Geographical Evaluation on Flood Hazards and Its Control with Focus to Jalpaiguri District, West Bengal

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Abstract: *Flooding is among the most prevalent and devastating natural disasters impacting human cultures globally. It arises from extreme precipitation, river inundation, storm surges, dam failure, quick snowmelt, and unregulated urban development. Flood hazards inflict significant harm on life, property, agriculture, infrastructure, and the environment, resulting in displacement, health crises, and economic instability. Efficient flood management necessitates comprehensive watershed planning, sustainable land-use strategies, advanced monitoring technologies and robust institutional collaboration. Public knowledge, community engagement and policy execution are essential in mitigating flood hazards.In this article, geographical evaluation on flood hazards and its control with focus to Jalpaiguri district, West Bengal has been discussed.*
Keywords: *Flood, Hazards, Control, Jalpaiguri District.*

I.   Introduction

Floods rank among the most prevalent and devastating natural disasters impacting human societies globally. A flood transpires when water inundates terrain typically devoid of moisture, generally as a result of extreme precipitation, river overflow, coastal storm surges, quick snowmelt, or dam failure. Floods represent a substantial percentage of global disaster occurrences, resulting in extensive fatalities, property destruction, agricultural devastation, and disruption of infrastructure and livelihoods (Chakraborty, S. & Mukhopadhyay, S., 2019).

Floods are a persistent occurrence attributed to monsoonal precipitation patterns, extensive river systems, and diverse topography. Significant rivers are susceptible to annual inundation, impacting millions of individuals. Accelerated urbanization, deforestation, encroachment upon floodplains, insufficient drainage systems, and climate change have exacerbated the frequency and intensity of flooding disasters (Simonovic, S.P. et al., 2020).

Flood dangers can be classified as riverine floods, flash floods, coastal floods, and urban floods. Riverine floods come from extended precipitation and river overflow; flash floods are the consequence of severe, short-duration rainfall; coastal floods are induced by cyclones and storm surges; and urban floods stem from inadequate drainage and unregulated urban development. Climate warming has exacerbated flood risks due to heightened extreme precipitation events and elevated sea levels (Wahid, A. et al., 2021).

Structural interventions, including embankments, dams, levees, and reservoirs, were the principal techniques employed for flood control. Nonetheless, it has become apparent that structural reforms alone are inadequate. Today's flood management approaches focus on a complete plan that combines building structures like dams and levees with other methods, such as early warning systems, land use planning, managing watersheds, planting trees, raising community awareness (Adeyemi, G.A. et al., 2021).

The context of flood hazards and their management indicates a transition from reactive disaster responses to proactive risk mitigation and sustainable water resource management. Comprehending the origins, patterns, and effects of floods is crucial for formulating effective mitigation and adaptation strategies to diminish vulnerability and bolster resilience in flood-prone areas (Mohanty, M.P. et al., 2020). The objective of the study was to geographical evaluation on flood hazards and its control with focus to Jalpaiguri district, West Bengal has been discussed.

II.   Research Methodology

Research methodology enables a researcher to explain the study approach to be used for the study. This methodology can be used in a systematic and logical way to try to answer a specific research question.

Study Area: Jalpaiguri district, West Bengal, India.

Hypotheses:
Hypothesis 1 ($^0H_1$): The flood hazards correlated to the Jalpaiguri District, West Bengal.
Hypothesis 2 ($^0H_2$): The flood control exposure correlated to the Jalpaiguri District, West Bengal.

Variables:

Dependent variables included age, gender, monthly income, caste, occupation, religion & independent variables included control, flood, hazards.

Research Design:

The research design defined the strategies that was investigate to introduce about research questions. The quantitative research design analyzed the data through numbers and big sample sizes. In this study, quantitative research design was used.

Primary Data:

Primary data is the data which is generated an individual researcher by way of his or her own observation or experience.In this research, primary data has been used.

Sampling Plan:

A sampling plan provides the framework to conduct research. In simple random sampling every individual gets an equal chance of being selected count. In this research, simple random sampling has been used.

Sample Size:

Here, as per above calculation, the sample size was 501.76 (for 98.75% confidence level). So, in this study the sample size was taken 500 due to permissible limit of fractional value. Out of 500, 250 male and 250 female respondents were taken for this study.

Methodology:

Questionnaires were distributed among respondents in the Jalpaiguri district of West Bengal after clearing the research objectives. They were provided with enough time in order to fill in the sheet statements and the sheet was collected from individual respondent for data analysis and interpretation.

Research Tools:

Structured Questionnaires (5 Point Likert Scale):

The most typical method for survey research is a systematic questionnaire. In survey research, a five-point Likert scale is frequently employed to gauge to what extent participants agree or disagree with a given statement [Note: Strongly Agree (SA): 5 points, Agree (A): 4 points, Neutral (N): 3 points, Disagree (D): 2 points, Strongly Disagree (SD): 1 point]. The following research tools were used:
➢ Flood Hazards Exploration Scale
➢ Scale of Flood Control Exposure
In this study, the structured questionnaires (5 Point Likert Scale) were used.

Data Analysis and Interpretation:

Data analysis is involving a number of statistical methods to describe, visually represent, summarize, and find patterns and evaluate a given set of information. It applies in both situations whether the data in the study is at the raw level, or in the case of an analytic study, the data is processed. Data interpretation is the assessment of the information by using one or more techniques to arrive at a conclusion. Pie chart is composed of several divisions and sections. In this research, pie charts have been used.

III. Data Analysis, Interpretation, Results And Discussion

(a) Personal Profile:

Table 1. Gender:

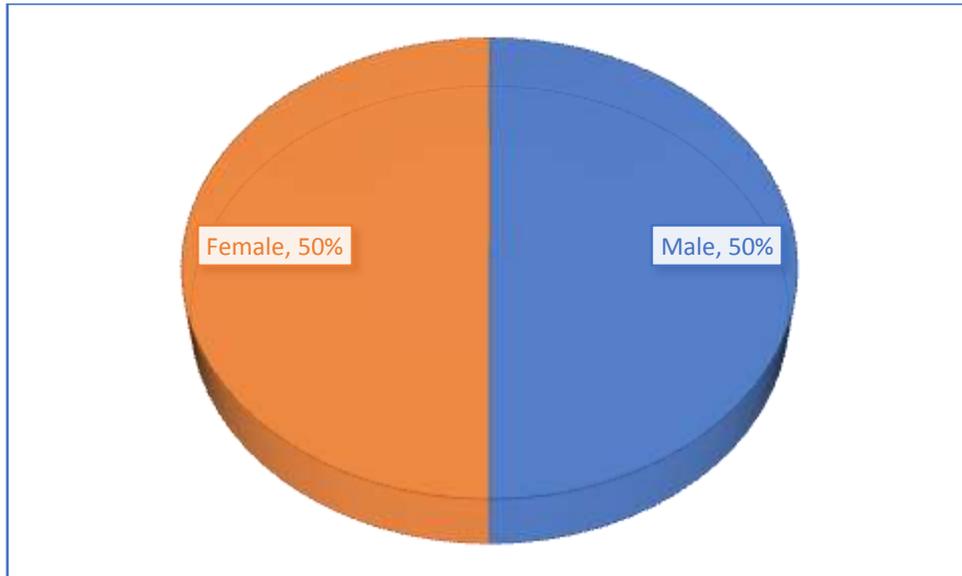| Options	Respondents	%
Male	250	50
Female	250	50
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure1. Gender (%)

From the above table & figure, it was found that the % of respondents were Male: 50% &Female: 50%.

Table 2. Age (in years):

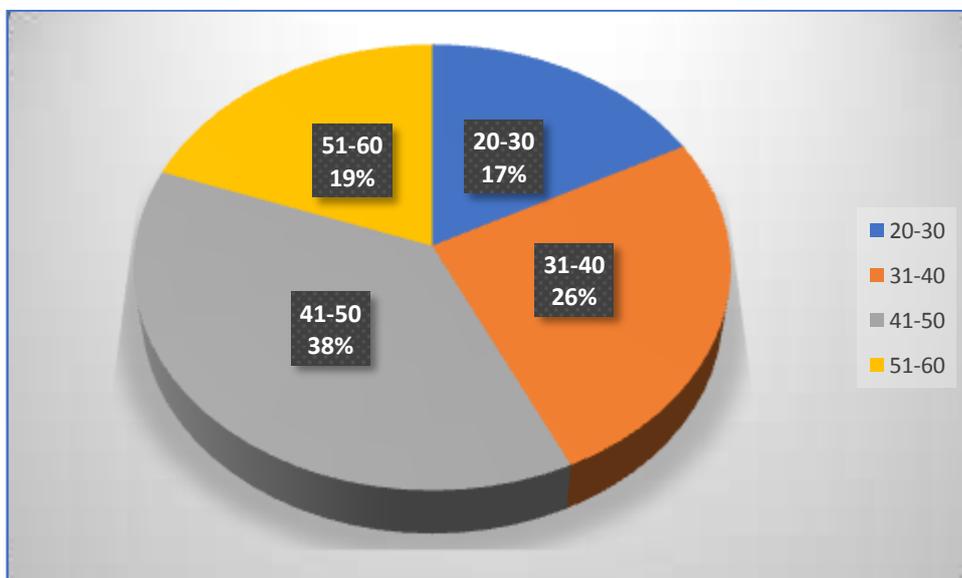| Options	Respondents	%
20-30	86	17.2
31-40	129	25.8
41-50	188	37.6
51-60	97	19.4
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure 2. Age (in years) (%)

From the above table & figure, it was found that the % of respondents were 20-30 years: 17.2%, 31-40 years: 25.8%, 41-50 years: 37.6%, 51-60 years: 19.4%.

(b) Flood Hazards Exploration:

Table 3. Loss of human life:

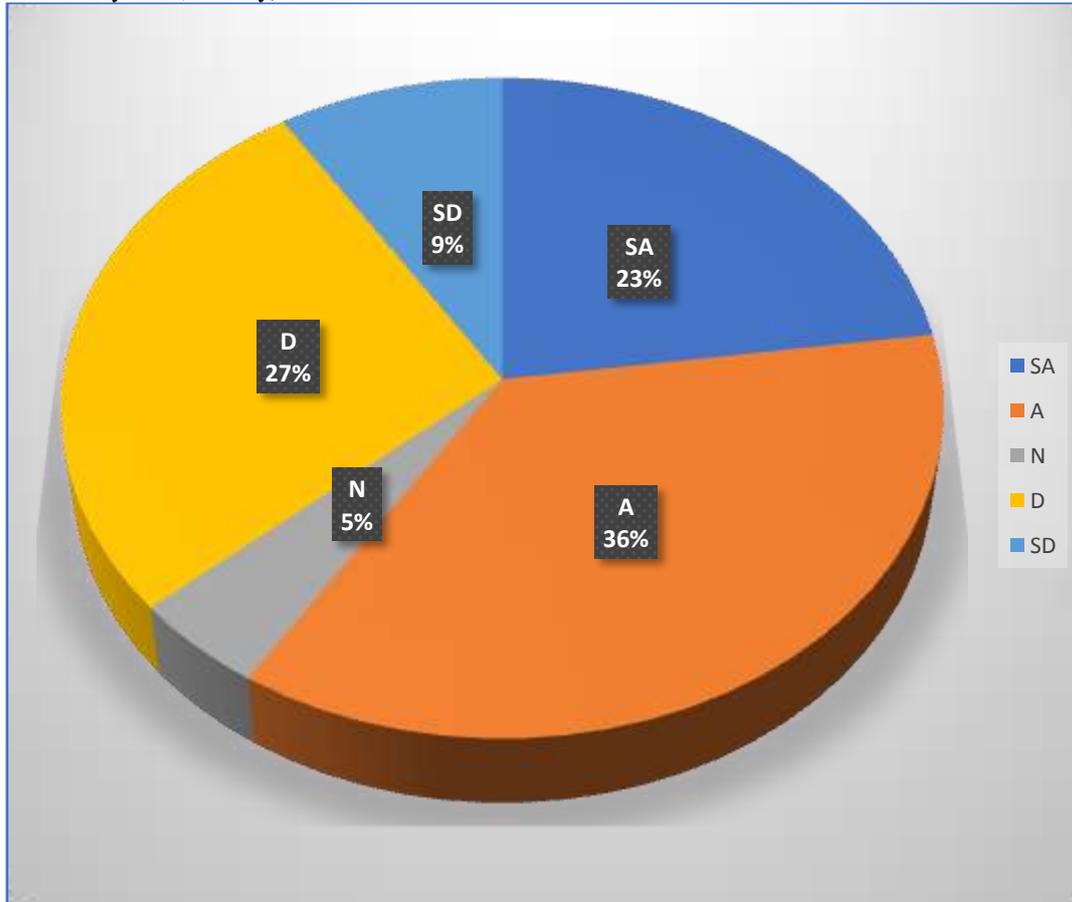| Options	Respondents	%
SA	114	22.8
A	181	36.2
N	23	4.6
D	137	27.4
SD	45	9
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure 3. Loss of human life (%)

From the above table & figure, it was found that the % of respondents were SA: 22.8%, A: 36.2%, N: 4.6%, D: 27.4%, SD: 9%.

Table 4. Damage to property:

Options	Respondents	%
SA	118	23.6
A	139	27.8
N	27	5.4
D	117	23.4
SD	99	19.8
Total	**500**	**100**

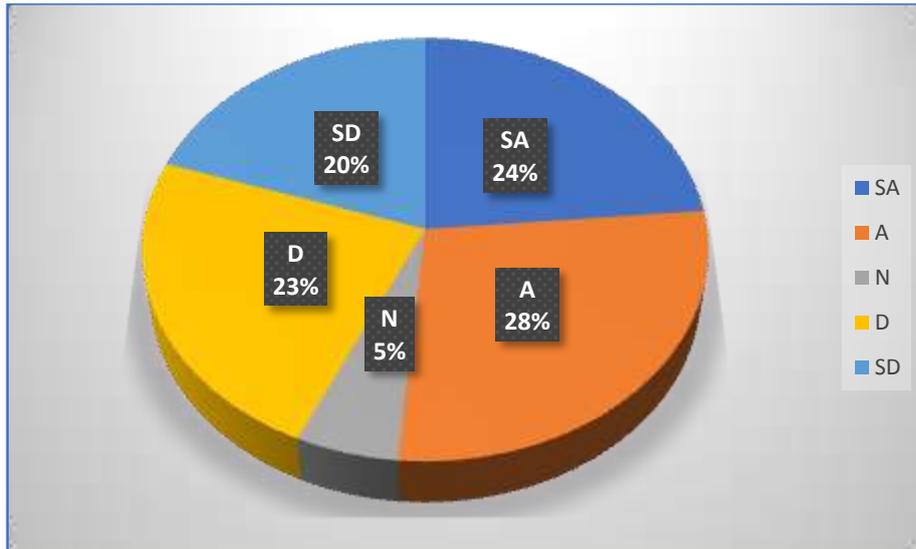(Source: Primary Data, Survey)

Figure 4. Damage to property (%)

From the above table & figure, it was found that the % of respondents were SA: 23.6%, A: 27.8%, N: 5.4%, D: 23.4%, SD: 19.8%.

Table 5. Destruction of crops:

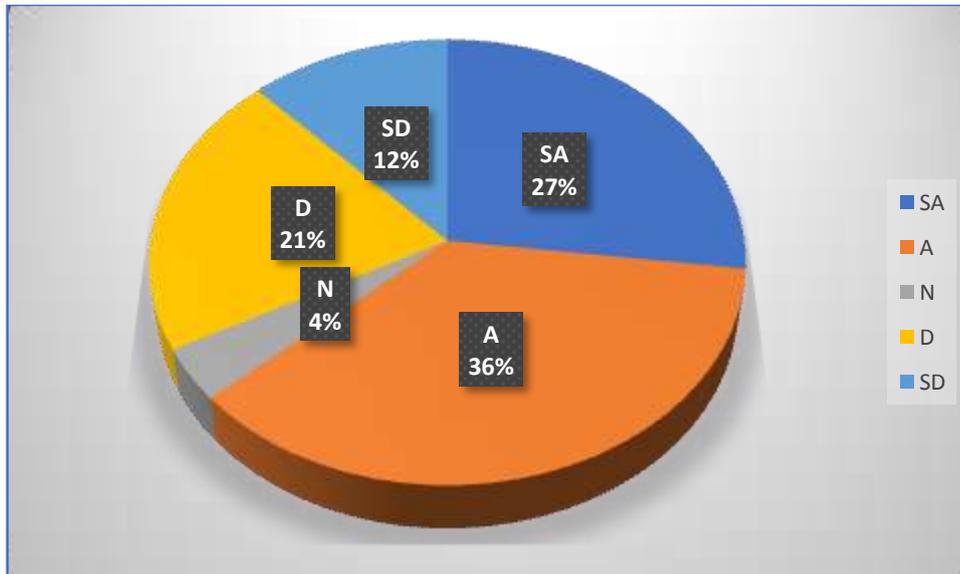| Options	Respondents	%
SA	135	27
A	182	36.4
N	19	3.8
D	104	20.8
SD	60	12
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure 5. Destruction of crops (%)

From the above table & figure, it was found that the % of respondents were SA: 27%, A: 36.4%, N: 3.8%, D: 20.8%, SD: 12%.

Table 6. Floodwaters can concentrate garbage, debris, and toxic pollutants:

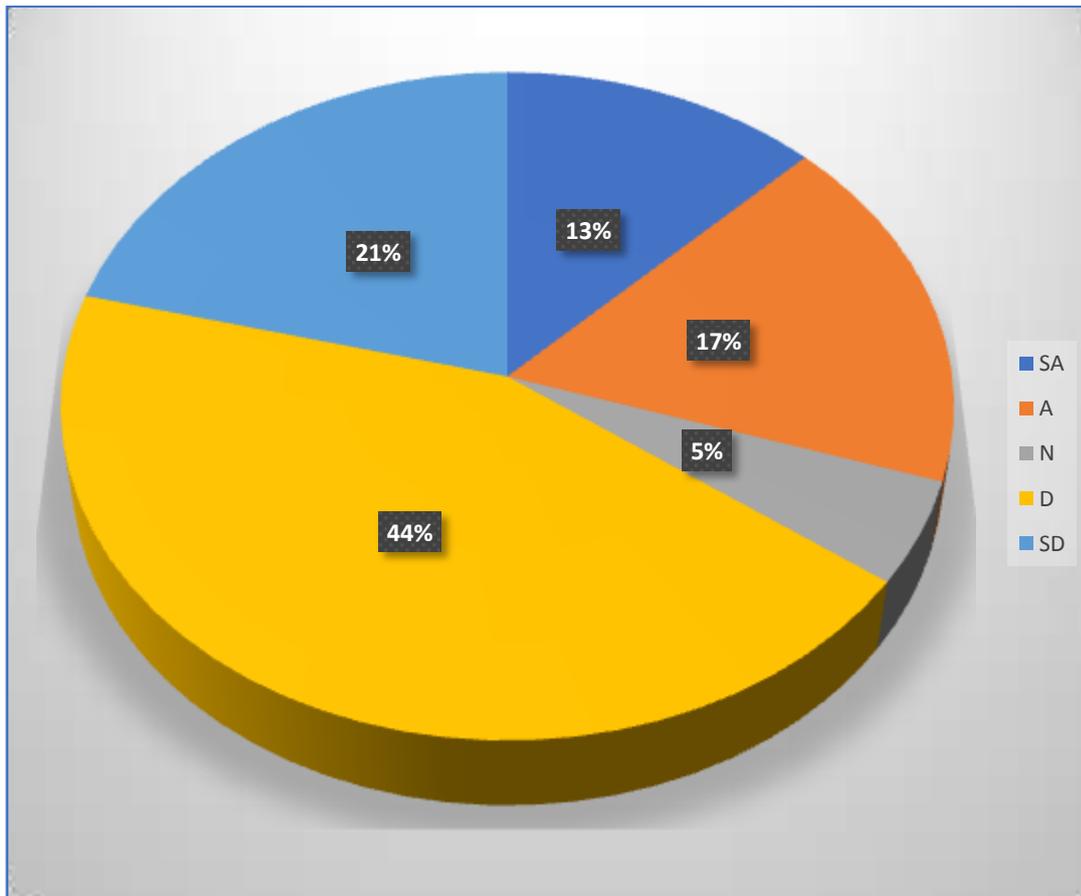| Options	Respondents	%
SA	63	12.6
A	87	17.4
N	25	5
D	220	44
SD	105	21
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure 6. Floodwaters can concentrate garbage, debris, and toxic pollutants (%)

From the above table & figure, it was found that the % of respondents were SA: 12.6%, A: 17.4%, N: 5%, D: 44%, SD: 21%.

Table 7. Polluted Drinking water:

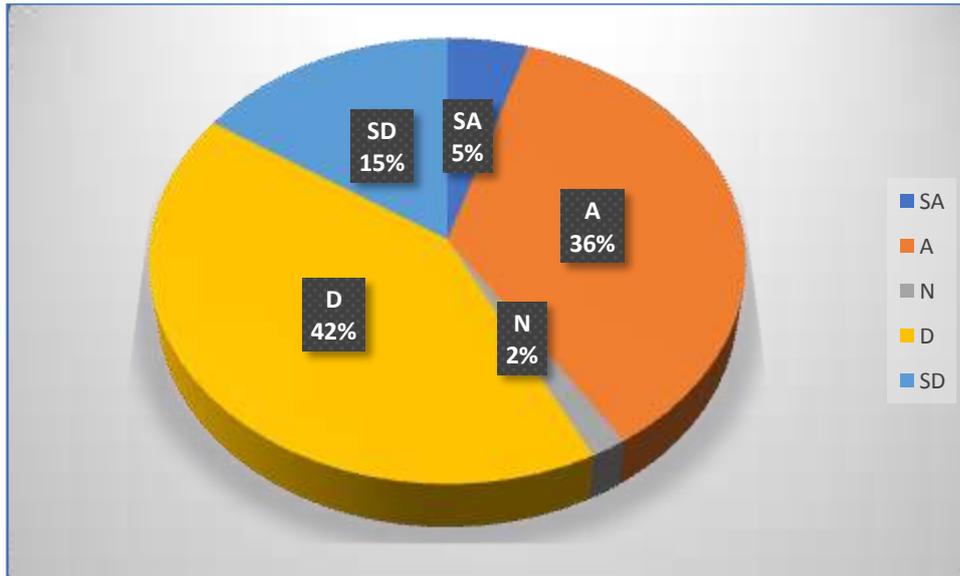| Options	Respondents	%
SA	24	4.8
A	180	36
N	9	1.8
D	209	41.8
SD	78	15.6
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure 7. Polluted Drinking water (%)

From the above table & figure, it was found that the % of respondents were SA: 4.8%, A: 36%, N: 1.8%, D: 41.8%, SD: 15.6%.

So, from the above it can be stated that the "Hypothesis 1 ($^0H_1$): The flood hazards correlated to the Jalpaiguri District, West Bengal" has been accepted.

(c) Flood Control Exposure:

Table 8. Implementation of the flood plain zoning approach as mandated by the Ministry of Jal Shakti:

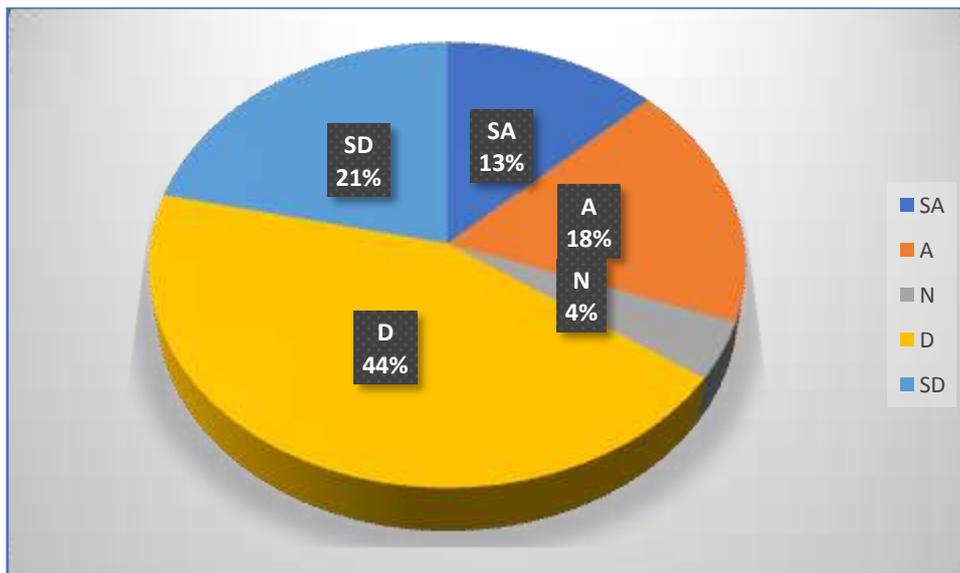| Options	Respondents	%
SA	64	12.8
A	89	17.8
N	21	4.2
D	219	43.8
SD	107	21.4
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure 8. Implementation of the flood plain zoning approach as mandated by the Ministry of Jal Shakti (%)

From the above table & figure, it was found that the % of respondents were SA: 12.8%, A: 17.8%, N: 4.2%, D: 43.8%, SD: 21.4%.

Table 9. Scientific research for modernization in the collection of hydrometeorological data, flood forecast formulation & forecast dissemination:

Options	Respondents	%
SA	54	10.8
A	78	15.6
N	6	1.2
D	225	45
SD	137	27.4
Total	**500**	**100**

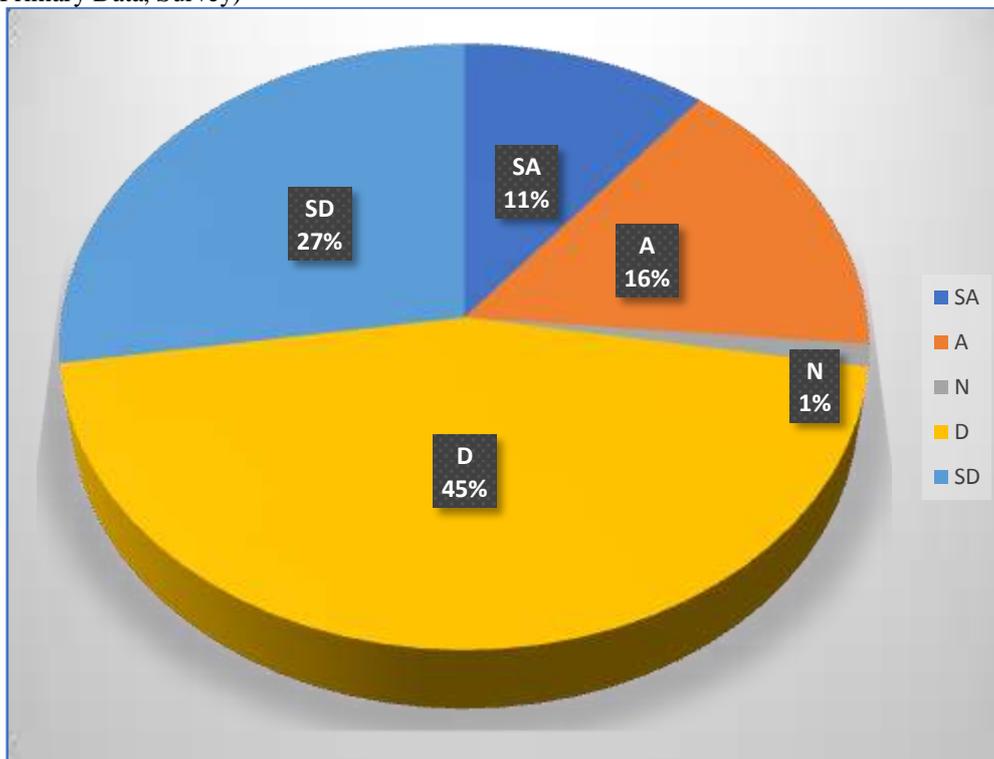(Source: Primary Data, Survey)

Figure 9. Scientific research for modernization in the collection of hydrometeorological data, flood forecast formulation and forecast dissemination (%)

From the above table & figure, it was found that the % of respondents were SA: 10.8%, A: 15.6%, N: 1.2%, D: 45%, SD: 27.4%.

Table 10. Use of space technology is essential for exposure of flood control:

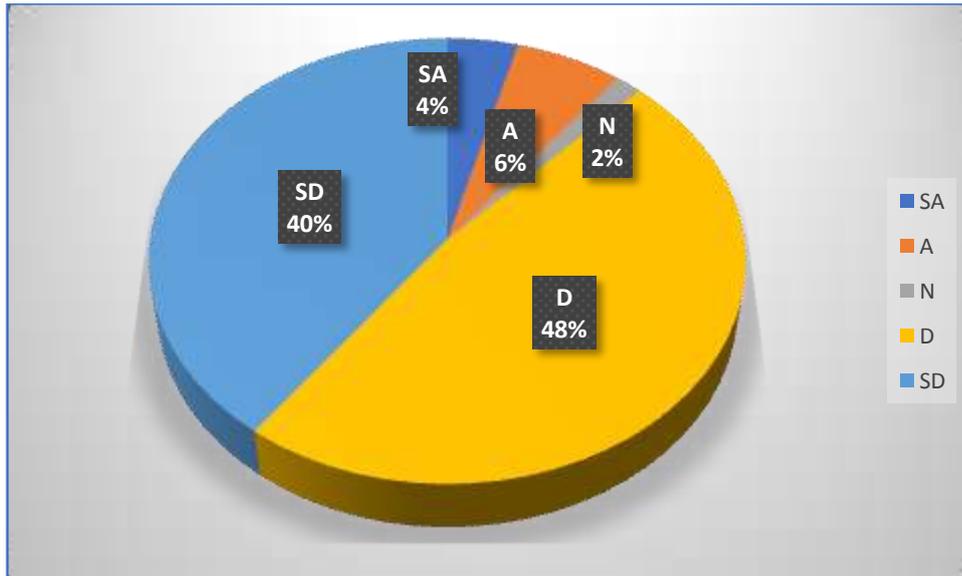| Options	Respondents	%
SA	21	4.2
A	32	6.4
N	8	1.6
D	240	48
SD	199	39.8
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure 10. Use of space technology is essential for exposure of flood control (%)

From the above table & figure, it was found that the % of respondents were SA: 4.2%, A: 6.4%, N: 1.6%, D: 48%, SD: 39.8%.

Table 11. The construction of large storage reservoirs that moderate flood peaks:

Options	Respondents	%
SA	72	14.4
A	86	17.2
N	23	4.6
D	176	35.2
SD	141	28.2
Total	**500**	**100**

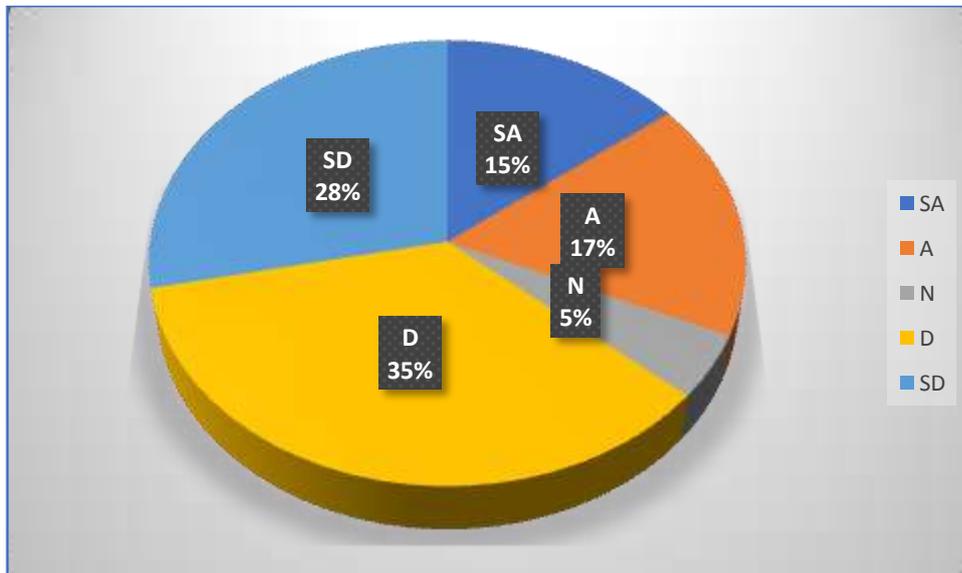(Source: Primary Data, Survey)

Figure 11. The construction of large storage reservoirs that moderate flood peaks (%)

From the above table & figure, it was found that the % of respondents were SA: 14.4%, A: 17.2%, N: 4.6%, D: 35.2%, SD: 28.2%.

Table 12. The anti-erosion works have been exposed:

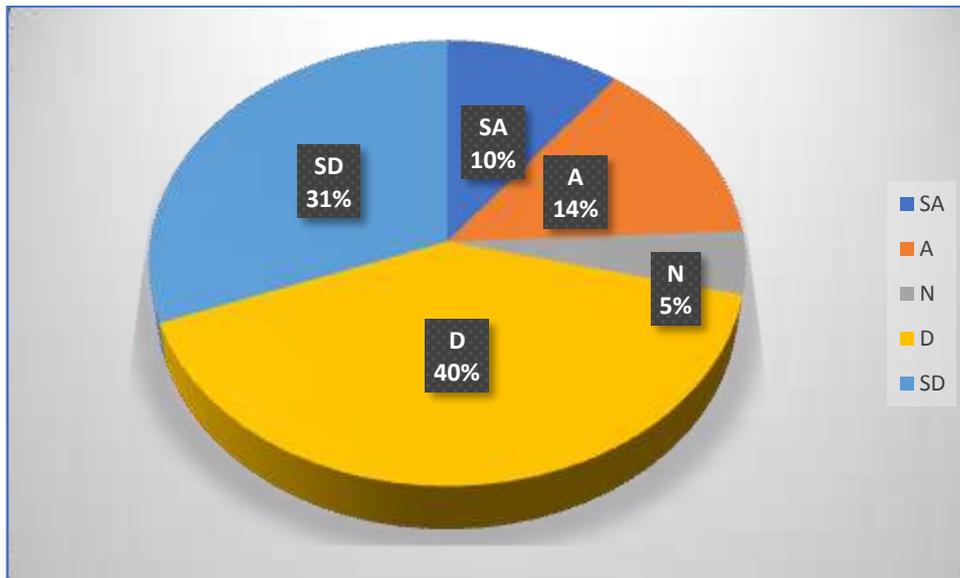| Options	Respondents	%
SA	52	10.4
A	69	13.8
N	23	4.6
D	202	40.4
SD	154	30.8
Total	**500**	**100**

(Source: Primary Data, Survey)

Figure 12. The anti-erosion works have been exposed (%)

From the above table & figure, it was found that the % of respondents were SA: 10.4%, A: 13.8%, N: 4.6%, D: 40.4%, SD: 30.8%.

So, from the above it can be stated that the "Hypothesis 2 ($^0H_2$): The flood control exposure correlated to the Jalpaiguri District, West Bengal" has been accepted.

IV.   Conclusion

Flood-prone Jalpaiguri district is shaped by flooding problems by the district's unique topography, rainfall patterns along with the bending patterns of the Teesta, Jaldhaka, and Torsa Rivers, the siltation & runoff impacts of the Eastern Himalayan foothills, combined with the spillage impact of anthropogenic activities like riverbank filing, deforestation, urban sprawl. Due to the complexity of the problem, an integrated approach to flooding is required. This means defusing the urban pressures and other components to decrease flooding impacts in Jalpaiguri. West Bengal's Jalpaiguri district combines natural and human impacts, resulting in flooding and necessitating an integrated approach to flood management with combined structural & non-structural components. Planning urban growth along with land use is essential for the region's sustainable flooding management & to reduce the impact. Proposed flood management strategies include enhancing drainage & bund systems, developing early warning systems, and encouraging resident preparedness.

Due to the sand being commercially sold, the riverbed dredging activity for the restoration of river systems has become revenue-neutral. As part of the dredging from Sevoke to Maynaguri, community-level silt-trapping structures are being constructed in sedimentation-prone areas to reduce the siltation that adversely impacts the agriculture of the downstream community. In the area, advocacy has been conducted for the installation of sediment trapping structures to protect areas that are downstream. There has been increased unconsolidated material displacement in the area contributing to the reduction of flood mitigation in the area.

While developing land, sustainable land use planning can help adapt to possible future flooding and runoff from construction sites. Along the Teesta rivers, many residents have had to modify their sources of income to include fishing and farming because of economic and environmental reasons such as pollution and sand encroachment. In the Jalpaiguri area, CWC and Waterways control the Teesta, Jaldhaka, Torsa, Raidak, and Sankosh rivers. For real-time alerts, advanced gauging systems and data transmission are essential, and they have used wireless sensor networks and machine learning, especially LSTM flood forecasting streams, to help

predict floods more quickly and accurately. These are improvements made to the FB-EWS systems. The Integrated Disaster Risk Reduction (IDRR) method incorporates Community Based Disaster Management (CBDM) with governmental systems for shelters, evacuation, and early warning systems, creating a hybrid structure for disaster risk reduction.

The floods in Jalpaiguri have had an economic and environmental impact on the local communities. They have forced people to migrate, and the floods have also destroyed road and bridge infrastructure. As a result, local governments and communities are forced to cope with the floods, provide emergency assistance, and repair or rebuild the embankments. It also located near the projection of the mighty Brahmaputra river the Jalpaiguri district is especially susceptible to river flooding and heavy rainfall because of its location at the foot of the Himalayas. The configuration of the district with multiple rivers and low-lying areas further exacerbates the drainage problem and flooding.

Multiple rivers and small streams called 'jhoras' make the Jalpaiguri district of West Bengal highly flood-prone Brahmaputra basin. Numerous geographical studies indicate that the presence of drainage congestion and the specific morphology of the streams and rivers of an area with specific rainfall distribution determines the area's flood-plain. Crippling flood management in Jalpaiguri is the impact of the flood, and so an integrated approach is required i.e., to educate the public, improve the drainage in the area and establish a flood early warning systems.

The Terai belt of the Jalpaiguri district is highly flood-affected due to its proximity to the West Bengal border. Combine with consistent rainfall, the Torsa, Jaldhaka, and Teesta rivers severally overflow their banks creating flood prone area, puts Jalpaiguri prone to severe flooding as well. Any flood management initiative in the Jalpaiguri region has to meet specific criteria and standards, with a minimum of three integrated specific elements.This refers to both structural and non-structural measures. Flood control measures also include activities and control measures within the watershed that are located upstream.

In Jalpaiguri, the community, local government & the system need to address the flooding. Non-structural methods will be efficient to control flood, to mitigate flood caused by heavy rainfall, extreme geographical floods for the areas with uncontrolled construction. The region where Jalpaiguri is located, The Dooars, is a region with extreme flooding. A high construction control deficit and uncontrolled development, severe overdevelopment along river banks within the basin of the mountains of the Himalayas is a cause of severe flooding & extreme overflowing banks.

References

[1].   Adeyemi, G.A. et al. (2021). Geographic Information System application in flood risks prevention, hazards reduction and planning. IOP Conf. Series: Materials Science and Engineering, 1036(012004), 1-5.
[2].   Chakraborty, S. & Mukhopadhyay, S. (2019). Assessing flood risk using analytical hierarchy process (AHP) and geographical information system (GIS): application in Coochbehar district of West Bengal, India. Nat Hazards, 99 (1), 247-274.
[3].   Mohanty, M.P. et al. (2020). Flood management in India: A focussed review on the current status and future challenges. International Journal of Disaster Risk Reduction, 49(1), 1-20.
[4].   Simonovic, S.P. et al. (2020). Floods and the COVID-19 pandemic—A new double hazard problem. Wiley Interdisciplinary Reviews, 1(1), 1-18.
[5].   Wahid, A. et al. (2021). Analysis of Flood-Prone Areas using Geographic Information System. ARPN Journal of Engineering and Applied Sciences, 16(24), 2660-2667.