GLOBAL WARMING AND ITS IMPACTS ON CLIMATE OF INDIA

Global warming is for real. Every scientist knows that now, and we are on our way to the destruction of every species on earth, if we don't pay attention and reverse our course.

Theodore C. Sorensen

Global warming is the 'talk of the town' in this century, with its detrimental effects already being brought to limelight by the recurring events of massive floods, annihilating droughts and ravaging cyclones throughout the globe. The average global temperatures are higher than they have ever been during the past millennium, and the levels of CO2 in the atmosphere have crossed all previous records. A scrutiny of the past records of 100 years indicates that India figures in the first 10 in the world in terms of fatalities and economic losses in a variety of climatic disasters.

Before embarking on a detailed analysis of Global warming and its impacts on Indian climate, we should first know what climate, green house effect and global warming actually mean.

CLIMATE

The climate is defined as' the general or average weather conditions of a certain region, including temperature, rainfall, and wind'. The earth's climate is most affected by latitude, the tilt of the Earth's axis, the movements of the Earth's wind belts, and the difference in temperatures of land and sea, and topography. Human activity, especially relating to actions relating to the depletion of the ozone layer, is also an important factor.

The climate system is a complex, interactive system consisting of the atmosphere, land surface, snow and ice, oceans and other bodies of water, and living things.

GREEN HOUSE EFFECT

Green House effect is the phenomenon whereby the earth's atmosphere traps solar radiation, and is mediated by the presence in the atmosphere of gases such as carbon dioxide, water vapor, and methane that allow incoming sunlight to pass through, but absorb the heat radiated back from the earth's surface.

Thus the Green house gases (GHGs) provide a blanketing effect in the lower strata of the earth's atmosphere, and this blanketing effect is being enhanced because of the human activities like burning of fossil fuels etc.

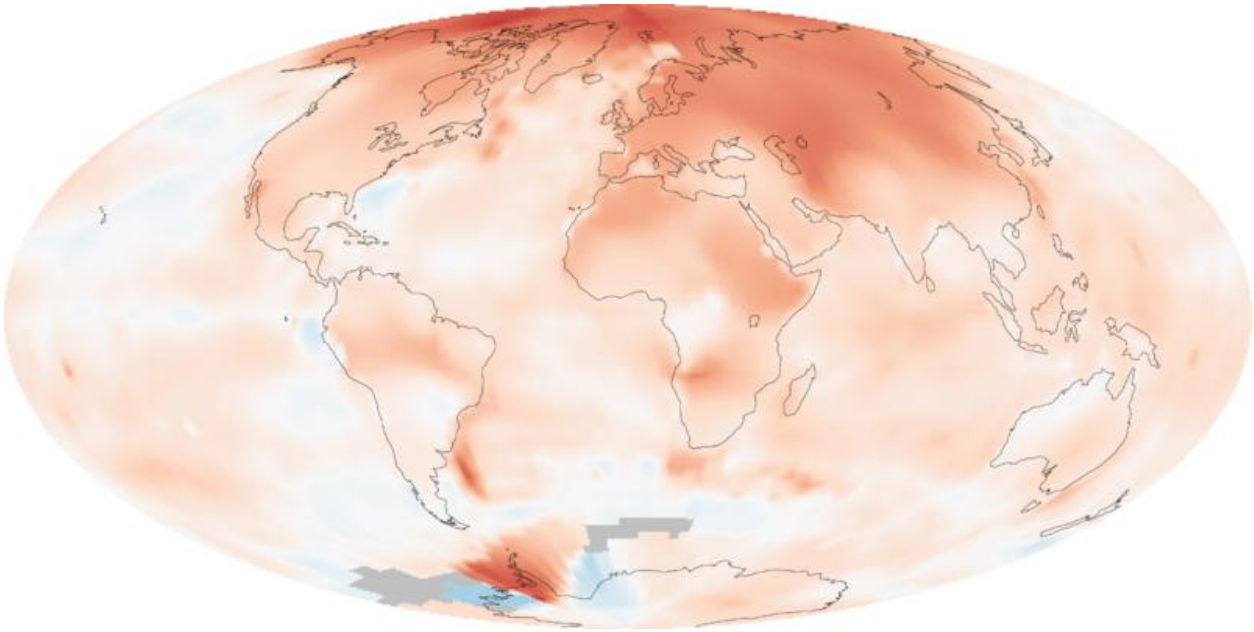
GLOBAL WARMING

'Global warming is defined as an increase in the average temperature of the Earth's atmosphere, especially a sustained increase great enough to cause changes in the global climate'.

The term global warming is synonymous with Enhanced green house effect, implying an increase in the amount of green house gases in the earth's atmosphere, leading to entrapment of more and more solar radiations, and thus increasing the overall temperature of the earth.

EFFECT OF GLOBAL WARMING ON THE EARTH'S CLIMATE

Detailed researches of climatic events of the past 150 years have revealed that the temperatures have risen all over the globe, with the warming occurring in two phases. The first phase was from 1919 to 1940, with an average temperature gain of 0.35°C, and the second phase was from 1970 to the present, exhibiting temperature gains of 0.55°C. Records show that the past 25 years have been the warmest time of the past 5 centuries. The global warming has resulted in the warming of the oceans, rising of the sea levels, melting of glaciers, and diminished snow cover in the Northern Hemisphere.



The above map illustrates an analysis conducted by the Goddard Institute for Space Studies (GISS) in New York City, based on temperatures recorded at meteorological stations around the world and satellite data over the oceans. The map illustrates how much warmer temperatures were in the decade (2000-2009) compared to average temperatures recorded between 1951 and 1980. The Arctic regions exhibited the most severe warming as depicted in red color. The blue colored areas show the lower than normal temperatures, and thus are very few.

The recent catastrophic climatic events like the massive floods in Pakistan and India, the Hurricane Katrina in the United States, the prolonged droughts in Australia, China, Pakistan, India and Texas, are all the results of increased temperatures due to global warming. During the 21st century, climatic disasters occurred five times as frequently and killed or affected seventy times as many people. Between 2000 and 2004, an average of 26 climatic disasters was reported each year. Thus, the immense geological changes will continue their destruction unabated if steps to mitigate global warming are not taken.

IMPACTS OF GLOBAL WARMING ON THE CLIMATE OF INDIA

AN INTRODUCTION TO THE PROFILE OF INDIA

India, the second most populous country of the world with a population over 1.2 billion, is a large country in South Asia. India lies to the north of the equator between 6° 44' and 35° 30' north latitude and 68° 7' and 97° 25' east longitude. It shares a coast line of 7517 km with the Indian Ocean, the Arabian Sea and the Bay of Bengal. It has land boundaries with Pakistan, China, Nepal, Bhutan, Burma and Bangladesh.

The Indian economy is considered as one of the fastest growing major economies. However, the country is plagued by the climatic disasters that continue to wreak havoc on its economy. As a result, in spite of the leaping economical progress, the majority of the people of India continue to live in poverty, with malnutrition and diseases corroding the society.

CLIMATE OF INDIA

Being such a huge country, India exhibits a wide diversity of temperatures; from the freezing cold winters in the Himalayas to the scorching heat of the Thar Desert. The above two regions play a very significant role in controlling the weather of India, making it warmer than to be expected with its latitude. The Himalayas participate in this warming by preventing the cold winds from blowing in, and the Thar desert attracts the summer monsoon winds, which are responsible for making the majority of the monsoon season of India. However, the majority of the regions can be considered climatically tropical.

MONSOON SEASON IN INDIA

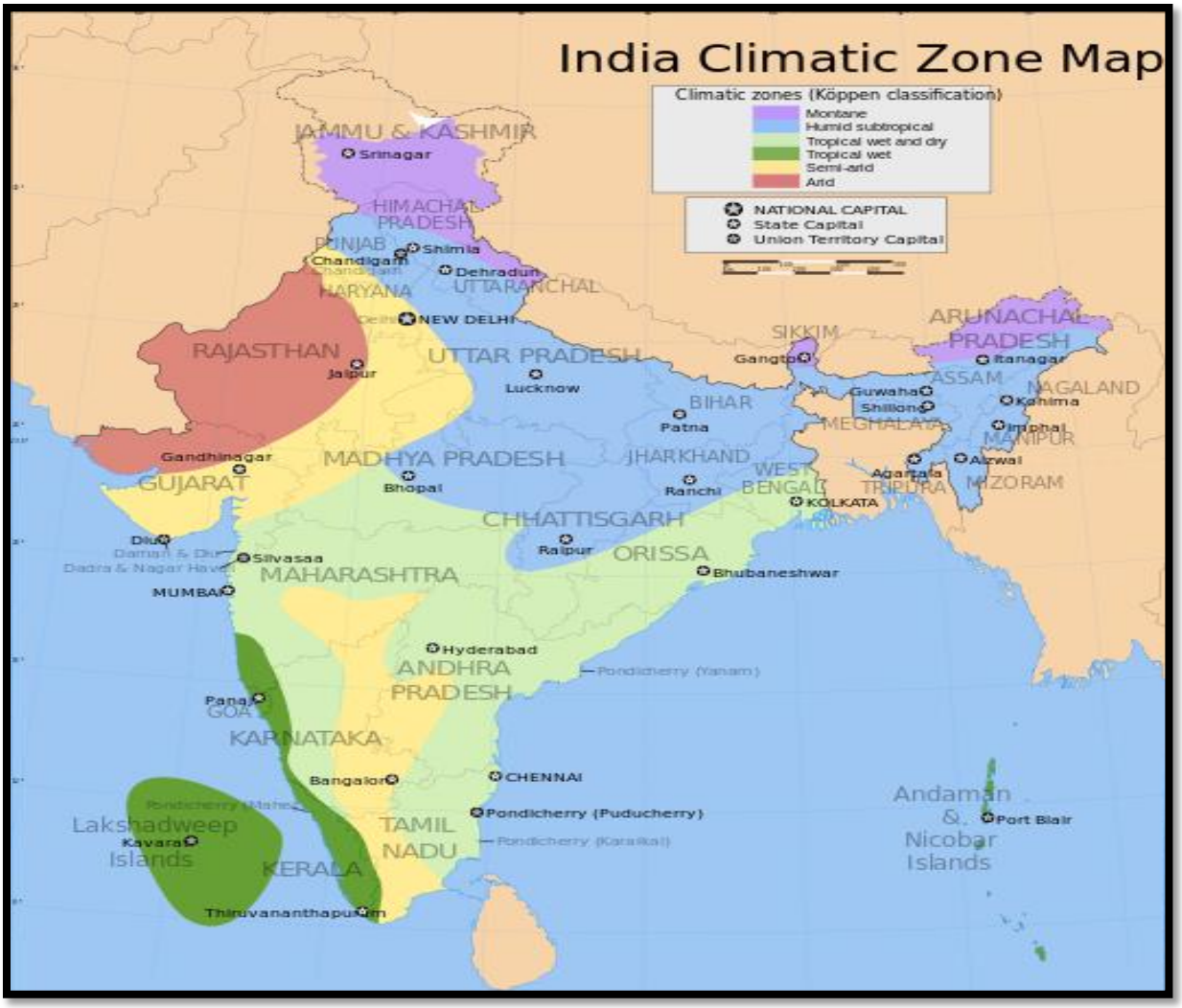
The climate of India is dominated by the monsoon season, which is the most important season of India, providing 80% of the annual rainfall. The season extends from June to September with an average annual rainfall between 750–1,500 mm across the region. The monsoon of India is regarded as the most productive wet season on the earth.

Definition of 'Monsoon'

Intergovernmental Panel on Climate Change (IPCC) describes Monsoon as a tropical and subtropical seasonal reversal in both the surface winds and associated precipitation, caused by differential heating between a continental-scale land mass and the adjacent ocean.

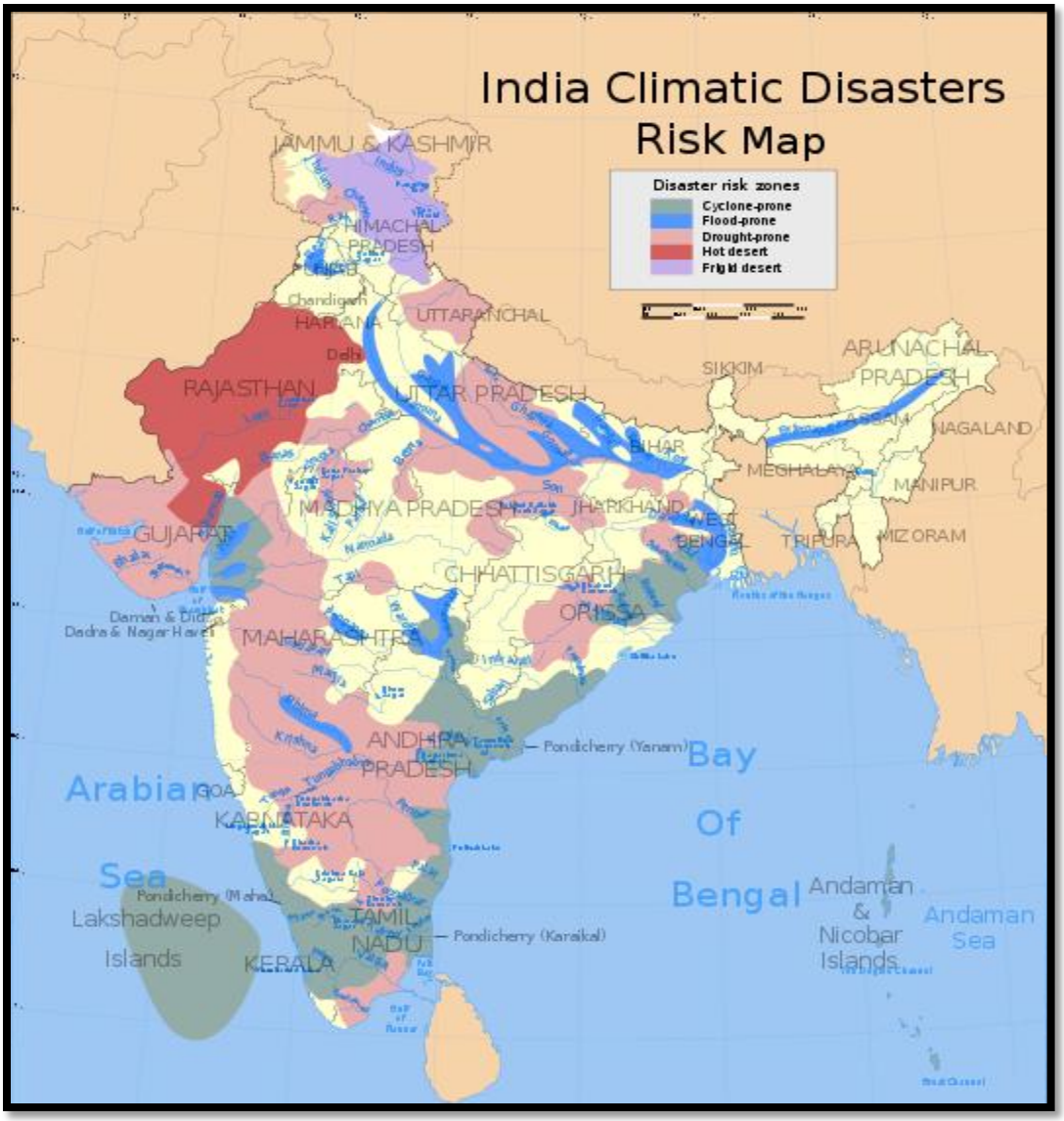
As explained above, the Himalayas and the Thar Desert are important forces controlling this season. The monsoon severity has increased in the last few decades due to the process of global warming, leading to the dreaded floods in India.

The figure below shows the major climatic regions of India, displaying the major portions to be monsoon prone.



IMPACTS OF GLOBAL WARMING ON CLIMATE OF INDIA

There has been a particularly alarming effect of global warming on the climate of India. India is already a disaster prone area, with the statistics of 27 out of 35 states being disaster prone, with most disasters being water related. The process of global warming has led to an increase in the frequency and intensity of these climatic disasters. According to surveys, in the year 2007-2008, India ranked the third highest in the world regarding the number of significant disasters, with 18 such events in one year, resulting in the death of 1103 people due to these catastrophes. A figure presenting the different disaster prone areas of India is given below.



With the increasing trends of global warming, predictions of severer climatic events have been made for India. The anticipated increase in precipitation, the melting of glaciers and expanding seas are projected to influence the Indian climate particularly severely, with an increase in incidence of floods, hurricanes, and storms. Global warming is also posing as a mammoth threat to the foods security situation in India with recurring and severe droughts and ravaging floods engulfing the arable land. Rising Temperatures on the Tibetan Plateau are causing the melting of the Himalayan glaciers, reducing the water flow in the rivers Ganges, Brahmaputra, Yamuna, and other major rivers, on which the livelihoods of hundreds of thousands of farmers depend.

According to the The Indira Gandhi Institute of Development Research, if the process of global warming continues to increase, resulting climatic disasters would cause a decrease in India's GDP to decline by about 9%, with a decrease by 40% of the production of the major crops. A temperature increase of 2 ° C in India is projected to displace seven million people, with a submersion of the major cities of India like Mumbai and Chennai.

RECENT CLIMATIC DISASTERS IN INDIA

FLOODS IN INDIA

India is the most flood distressed state in the world after Bangladesh, accounting for 1/ 5th of the global deaths every year with 30 million people displaced from their homes yearly. Approximately 40 million hectares of the land is vulnerable to floods, with 8 million hectares affected by it. Unprecedented floods take place every year at one place or the other, with the most vulnerable states of India being Uttar Pradesh, Bihar, Assam, West Bengal, Gujarat, Orissa, Andhra Pradesh, Madhya Pradesh, Maharashtra, Punjab and Jammu & Kashmir.

The climatic history of India is studded with a very large number of floods, which have wreaked havoc on the country's economy. A chart showing the large number of floods in the Indian state with average financial, land and cattle loss is given below.

Impact of Flood in India (1953-2006)

Years in group	Average area affected in '000 hectares	Average population Affected in million	Average human loss in '000	Average cattle loss in '000	Average economic loss in million rupees
1953-57	6664	16.76	399	33	140
1958-62	6448	11.714	648	31.8	148
1963-67	4342	12.636	347.2	6.4	98
1968-72	7832	34.53	1503.8	98	1162
1973-77	9606	44.956	3022.2	186.2	2542
1978-82	9588	46.518	2379	249	6382
1983-87	9162	55.80	1775.6	105.2	17540
1988-92	8531	37.42	2109	96	14928
1993-97	6821.4	33.66	1992.2	73	16090
1998-2002	5382.5	26.89	2143.25	59.03	16863.3
2003-06	2867.5	23.864	1563.75	34.14	NA

THE TOP FLOODS IN INDIA'S HISTORY

1. FLOODS IN BIHAR

Bihar is an over populated state in Northern India, extremely prone to floods. The total area covered by the state of Bihar is 94,163 km^2. Its average elevation above sea level is 173 feet.

Bihar faces the predicament of floods almost every year, with the link between India and Nepal through the Koshi River being one of the main reasons for the flood in Bihar. Excessive rainfall due to the recent global warming in Nepal leads to an overloading of dams and leads to flash floods in the Bihar region. The Recent years in which human death due to flood is more than 100 are given in the figure below.

a) **1987 Bihar Flood**

The flood of 1987 in Bihar was so destructive that it left a total of 1400 people and more than 5000 animal dead. A total of 67,881+680.86 lac INR was the damage to the state; affecting more than 29 million people. After this flood, the River Koshi has been named as" Sorrow of Bihar" (Bihar ka shok).

b) 2008 Bihar floods

The 2008 Bihar floods are considered as one of the most disastrous floods in the state's history. The flood affected more than 2 million people. The flooded and affected areas were Supaul, Araria, Madhepura, Saharsa, Champaran and Purnea.

OTHER MAJOR FLOODS IN INDIA

2005: Maharashtra flood

In 2005, a major climatic catastrophe occurred in the state of Maharashtra in the form of massive floorings, leading to a death toll of 5000 people. The areas of Mumbai, Chiplun, Khed, Kalyan, Ratnagiri and Raigad were completely flooded, hence naming the date 26 July 2005 as the BLACK DAY in the history of Mumbai.

2005: **Gujarat Floods**

the wave of floods in Maharashtra reached the state of Gujarat as well, accounting for one of the worst floods in the Indian History as it caused a financial loss of more than Rs.800 million. This disaster took place in a row of days from 30th June to July 11, killing more than 123 people and a total of 250k people were evacuated. Infrastructure of the state also suffered badly as train services, Road Operations and communications were destroyed.

2007 South Asian Floods

In 2007, global warming finally triggered a flood formation that was so devastating, that it annihilated the entire South Asian region, destroying large zones in India, Pakistan, Nepal, Bhutan and Bangladesh. It's most devastating effects were observed in South India, where it lasted for more than 15 days, killing more than 2000 people and affecting another 30 million. It was termed by UNICEF to be the worst flooding of South India in living memory.

2009 Indian floods

The 2009 India floods affected various states of India in July 2009. The most affected states were Karnataka, Orissa, Kerala, Gujarat and North-East Indian states, with over 200 people reported dead, and a million homes destroyed.

People evacuated from their homes due to the incessant floods in India wade in the waters, searching for a place to make camp.

2010 Ladakh floods

On 6th August 2010, Leh and many other villages of the Ladakh range were drowned by a downpour that killed at least 255 people, and resulted in a state loss of Rs. 133 crore. The unexpected heavy rainfall was attributed to the climatic changes resulting from global warming.

2011 Indian floods

The 2011 surge of severe precipitation affected India savagely, with surging flood waters in Northern and Eastern India affecting more than 10 million people as the swollen rivers washed away roads and towns, particularly in the states of West Bengal, Bihar, Kerala and Assam.

2012 Northern Indian floods

The year 2012 is also included in the continuous chain of years of floods in India. In Assam, at least 27 people died and 900,000 were forced to evacuate their homes as monsoon rains drowned large areas. Starting on 4 Aug, unremitting showers fell on the northern states of

Uttarakhand, Himachal Pradesh and Jammu, resulting in landslides, cloud bursts and flash floods. At least 34 people were killed and hundreds were made homeless.

OTHER CLIMATIC DIASTERS IN INDIA

DROUGHTS

As explained above, the process of global warming has such an impact on the climate that it increases the severity of precipitation at one time, and minimizes it in the other. Therefore, this process has resulted in severe drought like conditions in India, with tens of millions of deaths resulting from it in the past few centuries. India depends heavily on prolonged and optimum monsoons for its agricultural productivity, failure of which results in the decreased crop productivity, leading to droughts.

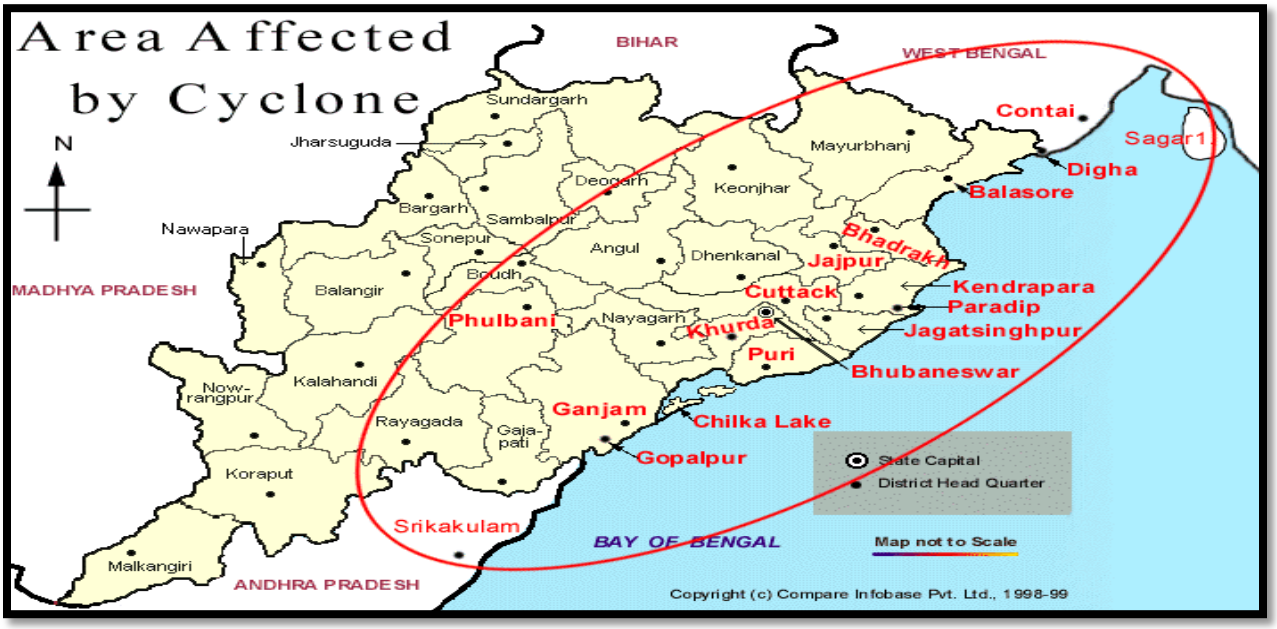
Of the total agricultural land in India, about 68% is prone to drought of which 33% is chronically drought prone, receiving rainfall of less than 750mm per year. This is particularly the states of Maharashtra, Gujarat, Rajasthan, Karnataka, Andhra Pradesh and Orissa. The World Record Of Drought Was In 2000 in Rajasthan, India.

People parched for water are ready to injure each other as they struggle to get water from a well in the drought affected areas of India.

According to researches, unabated global warming will lead to exacerbation of the droughts, cutting down the water availability in the plains of Pradesh and Bihar.
India's initial National Communication to the United Nations Framework Convention (UNFCCC) on Climate Change projects that Luni; the west flowing rivers of Kutchh and Saurashtra are likely to experience acute physical water scarcity. The river basins of Mahi, Pennar, Sabarmati and Tapi are also likely to experience constant water scarcities and shortages.

CYCLONES

As a result of global warming, the average number of Category 4 and 5 hurricanes per year has increased over the past 30 years. India has an 800 km coastline, and is therefore very susceptible to cyclonic activity. Cyclones have been observed to be more frequent in the Bay of Bengal than the Arabian Sea. Consequently the states of West Bengal, Orissa, Andhra Pradesh, and Tamil Nadu along the Bay of Bengal are the most affected. The notable cyclones in Indian history include the 1737 Calcutta cyclone, 1970 Bhola cyclone, and Cyclone 05B, which affected more than a million people.



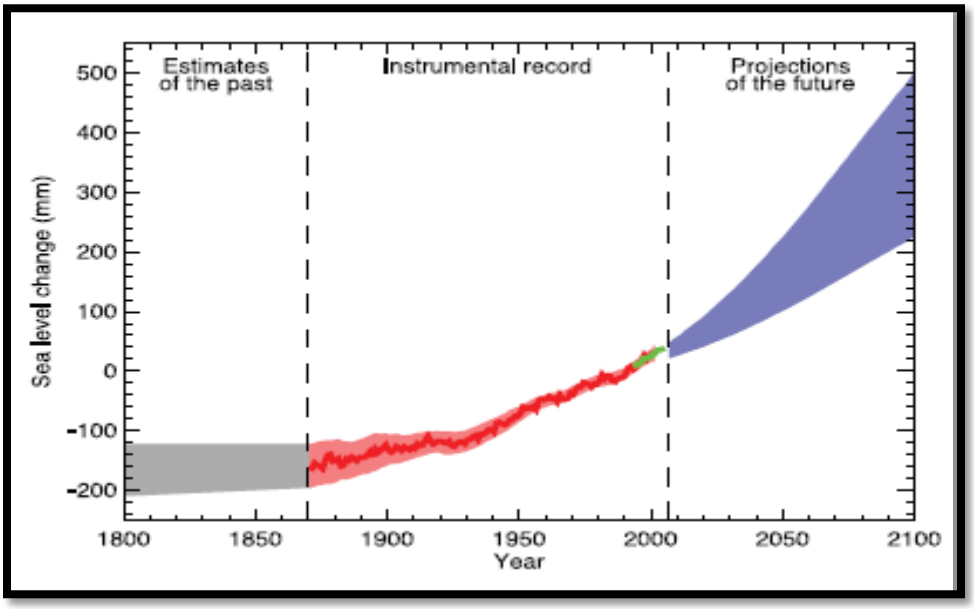
The National Institute of Oceanography (NIO), under the Council of Scientific and Industrial Research (CSIR), Government of India, researched on the impacts of climate change on sea level, to assess the degree to which mean sea level and the occurrence of extreme events may change, and concluded that an increased occurrence of cyclones in the Bay of Bengal, particularly in the post-monsoon period, along with increased maximum wind speeds associated with cyclones and a greater number of high surges under climate change has been observed. In addition, the strength of tropical cyclones, which represent a threat to the eastern coast of India and to Bangladesh, is also likely to increase.

CLIMATIC EFFECTS ON THE SEA AND COASTAL AREAS

As explained above, India has a long coastline with the Arabian Sea and the Bay of Bengal. The coastal areas of India are highly vulnerable to the effects of global warming, as they are densely populated with people who are totally dependent on the sea for their food supply. Therefore any damage to the natural cycle of the sea affects the people of India very severely.

Already global warming has resulted in an increased cyclonic activity, sea level rises displacing people, flooding, and the reduction in the sea food due to the acidification of the waters. Thousands of people have been displaced by ongoing sea level rises that have submerged low-lying islands in the Sundarbans. A one meter sea level rise is projected to

displace approximately 7.1 million people in India and about 5,764 Km2 of land area will be lost, along with 4200 Km of road. Around seven million people are projected to be displaced due to submersion of parts of Mumbai and Chennai if global temperatures were to rise by a mere 2 °C.
The effects of global warming have also caused damage to coastal infrastructure, aquaculture and coastal tourism. The aquatic ecosystems such as mangroves, coral reefs and grass lands have also been affected by the climatic change.



The above figure shows the evolution of global mean sea level in the past and as projected for the 21st century for the SRES A1B scenario.

INDIAN STEPS TO MITIGATE THE CLIMATIC CHANGES

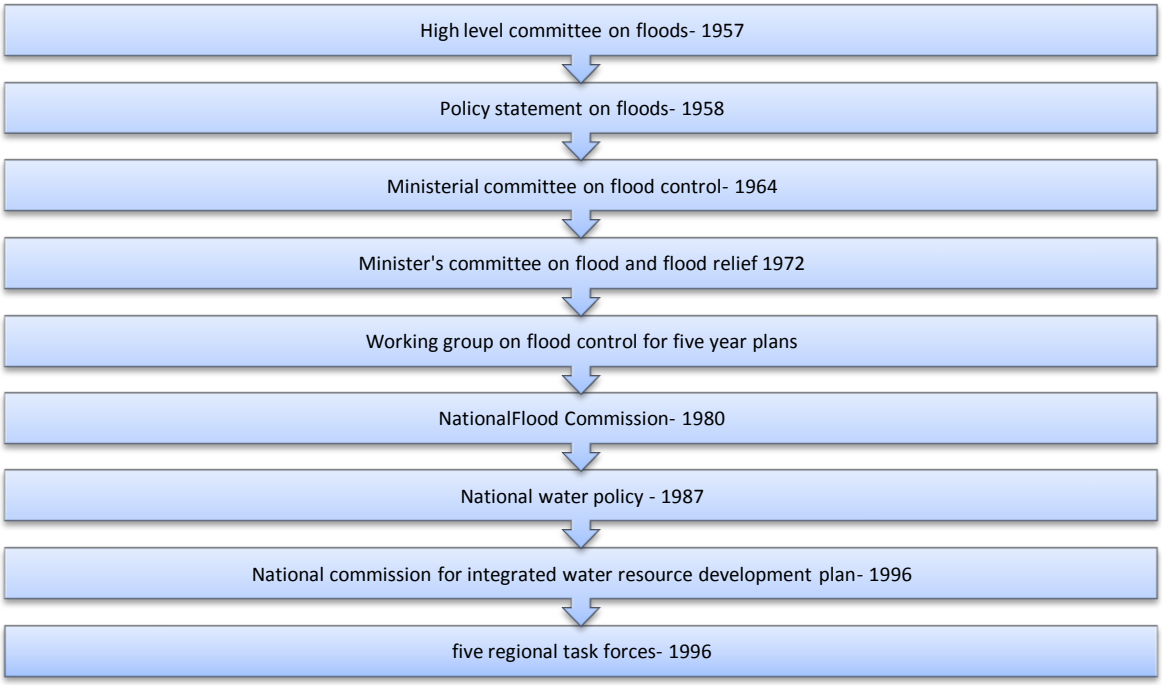
Thus the process of global warming has affected India intensely, destroying its economy and depriving its people of their basic needs like food and shelter. The current patterns of destructive floods, increasing intensity of cyclones, recurring droughts and the increasing temperatures are all the results of global warming. The Indian government also realizes the predicament it faces, and multiple steps to mitigate these disasters have been taken.

STEPS TAKEN BY INDIAN GOVERNEMENT TO MITIGATE FLOODS AND OTHER CLIMATIC DISASTERS

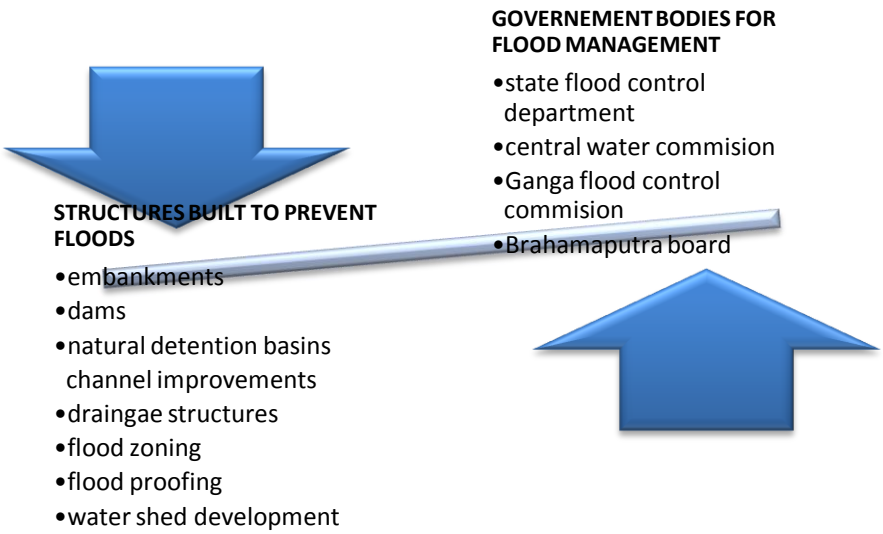
In India, National Disaster Management Authority (NDMA) is the apex body for addressing the disaster related policy issues and for laying guidelines. The Ministry of Environment and Forests, the Ministry of Science and Technology, the Ministry of External Affairs as well as the Prime Minister's Office are the offices related to climatic changes.

India has always been plagued by the recurrent and devastating floods. The history of mitigating steps taken by the Indian government can be traced back to 1953, when the unprecedented floods of 1953 struck India, at which time the first national policy in this

regard was made. After that, every government employed many policies and committees to counteract the dreaded floods and their devastations. Most notable of them were the following.



In addition, the following figure shows the government bodies and their roles in decreasing floods.



Community based disaster preparedness (CBDP)

The ministry of Home Affairs, government of India has taken an initiative at local level known as the community based disaster preparedness. It functions with the help of the local people as well as the NGOs to help prepare the people for different climatic disasters by mobilizing them easily, and helping in providing relief to the affected community. Other tasks of this committee include the preparation of seasonal calendars to predict the climatic disasters, mapping the risks faced by the community and taking actions to prevent them.

STEPS REQUIRED BY THE INDIAN GOVERNMENT TO MITIGATE GLOBAL WARMING AND RESULTING CLIMATIC DIASTERS

In spite of the steps taken by the Indian government, global warming continues to increase, and the resulting climatic disasters ravage the country in an unabated manner. This can be attributed to the lack of resources, and access to technology. To cope up with the climate change-disasters-security nexus, the country needs to have a better technical understanding, capacity building, networking and expansive consultation processes spanning every section of the society.

The committees and organizations working to counteract against the climatic disasters work independently from each other. The ongoing climatic changes, with an increase in a possibility of more disasters impose imperatives for a unity among all these bodies, resulting in an integrated risk management framework, creating a common platform for the committees to work on.

India has a distinctive vulnerability profile as the poor are the most affected. Tremendous weather events take place more frequently and are becoming more ruthless. Therefore the previous attempts of just rescuing the affected will not be enough now, instead, meticulous steps to prevent these disasters are required. This can only be met if the strategies and policies can cope with climate change, requiring the active participation of the government and the people.

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