METEOROLOGICAL DISASTERS DURING THE LAST TWENTY TWO YEARS

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Abstract *Disasters are sudden and mostly unanticipated events and occur in varied forms. Some occur annually such as floods, heat and cold waves etc., whereas some are seasonal such as hailstorms, thunderstorms, cyclones, etc. In India the maximum loss of human lives occurs due to floods and heavy rains. It takes on an average 1500 human lives per year which is 64% of the total loss of life in a year due to various natural disasters. In this study an attempt has been made to delineate the disaster prone areas in accordance with various meteorological parameters and their associated synoptic features. The study will in turn help the local authorities to take necessary action regarding disaster mitigation plan and help people to cope with natural disasters.*

INTRODUCTION

The word 'Disaster' comes from Greek word 'Astron' meaning star. In the ancient world, people believed that stars were responsible for everything that could happen to man. Man has faced natural calamities such as earthquakes, storms, floods and droughts, ever since he started living in the society. India is prone to varied types of natural hazards like earthquakes, floods, landslides, cyclones and drought which take more than thousand human lives per year. Even at the threshold of the 21st century many lives and properties are threatened by extensive damage resulting from cyclone, flood and drought.

United Nations declared the decade 1990-2000 as 'International Decade for Natural Disaster Reduction' (IDNDR). The objective of IDNDR is to reduce, through concerted international action, the impact of natural disaster such as loss of lives, property damage and socio-economic disruption.

It is found that in India average annual loss of human lives due to snowfall is 67, cold wave is 152, heat wave is 153, squall is 11, gale is 5, duststorm is 9, lightning is 45, thunderstorm is 74, hailstorm is 22, flood and heavy rains is 1441 and cyclonic storm is 348 (Table 1). About 40 million hectares in India is susceptible to flood of which about 30.8 million hectares have been protected by undertaking both structural and non-structural methods of flood control.

During the year 1987, the delayed onset of the monsoon in certain parts and the prolonged dry spell in most parts of the country, severely affected the agricultural operation in an area of approximately 58.6 million hectares, in 267 districts of 15 states and 6 union territories. About half of the area was not sown at all. The worst flood during last two decades, which took a toll of 1500 human lives, 1200 cattleheads, and damaged 18 lakh houses including 73,000 huts in Gujarat occurred on 11 August 1979.

In this study an attempt has been made to delineate the disaster prone areas in accordance with various meteorological parameters and their associated synoptic features. The study will in turn help the local authorities to take necessary action regarding disaster mitigation plan and help people to cope with natural disasters.

Table 1 Average annual loss of human lives due to various meteorological disasters (1975-1996).

Meteorological Phenomena	Yearly loss of human lives
Snowfall	67
Cold Wave	152
Heat Wave	153
Drought	00
Squall	11
Gale	5
Dust Strom	9
Lightning	45
Thunder Storm	74
Hail Storm	22
Floods and Heavy rains	1441
Cyclonic Storm	348

DATA USED

Since 1967, the office of Additional Director General of Meteorological (Research) brings out a publication entitled 'Disastrous Weather Events' annually. In this publication meteorological parameters such as snowfall, cold wave, heat wave, drought, squall, gale, duststorm, lightning, thunderstorm, hailstorm, flood and heavy rains, and cyclonic storm which are responsible for damage to life and property are enlisted chronologically. The publication also gives the area affected by the particular meteorological parameter and extent of damage caused. These informations are based on the various reports of the India Meteorological Department and press reports, which are helpful to reassess the various damages caused by severe weather. Furthermore, these basic climatological information can be used for planning the disaster reduction and also to identify the areas of disaster proneness. In the present study the information regarding the Disastrous Weather Events during 1975-1996 has been considered.

RESULTS AND DISCUSSION

Disasters are sudden and mostly unanticipated events and occur in varied forms. Some occur annually such as floods, heat and cold waves etc., whereas some are seasonal such as hailstorms, thunderstorms, cyclones, etc. Table 1 reveals that the maximum loss of human lives occurs due to floods and heavy rains. It takes on an average 1500 human lives per year which is 64% of the total loss of life in a year. Similarly, on an average the cyclonic storm takes a toll of 364 (15%) human lives while cold and heat wave take 162 (7%) and 144 (6%) human lives per year, respectively. The other meteorological parameters such as drought, thunderstorm, hailstorm etc. though cause extensive damage to public and private property, the loss of human lives due to these, is comparatively less (2% to 3%).

Flood and Heavy Rains

About 40 million hectares of India is susceptible to flood of which about 30.8 million hectares have been protected by undertaking both structural and non-structural

methods of flood control. About 8 million hectares are liable to flooding in any given year. Table 2 gives the account of some important recent floods. Synoptic situation associated with July 1991 flood over Vidarbha was as follows: A well marked low pressure area over northwest Bay moved northwest-westerly and dissipated over northwest Madhya Pradesh. Another low pressure area moved northwesterly.

Table 2 Some important recent floods.

Date	State	Disaster
23-25 July 1989	Maharashtra	917 people died, 1.1 lakh houses fully or partially damaged.
18-30 July 1991	Maharashtra	500 people died, 40,000 Hectares of crop land washed away.
8-12 July 1993	Punjab	320 persons died, property worth Rs. 284 crores lost.
8-13 Sep. 1992	Jammu and Kashmir	315 people died, standing crop worth Rs. 45 crores damaged.
14-20 Aug. 1986	Andhra Pradesh	262 persons died, Property worth Rs. 700 crores damaged.
2nd week to 4th week of Sept. 1985	Uttar Pradesh	220 people died, 1.2 million hectare of crop land submerged.
2nd week to 3rd week of Sept. 1993	Uttar Pradesh	171 persons died, public utility worth Rs. 500 crores damaged.
12-13 Nov. 1990	Orissa	159 persons died, paddy crop in 80,000 hectares of land damaged.
2nd week to 4th week of July 1988	Gujarat	130 people died, 2500 houses razed to ground.
2-7 July 1990	Rajasthan	90 persons died, crop in thousands of hectares of land damaged.

The synoptic situation associated with Gujarat flood in August 1979 is given below. A severe cyclonic storm crossed the Orissa coast at about 15 GMT on August 7, 1979, near Balasore. Later moving west-north-west across the east Madhya Pradesh as a deep depression, the system weakened into a well marked low over southeast Rajasthan by the evening of August 10, 1979. This well marked low moved further westwards and lay over southwest Rajasthan and adjoining north Gujarat State on August 11 and 12, 1979, respectively. The rainfall pattern for 48 hours from 0830 IST on 10th August to 0830 IST on 12th August is depicted in Fig. 1. Due to this heavy rain, Machhu dam II near Morvi town in Rajkot district (Gujarat) breached and the consequent flash flood submerged the Morvi town and nearby areas in Morvi and Malia taluks.

Cyclonic Storm

A cyclone, whose horizontal extent is about thousand kilometers, hits Indian coastal region with a ferocity that results in devastation and human suffering. Table 3 gives the total

number of occurrence of the cyclonic storm that struck different states causing loss of human lives. It has been observed that Andhra Pradesh and Tamil Nadu are the twin states which bear maximum destruction due to cyclonic storm. Machalipatnam cyclone in May 1990 was one of the severest cyclone in the Bay of Bengal with a peak intensity assessed by INSAT at T 6.5 on the Dvarak scale. The region was also struck near Chirala in 1977 by an equally intense (T 7.0) cyclone (Fig. 2a). Diviseema Island at the estuaries of the River

Fig. 1 Rainfall (cm) for 48 hrs during August 10-12, 1979 (Mukherjee et al., 1981).

Table 3 Frequency of occurrence of cyclones and loss of human lives.

	Occurrence of cyclones (total no.)	Total loss of human lives	Loss of human lives per year*
Jammu Kashmir	0	0	0
Himachal Pradesh	0	0	0
Punjab	0	0	0
Uttar Pradesh (including hills)	0	0	0
Haryana	0	0	0
Delhi, Chandigarh	0	0	0
Rajasthan			
Gujarat, Saurashtra, Kutch	5	674	31
Madhya Pradesh	0	0	0
Maharashtra including Goa	2	17	1
Bihar	0	0	0
West Bengal	7	834	38
Assam & neighbouring states	0	0	0
Orissa	9	235	11
Andhra Pradesh	24	14877	222
Karnataka	0	0	0
Kerala	3	112	5
Tamil Nadu	14	1531	70

*For calculating the average loss, the loss of human lives in 1977 Chirala cyclone, estimated to be 10000, is not considered.

Krishna and the main coast of Machalipatnam were affected by both these cyclones. In case of Chirala cyclone in 1977, sea water inundation extended up to a maximum extent of 12 km inland, while in Machililpatnam cyclone in 1990 (Fig. 2b), the inundation was up to 25 km. inland. In 1977 cyclone, the havoc was mainly caused by sea inundation while in 1990

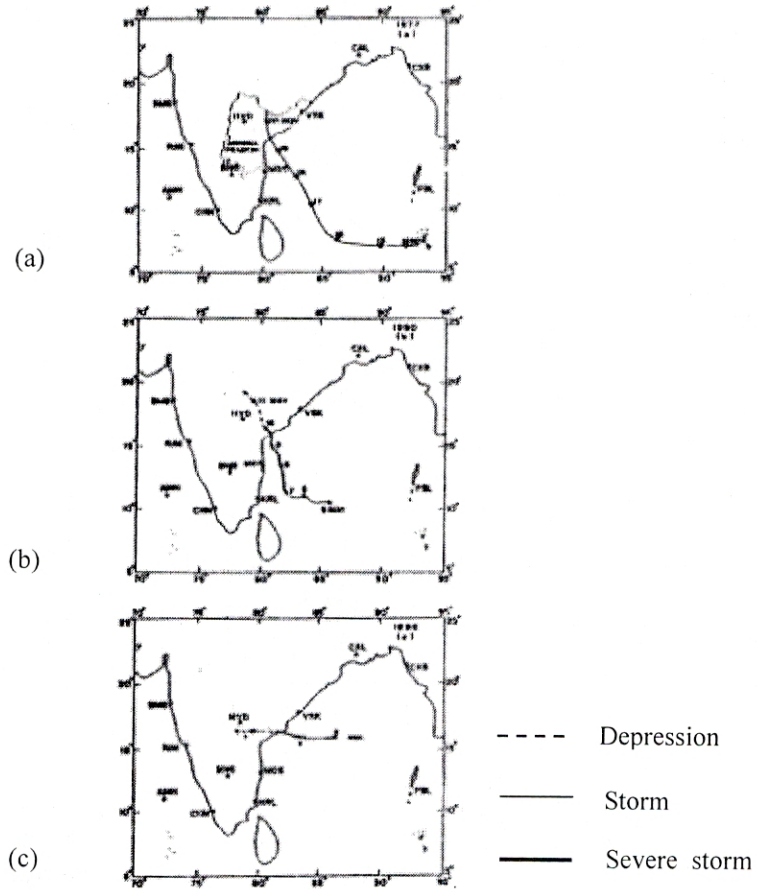

Fig. 2 Tracks of Andhra Cyclone

cyclone it was due to sea inundation as well as due to unprecedented heavy rains associated with floods. The loss of human lives in the 1977 cyclone was more than 10000 while in the 1990 cyclone, timely warning helped the Government machinery to evacuate more than 0.65 million people from vulnerable coastal areas. As a result, the loss of human lives was much less i.e. 967. However, the damage caused by 1990 cyclone to the properties and crops was as high as that in 1977.

A severe cyclonic storm in Andhra Pradesh on November 6, 1996 (Fig. 2c) took a toll of 971 human lives, 19823 cattleheads and 21.98 lakh poultry birds. Synoptic situation associated with the cyclonic storm was as follows: The low pressure area over north Andaman Sea off Tenasarim Coast lay over East to Central Bay on November 3, 1996, and associated cyclonic circulation extended up to mid-tropospheric levels. It became well marked on the evening of November 4, 1996. It then concentrated into a deep depression at 050300 UTC near Latitude 16°N and Longitude 86.5°E. It moved in westerly direction and

further intensified in to a cyclonic storm which lay centred at 050900 UTC near Latitude 16°N and Longitude 86.5°E. It moved in westerly direction and further intensified in to a severe cyclonic storm which lay centred at 060300 UTC near Latitude 16°N and Longitude 84°E about 300 km east of Machilipatnam.

The severe cyclonic storm off north Andhra coast moved west-northwestwards and further intensified into severe cyclonic storm with a core of hurricane winds at 0900 UTC of November 6 and lay centred at 061200 UTC near Latitude 16.4°N and Longitude 82.6°E. It further moved in a west-northwesterly direction and crossed north Andhra Coast about 50 km south of Kakinada at about 1600 UTC of November 6.

Drought

The drought in 1987, caused by the failure of the southwest monsoon over large part of the country was one of the worst in this century. In 1987, percentage departure of the monsoon from normal for the country as a whole was 19%. In the past, there were only four years for which the percentage departure of the monsoon rainfall was less than that in 1987. They were 1877 (-31%), 1899 (-29%), 1918 (-26%) and 1972 (-25%). Thus the drought in 1987 is the third severe most in this century.

During the year 1987 the delayed onset of the monsoon in certain parts and the prolonged dry spell in most parts of the country severely affected agricultural operation in an area of approximately 58.6 million hectares in 267 districts of 15 states and 6 union territories. About half of the area was not sown at all. The two worst affected states were Rajasthan and Gujarat where the year's precipitation was less than 50% of the normal. In these states and in few other states, 1987 drought was the third or the fourth in succession accentuating the distress to unprecedented levels. Even states like Punjab and Haryana where irrigational facilities are available, were adversely affected. Successive drought in Rajasthan, Gujarat and some other parts of the country from 1985 onwards led to severe shortage of drinking water both in urban and rural areas; nearly 54,000 villages faced acute problem of drinking water. Another serious dimension of 1987 drought was the severe fodder shortage experienced in the large parts of the country, particularly Rajasthan and Gujarat. Details of the damage due to droughts reported by state governments on account of rainfall deficiency are given in Table 4. It may be seen from the table that the drought damage increased progressively and attended a peak level in 1987.

Table 4 The details of damage due to drought reported by State Governments on account of rainfall deficiency during the southwest monsoon of 1985, 1986 and 1987.

	1985	1986	1987
No. of districts affected	107	280	267
Population affected (lakhs)	785-91	1919.42	2854.19
Cropped area affected (lakh ha.)	282-10	400.13	586.00
Cattle population affected (lakhs)	654.33	1919.89	1681.11

Heat Wave

Heat wave occurs mostly in North India. The major factors that may cause a severe heat wave are:

- Hot dry air.

- There should be region of warm dry air and appropriate flow pattern for transporting the air over the region.
- There should be little or no moisture present in the upper air over the area.
- Sky should be practically cloudless to allow maximum insolation over the region.
- The lapse rate should approach dry adiabatic in the air mass to allow warming to a considerable depth.
- Finally there should be a large amplitude anticyclonic flow or the thickness values should be considerably above normal in all layers.

During the last two decades the maximum incidents of severe heat wave have occurred in Rajasthan, which have taken a toll of 71 human lives per year. Table 5 reveals that the heat wave conditions have also been severe over the states of Bihar and Uttar Pradesh (Table 5).

Table 5 Frequency of occurrence of heat wave and cold wave and loss of human lives.

	Cold Wave			Heat Wave		
	Occurrence (total no.)	Total loss of human lives	Loss of human lives per year	Occurrence (total no.)	Total loss of human lives	Loss of human lives per year
Jammu Kashmir	19	70	3	1	0	0
Himachal Pradesh	20	19	1	3	39	2
Punjab	24	39	2	18	76	3
Uttar Pradesh (including hilly areas)	48	731	33	24	548	25
Haryana	17	18	1	15	45	2
Delhi, Chandigarh, Rajasthan	47	79	4	49	1488	68
Gujarat, Saurashtra, Kutch	17	87	4	8	52	2
Madhya Pradesh	16	14	1	13	120	5
Maharashtra including Goa	18	6	0	26	191	9
Bihar	59	2204	100	22	622	28
West Bengal	14	71	3	23	38	2
Assam and neighbouring states	2	0	0	4	0	0
Orissa	0	0	0	15	43	2
Andhra Pradesh	1	0	0	12	111	5
Karnataka	0	0	0	2	5	0
Kerala	0	0	0	0	0	0
Tamil Nadu	0	0	0	2	0	0

Cold Wave

Cold wave conditions are invariably associated with western disturbances. When western disturbances move towards northeast across the northern parts of Pakistan and the adjoining north west India, the associated cold wave condition remain confined to Punjab, Himachal Pradesh, north west Uttar Pradesh and north Rajasthan.

A well marked trough in the upper westerlies is more or less a common feature associated with the system of western disturbances. In the vicinity of the axis of these troughs the existence of a pool of cold air in the upper level can often be traced. This pool of cold air invariably travels with the troughs and is also seen to spread into lower level to manifest as surface cold wave. These westerly troughs which travel across north India during winter, are another causative factor for the cold wave over Bihar and West Bengal.

About 180 pilgrims to Amarnath Shrine lost their lives due to severe cold and uninterrupted rain in south Kashmir during the last week of August 1996. Synoptic situation associated with this cold wave was as follows: During the last week of August, low pressure area over east Rajasthan and neighbourhood moved in a northerly direction and lay as a well marked low pressure area over northeast Rajasthan and adjoining parts of Haryana on August 22, 1996. Associated cyclonic circulation extended up to mid-tropospheric levels. A cyclonic circulation extending up to 1.5 km asl lay over NW Rajasthan and adjoining Punjab and on August 25 as it merged with monsoon trough. The axis of the monsoon trough lay from Jaisalmer, Indore, Jagdalpur, and thence eastwards to east-central Bay on 27 August and from Barmer, Kota Gondia, and thence southeastwards to east central Bay on 28 August.

During the last two decades, the states of Bihar and Uttar Pradesh are most affected states due to cold wave. 2204 human lives lost in Bihar while loss of human lives in Uttar Pradesh was 731. Other states affected by cold wave were Gujarat Saurashtra-Kutch, Rajasthan and Jammu and Kashmir (Table 5).

Snowfall

Average loss of human lives due to snowfall is 67 per year. More than 150 people were killed in snow avalanches and landslides on Srinagar-Jammu National highway in the wake of unprecedented snowfall during later half of the week ending January 18, 1995. Jammu and Kashmir and Ladakh tribal belt recorded the heaviest snowfall during later half of the week in last 15 years. The associated synoptic situation was as follows: A western disturbance as an upper air system lay over north Afghanistan and neighbourhood on January 13, 1995. Moving eastwards it lay over Jammu and Kashmir and neighbourhood on January 15 and moved away northeastwards on January 16, 1995.

Another trough in the mid and upper tropospheric westerlies with its axis at same level was seen roughly along Longitude 73°E North of Latitude 20°N on January 16, 1995. Moving eastwards it was seen along Longitude 76°E North of Latitude 10°N on January 17, 1995. A western disturbance as an upper air system lay over north Paskistan and neighbourhood on January 18, 1995, with northeastward movement to Jammu and Kashmir.

CONCLUSIONS

1. Flood and heavy rains are the worst disastrous phenomena which takes on an average 1500 human lives per year. U.P. is the worst affected state due to flood and heavy rains. Other worst affected states are Gujarat and Maharashtra.
2. Cyclonic storm takes on an average a toll of 183 human lives pre year in Andhra Pradesh.

3. Cold wave conditions are most severe over Bihar while heat wave is the worst over Rajasthan.
4. Though loss of human lives the due to drought is nil, the damage to the agricultural crops and shortage of drinking water and fodder due to drought lead to unprecedented suffering to the mankind.

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REFERENCES

De, U.S. (1996) Tropical cyclone and storm surge hazard assessment. WMO/TD No. 761, Rep. No. TCP-40.

Mukherjee, A. K., Ramakrishnan, A.R. and Jambunathan, R. (1981) Mausam, 32(2), 115-126.

Ministry of Agriculture (1989) The drought of 1987 - response and management. Vol. I, Dept. of Agriculture and Co-operation, Ministry of Agriculture, Government of India.