Vulnerability and Capacity Assessment Index (VCAI) and Prioritizing Interventions for Climate Change Adaptation

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Contents

• Work plan for this visit
• Vulnerability assessment methodology
  – Introducing VCAI excel tool
• Introduction to multi-criteria decision making
• Future steps
Expectations From this Mission

• Present the draft methodology to NABARD staff and obtain feedback

• Discuss the ways to obtain additional feedback on weights and thresholds for indicators and sectors

• Discussion on multi-criteria methodologies for prioritization of adaptation practices and capacity building of NABARD staff on vulnerability assessment and adaptation prioritization
The place of vulnerability assessment in Adaptation Decision Making

1. Define objective
2. Identify climate trends
3. Assess vulnerabilities
4. Assess risks
5. Identify & assess adaptation interventions
6. Implement adaptation interventions
7. Monitor and evaluate

Source: Author
Vulnerability & Adaptive Capacity

**Exposure:** Related to external pressures i.e. hazards

**Sensitivity:** Related to that of the social and ecological system, obtained through observations by the

**Potential impacts:** Field surveys and group discussions

**Net impacts:** Qualitative assessments

*Source: Author*
Framework for defining Vulnerability

\[ V = f(E_{xt}, S_{xt}, A_{xt}) \]  
(Smit and Pilifosova, 2003)

- \( V \) = current vulnerability (damage a system will incur if it experiences climatic hazard in its present state)
- \( E \) = Exposure of system \( x \) at time \( t \)
- \( A \) = Adaptive capacity of system \( x \) at time \( t \)
Critical Thresholds

Climatic Stimuli (Stress)

System in question

Determinants of adaptation
- Economic resources
- Technology
- Information and skills
- Infrastructure
- Institutions
- Equity

Enhanced vulnerability

Determinants inadequate

Net high impacts

Reduced vulnerability

Determinants adequate

Net low impacts

Source: Prabhkakar and Srinivasan, 2010
Conceptual Frameworks for Assessing Vulnerability and Adaptive Capacity

- **ACCRA Framework**: More Conceptual
- **Nick Brooks et. al. (2005)**: Semi quantitative, heavily relies on weighing factors and proxy indicators, mostly useful at broader scales such as national and regional
- **CSIRO Framework**: Conceptual (and qualitative)
- **Adger et al. (2007)**: Conceptual, qualitative
- **Yohe and Tol (2002)**: Quantitative, broad scales
- **Swanson et. al. (IISD, 2010)**: Based on the conceptual model of Smit and Pilifosova (2003): Comprehensive and quantitative. Employs determinants approach (Economic, technology, information, infrastructure, institutions, & Equity).
# VCA Methodologies: Tools

<table>
<thead>
<tr>
<th>Frameworks and Tools</th>
<th>Vulnerability</th>
<th>Exposure</th>
<th>Sensitivity</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vulnerability as function of $S, E, &amp; C$</td>
<td>Current climate trends</td>
<td>Climate-induced events</td>
<td>Climate projections</td>
</tr>
<tr>
<td>A framework for social adaptation to climate change, IUCN</td>
<td>✔</td>
<td>✔</td>
<td>0</td>
<td>✔</td>
</tr>
<tr>
<td>Climate vulnerability and capacity analysis, Care</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CVAAA, SPREP &amp; CIDA</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Vulnerability to resilience, Practical Action</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Participatory tools for assessing climate change impacts and exploring adaptation options, LFP &amp; UKAID</td>
<td>Not clear</td>
<td>0</td>
<td>0</td>
<td>✔</td>
</tr>
<tr>
<td>Adaptation toolkit, Christian Aid</td>
<td>Not clear</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CRiSTAL, IISD</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CEDRA, Tearfund</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>CBA, IIED</td>
<td>Broad</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Refer to the Table 3 on methodologies employed in Indian context in the VCAI documentation
Common Findings from the Review

• Largely follows the vulnerability as a function of exposure, sensitivity and capacity
• Largely quantitative approaches but qualitative listing of vulnerabilities are also common particularly in small scale projects
• Advocates for participatory approaches and often employs participatory rural appraisal methodologies for identifying vulnerabilities
• Employs indicators for quantifying the exposure, sensitivity and capacity factors
• The concept of critical thresholds have been proposed but not been employed due to lack of clear boundary line and means of identifying thresholds
• Some have converted indicators into an index for better comprehension
• Often employed weights to convert indicators into an index
• The indicator and weights were obtained through stakeholder consultations
Developing Vulnerability Capacity Assessment Index (VCAI) for NABARD
Steps for Development of VCAI for NABARD

1. Consultation with NABARD on VCA requirements
2. Review of research and implementation literature for VCA methodologies
3. Consultations with communities, executing entities and NABARD
4. Development of methodological framework and set of VCA indicators
5. Review and finalization of methodology
VCAI Methodology: Expectations from Adaptation Fund

- Adaptation Fund (AF) defines a project as a set of activities that are aimed at reducing the climate change vulnerabilities and increase the capacity of communities.
- The AF gives specific stress for projects to address the vulnerabilities of the specific groups such as women, children, marginalized groups, displaced, indigenous etc.
- Apart from these broad underpinnings, there are no specific guidelines from AF on how to develop VCA methodologies leaving the approach to individual implementing entities.
Nature of Adaptation Projects by NABARD

• Mostly focus on natural resource management
• Address the vulnerabilities found typically in rural and marginal areas
• Specific focus of projects has thus far has been on
  – agriculture,
  – agroforestry and mangroves,
  – animal husbandry and fisheries
  – water conservation practices
  – Other broad rural development approaches
How the Project Proposals Addressed the Vulnerabilities

• Largely qualitative discussion on vulnerabilities with focus on exposure related aspects than the sensitivities
• Not so clear identification of vulnerability assessment indicators, indices and methodologies
• Gaps in terms of lack of clear linkage between interventions identified and vulnerabilities discussed
• Vulnerability assessments have been proposed to be conducted as a part of the project implementation
• There is a clear gap in the capacity of executing entities to conduct vulnerability assessments
## Vulnerabilities Identified by Some Specific Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Vulnerabilities identified</th>
<th>Proposed activities to address vulnerabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate proofing of watershed</td>
<td>• Dependency on rain-fed farming</td>
<td>• Soil and water conservation structures</td>
</tr>
<tr>
<td>development projects in the states of Tamil Nadu and Rajasthan</td>
<td>• High poverty levels</td>
<td>• Improved farming practices: Deep tillage, application of tank silt, nutrient management, change of cropping patterns and integrated farming systems</td>
</tr>
<tr>
<td></td>
<td>• Soil erosion</td>
<td>• Agro-forestry and agro-horticulture</td>
</tr>
<tr>
<td></td>
<td>• Degradation of irrigated lands</td>
<td>• Micro-irrigation, energy efficient devices</td>
</tr>
<tr>
<td></td>
<td>• Water pollution</td>
<td>• Agro-meteorological observatory and crop insurance</td>
</tr>
<tr>
<td></td>
<td>• Over exploitation of forest stocks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Declining water table</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Input intensive agriculture with mono-cropping</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Climate variability and projected changes</td>
<td></td>
</tr>
<tr>
<td>Conservation and management of coastal resources as a potential adaptation strategy for sea level rise</td>
<td>• Urbanization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Industrialization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Environmental degradation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Frequent storms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Poverty</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Lack of social services</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Lack of essential infrastructure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Overexploited fisheries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Coastal dependent livelihoods</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Integrated mangrove fisheries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Restoration of degraded mangroves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Training and capacity building on above</td>
<td></td>
</tr>
</tbody>
</table>
VCAI Design Considerations

• **Simple:** The tool has to be simple keeping in view the capacity considerations of the stakeholders engaged in designing and implementing adaptation projects.

• **Measurable:** The vulnerabilities have to be measured, desirably quantitatively, so as to provide a means of assessing the progress on the project time scale and beyond.

• **Scalable:** The projects vary in scales, from local to state and national level and hence the tool should be flexible enough to scale to the required level.

• **Comparable:** For the purpose of the NABARD as an executing agency, it is important that the vulnerability assessments from different projects be comparable. Hence, providing a basic minimum set of indicators that could be applicable in wide range of geographical and socio-economic conditions is essential for such comparisons at both generic and sectoral level.
Vulnerability and Capacity Assessment Index (VCAI)

- **VCAI**: is a vulnerability and capacity assessment tool developed based on the general underlying concepts of vulnerability assessments discussed earlier.

- **The scope**: The scope of the Index is to measure the vulnerability at the project level. However, efforts have also been made to include some policy and institutional indicators to contextualize the project at the project location that is not in isolation with the larger policy and institutional enabling environment.

- **Interpretation of the output**: The index outputs a normalized maximum value of 1 and a minimum of 0 where 1 is maximum vulnerability and 0 is no vulnerability. The index outputs can be obtained for overall project location, sub-locations such as villages or a section of communities and sub-sector level such as food and agriculture, biodiversity and ecosystem services etc.
VCAI cont...

- It employs a quantitative methodology coupled with participatory consultative approaches for prioritizing vulnerability indicators and their weightages.
- Adapts thresholds concept for normalizing the data, advocates a broad range of threshold values rather than a single value within which the value of indicators may fall in the real world.
- Provides ability to assess VCA at specific and aggregate geographical and sectoral levels.
- Provides ability to compare projects in terms of their performance for M&E purposes as it accommodates a generic set of indicators that are common to all the sectors included in the tool.
- All indicators and weights are fixed, provisionally, for each version of the methodology. However, it also provides ability to choose location-specific indicators.
Identification of VCA Indicators

- Case study in Purulia District of West Bengal in cooperation with DRCSC
Steps involved in indicator identification

• **Step I: Discussion on demographic background**

• **Step II: Hazard identification and prioritization**

• **Step III: Identification of vulnerability indicators**
  – Exposure
  – Sensitivity
  – Capacity
Computation of VCAI

Vulnerability and Capacity Assessment Index (VCAI) = (E-S)+C

Where

E is exposure value obtained by average of the exposure indicators

S is the sensitivity value obtained by average of sensitivity indicators

C is the capacity value obtained by average of capacity indicators
Indicators Framework

• The VCAI tool comprises of several exposure, sensitivity and capacity indicators categorized into generic and specific sectors.
• All indicator values are normalized before they are combined in the form of an index

<table>
<thead>
<tr>
<th>Sector/Category</th>
<th>Current No of Indicators in VCAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic</td>
<td>38</td>
</tr>
<tr>
<td>Food and Agriculture</td>
<td>21</td>
</tr>
<tr>
<td>Water</td>
<td>21</td>
</tr>
<tr>
<td>Land</td>
<td>13</td>
</tr>
<tr>
<td>Fisheries and Animal Husbandry</td>
<td>13</td>
</tr>
<tr>
<td>Biodiversity and Ecosystem Services</td>
<td>29</td>
</tr>
</tbody>
</table>
Normalization of Indicator Values for VCAI

The indicator values are to be normalized, for they differ in units, to bring them to a single scale.

**Normalized indicator value**

\[ z_i = \frac{x_i - T_{\text{min}}(x)}{T_{\text{max}}(x) - T_{\text{min}}(x)} \]

*Where*

- \( x_i \) is value of the index
- \( T_{\text{min}} \) is minimum threshold value of the index \( x_i \)
- \( T_{\text{max}} \) is maximum threshold value of the index \( x_i \)
VCAI Output

- The tool provides a graphical output to help the user compare different geographic locations on sectoral and aggregate levels.

Source: Author
VCAI Output

Vulnerability: Water

Vulnerability: Land

Vulnerability: Fishery and Animal Husbandry

Vulnerability: Forestry and Biodiversity

Go to the Excel Sheet
Steps Involved in Implementing VCAI

- **Step I:** Random sample of the villages where the vulnerability assessment has to be conducted
- **Step II:** Fix the baseline through consultations among project stakeholders against which the project has to be evaluated
- **Step III:** Collection of data for indicators
  - Conduct participatory rural appraisal sessions with communities
    - To introduce the purpose of the project to the communities
    - To familiarize the vulnerability indicators with communities
    - To obtain values for the indicators
  - Consult literature/published data for those indicators for which there is no values could be obtained from the PRAs
- **Step IV:** Input the data into the excel sheet
- **Step V:** Submit the excel data on regular intervals (annual) for monitoring and evaluation purposes
Using VCAI for Assessing the Project Progress

\[ Pe_x = Pc_1 - Pc_0 \]

Where:
- \( Pe_x \): Effectiveness of project x;
- \( Pc_0, Pc_1 \): VCAI values at times T1 and T2
- \( I_x, I_y, I_z \): Project interventions at time T1, T2 and T3 respectively

Source: Author
Further Steps

• Obtain sufficient number of responses from Executing Entities for indicator weights, sector weights and critical thresholds

• Finalize the excel tool after fixing the indicators and weights

• Finalize the documentation after considering the review remarks

• Future possible collaboration:
  – Conducting a training session on VCAI
  – Prioritization of adaptation practices using multi-criteria methodologies
Prioritizing Adaptation Practices
Objective
(identify the best adaptation option to highway flooding)

Criteria
(co-benefit)

Criteria
(Importance)

Criteria
(cost)

Alternative
(flood-proofing vulnerable routes)

Alternative
(re-routing highway in vulnerable locations)

Decision Hierarchy is an Inherent Problem of Adaptation Decision Making
Adaptation as a Multi-Criteria Problem

• Appropriate decision-making at the community level is critical for adaptation
  – Adaptation is highly context-specific and no one-size-fits-all.
  – Adaptation require engagement of different stakeholders that have different criteria, access to choices, expertise etc.

• But how do communities decide?
  – Community members have varying understanding on climate change and adaptation measures
  – What criteria underlies their decisions?
  – What factors influence their decisions?
## Tools for Decision Making

<table>
<thead>
<tr>
<th>Tool</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-benefit analysis</td>
<td>Easy quantitative comparison across alternative adaptation options</td>
<td>Difficult to get cost and benefit data for social parameters.</td>
</tr>
<tr>
<td>Multi criteria analysis</td>
<td>Could rank different adaptation options on considering multiple criteria</td>
<td>Pair-wise comparison may become so large ((n(n-1)/2)) that it becomes a lengthy task.</td>
</tr>
</tbody>
</table>
Multi-Criteria Decision Making (MCDM)

- Other tools not effective and robust enough
- Growing use in natural resources management
- Preferred method to prioritize and select adaptation policies and measures (UN)
- NAPA preparation process - Identifying high priority adaptation projects: Vanuatu, Bhutan, Mali, Senegal, Cape Verde
<table>
<thead>
<tr>
<th>MCA Method</th>
<th>Criteria</th>
<th>Region</th>
<th>Decision problem</th>
<th>Field of application</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHP, PROMETHEE</td>
<td>Cost, economic, social, environmental factors.</td>
<td>Greece</td>
<td>Selection of the best water project</td>
<td>Water management</td>
<td>Anagnostopoulos 2005.</td>
</tr>
<tr>
<td>AHP</td>
<td>Rainfall, elevation, water network, road network, nectar, pollen</td>
<td>Malaysia</td>
<td>Determining land suitability of bee zones.</td>
<td>Agriculture/land suitability</td>
<td>Maris et al. 2008</td>
</tr>
<tr>
<td>AHP</td>
<td>Conservation value, business investment, recreation visitor days, extent of river red gum, number of bird species</td>
<td>Australia</td>
<td>Identification of the best planning option in wetland management</td>
<td>Wetland management</td>
<td>Herath (2004)</td>
</tr>
<tr>
<td>Compromising programming</td>
<td>Cost, public appraisal, political impact quantity of water, health impact, flexibility, water demand control, time of water shortage, population impact</td>
<td>Iran</td>
<td>Selecting water and wastewater management options</td>
<td>Water management</td>
<td>Abrishamchi et al (2005)</td>
</tr>
<tr>
<td>AHP</td>
<td>Environmental performance, Political acceptability, Feasibility of implementation (sub-criteria, direction contribution to GHG emissions, indirect environmental effects, cost efficiency.</td>
<td>Trinidad and Tobago</td>
<td>Finding the most appropriate policy instrument for GHG-emission mitigation</td>
<td>Climate change</td>
<td>Blechinger and Shah (2010)</td>
</tr>
</tbody>
</table>
AHP - Analytic Hierarchy Process

• Widely used MCA method
  – Resource allocation
  – Strategic planning
  – Project/risk management

• Basic Steps:
  • Step 1: Define objective
  • Step 2: Structure elements in criteria, sub-criteria, alternatives.
  • Step 3: Make a pair-wise comparison of elements in each group
  • Step 4: Calculate weighting and consistency ratio
  • Step 5: Evaluate alternatives according to weighting
Analytical Hierarchy Process (AHP)

• AHP allows users to employ multiple criteria to assess and compare various alternatives
• Each criteria is weighed (each criteria has different importance)
• The weight of each criteria is determined by pairwise ranking process (comparing two criteria to see which one is more important)
Steps Involved in AHP through FGDs in a Project Context

- Identify locations for conducting FGDs with local consultation (presence of adaptation practices)
- Indicator vetting through Participatory Rural Appraisal Processes
- Identify discussants representing the socio-economic composition of the village in which FGDs are conducted
- Introduce the purpose of the discussion
- Demographics and identification of past climatic impacts
- Identification and ranking of practices based on how they were effective in minimizing the impacts, identify and rank indicators and criteria
- AHP process: Pairwise comparison of criteria, indicators and practices
- Wind up the discussion
- Consolidate the results to compare indicators and practices across locations
# Weighing between different options

Saaty’s Fundamental Scale of Judgment

<table>
<thead>
<tr>
<th>Intensity of importance</th>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
<td>Two activities contribute equally to the objective</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance</td>
<td>Judgment slightly favors one criteria over another</td>
</tr>
<tr>
<td>5</td>
<td>Strong importance</td>
<td>Judgment strongly favors one criteria over another</td>
</tr>
<tr>
<td>7</td>
<td>Very strong importance</td>
<td>A criteria is favored very strongly over another</td>
</tr>
<tr>
<td>9</td>
<td>Extreme importance</td>
<td>Judgment favoring a criteria is of the highest possible order of affirmation</td>
</tr>
</tbody>
</table>
Field surveys
Pictorial Representation of hierarchical nature of criteria, indicators and practices in AHP methodology
AHP application: An example

e.g. How to choose from a restaurant menu?

Choose dinner for tonight

Goal

Criteria

Alternatives

Price

Taste

Healthy

Sushi

Fried chicken

Salad

Curry

Prabhakar et al., 2014
Case 1: Nepal – drought -male

Reduce drought sensitivity and improve adaptive capacity

Bring effect on policy 0.78
Replicable 0.11
Easy to see the benefit 0.11

Availability of water 0.65
Increase in crop yield 0.18
Escape drought 0.09
Cost effectiveness 0.03
Less investment 0.05

Pump for groundwater 0.39
Harvesting surface water 0.38
Pest Control 0.06
Alternative Crops 0.06
Drought resistance varieties 0.12

Prabhakar et al., 2014
Case 1: Nepal – drought -male

Aggregated score of adaptation practices and their composition

Drought resistant varieties
Alternative crops
Pest control
Harvesting surface water
Pump for groundwater

Prabhakar et al., 2014
Case 2: Bangladesh – flood-female

Reduce flood sensitivity and improve adaptive capacity

Goal

Criteria

Indicators

Practices

Increase in yield (0.14) → Cost effectiveness (0.04)
Increase in income (0.14) → Communicability (0.78)
Improved communication (0.27) → Relates to alternative income (0.18)

Balanced nutrition (0.10) → Modern ag. knowledge (0.12)
Income diversification (0.10) → Embankment (0.77)

Homestead elevation (0.34) → Communicability (0.78)

Increase in income (0.14) → Income diversification (0.10)
Increase in yield (0.14) → Communicability (0.78)

Prabhakar et al., 2014
Case 2: Bangladesh – flood-female

- Income diversification
- Embankment
- Modern agriculture knowledge

- Increase in yield
- Increase in income
- Improved communication
- Balanced nutrition
- Homestead elevation

Prabhakar et al., 2014
Available Tools

• Super decisions software
• Excel based tools

Show
Super Decisions Software
Excel sheet (K. D. Goepel Version 12.08.2013)
Thank You!

For more information, please contact: sivapuram.prabhar@gmail.com