

Vulnerability indicators and mapping

Vulnerability indicators are the most common methodology in vulnerability assessment. The standard practice is to compile a list of indicators using criteria such as: suitability, following a conceptual framework or definitions; availability of data; and sensitivity to stresses and shocks. There are known pitfalls in an indicator-based methodology, but indicators are essential in any toolkit of vulnerability or sustainable development. A wider range of vulnerability methods should be considered.

On models and methods

The first step in an indicator-based vulnerability assessment is to select indicators. Generally this is done with regard to some conceptual framework, but often this linkage is descriptive and poorly related to the selection process. For instance, the common definition of food security as comprising economic, demographic and political dimensions may lead to indicators of GDP per capita, infant mortality and female literacy as ‘appropriate’ indicators. Each is clearly related to the definition, but not uniquely so and perhaps not the most sensitive indicator for capturing local conditions and multiple stresses.

Often missing, once an indicator data base has been compiled the next step is to explore its structure. What is the range of values? Are there critical thresholds for vulnerability? Are indicators correlated with each other? Are there clusters in the data that capture higher order factors (perhaps corresponding to the original definition)?

The next step, commonly done, is to transform the indicators into some sort of standard scores. Often these scores are mapped to identify geographic ‘hot spots’. Standard scores are the relative location between the low and high value in the data set, generally in the range of 0 to 1 or 0 to 100. For example, an international comparison of GNP per capita can be expressed as the 0=the minimum (some \$200) and 100=the maximum (some

\$20,000). Some use a range from negative (below the mean) to positive (above the mean) but this implies that negative scores can be balanced by positive scores.

Most studies come up with an aggregate vulnerability index by adding indicators across categories. For instance, a food security index might be the average of indicators of crop yield, income and nutritional status. Most studies do not weight the indicators analysts recognise that users may have different weights in mind.

However, there are a range of aggregation techniques beyond summing up standard scores (whether weighted or not). Critical failures and the concatenation of risks might be captured by only counting low scores. Targeting to specific socio-economic, vulnerable groups might imply a choice of indicators—for instance food security among pastoralists is not well represented by maize yields.

Very few studies seek to validate their index other than in a relative mapping of vulnerability and discussions with experts. The case of vulnerability mapping before and after Hurricane Mitch is informative.

Case example

The SEI is developing a working paper on food security indicators in South Africa. The exercise begins with a standard definition of food security and nominated national indicators from the Ministry of Agriculture. This data base was expanded to the provincial level—already

constrained by the lack of some data, but also by the overwhelming choice of data from various surveys and monitoring systems. The national/provincial indicators of food security were then related to global scenarios of sustainable development from the Global Scenarios Group. This step explored the ways in which South African food security might evolve in the next twenty years, as well as testing the robustness of 'downscaling' global scenarios to the national and provincial context. Finally, we sought to relate the global-provincial storyline and quantitative indicators to livelihoods using our field work in Limpopo Province. We concluded that the links between global driving forces and the nuances of local vulnerability are neither singular (multiple stresses dominate vulnerability) nor simple (a range of outcomes can be expected at the local scale within the context of the same global storylines). There does not appear to be a satisfactory empirical resolution to this conundrum, indeed it is the enduring feature of local vulnerability.

Expanding the toolkit

A sample of tools for vulnerability assessment is shown in the following table. They are useful for different aspects of vulnerability assessment, from understanding present vulnerability and defining the problem space to scenarios of future development, evaluation of adaptation options, and strategic planning. Some are suitable for multi-stakeholder analysis and participatory processes.

The choice of methodology must be guided by the locus of the problem—the nature of the actors and their networks, the role of environmental trends and surprise, the information needs of the users, and the resources available to the team. A sophisticated model that fails to address a key vulnerability is misleading and an abuse of the responsibility of the expert to provide robust assessments.

A spreadsheet with additional tools, a drawing canvass for building a flow chart of vulnerability projects, and a guided process of choosing generic tools is available in the Vulnerability Network web site.

Other relevant briefing notes

- Vulnerability, global environmental change and food systems (overview of vulnerability concepts)
- Resilience and vulnerability
- Agent based modeling of vulnerable food systems
- Choosing methodology

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Poverty and Vulnerability documents and discussions: www.VulnerabilityNet.org

GECAFS: www.Gecafs.org

Potential toolkit for Vulnerability/Adaptation Assessments

Tools	Present vulnerability	Problem definition	Development futures	Evaluation of adaptation	Strategic planning	Multi-stakeholder analysis	Stakeholder participation
1. Agent-based simulation modeling			✓		?	✓	?
2. Bayesian analysis				✓			
3. Brainstorming	✓	✓	✓	✓	✓	✓	✓
4. Checklists/ multiple attributes	✓			✓		✓	✓
5. Cognitive mapping	✓	✓	✓				✓
6. Cost-effectiveness/ Cost-benefit/ Expected value			✓	✓			
7. Cross-impact analysis			✓	✓			
8. Decision conferencing			✓	✓			
9. Decision/probability trees				✓			
10. Delphi technique	✓		✓	✓		?	?
11. Environmental assessment/ Strategic environmental assessment			✓	✓	✓		?
12. Expert judgement	✓	✓	✓	✓	✓	✓	
13. Focus groups	✓	?	✓	?		?	✓
14. Indicators/ mapping	✓		?			?	?
15. Influence diagrams/ Mapping tools	✓		✓		✓		✓
16. Multi-criterion analysis				✓			
17. Ranking/dominance analysis/pairwise comparisons	✓		✓	✓			✓
18. Risk analysis			?	✓			
19. Role-play	✓		✓				✓
20. Scenario analysis	?	?	✓	?	✓	✓	✓
21. Stakeholder consultation	✓	✓	✓	✓		✓	✓
22. Stakeholder Thematic Networks	✓	?	✓		?	✓	
23. Vulnerability profiles	✓	?	?			✓	✓
24. Wealth ranking	✓						✓

Definitions

1. **Present vulnerability** including development policy
2. **Problem definition** – scoping of issues and options to be included in analysis and design of projects
3. **Development futures** – pathways of future development
4. **Evaluation of adaptation** – to aid decision making between specific measures and the selection of options
5. **Strategic planning** – consideration of alternative futures, including cross-sectoral and regional issues.
6. **Multi-stakeholder analysis** – analysis of individual stakeholders within an institutional context
7. **Stakeholder participation** – whether stakeholders can participate in the tool

Tools

1. **Agent-based simulation modelling** – formalism of agents and their interactions at multiple levels
2. **Bayesian analysis** – statistical analysis used to re-assess probabilistic data in light of new data.
3. **Brainstorming** – free-flowing lists/diagrams of all ideas and options
4. **Checklists** – matrix
5. **Cognitive mapping** – conceptual model that incorporates diverse stakeholder perceptions
6. **Cost-effectiveness/ Cost-benefit/ Expected value** – econometric techniques
7. **Cross-impact analysis** – test robustness of risk-assessment and dependencies between events
8. **Decision conferencing** – quantitative analysis of options incorporating the uncertainties in interactive modes
9. **Decision/probability trees** – charts of relationships between decision modes; helpful for generating expected value
10. **Delphi technique** – range of views of experts through iterative written correspondence
11. **Environmental assessment/Strategic environmental assessments** – consideration of all environmental impacts taken into account before deciding on development
12. **Expert judgement** – the assessment of experts in the field on specific propositions
13. **Focus groups** – groups of stakeholders that discuss their opinions on certain topics
14. **Indicators/ mapping** – compilation of indicators into aggregate indices, often mapped
15. **Influence diagrams/ Mapping tools** – graphic identification of options when there are a number of decisions
16. **Multi-criterion analysis** – scoring and weighting of options using indicators and more than one decision criteria
17. **Ranking/ dominance analysis/ pairwise comparisons** – preference of options
18. **Risk analysis** – approaches to decision uncertainty including hedging and flexing, regret, minimax and maximin
19. **Role-play** – a participatory ‘game’ to uncover behaviour, trends and expectations
20. **Scenario analysis** – fuller picture of implications of uncertainty gained through simultaneous variation of key uncertainties
21. **Stakeholder consultation** – consultation with individuals and/or groups affected by future processes
22. **Stakeholder Thematic Networks (STN)** – mapping of the key actors and their interactions
23. **Vulnerability profiles** – mapping of the different indicators of vulnerability for different groups
24. **Wealth ranking** - classify members of a community into wealth categories