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A Community-based Approach to Mainstream Human-Nature Interactions into Coastal Risk Governance: A case of Katrenikona, India

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Abstract

Coastal rural communities, being intricately associated with their ecological settings, are often highly vulnerable to climate change. Amongst the many approaches of reducing the coastal vulnerabilities and achieving climate change adaptation, a potential solution is to improve risk governance through integrated coastal zone management. The coastal risk governance signifies not only the actions of the state but also of other stakeholders, especially the local communities. Community-based approaches have also for long been advocated for effective adaptation and mitigation against climate adversities. While human-nature interactions can significantly influence disaster risks, this research makes an attempt to understand various decisions and choices that a coastal rural community makes based on such interactions to mitigate and manage the climate-induced adversities. Through structured interviews, this research first identifies the significant domains that reflect on the prevailing human-nature interactions, after which the choice modelling technique is utilized to comprehend the community priorities for better climate risk governance, with a specific focus on coastal rural settlements of Katrenikona (Andhra Pradesh, India). The application of this methodology resulted in the formulation of a baseline for local coastal governance, which can be useful for informing various levels within local governments. The baseline consists of an assessment of the different community resilience domains derived based on the prevailing interactions of local communities with their surrounding ecological elements and measured by indicators of local coastal governance. The concept and method for measuring coastal risk governance based on community preferences are potentially replicable, and it can help to track the progress towards longer-term coastal management and local climate adaptation goals. At the same time, it can be turned into a self-evaluation tool to assist the local governments in reflecting on pertinent pathways involving community actions for effectively managing various climate risks and ecological impacts.

Keywords: Coastal Risk Governance; Human-Nature Interactions; Community-based Approach

Introduction

From 1999 to 2019, the disaster occurrences around the world have sharply increased by 74.45% (EMDAT, 2019), as compared to the previous couple of decades. Among the main lands, Asia tops the world at 45.1% in categories of disaster occurrence as well as the number of people killed (50.5%) and the incurred econom-

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ic damages (49.5%) (ARDC, 2019). The anthropogenic activities, steering climate change, are quoted as few of the main reasons that have been instrumental in changing the intensity and frequency of disasters (SR15, 2018). Among other terrain, coastlines are in particular noted to be highly vulnerable to the consequences of climate change due to their close association with the oceans (IPCC SROC, 2019) and are exposed to a variety of disasters such as sea-level rise, cyclonic storms, tsunamis, etc. Coastlines are valuable assets to any region not only in terms of ecosystem services they provide but also due to the livelihood and economic opportunities they attract (Martínez et al., 2007). Recent studies have shown that the exposure of coastlines worldwide to disasters is expected to surge (Bathi & Das, 2016). Coastlines being highly complex systems (Jozaei et al., 2020), any decision taken as a part of recovery after disasters can change the future path of the resilience of that system (Allison & Hobbs, 2004; Gunderson & Holling, 2001). Housing the growing population, livelihoods, and a major share of socio-economic activities, the resilience of rural coastal settlements is faced with several challenges, since the local population predominantly depends on marine ecosystems for their daily survival (IPCC SROC, 2019). These settlements are often exposed to multiple disturbances, in the form of tropical cyclones (for instance, the Indian cyclones Amphan 2020, cyclone Fani 2019, etc.,), floods due to abnormal rainfall (Godavari Floods of India 2020), tsunamis (Indian Ocean tsunami 2014) and stormwater surges (Prince et al., 2020). Such catastrophic events impact the communities in several ways, and in some cases forever change the local footprint, infrastructure, and economy of the areas affected. Depending on the human-nature interactions locally, such events may have profound implications on natural resources and in turn on the people (Bajaj, 2020; Stern, 2007). As a response, many communities choose local-level adaptations to disasters, which has an influence on the overall coastal risk governance (Dronkers & Stojanovic, 2016).

Governance, in general, is understood as the interaction of a government and its citizens; in a sense that citizen participation also provides inputs to strengthen the governance at different levels (Moore et al., 2011). However, there is often uncertainty and ambiguity with respect to the interventions in planning decisions through this approach (Moser et al., 2012). Decentralization of coastal zone management to promote community-based approaches has been widely discussed in Asian countries, with an objective to cooperatively maximize the performance of delegated authority for managing coastal zones (UNFF, 2009). Countries like Malaysia are still between classic deconcentration and coercive devolution where the flow of power is directed from upper to lower levels in a diversified manner. Contrarily, Indonesia and the Philippines have been in the cooperative devolution and devolved experimentation stages where two-way partnerships with more concern to local capacities, resources, and solutions have been considered (Siry, 2006). In India, coastal settlements are governed at various levels by strategically designed policies included in the Integrated Coastal Zone Management Plan (ICZM), National Disaster Management Plan (NDMP), and regional development plans. Although the necessity to expand the scope of community-based efforts and communities to identify local risk reduction measures and implement them is highlighted in NDMP 2019, the community participation at present is still limited to short-term disaster preparedness and contingency planning (NDMP, 2019). Consequently, the local-level adaptive measures in the long term often mesh with the already existing national policies and make their implementation challenging (Sethi et al., 2021). At the same time, the inclination of communities towards adopting local-level adaptive measures emphasizes the need for amendment of existing disaster risk management strategies, which is possible through effective coastal risk governance.

Over that background, this study aims to understand the local perspectives of adaptation and contribute to governance by prioritizing community choices. This research particularly addresses the research question pertaining to the priorities of the local people, as to among the given choices leading to resilience, what would the natives prioritize? In doing so, this study emphasizes on application of choice experimentation using selected parameters in coastal rural settlements for mainstreaming human-nature interactions into coastal risk governance, followed by the interpretation of priorities of local communities which can act as an input for coastal risk governance. A case study of rural settlements along the coast of Andhra Pradesh, India which is a highly vulnerable (Prince et al., 2020) and heterogeneous region regarding social, economic, and environmental factors, has been selected for the purpose of this study.

Overall, this paper comprises five sections, including the introduction (Section 1). Providing a theoretical background, Section 2 defines the role of human-nature interactions in coastal risk governance and adaptation. Section 3 introduces the case of the selected coastal settlements and gives an overview of the adopted research methodology. The study results are presented in Section 4 along with critical discussions. Section 5 highlights the key conclusions and the future scope of research.

Theoretical background

Interacting closely with each other, human societies and nature have patently co-evolved within unique bio-cultural systems (Bergamini et al., 2013). Humans are interconnected and dependent on nature in many ways that are often complex (Liu et. al., 2007) and disasters result from the slightest disturbances in these complex interactions (Shaw, 2010). Understanding these complex interactions, therefore, paves way for reduced disaster risk and global sustainability (Liu et al., 2020). Particularly in fragile systems like coastal areas where the environment and its natural resources are conditioned by the actions of the society (Plag & Jules-Plag, 2013), the human and the natural systems emerge as overlapping components forming a holistic complex socio-ecological system (Schouten et al., 2009). The inherent definition of human-nature interaction in such systems varies over time based on governance decisions (Seymour, 2016). Greater changes observed in human-nature interaction indicate the transformation of that system, increased uncertainty, and a possible risk of disaster (Hossain et al., 2020). Different approaches have been evolved to deal with uncertainties, particularly after the events of disasters, and one of those prominent approaches is adaptation.

By choosing an adaptive approach, human behaviour deviates from its original state of response (Winterhalder, 1980). Hence, adaptations are often recommended as a part of recovery plans (IPCC, 2012). Disaster researchers and policymakers recognized the necessity to address adaptation concerns within disaster risk reduction strategies as a part of the Hyogo Framework for action: 2005-2015 (UNISDR, 2009). The United Nations Framework Convention on Climate Change (UNFCC, 2007) defines adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". It can either be a specific action, a systemic change, or an institutional reform (Shaw, 2010). Adaptation can be both beneficial as well as it can moderate the loss that would have been incurred otherwise, thus minimizing the adverse effects and maximizing the opportunity concerning the unmanageable climatic stressors (Le, 2019). In thecase of rural coastal communities, depending on the magnitude of human-nature interactions, adaptation options can have profound effects on the resilience and sustainability of the system (Garmestani et al., 2019). However, the adaptation aspects at a smaller scale are usually difficult to govern and mainstream into decision making, and the rural communities too, are often disadvantaged because of various reasons like little formal education, poverty (Lade et al., 2017), isolation, and vulnerability to disruption. This results in their opinions being unheard and concerns unaddressed in decision-making and policy development. In such cases, decisions and their successful strategic implementation become questionable, especially when the strategies do not suit the communities' needs.

This research particularly builds on the developed understanding that adaptation after disasters can abruptly affect human-nature interactions. The interactions in this context are considered as the interdependencies of social and environmental parameters. Considering the role of human-nature interactions in disaster risk and the gaps in governance in context of coastal areas, this study is aimed at preparing a framework that is community-based and mainstreams human-nature interactions for improving coastal risk governance. The framework proposed mainstreams human nature interactions into rural development planning with the understanding that by considering the interactions, ambiguity in decision making over adaptations can be reduced. The context of "mainstreaming" was to internalize the human-nature interactions into development decision-making and inform policy decisions on ecological conservation and human development through community participation.

Materials and methods

Study area

The east coast of India, along the Bay of Bengal, often faces tropical cyclones, storm surges, tsunamis, sea-level rise, heatwaves, and heavy rainfall, making many important cities and settlements vulnerable. In the state of Andhra Pradesh alone (location shown in Figure 1), which has a coastline of 972 km, almost 29 million people are vulnerable to a variety of disasters. Among the vulnerable population, 3.3 million reside within 5 km of the coastline (Prasad et al., 2020). For this research, two coastal rural settlements from Katrenikona Mandal, surrounding the Godavari delta region, were selected namely, Balusutippa, population 5468 (Figure 2) and Magasanitippa, population 576 (Figure 3).

Earlier, various studies have demonstrated that handling floods around the coastal region often poses a lot of challenges and calls for integrated solutions

to comprehensively address the arising issues (Habibi et al., 2021). The Godavari estuarine region is the second-largest estuarine region in India (Satapathy et al., 2007). Katrenikona Mandal, situated in the East Godavari River estuarine ecosystem constitutes the second largest area of mangroves, along the east coast of India, providing significant ecological and economic benefits and livelihood services to the local communities. The selected settlements of Magasanitippa and Balusutippa are remotely located in Katrenikona Mandal, and often witness a frequent rise in sea level which inundates their major land areas. Fishing and plantations, followed by traditional occupations such as aqua-farms are the major livelihood sources for both the settlements. The communities in these settlements substantially rely on natural ecosystems for their primary income, particularly the ecosystems supporting diverse local fisheries including mollusks, fishes, prawns, and crustaceans (mangrove crabs, yellow crabs) (Figure 4). Both the settlements are often influenced by the impacts of climate change, urbanization, and industrialization due to natural oil resources available in their surroundings. Being located within the mangrove forests, the selected settlements have poor road connectivity and are largely disconnected from the neighbouring areas. Waterways are the only means of transport for these settlements and high levels of illiteracy were also observed in both the settlements during the surveys.

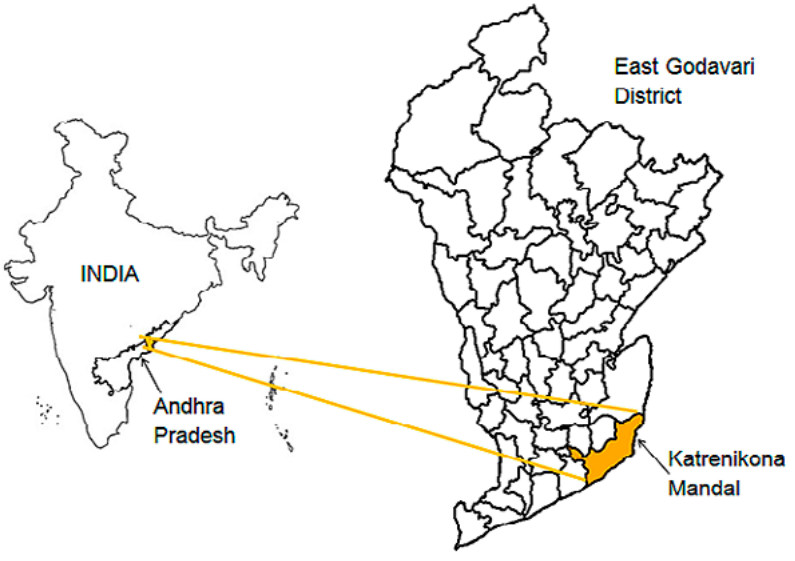

Figure 1. Location map of Katrenikona Mandal in India
Source: Authors

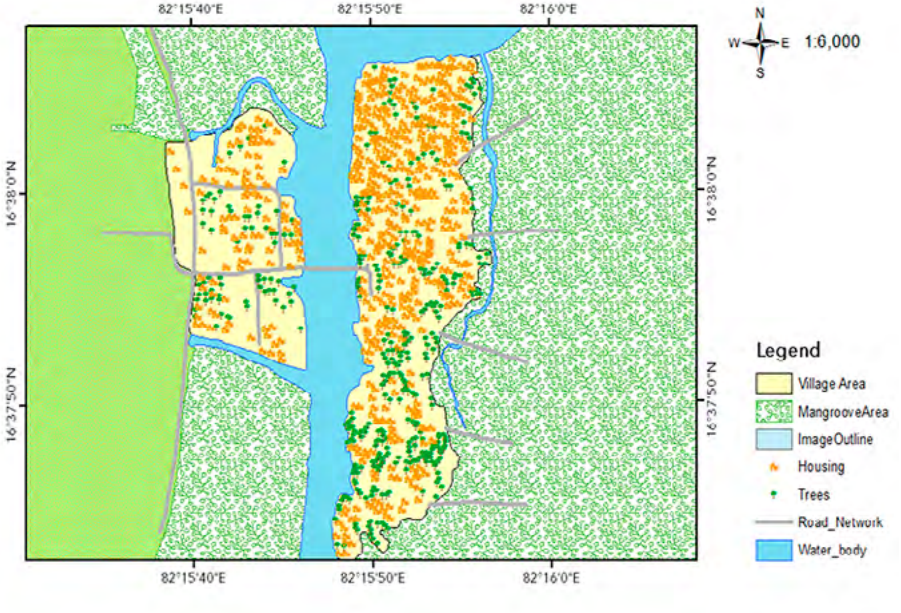

Figure 2. Case study settlement 1: Village of Balusutippa
Source: Author, based on Google imagery and ground surveys

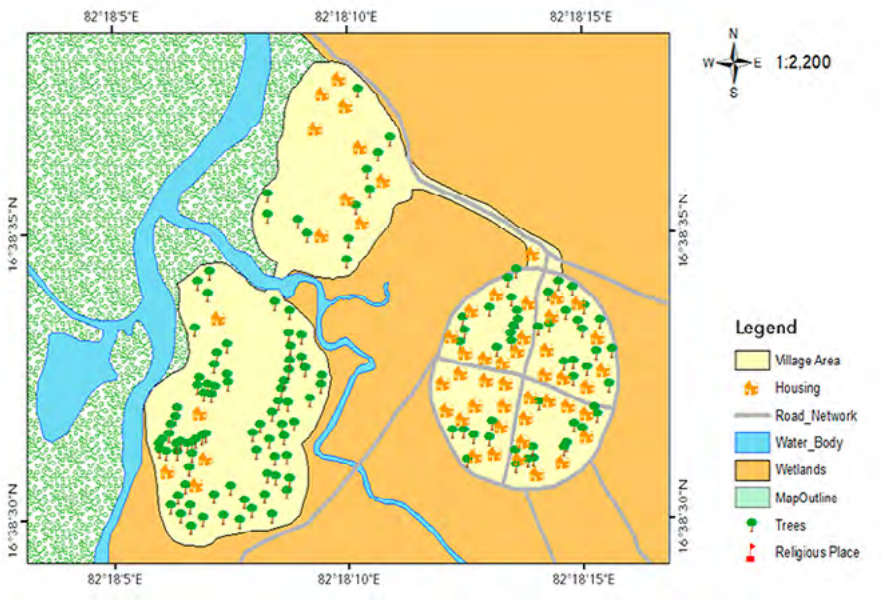

Figure 3. Case study settlement 2: Village of Magasanitippa
Source: Author, based on Google imagery and ground surveys

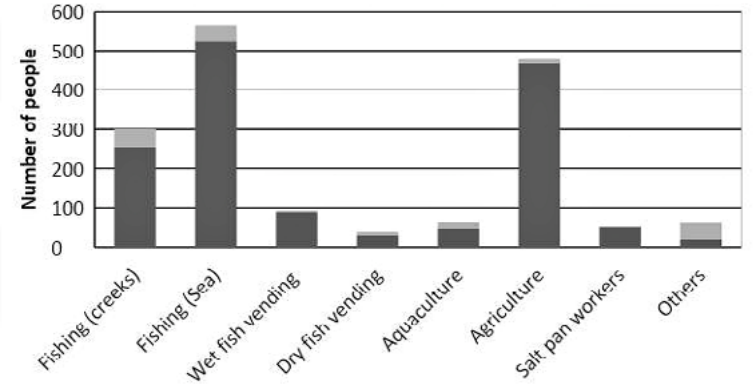

Figure 4. Major sources of income in Balusutippa and Maasanitippa
Source: Author, based on primary surveys

During cyclone 7B in 1996, both the selected settlements suffered substantial losses. However, over the past decades, owing to the effective warning and evacuation systems by the Government of India, there has been a considerable reduction in the number of casualties from cyclones (Marchand, et al. 2008). However, it is important to note that there is no accountability for the loss of ecological systems that communities have been traditionally dependent on for their livelihood. As a result, rural communities are increasingly becoming vulnerable to various climate disasters and are forced into a poverty trap.

Unfolding parameters

An indicator-based framework (Deshkar, et al., 2019) considering five dimensions and four indicators under each dimension has been applied to further this research. The immediate drivers in the system and their causal factors are critical to look at as separate entities because of the existing complexity in the system and various perspectives in place (Young, 2002; Lambin et al., 2003). The human-nature interactions, on the other hand, are subjected to change due to fluctuations in the system (Seymour, 2016). For this purpose, five potential dimensions that influence human nature interactions had been identified and considered for this study, which include Ecosystem Services (ES), Ecosystem Governance (EG), Livelihoods (L), Socio-Culture (SC), and Natural Hazards (NH). Choice-sets were broadly evolved under these sets of dimensions. The four indicators under each dimension were case study-specific and dynamic parameters identified on a situational basis (as shown in Figure 5). Indicator selection considered two primary interests, namely, the interdependence of humans on nature or nature on humans.

Ecosystem services, defined as benefits obtained from ecosystems, (Millennium Ecosystem Assess-

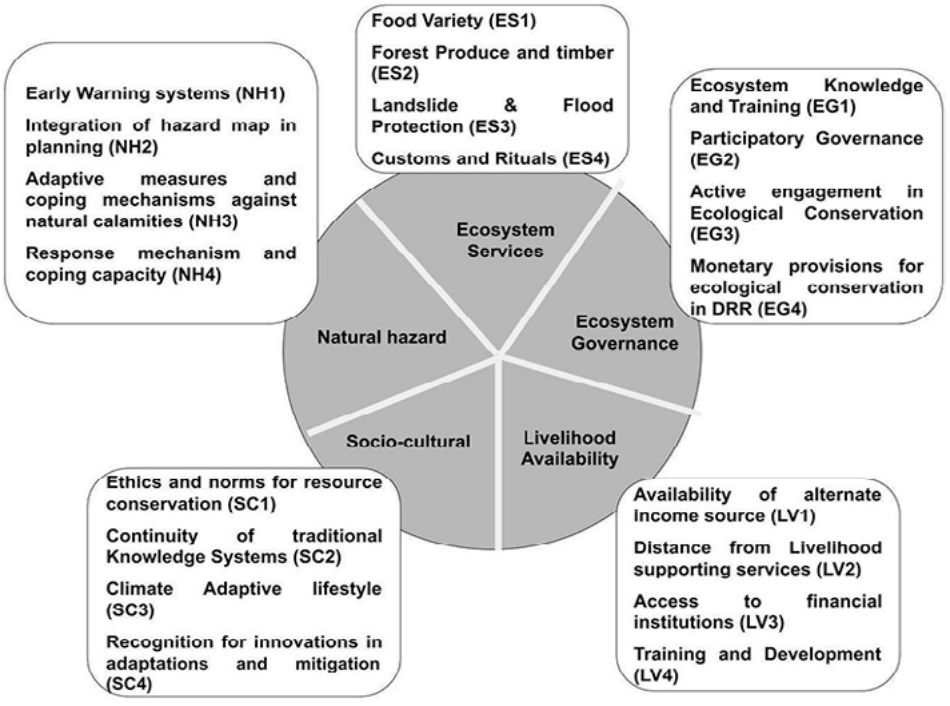

Figure 5. Dimensions influencing human-nature interactions and their relevant indicators
(Modified based on Deshkar et al., 2018)

ment Report, 2005) were bifurcated as indicators in terms of food variety; forest produce; water recharge and flood protection; and customs and rituals. Adequate food variety was also considered as an indicator of diversity. Further, Ecosystem Governance refers to the processes of decision-making involved in the control and administration of the environment and natural resources. The human population as a subsystem of a larger ecological system was referred to as the socio-cultural dimension in this context. Then, a person's livelihood has been understood as their means of securing the necessities namely food, water, shelter, and clothing. Building on the understanding that a shift from nature-based livelihoods to non-nature-based livelihoods can change the system properties and hence the disaster risk, shifting to a non-nature-based occupation is often suggested as an adaptation. The parameters influencing choice for nature-based livelihoods include the availability of alternative income sources (Thekaekara et al., 2013), distance from livelihood support services, access to financial institutions, training, and development (Dhanya et al., 2013). Therefore, the respective indicators as mentioned in Figure 5 have been selected for this study. Natural hazards, described as events beyond human control (Palm, 1990), have varying effects on humans, leading to increased vulnerability (Adebimpe, 2011). However, there are certain measures to reduce the impacts of natural disasters on the human systems. For instance, the early warning systems, integration of hazard maps in planning, adaptive measures and coping mechanisms against natural calamities, response mechanisms, and the community capacity to mention a few. Correspondingly, these were the indicators chosen under the dimension of natural hazards.

Choice experimentation

Perception-based studies are often used to demonstrate the social outlook over a particular issue which gives feedback to the adaptive measures and provides an evidence base to planning. Recent studies related to resident-perception towards environmental quality in Pathumthani, Thailand reveal that understanding local preferences could very well support the sustainable growth of cities (Iamtrakul & Chayphong, 2021). Therefore, the choice experimentation method is chosen to determine the coefficients of key attributes that contribute to disaster risk resilience. The survey format designed for the study comprises of two sections, the first of which includes a set of questions related to the socio-economic conditions of the residents and the second one entails the choice sets for all the study aspects. In the choice-based survey, the respondents were given two generic alternatives for each choice set, derived using two contradictory phases for four defined variables. The choice sets were shown to respondents and by analysing how they make preferences for different sets within a particular aspect, the implication of the individual indicators was evaluated. The estimated utility functions showed the perceived value of the indicator and how sensitive the community perceptions and preferences were for a change in

their resilience. These evaluations were then used to create models that helped to determine the best-suited development options from the community perspective. As there were four indicators defined for each of the five aspects, the study defined two contradictory phases for each indicator, the positive aspects being denoted by '1' and negative aspects by '0'. The combinations were done using the binary method in a way that no two choices were the same (as shown in Table 1). The choice sets were arranged in a different combination of the selected variables based on which the respondent had to select a preferred choice.

Table 1. Formation of choice sets for variables within one aspect

S.NO.	CHOICE A	CHOICE B
1	0 0 0 1	1 1 1 0
2	0 0 1 0	1 1 0 1
3	0 0 1 1	1 1 0 0
4	0 1 0 0	1 0 1 1
5	0 1 0 1	1 0 1 0
6	0 1 1 0	1 0 0 1
7	0 1 1 1	1 0 0 0

Source: Based on Deshkar et al., 2019

Data collection

The questionnaire was designed to facilitate choice modelling through the conduct of a choice experiment aimed at answering the basic research question: "Which of the following do you think should be the major priority for decision making in the region?" and the same was explained to the community. The disaggregated data for this research was obtained using choice modelling questionnaires during community consultation. It was conducted in the form of a survey involving 46 participants, in July 2016 for both the settlements. The sample of the participants in the workshops was identified through stratified random sampling, which included members of the local community based on their livelihoods and relation to mangrove fishery resources. For the ease of communication and improving interest, visual graphics were used for the choices displayed to the participants. The basics for the preparation of the questionnaire and understanding the scenarios in the village were obtained through a reconnaissance survey. The process of collecting the raw data during the community consultation survey comprised a display of the complete set of indicators to the respondents and analysis of how they make preferences between the given services. The implicit valuation of the individual elements making up the service was also determined. Considering the existing illiteracy and the duration of the process, a suitable format that combined text and a pictorial approach (Abley, 2000) was adopted. The survey questionnaires were explained to the community during a community consultancy survey, via display sheets, making it easier for the participants to intercept their choice of preference. After the end of the choice experimentation, a group discussion among the participants was conducted in the form of an interview to understand the reason behind their priorities. The study data was based on preferences among alternative combinations and was gathered through a group research survey. The final selected choices were the key intervening points (leverage points) to influence design actions.

Statistical analysis

The statistical analysis is based on logistic regression of different variables. The coefficients obtained by logistic regression are usually challenging to interpret because of the non-linearity and the complicated algebraic translations. Amongst all the choices of transformation, the log of odds is one of the easiest ways to understand and interpret the coefficient values and hence chosen for this study. An interpretation of the logit coefficient which is usually more intuitive is the "odds ratio". The relation p/(1-p) (where p is the probability of occurrence of an event in the design period). So, if we consider the exponent constant (e=2.72) and raise it to the power of the coefficient we get the odds ratio. The interpretation of the odds ratio can be done as one unit difference in predicator X corresponding to a multiplicative change of 'e to the power of coefficient in the odds of Y'. Thus, the exponentiated values of the coefficients (Odds Ratio) were calculated. Coefficients obtained through the logit model in R provided the basis for interpreting the statistical significance of each variable. The values of vectors of community resilience components were estimated for both the settlements.

Results and discussion

Livelihood Aspect of Resilience

Under the dimension of livelihoods, 'the alternate sources of income' (LV1) is revealed to have the highest odds ratio as compared to other sub-parameters of 'livelihood' (refer to Figure 6). This finding implies that the local people perceive that the alternate sources of income play a major role in strengthening resilience in their socio-ecological system. From the results, the local preferences for an alternate source of income also attest to the risk of the ecologically-based

occupations particularly in this region, and the low livelihood security. Specifically, the community members engaged in fishery-based occupations highlight the need for more effective policies on the conservation and the protection of natural resources and their quality. Building resilience to livelihoods is a complex policy issue, especially in highly nature-dependent systems. It involves a large and intertwined set of policies, and the involvement of multiple departments, to decide which alternative livelihoods are to be provided, so as to maintain the system in a stable state.

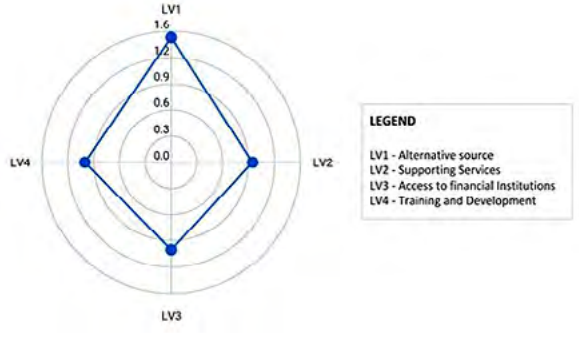

Figure 6. Odds ratio for livelihood parameters

Further, a few of the underlying reasons behind the highest priority given to alternate sources of income are identified to be the degrading fish catch per person, since the past decade, which is also mentioned in the works of Maheswarudu (2014); the low-income levels for people dependent on the ecosystem services due to lack of diversity in incomes and the geographical remoteness limiting the options of alternate livelihood income sources. Anneboina et al., (2017) and Ravikanth and Kumar (2017), have also previously underlined the mangrove-fishery linkage, considering fisheries as the main source of livelihood to many people of this area and in overall India, which relates factual in the study. The availability of alternative income improves the property of diversity and hence resilience in a socio-ecological system (Mallick, 2019). The diversity existing in a social-ecological system and the types of livelihoods reflect the interrelationships and sustainability in the coastal rural settlements.

Ecosystem Services Aspect of Resilience

Within the dimension of Ecosystem Services, the 'food variety' (ES1) has been locally considered to be the most important factor (refer to Figure 7). Earlier, Brown et al. (2008) have pointed out that the coastal poor tend to prioritize provisioning and regulating services, which is also found partially valid in this research. Though the highest priority was given to provisioning services, the next priority was given to regulating services and the least to cultural services. Considering the existing scenario, there is a severe salinity existing in the study region (Ramasubramanian et al., 2004), providing no option for the growth of a variety of food products. The next important sub-factor is highlighted to be the 'forest produce and timber'. As Dahdouh-Guebas et al. (2006) observed in the case of mangrove resource use, 97% of their sample accepted the rules of the forest department, to not access the mangrove timber from the forest, while some of the samples disliked the rule of high fines if the wood was to be collected. However, people in the study region argue that due to their isolated geographic location, accessing LPG was difficult. They also mention that the wood they prefer would be dried timber since they use it for cooking purposes only and they know the value of mangrove protection from cyclones. Though the selected settlements have access to resources like mollusks, river fish, and mangrove crab, access to mangrove timber is completely considered illegal. According to the recognition of the Forest Rights Act, (2006) accessibility to forest resources has been allowed based on the co-existence of the tribes with the forests in India.

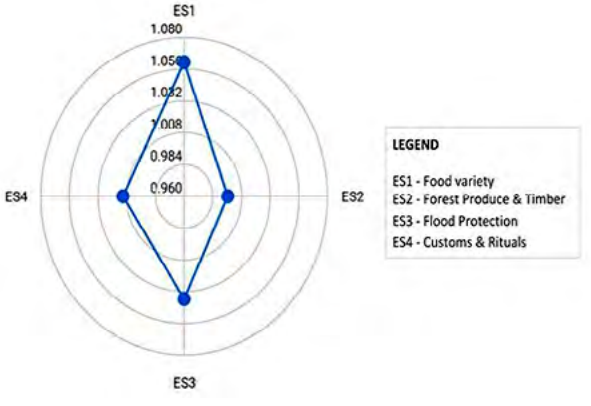

Figure 7. Odds ratio for Ecosystem Services Aspect of Resilience

Although a similar situation exists, the law states the access only to the scheduled tribe's community, the marine livelihood people are not legally allowed to access the forest resources, especially the dried mangrove firewood, which is also one of the critical observations in this study. A need to focus more on this area is also identified through this study to promote sustainable use of mangrove timber and improve community-based forest management. The high salinity in soils is identified to be a barrier to the improvement of ecosystem services. Around 90% of the selected survey samples pointed out the industrialization, specifically the oil and natural gas-based industries in the region, is the main reason behind the out-migration of the fishes, which could also be a point for further investigation.

Socio-cultural Aspect of Resilience

For the indicators of social-cultural dimension (refer to Figure 8), the highest preference was given to 'recognition for innovations in adaptation and mitigation' (SC4), followed by ethics and norms for resource conservation (SC1). Firstly, the recognition for innovations in adaptation and mitigation is another important parameter that encourages adaptation in the community. The community strongly believes that recognition would encourage innovation in adaptation and mitigation among the communities. Perhaps, the study results are also in line with the earlier study conducted by Gunderson (2010), which emphasizes 'episodic learning', as a need for the creation of new approaches to solving problems revealed by an ecological event. Innovations in socio-ecological systems in terms of livelihoods, lifestyles, etc., after a disaster event in these areas, should be recognized and encouraged, as they may improve the capacity of social-ecological systems against any adverse situations. The priority for recognition of innovation reflects the presence of already existing innovations, which must be recorded and recognized at some level of governance. Secondly, the ethics and norms existing in a community determine resource conservation at a smaller scale. For example, the community has a norm of not going for crab catching during the full moon day, which as an ethic had been followed for generations. Also, they are not supposed to catch a juvenile mangrove crab. The government norm of banning fishing during certain seasons allows the fish to reproduce and hence resources are conserved. Thus, the priorities justify the contribution to resilience in socio-ecological systems.

Ecosystem Governance Aspect of Resilience

During the choice experimentation process, the participants have recognized more importance for the sub-factor of 'ecosystem knowledge and training' (EG1) in the group of Ecosystem governance, followed by participatory governance (refer to Figure 9). Notably, training workshops were occasionally conducted by the Government of India through non-government organizations, for the conservation of biodiversity in the region as well as for the employment of localities as tour guides. A well-designed training session for the ecosystem knowledge for various age groups as well as various stakeholders is found to be necessary, as the communities mentioned the need for such knowledge and training. The National Disaster Management Plan (2019) considers vocational training and skill development as one of the strategies for disaster risk reduction. However, due to prevailing illiteracy in the region, the strategy did not suit the people.

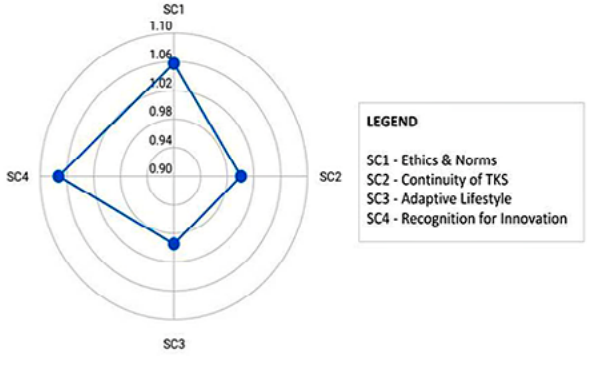

Figure 8. Odds Ratio for Socio-Cultural Aspect of Resilience

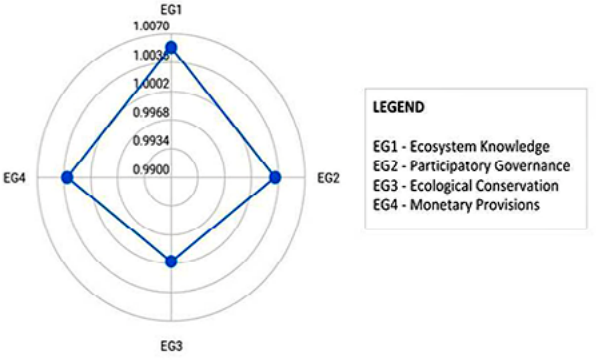

Figure 9. Odds ratio for Ecosystem Governance Aspect of Resilience

Natural Hazards Aspect of Resilience

It is to be noted that the 'Natural Hazards' dimension was given the lowest priority for its contributions to resilience in selected coastal settlements. This also implies that the existing practices, namely the evacuation, warning, and help received from the government at the time of disasters were considered to be adequate by the communities. Though some of the participants mentioned that river floods removed the salinity existing in the soils after a storm surge, the validity of the contribution of natural hazards component in the socio-ecological systems remains to be explored. Within the group of natural hazards (refer to Figure 10), the highest importance is given to adaptive measures and coping mechanisms against natural calamities. Also, the duration of early warning systems and their accuracy determines the vulnerability reduction. The present early warning systems could protect the lives of people, but it is important to note that the natural resources are still at risk, ultimately keeping the recovery of socio-ecological systems in question.

Further, the access to mangrove-based resources to the marine fishery communities and chances for improvement of community-based forestry remains to be investigated further. Also, this research has identified a need for immediate implementation of 'recog-

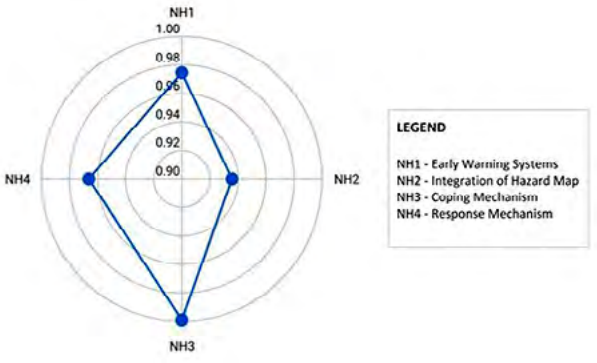

Figure 10. Odds ratio for Natural Hazards Aspect of Resilience

nition for innovations', innovations being one of the important properties for resilience in the socio-ecological systems. Since, at a community level, adaptation is highly preferred, it is important to dynamically take the necessary actions.

Based on the statistical analysis, the values so achieved through the logistic regression indicated the levels of significance for each component to resilience as shown in Table 2.

Community Preferences for Coastal Risk Governance

The results derived through this study underscore the priorities of local communities concerning various parameters that can improve resilience in the system. The overall schematic diagram for community preferences for resilience in selected coastal rural settlements is shown in Figure 11. The study results highlight that the strengthening of 'nature-based livelihoods' is the most significant factor that can contribute to the resilience in these coastal rural settlements (Figure 11). It has been chosen as a priority for planning and disaster risk reduction from a community perspective. The same has also been simultaneously explored through secondary data and further discussion with local communities. In both the villages, the locals believe that the prior focus on livelihoods with the appropriate governance of natural resources

Table 2. Level of significance of each of the selected parameters:

Level of Significance	1	2	3	4	5
	Livelihoods	Environmental Governance	Ecosystem Services	Socio- Cultural	Natural Hazards
1	LV1	EG1	ES1	SC4	NH3
2	LV3	EG2	ES3	SC1	NH1
3	LV4	EG4	ES4	SC2	NH4
4	LV2	EG3	ES2	SC3	NH2

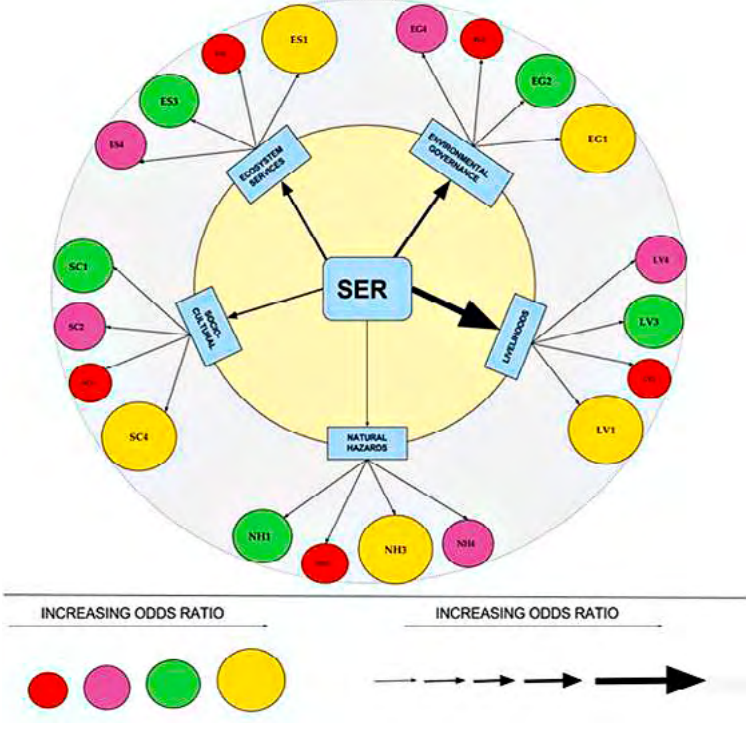

Figure 11. Schematic diagram for identified community preferences in Katrenikona

Table 3. Local priorities and their directions to future resilience and sustainability

Dimensions	Current status and contribution to resilience	Chosen Priority-based Directions of dimension for resilience and sustainability	Chosen Priority for the parameter	Chosen Directions for resilience and sustainability
Nature-based livelihoods	Decreasing and hence low contribution to resilience	↑	Alternate sources of income	↑
Ecosystem Services	Decreasing due to increased frequency of climatic stressors and pollution.	↑	Food variety	↑
Socio-Cultural	Decreasing - however, belief in tradition is not high. Technological and scientific methods are preferred.	↓	Recognition for innovations	↑
Ecosystem Governance	Stable	↑	Ecosystem Knowledge and training	↑
Natural Hazards	Normal.	↑	Adaptive measures and coping mechanisms	↑

would positively fortify the resilience in these coastal villages. Since nature-based livelihoods are worst affected during a disaster, strengthening them with modern technology or diversifying them is their idea for gaining resilience.

One of the arguments of mainstreaming human-nature interactions into development planning is that the funds need to be utilized effectively by focusing on parameters with changing human-nature interactions. By focusing on varying human-nature interactions, it is ultimately leading to reducing disaster risk and thereby resilience. For performing choice experimentation, this research has tried to understand the priorities of the local community for gaining resilience. Not all the priorities chosen by local communities can be sustainable. So, there is a need to examine their choices for consideration before mainstreaming into development planning. This process aligns the local level adaptation with global goals. Also, focussing on improving strategies through community preferences in these human-nature interactions could help reduce conflicts among stakeholders. Based on the derived research findings, Table 3 discusses local priorities and their directions to future resilience and sustainability.

Conclusion

Through conducting a choice experiment with the local people in selected coastal rural settlements of Katrenikona Mandal, this research has tried to uncover the priorities in the resilience components of human-nature interactions. Due to the illiteracy in selected communities, remoteness, and hurdles for use of technology, the conduct of the study was highly restrained, for instance, the language barrier due to which the visual display sheets were used for choice experiments. However, with improved technology, a similar method can be utilized at larger scale using software application aid. The use of animations or regional visuals can also create interest and overcome the challenges of conducting such a kind of data collection. Moreover, this paper essentially proposes the possibility of choosing human-nature interactions as a common measurable factor for achieving resilience. It also enables connecting among various levels. The paper supports the fact that changes in human-nature interactions occur predominantly at a local level and can be influenced by the decisions taken by the local communities. However, it is also important to note that any changes above or below the local level can influence the changes in human-nature interac-

tions. The rapid pace at which the coastal systems are changing requires governance and management strategies that are robust to uncertainty. This study stresses the role of community opinions in decision-making. However, opinions of communities in coastal risk governance are limited to risk assessment and experience. Evidence from the discrete choice experiments performed reaffirms that the communities' preferences can have a high impact on resilience as well as the transformation of the system. This paper sets the groundwork for working towards the possible desired trajectories in a system, as a way of interpreting changes in the community decisions and adaptations for future change under increasing uncertainty with a focus on variations in human-nature interactions. It also influences how decision-making can be mainstreamed into policy planning, hence contributing to improved coastal risk governance.

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