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Land Use Effects on Climate Change and Role of Social Capital in the Context of Cyclone Ockhi in Kerala

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Abstract : *Land use changes have made Kerala State extremely vulnerable to natural calamities and shifting climatic dynamics. Landslides and floods are the State's most frequent natural disasters. An initial assessment indicates that the State's coastal regions, especially South Kerala, have seen changes in land usage, which has led to climate change and increased susceptibility to cyclones and other natural catastrophes. The coastal community's social networking with other communities is too poor, which is likely the reason they are having a difficult time recovering after storm Ockhi in 2017. As a result, post-disaster rescue and relief efforts in Thiruvananthapuram indicate that there is likely uneven social capital distribution among various demographic and spatial/regional groupings, which has a negative impact on how victim's post-disaster demands are met. Therefore, this study uses satellite imagery and maps to investigate how land use and land cover affect climate change in the Ockhi-affected areas of the Thiruvananthapuram district. Using a primary survey conducted in two villages in Kerala hit by Cyclone Ockhi, it also examines the spatial distribution of social capital and how well it works in allocating relief aid to the victims. The findings indicate a notable shift in the land cover and land use in the Thiruvananthapuram district's coastal region between 2000 and 2018. Furthermore, the inability of the government to help fishermen develop resilience demonstrates a distinct spatial distribution of social capital between coastal communities and other groups. Thus, it appears that social capital is essential throughout the natural catastrophe restoration phase.*

Keywords: Climate change, Coastal Communities, Disaster aid, Geographic Information System, Ockhi, Social capital

INTRODUCTION

Being one of the most densely populated states in India (860 persons per square kilometer), Kerala is particularly vulnerable to natural disasters and shifting climatic conditions. In the state, landslides and floods are the most frequent natural disasters. Seasonal drought, lightning, forest fires, shoreline erosion, strong winds, and earthquakes are major hazards in Kerala (PDNA, 2018; Ministry of Earth Science, 2017). But over the past six years, the state has seen floods, the Covid-19 pandemic in 2020, landslides in 2018, 2019, and 2024, a powerful tropical cyclone in November 2017, and Ockhi. The coastline of the Thiruvananthapuram district was severely damaged when Ockhi struck the Kerala Coast on November 30, 2017. Kerala reported that the storm killed 75 persons and left 141 missing (Parliament of India, 2018). In Kerala, the worst floods since 1924 occurred seven months following Cyclone Ockhi. The state was devastated by torrential rains in 2018 and 2019, which caused landslides and flooding in all 14 districts. According to PDNA (2018), 433 people lost their lives and over 5.4 million people were affected. According to Government order No.(P)No.05/2018/DMD, the entire districts of Alappuzha, Ernakulam, Idukki, Kottayam, Pathanamthitta, Thrissur, and Wayanad were deemed to be affected by flooding, making them the seven worst-affected districts. Kerala's rehabilitation and restoration will cost Rs. 31,000 crores over five years. NGOs, philanthropic organizations, and individuals must collaborate with the government to guarantee the State's speedy recovery (PDNA, 2018).

Tropical cyclones, floods, and pandemics have devastated the Kerala's coastal communities. State provided support to fishermen's families during Cyclone Ockhi, flood, and Covid 19. Affected fisher families are attempting to start over a year after Ockhi (Scroll, November 29, 2018), indicating that the community has not gotten enough assistance and rehabilitation. However, the post-flood rescue and assistance actions are outstanding. There were no allegations of diversion of products, pilferage of citizens' money, irresponsibility of help givers, or a scarcity of food, mattresses, blankets, and medications at relief centres (Sen, 2019). This is in stark contrast to the assistance distribution following Ockhi, where the fishing community is still suffering. The allocation of following the catastrophe needs to victims has been negatively impacted by the probable imbalance in social capital

distribution among various demographic groups and spatial/ regional groups, according to Kerala's post-disaster relief and rescue initiatives. Social capital, to put it simply, is what holds people together. Thus, in the Thiruvananthapuram district's Ockhi-affected areas, the current study aims to investigate the implications of land use and land cover on climate change. It also examines the impact of several characteristics of social capital at community levels on disaster aid distribution in Ockhi affected areas. The major research questions in this regard are 1) What impact do changes in terrain and usage have on natural disasters in selected areas? 2) How social capital variations effect natural disaster recovery and help distribution?

REVIEW OF LITERATURE

The Indian subcontinent has significant yearly, interannual, seasonal, and decadal variations in surface temperature, as well as significant spatiotemporal variability in other meteorological indices (Gogoi, et al. 2019). Economic considerations frequently inform land use decisions, which are impacted by a variety of issues as a result of market globalization (USGCRP, 2018). Additionally, land usage reacts to weather and climate changes. The available literature reveals that through modifications to moisture influences the climate (Gogoi et al. 2019; Pielke et al., 2011). According to Bonan (2008), land usage and cover can impact land surface climate by altering temperatures and moisture. These alterations, as a consequence, result in natural disasters occurring in the separate regions in accordance with the geographical conditions of those regions.

In the aftermath of a catastrophe, social capital is an extremely important factor in the reconstruction process (Holling 1973, 2002; Mimaki Yukiko Takeuchi, Rajib Shaw, 2009; LaLone, 2012; Veszteg, 2015). The notion of social capital was initially introduced by Hanifan (1916) in his studies of rural school community centers. The term was rediscovered by Canadian urban sociologist Seely, Sim, and Loosely in 1956, as well as by Homans and Jacobs in 1961 and Loury in 1977 for the first time. The French cultural theorist Pierre Bourdieu and the American social theorist James S. Coleman are credited with developing the idea of social capital in 1980s. On the basis of Bourdieu's (1985) theory, social capital is created through the formation of social networks and interactions. In 1988, American sociologist James S. Coleman claimed that social capital is intrinsic to human relationships. Coleman's argument was based on the phrase 'social capital'. Robert Putnam defined social capital as relationships, standards, and trustworthiness that help people work together to achieve goals (Putnam, 1993; 1995; 1996; 2000). Putnam was the one who brought about the subtle transformations that were necessary for the concept to be understood. Social capital can be defined differently depending on the source. One example is the capacity of individuals to collaborate for the achievement of shared goals within groups and organizations (F. Fukuyama, 1995, 2001).

Research has shown that communities that have a bigger pool of social capital tend to be more effective in post-disaster rescue and recovery effort. The pace and ease of recovery depend on the event's magnitude and the social system's resilience to its effects (Holling 1973, 2002). According to Cannon (1994) and Wisner et al. (2004), it is true that the livelihoods of people and their access to social capital are the decisive factors in determining how well they are able to deal with and recover from a disaster. At the local level, social capital has a great capacity for building back up after recovery (Ardhana, 2005; M. Yamani, 2011; Hidayathi, 2018).

Social capital improves catastrophe preparedness, according to several research. Social capital improves disaster preparedness and recovery (Ardhana, 2005; M. Yamani, 2011; Hidayathi, 2018). The 1995 Kobe earthquake entombed hundreds beneath rubble and in destroyed residences, resulting in numerous fatalities. Friends, family, and strangers facilitated rescues and saved lives (Aldrich, 2012a, 2012b, 2012c). The majority of floods occurred in Bangkok in 2011. Pre-stocked food, water, and other provisions sustained 9 million families. Northwestern Sai Noi exhibited eccentric characteristics.

The Sai Noi community successfully resisted the flood. Untrained, the villagers of Sai Noi constructed barricades, filled sandbags along the hazardous river embankment, monitored flood levels, provided sustenance and hydration to affected families, evacuated those trapped in their homes, cared for the sick and injured, and remained vigilant against looters (Roasa, 2013). In Italy, stringent COVID guidelines for families, relatives, and neighbors reduced infection rates (Bartscher et al., 2020). Italy analyzed the labor patterns of various experts and officials. Employers and employees adhered to COVID-19 guidelines by wearing masks, sanitizing hands, and observing social distancing in the office (Kokubun 2020).

World Bank (2002) developed "Integrated Questionnaire for Social Capital Measurement, SC-IQ". Social Capital Assessment Tool (SOCAT), measures these characteristics (World Bank, 2000). It is a broader instrument for collecting data on social capital at household level, community level and organisational level (Grootaert and Van Bastelaer, 2000).

According to Mayor (2001), education boosts social capital in India. Serra (2001) identified Kerala to have the most social capital in India. A study of five Indian states by Blomkvist and Swain (2001) indicated that Kerala has the most associational life. Associational life in Kerala is strongest in agitation but weakest in civic consciousness (Jose Chathukulam and M.S. John, 2003). Babu and Sarada (2014) found that women micro entrepreneurs who belong to religion/caste-based groups, political parties, and saving groups perform better than others. In Sundarbans, India, Saswata Sanyal and Jayant K. Routray (2016) found that social capital functions as informal insurance against small-scale disasters. J.K. Behera (2021) studied social capital literature in Puri state, Odisha State, India, a disaster-prone state, from October 2020 to April 2021. Disaster victims received considerable support from bonding and bridging social capital, whereas linking primarily helped close contacts.

In this framework, land use and land cover trends, advancements, and consequences on people's lives, especially the poor, must be identified. Thus, this study examines how land usage and cover changes have affected climate conditions in Thiruvananthapuram district's Cyclone Ockhi affected areas from 2000 to 2018.

METHODOLOGY

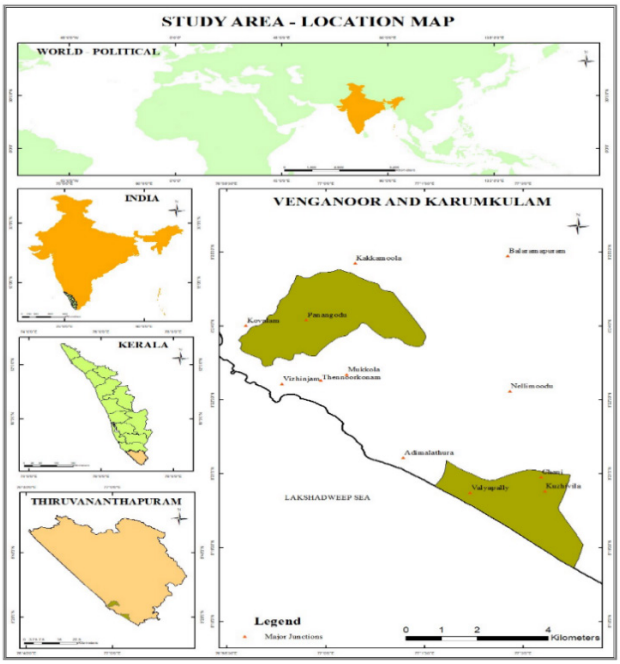
According to a recent assessment, the impacts of global warming are expected to increase the frequency of cyclones like Ockhi in the future (assessment No.211, Parliament of

India, 2018). Since the nation has recently seen disasters like cyclones in Odisha, floods in Mumbai and Assam, drought in Chennai, etc., the findings of this study assist policymakers in strengthening the role of social capital in improving community disaster preparedness as well as in rebuilding resiliently after recovery, both locally and nationally. Kerala has a relatively high level of human development when compared to other states. Coastal communities still lack sufficient social capital to access resources. Therefore, other states will also benefit greatly from research on the factors that influence social capital across communities and various geographical forms.

It is found that SOCAT (World Bank, 2000), with minor modifications, has been more suitable for the current study since it covers a variety of social capital aspects at the household and community levels. The study's methods include a review of the literature, maps and images from Google Earth, key informant interviews, focus groups, participatory methods, household surveys, and empirical analysis.

The study has selected two villages that were devastated by cyclones: Karumkulam Gram Panchayat, which is located in the coastal area, and Venganoor, which is located in the inland sector of Thiruvananthapuram district. The location map of the selected villages is given in figure 1.

Figure 1 : **Location map of study area**



Source: Compiled by the authors, 2023

All of these localities have been the subject of primary surveys. The sample households are selected using a three-stage stratification random sampling method, which includes block, village, and household levels. The interview process involves 60 households from each of the two villages, resulting in a total of 120 households, due to the comparable population density of the villages. The village assessment register is used to randomly determine participant households. A structured questionnaire is employed to gather data regarding their socioeconomic status, demographic profile, disaster aid received, and losses sustained. Additionally, queries are posed to evaluate the extent of social capital among the victims.

The following three aspects of social capital have been investigated: (a) structural aspect of social capital, which refers to network and association memberships; (b) cognitive aspect of social capital, which refers to trustworthiness and conformity to rules; and (c) collective action, which is a measure of output. The diversity of membership, participation in the decision-making process, the level of mutual support, solidarity, and trust, the extent to which conflicts are avoided, and collective effort to deliver services are the indications. In order to determine the latent variables of the various aspects of social capital, open-ended talks with the focus group or key informant interviews and surveys are utilized.

To determine the values of these variables, many scales have been employed. Using the formula displayed in Equation 1, the values of each of these variables have been normalized.

$$\frac{x_{ijactual} - x_{i\min}}{x_{i\max} - x_{i\min}} \quad \text{---------- (1)}$$

Where, X_{ij} actual = Actual value of the i^{th} variable for j^{th} households

X_i min is the minimum value of the i^{th} variable for all households

X_i max is the maximum value of the i^{th} variable for all households

The simple average of normalised values of these variables will lie between zero and one. The values of zero and one indicate the lowest and highest values of cases within the sample population. For the purpose of aggregating these standardized indicators into a composite index, weights that are either equal or unequal have been allocated to them accordingly. Existing empirical investigations of social capital data have revealed support for both the use of an aggregate index (either multiplicative or additive) and for the inclusion of individual social capital dimensions. This support was found to be supportive of both of these approaches.

The effects of changes in terrain cover and land usage in regions that have been affected by disasters have been depicted with the assistance of satellite imagery and maps of selected study areas. This has revealed the flaws in the current system intended to prepare for and recover from disasters. Furthermore, in light of the growing number of natural disasters that occur across the country, a study framework that is based on satellite imagery can be utilized to initiate appropriate risk informed development strategies and decisions at the national level.

The current research produced data sets on the amount of social capital that is present in coastal communities as well as communities that are located in inland village within the study area. There are two villages that each have their own unique map that covers the years 2000 to 2018. Inequities in the allocation of victim assistance are brought to light by the data sets that were developed on significant social capital factors for each of the two villages under consideration. Furthermore, in order to evaluate the effectiveness of the

disaster management system, the consequences of changes in land usage and terrain cover that took place in the study areas from the year 2000 have been documented.

RESULTS

In the village of Karumkulam, the figures 2, 3, 4, and 5 illustrate the various ways in which land usage and land cover have changed over time.

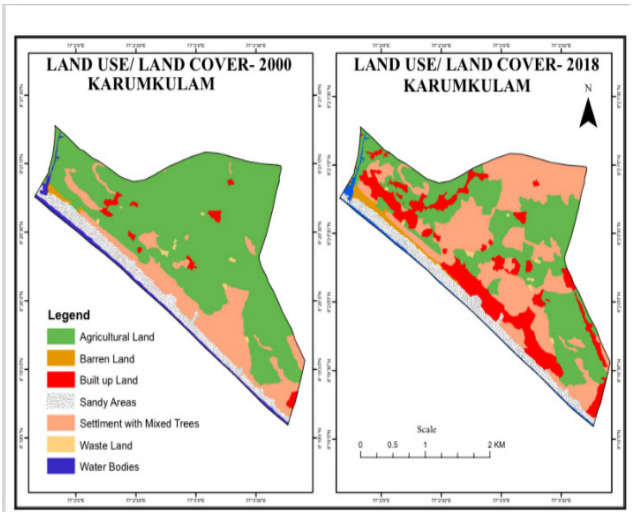
Figure 2: **Karumkulam Village in the year 2000**

After conducting an examination of Google Earth images taken in the coastal village of Karumkulam Gram Panchayat in the years 2000 and 2018, it was discovered that the land use pattern of the area under study has undergone a significant transformation. Along the coastline belt, the built-up area has risen by 500 meters. From what has been observed, the map of the study area does not exhibit a significant amount of evidence for beach erosion throughout the time period under investigation.

Figure 3: **Karumkulam Village in the year 2018**

The natural landscape has been seen to undergo alterations as a result of the presence of a stream in the northwestern region of the Karumkulam Panchayat.

Figure 4: **Land use / Land cover Change in Karumkulam Village**



Source: Compiled by the authors, 2023

It has been discovered that the Google Earth images of the inland village of Venganoor have revealed a higher rate of land-use change than was expected. The figures 5, 6 and figure 7 are an illustration of this fact. Based on the findings of the analysis, it can be seen that the population density in the hamlet has increased. All of the study area's agricultural land, with the exception of the wetland areas, has been developed into settlements.

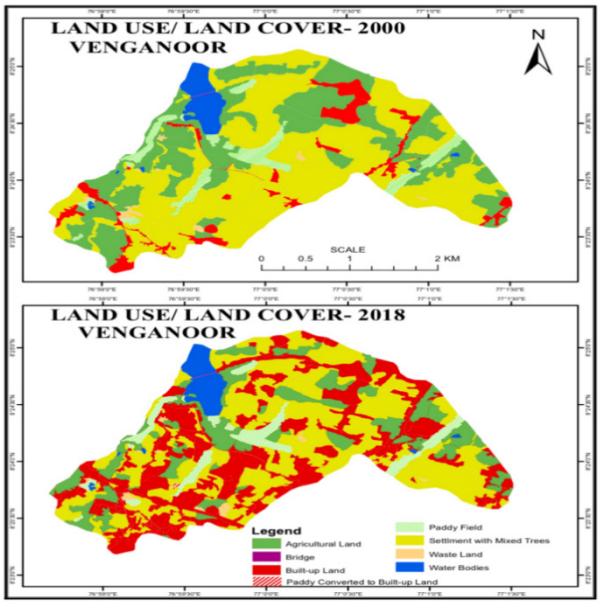
Figure 5: Venganoor Village in the year 2000

Along the highway region, there has also been documented evidence of a higher rate of expansion of built-up land. In the year 2000, a large algae bloom was discovered in the region surrounding Vellayani lake.

Figure 6: Venganoor Village in the year 2018

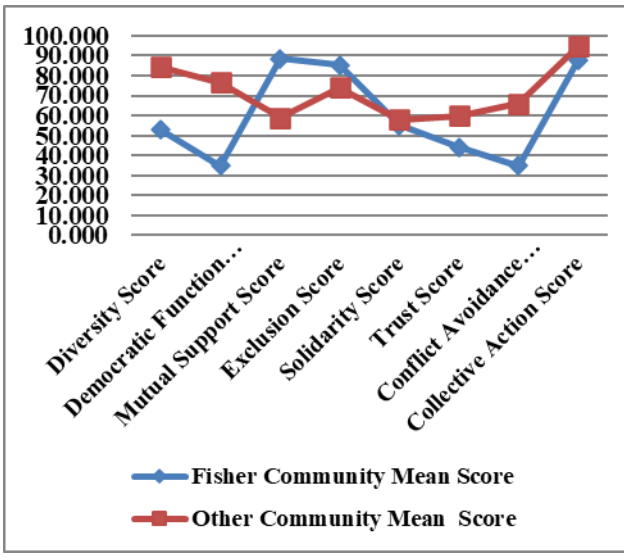
This is another significant alteration. It has been determined that the area has a siltation effect. It is estimated that approximately fifty percent of the lake was exposed to an algae bloom in 2018. Because of the heavy rainfall and the flow of fresh water into the lake, it is known that the process of eutrophication and the growth of algae are both prevented from occurring further.

Figure 7: **Land use / Land cover Change in Venganoor Village**



Source: Compiled by the authors, 2023

Figure 8: Score of Indicator Variables for Comparison



Source: Compiled from primary survey, 2023

The disparities between coastal and inland towns in a number of social capital aspects are evident in Figure 8. It is discovered that while all other social factors, particularly the diversity score, which shows membership in associations and networks, and the democratic function score, are high among inland communities, the mutual support and exclusion scores are high among coastal communities. It is an obvious sign that the inland villages have a large amount of social capital.

DISCUSSION

According to a sample survey in two cyclone affected villages in Thiruvananthapuram, 98.5 percent of Karumkulam's coastal homes live below the poverty line. This region's 95.6% of households are below high school. 21.3 percent of homes in Venganoor are below poverty line, and 65.8 percent of respondents are graduates. This highlights the social and economic disparities between coastal settlements and inland regions. Coastal villages survive on fishing. Their daily cost could be 500–2500 rupees. The housing condition in fishing settlements is poor, and about 80 percent of survey respondents reported inadequate toilet facilities. Their only source of sanitation is public toilets, which cost one to five rupees. Their membership in at least one group has been identified. Living standards are much higher in inland communities. At least one inland village family member works in a Gulf country in 35.1 percent of the households. At least one family member works in the government for 28 percent of survey respondents. All represent at least three organizations.

CONCLUSION

The land use pattern of the area under study has changed significantly in response to weather and climate changes, according to an analysis of Google Earth photos taken in both villages in 2000 and 2018. Settlements and commercial structures have taken the position of the coastal belt that was previously occupied by coconut cultivation. In addition, a linear pattern of settlement development occurred along main roadways in the area under consideration. Nearly the entire geographical area of Karumkulam village has been distinguished by a transformative pattern of land use, which has resulted in the conversion of agricultural land into built-up land. Additionally, the data shows that Cyclone Ockhi had a more severe impact on coastal residents than inland residents. Due to inefficient aid distribution and limited social capital, they return to normal after a year and a half. However, those who live inland and have high levels of social capital are bounce back quickly.

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