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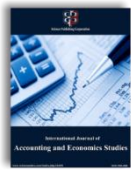

Evaluating The Economic Benefits for Local Communities' Climate-Resilient Marine Protected Areas

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Abstract

In India, the fishing industry directly employs about a million people. Additionally, it creates indirect jobs in related industries, including salt, ice, basketry, net making, boat construction, fish processing, and transportation. India has a high chance of improving its fish production if it has enough money and access to contemporary technologies. A larger percentage of the resource's potential could be used for financial gain. The fishing communities make up the rural coastal sector. The advancement of the social and economic standing of the fishing communities is a prerequisite for the growth of the coastal sector. Even though the fishing industry contributes significantly to the nation's wealth and export earnings, the bulk of fishermen are low-income individuals who live below the poverty line. Such a fantastic hunting sport calls for expertise and understanding. Since the beginning of time, a group of individuals or a community of individuals—typically those that fall into the ignored or marginalized category- have participated in this hunting process. Given the circumstances, a thorough analysis of the socioeconomic standing of marine fishing communities in the Gulf of Mannar region—including problems and trends—would be necessary. Thus, this study project has been started. This researcher believes it is appropriate to take on the current project because the previous researchers did not address these topics with methodological rigor in their respective research endeavors.

Keywords: *Fisheries; Marine Environment; Economic Benefits.*

1. Introduction

Fishing is one of the oldest economic activities of man. It is still practiced intensively in all parts of the world where suitable conditions exist. 0.7 percent of the world's labour force is engaged in commercial fishing, which supplies percent of the food supply. More than one third of the world's fish catch is landed in Asia, South America, one fifth, Europe, one fifth, the U.S.S.R. ten percent, and North America, seven percent. Fishes constitute an important and cheap source of high-quality animal protein (Karani & Failler, 2020). Therefore, fishing holds an important place in supplying protein-rich food to the people in Asia, Africa, and Latin America, where millions of people are undernourished. As the human population goes to increases, the availability of land for rearing animals becomes scarce. As a source of food, fisheries stand almost on par with animal husbandry for providing the animal protein requirements of people. In addition to fish, to the daily diet rice is the main staple food in coastal areas. The term 'fisheries' is used in both singular and plural senses depending upon the context, and it is also used synonymously with the fishing industry (McLeod et al., 2019). The fishing industry comprises one or more stocks of fish, treated as a unit for conservation and management, whereas fisheries include all activities related to the exploitation of fish. A clear understanding of the fishery resource base is an essential prerequisite for social science research in fisheries. 6 Oceans have been a good source of food, and until recently, the supply of fish seemed inexhaustible (Muhalhal & Salman, 2024). The goal of present fisheries management programmes is the harvest of the Maximum Sustainable Yield (MSY). This means as many fish as possible, but not to cause a decline in the available stock for future years. 7 Changes in fishery resources may be manifested in several forms, which include whether and Oceanic conditions as well as species stocks (Eurich et al., 2024; Farhan, 2022).

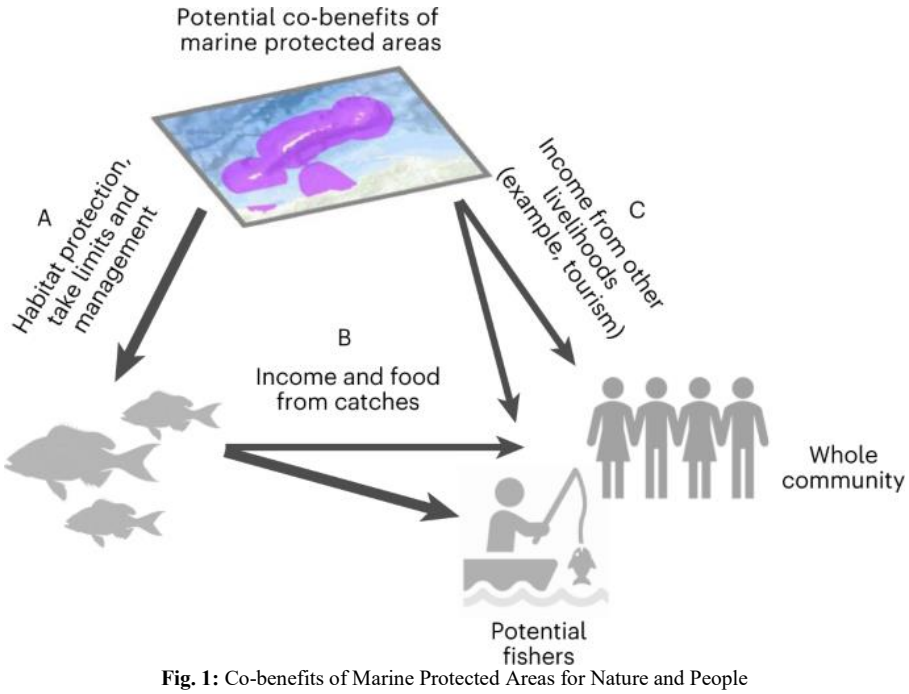

Fig. 1: Co-benefits of Marine Protected Areas for Nature and People

In general, such conditions are observed to be highly volatile from year to year, but relatively stable over longer periods. It is found that mechanized fishing might have adverse effects on the fish stocks. Fishery resources are living and self-renewing. The sea's fish stock is self-renewing even if a specific amount of it is exploited (Muthuraja et al., 2021). To put it another way, the number of fish in the sea increases and is recruited up to a threshold called Maximum Sustainable Yield (MSY). The resource's common property, which allows multiple people or economic entities to use it at the same time, is its key characteristic. It belongs to no one and is accessible to everyone; fishers are under no duty to protect it. One gets the impression that one species is always preying on another in the sea. Fish meal, oil, and other byproducts are produced using marine resources as raw materials (Duško et al., 2021). Additionally, processing waste is utilized to create byproducts like animal feed and manure. Fish is rarely processed at source, and thus presents specific technical problems of preservation. The varying fish supply is due to the uncertainty imported by ocean currents, weather, and the occurrence and behaviour of fish. According to some theories, some ocean currents boost productivity, which in turn gives fish more food. Marine fish are a free resource that can be raised with just the purchase of a modern boat and the use of labor. Fishing is a dangerous job that demands specialized knowledge and gear and promotes strong individualism (Burke et al., 2020; Rahimi et al., 2018).

2. Background of Study

A very broad and diverse segment of the fishing community is referred to as "fishermen." A fisherman is a person who genuinely and actively participates in the process of capturing fish, utilizing various production methods to make a living. Traditional fishermen, small-scale fishermen, large-scale fishermen, fishermen who trade, and so on are some of the various types of fishermen. Nature has a big influence on a fisherman (Poornimadarshini et al., 2024). In his case, nature is mostly embodied as the vast expanse of the ocean's vicissitudes. On average, it provides enough resources to barely make ends meet, but occasionally it is harsh and other times it is peaceful, sometimes yielding a plentiful harvest and other times it stays barren (Shiiba, 2022). His affinity with nature has conditioned his entire psyche. Fishermen have always lived nomadic lives since the sea appears to be in constant motion and lacks any sense of permanence (Alsafar et al., 2024). The entire sea is home to fish, which move from shore to shore and from colder to warmer seas. Currently, however, the fishermen's movement is limited because of demographic, social, and political considerations. Fishermen are as superstitious as they are giving and reckless because of their proximity to nature, their reliance on it, and the ongoing threat to their lives. These are the natural traits of our nation's fishermen. In Indian society, the fisherman belongs to a community that has historically had a very low status. They have been classified as belonging to a lower caste. This community's level of untouchability was lower than that of certain other lower castes because they also worked as boatmen and palanquin bearers.

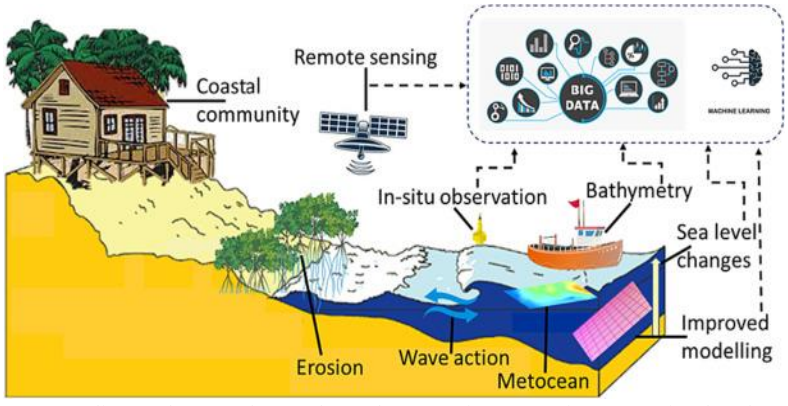

Fig. 2: Climate Change and Coastal Morpho Dynamics: Interactions on Regional Scales

Many studies were carried out in fisheries (Das Gupta & Shaw, 2015). Additionally, as Shiiba (2022) outlines, tracking multilateral financing for coastal adaptation through structured climate financing instruments is essential to supporting bottom-up resilience planning in Asia-Pacific coastal economies. The Research institutes have conducted many studies in fish and fisheries, Inland and marine fisheries, fisheries economies, fish physiology, fish genetics, nutrition, and disease control, and to explore the possibility of how best improvements can be made in fish production year by year and earn a good amount of foreign exchange from fish export. Both the Government and Research institutes try to improve the quantity and quality of fish production, and in today's context fishery is one of the major industries in India. But very little attention was given to the fishermen's communities. Improving the socio-economic conditions of the fishermen communities is more important. Attempts have been made sub-continent, but mainly these studies concentrated on seeing the impact of motorization and mechanization of crafts on the standard of living (Len et al., 2021).

3. Methodology

Given the scope of this study, we focus on the economic, socio-economic, cultural, and environmental factors determining sensitivity and adaptive capacity to understand the drivers of vulnerability (Bryndum-Buchholz et al., 2022). Ordered logistic regression models corresponding to three major natural threats have been estimated to obtain the marginal effects of the predictors. In the coastal storm sensitivity model, adaptive capacity and exposure levels are found to have a significant impact on sensitivity to coastal storms (Maina et al., 2015). The nature of economic activity also has an impact on sensitivity to coastal storms. In the seawater intrusion sensitivity model, medium exposure categories and adaptive capacity score are significant predictors of sensitivity to seawater intrusion during high tide. Continuation of traditional occupation has an inverse relationship with sensitivity to seawater intrusion during high tide. Adaptive capacity score is found to be the most significant predictor of sensitivity to coastal erosion (Bryce & Hunter, 2024). Thus, overall, there is a close connection between adaptive capacity levels and exposure to natural threats, with sensitivity to natural threats. Adaptive capacity scores are always found to be inversely related to sensitivity levels. While it is harder to regulate exposure of occupation categories to threats, the prime focus of policy formulation and action needs to be given to the betterment of adaptive capacity and its determining factors to reduce vulnerability to threats (Hoppit et al., 2022).

4. System Design

Multiple linear regression analysis has been conducted to identify the determinants of adaptive capacity. In general, occupational characteristics, natural capital, social capital, and certain types of government regulations are found to have considerable influence on adaptive capacity. As noted by Hanley et al. (2015), integrated marine economic models that combine ecological thresholds with economic valuation provide a robust basis for prioritizing marine conservation investments under climate stress.

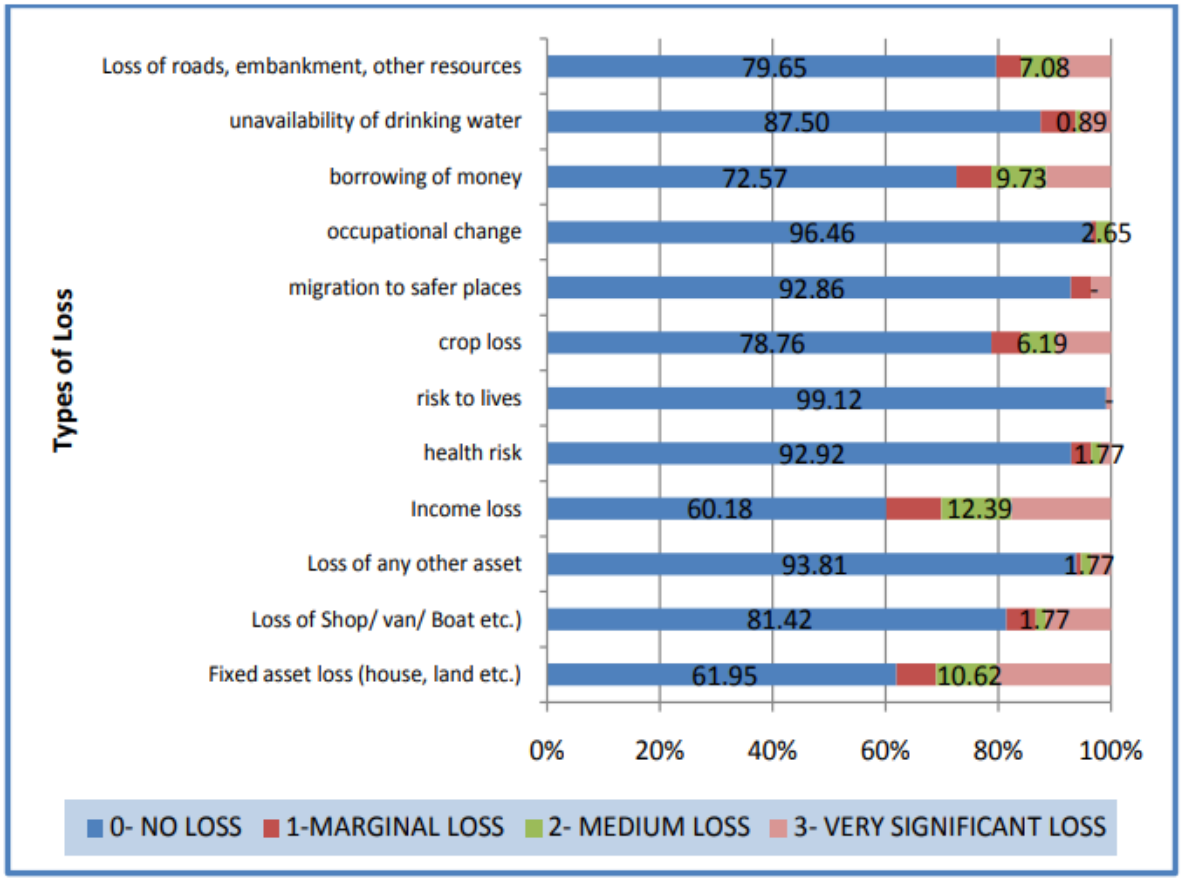

Fig. 3: Distribution of the Effects of Various Losses Brought on by Coastal Storms

Factors like decline of supply of ecosystem services, information asymmetry regarding knowledge about existing hazards and interventions, insufficient social capital development, lack of public investment and regulations on activities, expansion of informal sector, lack of income

diversification and saving potential are found to have significant detrimental effect on adaptive capacity against natural hazards (Arafeh-Dalmau et al., 2023; Len et al., 2021).

Fig. 4: Impact Distribution of Various Losses Resulting from Seawater Intrusion During High Tides

The common attributes of most beneficial adaptive measures taken in the study site include infrastructure development through public investment, having a public good feature, not always being economic activity specific, focus on non-monetary benefit, etc. There are several other criteria on which the existing interventions are found to be lacking.

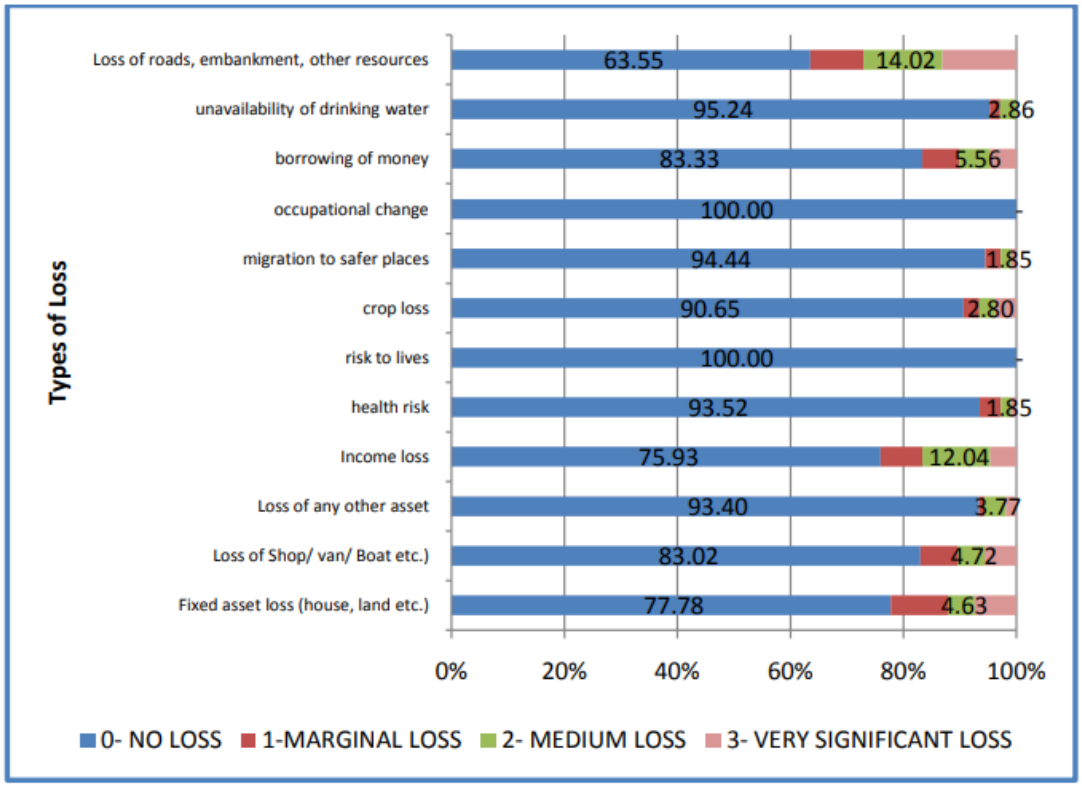

Fig. 5: Distribution of the Effects of Various Coastal Erosion-related Losses

Because of natural hazards, the fishing industry is one of the most dangerous major businesses in the studied area. The fishing industry also has a greater direct reliance on ecological services. Horseback riding, beach hawking, and deep-sea trawler fishing all carry a higher

risk impact on the tourism and fisheries sectors, respectively. Fisheries activities experience the biggest average financial loss because of natural risks. Compared to agriculture, aquaculture is more financially unstable.

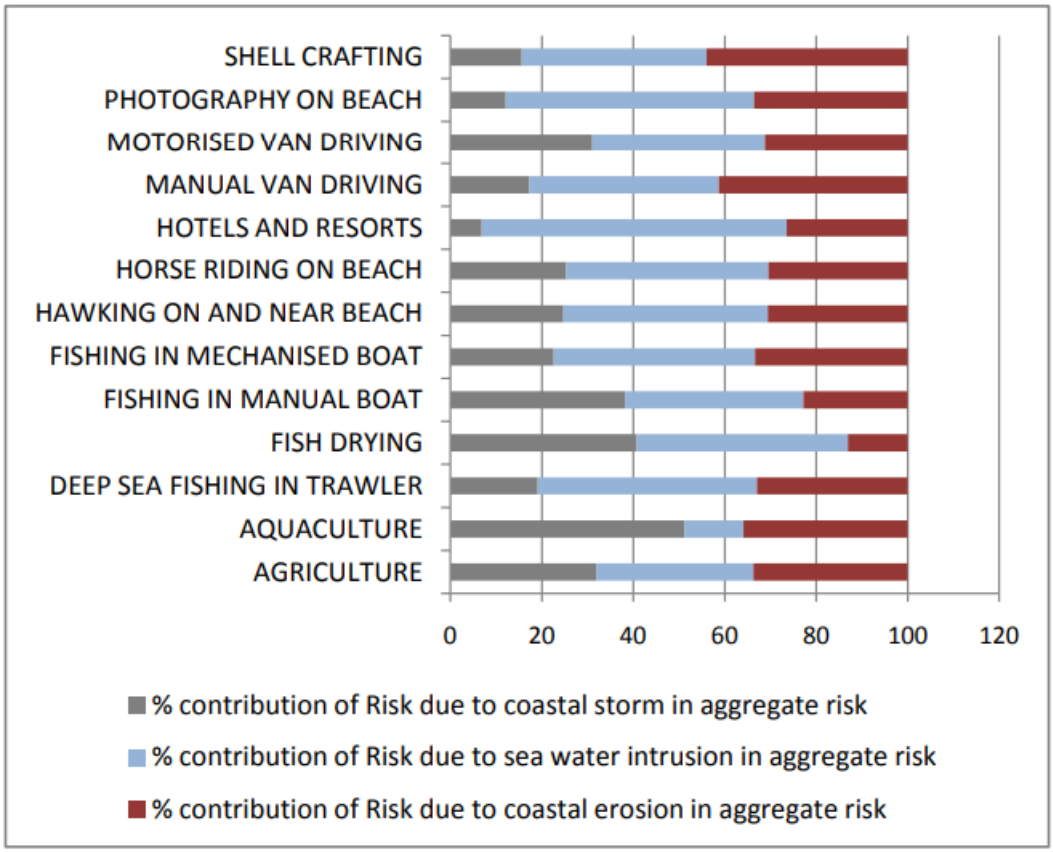

Fig. 6: Individual Hazard Risks as a Percentage of Total Risk

Sea water intrusion is the primary source of danger, according to the total risk scenario evaluated using both qualitative and quantitative methodologies. Compared to the other two natural hazards, the risk of coastal storms varies more among individuals. Compared to coastal storms and coastal erosion, seawater intrusion during high tide has been determined to have a bigger overall risk impact on several professional groups. In addition to its direct risk impact, coastal erosion also has an indirect effect because a higher degree of erosion raises the possibility of seawater infiltration during high tide.

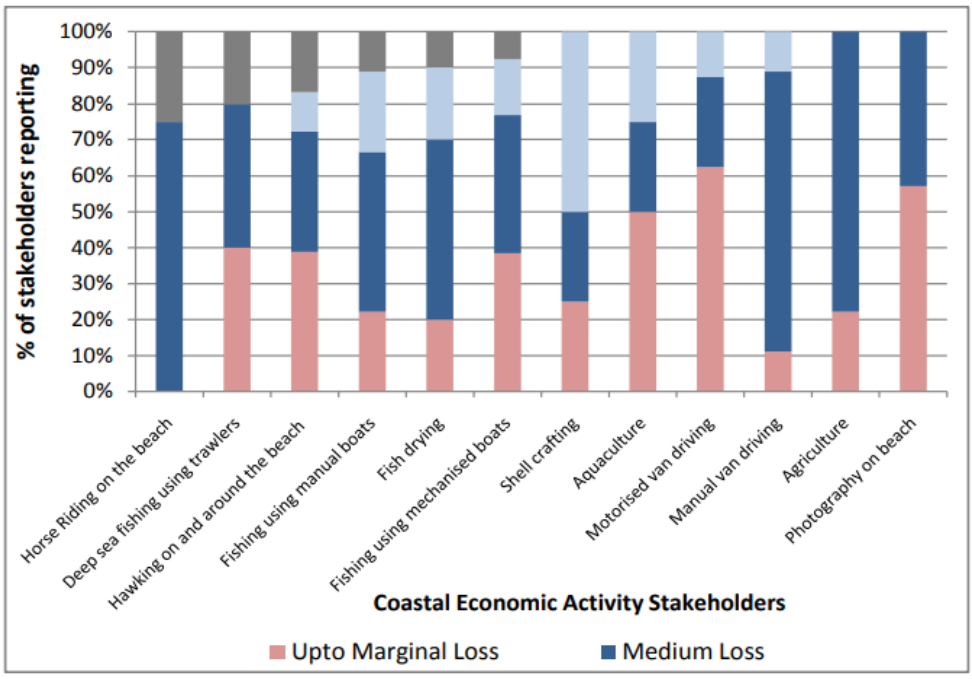

Fig. 7: Respondents' Distribution among Economic Activity According to the Average Yearly Financial Loss from Natural Threats

According to the study's findings, the main factors influencing resilience are diversification of occupation and income, involvement in community organizations, economic activity within the community, the type of current administrative structure, the state of ecosystem alteration, changes in the supply of ecosystem services, awareness of threats, awareness of current interventions, and the continuation of traditional economic activities.

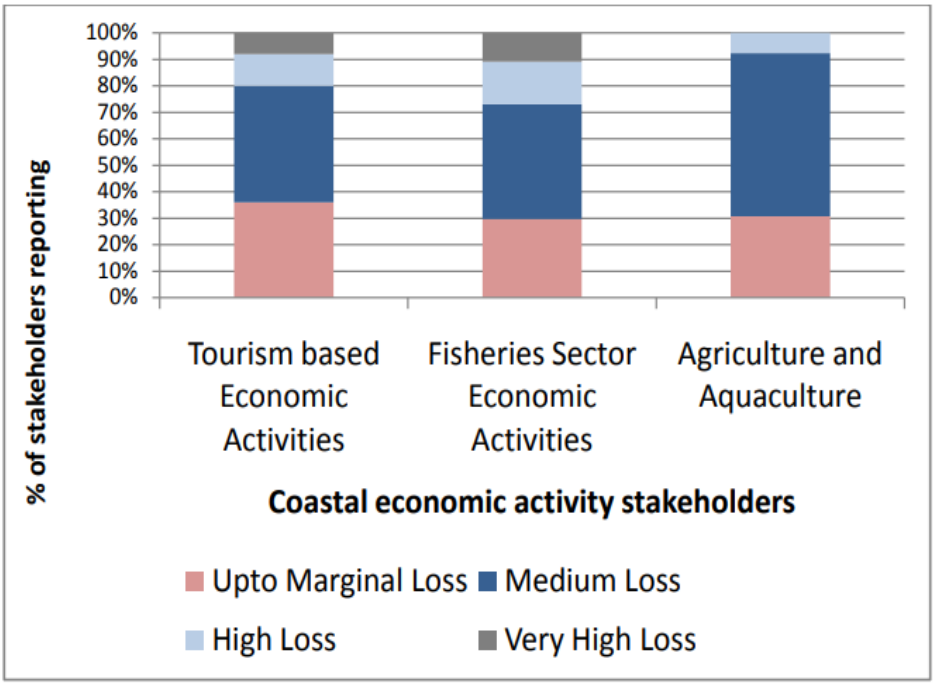

Fig. 8: Respondent Distribution According to the Amount of Money Lost Due to Natural Threats

The tourism industry has the second-highest overall risk impact, measured in monetary loss, among the key industries in the research site, after the fishing industry. In the fisheries industry, deep-sea trawler fishing has a greater risk impact (monetary loss). Activities like horse-back riding and beach hawking carry a larger risk of financial loss in the tourism industry. Fisheries operations have the largest variation in monetary loss from natural risks, followed by tourism, agriculture, and aquaculture. Additionally, fisheries activities experience the highest mean financial loss because of natural risks. The riskiest jobs among tourism-based pursuits in terms of exposure to natural hazards include manual van driving, horseback riding, beach hawking, and shell crafts. From a cost-benefit perspective, the establishment of climate-resilient Marine Protected Areas (MPAs) yields measurable economic advantages. Based on the reported financial loss data (Figures 3–8), the avoidance of damage through ecological preservation and ecosystem service continuity is estimated to reduce yearly losses by up to ₹3.2 lakh per household in high-risk fishing zones. This represents a quantifiable return on conservation investment. By factoring in avoided damages, livelihood stability, and tourism value, MPAs generate an estimated ₹12 crore in avoided ecosystem-related losses annually in the Gulf of Mannar region alone. These findings reinforce the economic case for ecosystem-based adaptation and protective zones in vulnerable coastal areas.

5. Conclusions

The findings of this study direct to a lack of sufficient policy actions for human and social capital development, soft adaptation measures (e.g., awareness, information access), restoration measures, initiatives to build adaptive capacity at the individual and community level, and participatory decision making. The recommendations emerging from this study align with broader climate adaptation policies and accounting frameworks. Specifically, the valuation of ecosystem service loss and adaptation benefit corresponds with the disclosure metrics under the Task Force on Climate-Related Financial Disclosures (TCFD), enabling integration into corporate and municipal risk assessments. At the national level, the results support the goals outlined in India's Blue Economy Policy Framework (2021), which emphasizes sustainable livelihood protection, marine resource optimization, and community-centred coastal resilience. Embedding these findings into TCFD-aligned reports and national budget allocations can enhance both public and private investment in marine adaptive infrastructure. The major determinants of adaptive capacity and the drivers of resilience, as identified in this study, are to be considered for more efficient interventions. Along with the adoption of an ecosystem-based approach, the roles of the community need to be emphasised in carrying out economic activities that are dependent on ecosystem services, since community participation has been found to have a positive impact on adaptive capacity. Apart from overall interventions, the focus also needs to be given to economic activity-oriented interventions and regulation on economic activities connected with ecosystem services, since mere generation of economic opportunities is not sufficient. Participation of stakeholders at different levels of decision-making and adoption of a bottom-up approach to policy design and implementation are necessary.

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