

# Climate vulnerability assessment and livelihood resilience of coastal communities: A Review of trends and Linkages

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## ABSTRACT

This article presents an approach to analyse the evolution of themes of climate change studies associating climate vulnerabilities and livelihood resilience focussing coastal communities in their socio-ecological systems. From a bibliographic perspective, researchers have addressed the linkage of climate vulnerability assessment and resilience at the biodiversity or species level, ecosystem and adaptation options etc., in relation to climate change. But, underscores the linkage and trends connecting livelihood resilience to climate vulnerability assessment in relation to coastal communities. This study proposed to fill this gap and attempts to explore the evolution of themes and research topics through traditional bibliometric and intellectual structure mapping including co-word analysis. The results will discuss the emerging topics using theme modelling from the published literature and depicts the multidisciplinary facets of climate change studies focussing coastal communities and strengthening the knowledge base of vulnerability and livelihood resilience in context to socio-ecological systems for coastal communities.

*Key words* : Social vulnerability, Coastal Resource dependency, Climate change studies, Socio-ecological systems, Thematic evolution

## Introduction

Over the recent decades, it has been found that the coastal communities residing near the coast have been affected by the climatic changes and its variability around the globe (Juan- Carlos Ciscar, 2011). The sea- level rise has been accelerated and coastal communities are witnessing the consequences of the sea level changes, coastal flooding patterns (Sajjad *et al.*, 2020), tidal erosion, infiltration of salt water (Rakib *et al.*, 2020) and associated weather patterns. All these dramatic effects may disrupt the community livelihoods options (Adger, 2003), or can causes multi- dimensional and long- lasting impacts on the coastal communities, especially for those where the

coastal resource dependency is high (Marshall *et al.*, 2013; Cinner *et al.*, 2011). Apart from the decline in marine ecosystem resources (Jongman, 2012), the exposure to the health impacts due to climate change are other dimensions added to the social vulnerability (Ashrafuzzaman and Furinin, 2019; Tauzer *et al.*, 2019). The combined impacts of climate change and influences are reflected in the increased sensitivity and exposure to the changes in life-style and livelihood of the coastal communities (Neumann, 2015). Higher the scale of exposure, the major chances of migration of communities to a non- coastal area (Codjoe *et al.*, 2017). In the past few years, significant international attention has been shown in assessing the social vulnerability and resil-

ience in terms of climate change. Such assessments have helped the decision-makers in building up of effective strategies to address the climate change (Chase, 2017).

According to the Intergovernmental Panel on Climate Change (IPCC), a structured framework has been more useful in validating the variables of vulnerabilities with respect to climate impacts (Sharma and Ravindranath, 2019). Vulnerability is a conscious effort to recognize that, a) multiple forces could be influenced by climate change and b) future ecological and societal vulnerabilities in the changing climate are often influenced. Vulnerability is therefore strongly associated with three principles that are core to these global frameworks:

a) Problem Framing (what is vulnerable, what the various vulnerability determinants are) b) Methods and data (what type of data and knowledge currently being utilized, models used to inform the vulnerability, tools being used to communicate the vulnerability) c) Adaptation (to what extent, adaptation is considered as a mean of addressing the vulnerability, are the adaptation options evaluated, practised and prioritised).

The present study is proposed to fill the gap and attempts to address the vulnerabilities of climate change in terms of livelihood resilience focussing on coastal community studies. The study helps in understanding concept of vulnerability frameworks and livelihood resilience of climate change in determining, (i) the issue of *what* is being researched by *whom*, and (ii) to present a thematic evolution of a given research field and mapping for detecting and visualizing conceptual subdomains. We do this by using the traditional bibliometric and intellectual structure mapping using statistical analysis and augmenting this with the emerging motor topics using theme modelling from the published literature. There may also be dialogue of the divergences and theoretical-methodological inconsistencies among resilience and vulnerability. The current study will aid to resolve this issue to an extent by exploring the methodological approaches through the thematic evolutionary structure of vulnerability assessments and social resilience focussing livelihood and social capital at the core narrowing for coastal communities.

## Materials and Methods

### Literature search and data processing

We conducted a multi-step literature search on

December 27<sup>th</sup>, 2019 using Scopus online research database, which is the largest and comprehensive bibliographic database. By searching "*climate change*" OR "*climate\**" in the titles, abstracts, or keywords of the Scopus English language articles published before 2019, we screened the climate change related articles from the other literature in the first step. In the next step, we extracted the literature further using "*vulnerability analysis*" OR "*vulnerability assessment*" OR "*vulnerability\**" as the Boolean search strings to sample the literature focusing on climate change and vulnerability assessment. As per the objective of the study, to analyse the livelihood resilience literature linking vulnerability and climate change, by searching "*livelihood resilience*" OR "*livelihood\**" OR "*adaptive capacity*" OR "*adaptation\**" was used. As the primary review is focused on coastal and social communities, the final search "*coastal communi\**" OR "*socio\**" OR "*socio-\**" was used to get the relevant extraction of the literature. After having the refined literature, the inclusion parameters such as considering only final published journal articles, last fifteen years (2005 to 2019), and top 2000 articles based on highest citation count were retrieved and used as a sample data for further analysis. The total sampled 2000 articles were used for further data cleaning and data pre-processing to detect the duplicity and relevancy of the articles. The bibliographic information of each sampled article was saved for further data analysis.

### Data and Cluster Mapping

#### Clusters and Mapping

The R-studio package was used for the analyses and clustering of the keywords. The clustering of keywords is often used for the mapping of science and linkage associations. The mapping of such analysis is revealed due to the keyword interconnections which are reflected as an outcome of clusters which denotes the themes of the domain literature. These clusters are important as they provide the research themes and is characterized by the parameter's 'density' and 'centrality' (Cahlik, 2000; Coulter *et al.*, 1998). The classification of these themes through the strategic two-dimension diagram drawn from both median and mean values of centrality and density reveals the themes into four groups. The x-axis represents the centrality and y-axis as density of keyword rank values (Cahlik, 2000; Callon *et al.*, 1991; Courtial, 1994; He, 1999). The centrality (also called as Callon's Centrality) measures the external

strength and association to other themes using the degree of interaction of network with other networks (Callon *et al.*, 1991). This provides the importance of themes in the line of development of entire research field in question. The density (also called as Callon's density) on other hand majorly focuses on measuring the internal strength of the network. This strength is based on keywords belonging to theme and number of keywords in the themes thereby indicating the theme's development. The four quadrants of the two-dimensional strategic diagram can be understood to be a set of research themes where each quadrant expresses the different themes.

The four quadrants of the two-dimensional strategic diagram represent the following themes and trends of the research field (Cobo *et al.*, 2011; Cahlik, 2000):

- The upper right quadrant represents the *motor themes* of the domain research.
- The lower- right keyword clusters in the quadrant represent the basic and transversal themes, which are important but are not developed.
- The upper-left quadrant keyword clusters represent the well-developed themes having internal ties but having no external connections.
- The lower-left quadrant keyword clusters represent weakly developed themes having low centrality and density values but marginal importance. They generally represent either emerging or disappearing themes.

The analysis will aid in understanding the knowledge development including growth of climate change vulnerabilities studies, livelihood resilience predominantly focussing on coastal communities. The multi-access of the research themes and evolution depicting multidisciplinary facets of climate change studies focussing coastal communities research. The discussion and analysis will explore the major research gaps and lead to future research directions including strengthening the knowledge base of coastal communities and vulnerability studies assessments based on results revealed.

## Results and Discussions

### Growing interest in Vulnerability and resilience studies focussing coastal communities

The literature analysis shows that there is a considerable growth of studies focussing coastal communities and climate change. These studies focus on the broad dimensions of vulnerability assessments, adaptive capacity, mitigation and resilience primarily. These dimensions were further explored in terms of investigating climate change impacts, sea-level rise impacts, scenario modelling, ecosystem services, integrated assessments, livelihood studies and governance mechanisms involved which describes the multi-facet research topics covered (Fig. 1). Particularly, the topics explicitly related to understanding climate change aspects in relation to so-

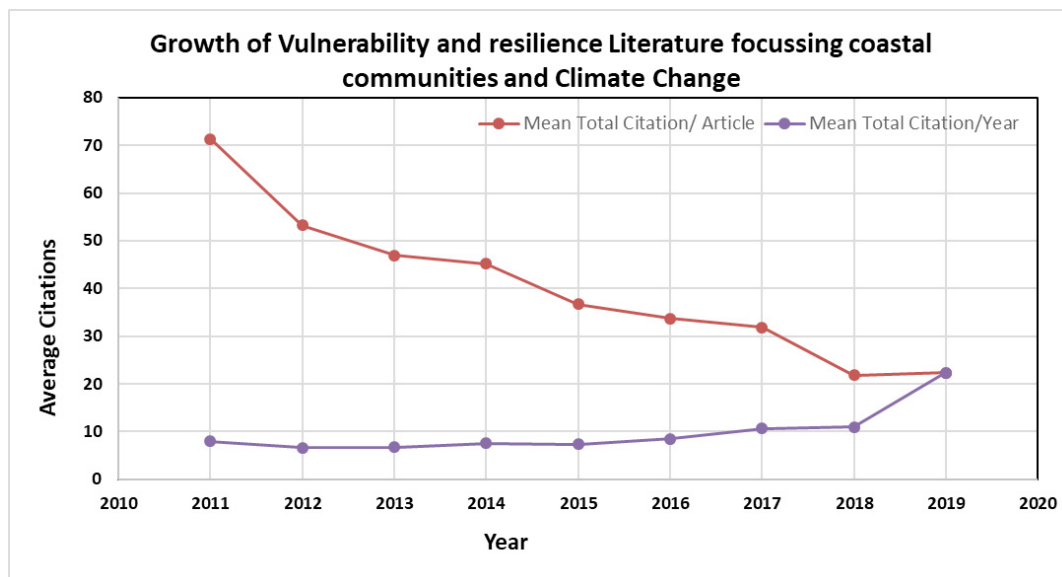


Fig. 1. Growth of Vulnerability and resilience literature focussing coastal communities and climate change (Source: Scopus)

cial communities impacts and adaptations which includes livelihoods and mitigation measures.

The linkage between climate change, vulnerability and adaptive management network includes the different key concepts explored covering namely climate effect, vulnerability, adaptive management, environmental policy, governance approach, nature-society relations, integrated approach, showcases the trends in the application of vulnerability assessment with their strong association with each other. In minimizing the negative effects of climate change in the coastal communities, the governmental & non-governmental agencies will need to do substantial investments in terms of the adaptive management (Neumann, 2015). This can be undertaken in context to the governmental approach and environmental policy to build up a strong resilience approach (Cinner, 2018).

Similarly, the association of climate change, biodiversity and ecosystem services includes the key topics reconnoitring environmental change, biodiversity linkages, ecosystem services and global warming. Many of the negative consequences of climate change are related to the ecosystem services that has provided food, shelter, fibre etc and these ecosystem services are directly interconnected with

the livelihood structuring and resilience among the coastal communities. The network depicts that the climate change and demographic effects are particularly prevalent for the damage towards the ecosystem services provided by the coastal communities. There is a slight increase in the number of extinct species of marine resources prevalent to the coastal communities due to climate change (Molua, 2018). This is a matter of fact that the climate change alters entire ecosystems along with all the species living in coastal community. Sometimes, a gradual climatic change allows the species to evolve and adapt to the new conditions within the coastal community. This results in the negative effect on local communities' livelihood.

The evolution structure of key topics suggests the change dynamics of researchers interests over a period of time. Over the past few years there is a seen a paradigm shift from generalizing the climate change impacts on health risks, agriculture etc towards the more refined approaches which includes vulnerability, uncertainty models, adaptation strategies, food security, livelihoods adaptive capacities. In the past five years the more focus of the studies is on the resilience, integrated impact assessments and sustainability aspects (Fig. 2).

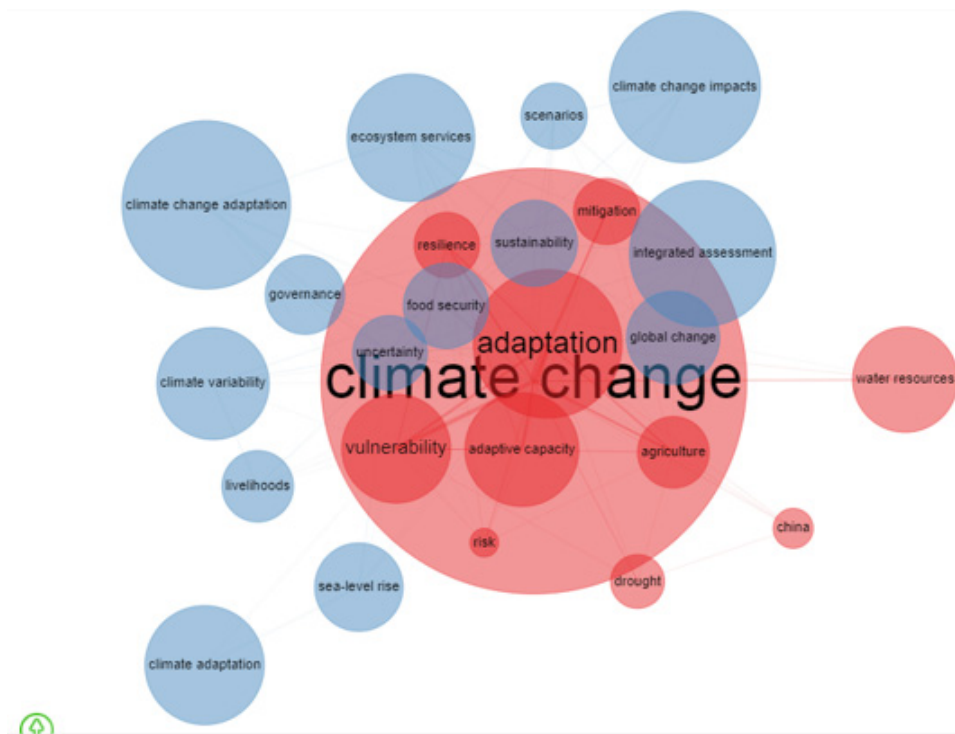


Fig. 2. Evolution structure of key topics in the domain

The cluster of studies demonstrating the climate change and human health assessment showcases the network cluster of the research which has a weak linkage of association with recent trends of the topics as the distance between the keywords is too far. The health of human beings living near the coastal communities does get impacted due to the climate change. It will affect weather extremes which will indirectly affect the clean air, food, water etc. Now a day, climate change is considered as a top priority risk in term of human health. The emerging of interconnected studies involving climate change and agriculture which further focusses on global warming, food security, food supply, crop yield, climate model and uncertainty models, showcases the climatic change effects on agriculture which leads to the complications in the food security, lesser crop production, crop yield etc. The large part of the coastal community is dependent on the agriculture and many places it is a secondary source of income for the coastal resource dependent communities providing a safety net to these communities. If there is an increase in temperature with respect to the optimum level, naturally there will be a decline in the crop yield (Mendelsohn, 2009) affecting the livelihoods and drastically transforming the community structures and thereby altering the socio-ecological systems. The other interconnected

cluster of topic flourished in recent years as identified from the results are the climatechange and water nexus exploring the water resources, water management, irrigation, water resources, drought management and water supply. There is a rise in the temperature of coastal waters as evident from the scientific studies and increase in the atmospheric concentrations of carbon dioxide are resulting the coastal waters to be more acidic. This increase in the acidic levels of oceans adversely affects the pattern and dynamics of coastal resource dependent communities as well as marine ecosystems (Rehana and Mujumdar, 2012). These will lead to the transformative adaptation and resilience patterns among the coastal dwelling communities and demands need for focussed research on these aspects of socio-ecological system change in terms of vulnerability and resilience to livelihood structures and impacts.

**Evolution of Research Themes and inter-linkages**

As compared to the generalized findings of the prominent key topics, this section describes the categorization of themes based on its evolution and development over a period of time. The two-way strategic diagram, which is based on the centrality and density measures of the keywords identified from the literature survey reveals the multitude of themes and its association presented in Fig. 3.

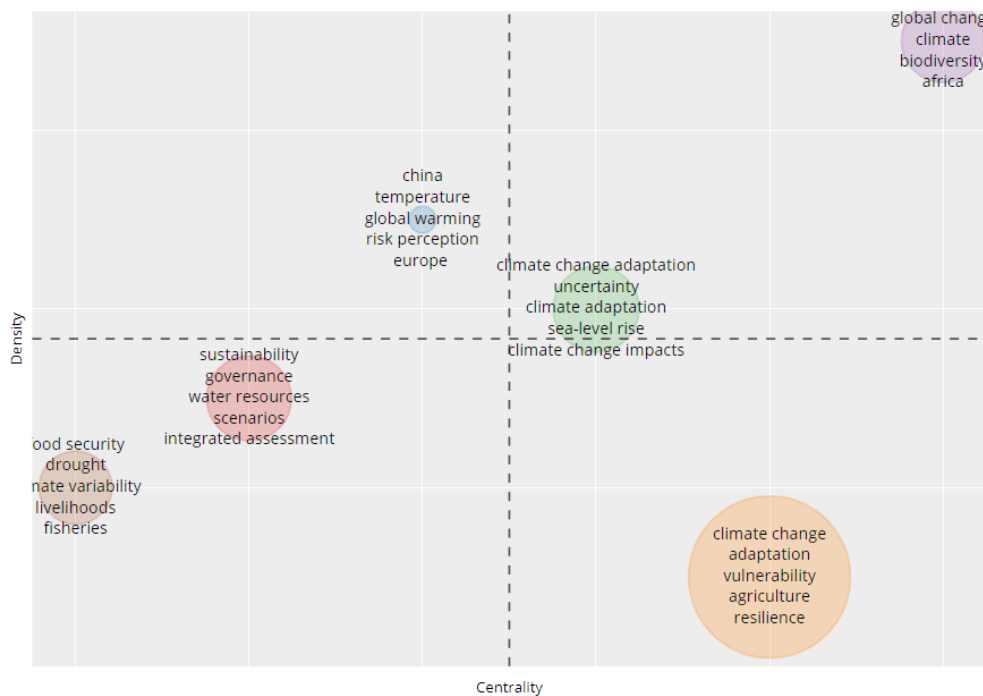


Fig. 3. Research themes and Research clusters evolved over the period of time



### Basic and Transversal Themes

- The motor themes of the domain research in the field of vulnerability assessment and livelihoods resilience for coastal communities are represented by the group of foundation studies related to climate change adaptations, its uncertainties' and the impacts because of climate change on global climate and biodiversity. These areas are also showing external linkages to the evolved concepts and allied closely related conceptual themes supporting and creating foundation pathway for other emerging researches in the area of climate change and communities (upper right quadrant).
- The study indicates that the basic divergence associated with the climate change and community studies involves the interdisciplinary as well as multidisciplinary approaches towards the resilience, vulnerability and adaptation. The majority of studies focussing on agricultural vulnerability and resilience of coastal communities (lower- right quadrant)
- The upper-left quadrant keyword clusters identified in the results depicts that the climate change risk perception studies associated with different phenomenon like temperature, global warming although are well developed themes but are of very marginal importance. These themes also represent its peripheral characteristics due to its very specialised in nature.
- The lower-left quadrant keyword clusters in the result although revealed as weakly developed themes but they signify the emerging discipline in the current context of climate change with respect to socio-ecological community systems. The result under this theme category depicts that community studies related to marine ecosystem-oriented livelihoods for the coastal communities are amongst the recent emerging key focus for researchers. The other emerging themes are related to science policy interface which prominently addresses the sustainability, governance and scenario-based modelling including integrated assessments for the marine resources.

### Discussions

The impact of global Climate Change in recent years has been studied by many researchers across three

key areas of impact, adaptation and mitigation. The present review study indicates strong focus on local coastal communities and their vulnerability to sea-level rise, flooding, high frequency of storms, warmer ocean temperatures etc. Climate adaptation and livelihood resilience studies and its association and linkages in the domain of coastal communities are explored with reference to a fifteen-year time line (2005-19). Maximum number of studies have been conducted in Bangladesh, India, China, and European countries etc.

The study showcases the emerging and recent themes in the research domain relying on tools for analysing impacts, perceptions and strategies prevalent to the livelihood resilience and vulnerability assessments. Investigations based on the scenario-based analysis will always be helpful in identifying the stressors on socio-ecological and socio-economic measures towards future climate adaptation approaches. Adaptation measures including social infrastructure improvements, such as capacity building, marine resource management, technological interventions, change in the perception including behavioural initiatives could be a future direction for assembling a comprehensive climate adaptation strategy for coastal communities.

A science based integrated model and amalgamated with governance practices can help policy makers effectively address the adverse impacts of climate change and livelihood options for coastal communities. At the global level, this study recommends that future reviews could include mapping vulnerability studies, livelihood resilience for coastal communities with the UN Sustainable Development Goals. Such a mapping process will provide a road map and existing gaps for future sustainable development which could be addressed by researchers.

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