Impact and effectiveness of flood protection projects under RIDF in North Tripura: a case study on community response and implementation outcomes

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Abstract

The study assesses the impact of the Flood Protection Project in North Tripura, funded under the Rural Infrastructure Development Fund (RIDF) by NABARD. Based on respondents' perceptions, the findings reveal that the project was reported to be largely successful by 85% of respondents and 83.33% acknowledging the adoption of best practices. About 65% rated the project as highly effective, citing major improvements in local infrastructure, income, and employment. Despite these positive outcomes, challenges such as insufficient funding and lack of proper maintenance were noted, emphasizing the need for policy reforms and better resource allocation. Overall, the project has significantly enhanced community resilience, infrastructure, and economic growth in North Tripura, with strong support for expanding similar initiatives in the future. The findings suggest that strengthening maintenance funding and local participation mechanisms can enhance the long-term sustainability of RIDF flood protection projects.

Keywords: Flood Protection, RIDF Projects, Community Resilience, Rural Infrastructure Development, Implementation Effectiveness, Sustainable Development

Introduction

Floods are recurring natural phenomena that cause extensive damage to vast areas, leading to the destruction of infrastructure, human settlements, public life, and the economy (Mandal *et al*., 2024) [11]. It hampers agricultural and forest lands, crops and livestock, and human life (Mandal *et al*., 2024) [11]. On average, floods of various types cause water logging both perennial and seasonal across about 11.6 million hectares in the country, with low-lying areas being the most affected. It is essential to investigate the adverse impacts of waterlogged ecosystems resulting from floods and to develop sustainable land management solutions. (Mandal *et al*., 2024) [11].

In the last decade, there have been many destructive floods in various parts of the world. Despite the extensive investment in flood control works, neither flood occurrences nor damages are decreasing. A possible consequence of climate change is an increased frequency of extreme meteorological events that may cause floods. Discussion is offered of some recent large floods in the world and of the experiences in combating floods in Japan. Floods change over time as societies change. There is no single universal remedy against floods and site-specific local efforts are necessary. It is essential to undertake damage mitigation measures together with physical control measures for flood management in an integrated approach, using a mixture of structural and non-structural means. Flood control is a necessary precautionary measure to ensure that the damages caused by flooding are kept at to the bare minimum. Moreover, they prevent any development or urbanization into unsafe floodplains and protect the lives and property of those who reside in floodplains. Financially, they reduce the burden placed on municipalities and communities where flood damages are extensive and frequent. They also help ensure that there is fresh, uncontaminated water suitable for drinking.

Flood control (or flood mitigation or flood alleviation) methods are used to reduce or prevent the detrimental effects of flood waters. Flood relief methods are used to reduce the effects of flood waters or high-water levels. Flooding can be caused by a mix of both natural processes, such as extreme weather upstream, and human changes to water bodies and runoff. A distinction is made between structural and non-structural flood control measures. Structural methods physically restrain the flood waters, whereas non-structural methods do not. Building hard infrastructure to prevent flooding, such as flood walls, is effective at managing flooding. However, increased best practice within landscape engineering is to rely more on soft infrastructure and natural systems, such as marshes and flood plains, for handling the increase in water. To prevent or manage coastal flooding, coastal management practices have to handle natural processes like tides but also the human-caused sea level rise. Flood control and relief is a particularly important part of climate change adaptation and climate resilience, both sea level rise and changes in the weather (climate change causes more intense and quicker rainfall), which means that flooding of

human infrastructure is particularly important in the world over.

India is particularly prone to floods, affecting about 40 million hectares annually (FAAAI, 2023; Jain *et al*., 2020; IPCC, 2023) [5, 9, 8]. Structural and non-structural flood control measures are increasingly integrated to enhance rural resilience (Kumar & Sinha, 2022; Sharma *et al*., 2021) [10, 18]. Their socio-economic implications—damage to property, loss of livelihoods, and agricultural disruption—necessitate strategic and sustainable flood management interventions (Mandal *et al*., 2024) [11].

In recent years, the NABARD-funded RIDF scheme has emerged as a vital mechanism for financing flood control and rural resilience projects. The present study examines the implementation of the "Flood Protection/Anti-erosion work along the Juri River" in North Tripura, focusing on its effectiveness, economic benefits, and sustainability.

Unlike prior studies that rely solely on descriptive outcomes, this paper integrates statistical, spatial, and economic analyses to evaluate the real impact and policy relevance of RIDF flood protection projects.

Methodology

A descriptive mixed-method design was used, combining quantitative and qualitative techniques (Creswell & Plano Clark, 2018; NABARD, 2021) [3, 13]. The present study was conducted by the survey based descriptive method, consists of both qualitative and quantitative studies. *The main objective of the present study is to Document the good practices and impact of RIDF projects entitled " Flood Protection/ Anti erosion work along the bank of river Juri" in Tripura*.

The study was conducted in the state of Tripura, India, located in the north-eastern part of the subcontinent. Tripura is bordered by Bangladesh to the north, west, and south; by Mizoram to the east; and by Assam to the northeast. The state lies at approximately 23.745127° N latitude and 91.746826° E longitude. The documentation of the project undertaker in North Tripura with the project entitled " Flood Protection/ Anti erosion work along the bank of river Juri". To collect responses a simple random sampling technique has been used followed by focus group discussion. A total of 60 sample households and local people have been investigated by a personal interviewing method during October 2023 to January 2024 with the help of a structured interview schedule for collecting information. Statistical methodology like Frequency, Percentage, Chi-square test was calculated to full fill the objectives.

Result & Discussion

The implementing agency of this project is PWD (Water Resources) in North Tripura. This project comes under the sector of Agriculture - Other than Irrigation with the purpose of flood protection measures along the bank of river Juri. The Anti erosion work along the bank of the river Juri project started on 01/04/2019 and it ended on 31/03/2022. The total loan Sanctioned Amount and loan disbursement amount is Rs 53422000.00 only.

The flood protection project is located on the bank of the Juri River. The field survey was done on 14th November 2023, where interaction was done with local residents to gather insights on various aspects, including the flood protection system, economic conditions, and agricultural practices. The interactions provided valuable information, shedding light on the community's resilience, challenges, and the impact of the Flood protection measures on their livelihoods. The study aims to contribute to a comprehensive understanding of the region's dynamics and support informed decision-making for sustainable development.

The table 1 reveals that 68.33% of the responses were in male group and 31.67% of the responses were female and 85% of the respondent's remark was positive regarding implementation of flood protection project and only 15% respondent recorded negative response regarding implementation of the project. This table also reveals that 83.33% of the respondents agreed to the implementation of best practices and the benefits availed but 16.67 % was not much happy with the best practices implemented under RIDF project.

Fig 1: Flood protection in Juri River

Fig 2: Flood protection in Juri River

Table 1: Status of flood protection project in Juri River in North Tripura

Sl. no	Scale	Frequency	Percentage	Chi sq.	*p* value
1	Gender				
a	Male	41	68.33	8.067	0.005
b	Female	19	31.67		
2	Implementation of Flood protection project under RIDF by department				
a	Yes	51	85	29.400	0.000
b	No	9	15		
3	Adoption of any specific best practices in the implementation of Flood protection projects				
a	Yes	50	83.33	28.400	0.000
b	No	10	16.67		
4	Impact of best practices on the overall success of the projects				
a	Highly effective	39	65	22.800	0.000
b	Moderately effective	15	25		
c	Somewhat effective	6	10		
d	Not effective	0	0		
5	Percentage of Flood protection projects have incorporated these best practices				
a	0-25%	6	10	30.000	0.000
b	26-50%	11	18.33		
c	51-75%	27	45		
d	76-100%	16	26.67		
6	These Best practices been implemented across the Flood protection project				
a	Widely	38	63.33	11.100	0.004
b	Moderately widely	15	25		
c	Somewhat widely	7	11.67		
d	Not widely	0	0		
7	Characters use to assess the impact of Flood protection projects				
a	Employment generation	14	23.33	8.400	0.038
b	Improved infrastructure	21	35		
c	Income enhancement	18	30		
d	Increase in trade activities	7	11.67		
8	Positive impact of Flood protection projects in Tripura using the selected parameters				
a	Very high	18	30	38.400	0.000
b	High	27	45		
c	Moderate	15	25		
d	Low	0	0		
e	Very low	0	0		
9	Parameter has demonstrated the most significant improvement due to impact of Flood protection projects				
a	Lack of proper maintenance	21	35	5.700	0.058
b	Insufficient funding	24	40		
c	Inadequate training for beneficiaries	0	0		
d	Limited access to markets	15	25		
e	Regulatory hurdles	0	0		
10	Importance of policy changes for addressing challenges				
a	Extremely important	30	50	22.800	0.000
b	Very important	15	25		
c	Somewhat important	15	25		
d	Not important	0	0		
11	Recommendation on changes in funding allocation				
a	Yes	33	55	0.600	0.439
b	No	27	45		
12	Plans to expand or develop additional Flood protection projects in Tripura in the near future				
a	Yes	54	90	38.400	0.000
b	No	6	10		
13	Role of future Flood protection projects in boosting the economic growth of the state				
a	Extremely significant contribution	45	75	86.700	0.000
b	Significant contribution	9	15		
c	Moderate contribution	6	10		
d	Minimal contribution	0	0		
e	No contribution	0	0		

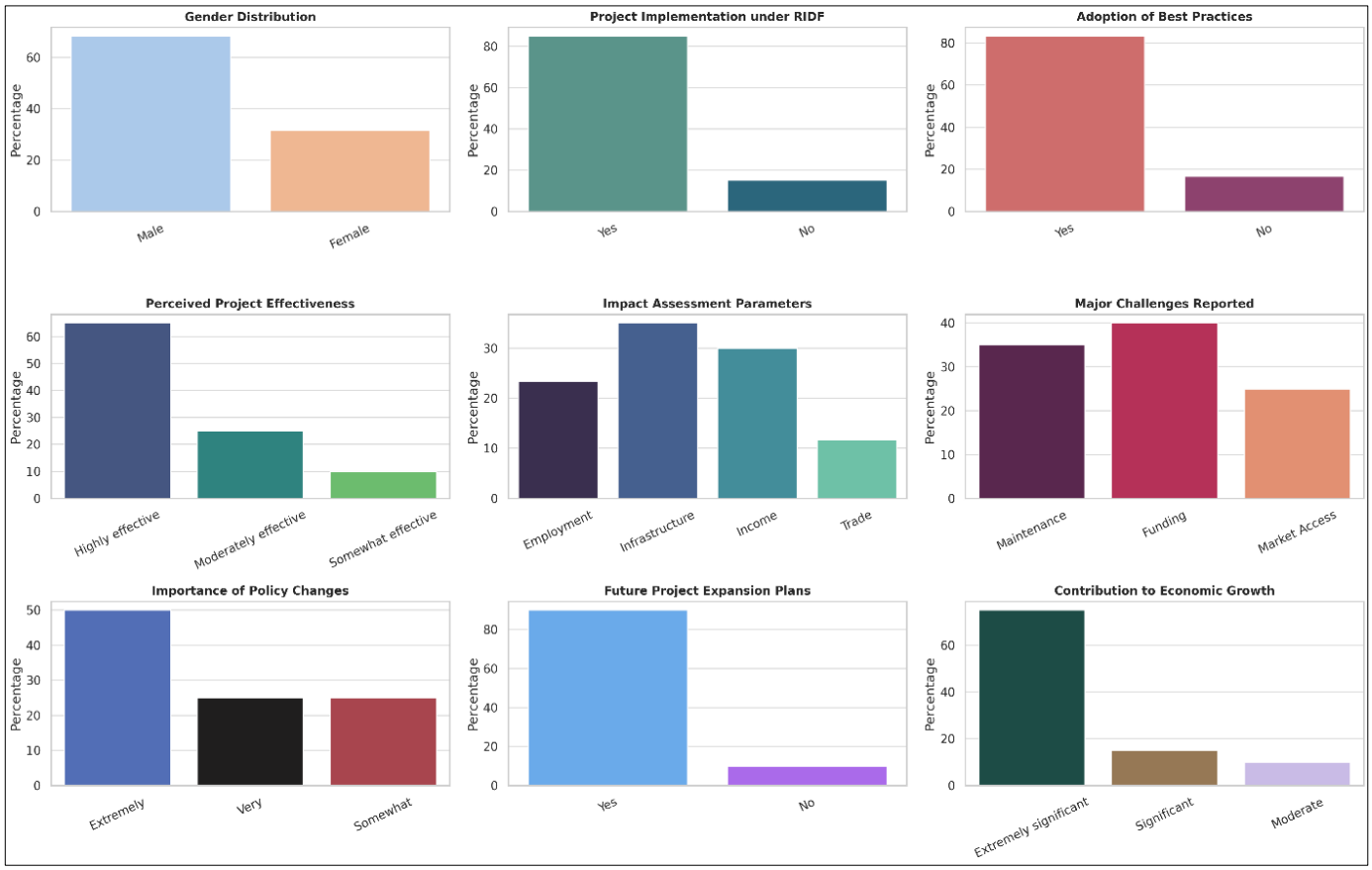

Fig 3: Demographic profile, project effectiveness, best practice adoption, impacts, challenges, and policy perspectives of the RIDF Flood Protection Project in North Tripura

Apart from this, the significantly highest percentage (i.e. 65%) said that this project is highly effective followed by 25% said it is moderately effective which is then followed by 10% who said this project is somewhat effective. About 71.67% of the respondent informed that they have incorporated best practices and 63.33% of respondents said that best practices had been implemented across this project widely followed by 25% said moderately widely.

According to this table, 35% of respondents said their local infrastructure improved due to the implementation of a Flood protection project followed by 30% said their income enhancement followed by 23.33% said employment generation and 11.67% said the increase in trade activities improved due to implementation of Flood protection project. 30% of the respondents said that the positive impact of this project is very high followed by 45% respondents said high and lastly 25% that impact is moderate. When it comes to challenges 35% of respondents said lack of proper maintenance was the main problem, 40% mentioned insufficient funding followed by 25% said Limited access to markets as main challenges. This table also reveals that 50% of respondents said that policy changes are extremely important for addressing challenges followed by 25% saying very important and 25% saying somewhat important. 55% of respondents recommended changes in funding allocation while 45% said changes in funding allocation are not necessary. The significantly highest percentage (i.e. 90%) has said that there is a plan to expand or develop an additional similar project in the near future. Majority of the respondent *i.e.* 75% are agree with that the role of this project in boosting the economic growth of the state is significantly extremely high.

Similar outcomes have been observed in flood protection initiatives elsewhere in the Northeast (Choudhury & Tripathi, 2023; Pathak *et al*., 2022) [2, 16], where local participation significantly enhanced sustainability (Narayan *et al*., 2020; Hallegatte *et al*., 2019) [14, 6]. The flood protection project in North Tripura funded by NABARD has a great impact as it helps the local people in overcoming the difficult situation during the peak flood season of the year.

Maintenance and sustainability framework

The long-term success of flood protection projects under the Rural Infrastructure Development Fund (RIDF) depends not only on their initial design and construction but also on their post-implementation maintenance and sustainability mechanisms. In the North Tripura case, despite the project's strong community impact, survey results indicate that 35% of respondents identified lack of proper maintenance and 40% noted insufficient funding as key challenges. These issues, if unaddressed, could compromise the durability and efficiency of the flood protection structures in future years. Integrating local water user committees aligns with global best practices in decentralized flood governance (Ostrom, 2010; UNDRR, 2022; Bhaduri *et al*., 2016) [15, 19, 1].

To address this, a Maintenance and Sustainability Framework should be institutionalized across all RIDF-funded flood

protection initiatives. The framework must emphasize community participation, regular funding, and multi-level accountability. The proposed framework can be summarized as follows:

Table 2: Proposed maintenance and sustainability framework outlining institutional responsibilities at multiple levels

Level	Action Required	Responsible Stakeholders	Expected Outcomes
Community / Village Level	Form local *Water User Committees (WUCs)* to oversee minor repairs, embankment inspection, and cleaning of drainage channels.	Gram Panchayats, Beneficiary Groups	Improved ownership and quicker response to maintenance needs.
District / Project Level	Develop an Annual Maintenance Plan (AMP) integrating preventive maintenance schedules, periodic inspections, and early warning systems for erosion.	PWD (Water Resources), District Administration	Reduction in infrastructure degradation and better coordination.
State / NABARD Level	Allocate a recurring maintenance budget (at least 5% of total project cost) in the RIDF sanctioning process. Encourage convergence with MGNREGA and State Disaster Mitigation Funds for maintenance labour costs.	NABARD, State Finance & Water Resources Departments	Financial sustainability and reduced dependence on ad hoc funding.
Monitoring & Evaluation	Introduce digital monitoring dashboards for real-time reporting of embankment condition, rainfall intensity, and repair status.	NABARD, NIC, State Disaster Management Authority (SDMA)	Transparency, accountability, and evidence-based decision-making.

Source: Author's synthesis based on Bhaduri *et al*. (2016) [1]; Choudhury & Tripathi (2023) [2]; Jain *et al*. (2020) [9]; NABARD (2021) [13]; MoWR (2020) [12].

Policy integration and recommendations

For RIDF-funded flood protection projects to achieve maximum impact, their design and implementation must align closely with broader national and state-level policy frameworks on flood management, climate resilience, and rural infrastructure. The following recommendations emerge from the study's findings and field evidence in North Tripura:

Integrate with National Flood Management Policy (2023): Align RIDF projects with basin-level flood risk planning.

- Community-Led Maintenance: Empower Water User Associations for monitoring and upkeep.
- Financial Decentralization: Allocate recurring maintenance funds in annual RIDF budgets.
- Climate Resilience Focus: Incorporate IMD's rainfall projection models in future project design.
- Capacity Building: Train local engineers and contractors on eco-friendly "soft" flood control structures.
- Digital Monitoring: Develop a web-based RIDF Flood Dashboard for real-time updates.

Conclusion

The findings clearly indicate that the flood protection project implemented under the Rural Infrastructure Development Fund (RIDF) in North Tripura has had a significant positive impact on the local community and overall regional development. A majority of respondents acknowledged the successful implementation of the project and the adoption of best practices, leading to improvements in local infrastructure, income generation, employment opportunities, and trade activities.

Most respondents perceived the project as highly effective and beneficial in mitigating flood-related challenges, with many noting its strong role in boosting the economic growth of the state. However, some challenges persist, notably insufficient funding and lack of proper maintenance, highlighting the need for policy reforms and improved resource allocation.

Overall, the study concludes that the flood protection project has been highly impactful, contributing substantially to community resilience and sustainable development in North Tripura. The overwhelming support for expanding similar initiatives underscores the project's success and future potential in strengthening regional flood management and economic stability. Further studies may focus on comparative evaluations across multiple RIDF flood protection projects in Tripura.

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Declarations

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Conflict of Interest: The authors declare no conflict of interest.

Ethical Approval: Not applicable as the study involved only survey-based human participants with informed consent.

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