage, the two districts of our state should be on alert. If necessary, to address all these risks in the future, the Civil Defence Force and Fire Department from the bordering blocks or subdivisions of these two districts, Murshidabad and Nadia, can be made ready to handle accident situations with special training.Also, the various machines used in our treatment, such as X-ray machines or CT scan machines, may sometimes create a possibility of radiological risk.

Fires

Fire is one of the natural calamities that occur frequently in different parts of India and causes huge losses (life and financial), Besides, every year many people die due to fire accidents in different parts of India. Fire is basically a combination of three things – oxygen, fuel, and heat.
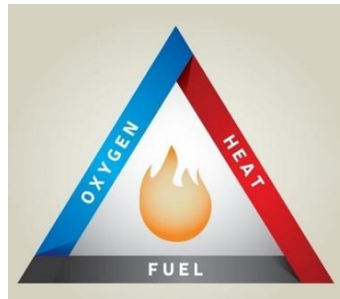
Fig. 10 Fire Triangle

Although fire is an unnatural disaster, it can occur due to both natural and unnatural causes. According to National Crime Records Bureau report in the year 2019- Fire cases were registered at 11,037 and deaths at 10,915. In 2020 fire cases registered 9,329 and deaths 9,110. It can be said that about fifty people are dying every day due to fires in India. In addition to these fires, natural fires caused by wildfires or lightning strikes cause considerable damage and damage to the environment and ecosystems every year. Fires, if not controlled quickly, spread rapidly and causesevere damage to human life, livestock, and property, including vegetation. According to data from Firepedia and NCRB, the number of deaths due to fire accidents is over 30,000 in India every year. Below is an idea of the dead and wounded through a graph: -
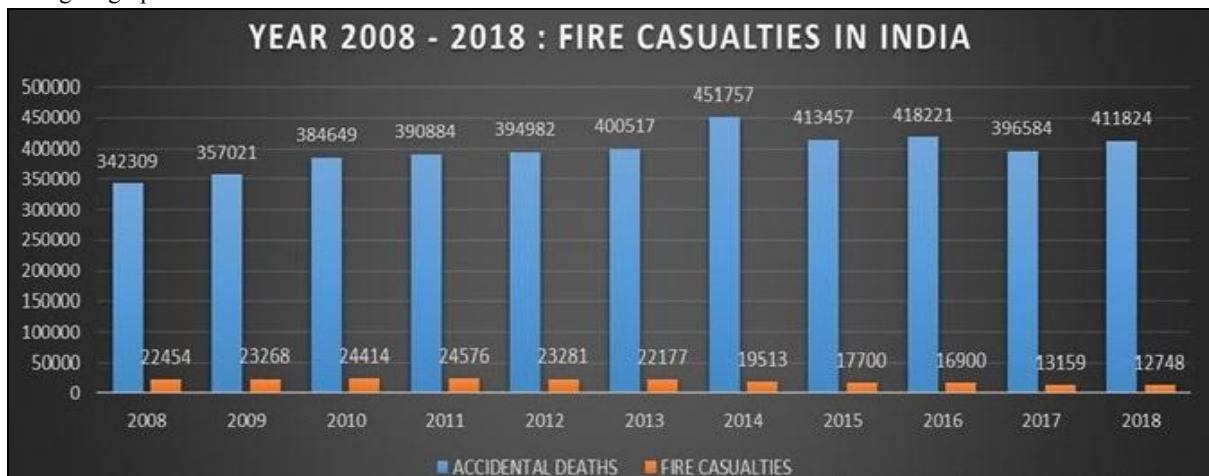

Fig. 11 Fire Casualties in India Time-Period 2008-2018.

According to the intensity of these fires are divided into several categories such as Class-A, Class-B, Class-C, Class-D, and Class-F. Most fires in rural or urban areas are caused by carelessness in the kitchen. Accidental fires are also observed in various industrial sectors. Besides, fires are often accidentally spread from the firecrackers during various events such as Diwali, Dussehra, or when fireworks are lit during the opening ceremony of the New Year.Also, fire can occur from the short circuit of electricity That has also been noticed. Also in India, temporary structures are constructed during various events (using wood, bamboo, or different fabrics) and these temporary structures often cause accidental fire damage. This time we will see at some major fire accident losses in India-

Sl. No. of fire Incidents	Date of Fire Incidents	State	Fire Incident	No. of Deaths
01	07-06-1997	Tamil Nadu	Brihadeeswarar temple fire	48
02	13-06-1997	Delhi	Uphaar Cinema	59
03	08-06-2001	Tamil Nadu	Mental Asylum, Erwadi	25
04	26-06-2002	Uttar Pradesh	Shree Lee International footwear factory, Agra	42
05	27-02-2002	Gujarat	Train fire, Godhara	58

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06	14-05-2003	Punjab	Train fire, Ludhiana	38
07	23-01-2004	Tamil Nadu	Padmapriya Marriage Hall, Srirangam	57
08	16-07-2004	Tamil Nadu	Kumbakonam School	94
09	10-04-2006	Uttar Pradesh	Brand India Trade Fair, Meerut	57
10	22-11-2006	West Bengal	Leather factory, 24 Pargana (S)	30
11	29-10-2009	Rajasthan	IOC Oil Depot	12
12	23-02-2010	Karnataka	Carlton Tower fire, Bangalore	9
13	29-03-2010	West Bengal	Stephen Court	42
14	12-09-2011	West Bengal	AMRI Hospital	90
15	30-07-2012	Andhra Pradesh	Train fire, Nellore	47
16	09-05-2012	Tamil Nadu	Sivakasi Firework Factory	40
17	28-12-2013	Andhra Pradesh	Train fire	26
18	04-11-2016	Kerala	Puttingal Devi Temple, Kollam	108
19	02-12-2019	Delhi	Arpit Hotel Fire	17
20	24-05-2019	Gujarat	Takshashila Centre, Surat	20
21	12-08-2019	Delhi	Factory Building in Anaj Mandi area	43

Table- 4. Several major fires and death tolls in India from 1997 to 2019.

War

War is one of the man-made disasters of the 21st century and one of the most dangerous. Two or more countries go to war when there is a problem between two or more countries over delimitation of borders or economic problems between more than one country or an unauthorized interference in the sovereignty of a country or a sudden attack on a country and when all these problems cannot be resolved at the diplomatic level or through negotiation, then two or more countries go to war. When war breaks out between two or more countries and both sides possess equal military power, or there is a threat of nuclear war. Then the result of that war is devastating. Also, war can happen for many reasons. When a superpower goes to war, there is still the possibility of catastrophic consequences. From the history of war, we learn a lot about the horrors of World War I and World War II. Also, the entire world is witnessing the effects and risks of the Cold War in the 21st century. Our India has also seen more than seven thousand foreign invasions since ancient times. And even after independence India has been involved in several wars with some neighboring countries over border issues or to prevent attacks or sometimes for humanitarian reasons. All these war and post-war losses, and risks have been successfully faced by the Indian Army, the people of India, and the strong leadership of India. And we risk war to protect this vast territory of India. But to date, India has not attacked any neighboring country first or engaged in war. India has always gone to war to counterattack after being attacked. Battles cause quite a lot of damage viz A lot of peoples and animals die, villages and townships are destroyed, cultivable land is destroyed which lasts for several decades, and economic depression occurs. Prolonged wars can also lead to food shortages, water shortages, broken medical systems, economic depression, and famine.At present India is one of the first countries in the world economically and fourth in the world militarily. Below is a list of wars India has been involved in since independence and the number of casualties.

Sl No.	War	Year	Casualty or Losses	Result
01	Kashmir War (India and Pakistan)	1947	1,104 Indian soldiers were martyred and 3,154 were injured. Whereas Pakistan Army's death toll was 6000 and wounded 14000	Ceasefire agreement.
02	Sino-Indian War (India and China)	1962	1,383 were martyred and 1,696 missing, 548 – 1,047 were injured	Aksai Chin in Chinese control.

			3,968 captured. Whereas China-722 killed.1,697 wounded.	
03	India-Pakistan War	1965	The Indian army Martyred 3000, while Pakistan suffered 3,800. The Indian army was in possession of 1,920 km2 (740 sq mi) of Pakistani territory and the Pakistan army held 550 km2 (210 sq mi) of Indian territory.	Tashkent Declaration
04	India-Pakistan war	1971	India had 3,000 Martyred and 12,000 wounded. As Pakistan suffered with 8,000 killed and 25,000 wounded.	India won. and Bangladesh Establish.
05	India-Pakistan War or Kargil War (Operation Vijay)	1999	Indian casualties were 527 Martyred and 1,363 wounded. Pakistan Side-737–1,200 killed.	India regains possession of Kargil

Table-5. Wars and losses with India since Independence.

Terrorist Attack: If there is another large-scale unnatural disaster after war, it is terrorism. Terrorism usually refers to the deliberate use of violence or fear against civilians to achieve political or economic goals or to forcefully rule a place.Terrorist attacks have happened or are heard happening in almost every country in the world, India is no exception. Again, even after seeing the economic development or social development or other development of a country, terrorist attacks happen to temporarily stop all those development processes or to create unrest in the minds of the common people. With the availability of sophisticated weaponry in the hands of militants, today's terrorist attacks also cause more losses and more casualties. Although the Indian army, Commando forces, and Indian Police administration are ready to deal with terrorist attacks in our country. However, it takes time and money to carry out rescue operations and restore normal life after a terrorist attack. We have seen the Mumbai terror attack in 2008, the Uri attack in 2016, and the horrific Pulwama attack in 2019 in our country. From 2000 to 2023, India witnessed about 23,900 cases of terrorist attacks in which about 46,000 people died (*According to satp.org*).The dead included security personnel and civilians.

Road and Train Accidents: Road accidents and train accidents are among the manmade disasters in India.Due to these road accidents that happen almost every year, many people lose their lives and various properties are lost. Road accidents also occur due to mechanical faults or landslides in hilly areas. Accidents also occur due to drowsy driving or overspeeding. The cause of the train accident is usually due to the bending of the train line or to fault in the signal system of the train or when the train line is washed away by monsoon. Many people die in both train and bus accidents. As India has a large area, road accidents naturally account for a large number of deaths. That is, only India has the most road accidents in the world, about 1.5 million people die in road accidents every year *(According to The Economic Times)*. Also, according to other data, road accidents in India cost the social sector **147,114** crores *(According to India Times)*. Also, although the number of train accidents is relatively low in India, the death toll in these cases is high. And the cost of damages exceeds billions of dollars. An example is the bus accident in Uttar Pradesh in 2022 where 22 School Children were Injured or the Balur Ghat bus accident in West Bengal Where a government bus broke the guardrail of a bridge and fell into the canal killing 40 people on the spot in 2020. Also, to give examples of train accidents, are many examples, among them the Kormandal Express accident that happened a few days ago (June 2023) in Balasore, Odisha. Where **296** people died and **1200+** people were injured.

Digital disaster is also another example of Man-made disasters. When there is an attempt to hack a banking sector website or an important official website or a sudden virus attack occurs, it temporarily affects the entire country, it is called a digital disaster. In other words, Digital Disaster is a disruption in the normal process of the digital domain, either intentionally or mechanically. Presently digital disaster is the cause of various problems worldwide including

India. Examples of Digital Disaster are Violation of Privacy of stored data,Cyber attacks in various public and private sectors. Sudden system failure due to software or hardware errors. Loss of telecommunication network due to natural calamities or other unnatural causes, Spreading various fake news on social media without verifying it etc.India has a strict law to ensure cyber security, IPC IT-Act 2000.Apart from that, the Police Administration Department of India also keeps a watchful eye to ensure this cyber security. White hackers and government guidelines should be followed to avoid various cyber frauds. Do not click on or search for any link or any attractive offer link or any banking link without verification. Also, if any cyber fraud occurs unknowingly or unexpectedly, a complaint should be promptly reported to the officer in charge of the Government Cybercrime Department without wasting time.
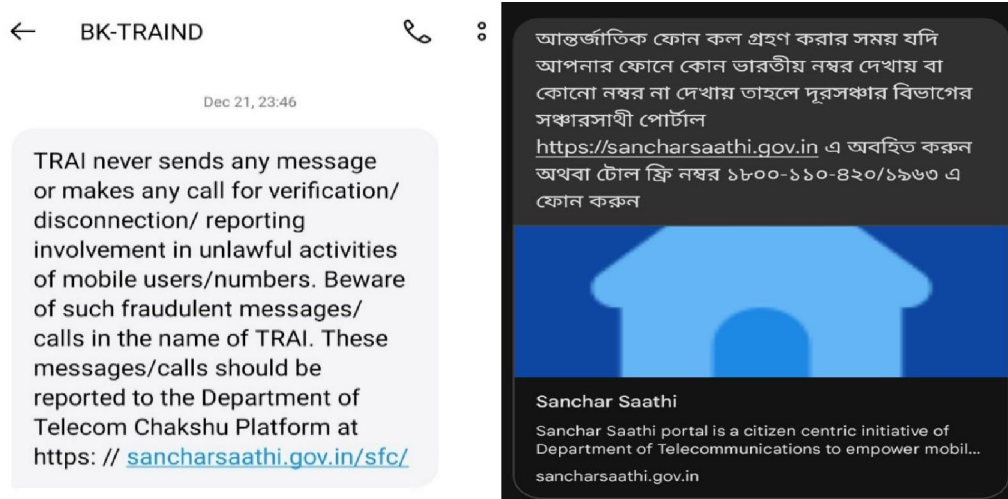
Fig.12 Warning Message from TRAI.

Some of the important Unnatural or man-made Disasters have been discussed above and apart from these there are several other Unnatural Disasters like- Pollution due to prawn cultivation, Betting factory explosion, riots, Food poisoning, Industrial disaster, Environmental pollution crisis, etc.

Among them, food poisoning is one of them. When food poisoning occurs in any region and district or any part of the state, it can be fatal. For example, when food poisoning occurs, many people can be affected, or the presence of bacteria in water or intestinal disease, etc.

Also, these days many people have lost their lives due to explosions from beet factories in different parts of India, which can be put under a man-made disaster.

III. DISASTER PREVENTION AND MITIGATION MEASURES

The Government of India has adopted several preventive measures to deal with disasters and the 10th Five Year Plan document of India has detailed the various strategies it has adopted to deal with disasters. Besides, the Government of India has undertaken several projects for disaster-prone areas viz Building embankments along various rivers to prevent floods, or constructing shelter houses for cyclone base areas, etc. This time I will also discuss Prevention and Mitigation measures to deal with disasters in India.

Disaster Response: Disaster response generally refers to the measures taken to carry out rescue operations after a disaster occurs or when a disaster occurs suddenly, it can also be said that disaster response is the response that is taken immediately and quickly after a disaster occurs. As an example, cover or secure sources of drinking water or other food, begin providing emergency medical care, begin search and rescue operations, initiate fire-fighting measures, Resource Management, or take measures to prevent looting and secure other structures, such as providing necessary emergency medicine. Emergency response activities are those that are carried out during real emergencies, such as evacuating threatened communities to safe places, evacuating many communities or people whose livestock is at risk during storms, floods, etc. After the disaster, care should also be taken to ensure that no one can trespass and create problems at the disaster site where disaster response operations are underway.

Disaster Recovery: Disaster recovery refers to helping disaster-affected communities recover and rebuild or recover to the proper level of functioning when rescue operations are over after a disaster has occurred. that is the measures taken to return to normal life after a disaster is called disaster recovery. That is, after a disaster, good communication systems are cut off, food shortages occur, recessions occur, and various problems occur, such as physical illness, and mental problems among different peoples, and adopt management to solve them. After a disaster, recovery can be done by providing various assistance to the affected people in the disaster area such as financial assistance, medical assistance, rebuilding of damaged houses, etc. This disaster recovery process can be divided into several categories - Emergency phase, Transition or recovery phase, and reconstruction phase.

Emergency phase: This level is usually the focus. That is, after a disaster, the first goal is to take control of the disaster-affected area and start search and rescue operations, take first aid measures to save lives provide emergency medical assistance and assess all the disasters to quickly restore communication systems, and start repairs. doing, and relocating residents, etc.

Recovery or Transition Phase: This phase usually allows people to return to the area where the accident occurred return to work or begin repairs to damaged buildings and infrastructure. So that people can return to normal as soon as possible, as a result, mental recovery begins, and people get back to work after depression.

Reconstruction Phase: What is done at this stage is usually characterized by communication systems, utility roads, and physical realignment. And residents return to their previous areas, to repair or rebuild their damaged housing or resume agricultural activities.

Disaster Mitigation: Disaster mitigation is defined as - a sustainable action taken by the government to reduce or eliminate the risk to people and property from disasters. For example, it can be said to build emergency housing, such as in a flood area or a cyclone base area, these organizations are widely used, also providing safe drinking water, repairing houses or sanitization systems, Making arrangements of dry food, essential documents, and essential life-saving medicines.
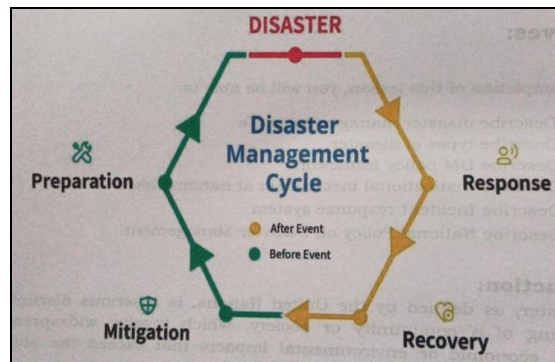

Fig. 13 Disaster Management Phases.

Forces used in disaster response in India: Now we will know in detail about all the forces that are used to deal with natural and unnatural calamities in India. And before that, we need to know about **NDMA** (National Disaster Management Authority), NDMA is an organization owned by the Government of India. This organization was created through several stages. After the devastating earthquake in Gujarat in 1999, the Government of India set up a High Power Committee in August 1999 to deal with the disaster. The main function of this committee was mainly to plan and make suggestions for disaster management. Later, on 23 December 2005, the Government of India enacted a law (Disaster Management Act) to create the National Disaster Management Authority, and the honorable Prime Minister of India was declared as the head of this NDMA and in the case of states, the main responsibility and head of this department is the state Honorable Chief Minister. The Department of Disaster Management extends from the central level to the panchayat level. In the case of states, the District Magistrate is in charge at the District level the Sub Divisional Officer is in charge at the Sub Divisional level the Block Development Officer is at the Block level and the Pradhan or Municipality Chairman is in charge at the Panchayet or Municipality level. The main task of NDMA is to build a safe and disaster-resilient India through technology or sustainable development strategies In addition, NDMA also works to formulate policies for disaster management or develop their own capacity for disaster management.

NDMA also coordinates and works with various organizations at national, regional, and international levels in disaster response.

NDRF: (**National Disaster Response Force) -** NDRF was formed in 2006 with eight battalions under the Disaster Management Act of India (Section 44 of the Disaster Management Act, 2005). This force is created to deal with natural and man-made disasters. initially, the NDRF forces were supposed to be responsible for law and order, but later on, these forces only worked in disaster response as per the directives of the DG of the NDRF. There are a total 16 battalions in NDRF under the Ministry of Home Affairs, Government of India. Equipped with modern equipment and specially trained for disaster response, these forces are always ready to deal with natural or man-made disasters.

Fig. 14Images of Various awareness training programs of NDRF forces.

Presently, this force has the reputation of conducting more than 70 rescue operations in India. NDRF has also conducted rescue operations on foreign soil with distinction. Currently, efforts are underway to improve this force more technically. NDRF has its own camps in various states of India, including West Bengal, from where they conduct rescue operations Also, this force provides various trainings to the students and organizes various seminars to deal with disasters. The motto of this NDRF is "आपदासेवासदैवसर्वत्र" in English- Disaster service always everywhere.

SDRF: State Disaster Relief Force-SDRF is a force similar to NDRF to deal with disasters however, this force is under the control of the State Government and this force is created as per section 3.4.5 of the National Policy on Disaster Management Act 2009. As many as 24 state governments and Union Territories have developed their own SDRFs and are deployed at airports, railways, or major road locations after appropriate training. So that these forces can quickly reach the disaster-affected place to deal with any disaster. The force also organizes various programs for disaster preparedness awareness in the states. Also during disasters various child forces like NCC, NSS. of the state or

various volunteers also provide training and technical assistance on what to do to deal with disasters. The role of NDRF as well as SDRF was also appreciated in the fight against the coronavirus pandemic that happened a few years ago.

Civil Defence: Civil Defence Established on 24 October 1941 during British India. At that time the main functions of this civil defense force were mainly - crowd control, delivery of relief work assisting the government in various law and order activities and assisting the government in various civil defense activities or supervising various rescue operations. From that point of view, India's oldest established force to deal with disasters is the Civil Defense. In the post-independence period. The Civil Defense Act 1968 (the Act was passed by the Parliament of India) was created to maintain law and order in some cases, in the wake of the 1962 India-China War and the 1965 India-Pakistan War, to carry out rescue operations and other services, relief work, and reconstruction work. Later in 2009 and 2010 the Civil Defense Act was suitably amended and vide Notification No. 3-The primary roles of civil defense have been retained and disaster management has been included as an additional role for the Civil Defense Corps. Currently, the Civil Defence crops are usually deployed to the disaster site, either before or after the disaster. There are departments from the Civil Defense Department and from the Center level to the Panchayat level. The force works diligently in disaster and post-disaster recovery, including relief, to deal with various epidemics and to meet the needs of various social schemes of the government, in some cases to maintain law and order and to raise public awareness of disasters. Special training (Practically) is provided by the office of the District Magistrate or Sub-Divisional Officer to work in Civil Defense and the certificate is given after the training. According to that document, these forces work as volunteer workers registered with the District Magistrate. At present, they are deployed at different bus stands or different railway stations, different airports, different river ghats in Different border areas, In different govt offices and Hospitals etc. Civil defense is also seen to deal with different types of cyclones or epidemics. At the ground level, Civil defense voluntary forces are the first line of defense to deal with disasters (Natural or man-made). So to better deal with various disasters, along with the modernization of these forces, there is a need for more appropriate training, clothing, and financial assurance. Civil Defence's official motto is "सर्वभूतहितेरतः" in English- "Engaged in the welfare of all beings" taken from Bhagavad Gita.

Fig. 15Images of Members of West Bengal Civil Defense during Durga Puja, Kali Puja, Ghat duty, and several public awareness work duties including social work.

Home Guards: Home Guard is one of the oldest forces after Civil Defense among India's disaster response forces. And this force is a volunteer force, and it was created in December 1946. At that time the force was created primarily to assist the police in dealing with communal riots and civil unrest.Since independence almost every state in North-East India and South-West India and several Union Territories and now almost every They are seen and work in the state. During the 1962 Indo-China war, their role was commendable. They also work with the police in maintaining communal harmony and internal security situations, today these forces are found in almost every state of India and their main function is to assist the police or police administration in maintaining law and order. They also work with the police in maintaining communal harmony and internal security situations, but also in various emergencies such as air strikes, fires, cyclones, earthquakes, epidemics, and Pandemics, etc., the official motto of this force is निष्कामसेवाin English- "Selfless service".

Fire Service: The Fire Brigade or Fire Service is one of the oldest disaster response organizations in India. This organization was first created in British India in 1803 AD in the city of Mumbai and later in 1822 AD in Calcutta as Calcutta Fire Service. This force was administered by the British Calcutta Police at that time. Later, through post-independence legislation, This force was brought under the Disaster Management Act. These forces usually deal with natural and man-made disasters, one of which is firefighting forces working under the direction of DG Fire at the central and state levels. At the local level as well as the police administration, this force has its own station, and an officer-in-charge is in charge of that station. Apart from putting out big and small fires, firefighters have been working diligently risking their lives to deal with various natural and man-made disasters. These specially trained forces are always ready to deal with fire and other natural and unnatural disasters. The force has the power to make laws and take measures to deal with fires. the official motto of this force is "We serve to save".

Fig16. Fire brigade or fire service fire extinguishing method. Various rescue methods and training.

Aapda Mitra: Aapda Mitra (Established in 2016) is not a force, but it is an important scheme of the Government of India to deal with a disaster and reduce risk. In November 2016, the Hon'ble Prime Minister of India released a 10-point resolution on disaster response and risk reduction at the Asian Ministerial Conference, emphasizing a culture of volunteerism. Later, the Aapda Mitra scheme was taken up by the Government of India to reduce the risk of natural and man-made disasters. Aapda Mitra training is mainly given to boys and girls of Civil Defence, NCC, NSS, and other voluntary organizations. Through this scheme, various boys and girls recruited from various voluntary organizations and schools are given suitable training for dealing with disasters at government expense. At the end of the training, the volunteers are provided with an Aapda Mitra original certificate along with an honorarium and various kits to be used in disaster response including dress, safety shoes, torch light, Knife, Helmet, and water bottle. And the person who stands first in this training is specially rewarded. The scheme is mainly adopted for those districts or border areas, or those areas or districts prone to natural and unnatural calamities including floods, and earthquakes. A target has been taken to keep at least 200 trained Aapda Mitra volunteers in reserve in each district.

Fig. 17Aapda Mitra Training and Rescue Operations.

Medical Team: When many people are injured or killed at a disaster or accident site and those sick people need treatment, the medical team helps them. This medical team consists of doctors, nurses, and other paramedical staff including other assistants. All these medical teams include doctors, nurses, and other paramedical staff from medical colleges and other local hospitals or various private organizations, the Red Cross Society, and the National Health Mission. If necessary, Temporary hospitals are also opened at the accident site to provide treatment. For example, during the Bhopal gas accident in India, many people were seriously injured and the role of the medical team in Bhopal to provide them with services and other medical facilities is considered with respect. Besides, the presence of medical teams can be observed at several disaster or accident sites But the biggest example is that the contribution of doctors and other medical and paramedical staff was important in fighting the coronavirus pandemic in India. Many doctors and other nursing staff have also died fighting this epidemic. The Indian Army and Air Force honored the doctors by showering them with flowers from army helicopters keeping in mind their important contribution in fighting the Corona pandemic.

Engineering and Technology Team: When a natural disaster or man-made disaster occurs in a place and the communication system of that place breaks down, this technology team is needed to rebuild the communication system. So that other technical communication systems including roads can be reconnected Because if the communication system is not good, it is difficult to reach relief and rescue or other help at the disaster or accident site. These teams can usually be in both government and private sectors. Besides, their importance is immense in predicting various natural and unnatural disasters. Also, by analyzing the images and data obtained through satellites, the likely paths of various cyclones are predicted thereby preventing a lot of loss of life and property damage.

Indian Army and other Forces: When the above-mentioned forces work together to deal with a disaster, Or in the case of conducting a rescue operation, even after all the Disaster forces work together, there is a lot of speed or manpower falls short. When other technical problems occur during rescue operations. At that time, with the quick permission of the Ministry of Home Affairs of India, the help of several central forces including the Indian Army, Air Force, Coast Guard, ITBP, BSF, SSB, CRPF, and the other Central forces or Paramilitary forces in reserve with the states was taken. For example, during the Uttarakhand disaster, the Indian Army and other forces including the Indian Air Force participated in the rescue operation. In addition, various units of the Indian Army and various central forces have been seen participating in rescue operations and technical assistance during the cyclone in the southwest and southeast parts of India. Besides, after the collapse of the Vivekananda flyover in Kolkata, West Bengal, the help of the Indian Army was taken to normalize the situation. To deal with the situation after Cyclone Amphan in 2020, the help of various units of the Indian Army including NDRF, ODRF, and other central and state forces was taken. In addition to the Coast Guard in India's coastal areas and India's island areas, the Indian Navy also assists in disaster response. Also, to deal with various disasters, various transport authorities various government agencies of India, and various voluntary organizations also help India to deal with disasters.

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49

IV. TECHNICAL SOLUTION OF DISASTER IN INDIA

This time we will look at how natural and man-made disasters can be dealt with technologically.

Early Warning System for Floods: Floods are one of the major causes of natural disasters in India. India is a riverine country. Therefore, early warning measures should be taken to control floods, and digital projects involving river gauge networks should be implemented, along with meteorological monitoring of riparian areas in rivers. Other wild response measures should be taken including evacuation of people to safe places when a flood is likely or flood is predicted. Also during summer when the water in the river is low, the project to increase the depth of the river should be taken up and implemented. Actions should be taken to ensure that no garbage like plastic or other floating material is carried in the river. Besides, it is necessary to monitor the river embankments at regular intervals every year and to clear the silt accumulated in the river embankments. In addition to the depth of river water, several technical projects should be undertaken and implemented such as a warning or automatic alarm using various sensors sounding when the river water increases or decreases.

Early Warning System for Earthquake: Earthquake warning involves several projects including the installation of sensors for forecasting earthquakes. For example, if we can get this message of the earthquake in an advance warning and that message if we can reach the populated place or earthquake-prone area in advance. It can be sent in the form of a mobile message or email or a morning system can be activated to avoid multiple casualties including loss of life. All these smart projects can use the Internet of Things or Machine Learning if needed.

Early Warning System for Cyclone: Cyclone tracking system should be used i.e. through artificial satellites the exact position of the cyclone and possible impact site can be reviewed and advance measures can be taken at that place. Along with cyclones, heavy rains can also be predicted using sophisticated and advanced weather technology. And to say that the India Meteorological Department gives early warning signals using this advanced technology. So the amount of damage is also decreasing.

Use of GIS in Disaster Management: The use of Geographic Information Systems or GIS is very important in dealing with disasters because it can be used for hazard mapping during or after a disaster to assess the vulnerability of a disaster site or to identify various disaster-prone areas and for risk analysis. Also, in case of man-made disasters, GIS can be used to identify the accident site and know the exact location. So that using this state-of-the-art system, the real disaster or accident site can be identified, and rescue operations can be started quickly.

Use of remote sensing during or after disasters: Satellite image techniques and remote sensing can be used to assess the extent of damage or to assess damage during or after a disaster. This will allow a true assessment of the extent of damage caused by disasters. For example, in the case of several cyclones including Ampham, remote sensing and satellite images were used to determine the extent of damage and the area of damage. Also, these technologies are currently being used in multiple locations, especially in remote areas including the disaster-prone areas of Northeast India.

Use of Drones in disaster areas: In disaster-stricken areas, a drone or drone technology makes the work of rescue workers easier, these drones help to find lost people or lost animals. Also, for disaster-affected areas, this drone technology helps in search and rescue operations as well as various damage assessments and mapping. Drone technology helps to gather real information, especially in those places that cannot be reached after an accident. In addition, drone technology and UAV technology help to determine if someone is buried under any debris in a disaster-prone area.

Use of Communication satellites: Satellite communication can be used in disaster-affected areas or remote areas affected by disasters when normal communication systems are down or mobile or telecommunication communications are damaged. That is, through satellite communication, the rescue team can be kept in touch with the disaster-affected area.

Use of Mobile Applications: Nowadays, almost everyone has a sophisticated smart mobile, so in the future, special mobile applications can be used to deal with disasters. Disaster response requires the development of mobile applications that provide real-time data access. These applications can also provide communication channels with emergency alert messages All these mobile applications can be used by officials of disaster-affected areas and those involved in disaster response.

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50

Use of IoT (Internet of Things): IoT and IoT-related sensors can collect real data from connection to water level, volcanic eruption, and earthquake measuring devices thereby collecting real-time data and sending it to the user. IoT devices, along with various sensor technologies, are capable of early detection of various natural and unnatural disasters like earthquakes, volcanic eruptions, and cloud bursts, and send warning messages. Examples include Internet of Things firefighting, or early warning of wildfires and landslides, along with measuring the height of various rivers.

Using Smart Infrastructure: Smart infrastructure should be built, and smart technologies should be incorporated in various areas such as hospitals, power stations, and transportation so that they can serve during disasters. These centers can be controlled using various programs.

Artificial Intelligence (AI) and Data Analysis: In the era of artificial intelligence, if we can collect the previous data on disaster-prone areas and identify the vulnerable areas based on the analysis of that data, it will be easier for us to deal with disasters in the future. AI algorithms can also be used to analyse the data using various data and improve the accuracy of the early warning system and use it. Data analysis is very important in the field of disaster management because when and where natural or unnatural disasters occur and if the disaster data is properly collected and if these obtained data are properly analysed then we can take early warning measures before the next natural or unnatural disaster occurs.

Social Media Monitoring: In the case of many natural or man-made disasters, it can be observed that many times the actual data or correct information about that disaster is not available, so one has to rely on social media to get all that data. As a result, various information can be obtained through social media before or after a disaster, and decisions can be made during emergencies. Also, in the case of several man-made disasters or various natural disasters, the importance of these social media is also immense for the government to send various warnings quickly.

Use of Structural Engineering: First, some buildings have to be constructed that can withstand calamities like earthquakes, floods, or cyclones. Some infrastructure or buildings should be constructed from where relief or rescue operations can be carried out or the place can be considered as a safe place during disaster. To implement these, structural engineering techniques should be employed.

Mock Drills and Simulations: All persons involved in emergency response need to be regularly monitored at regular intervals. By doing all this Mock drill, the rescuers will also be able to adopt new strategies and they will be technically fit and ready to deal with the disaster. In accident- or disaster-prone areas this should be done to create awareness and early preparedness among different public, especially students.

Fig. 18Mock Drills and Training.

Disaster can also be dealt with in various ways such as:

Curriculum can be introduced from upper primary level on multiple awareness topics including disaster preparedness and management. Encouraging students to undertake and implement various disaster prevention projects. Incorporating

multiple topics in the curriculum including how to overcome disasters or manage disasters without spreading panic. Currently, we are seeing increasing effects of cyclones, heatwaves, or extra cold currents as well as outbreaks of multiple viruses including malaria, and dengue. To avoid the effects of these, the amount of mangrove forests should be increased along with plantations in riverine or coastal areas. Also to avoid malaria and dengue, keep the surroundings of the house clean and if necessary spread bleaching powder occasionally. If necessary, the waste should be disposed of in a scientific manner.

Care should be taken with many small organisms including wildlife, animals, and birds because they also play an important role in protecting nature or protecting the environment by dealing with various unnatural disasters. Global warming causes problems like heat waves. Global warming causes problems like heat waves. So to reduce the impact of heat waves, first we need to plant trees and do it on a large scale, for this tree planting, public open spaces or around roads or various private open spaces which are less used can be used and also planting shade trees on the banks of rivers. can go Also, by reducing the use of fossil fuels, the use of all those fuels should be increased to reduce pollution. As a result, the natural balance will be preserved, and the number of disasters will be reduced.

Role of Computer Science Student for Disaster Management: As a Computer Science student, I will now discuss what measures can be taken or what role can be taken in dealing with disasters-

Design Early Warning Systems: Develop software or algorithms that can predict natural disasters such as earthquakes, floods, tsunamis, or Manmade disasters. To predict disasters with accurate information. Disaster-related data can be collected through various sensors or satellites and sent to the Meteorological Department in a consolidated manner As a result, the Meteorological Department analyzes all the data received and can provide timely warnings or notifications to deal with disasters. More and more projects should be developed with all these early warning systems so that they are useful in dealing with disasters.

Design and Developed Disaster Management Related Software: Some software or applications need to be developed, which can help in disaster management or disaster response. This software should be developed in such a way that it contains all kinds of disaster-related information For disaster or disaster management which may include early warning systems, disaster assessment systems or other information including resource allocation. So that those who are participating in disaster response, can get all kinds of information through this software or applications, or get necessary instructions and send any new information if necessary.

Machine Learning and AI Applications: Machine learning and artificial intelligence is some of the most widely used technologies in the current era. There are different types of disasters, and machine learning algorithms can be used to predict disasters and assess disaster risks, including optimizing resource allocation. There are currently various AI-powered chat boxes that can be used to share real-time information during a disaster or to know what to do during an emergency.

Data Protection and Cybersecurity: The database contains a number of sensitive data related to disaster risk that need to be protected. It is important to strengthen the security of all these data, besides ensuring the integrity of the communication network in case of emergency.

Education and Public Awareness: It is important to strengthen the security of all these data, besides ensuring the integrity of the communication network in case of emergency. So that the use of various technologies including cyber security, data protection or disaster management can be discussed and trained. As a result, in natural or man-made disasters, instead of waiting for others to deal with the disaster, they will be able to deal with the disaster themselves.

Technical Education and Networking: Technical education is of immense importance in dealing with disasters or accidents. Therefore, the first thing to do is to take more technical education along with traditional education and Must have a thorough knowledge of networking along with knowledge of computer science or other engineering subjects. Keep yourself technically updated so that you can move forward with the times not only in disaster management but also in other areas. Hence the importance of networking and computer technical education is immense to keep up with the current technology.

Robotics: After a disaster, there are some places where rescue operations are difficult, then robots are used to carry out rescue operations quickly. Robotic technology also helps when searching for living or dead animals in inaccessible places or under rubble. For example, robots can be used for various firefighting systems such as in case of wildfires or

for extinguishing various factory fires, and also for performing various rescue operations under various rubbles. So we need to take all the knowledge and concepts related to this robotics and apply them to deal with disasters.

Case Study: Case studies on various disasters are basically real situations or real-life examples. With the help of these case studies, real statistics on various natural or man-made disasters that have occurred in the past and an idea of the damage associated with possible future disasters can be obtained. Also, through different case studies about disasters, we can learn about different models like - the PAR Pressure and Release Model or possible different effects. For example, disasters such as tsunamis, earthquakes, or cyclones have occurred in the coastal regions of India or in the Indian Ocean region. On all these issues we can learn from the outputs that come out of the case studies, how the various natural calamities that occurred during the disaster were dealt with. And how to deal with future disasters.

Personal Opinion: To form special teams for disaster development in border districts and train them in the use of cutting-edge technology and deploy them as needed. In addition, members of other government departments, including the administration, should also be trained in disaster management and be specially prepared.In disaster-prone areas, students can also be given civil defense training.To promote and increase awareness on cybersecurity.

In addition to the above, measures can be taken to deal with disasters from other departments of engineering from the department of civil engineering, some earthquake-resistant designs and implementation can be done, such as various bridges, or various buildings or tunnels that are earthquake-resistant, which will reduce the amount of damage from earthquakes. Besides, it is possible to deal with disasters by adopting various proper plans from the Department of Mechanical Engineering. Various ways to protect against various types of chemical, biological disasters, or nuclear disasters can be obtained from the Chemical Engineering Department. Besides, by following different mathematical models, we can get a clear idea of the effect of the damage after the disaster, which will help to deal with the disaster in the future.

V. CONCLUSION

Natural or man-made disasters can anytime occur, in some cases unforeseeable, so disaster is inevitable. So, we should always be prepared to face the disaster, without fear and panic. Although we cannot manage or control nature, we can use technology to stay alert and aware of various dangers. We have noticed that natural disasters and man-made disasters have increased in the last three to four decades, so have various technologies to deal with them. So we can use technology to stay aware of various disasters. This paper mainly shows several disasters such as natural disasters and manmade disasters. An attempt has been made to give a detailed idea of the damage that India has faced in the past years due to various natural calamities. Apart from this, various inaccessible or disaster-prone areas of India are shown through the map of India (Map provided by NDMA, Govt. of India). Also, the detailed discussion of various disasters that occur in the Indian subcontinent, especially cyclone earthquakes, drought, Floods, Landslides, COVID-19 pandemic, etc. has been mentioned in this paper. Apart from the fact that several unnatural disasters and their damages have also been discussed, this paper has also said that in the future, if any unintended disaster occurs in India from various neighboring countries. Apart from these, various forces of India engaged in dealing with various disasters are also discussed here.

India is the seventh-largest country by area in the world, about 140 million people live here. So, naturally the risk, potential, and number of risks and disasters are high. Therefore, we have discussed how to deal with disasters and risks from a technical point of view as well as the adoption of various strategies. I have tried to discuss how measures can be taken from the background of computer science engineering to deal with disasters, deal with disaster risks, or provide early warning signals or forecasts. The role of computer science in dealing with disasters has been highlighted through several points, which I believe will play a special role in dealing with disasters and reducing risk in the coming days and will continue to do so in the future. I am also optimistic that the use of artificial intelligence, machine learning, or the Internet of Things as well as the use of computer programming in various fields will take disaster management to a better level in the future. Also, an idea of how other engineering departments can help in disaster response is given in this paper.

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53

Fig. 19 Training to Provide Emergency CPR

The first thing that is needed to deal with a disaster is planning and its implementation. Besides, everyone must work together hand in hand to face the disaster. India has already experienced many small and large disasters (natural or man-made). And remarkable is that the government and above all the common people have faced these disasters hand in hand and will continue to do so in the future. Also, in the coming days, we have to play a role in protecting the nature of India. We have to come forward to protect the various resources of nature like rivers, canals, bills, seas, and various forests and various wildlife, and animals. And keep the surroundings clean. As a result of this, we may be saved from several natural and unnatural disasters. By using science and technology in dealing with disaster situations, or in other research areas, we can move our country forward and other losses can be avoided and reduced. In the future, I will try to write and work on disaster management based only on technology.And will also do several project-based work on safety and security.This review paper of mine will be useful in the coming days in disaster management or related research and will help in developing various disaster management projects.

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AUTHORS PROFILE:

Mr. Subhankar Sarkar, Corresponding Author - B.Tech&M.Tech in CSE, B.ED-Pedagogy of Mathematics. A.D.F.M. & P.G.D.F.S.E - Fire & Safety. Member - West Bengal Civil Defence & Disaster Management (Murshidabad Unit. West Bengal), India. Research Interest - Internet of Things, Cloud Computing, Machine learning, Disaster Management. Contact Email-elinksuvankar.sarkar@gmail.com