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Socio-Economic Damages of Floods in India: (1953-2011)

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Abstract:
Natural disasters, especially floods after 1950's, are raising the social and economic losses in India. The most severe hazard in India is flooding induced by summer Monsoons. In comparison of other rivers of the world India have the high discharge of water per unit area in a short time of Monsoon months (June to September). Rapid urbanization without proper land uses managements usually worsens the flood problems. It has been found that flood affected population in the country is increasing with a slope of 0.31 million people per year. A total of 97551 human lives were lost and Rs. 2131.14 billion with an average of Rs. 36.12 billion per year of economy have been reported damage due to floods during 1953-2011. These findings sustain the common belief that the flood and related damages are with time increasing in the country. In this study an effort made to highlight the different type of socio-economic damages, so that a strategy may be formulated to solve the flood problems in India.

1. Introduction

Among all natural hazards, floods are the most frequent disaster to be faced by world. Heavy rains, monsoonal rains and tropical cyclones are the most common causes of floods, which together account for 91 % of all the floods and 99 % of all displaced people (Few 2003; Tschakert et al. 2010). Floods that significantly disrupt or incapacitate a society by causing a large number of fatalities and costly damage have primarily been associated with developing countries, for example, Bangladesh and India (Singh and Kumar, 2013). More than one-third of the world's land area in 90 countries is exposed to catastrophic flooding representing about 82 % of the world's population (UNDP 2004; Dilley et al. 2005; Adhikari et al. 2010). Flooding, on an average, claims more than 23,000 lives per year over the globe and adversely affects 140 million people each year (Smith, 1996; WDR 2003, 2004).

Events such as the 1931 and 1938 flooding of the Yellow river in China, Bangladesh in 1987 and 1988, the great floods of the Mississippi river in 1993, Mozambique in 2000 and flooding in Myanmar from cyclone Nargis in 2008 serve as Grave testimony to the immense consequences floods can inflict on population worldwide. In addition, the frequency and magnitude of disastrous floods has increased on account of the global warming and impacts of economic development over the past 25 or 30 years (Knox 2000; Milly et al. 2002; Emanuel 2005; Jonkman and Kelman 2005; Macklin and Rumsby 2007; Zhang et al. 2008; Dankers and Feyen 2008; Allamano et al. 2009; Tschakert et al. 2010; Pall et al. 2011; Syvitski and Brakenridge 2013; Singh and Kumar, 2013).

Furthermore, floods are the most common and deadliest hazards in India where several disastrous floods hit India mainly in 1971, 1973, 1976, 1977, 1978, 1980, 1984, 1988, 1993, 1995, 2006 and 2010 (Kayastha, 1983; Kale, 2004; CWC, 2010; Singh and Kumar, 2013). Roughly 40 million hectares of land and approximately one-eighth of the country's geographical area, are liable to floods (Gupta et al. 2003; Mohapatra and Singh 2003; Roy et al. 2008). Flood-prone area in India has increased substantially with time at the rate of 0.014 million hectare per year. The annual average area affected by floods for the period 1953–2007 is 7.51 million hectare with variability ranging from 0.5 million hectare in 2006 to 17.5 million hectare in 1978 (Singh and Kumar 2013). The area susceptible to floods has been shown in Fig. 1. The chronic flood-prone basins are Ganga and Brahmaputra covering northern and north-eastern parts of the country. According to Das et al. 2009, during past few years the severity and intensity of floods have increased in various parts of country because of climate change (Singh and Singh 2011).

Floods mostly occur due to the extreme spatial and temporal variations in the rainfall pattern over the short monsoon period of 3–4 months, resulting in a very heavy discharge from rivers Ganga, Brahmaputra, Indian Peninsula rivers and their tributaries during this period (Pisharoty and Asnani, 1957; Nandargi, 1996, Rakhecha and Pisharoty 1996; Starkel et al., 1998; Kale, 2002; Kumar et al. 2005). In addition, inadequate capacity within river banks to contain high flows, silting of riverbeds, change in river course, poor natural drainage in the flood-prone area, dam break, improper management , sudden release of water during rainfall periods and glacial outbursts are other factors leading to the occurrence of floods (Dhar et al., 1975; Bhan 2001; Nandargi and Dhar, 2003, Mohapatra and Singh 2003). Exceptionally high floods have also occurred due to breaching of dams, e.g. the Machhu dam in Morvi town of Rajkot district in Gujarat breached on August 11, 1979, washing away about 1500 people, damaging 8000 houses completely and tremendous destruction of livestock, property and agriculture lands (IMD, 1979; Dhar et al., 1981; Singh and Kumar 2013). Collapse of Khadakwasala-Panshet dams in July 1961, in Pune is

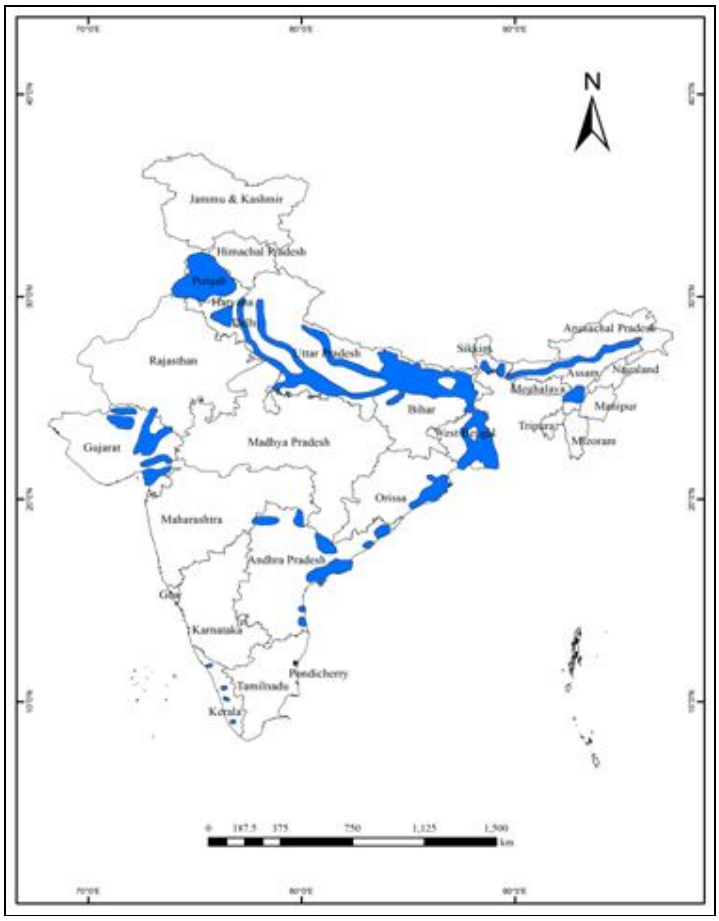


Figure 1: Flood prone map of India (2001).
Source: Mohapatra and Singh 2003.

another example of dams giving way due to heavy rush of flood waters (Dhar et al., 1980; Dhar and Nandargi, 2003). Anthropogenic activities are other factors of occurring floods. The widespread urbanization and consequential increase in built up area in cities causes increased flood water flow in the drains leading to floods especially in the streams near towns (Singh and Kumar 2013). Moreover deforestation and shifting cultivation in the catchment areas of rivers results in increased direct runoff and resultant floods. That's why these floods causes more damages in terms of loss of life, property, industry, agriculture, public utilities and economic activity than any other natural disasters in the country (Dhar and Nandargi, 2003; NDMA 2008). Floods also leave in their wake epidemiological threats, breakdown of social order, migration (temporary and permanent), spreading of diseases, change in ecosystem and a constant obstacle to the local development programs like as transport and communication. The water logged situation disrupts the whole crop cycle and production is severely affected. Many people become victims of water borne diseases like diarrhea, cholera, dengue and Japanese encephalitis, as the flood waters stagnate and the natural lines of drainage are disrupted due to construction of embankments, roads and other encroachments (Gupta et al., 2013).

Roughly, 30 million people in the country are affected by floods and more than 1,500 lives are lost each year, which accounts for about one-fifth of the global death count due to floods (Gupta et al. 2003; (CWC 2010, Singh and Kumar, 2013). Despite such a huge number of flood fatalities annually, no single study has presented a comprehensive spatial and temporal analysis of flood fatalities, injuries and damages for the country over a long period of time. However, the loss of life and damages associated with flooding has been studied from a nationwide perspective (Berz et al. 2001; Mitchell and Thomas 2001; Thomas and Mitchell 2001; Jonkman 2005; Jonkman and Kelman 2005; Bryant 2005; Ashley and Ashley 2008; Di Baldassarre et al. 2010; Diakakis et al. 2012).

The statistics show that floods have a large impact on human well-being on a global scale. As a direct consequences floods may be lead to economic damage and damage to ecosystem and historical and cultural values. Furthermore floods can lead to the loss of human life and other human health effects. In directly floods can cause the loss of economic and agricultural production and a decrease of socio-economic welfare. However, a study that analysis global statistics on damages caused by floods and their post hazards impacts is not yet found in the literature. Although every flood can be considered as a unique event with unique characteristics, Pattern may be observed when a large number of floods are studied. Therefore, to fill the research gap the present study has been taken to help in establishment of flood warning network and to set up proper flood management system and policies measures.

2. Objective of the Study

The foremost objective of the study is to draw attention to the trends of floods and related damages that have occurred in India from 1953 to 2011.

3. Data sources and reporting methods

At hand study is largely based on secondary data collected for the period of 1953 to 2011 from the published report of Water and Related Statistics of Water Resources Information Directorate, Central water Commission (CWC), New Delhi. The report available by CWC is only trustworthy and official sources of data in India for flood related studies. Based on the above record, simple statistical computation such as ratio between flood affected area and various damages ware made and subsequently information was summarized in the form of simple bar graphs with Microsoft based on spread sheet. The possible presence of any trend in the occurrence of damages in time can be useful to understand flooding and to protect lives and properties. Therefore, to determine yearly variations in different flood damages and the identification of the highest and lowest flood affected years, method of simple linear trends was adopted. For the better understanding of the observed trends in various flood damages (maximum, minimum, and averages) anomalies of annual average were also calculated.

4. Study Area

India is the seventh largest country of the world spreads over an area of 3.29 million km^2. The wealth and social wellbeing of its inhabitants mostly depend upon the traditional rainfall during the summer monsoon, which is not uniformly distributed over the Indian region and there are large seasonal as well as annual variations of rainfall in both space and time. Some regions get heavy to very heavy rainfall while others get little rainfall. This unequal distribution of monsoon rainfall is one of the major causes of floods in the Indian River basins, i.e. (a) Brahmaputra river basin (b) Ganga river basin (c) North-west rivers basin and (d) Central India and Deccan rivers basin. India's population is largely concentrated in these river basins and as a result, huge number of people and their livelihoods are badly affected. In recent times, flooding has claimed more lives than any other natural disaster in these basins. The area liable to floods in the country has been shown in Fig.1.

5. Damages due to Floods

Floods affect the millions of the people annually in the country and destroy their livelihood. It causes loss of life, damages to their land, home, crops, property and other things of public utilities. The sum of damage varies from year to year depending upon the magnitude of flood and size of flood affected area. The cumulative damages associated with floods in India during 1953 to 2011, are presented under:

5.1. Flood Affected Area

The area affected by floods each year for the second half of the last century and initial phase of the present century has been demonstrated in Fig. 2. It was observed that flood affected area in India exhibited a discernible decreasing trend with time and about 0.015 million hectare area per year decreased in the country. This is a significant finding because the results do not support the widespread belief that the floods in the country are progressively increasing. Flood affected area varied from year to year in the last sixty years and it was observed as low as 1.1 million hectare in 2006 and as high as 17.5 million hectare in 1978. The analysis further demonstrated that the number of years when the flood affected area was >10 million hectare was high during 1970s and 1980s and the year 1971, 1973, 1976, 1977, 1978, 1980 crossed the 10 million hectare landmark (Fig. 2). Moreover, flood affected area varied closely with the variation in the rainfall distribution in the country. In general, the years of excessive or high intensity rainfall had higher area under flood prone. Also, the deposition of silt and gravel in large quantities in the river channels is the major reason for higher flood affected area in the country. The flood affected area showed higher coefficient of variability (47%) during 1953-2011 period. About 426 million hectare area was observed to be flood prone in India during the study period and on an average more than half of the flood affected area is under agriculture (CWC, 2010). This amounted to substantial financial losses due to the submergence of standing crops. Jain et al. (2007) reported that the assessment of flood prone area is not done scientifically in India. Often higher figures are reported and the actual area submerged may reduce if a careful scientific assessment is carried out.

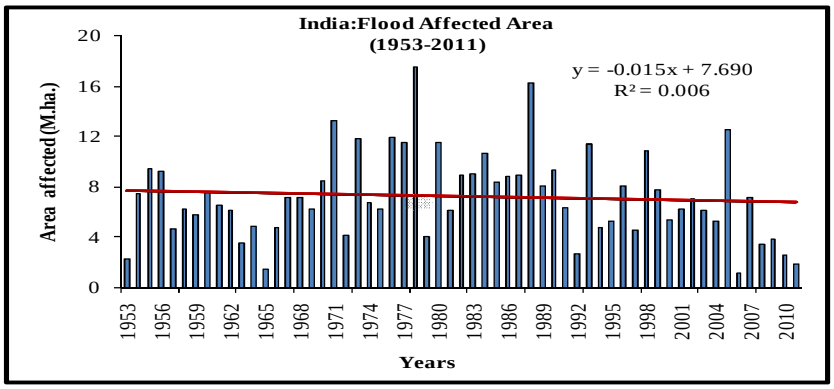


Figure: 2

5.2. Flood Affected Population

The number of people affected due to floods in India during 1953-2011 periods has been shown in Fig. 3. This figure exhibited large fluctuations in the flood affected population. The overall trend of flood affected population in the country is increasing with a slope of 0.31 million people per year. The increasing trend in the flood affected population in India is in agreement with those reported in World Water Development reports and the findings of the impacts of the global flood disasters reported by Jonkman (2005). Bihar has the highest number of flood affected people in India followed by Uttar Pradesh and West Bengal. Higher number of affected people in these states can be attributed to greater flood plain occupancy, high density of population and greater channel alterations by human structures (Rao, 1975; Chaphekar and Mhatre, 1985; Ives, 1988; Hofer, 1994). The total number of flood affected people in India during the study period is about 1913 million accounting to 32.5 million people per year. There is a high correlation (0.67) between flood affected area and the number of people affected. Also, a high coefficient of variability (52%) was observed annually in the number of people affected by floods. The flood affected population has risen from an average of 15 million in 1950's to about 30 million in the first decade of 21st century. The flood affected population in the country has increased substantially during 1970s and 1990s and the increase was observed more than 3 fold in comparison to previous decades, whereas it was observed to be 1.5 times in the last two decades of 20th and 21st centuries. The maximum flood affected population in country was observed in the year 1978 (70.5 million) while it was observed lowest in the year 1965 (3.6 million). Interestingly, the flood affected population has demonstrated a declining trend in India in recent years. This may be presumably attributed to improved flood forecasting technology and warnings issued well in advance by various flood controlling agencies in the country.

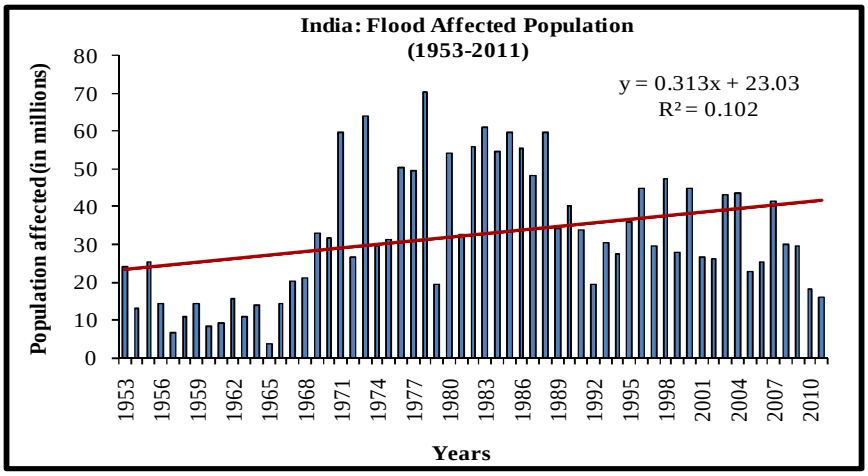


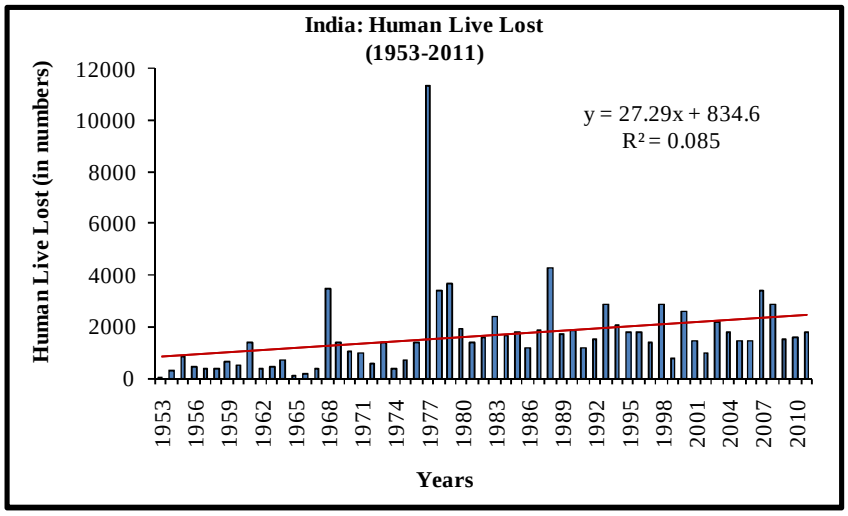
Figure: 3

5.3. Human Lives Lost

About 97551 human lives were lost due to flood disasters in India and this loss has progressively increased during 1953-2011 (Fig. 4). These results are in agreement with various other studies carried out in India (Rosenfeld, 1994; Kale, 1997) and it has been attributed to heavy impacts from deforestation, overgrazing and cultivation. A similar increasing trend in loss of human lives has been observed globally, in South Asia and Europe (Hoyois and Guha, 2003; Jonkman, 2005; Shrestha, 2008). This increase in flood related death toll has been attributed to improved information communication technology (ICT), leading to increase in reporting activities (Shreshtha, 2008). The impacts of population and economic growth, rapid urbanization, environmental degradation, and climate change are some of the factors that contribute to this increased trend (Shrestha, 2008). On an average about 1653 people died every year due to flood disaster in the country. There was unprecedented loss of lives in the year 1977 when 11316 persons lost their life due to floods followed by 1988 (4252), 1979 (3637), 1968 (3497), 1978 (3396) and 2007 (3389). The average death toll has increased more than five fold in the 21st century in comparison to the fifties, whereas it was observed about seven times during the decade of seventies of the twentieth century. The loss of lives was only 16 persons per million hectare of flood affected area in 1953 while it was observed as high as 1300 persons per million hectare of flood affected area in 2006.

5.4. Damaged Houses (Numbers and Value's)

Every year floods damage large number of houses and other buildings in India. The pattern of house damage in the country has been shown in Fig. 5 and it has also increased progressively



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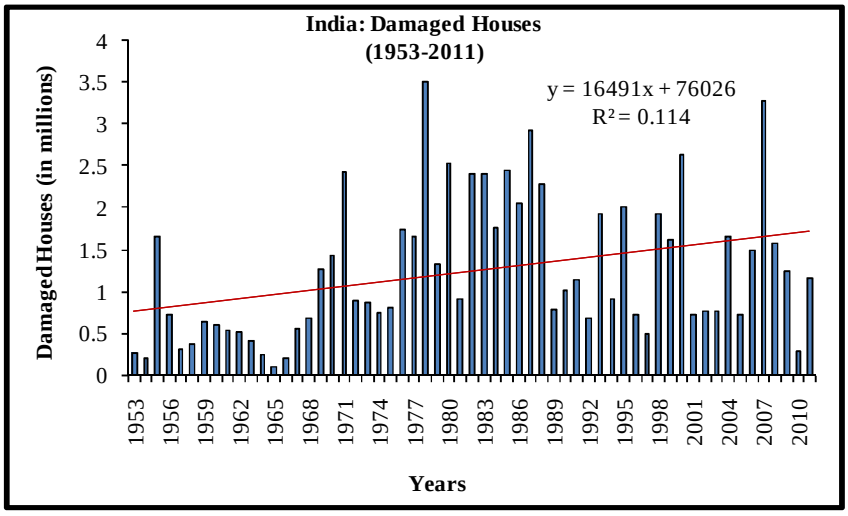


Figure: 5

during 1953-2011. The analysis revealed a loss of about 74045000 houses during the study period and on an average about 12.55 lakh houses were annually affected by flood. The minimum (1.13 lakh) and maximum (35.08) houses were damaged in 1965 and 1978, respectively. However, there is a high correlation (0.55) between damaged houses and area affected by the floods in India. The analysis revealed that the damage of houses due to floods in the country was more after 1980 and it is presumably attributed to urbanization process and increasing population. However, this damage can be minimized by developing advanced flood forecasting systems and by issuing early flood warnings in the country. When the damages of houses due to floods increase the value of damages to houses also increase. Fig. 6 shows the trend in the value of damages to houses due to floods in India. The value of damage to houses has increased since 1953. The total values of damaged houses during 1953-2011 were found to be Rs. 333.75 billions and the average is Rs. 5.65 billion per year. The year 2009 shows the highest value of damaged houses while 1965 has the lowest value. Also, it is revealed that there is increase in value of damages to houses subsequent to 1998 while in this period much of measures taken to control floods are adopted.

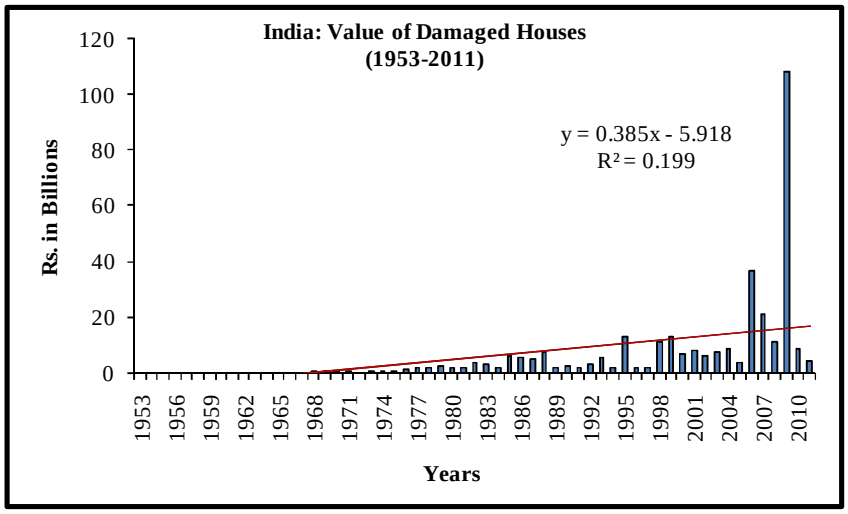


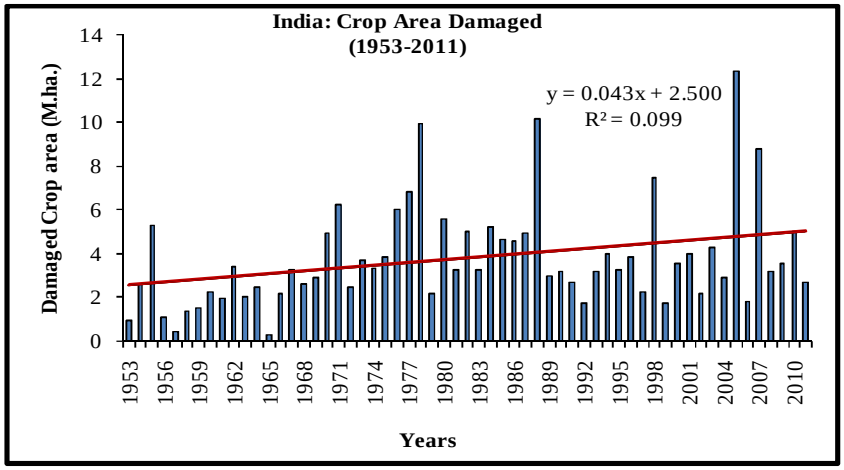
Figure: 6

5.5. Damage to Crops (Area and Value's)

Also, the flood disaster annually destroys the standing crops in India. The pattern of damaged crops with respect to area and value has increased during 1953-2011 (Fig. 7 and 8). Normally, floods in India destroy already matured or nearing maturity crops during the second half of monsoon season namely during the month of August and September when unprecedented rainfall occurs in the catchment areas. The total cropped area damaged during 1953-2011 was observed to be about 223 million hectare and the average is about 3.8 million hectare per year. A minimum of 0.27 million hectare land was affected due to floods during the year 1965 when the magnitude of flood was very low while the maximum during the year 2005 (12.3 million hectare), a year of moderate floods. The huge damage to crops in India can be attributed to poor structural measures undertaken in the floodplains of India. Moreover, there is a substantial flow reduction in most rivers of India due to impacts of climate change and construction of reservoirs and dams. This subsequently results in shrinkage of channel width and these abandoned channel portions were found rich in productive alluvial soils. Interestingly, to achieve high agricultural production, farmers tend to cultivate these alluvial soils once occupied by river. Therefore, causing severe damage to crops during the time of floods. Annually on an average crop of worth Rs. 11 billions per year (at 1993-94 prices) were damaged due to floods in India. The total value of damaged crops during the last sixty years was observed to be Rs. 660.09 billions. The highest crop loss of Rs. 73 billion was observed in year 2003 while it was found lowest in 1965 (Rs. 0.06 billion).

5.6. Loss of Livestock

Loss of livestock is also a common problem during floods in India. The loss of cattle demonstrated a discernible increasing trend during the study period (Fig. 9). Interestingly, loss of cattle due to floods increased till the year 1979 and subsequently in recent years it demonstrated a declining trend continuously. This can be attributed to better flood management planning and programmes undertaken towards flood control in the country. Furthermore, about 5696000 cattle were lost during the period of 1953 to 2011 and on an average about 97000 cattle were lost annually due to floods. The estimated loss of livestock was only 5000 in the year 1963 and 1964 while it increased up to 6, 18,000 in the year 1979 showing 120% variability. Analysis of livestock damages revealed a weak correlation (22 %) between the



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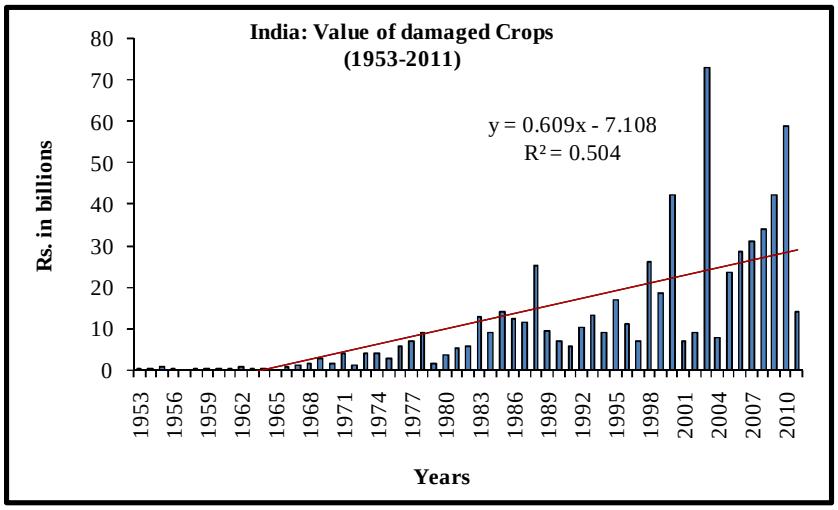

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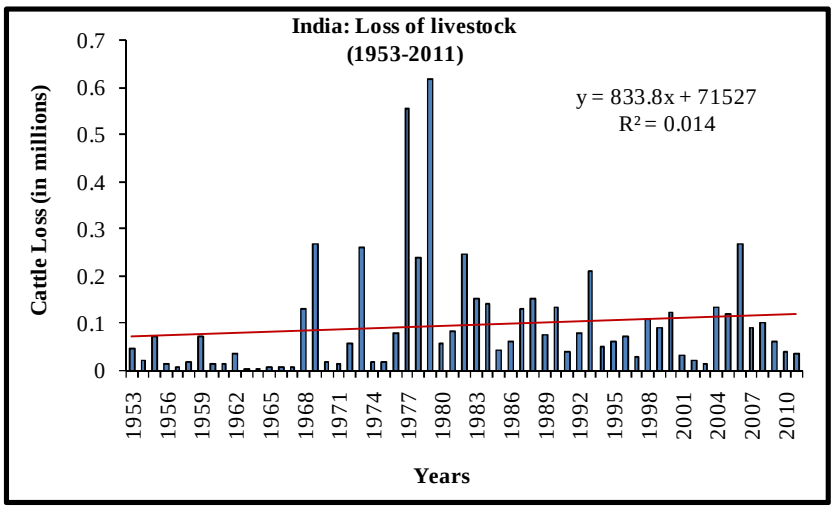


Figure: 9

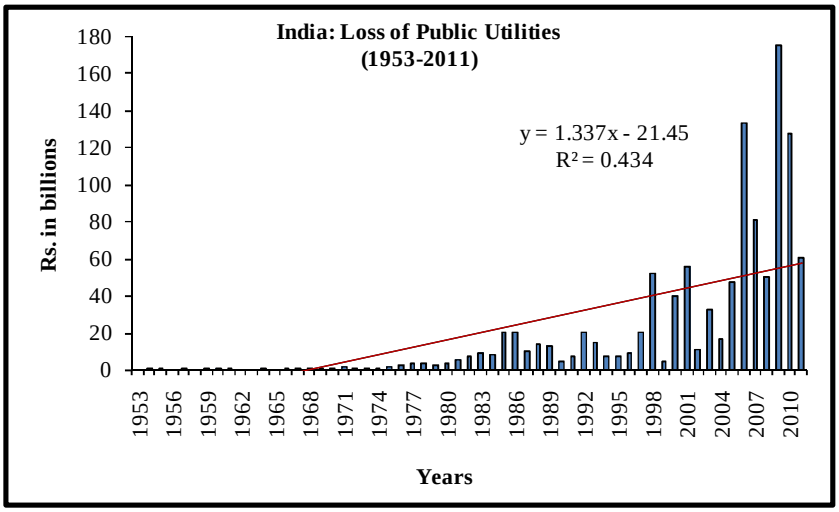
area, affected by floods and the loss of livestock. Such revelation may be anomalously attributed to under or over reporting of damages to livestock during various years. The under and over reporting of the loss of livestock is probably due to negligence, lack of awareness, bureaucratic hurdles and to gain the compensation (Sreekesh, 2009).

5.7. Damage to Public Utilities

When floods occur in India, it not only leads to the loss of human lives but also to infrastructure and utilities. The damage to public utilities such as rail, roads, telephone, electricity, industries etc. is very common during flood time in the country. During 1953-2011, the total damage of public utilities was reported to be about Rs. 1102 billions with an average of Rs. 18.7 billion per year. The maximum damage to public utilities in the country was observed in the year 2001 (Rs. 175 billion), while it was found lowest during the year 1962 (Rs. 0.01 billion). The damage to these utilities was found to be very low till the year 1980 and subsequently it enhanced exorbitantly (Fig. 10). The loss of public utilities after 1980 is primarily attributed to their expansion in the country.

5.8. Total Economic Losses

Every year flooding causes billions of rupees loss in India. The reported total damages due to floods have increased immensely since independence in the country (Fig. 11) and it can be attributed to huge investment and consequent expansion of various utilities to remote areas. The total damage loss during 1953 to 2011 was found to be about Rs. 2131.14 billion with an average of Rs. 36.12 billion per year. Maximum loss of Rs. 325.54 billion was observed in the year 2009, whereas it was reported to be lowest in the year 1965 (Rs. 0.07 billion). Substantial losses due to floods have been observed to public utilities, houses and crops. In addition, floods also affect the social life in the flood affected areas. Floods lead to seasonal and permanent migration of people from affected areas in search of alternative livelihood options. Also, it temporarily or permanently displaces the people from their native place to temporary settlements or resettlement colonies and makes them environmental refugees. Moreover, it increases the disparities among the different sections of the society and deprives them of opportunities of growth.



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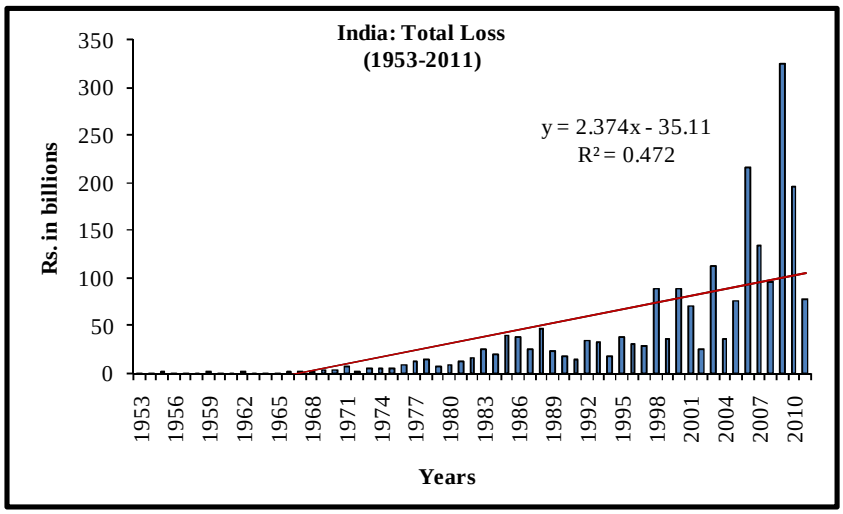

Figure: 11

5.9. Conclusion

Floods have been occurring in India since the past several hundreds of years and causing damage to life and property. On an average about 1653 people died every year due to flood disaster in the country during 1953-2011. Annually, it affected about 32.5 million people and inundated about 7.2 million hectare of land. Nearly half of the affected area is under agriculture and average crop loss is about 11 billion per year (at 1993-94 prices). Besides, it also caused damages to houses, livestock and public utilities. In addition, almost all damages due to floods have exhibited an increasing trend since independence. The only logical explanation to the fact is that the concentration of the population in the most flood prone areas has increased remarkably in recent years and the water-carrying capacity of the rivers has been affected by haphazard development along the rivers. An increase in flood events and flood related human fatalities is attributable to population increase, urban expansion, enhancement of means of reporting and recording disasters through information communication technology, increased social and media interest and increased human interference in the hydrological processes through the expansion of public works, road network etc. However, a slight respite has been observed in damages due to floods in recent years and anomalously it can be attributed to changing rainfall pattern due to recent climatic changes and execution of various structural (embankments, flood walls, channel improvement, diversion of flood waters) and non-structural measures (flood proofing, forecasting, warning systems, rescue services) in river basins of the country.

To sum up, floods have occurred in the past and will continue to occur in future as well. It is neither possible to totally stop floods nor to completely eliminate the flood damages. However, it is possible to minimize the severity of the impact and damage potential by river friendly and multi-pronged measures that are based on the scientific understanding.

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