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Research Article

ANNUAL AND DECADAL TREND OF HUMAN RISK OF FLOOD HAZARDS IN INDIA

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ABSTRACT

Introduction: Flood is a frequent and most destructive hazard in India. It is a recurrent phenomenon, which cause huge loss of lives and damage to livelihood systems, property, infrastructure and public utilities. It has large social consequences for communities and individuals.
Objective: In this study, events and human deaths due to flood hazards in India have been discussed in terms of their annual as well as decadal trend for last 40 years.
Methodology: Data of events and human deaths of flood hazards have been analyzed using secondary data of 1975–2014. Data were collected from the website of National Disaster Management Authority, New Delhi.
Results: Out of 40 years, flood has39 years with casualty. Median (IQR) of flood events and human deaths were 5 (3-6) and 1194 (581-2015). Kruskal Wallis H test revealed that there was significance increasing trend in flood events ($p<0.05$) while insignificant change in human deaths ($p>0.05$) over the decades.
Conclusion: In India, despite many preventive measures for floods, its annual, as well as decadal human deaths are still high. Planning for long term sustainable development in flood prone areas and increasing coping capacity of the people are most important ways of reducing human vulnerability and risk.

INTRODUCTION

India is one of the most disaster prone countries in the world. Due to its specific location, it is frequently affected by many hazards and disasters. Flood is the most common natural disaster in India**[1].** India is highly vulnerable to flood. Out of the total geographical area, around 12.2% is flood prone. Flood is a recurrent phenomenon, which cause huge loss of lives and damage to livelihood systems, property, infrastructure and public utilities **[2].**The immediate impacts of flooding include loss of human life, damage to property, destruction of crops, loss of livestock, and deterioration of health conditions owing to waterborne diseases are just some of the ways a flood can impact upon a community. India witnesses floods almost every year, usually due to excessive rain. A flood is an overflow of water that submerges land which is usually dry**.** Flooding occurs when overflow of water from water bodies, such as a river, lake, or ocean, in which the water overtops or breaks levees, resulting in some of that water escaping its usual boundaries**[3].** Massive flooding can often have a devastating impact on the economy of a region and the livelihood of its people. It has large social consequences for communities and individuals **[4].**

Till the date, in developed countries, human deaths due to flood hazard and disaster, reduced significantly while in developing countries, where socioeconomic and demographic factors are poor, the major challenge is to reduce deaths **[5, 6].** In this study, flood events and associated human deaths have been discussed for last 40 years using secondary data.

Objective

There are two main objectives in this study,

1. Discussion about number of flood events and human deaths by floods during the last 40 years.
2. Comparison of decadal events/human deaths of floods in the last 40 years.

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MATERIALS AND METHODS

In this cross-sectional study, data were collected for flood hazards for the period of 1975–2014 (i.e.40 years), from the website of National Disaster Management Authority, New Delhi. www.ndma.gov.in.[2]. Data of the flood hazards and disasters, annually/decadal have been presented by tables, statistical diagrams i.e.line diagram, box plot and bar diagram. The bar diagram has been used to show the moving average of decadal human deaths over the decades. Descriptive statistics including mean, standard deviation (SD), median, inter-quartile range (IQR), minimum and maximum have been used to describe the data. As flood events and human deaths are discrete data, non-parametric methods have been used to compare the decadal events and human deaths. Kruskal Wallis H test was used to compare the mean ranks of events / human deaths among the four decades. Mann Whitney U test was used to compare the mean ranks between the decades in case; Kruskal Wallis H test was found significant. Minimum, 95% of confidence interval and $p<0.05$ have been considered to be statistically significant. Statistical Package for Social Sciences version 22 (SPSS-22, IBM, Chicago, IL, USA) has been used to analysis of the data.

RESULTS

In this study, data of human casualty of flood hazard and disaster was analyzed for last 40 years. Of 40 years, floods were reported in the 39 years.

During the years, total 237 flood events were recorded with mean (±SD) and median (IQR) was 5.6(±3.8) and 5(3-6) (table 1).

Minimum 1 event was occurred in the year of 1975&1981 while maximum 17 events occurred in the each year of 2005 &2006 (figure-1). During the first 25 years (1975-1999), most of the years (22), flood events was ≤5 and rest of the 15 years (2000-2014), except one year it was ≥ 6(figure-1).

In decadal flood events, median (IQR) was also showing increasing trend since first decade 2(1.5-4.5) to fourth decade 7.5(6-16.3) (figure-2). Kruskal Wallis H test was used to compare the mean ranks of flood events among the four decades. Result shows that there was a statistically significance difference among the mean ranks ($p<0.05$) (table 1). Mann Whitney U test indicated that there were significance difference in mean ranks of flood events between the decades of 1^{st}&3^{rd}, 1^{st}&4^{th}, 2^{nd}&4^{th} and 3^{rd}&4^{th} ($p<0.05$)(table 1).

During the years, total 53673 human deaths were reported with mean (±SD) and median (IQR) was 1376 (±1199) and 1194 (581-2015) (table 2). Minimum 224 human deaths were occurred in the year of 1990 while maximum 6453 human deaths were reported in the year of 2013(table 2, figure-3). Mean human deaths during the first 25 years (1975-1999) was 1262(±934) and rest of the 15 years (2000-2014), it was 1721(±1777) (figure-3). Similarly decadal mean human deaths were also showing increasing trend since 1^{st} decade (1244) to 4^{th} decade (1712) (table 2, figure-4). Kruskal Wallis H test was used to compare the mean ranks of human deaths among the decades. Result shows that there was no statistically significance difference among the mean ranks ($p>0.05$) (table 2).

Table 1 Descriptive Statistics of the Flood Events (1975-2014)

Duration	1975-2014	1975-1984 (1^{st} decade)	1985-1994 (2^{nd} decade)	1995-2004 (3^{rd} decade)	2005-2014 (4^{th}decade)
N	217	26	41	53	97
Mean ± SD	5.6±3.8	2.9±1.6	4.1±1.8	5.3±2.1	9.7±4.9
First Quartile	3	1.5	2.8	3	6
Second Quartile (Median)	5	2	4	6	7.5
Third Quartile	6	4.5	5	6	16.25
Minimum	1	1	2	2	5
Maximum	17	5	8	9	17
Flooding years	39	9	10	10	10
Mean Ranks		9.72	15.35	22.15	31.75
Kruskal Wallis Test		Chi square value =20.32, p <0.001			
Mann Whitney U test		Between the decades of 1^{st}& 3^{rd}, 1^{st}&4^{th}, 2^{nd}&4^{th} and 3^{rd}& 4^{th} ($p<0.05$).			

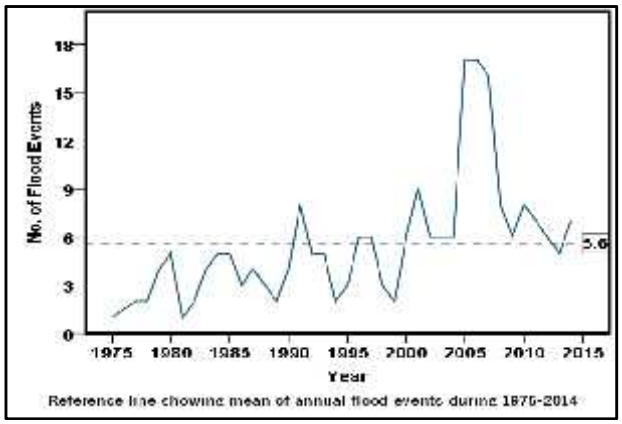

Figure 1 Distribution of annual flood events during 1975-2014

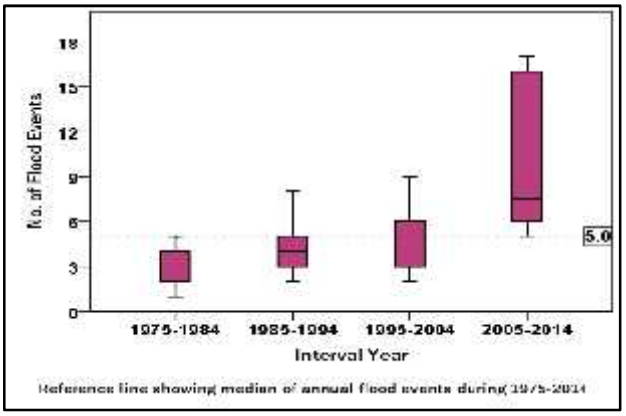

Figure 2 Distribution of decadal flood events during 1975-2014

Table 2 Descriptive Statistics of the Flood Human Deaths (1975-2014)

Duration	1975-2014	1975-1984	1985-1994	1995-2004	2005-2014
N	53673	11194	12314	13049	17116
Mean ± SD	1376±1199	1244±1413	1231±657	1305±714	1712±1783
First Quartile	581	452	687	574	619
Second Quartile (Median)	1194	740	1306	1320	1347
Third Quartile	2015	1671	1746	2097	2071
Minimum	224	253	224	452	279
Maximum	6453	4610	2100	2357	6453
Flooding years	39	9	10	10	10
Mean Ranks		16.44	20.40	21.20	21.60
Kruskal Wallis Test			Chi square value =1.20, p =0.754 (p>0.05)		

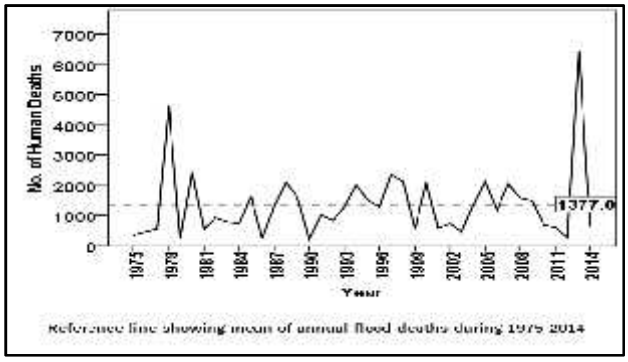

Figure 3 Distribution of annual flood human deaths during 1975-2014

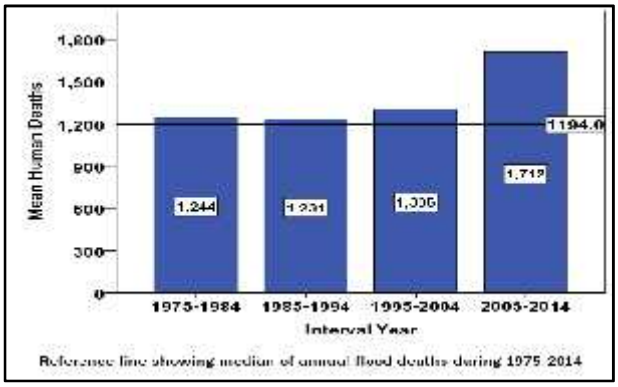

Figure 4 Distribution of decadal flood human deaths during 1975-2014

CONCLUSIONS

In India, despite many preventive measures for floods, its annual as well as decadal events and human casualties are showing increasing trend during 1975-2014. When we see the flood events, in recent 10 years, it was increased dramatically with around 10 events per year which was approximately 2.5 times with annual mean events (around 4) in first 30 years. Similar trend was observed for human deaths. In recent 10 years, it was around 1721 human deaths per year which was approximately 1.5 times with annual deaths (1262) in rest 30 years. Conclusively, data of the floods, showing significant increasing trend in events over the four decades ($p<0.001$) while insignificant increasing trend in human deaths over the four decades ($p>0.05$).

Flooding occurs naturally; however, some floods are extreme and we must reduce their severity and impacts. There is a need to focus on flood disaster mitigation through minimize the flood incidences **[7].** A warning system can help to reduce the probability of risk in flooding. People in threatened areas need to be warned in time for a flood so that they can bring themselves, their livestock, pets and valuables to safety **[8].** A flood mitigation plan should be developed based on an integrated approach covering all relevant aspect of water management. The need of time is to strengthen pre disaster planning, on disaster and the post disaster responses in making the policies and preparedness and emergency arrangement.

Many studies revealed that socioeconomic variables which are much more responsible for increasing or decreasing vulnerability and risk, can reduce the human risk **[5, 7, 9, 10].** A study "Okayo *et al.* (2015)" revealed that high level of uptake of precautionary measures was significantly associated with factors like closeness of house to river, level of income, marital status, occupation, household composition, social organization type ($p<0.05$)**[11].** Human risk reduction should be minimize through increasing coping capacity of the people because improving coping capacity of the people is generally recognized as one of the most important ways of reducing vulnerability**[5].** Improved warning and evacuation systems have cut the death toll of disasters. The key is to identify the users of early-warning information and the most efficient way to reach them with credible information to enhance their decision-making process **[5,6].**

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