

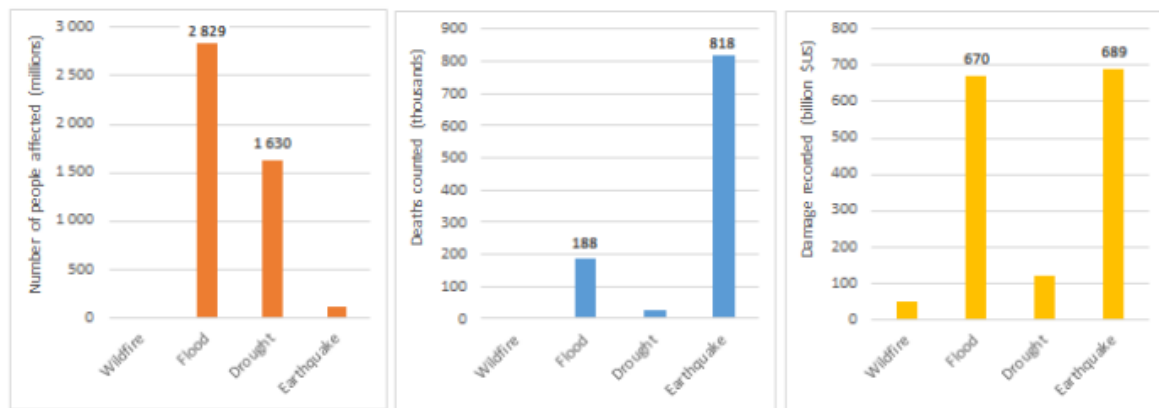
## **Flood Prone Areas: Problems and Prospects**

**Subject:** Geography/ **Paper:** Regional Geography of India

**Sem.- IV/Paper-II/Unit-V**

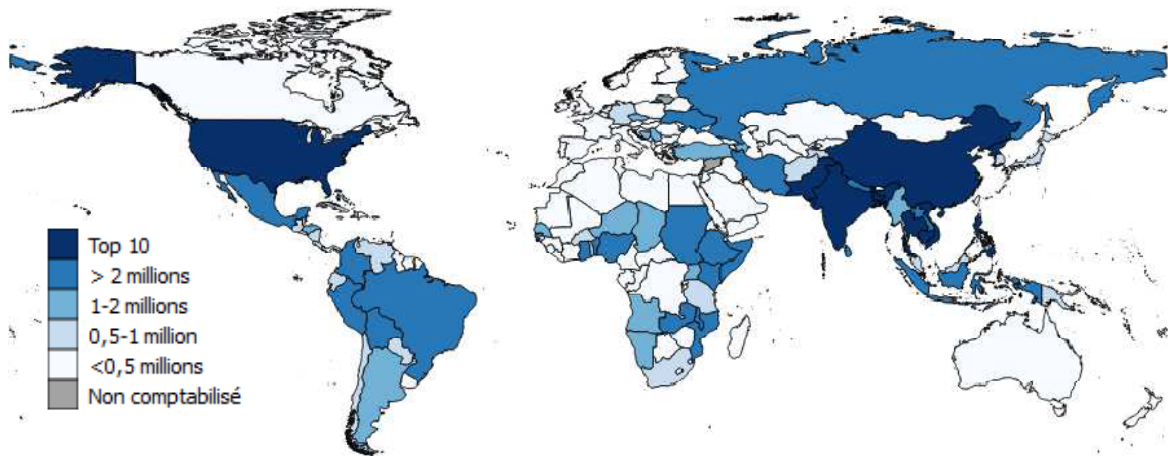
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With more than 2.8 billion people affected since 1990 around the world (EMDAT, 2016), flooding is the phenomenon with the most impact on human population worldwide (UNISDR, 2015). However, it is more of an economic risk because of the material damage caused rather than a lethal risk for the affected population. A comparison with other types of natural disasters shows, for example, that floods produce significantly fewer deaths than earthquakes (Figure 1).



**Figure 1: Comparison of the damage caused by different natural disasters since 1990 on a global scale (Data source: EMDAT - 2016)**

The material damage has a significant impact on the living conditions of the people affected by the floods, in particular by the degradation of buildings (housing and strategic infrastructure such as hospitals and schools), disruption or breakdown of networks (drinking water, sanitation, waste, energy, transport), disruption or cessation of economic activities, and displacement of populations. Globally, some countries are more affected by floods than others (Figure 2). Asia is particularly exposed: 9 of the top 10 countries in terms of flood-affected populations are in Asia (including China in first place). The detailed human and material impact due to floods for each country of AFD intervention are presented in annex.



**Figure 2: Global distribution of people affected by floods since 1990 (EMDAT, 2015)**

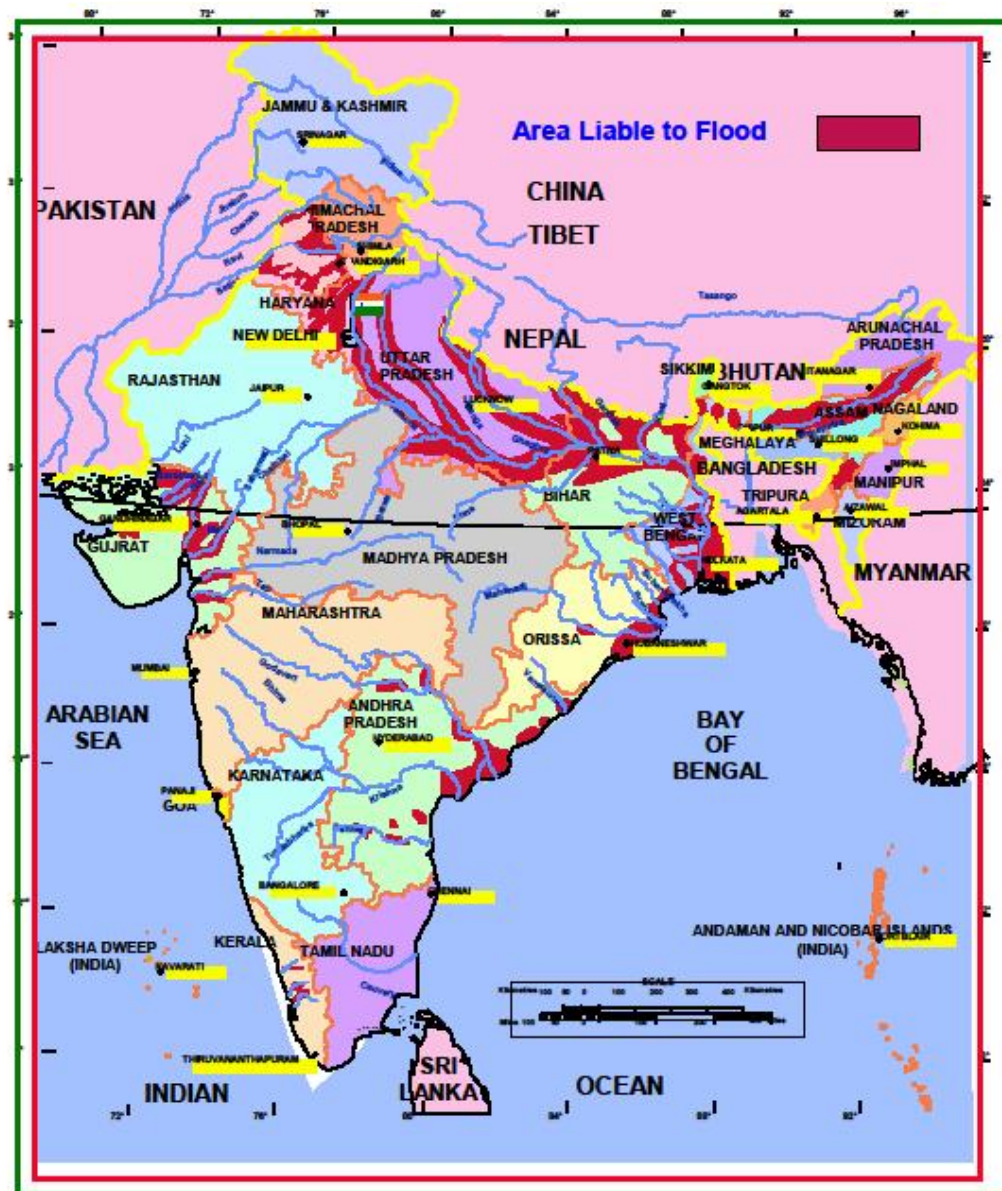
### **FLOOD PRONE REGIONS OF INDIA:**

India is highly vulnerable to floods. Out of the total geographical area of 329 million hectares (mha), more than 40 mha is flood prone. Floods are a recurrent phenomenon, which cause huge loss of lives and damage to livelihood systems, property, infrastructure and public utilities. It is a cause for concern that flood related damages show an increasing trend. The average annual flood damage in the last 10 years period from 1996 to 2005 was Rs. 4745 crore as compared to Rs. 1805 crore, the corresponding average for the previous 53 years. This can be attributed to many reasons including a steep increase in population, rapid urbanization growing developmental and economic activities in flood plains coupled with global warming.

An average every year, 75 lakh hectares of land is affected, 1600 lives are lost and the damage caused to crops, houses and public utilities is Rs.1805 crores due to floods. The maximum number of lives (11,316) was lost in the year 1977. The frequency of major floods is more than once in five years.

Floods have also occurred in areas, which were earlier not considered flood prone. An effort has been made in these Guidelines to cover the entire gamut of Flood Management. Eighty per cent of the precipitation takes place in the monsoon months from June to September. The rivers bring heavy sediment load from catchments. These, coupled with inadequate carrying capacity of rivers are responsible for causing floods, drainage congestion and erosion of river-banks. Cyclones, cyclonic circulations and cloud bursts cause flash floods and lead to huge losses. It is a fact that some of the rivers causing damage in India originate in neighboring countries; adding another complex dimension to the problem. Continuing and large-scale loss of lives and damage to public and private property due to floods indicate that we are still to develop an effective response to floods. NDMA's Executive Summary Guidelines have been prepared to enable the various implementing and stakeholder agencies to effectively address the critical areas for minimising flood damage.

India can be broadly divided into the following four regions for a study of flood hazard. In addition the Andaman and Nicobar Islands and Lakshadweep have peculiar characteristics, which result in drainage congestion, flooding and erosion in coastal areas, as described in Para 1.3.



**The Brahmaputra River Region:** This region consists of the rivers Brahmaputra and Barak and their tributaries, and covers the states of Assam, Arunachal Pradesh, Meghalaya, Mizoram, Manipur, Tripura, Nagaland, Sikkim and the northern parts of West Bengal. The catchments of these rivers receive very heavy rainfall ranging from 1100 mms. to 6350 mms which occurs mostly during the months of May-June to September. As a result, floods in this region are severe and quite frequent. Further the hills, where these rivers originate, are fragile and susceptible to erosion and thereby cause exceptionally high silt discharge in the rivers. In addition, the region is subject to severe and frequent earthquakes, which cause numerous landslides in the hills and upset the regime of the rivers. The predominant problems in this region are cloud bursts followed by flash floods, soil

erosion in the watershed and bank erosion along the rivers, flooding caused by the spilling of rivers over their banks, drainage congestion and the tendency of some of the rivers to change their courses. The plain areas of the region suffer from the inundation caused by spilling of the Brahmaputra.

**The Ganga River Region:** The river Ganga has many tributaries, the important ones being Yamuna, Sone, Ghaghra, Raphti, Gandak, Burhi Gandak, Bagmati, Kamla Balan, Adhwara group of rivers, Kosi and the Mahananda. It covers the states of Uttarakhand, Uttar Pradesh, Jharkand, Bihar, south and central parts of West Bengal, Punjab, parts of Haryana, Himachal Pradesh, Rajasthan, Madhya Pradesh and Delhi. The normal annual rainfall in this region varies from about 600 mms to 1900 mms of which more than 80 per cent occurs during the SW monsoon. The rainfall increases from west to east and from south to north. The flood problem is mostly confined to the areas on the northern bank of the river Ganga. Most of the damage is caused by the northern tributaries of the Ganga. They spill over their banks and change their courses frequently. Even though the Ganga is a mighty river carrying huge discharges of 57,000 to 85,000 cubic meter per second, the inundation and erosion problems are confined to relatively few places. In general, the flood problem increases from the west to the east and from south to north. In the north-western parts of the region, there is the problem of drainage congestion. The drainage problem also exists in the southern parts of West Bengal. The flooding and erosion problem is serious in the states of Uttar Pradesh, Bihar and West Bengal. In recent years, the states of Rajasthan and Madhya Pradesh have also experienced some incidents of heavy floods. The problem of flooding and drainage congestion is getting accentuated due to large- scale encroachment of flood plains of the rivers for habitation and various developmental activities.

**The North-west River Region:** The main rivers in this region are the Indus, Sutlej, Beas, Ravi, Chenab and Jhelum. These rivers are the tributaries of the Indus. They carry quite substantial discharges during the monsoon and also large volumes of sediment. They change their courses frequently and leave behind vast tracts of sandy waste. This region covers the states of Jammu and Kashmir, Punjab and parts of Himachal Pradesh, Haryana and Rajasthan. Compared to the Ganga and the Brahmaputra river regions, the flood problem is relatively less in this region. The major problem is that of inadequate surface drainage which causes inundation and water-logging over vast areas. Indiscriminate use of water for irrigation and development of low-lying areas and depressions has created problem of drainage congestion and water logging.

**The Central India and Deccan Region:** Important rivers in this region are the Narmada, Tapi, Mahanadi, Godavari, Krishna and Cauvery. These rivers have mostly well defined and stable courses. They have adequate capacities within the natural banks to carry the flood discharge except in the delta area. The lower reaches of the important rivers on the east coast have been embanked, thus largely eliminating the flood problem. However the embankments need to be raised and strengthened to latest standards to continue to provide protection against floods and erosion. This region covers the states of Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, Orissa, Maharashtra, Gujarat and parts of Madhya Pradesh. The region does not have serious flood problem except that some of the rivers in Orissa State namely Mahanadi, Brahmini, Baitarni, and Subarnarekha are prone



to floods every year. The delta and coastal areas of the states on the east coast periodically face flood and drainage problems in the wake of monsoon depression and cyclonic storms. The problem is accentuated when the floods synchronize with high tide. The rivers Tapi and Narmada, are occasionally in high floods affecting areas in the lower reaches in Gujarat.

### **PROBLEMS IN FLOOD PRONE AREAS**

Floods have the greatest damage potential of all natural disasters worldwide and affect the greatest number of people. On a global basis, there is evidence that the number of people affected and economic damages resulting from flooding are on the rise at an alarming rate. Society must move from the current paradigm of post-disaster response. Plans and efforts must be undertaken to break the current event-disaster cycle. More than ever, there is the need for decision makers to adopt holistic approaches for flood disaster management.

Extreme flooding events are not relegated to the least developed nations, but can also devastate and ravage the most economically advanced and 23 industrialized nations. In the last decade there has been catastrophic flooding in Bangladesh, China, India, Germany, Mozambique, Poland, the United States and elsewhere. When floods occur in less developed nations, they can effectively wipe out decades of investments in infrastructure, seriously cripple economic prosperity, and result in thousands of deaths and epidemics. The majority of the deaths associated with such disasters can be found within the most vulnerable members of society, namely women and children.

Flood damage is defined as all the varieties of harm provoked by flooding. It includes all detrimental effects on people, their health, and properties; on public and private infrastructure, ecological systems, cultural heritage, and economic activities (Messner & Meyer, 2006). Understanding the nature of flood damage is important in assessing flood risk. For most people, the benefits of flood risk reduction at the coast is the direct flood damage on property and economic activity avoided as a result of schemes to reduce either the frequency or impact of flooding (Penning-Rowsell et al., 2013). However, the consequences of flooding for people are more complex. Following Smith and Ward (1998), we can classify flood losses into direct and indirect losses. Direct losses are caused by the physical contact of the floodwater with humans, property, or other objects, and the location of the flood will indirectly affect networks and social activities, causing indirect losses (e.g., disruptions of traffic, trade, and public services). Further, we can distinguish between immediate or long-term consequences and tangible or intangible consequences. Such consequences depend on the land uses found within the floodplain. **IMMEDIATE IMPACTS** of flooding can include loss of human life, damage to property and infrastructure, and destruction of crops and livestock. Examples of **LONG-TERM IMPACTS** include the interruption to communication networks and critical infrastructure (such as power plants, roads, hospitals, etc.) that can have significant impacts on social and economic activities. More difficult to assess are the **INTANGIBLE IMPACTS**; for example, the psychological effects of loss of life, displacement, and property damage can be long-lasting (see Table 2.4). Methods of assessing these impacts are equally varied. They range from quantitative (financial or economic) to more qualitative approaches.

There are some common problems in flood prone regions which can be seen under following sub heads:

**Problems to Agricultural Land:**

- a. **Deposition of sand and debris on productive lands:** During floods, your fields will experience different amounts of erosion, sediment deposition, and crop residue accumulation. To avoid compaction of these soils it is crucial let soils drain and dry out sufficiently before removing any large debris from fields or working the soil. If crop residues sediments have accumulated less than 4 inches, then normal field operations can be used to prepare the fields. If larger

**Fields covered with sediment and debris**



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amounts of debris or sediments have accumulated, then deeper moldboard plowing may be necessary.

- b. **Erosion of Agricultural Soils:** The recent floods in Kerala parts of Kodagu in Karnataka led to widespread soil erosion. gradual loss of soil productivity can have a lasting impact on local economy. Soil degradation due to flooding is a serious concern. An estimated 14 million hectares of land suffer soil degradation due to flooding annually in India, e.g. After the 2009 floods in North Karnataka, 13 flood-hit districts lost around 280 million tons of top soil. It also led to loss of soil nutrients across 10.75 million hectares of farmland. Under market prices, the replacement of nutrients such as nitrates, phosphates and iron would have cost around Rs. 1,600 Crore. Besides, the cost of replenishing the organic material lost would have cost nearly Rs. 850 Crore. In addition, considerable amount of time and concerted programs of recovery are needed to recover and replace the soil productivity. At present, soil profile of affected districts in Karnataka indicates "shallow or very shallow" soil depth. They also exhibit organic carbon deficiency, and low productivity of land.

**Eroded Field**



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Soil takes thousands of years to form through natural processes and through recent inputs by farmers. Floods result in this being swept away to be dumped in reservoirs or in the sea. However, not all floods are bad for the soil. E.g. floods along the banks of the Ganga, Kosi, Brahmaputra. These and other rivers emanating from the mountains carry with them, loosened alluvial soil. They wash over farmlands as well as replenish flood plains with fertile soil.

- c. **Flooded soil syndrome—loss of beneficial fungi which mobilize soil-based plant nutrients:** Fallow Syndrome is a condition where crops planted the year after an extended period with no plant growth exhibit reduced early growth and yield. On corn plants the syndrome exhibits classic phosphorus (P) deficiency symptoms, including slow-stunted early

growth, purple coloration, and poorly developed roots. This effect is called Fallow Syndrome because it is observed in soils where, for moisture conservation, the land has been idled for a year and kept fallow with no crop or weed growth. This allows accumulation of moisture in the soil for the next cycle of crop production. A similar syndrome can be observed after extensive flooding due to the lack of plant growth in submerged areas. This is sometimes called "Flooded Soil Syndrome." This may be an issue in 2012 in the Missouri River floodplain as the flooding spanned a long period during the 2011 growing season. Crops were planted and there was some growth before the flooding, but none the rest of the season. The syndrome tends to affect corn more than soybean, but it can be an issue with soybean as well.

#### **Loss of lives and property:**

Immediate impacts of flooding include loss of human life, damage to property, destruction of crops, loss of livestock, non-functioning of infrastructure facilities and deterioration of health condition owing to waterborne diseases. Flash floods, with little or no warning time, cause more deaths than slow-rising riverine floods. In monetary terms, the extent of damages caused by floods is on the one hand dependent on the extent, depth and duration of flooding, and the velocities of flows in the flooded areas. On the other hand it is dependent on the vulnerabilities of economic activities and communities.

#### **Loss of livelihoods:**

As communication links and infrastructure such as power plants, roads and bridges are damaged and disrupted, economic activities come to a standstill, resulting in dislocation and the dysfunction of normal life for a period much beyond the duration of the flooding. Similarly, the direct effect on production assets, be it in agriculture or industry, can inhibit regularly activity and lead to loss of livelihoods. The spill over effects of the loss of livelihoods can be felt in business and commercial activities even in adjacent non-flooded areas

#### **Decreased purchasing and production power:**

Damage to infrastructure also causes long-term impacts, such as disruptions of clean water and electricity supply, transport, communication, education and health care. Loss of livelihoods, reduction in purchasing power and loss of land value in the flood plains lead to increased vulnerabilities of communities living in the area. The additional cost of rehabilitation, relocation of people and removal of property from flood-affected areas can divert the capital required for maintaining production.

#### **Mass migration:**

Frequent flooding, resulting in loss of livelihoods, production and other prolonged economic impacts and types of suffering can trigger mass migration or population displacement. Migration to developed urban areas contributes to the overcrowding in the cities. These migrants swell the ranks of the urban poor and end up living in marginal lands or informal settlements that are prone to

floods or other risks. Selective out-migration of the workforce sometimes creates complex social problems.

#### **Psychosocial effects:**

The huge psycho-social effects on flood victims and their families can traumatize them for long periods of time. The loss of loved ones can generate deep impacts, especially on children. Displacement from one's home, loss of property, loss of memorabilia and livelihoods, decreased levels of security in the aftermath of floods and in temporary shelters, and disruption to business and social affairs can cause stress. The stress of overcoming these losses can be overwhelming and produce lasting psychological impacts.

#### **Hindering economic growth and development:**

The high cost of relief and recovery may adversely impact investment in infrastructure and other development activities in the area and in certain cases may cripple the frail economy of the region. Recurrent flooding in a region may discourage long-term investments by the government and private sector alike. Lack of livelihoods, combined with migration of skilled labour and inflation may have a negative impact on a region's economic growth. Loss of resources can lead to high costs of goods and services, delaying its development programmes.

#### **Political implications:**

Ineffective flood response and relief operations during major flood events regularly lead to public discontent or loss of trust in the authorities or the state and national governments. Lack of development in flood-prone areas may cause social inequity and even social unrest posing threat to peace and stability in the region.

#### **PROBLEM ON THE BASIS OF CASE STUDIES:**

The study by Tata Trust entitled "Development Profile In Flood Prone Areas", for the study of the problem – development profile in the flood prone areas of Uttar Pradesh, Bihar, West Bengal and Assam – was at the centre while deciding on the broad research strategy. In order to understand problem and to advocate for change – livelihood enhancement among the flood affected population, which can be seen with sub heads given below:

#### **BIHAR REGION:**

##### **Floods and Agriculture**

Land is the most important asset that a rural household might possess. The same holds true for the flood prone villages. The studies of villages shows that average landholding was found to be around 1.15 acres (if we include the three outliers the average landholding goes up to 2.8 acres), but land distribution is skewed and in some of the villages, the respondents reported that most of the land would be owned by a few (mostly higher caste) people in the village. On an average, around 44% of the households in the villages were reported as landless. The cause of landlessness could be multiple in these flood prone villages. Certain communities like the *Harijans* and *Mushahars* were found not to own any land. Sometimes they would be resettled on some upland where



wage/agriculture labour becomes their sole livelihood activity. An important locale specific reason of landlessness in the flood prone areas is river bank erosion and change of river course. Landlessness and skewed landholding distribution are the major cause for many people to work as sharecroppers and cultivate land on 'Batai' basis.

#### **Floods and Animal Husbandry**

Animal husbandry is often an important livelihood for a rural household. There is about average around 60% of the households would have small ruminants like goats, around 31% engage in poultry and around 40% of the households would engage in dairy activities. The proportion of buffaloes and cows are higher in the rural areas of this region. In areas more prone to sailaab, waterlogging and erosion, that is in the districts of Supaul, Khagaria, Madhubani and parts of Kishanganj, lesser proportion of people are engaged in animal husbandry.

The floods tend to have myriad adverse impact on livestock: it may result in enhanced mortality as the gushing water might wash away the cattle, increased morbidity through various diseases, reduce the area available for grazing and foraging, and in case of crop failure, reduced crop residue and fodder. A survey reveals that flood reduced income from animal husbandry. In many of the studied villages, the respondents complained that as a result of floods, milk production would reduce by nearly 55%.

#### **Floods, Housing and Mobility**

In the study villages in Seohar and Sitamarhi, households had elevated their houses by soil filling to cope with floods. Sometimes the people would use government schemes like Indira AwasYojana to dig out soil from the neighbouring areas in order to elevate their houses. However, mobility during the floods continued to remain a problem. During floods, limited number of boats, are the only mechanism for transportation. Transporting sick people to nearby hospitals becomes extremely difficult. (We have witnessed cases where sick people would be carried on a charpoy by four people and via boat-van-trekker). Mortality during transit is not uncommon.

#### **Water Supply, Sanitation and Health in Flood Prone Areas:**

In most of the villages of this region are found that handpumps are the only source for drinking water. In some villages (like one in Kishanganj) water would be supplied by the government through public standposts, but water supply was not reliable. As a result, even in such cases the villagers still depend on the handpump. There is a general perception in the area that water from handpump, that is, groundwater, is good for health. The same time, handpumps located in areas where one were expect contamination from humans and animals. Moreover during floods, handpumps located in the lowland would get submerged and people then either end up drinking flood water or shift to hand pumps in upland areas of the village or, fetch water from outside. In very few villages, some NGOs have been able to inculcate the Development Profile in Flood Prone Areas.

#### **Education in Flood Prone Areas**

In this region primary schools are closed down during the floods. During floods, the access to the school becomes difficult and hence they simply do not come to teach. Kosi region is considered a lucrative posting for the teachers as they avail of "flood vacation" apart from the normal vacations. Sometimes schools are closed down because they are located in the lowland (in

one occasion in Kishanganj we came across a two-storied pucca school building constructed on the river bed) and gets flooded. When they are located on upland they often become sites for relief camps.

### **Migration in Flood Prone Areas**

In a natural hazard prone area, migration can be a livelihood diversification as well as a coping strategy. In rural Bihar, where family size is large, per capita landholding is low, and over and above that, the return from land is low due to floods, water logging and river bank erosion, migration is expected to be a widely practiced phenomenon.

Life in flood prone areas is characterized by a low level equilibrium manifested by subsistence living, setbacks via crop and livestock losses, and in some cases, through loss of life. In such a scenario, it can be argued that saving in assets like land and house, and continuous adjustment to floods and erosion, is fuelled by remittances. Remittances tend to be the insurance, based on which the life-livelihood cycle in the flood prone area runs.

### **EASTERN UTTAR PRADESH REGION:**

#### **Floods and Agriculture**

Agriculture is prime livelihood for Eastern U.P. Region also. Most of the households are either owner cultivators or sharecroppers. The latter are either landless or had been effectively reduced to a landless status when the land was lost to the river as a result of river bank erosion or due to the changing course of the river, or when the land became uncultivable because of flooding/water-logging and ensuing sand deposition.

In many villages people adapted to the natural hazards and the resulting adverse impact on agriculture by bringing a change in the cropping pattern: in some villages, paddy got replaced with gram and in some other village, people cultivated vegetables in small patches instead of large scale potato cultivation.

#### **Floods and Animal Husbandry**

In Eastern Uttar Pradesh flood region, around 70% of the households are engaged in dairy. The other important activities are goat rearing and around 13% of the households are engaged in this activity. Livestock, like land, was found to be susceptible to adverse impacts from floods. The floods affected the livestock population in two ways:

Direct loss of animal and cattle in floods as the force of flood water might wash away the livestock population. During the flood and post-flood months, the animals are susceptible to various diseases which often resulted in livestock mortality.

#### **Health and Education in Flood Prone Areas**

During flood the region face the increases the number of disease incidence. The diseases are either water borne diseases such as diarrhea, or skin diseases which resulted from long term exposure to polluted and often toxic flood water. After hazard the people has to travel to reach a treatment centre, which are located in remote area. Access to health services is a big challenge in most of the rural areas of eastern Uttar Pradesh, because of the remotely located health service centers with dismal road condition.

Educated facilities are available as primary level in villages but are remains closed during flood months. The closure of schools during floods is cause by following:

- The schools, if located on upland, becomes a relief camp
- If not located on upland, the access to schools becomes challenging for the teachers who would come from outside the village. Sometimes a component of moral hazard on the part of the teachers also works, and on pretence of inaccessibility, teachers tend to deliberately skip attendance.
- In some villages where the children had to travel kilometres to a neighbouring village to attend school, access to the school for the student could also be difficult, even if the school is located on an upland.

### **Migration in Flood Prone Areas**

In Eastern Uttar Pradesh, like in most other flood prone areas, where the life and livelihood is increasingly vulnerable to natural hazards, migration is both a process of livelihood diversification and a coping strategy. Migration is a prevalent practiced in rural areas. More than 80% of the households have one or two members of their family who migrate to far off places like Delhi, Mumbai and Hyderabad in search of livelihoods.

## **ASSAM REGION**

### **Floods and Agriculture**

In flood prone areas it is not just the absolute quantum of land that matters, it is the quality of the land or more specifically, the cultivable potential of the land. Landlessness in hazard prone areas could be an outcome of social processes or – more importantly – an outcome of natural processes like river bank erosion or changing of courses of the rivers. The cultivable potential of the land depends on the magnitude of the adverse impact of floods and water logging.

### **Floods and Animal Husbandry**

Apart from agriculture, animal husbandry is another prominent livelihood activity in rural areas. Households are engaged in goat rearing, poultry farming, dairy activity, piggery and fisheries. At the same time, these are also vulnerable to natural hazards which resulted in loss of production and sometimes mortality of animals. In rural areas, losses of animal and adverse effects of floods on income generation from animal husbandry are prominent features. The livestock are also prone to various water borne diseases and given the dismal state of animal husbandry departments in the area, morbidity often translated into mortality.

### **Health and Education in Flood Prone Areas**

The people, young and old, were prone to diseases which are either waterborne or resulted from a long exposure to contaminated flood water. In rural areas, people affected by the onset of waterborne diseases like diarrhoea and dysentery during and post-flood. Also the exposure to contaminated flood water resulted in skin diseases. The children are more prone to cough and cold. In such cases easy access to medical services becomes a necessity.

In the rural areas of the region, as advent of floods the schools closed down because either the students are not able to come to the school or because the schools are transformed into rescue and relief camps. The problem in these region are that once the kids stopped going to school for some months, they would get engaged in some labour job and subsequently many actually stopped

going to school altogether. Thus the drop-out rates increased and often young people prematurely joined the unorganised labour force.

### **Floods and Migration**

The villages faces myriad problems as a result of floods: in some villages, access to drinking water is difficult, particularly during the flood months. Some people faces difficulty in practicing agriculture and faced agricultural labour shortage. Severe loss of property, landlessness etc. are the major problems so the people hardly has any other option but to migrate.

### **Prospects for development of Flood Prone areas:**

**A. Steps to Optimize Your Soil Fertility After a Flood:** Floods bring with them a lot of potential for nutrient additions and losses to agricultural fields and the only way to know where your field stands is to test the soil.

- After the soil surface is dry, the soil should be tested to determine fertilizer requirements to optimize crop yield.
- When planting soybean after flooding, the seed should be inoculated to help ensure nodulation and nitrogen fixation flooding can reduce some of the microbial populations responsible for this process.
- Phosphorus deficiencies (slow early growth and purple coloration) may still occur even if soil tests indicate an adequate amount of phosphorus as flooding can decrease populations of soil microorganisms responsible for increasing phosphorus availability.
- If cash crops are not being planted after flooding, consider planting a cover crop to protect the soil from further erosion and to promote the growth of microorganisms that are essential for nutrient cycling.

**Nutrient Deficiency from Flooding**



**Soil Crusting**



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For more information regarding fertilizer recommendations in South Dakota see our newly formatted Fertilizer Recommendation Guide. Going forward we are also taking the steps needed to update these recommendations. Several projects are starting or underway where SDSU researchers are looking at nitrogen fertilizer requirements in corn and oats. This coming summer we will also start a project looking at the response of corn to phosphorus, potassium, and sulfur fertilizer (Jason, 2019).

**B. Post-Flooding Soil Management:** Deposition of sediment and other debris on otherwise productive land requires post-flooding management to:

- Remove sediment and debris barriers to crop production;
- Repair the physical damage to the soil;
- Stimulate soil microbial activity; and
- Limit indirect impacts like soil crusting.

Experts in the science and management of soils have identified methods to revitalize soil health so farmers can repair their soils and return land to a productive state. Agricultural consultants and university extension staff provide information about these methods and assistance in implementing the steps to recovery. However, not all fields can be reclaimed and losses are often significant.

C. **Replenishment of Eroded Soil:** However, in south and central India, floods wash away rich, weathered soils that are deposited in reservoirs or as sand bars along the river bed or in the sea. Agricultural and plantation practices to reduce the incidence of soil erosion should be employed effectively. Soil replenishment should be a part of the rehabilitation program in flood-affected areas. State agriculture universities, with the help of earth observing satellites, should assess the intensity of the problem. With this, consistent and long lasting effort is needed to boost the lost soil health and productivity.

D. **Recovery Plans:** Producers face a number of legal, economic, and physical challenges when developing their recovery plan.

- **Removing barriers to crop production:** To adequately address debris and sedimentation in fields, farmers must first determine if the material and objects can be tilled into the soil, or if physical removal is required. Physical removal is costly because of the volume of the material and the distance of transport. Regulations prevent sediments from being placed into the river.
- **Repairing the physical damage to soil:** Erosion occurs when soil is carried away with the flood water. Gullies and gaps in the field will form as a result of the loss of soil. Some erosion can be corrected with tillage. However, more often, the gullies are filled with sediment and then topsoil from another area in the field. If the cost of repair is too high, the farmer may be forced to abandon the field. Land easement programs offered by the USDA Natural Resources Conservation Service may offer options to reclaim some of the lost capital.
- **Stimulating soil microbial and fungal activity:** Arbuscular mycorrhizae (AM) are symbiotic fungi that grow on and in plant roots. The fungi penetrate roots without harming them. As a result, the fungi receive food—carbohydrates—from the plant and the plant will receive nutrients—primarily phosphorus—from the fungi. Since no plants grow in these fields during prolonged flood events, the fungi are lost from the system. In order to re-establish the population of fungi, producers can plant cover crops. A “cover crop” provides good ground cover to protect the soil from erosion and can range from legumes (beans) to small grains. Cover crops add organic matter to soil while also stimulating microbial and fungal activity.
- **Crop Insurance Programs:** The crop insurance program provides coverage for arable land. Through Risk Management Agency, administrators can regulate the program under the guidance of the Crop Insurance Corporation. Program responsibilities include regulating, reinsuring, and overseeing all aspects of the program, including standards for claims payments, rate setting, and crop insurance policy revisions. The program may in partnership between the government and private insurance companies.



**E. Planning for Governance and Coordination Measures:** While it is essential to assign a command control structure prior to an emergency, in most countries the lead emergency agency is neither the health ministry nor a specific department within it. Yet the health appropriate agencies should interact with all the stakeholders and organizations involved in emergency preparedness, response and recovery, including for floods. The concrete roles of each actor – their authorities, responsibilities and accountabilities, both organizational and individual – should be delineated in order to ensure seamless, effective, timely and efficient actions.

A range of standard operating procedures and guidelines are required to deal with flood events. This includes procedures to request, receive and coordinate support with international health partners in cases of large-scale emergencies that exceed national capacities. The lead emergency agency should cooperate with the health authority to ensure that systems are in place to receive, screen, register and task partners, and to anticipate, request and receive donations of medicines, health technology and consumables. Within this lead agency, the tasks and responsibilities required of every person concerned with flood response and recovery are set out and assigned to ensure efficiency and accountability. When a health cluster is formed, WHO should be the leading agency (Inter-Agency Standing Committee, 2015).

**F. Planning for Emergency Financing:** A health financing system for flood events is to be planned for, in particular: • budget for health programmes (e.g. staff, activities/services, health supplies, hospitals and infrastructure); • contingency funds for emergency response and recovery; • financial arrangements for emergency care (e.g. cost waiver policies, treatment of nonresidents, medical repatriation); • compensation systems (e.g. long-term care, insurance); and • management of multinational or bilateral foreign aid.

**G. Preparing for risk communication:** It is vital to ensure that people have access to prior information on what they must do to keep healthy during floods. Such information requires preparation far in advance. Identification of multiple communication formats and tools must take account of the fact that the main communication lines from radio and TV very often do not work in flooded areas. Therefore, it is very important that people living in flood-prone areas receive the necessary information once or twice per year through generic information channels. Risk communication is related to citizens' responsibility to play a role in flood mitigation. Community involvement and shared responsibility in the process of planning for preparedness, response and recovery may stimulate inhabitants to develop flood mitigation habits. Information disseminated to the community should include details of effective flood preparedness measures and ways to integrate these into daily life (Bubeck, Botzen and Aerts, 2012).

**H. Health Service Delivery:** Health services include all services dealing with the diagnosis and treatment of disease, or the promotion, maintenance and restoration of health (WHO Regional Office for Europe, 2008). Public health, pre-hospital and facility-based clinical services must be well prepared to respond effectively in the event of an emergency with health consequences. They should have the capacity to scale up service delivery to meet increased health needs (e.g. through increasing bed capacity, establishing temporary facilities or mobile clinics, vaccination campaigns) and to take specific measures related to certain hazards (e.g. isolation of infectious cases). Flooding may require health care services to expand beyond normal capacity to meet

community demand. In the preparation of an event, it is very useful to develop health service delivery plans as these can be utilized to help determine preparedness priorities and plan preparedness activities. The Health Resources Availability Monitoring (formerly Mapping) System (HeRAMS) can be used as a guide to assess the health service components needed to function in response to, and recovery from, flooding (WHO, 2009, 2012a). The Hospital Safety Index provides an assessment tool to prepare health facilities for future hazard risks 9 (including floods) in order to maintain resilience throughout the stages of emergencies and disasters (WHO and PAHO, 2015). Furthermore, real-time simulation exercises are useful tools to ensure compliance and readiness of the health system – public health institutions, hospitals, community health centres and nursing homes – to implement measures to protect people in the event of a flood. Participants at the flood meeting held in Bonn in October 2015 suggested annual all-hazard simulation exercises (flood day) in which a flooding scenario is integrated for planning and to educate the public and health services.

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**NOTE: I hope you people will read the above material and reframe with extra material as per your need.**