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Risk Informed Development: A Case of Pathanamthitta

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ABSTRACT:
Risk-informed development is a risk-based decision process that enables development to become more sustainable and resilient(Sendai framework for disaster risk reduction, 2015). It forces those who make development decisions to comprehend and accept the fact that all development decisions generate unpredictable risks as well as possibilities. systematic evaluations of complex threats, hazards opportunities, doubts, risk preferences, and perceptions to guarantee resilient and sustainable development. By integrating catastrophe and climate change risks and how to address them into routine development decision-making, risk-informed development may be accomplished. The dangers encountered by communities that reside in the most disadvantaged circumstances are prioritised in risk-informed development. It operates from the viewpoint of those who are themselves most at danger. Kerala is prone to a wide range of dangers and has recently been the victim of several significant natural disasters. While disasters cannot always be prevented, the vulnerability of individuals and property to different hazards may be significantly and sustainably decreased via preparedness, mitigation, and preventive measures and strategies.This paper focus on background study, literature study ,primary study on Risk Informed Development ,hazard and vulnerability assessment .In addition it help to understand concepts of Disaster , Hazard ,exposure ,vulnerability,resilience etc.The study focuses to understand Parameters Used to analyse Hazard impact and Socio-economic-vulnerability. Parameters Used to analyse Hazard impact and Socio-economic-vulnerability in pathanamthitta,it comes in Manimala – Pampa- Achenkovil riverbasin that experiencing flood and landslide continuously (2018,2019)
.

KEYWORDS: Risk Informed Development, Vulnerability assessment, Risk assessment

I. INTRODUCTION

Study aims to demonstrate importance of using Risk Information as part of masterplan preparation and zoning regulations. As defined by the UN Office for Disaster Risk Reduction, potential loss of life, injury, or damaged or destroyed property that could happen to a system, society, or community in a certain period of time, as evaluated probabilistically as a factor of hazard, exposure, vulnerability, and capability[1] .There are three types of risks: natural, anthropogenic, and socionatural .Development can become more sustainable and resilient by using a risk-based decision-making approach known as "Risk Informed Development." It forces those who make development decisions to comprehend and accept the fact that all development decisions generate both opportunities and unpredictable hazards. To ensure that development is robust and sustainableIt is necessary to conduct systematic analyses of complex threats, hazards, possibilities, uncertainty, and risk tolerances. The mainstreaming including the management of catastrophe and climate change risks into normal development decision-making can lead to risk-informed development. When risk is consistently acknowledged, appraised, and handled when pursuing specific development paths and practises, it is regarded a normal and integral element of economic activity and development and the adaptation objective is achieved. [2]

Risk-informed development gives populations living among the most vulnerable circumstances a higher priority when considering risks. It operates from the viewpoint of those who are themselves most at risk. The main objectives of risk-informed development are to strengthen the resilience of communities and the environments they inhabit, to equip the most vulnerable communities for future dangers, and to take proactive steps to mitigate such risks. Our living conditions contain risk elements, such as ecosystem

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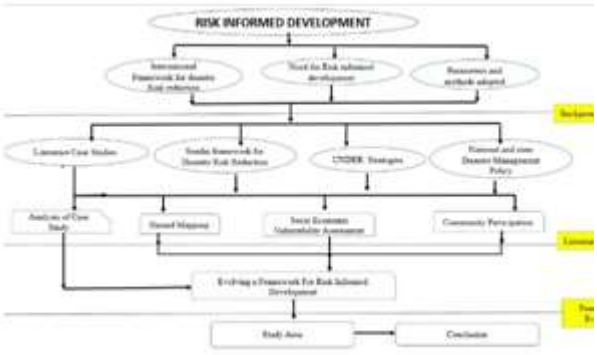
services and environmental capacity. Unfortunately, risk factors also include people's behaviour and societal, economic, and psychological circumstances that make some people more vulnerable than others. Communities most at risk indicate that when development is not risk-informed, instead of giving progress, this so-called "development" actually creates risk, increases current risk, and eliminates potential development gains.[3]

Objectives of the study are..

- Approaches for the preparation of Risk Informed Master Plan
- To Identify Parameters and Indicators for Risk Informed Master Plan
- To evolve an assessment framework for preparation of Risk informed Master Plan

II. METHODOLOGY



Through background study in depth understanding about Disaster risk reduction,need for risk development ,parameters and methods adopted for risk informed development were analysed.

Literature review of various journals undrestanding the basic defenitions,analysing literature case studies and best practices.Studied in detail Sendai framework for disaster risk reduction and united nations disaster risk reduction strategies (UNDRR).Hazard mapping ,Socio-Vulnerability assessment methadologies and Community participation that to be used in preparing risk informed development plans are discussed

Secondary data and primary collection is conducted.The data collected of Pathanamthitta muncipality is analysed .Strategies and proposals are formulated for Risk informed development of Pathanamthitta

III. LITERATURE STUDIES

According to the Sendai Framework for Disaster Risk Reduction 2015–2030, risks related to natural and human threats must be "factored into planning and development at every level across all sectors, like in disaster preparation , recovery, and rebuilding... to prevent and reduce risk."[1]

The Sendai Framework, is a key tool for achieving SDG(Sustainable Development Goals), lays seven targets for mitigation and avoidance of disaster – Related Losses. By considering risk management as a crucial aspect of all human activity—economic, social, and environmental, it marks a paradigm shift from the idea of disaster risk. A detailed list of guiding principles for reducing the effects of disasters while addressing key disaster risk factors is provided along with its seven global objectives[1]

By lowering communities' susceptibility and enhancing their ability to cope, an integrated DRM (Disaster Risk Management) strategy seeks to minimise the economic and social impacts of a disaster. The emphasis of the post-2015 agenda for Development and the Sustainable Development objectives has been the comprehensive integration for "Disaster Risk Reduction"(DRR) techniques in planning related investments. The implementation of Risk-sensitive development measures through the Community Resilience Framework begins with sound planning at all levels—not just the national level but also the community and local government levels.Because of this, the DRM planning process should be based on knowledge of the risks, levels of exposure and vulnerability that exist in a particular region, especially in those that are most vulnerable**..** Therefore, ensuring the robustness of development strategies depends critically on the integration of DRM into the planning process. The DRM's 5 pillars are: "(i) **Identification of Risk**; (ii) **reduction of Risk**; (iii) **preparation**; ; and (v) **resilient recovering"**. [4]

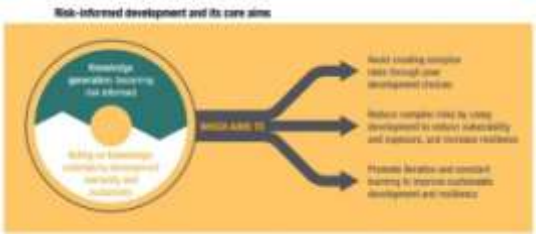


Figure 1 -Risk informed development core aims
Source [3]

Risk Sensitive Development Planning " a case study from Sri lanka

A score, indicator, or index to evaluate risk-sensitive developments at the community or division level was developed from this study to assist policy decision-makers in making informed decisions about future development investments..

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Every development plan, from the local to the global scale, will go through a assessing procedure for disasters and global warming and climate related risk sensitivityLow susceptibility to catastrophe and climate risks and strong resilience towards hazards are the ultimate goals of risk-sensitive development[4]

Risk Informed Urban Planning -Bangladesh case study

Bangladesh is a risk-sensitive nation, andas such, the Urban Development Directorate (UDD) and Ministry of Housing and Public Works are collaborating on a pilot project called "Development Plan for Mirsharai Upazila, Chattogram District: Risk Sensitive Land Use Plan (2017-2037)".If the region's pilot project is deemed effective, it will be implemented in other regions as well.Seismological surveys for earthquake risk assessment, landslide likelihood assessment, water logging evaluation, groundwater contamination assessment, and status of biodiversity evaluation are just a few of the assessments being carried out as part of this project. A Land Suitability Map would be produced by combining all of these evaluations[5]

Spatial Analysis of Flood and Landslide Vulnerability Areas (Case Study of Trenggalek Regency)

This mapping methodology may provide a thorough understanding of the flooding risk and potential for risk evolution, like the emergence of diseases linked to flooding. Rainfall, soil permeability, vegetation (land cover), gradient, and land use form were some of the flood risk elements that were taken into consideration. Floods' geographic dispersion could be foreseen using the five parameters. The amount of flood disaster and land use were combined in this model to determine flood risk. Each risk factor were assigned a set weight based on its influence on a flood to determine the level of flood disaster. Given a greater weight since rainfall has a greater influence than slope, heavy rainfall receives a higher score over light rainfall within the classification of rainfall.Rainfall (weighted at 40), slope (weighted at 25), vegetation (15), soil (10), and land form were the next criteria in order of increasing weight, assuming that the maximum weight was 100. (10). The largest total value indicated the largest level of calamity, andvice versa, according to the weighted score values. The flood risk map was created.[6]

The evaluation of landslides was based on five parameters.,:

1. Geology, includes stratigraphy, geological structure, rock weathering, and rock and soil physical and technical qualities.
2. Morphology, such as surface and slope.
3. Rainfall, including the duration and intensity of the rain.
4. Land use, including vegetation and land processing
5. seismicity, including earthquake intensity

The characteristics stated above were used to classify landslide vulnerability.Both elements were taken into consideration when creating a geographic model of landslidevulnerability. Each element was assigned a specific weight, analogous to flood risk mapping. Slope and geological qualities had the most influence,therefore they were each given more weight, while land cover and rainfall each were given less..

Total score = $\sum$ (score for each factor) x (weight) [6]

Combining Hazard ,exposure and social vulnerability -Rotterdam Case study

Inputs from flood risk assessments are used to evaluate flood risk management (FRM) tactics. Such risk analyses often offer estimates of the number of lives lost and the amount of financial harm. However, the effectiveness of risk-reduction policies also rely on households' ability to prepare for and respond to floods, based on social vulnerability. This case study demonstrates how an evaluation of FRM(Flood Risk Mitigation) techniques can benefit from a combined assessment of risk, exposure, and social vulnerability. Data on risk and exposure are integrated with an assessment of social vulnerability.[7]

Numerous socio-demographic traits have been identified as social vulnerability predictors. Wealth, age, and ethnicity are the most frequently used traits. Socioeconomic status, age, ethnicity, single-parent households, and the year the property was built are all factors that are taken into account by the SVI. Through insurance, social safety nets, and entitlement systems, greater money improves people's chances of preparing for disasters and recovering from losses. Age affects susceptibility in two different ways. On the one hand, families with small children may experience more difficulties when evacuating and may spend more time and money caring for them. On the other side, older households may have mobility issues that make it difficult for them to flee during flood occurrences, adding to the load on others to provide care[7]

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Both the percentage of kids under 14 and indeed the percentage of people over 65 are designated as vulnerable groups in this study because age is a key factor in social vulnerability. Since single-parent households frequently lack the resources to hire outside help to look after their children, an indication of these households is also used in the SVI. This may hinder the ability to withstand risks and recover from them.[7]

The year the house was built is also taken into consideration as a proxy for how vulnerable it is physically or structurally. Older properties are frequently more susceptible and less resilient to floods than newer properties due to changes in foundation type and interior wall construction. Hazard, exposure, and social vulnerability have been merged in this study to enhance the assessment of flood risk management measures. In locations prone to flooding, identifying socially disadvantaged people can aid policymakers in creating the best mitigation strategies. Areas with a high concentration of senior citizens may benefit from structural flood protection systems. Including both physical and social sensitivity in risk assessment studies allows for a complete examination of the efficiency of risk management strategies. While the results of a physical vulnerability assessment can point policy makers in the correct direction of a tactic that is effective in lowering flood risk, the addition of a social vulnerability evaluation will help tailor such strategies to local differences in capacities and requirements to implement strategies[7]

Responses in Nepal Tarai's Marginalised Basins towards Flood-Assessing Context of Flooding

A household survey and participatory rural appraisal (PRA) methods were used to produce the primary data.People's perspectives of floods, damage and impact on flood circumstances were the subject of shared learning dialogues (SLDs) at the individual, local, and national levels. The team's 25-parameter checklist was created after discussion with the surrounding community. These were its component parts: Physical, social, gender-related, economic, communication, resource access, and psychological issues are just a few. At each VDC(Village Development Committee), a total of seven SLDs with flood victims and key informants (KI) were conducted. In each SLD, every effort was made to have an equal number of men and women, but this wasn't always practicable. Local partners were requested to tour villages and ask women representative to actively participate in order to make sure that women were represented in SLDs. The frequency and length of the sessions were recommended by the community. In order to get the discussion's mixture of Bhojpuri/Maithili and Nepali languages transcribed in Kathmandu and summarised in English, all sessions were recorded. The SLDs were successfully carried out collaboration with regional NGOs.All VDCs' village-level adaptation action plans were conceptualised using the results of SLDs, hazard maps, vulnerability mapping, and PRAs conducted at the ward level[8]

IV.EVOLVING A FRAMEWORK FOR RISK-ASSESSMENT

An analysis of possible hazards and an evaluation of current Exposure and Vulnerability conditions that Jointly potentially harm people, assets, services, livelihoods, and ecosystem on which they depends help identify the type and extent of disaster risk.A large number of criteria that define physical, social, economic, and environmental characteristics can be used to analyse the vulnerability of households and communities holistically and qualitatively. In addition to being multi-dimensional, vulnerability is also dynamic [9]

Exposure rating (which includes infrastructure, productive resources, Facilities, and Human & social factors), and present level of reaction grading are the major inputs in this tool. For risk assessment, a grading system is used to each parameter. An improvement to the grading system is suggested to make the qualitative grading more reasonable. It is advised to rate hazards independently from vulnerabilities, and it is advised to create a risk matrix with two-dimensional hazard affect and vulnerability indices. Since hazard risk is a result of hazard impact and the vulnerability of the affected individuals, their joined matrix will provide the risk grade of the particular location.To aid in the recognition and understanding of existing and potential risks, stressors, shocks, and exposures hazards to both human beings and physical assets , the Quick Risk Estimation (QRE) tool was developed. Instead of doing a thorough risk assessment, the QRE Tool engages multiple stakeholders.[9]The hazard indicators in the QRE tool are in line with the SDG and the Sendai Framework, which runs from 2015 to 2030.[10]Risk assessment is conducted using a classification scale for each parameter, and a risk matrix is then created for each ward according to the parametres and Scoring method outlined by Local Self Government Department, 2022 through a government order "Guideline for Risk Informed Master Plan". It is suggested that risk impact and vulnerability ratings be completed independently, and that a risk matrix be created with the risk impact score and

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vulnerability index on two axes. This joined matrix provide the risk rating of the specific location.[9]

V.STUDY AREA-PATHANAMTHITTA

The Municipality posses total geographical area of 23.5 sq.km and total population of 37,538 as per 2011 census. Pathanamthitta municipality is located almost in the central part of the district. It is a major administrative centre of the settlements spread over Pathanamthitta district and functions as a service centre to the surrounding settlements.Muncipality consist of 32 wards. The River Achankovil forms the southern boundary of Pathanamthitta town. As per the District Urbanisation report, Pathanamthitta (2011) Pathanamthitta municipality is proposed as a first order settlement in the district. Combination of Agriculture, Plantation and tertiary activity has been identified as the activity of Pathanamthitta town. The economy of the region is agriculture oriented and primary sector activity is the character of the region

Figure-2 :Base map of Study area

Source[11]

The general slope and the consequent flow of drainage water is mainly tend towards the Achankovil River. There are numerous rivulets, which drain water from the northern uplands to Achankovil River. The main water source is from Achankovil River and also from minor streams.

Major portion of land is under Agricultural use (Dry agriculture use (9.13 Sq.Km) and Paddy (2.32 Sq.Km)). The Residential use having 9.08 Sq.Km which is 38.73% of total area comes after residential use[11] Paddyland conversion have intensified the problem of flooding and drainage. wards lying close to Achankovil river is being converted. Paddy lands are mainly converted into residential, dry agriculture, commercial, transportation, public and semi-public, industrial use. The rate of conversion of paddy and wet land is alarming in the town.

Pathanamthitta town have been isolated from the remaining part of the district due to inundation of water public transportation system has been disrupted even up to five days.

14.81% of the of the municipality experience flooding and the maximum flood level was about 9m[11]Land slide is common in Peringamala, Vettipram and Mailadumpara areas. Banks of Achancovil river, Nampakar thod, Broad and flat bottom valleys (paddy fields) at Kumabzha, Vettipram and Pathanamthitta town areas are prone to flood. Also the town is prone to moderate lightning and Earthquake having magnitude above 3.[11]

From Secondary analysis Pathanamthitta Municipality is prone to disasters such as Landslide, Flood, Lightning, etc . The municipal area has an undulated terrain with lots of hills and rocks.. The

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difference in ground elevation between Indian mean sea level and 15 m to 150 m. The general slope and the consequent flow of drainage water tend towards the Achankovil River. Major portion of land is under Agricultural use. 9.5 % of the total area of the town is wetland. . Paddyland conversion have intensified the problem of flooding and drainage. The rate of conversion of paddy and wet land is alarming in the town.During Mega flood 2018 All major centers of the district, including the district headquarters Pathanamthitta town have been isolated from the remaining part of the district due to inundation of water public transportation system has been disrupted even up to five days. 14.81% of the total area of the municipality experience flooding.

The Quick Risk Estimation (QRE) method was developed to help detect and comprehend present and potential threatsDisaster risk assessment appears to be the qualitative or qualitative method for evaluating the nature and extent of disaster risk by analysing possible dangers and assessing current situations of exposure and susceptibility which together may destroy lives, assets, facilities, lively hood, and the environment.Validation of Risk assessment in Flood prone areas implies combined effect of hazard and vulnerability will give Risk Intensity of an Area.

VI. VALIDATION OF RISK ASSESSMENT

Ward no 4 Vettipuram is prone to both Flood and landslide . Ward no 15-Kumbazha North is Prone to Flood.[12]

For basic validation of Vulnerability assessment and Hazard evaluation details of these wards are collected from secondary sources -Pathanamthitta muncipality publications , Pathanamthitta District disaster management report , Pathanamthitta Muncipality Master Plan etc.

Ward no-4 Vettipuram

Vettipuram is the 4 th ward of Muncipality with area 0.62 Sq .km and Population of 1078 thus population Density 1737 .Ward has a housing stock of 322 with 2 colonies (with 120 and 22 houses).Agriculture is the major activity of the ward and majority of people engaged in agricultural activities.Paddy and Rubber cultivation is Major source of income .Recreation area , Community hall, Religious buildings , markets etc present inside the ward.

Hazard Impact Rating

Table 1 Hazard Impact Rating

Parameter	Observation	Value (Scoring)
Intensity (Flood Inundation)	0-3 m Flood inundation in Residential Area and Paddy Field and River Bank 3-6 m (less than 50% of ward area)	4
Return Probability	1 in 10 years	3
Hazard Duration	2 to 5 days	0.67

(Source:Author Generated w.resp to Data collected from various secondary sources,Primary survey - 2023,interviews etc..)

Evaluating Hazard Impact at Flood planes of ward no 4 Hazard impact score = **7.67**/ 10

Vulnerability Rating

Table 2 Vulnerability Assessment (Social Vulnerability)

Parameter	Sub Parameter	Observation	scoring	Max score
Social (30%)	% Population Affected	Less than 25%	1.87	
	Economically backward population	104/322 Household Pink Rationcard(ie above 20%)	6	
	Women Headed Family	Below 10% (approx wardwise no unavailable)	1.5	
	Children with age less than 6	10% Population below 10 years	0.75	
	Senior citizen (above 60)	15-19% above 60 age group	2.25	

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	Differently abled population %	Below 5% (Exact no unavailable)	0.75	
	Transgender Population	Less than 2% (Exact no unavailable)	0.75	
	Socially Backward Population (SC/ST)	94 SC Houses in Kumbangal Colony(above 20%	1.5	
			15	30

(Source:Author Generated w.resp to Data collected from various secondary sources,Primary survey - 2023,interviews etc..)

Table 3 Physical Vulnerability Assessment

Parameter	Sub Parameter	Observation	scoring	Max score
Physical (20%)	Building type	More Moderate Houses Mainly in Colony	2.67	4
	Connectivity /access	Moderate Internal Road network (3-7m road)	1	3
	Building Age	Majority building 10-50years (According to Master Plan)	1	1.5
	No of Floor	Exact data Unavailable (few building have 3+ floors)	0.5	.75
	Road network	Less than 25% affected	1.05	4.2
	Railway	Not applicable	0.7	2.8
	Landcover	More Agricultural Land	0	3
			6.92	20

(Source:Author Generated w.resp to Data collected from various secondary sources,Primary survey - 2023,interviews etc..)

Table 4 Basic service vulnerability

Parameter	Sub Parameter	Observation	scoring	Max score
Basic service(20%)	Social Infrastructure	Less than 25% Infrastructure affected)	2.25	9
	Water Supply	Less than 25% affected (Majority own well)	1.5	1.5
	Sanitation	Not sevearly affected (not a centralised system)	1.25	5
			5	20

(Source:Author Generated w.resp to Data collected from various secondary sources,Primary survey - 2023,interviews etc..)

Table 5 Economic Vulnerability Assessment

Parameter	Sub Parameter	Observation	scoring	Max score
Economic (15%)	% Population in primary sector	More than 30% workers in agriculture sector	9	9
	% Economic activity likely to be affected	More than 20% agriculture activity (paddy , rubber) likely to be affected	6	6
			15	15
Environmental /Heritage (10%)	Ecologically Important area and Heritage Structure	No ecologically Important area and no Heritage Structure in the ward	2	6

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			1.33	4
			3.33	10
Coping Capacity(5%)	Presence of local Disaster management plan , Evacuation Plan ,Emergency Response team etc	Satisfactory coping capacity of Local body	0	5
			0	5
Total			45.25	100

(Source:Author Generated w.resp to Data collected from various secondary sources,Primary survey - 2023,interviews etc..)

Vulnerability Impact assesment of ward no 4 gives cumilative score **45.25**/100

Hazard Intensity Score is 7.67 and vulnerability Scoring is 45.25 thus their combined effect provides **H5 -High risk Intensity** for the evaluated ward .From Risk matrix H5 means risk intensity is between High and Moderate(Risk matrix)[9]

IV. CONCLUSION

Development may become more resilient and adaptable by using a risk-based decision-making approach known as "risk-informed development." By integrating catastrophe and global climate Risks and their mitigation into routine development decision-making process, risk-informed development can be accomplished. Risk-informed development gives populations living within the most vulnerable circumstances a higher priority when considering risks. It operates from the viewpoint of those who are themselves most at risk. RID (Risk Informed Development) enables sustainable development to transform into a tool for risk reduction, risk avoidance, and resilience building by incorporating Disaster -based decisions in growth planning and implementation through a framework of ongoing learning.The study gave an understanding of Risk , Exposure and Vulnerability and how it integately make an Hazard into a Larger Risk . Parameters and Indicators used for Hazard mapping , Hazard impact analysis , and Vulnerability assessment are analysed from various case studies .

Framework for Hazard impact assessment and Vulnerability assessment evolved with reference to Quick Risk Estimation Tool (QRE) by UNDRR.Study area Pathanamthitta Muncipality analysed based on topography , landuse distribution ,Disaster History , Hazard prone mapping etc . Scoring method used to validate a ward (vettipuram -4) to evaluate combined effect of Hazard impact of Flood and Vulnerability of the slected area.For further analysis and the creation of the Risk Reduction Plan, Sector level recommendations, and Land Use Plan, the risk assessment completed at the ward level .For the total hazard-prone area must be overlaid with the current land usage plan in Geographic Information System (GIS).

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