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Flood hazard being most notorious of any other type of natural hazard is responsible for posing serious challenge to the natural as well as socio-economic environment of the region. Floods have devastating effects on human habitat and activities like agriculture, industry and settlement, and at times cause loss of lives and materials. Still the flood prone areas of the river valleys of the world are the most habited parts of the world. The phenomena of floods is not new, but it is felt more now as there is rapid increase in population and in the all round activities which put pressure on land. It has existed from time immemorial.

Uttar Pradesh is one of the three major flood prone states of India, the other two being Bihar and West-Bengal. The damages caused by floods in Uttar Pradesh during the past fifteen years from 1975 to 1989 were maximum in 1983 amounting to Rs. 24,599.7 million, the highest for any year in memory. As many as 3,275 human lives were lost and 153,086 cattles perished.

The study region or the state of Uttar Pradesh is situated in northern part of India between 23°52'N and 31°28'N latitudes and 77°04'E and 84°38'E
longitudes. The state forms an international boundary with Tibet and Nepal. On the east it is bounded by Bihar on the South by Madhya Pradesh and on the northwest and west by the states of Himachal Pradesh, Haryana, Rajasthan and Delhi. Uttar Pradesh is divided into sixty three districts according to 1990 records and had a total population of 11,08,62,103 persons in 1990 according to figures collected by Ministry of Information and Broadcasting, Government of India. The state accounts for twenty four per cent of the total flooded area in the country and about twenty three per cent of the total damages occurring from floods in the country. The eastern half of the state is more vulnerable wherein some area gets affected by floods almost every year. The eastern districts are most severely affected by the floods. The rivers which cause damage are the Ghaghara, Sarda, Gandak, Rapti, Gomati, Yamuna and Ganga. The problem of drainage congestion is also found in the western and northwestern districts of Uttar Pradesh. Since the state is highly flood prone and more often affected by floods, it has been selected for special study to look for the causes, extent damages of floods and to find measures to control them.

The thesis is presented in eight chapters of which the first one introduces the physical setting
of Uttar Pradesh, by describing its structure and relief, drainage, climate, soils and physical divisions. Structurally Uttar Pradesh is a part of Indo-Ganga Plain formed of alluvium filled asymmetrically in the Indo-Ganga trough. The deposits are continuous and conformable series of fluviatile and sub-aerial deposits, mainly composed of unconsolidated beds of clay, sand, gravel and their mixture in varying proportions. The depth of alluvium is estimated between 2000 to 6000 metres by various authors. An almost imperceptible change in elevation and uniform surface material are the two noteworthy features in the physiognomy of the region. The Khadar, the bhangar and the gravels are the only variants according to their location and age in almost homogenous deposit. The silt, clay and sand particles of the Khadar are renewed annually and occupy the riverine tracts, while the bhangar makes the interfluvial zone above the general flood limits and gravels of the Tarai and Bhabar zone are the loosely set sediments ranging from fine silt or clay particles to coarse sands, pebbles and even boulders and spread haphazardly in the zone of the break-in slope at the foot of the Siwaliks. About one sixth of the state is occupied by the Himalaya with 3000 metres and above while Siwaliks have a height between 300 metres and 600 metres. The remaining part
of the state consists of plains with a relief of 150 metres and below. The uplands in southern part of the state have a relief of 150 to 300 metres.

The state is divided into four physical regions, viz. the hill areas in the north along the Himalaya or the montane tract, a submontane tract comprising of Bhabar and Tarai, the Yamuna Ganga Plain with fertile alluvial soil and the hill plateau region lying to the south of Ganga plain or the trans-Yamuna tract.

In the plain region of almost uniform topography, the soils are by and large homogeneous. The alluvial soils in places have the usar and bhur deposits which depending on the drainage conditions mechanical and chemical constituents and climatic characteristic are found in different parts. Because of slight changes, the soils of Uttar Pradesh are grouped into seven types as Hill soil, Bhabar soil, Tarai soil, Alluvial soil, Vindhyan soil, Bundelkhand soil and Aravalli soil.

Rivers with their tributaries are the main channels of drainage. The north and northeast and northwest of the state is drained by the river Ganga and Yamuna and their tributaries. River Yamuna itself
is a major tributary of river Ganga. The other tributaries of the Ganga are the Ghaghara, the Sarju, the Sarda, the Rapti, the Gomati and the Ramganga. In the southwest and south the drainage is through the rivers Chambal, Sindh, Betwa, Ken and Son all these join the river Yamuna or the Ganga. The Himalayan rivers are perennial in nature and carry waters from snow melt and monsoon rainfall. These rivers also carry detritus and deposit them when they are not able to carry it. It is possible to recognize five drainage basins in Uttar Pradesh, viz. the Ganga basin, Yamuna basin, Ghaghara basin, Gomati basin and Ramganga basin.

In Uttar Pradesh, climate is very much influenced by its nearness to the Himalaya. The mean annual temperature in plains varies from 25°C to 26°C. In the foot-hills and hills of Uttar Pradesh, the mean annual temperature is about 13.3°C. The temperature decrease as the latitudes increase. It experiences a typical monsoon type of climate. The average annual rainfall of Uttar Pradesh varies from 839 mm to 889 mm. Generally the rainfall decreases from east to west and north to south. Surplus amount of water is received during the rainy season and more particularly in the months of August and September. Altogether the state has a cold weather season from November to February,
a hot weather season from March to mid-June and a season of general rains and retreating monsoons from mid-June to October.

The second chapter presents the occurrence of floods in a historical perspective. The evidences of several floods occurring in Ganga Plain are found in literatures of ancient and medieval times. Old Sanskrit literatures, the Puranas and Mahabharat, also give such evidences. The oldest systematic record in connection with flood occurrences was available only after 1872 flood, which caused great damage to the study region. The notable floods of 19th century are of 1894 and 1898, while in the 20th century the study region had witnessed extensive floods in 1910, 1924, 1926, 1938, 1948, 1955, 1971, 1973, 1978, 1980, 1982, 1983, 1985, 1986 and 1988. The floods of 1983 were the worst in respect of damages caused. The frequency of flood has increased significantly from 1954 onwards due to man's interference with his natural environment.

Chapter three relates to the causes and pattern of floods in the study region. Floods result from natural as well as human factors. In fact human factors intensify the severity of floods. The Himalayan rivers stand out as a separate class with floods occurring almost every year. The reason for it is heavy rainfall
in the Himalaya, steep slopes of the rivers before they debouch into the plains and also absence of easy outflow facilities. Each river system has its own characteristic periods and cause of flooding.

All the river basins are prone to floods in view of the extreme variability of the monsoons. A very remarkable cause of floods in these rivers is acute kink in the longitudinal profile at the junction of two contrasting slopes of steep mountains and flat plains. Then almost all the rivers have only one common exit i.e. the river Ganga. During the rainy season the already swollen main river receives waters from its tributaries and overflows. An important feature of rainfall over the state is its great concentration in short period of the year. The problem creeps up as the ground gets wet and does not reduce run-off by soaking and also the evaporation is less due to high humidity and cloudiness. All these conditions favour floods. Then meanders greatly retard the velocity of the stream by interlocking spurs formed in between the curves, so the discharge gets constricted and water overflows on to the plains. Yet another problem is that Himalayan rivers are subject to occasional catastrophic floods due to landslides in their upper course on the steep mountains. Beside physical factors, human factors
further contribute to the rivers propensity for flood. It is a fact that ruthless destruction of forests has led to increase in floods. Unregulated explosion of settlements in flood-plains also gives rise to flood damages.

The time of flood occurrence is directly related to the outburst of the monsoons, which usually fluctuates in time. Floods mostly occur around August and September. On the basis of duration of floods, the region is divided into three flood zones, viz. high duration zone, medium flood zone and low flood zone. The magnitude of flood varies from river to river and also from year to year. On the basis of nature of flooding the flood prone area is divided into flash flood and normal flood areas. Flash floods are due to failure of dams and embankments, the time lag is short and as it is sudden, more lives and property is lost while in normal floods warning can be made as water swells up slowly. But it is observed that by passage of time there is increase in intensity, frequency and magnitude of floods simply because of man's interference with nature.

Chapter four refers to perception and management of flood hazard. The response by the occupants indicates perception of the floods. The study
revealed that majority of people perceive floods as hazard. The perception of flood magnitude for future varies for different intensity zones. There are also differences between the levels of affinity for the flood plain especially according to occupants, which indicates that non-cultivators have less affinity to the flood plain. As regards perception towards advantage and disadvantage of floods, people do not have clear picture, and same is the case of health and diseases. But on the whole everyone is aware about the floods.

Management of floods deals with the way occupants have adjusted to this hazard and the way they abated with it. The various methods followed by the occupants to adjust with flood hazard are simply based on experience, trial and error. Adjustment to floods are either economic or social. Economic adjustments differ according to the intensity of flood. The occupants have evolved methods of farming in case of agriculture which can cope with the situation of floods. After trying various crop combinations it was found that paddy and jowar can resist floods to a great extent. Land is not devoted to crops in the Kharif season owing to impending floods, but on the other hand as the floods leave a layer of fertile soil, maximum
area is devoted to rabi crops like wheat, gram, barley, peas etc. As for livestock people cope with the problem by selling off cattle during flood times or by sending them to safer places. Fishing is practised on large scale in flood prone areas. Some people have also migrated to do skilled jobs to support their family during floods. The social adjustment is in terms of houses which are made on higher plinths and are made of cement. Contamination of water generates health problem but occupants of high flood zone have become immune to it while in other places medical facilities take care of them. Education too is affected as due to floods the institutions are not able to open, both in the rural and urban areas.

An overall assessment of flood damages is given in chapter five with the help of systematic and districtwise analysis. The systematic approach was adopted to estimate the flood damage in respect of crops, houses and human as well as cattle lives lost. All the variables show an increasing trend in case of damages from 1978 onwards. The study is done on district level for a period of fifteen years from 1975 to 1989 and therefore 57 districts have been undertaken.

The districtwise analysis of damages is based on data for various districts of the state. Averages
of three years have been taken to get a clear picture of losses and the study area has been divided into five zones for convenience. The zones thus demarcated are: Hill zone, Western zone, Central zone, Eastern zone and Bundelkhand zone. The study of each district from every zone shows that eastern zone is most affected zone followed by Central zone and western zone. Hill zone and parts of Bundelkhand had very low or nil damages from floods during fifteen years. It has also been observed that the years 1978 to 1980 and 1981 to 1983 have higher damages than the other years.

The overall damages in fifteen years in Uttar Pradesh from 1975 to 1989 regarding the number of villages involved, population, total area, cropped area, and houses damaged are described in chapter six. The average figures of various damages of respective districts were plotted under five categories of very high, high, medium, low and very low damage. Every variable showed a distinct pattern of damages. Only one district had very high number of flood affected regions, while maximum number of districts had low percentage of villages affected. A very high percentage of population got affected in five districts of the study area. But in a large number of districts a small population was affected medium and very low per cent
of population was affected in thirteen and twelve districts respectively. Two districts had a very high percentage, eight districts had high and medium percentage, the maximum twenty three had low and the rest very low percentage of area affected by floods. The cropped area affected reflects that three districts of the state had very high damages and three districts had high damage of cropped area. But medium degree of cropped area was affected in fourteen districts, while low and very low category accounted for twenty and fifteen districts of the state. In terms of houses affected by floods in fifteen years from 1975 to 1989 it is observed that one district falls in very high group, two in high group, eight in medium group and eleven in low group. The remaining thirty three districts belong to very low group of house damages.

Chapter seven presents protection measures, planning and forecasting to reduce flood damages. Government has taken up various measures to protect life and property from the onslaught of floods. These measures cover aspects such as construction of embankments, improving drainage, extension of waterways, water diversion, seepage, raising of plinth, etc. The problem of waterlogging and sewage is also looked after. Planning and forecasting also play an
important part to reduce flood damages. Planning started in 1954, when policies were made and implementation of policies is done to provide relief from floods. For this purpose certain amount of money is sanctioned in every five year plan. Reports on floods are prepared to project the entire flood situation of the study region annually. Forecast is made well before time to evacuate the place. This is a great help in reducing damages to life and moveable property.

The study in general concludes that the floods are an annual phenomena in Uttar Pradesh and repeatedly occur during the monsoon months. The upper reaches of rivers with a varied relief and large scale deforestation intensify flood situation. However in terms of damages eastern parts of the state are the worst sufferers wherein villages, cropped area, population, livestock and houses are affected. The districts bearing massive inundation are Bahraich, Gonda, Basti, Sitapur. The other parts of the state also get significant flood damages, except the districts of hill zone and some districts of Bundelkhand zone which are least affected by floods. During fifteen years from 1975 to 1989, the floods of 1976, 1978, 1980, 1982, 1983, 1985, 1986 and 1988
resulted in very severe flood damages. Out of these the flood of 1983 was most disasterous.

The time of occurrence of floods in a year is directly related to the outburst of the monsoons, which generally happens during the end of July and continues through August to September. Uttar Pradesh experiences both flash floods and normal floods. Flash floods take place suddenly and cause heavy damage as they are the outcome of dam or reservoir failure or arise due to landslides. Normal floods have a gradual rise in water levels in the river.

People have adjusted to some extent with the flood hazard. Various methods on the basis of their experience have been adopted as a safeguard like raising the plinth of houses, less investment in the rainy season for agricultural operations, moving livestock to safer places, etc. There is great awareness among people regarding the perception of floods. Government is also looking after the protection from flood hazard and various plans and forecasting schemes are being implemented in this regard. Still there is a need to boost up the implementation of schemes for proper control of floods and their damages. For all this short term solutions along with long term solutions are required to be implemented.
Considering above mentioned situation in mind, few directions are suggested to tackle the problem. Massive plantation of trees especially in mountainous areas will check soil erosion, construction of diversion canals will take out surplus water, encroachment on flood plains be checked, embankments and other buildings be made of concrete, scientific agricultural practices should be taken up, cleaning of river beds be undertaken regularly, more stations should be established to record danger levels of rivers and forecasting be done well before time, relief should be intensified and indepth planning as well as its implementation be done. These measures will help reduce flood damages.