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Assessment for Adaptive Resilience Index in Kuttanad Wetland Region – A Case of Alappuzha

[1]Arundhathy.S, [2] Dr. Annie John

[1]*M.Plan student(Urban planning), Department of Architecture,TKM College of Engineering, Kollam, India*
[2] *Professor, Department of Architecture, TKM College of Engineering, Kollam, India*

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ABSTRACT:India's most vulnerable wetlands areas are found in the Kuttanad region in Alappuzha. It is the lowest location in India and one of the few sites in the world where farming is practiced between 1.2 and 3.0 meters (4 to 10 feet) below sea level. Natural disaster frequency and intensity have increased as a result of increasing risk exposure in wetland zones brought on by urbanization and the early stages of climate change. Building resilience to these challenges is the best method to enhance urban planning and management. This study set out to identify vulnerabilities while taking into account socioeconomic, physical, and geological elements to build a resilient planning approach for the Kuttanadregion.. Using the adaptive resilience index technique, the study determined the most vulnerable area in the Kuttanad region in Alappuzha district. Finding the most vulnerable regions in Kuttanad will help with the development of site-specific adaptation and resilience programs that are sustainable, efficient, and effective.

KEYWORDS:Climate change, Vulnerability assessment, Adaptation, Resilience

I. INTRODUCTION

The Kuttanad wetland system, which is a portion of the Vembanad wetland system, is renowned for the cultivation of paddy on land made by draining delta swamps in brackish waters at a depth of one to two meters below sea level.[2] The area is praised for its picture-perfect backwaters, lagoons, and canals as well as the resilient character of its inhabitants in the face of adversity. But still, as they deal with the devastating effects of climate change, the inhabitants of Kuttanad, who inhabit 62 grama panchayats in Alappuzha, Kottayam, and Pathanamthitta, are currently most concerned about recurrent floods, torrential downpours, and the incursion of saline water from the sea.[3] In addition to CO_2 emissions from fuel wood, other gas emissions such as SO_2, NO_x, and even methane from rice fields are also contributing to climate change in Kuttanad. The Kuttanad region is also characterized by background radiation that naturally occurs from the thorium-rich coastline and spreads throughout the entire wetland system, but its effects on the greenhouse effect have not yet been well studied and quantified. The Kuttanad region is also below sea level, making it susceptible to seawater intrusion due to the sea's rising level, which is thought to be caused by climate change. If the hazard is not sufficiently addressed, any rise in the amount of carbon in the air will eventually cause an increase in atmospheric temperature (perhaps by roughly 10^{o}C in the next 50 years or even less).

II. AIM

To identify the most vulnerable communities in the Kuttanad region in the Alappuzha district

III. STUDY AREA

Alappuzha district's Kuttanad, known as the "Rice Bowl of Kerala," is located right in the middle of the backwaters. Its abundant paddy fields are what gave rise to its unusual moniker. It is a sizable piece of reclaimed ground located in the district's interior, protected by dikes from water that is deeper than it seems. All who pass through this region while traveling by houseboats are entranced by the scenery of the countryside. Alappuzha is categorized as high land, low land, and medium land according to its physiographic nature, but Kuttanad is a region that belongs to the low land area and is vulnerable to the changing climate.[2]According to some theories, it may be the only location in the world where farming is possible up to two meters below sea level. Geographically, Kuttanad is made

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up of a sizable mosaic of fragmented terrain, characterized by rivers, long expanses of paddy fields, backwaters, marshes, ponds, coconut trees, and a system of canals. Paddy cultivation has been practiced in Kuttanad for many years.

IV. ASSESSMENT FOR ADAPTIVE RESILIENCE INDEX

A city's resilience over time can be assessed using the Adaptive Resilience Index. The Index provides insight into the multiple factors that affect and contribute to the resilience of the city by customizing the instrument to a specific urban situation.[4]The discussions and ideas surrounding the City Resilience Index, which was first proposed by The Rockefeller Foundation, served as the basis for this study's analysis and development. This strategy has been modified to fit within the framework of this research since it integrates resilience concepts in a significant way and is relevant to the study area (The Rockefeller Foundation and Arup, 2016b).[8]

Parameters	Dimensions	Sub dimensions	Very Low (1)	Low (2)	Medium (3)	High(4)
Social	Demography	Population density	<500	500-1000	1000-1500	>1500
		Population dependency	>20%	20-15%	15-5%	<5%
		Growth rate	<0.2	0.2-0.4%	0.4-0.6%	0.6-0.8%
	Health	Public healthcare facilities	Not satisfied	Facilities are there but in poor condition	Scope of more improvements	Highly satisfied
		Accessibility	>6m	5-6m	3-5m	<3m
	Education	Literacy rate	<90%	90%-95%	95%-97%	>97%
		Accessibility	>6m	5-6m	3-5m	<3m
	Risk exposure	Loss of infrastructure during floods	Very low damages	Low damages	Moderate damages	High damages
	Housing	Facilities in colonies	Poor	Average	Moderate	High
Economic	Agriculture	Production in each village	<500Ha	500-1000Ha	1000-1500Ha	>1500Ha
	Fisheries	Growth rate	0.2	0.2-0.4	0.4-0.6	>0.6
	Animal husbandry	Production rate w.r.t cattle	0.4	0.4-0.6	0.6-0.8	>0.8
Environment and Infrastructure	Transportation	Accessibility	>6m	5-6m	3-5m	<3m
	Water resources	Clean water access		No		Yes
		Presence of a drainage system		No		Yes
	Energy	Fully electrified		No		Yes
		Use of renewable energy		No		Yes
Governance	Policies and schemes provided for the integrated development			No		Yes

Table 1: Parameters Considered for adaptive resilience index

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	Social dimension	Economic dimension	Environment &Infrastructure	Governance
Weightage score	3	1	4	5

Table 2: Weightage score for adaptive resilience index

Source: (UN, 2020)

Table 3: Assessment of adaptive resilience index

V. ANALYSIS OF ADAPTIVE RESILIENCE INDEX IN KUTTANAD WETLAND REGION IN ALAPPUZHA DISTRICT

Based on the developed Adaptive Resilience Index, information was gathered from primary sources through meetings and interviews with experts and government officials at the national and local levels as well as secondary sources, such as researcher's reports and policy documents of relevant sectors, departments, and agencies of the city. On a scale of 1 to 5, each dimension, sub-dimension, and indicator were given equal weight, and the scoring was done using references from the literature and input from pertinent stakeholders. Most are given a weight of 1 and are seen as having equal relevance when contributing to the related dimensions, sub-dimensions, and index since they did not notice a significant difference in the weightings for the dimensions, sub-dimensions, and indicators. Based on stakeholder opinions, relevant standards, and standards in national regulations, such as targets in plans and strategies of the city, as well as references from other case studies, a score rating from 1 to 5 is assigned to each indication. Indicators are rated on this basis both numerically and qualitatively by the clarifications provided by the data and information gathered. Data aggregation was done to get a score for the sub-dimensions based on the score of the relevant indicators set from scoring the outcomes for each indicator. The score for dimensions with multiple sub-dimensions was also aggregated before the index score was determined.

The Adaptive Resilience Index (ARI) comprises four dimensions including Social-cultural; Economic; Environment and Infrastructure, and Governance. Then it is formulated with the use of criteria weighting, as illustrated in the equation:

ARI = (S.Sw) + (E.Ew) + (I.Iw) + (G.Gw)

In this formula:

ARI is the Adaptive Resilience Index

S is the socio-cultural score

Sw is the sociocultural weighting

E is the economic score

Ew is the economic weighting

It is the infrastructure/environment score, Inw is the infrastructure/environment weighting

G is the governance score

Gw is the governance weighting

Accordingly, since each dimension consists of several subdimensions, then the adaptive resilience of each of the four dimensions is calculated by applying a sub-dimension weighting as well, for example:

The adaptive resilience of the Socio-cultural dimension is calculated as in the equation:

S = (Sd1.Sdw1) + (Sd2.Sdw2) + … + (Sdn.Sdwn)

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	Social resilience	Economic resilience	Environment and infrastructure	Governance	Adaptive resilience
Champakulam	8.67	1.67	11	20	40.92
Edathua	9	1.33	11	20	44.33
Kainakary North	9	2.33	9	20	40.33
Kainakary South	10.67	2	11	20	43.6
Kavalam	6.33	3.67	8	20	37.97
Kunnumma	5.67	3.67	8	20	37.27
Muttar	7.33	1.67	10	20	39
Nedumudi	8.67	1.33	10	20	39.93
Neelamperoor	6.33	2	8	20	36.33
Pullikunnu	6.33	2.33	8	20	36.33
Ramankary	6.67	2.33	8	20	37
Thakazhi	8.33	1.67	10	20	40
Thalavadi	6	1.67	10	20	37.47
Vellyanad	7.33	1.67	10	20	39

Table 4:Assessment of adaptive resilience index

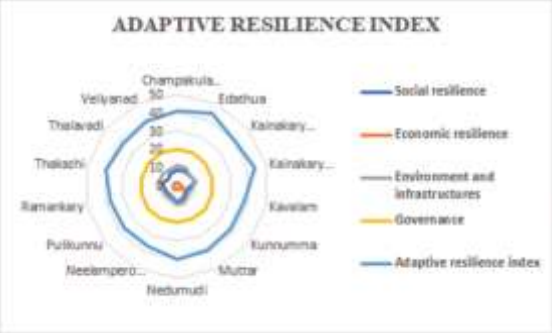

Figure 1: Adaptive resilience index of various Villages in Kuttanad

Figure 2: Resilience index of various dimensions

The economic resilience in the Kuttanad region is low as compared to the other three dimensions. Due to this reason, people could not earn sustainably throughout their life with changing climate change.The resilience of the economic sector is really in a bad condition to cope with the vulnerability faced in that region. The social resilience of the Kuttanad region is high compared to other regions.

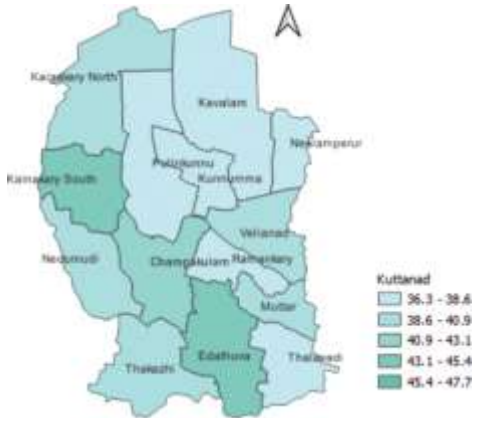

Figure3: Map of adaptive resilience index of Kuttanad taluk region

The adaptive resilience index is higher in Edathua and Kainakkary South region. The high resilience capacity in these regions will help to cope with the vulnerability of that region.

VI. CONCLUSION

The study used the adaptive resilience index in an attempt to determine which villages in the Kuttanad region were the most at risk. For the assessment of susceptibility, different parameters from diverse literature studies were examined. The most vulnerable communities in Kuttanad can be identified, which aids in formulating development initiatives for the region as a whole.

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