14

ASSESSING VULNERABILITY OF COASTAL HOUSEHOLDS

Shyam S. Salim and Remya R.

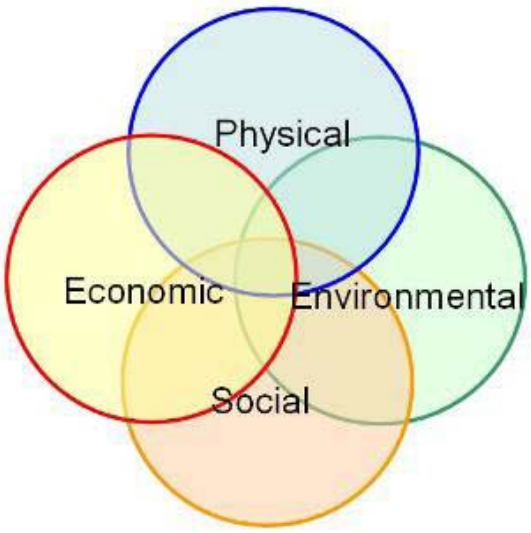
Definition

According to Intergovernmental Panel on Climate Change (IPCC), vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed; its sensitivity; and adaptive capacity (IPCC, 2001). Vulnerability assessment is the analysis of the expected impacts, risks and the adaptive capacity of a region or sector to the effects of climate change. A vulnerability index is a composite of multiple quantitative indicators that via some formula, delivers a single numerical result.

Theoretical back ground

Vulnerability is

- multi-dimensional (e.g. physical, social, economic, environmental, institutional, and human factors define vulnerability);
- dynamic i.e. vulnerability changes over time;
- scale-dependent (vulnerability can be expressed at different scales from human to household to community to country resolution)
- site-specific



Exposure (E), Sensitivity (S) and Adaptive Capacity (AC) are the key factors that determine the vulnerability of households and communities to the impacts of climate variability and change (IPCC 2007). Indicators for each of these factors are therefore essential elements of a comprehensive vulnerability. Exposure is the direct danger (i.e., the stressor), and the nature and extent of changes to a region's climate variables (e.g., temperature, precipitation, extreme weather events). Sensitivity describes the human-environmental conditions that can worsen the hazard, ameliorate the hazard, or trigger an impact. Adaptive Capacity is the

potential to implement adaptation measures that help avert potential impacts. The mean values of the three sub-indices of Exposure (E), Sensitivity (S), and Adaptive Capacity (AC) are combined to develop a composite vulnerability index by using the following additive (averaging) equation (Islam et al. 2014).

Vulnerability (V) = Exposure (E) + Sensitivity (S) - Adaptive Capacity (AC)

Practical Utility

The greater the exposure or sensitivity, the greater is the vulnerability, while the greater the adaptive capacity, the lesser is the vulnerability. Reducing vulnerability would involve reducing impact, or increasing adaptive capacity. Thus by adopting mitigation measures, a population vulnerable to climate change could be converted to a climate resilient community. A new framework titled 'CReVAMP' – "Climate Resilient Village Adaptation and Mitigation Plan" has been conceptualised for planning and implementing village level adaption and mitigation plan. CReVAMP is developed to identify existing climate adaptation and mitigation- probing alternatives and their trade-offs, sensitizing and improving the resilience of community towards climate change and initiating a multi stakeholders platform for developing a climate knowledge and information systems. This kind of bottom up approach would help the climatologists and policy makers to implement climate adaptation plans for the district, state and finally for the country (Shyam *et al.,* 2014).

Key words

Vulnerability, exposure, sensitivity, Adaptive Capacity, mitigation, resilient, CReVAMP, bottom up approach

Software support

The data can be tabulated in MS-excel. However, it may also be computed in software such as R, SPSS etc.

Data requirement

After selecting the study area which consists of several regions, a set of indicators are selected for each of the three component of vulnerability. A list of possible indicators is provided in the Annexure 1. The indicators can be selected based the availability of data, personal judgement or previous research. Since vulnerability is dynamic over time, it is important that all the indicators relate to the particular year chosen. If vulnerability has to be assessed over years then the data for each year for all the indicators in each region must be collected.

Methodology

1 *Data collection*

Construction of vulnerability index consists of several steps.

- First of all, a pilot study should be conducted to identify the coastal districts most vulnerable to a natural disaster within a state. After identifying the districts, the villages within the districts have to be earmarked for carrying out the study using Iyengar and Sudarshan method (1982).
- The second step is to classify the households from the selected villages. The data can be collected using a multi-method approach by employing stratified random sampling technique. Sensitivity, adaptive capacity and exposure data are collected using household questionnaires by identified / trained enumerators. Inorder to assess vulnerability at household level, the ward details of each study area has to be collected.
- Thirdly, local self-governments of each district involved in the study educated local people for further training, prior to the implementation of survey.

- In the fourth step, these selected people were trained in topics covering climate change, vulnerability, sensitivity, exposure, adaptive capacity and resource management. They were also specifically trained in conducting household surveys among fishers.

2 *Data Analysis*

The data collection aimed at identifying the extent of vulnerability as well as the component structure of vulnerability category measured by items with a Likert-type response scale and to summarize the data contained in numerous items into one or more subscales of vulnerability category that can be used in further models. A composite vulnerability index approach was used in this study to evaluate relative exposure, sensitivity, and adaptive capacity (Islam et al. 2014). A composite index approach calculates vulnerability indices using aggregate data for a set of indicators. Using the set of indicators the vulnerability of fishery based livelihood systems using the combination of individual indicator was quantitatively assessed. Since each indicator was measured on a different scale, they were normalised (rescaled from 0 to 1) by using the following equations

$$x_{ij} = \frac{X_{ij} - \min_i \{X_{ij}\}}{\max_i \{X_{ij}\} - \min_i \{X_{ij}\}}$$; if x_{ij} increases with vulnerability..... (i)

$$y_{ij} = \frac{\max_i \{X_{ij}\} - X_{ij}}{\max_i \{X_{ij}\} - \min_i \{X_{ij}\}}$$; if y_{ij} decreases with vulnerability.....(ii)

Where, x_{ij} and y_{ij} are the variables representing effects on the vulnerability indices. The values after normalisation are transformed into a four point Likert scale, categorised as 0-0.25, 0.26-.5, 0.6-0.75 and 0.76-1 which are assigned score values 1 (low), 2 (moderate), 3 (high) and 4 (very high) respectively. The mean values of the three sub-indices of Exposure (E), Sensitivity (S), and Adaptive Capacity (AC) were combined to develop a composite vulnerability index (V) by using the following additive (averaging) equation (Islam et al. 2014).

Vulnerability (V) = Exposure (E) + Sensitivity (S) - Adaptive Capacity (AC)

Thus, the overall vulnerability index was calculated each for the regions and the computation was attempted to arrive at vulnerability indices at household level. Respondents households were asked to opine responses referring to their knowledge on degree of vulnerability related to various aspects of climate change, livelihood and adaptation and mitigation options etc. Different components were identified under various categories like Exposure, Sensitivity and Adaptive capacity which were found to influence the overall vulnerability of the coastal population of both the study areas (Annexure –I).

Worked out example

The example for assessing vulnerability of coastal households has been taken from the GULLS (Global Understanding for Local Learning Solutions) project, which focuses on determining the social vulnerability of coastal communities in the hotspot countries of Southern hemisphere. In the present study, Poonthura village of Thiruvananthapuram district from the south west hotspot region is selected. The study determined the scope of developing village level adaptation and mitigation plan for the community through a comprehensive analysis of the community perception on climate change impacts, vulnerability and existing adaptation mitigation strategies.

Within the communities we targeted fishery-dependent households, which constituted 500 households

from Poonthura. The data was collected during 2014 using a multi-method approach. A stratified random sampling technique was followed to select response households. Participants were mostly head of households or an adult member. The method of data collection was unique with initially, developing relationships and rapport with the local self-government officials (Panchayath), line departments and women self-help groups within the communities by regular visits and focussed group discussions. Secondly, local self-governments of each district involved in the study educated local people for further training, prior to the implementation of survey. Thirdly, these selected people were trained in topics covering climate change, vulnerability, sensitivity, exposure, adaptive capacity and resource management. They were also specifically trained in conducting household surveys among fishers. Face to face interviews was conducted at household level which almost consumed an hour. Periodic monitoring and evaluation was done followed by a sensitisation workshop for the two study regions. In order to assess vulnerability at household level, the ward details of study area was collected. Poonthura village consisted of two coastal wards from where data was collected.

Out of the numerous indicators mentioned in Annexure 1, those respective to sensitivity, exposure and adaptive capacity were appropriately categorised. For each component of vulnerability, the collected data are then arranged in the form of a rectangular matrix with rows representing regions and columns representing indicators. Let there be M regions/districts and let us say we have collected K indicators. Let *Xij* be the value of the indicator *j* corresponding to region *i.* It should be noted that this type of arrangement of data is usually done in statistical analysis of survey data. Obviously the indicators will be in different units and scales. The methodology used in United Nations Development Programme (UNDP)'s Human Development Index (HDI) (UNDP, 2006) is followed to normalize them. That is, in order to obtain figures which are free from the units and also to standardize their values, first they are normalized so that they all lie between 0 and 1. Before doing this, it is important to identify the functional relationship between the indicators and vulnerability. Two types of functional relationship are possible: vulnerability increases with increase (decrease) in the value of the indicator. Assume that higher the value of the indicator more is the vulnerability. It is clear that higher the values of these indicators more will be the vulnerability of the region to climate change as variation in climate variables increase the vulnerability. In this case we say that the variables have ↑ functional relationship with vulnerability and the normalization is done using the formula

$$x_{ij} = \frac{X_{ij} - \min_i \{X_{ij}\}}{\max_i \{X_{ij}\} - \min_i \{X_{ij}\}}$$

It is clear that all these scores will lie between 0 and 1. The value 1 will correspond to that

region with maximum value and 0 will correspond to the region with minimum value. The values after normalisation were transformed into a four point Likert scale, categorised as 0-0.25, 0.26-.5, 0.6-0.75 and 0.76-1 which are assigned score values 1 (low), 2 (moderate), 3 (high) and 4 (very high) respectively. Thus, by doing the step by step analysis mentioned above, the results of Vulnerability of Poonthura village is represented in the table.

Vulnerability of Poonthura fishing village

Locations	Exposure	Sensitivity	Adaptive Capacity	Vulnerability
Poonthura	2.80	2.57	2.52	2.85

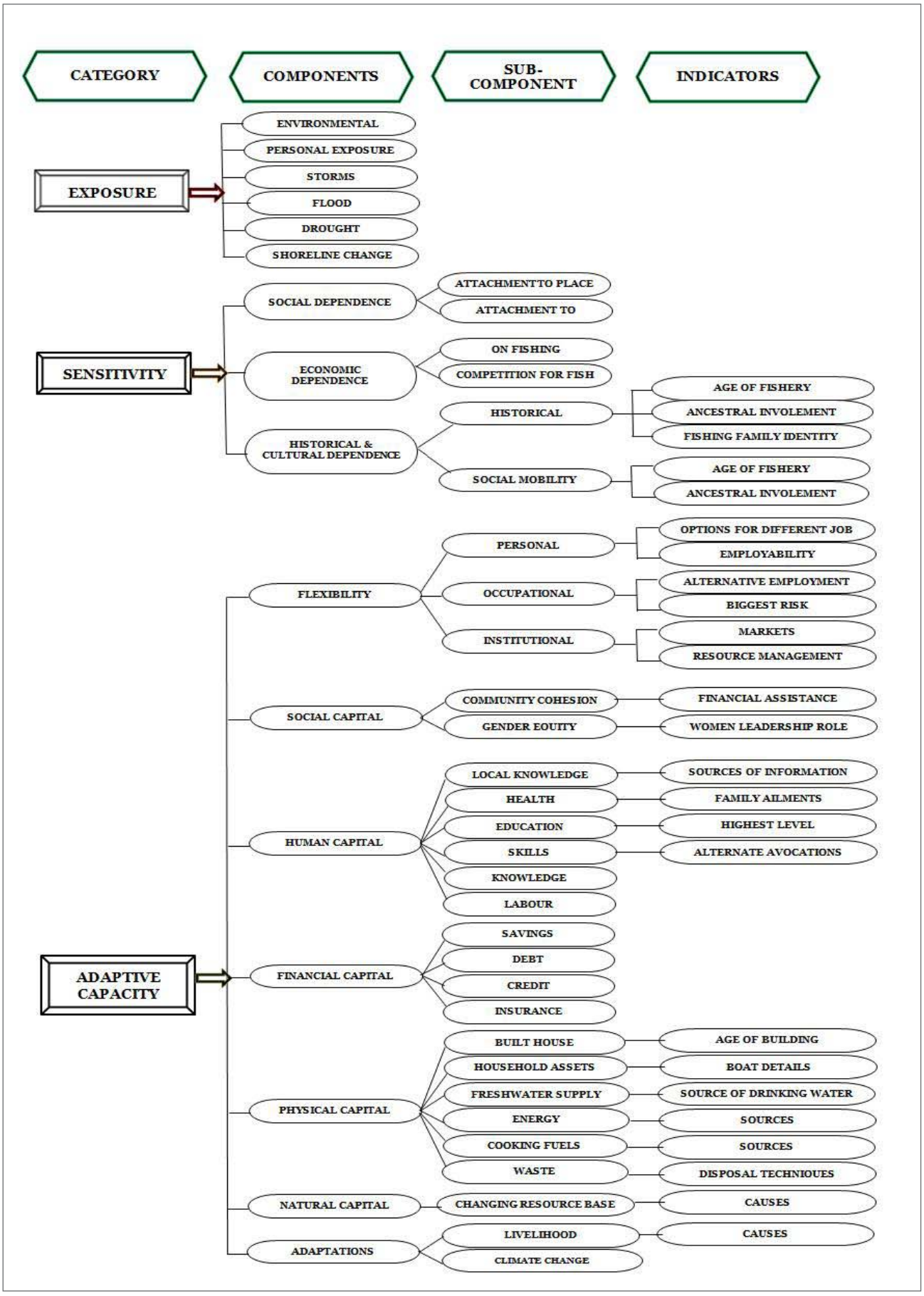
Interpretation of results

The overall vulnerability values indicate that Poonthura village is moderately vulnerable to climate change. The proximity of Poonthura village to the sea can be attributed as the major factor contributing the increase in vulnerability. In addition higher exposure on account of environmental changes, occurrence of drought and shoreline changes is also attributed to higher vulnerability in Poonthura. The adaptive capacity of the village is low when compared to exposure and sensitivity values, indicating the urgent need for developing appropriate adaptive interventions.

Suggested readings

- IPCC (2001) Climate change: impacts, adaptation and vulnerability: Contribution of working group II to the third assessment report of the Intergovernmental Panel on Climate Change. In: McCarthy JJ, Canziani OF, Leary NA, Dokken DJ, White KS (eds) Cambridge University Press, Cambridge
- Islam, M.M., Sallu, S., Hubacek, K. et al. Reg Environ Change (2014) 14: 281. doi:10.1007/s10113-013-0487-6
- Iyengar, N.S. and Sudarshan, P. (1982) A Method of Classifying Regions from Multivariate Data. Economic and political weekly, 17, 2048-2052.
- Patnaik, U and K. Narayanan, 2005. "Vulnerability and Climate Change: An Analysis of the Eastern Coastal Districts of India", Human Security and Climate Change: An International Workshop, Asker
- Shyam S Salim, Kripa V, Zachariah PU, Nivedita Shridhar, Ambrose TV (2014) Climate change awareness, preparedness, adaptation and mitigation strategies, fisher folks perception in coastal Kerala. Journal of Aquatic Biology and Fisheries, Vol. 2/2014. pp 670-681
- Shyam, S Salim and Kripa, V and Zacharia, P U and Mohan, Anjana and Ambrose, T V and Manjurani, (2014). *Vulnerability assessment of coastal fisher households in Kerala: A climate change perspective.* Indian Journal of Fisheries, 61 (4). pp. 99-104.
- Shyam, S Salim and Shridhar, Nivedita and Fernandez, Reeja (2017*) Climate change and need for proactive policy initiatives in Indian marine fisheries sector.* Climate Change, 3 (9). pp. 20-37. ISSN 2394-8558
- UNDP (2006) Human development report, United Nations Development Program. Available at: http://hdr.undp.org/hdr2006/statistics/

Annexure-1


CATEGORY
COMPONENTS
SUB-COMPONENT
INDICATORS
EXPOSURE
ENVIRONMENTAL
PERSONAL EXPOSURE
STORMS
FLOOD
DROUGHT
SHORELINE CHANGE
SENSITIVITY
SOCIAL DEPENDENCE
ATTACHMENTTO PLACE
ATTACHMENT TO
ECONOMIC DEPENDENCE
ON FISHING
COMPETITION FOR FISH
HISTORICAL & CULTURAL DEPENDENCE
HISTORICAL
AGE OF FISHERY
ANCESTRAL INVOLEMENT
FISHING FAMILY IDENTITY
SOCIAL MOBILITY
AGE OF FISHERY
ANCESTRAL INVOLEMENT
ADAPTIVE CAPACITY
FLEXIBILITY
PERSONAL
OPTIONS FOR DIFFERENT JOB
EMPLOYABILITY
OCCUPATIONAL
ALTERNATIVE EMPLOYMENT
BIGGEST RISK
INSTITUTIONAL
MARKETS
RESOURCE MANAGEMENT
SOCIAL CAPITAL
COMMUNITY COHESION
FINANCIAL ASSISTANCE
GENDER EQUITY
WOMEN LEADERSHIP ROLE
HUMAN CAPITAL
LOCAL KNOWLEDGE
SOURCES OF INFORMATION
HEALTH
FAMILY AILMENTS
EDUCATION
HIGHEST LEVEL
SKILLS
ALTERNATE AVOCATIONS
KNOWLEDGE
LABOUR
FINANCIAL CAPITAL
SAVINGS
DEBT
CREDIT
INSURANCE
PHYSICAL CAPITAL
BUILT HOUSE
AGE OF BUILDING
HOUSEHOLD ASSETS
BOAT DETAILS
FRESHWATER SUPPLY
SOURCE OF DRINKING WATER
ENERGY
SOURCES
COOKING FUELS
SOURCES
WASTE
DISPOSAL TECHNIOUES
NATURAL CAPITAL
CHANGING RESOURCE BASE
CAUSES
ADAPTATIONS
LIVELIHOOD
CAUSES
CLIMATE CHANGE