

Vulnerability indicators

State-of-the-art and policy implications

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State-of-the-art of vulnerability research

Vulnerability indicators

Implications for policy

State-of-the-art of vulnerability research

Vulnerability

- ▶ Definitions of vulnerability
 - ▶ There are many
 - ▶ There are many similar concepts
 - ▶ risk, sensitivity, adaptability, resilience, *etc.*
 - ▶ overlap non trivially in meanings (Gallopín, 2006; Hinkel, 2008; Ionescu et al., 2009)

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 - ▶ risk, sensitivity, adaptability, resilience, *etc.*
 - ▶ overlap non trivially in meanings (Gallopín, 2006; Hinkel, 2008; Ionescu et al., 2009)
- ▶ Methodologies for assessing vulnerability
 - ▶ There are many
 - ▶ Very different types of approaches
 - ▶ modelling, indicators, participatory
 - ▶ “context” versus “outcome” (O’Brien et al., 2006),
“top-down” versus “bottom-up” (Dessai and Hulme, 2004)

ADAM Meta-analysis

- ▶ Meta-analysis of
 - ▶ **Definitions** of vulnerability and related concepts (risk, adaptation, adaptive capacity, resilience, etc.)
 - ▶ **Methodologies** for assessing these concepts
- ▶ Data
 - ▶ Journal articles cited in the IPCC AR4 Europe chapter (123 Studies)
 - ▶ Further case studies and conceptual papers in the fields of climate change, disaster risk reduction, food security and development.

Findings: Definitions

- ▶ A common form could be identified.
 - ▶ **Vulnerability is a measure of possible future harm.**
 - ▶ Measure of harm
 - ▶ **Normative** preference criteria on the “badness” of a state
 - ▶ *E.g.*, mortality, number of people affected by floods, loss of land
 - ▶ Possible future
 - ▶ Not current but future harm is of interest.
 - ▶ Harm may or may not happen.
- ▶ Not much more can be said beyond.
 - ▶ Scientific language definitions are not more precise than ordinary language ones.

Example: IPCC Definition of vulnerability

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- ▶ “Vulnerability is a function of the [. . .] climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.”
 - ▶ This is not a definition!
- ▶ Vulnerability is “the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.”
 - ▶ defined on other vaguely defined concepts
 - ▶ normative aspects

Findings: Methodologies

- ▶ The same common form could be identified
 - ▶ **Vulnerability is a measure of possible future harm**
- ▶ Little systematic relationship between definitions and methodologies
 - ▶ Any methodology can be derived from any definition.
- ▶ Methodologies are identical to those applied in related fields (e.g. disaster risk, resilience).
 - ▶ Identity is, however, difficult to see because different labels are used for the same methodological steps.

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- ▶ Rather the development of methodologies for assessing vulnerability (including indicators) should be informed by spelling out the specific research question or policy objective addressed.
- ▶ Any assessment involves normative choices to be made
 - ▶ The meaning of harm needs to be defined
 - ▶ It is therefore a good idea to involve relevant stakeholders

Vulnerability indicators

Indicators

- ▶ An indicator is a function from observable variables to a non-observable variable.
 - ▶ *E.g.*, the Human Development Index:
 $(lifeexpect, literacy, education, GDPpercapita) \mapsto HD$
- ▶ Indicators are used to compare between phenomena that we cannot directly observe.
 - ▶ compare in time: *e.g.*, development of one region over time
 - ▶ compare in space: *e.g.*, between different regions
- ▶ Developing an indicator means developing a model
 - ▶ Indicators are simple, static models as opposed to dynamical computer models.

Vulnerability indicators

- ▶ A vulnerability indicator indicates possible future harm.
 - ▶ It is a function from a couple of observable variables to a non-observable variable that stands for vulnerability.
 - ▶ $(V_1, V_2, \dots, V_n) \mapsto \textit{vulnerability}$

Vulnerability indicators: Challenge

Developing vulnerability indicators involves one peculiar challenge

- ▶ They indicate a possibility
 - ▶ Vulnerability indicators indicate “possible future harm” and *not* “current harm”
- ▶ Compare with the human development index
 - ▶ indicates current state of development
- ▶ In the academic and policy literature this forward looking aspect causes great confusion

Approaches towards indicating possibility (1)

- ▶ Indicate current potential for future harm
 - ▶ The indicating variables refer to the potential to encounter or prevent harm in the future
 - ▶ Many different concepts used to express this idea
 - ▶ *E.g.* ability, capacity, adaptive capacity, resilience, *etc.*
 - ▶ Prominent variables are
 - ▶ GDP and other types of capitals such as technology, education, social capital, *etc.*

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 - ▶ GDP and other types of capitals such as technology, education, social capital, *etc.*
- ▶ Indicate current rate of change towards future harm
 - ▶ The indicating variables refer to a rate of change
 - ▶ Less frequently used
 - ▶ Examples
 - ▶ sea-level rise, population growth, inflation rate, *etc.*

Approaches towards indicating possibility (2)

- ▶ Compute possible futures and evaluate harm
 - ▶ “Classical” model-based impact and vulnerability assessments
 - ▶ Climate scenarios → possible impacts → evaluate harm for impacts
 - ▶ These are not indicators
 - ▶ They are dynamical models and not static ones
 - ▶ *E.g.*, ATEAM

Steps in developing indicators

1. Definition of the phenomenon
 - ▶ Define purpose
 - ▶ Define system
 - ▶ We are modelling, so we have to define the system we are modelling
 - ▶ Define harm
2. Selection of (indicating) variables
3. Aggregation of the variables
 - ▶ Not a necessary step

Theory-driven approaches

- ▶ Indicating variables are selected and aggregated based on existing theories or models.
- ▶ For example
 - ▶ Theory:
 - ▶ The capability approach of (Sen, 1983) suggests that the ability to participate in political activities is important for reducing poverty.
 - ▶ Deductive Conclusion:
 - ▶ Choose variables that measure participation in policy.

What theory do we have available?

- ▶ Bio-physical
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 - ▶ Only help to project future harm
- ▶ Social
 - ▶ No general theory available
 - ▶ But some general principles
 - ▶ Sen (1983)
 - ▶ “Root causes” of vulnerability (Blaikie, 1994)
 - ▶ IPCC 8 determinants of adaptive capacity (Smit et al., 2001; Adger et al., 2007; Yohe and Tol, 2002; Tol and Yohe, 2007)
 - ▶ Only help to select but not to aggregate variables

Data-driven approaches

- ▶ Given (existing) data, a statistical model that explains observed harm based on a set of indicating variables is developed.
- ▶ For example
 - ▶ Data:
 - ▶ There is data that shows that heat-wave mortality was highest in low-income neighbourhoods.
 - ▶ Inductive conclusion:
 - ▶ People in low-income neighbourhoods are vulnerable.

What data do we have available?

- ▶ We need data for both the indicating variables as well as harm.
 - ▶ Few data for harm.
- ▶ If we would have a lot of data, we would have theory.
- ▶ It is very unlikely to build (simple) models (*i.e.* indicators) from data when
 - ▶ there are many variables involved;
 - ▶ we consider vulnerability in general (*i.e.* when we model the whole world).

Literature (1)

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- ▶ Hybrid approaches
 - ▶ Theory-driven
 - ▶ All select variables based on “determinants literature”.
 - ▶ Data-driven
 - ▶ Some use data to narrow down the list of variables (e.g. Brooks et al., 2005).
 - ▶ Few aggregate; if so
 - ▶ not based on theory
 - ▶ but on expert judgement or normative decisions of stakeholders

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- ▶ Scale
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- ▶ Scale
 - ▶ Some work at national and global scales
 - ▶ Most work at local (household) scales
- ▶ Purpose
 - ▶ to assess how “dangerous” climate change is in order to define mitigation targets.
 - ▶ to understand what causes vulnerability.
 - ▶ social processes are best (or can only be) understood at local levels.

Bottom-line

- ▶ We use vulnerability at very early stages of theory formation.
 - ▶ Vulnerability gives us a first idea of a problem.
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- ▶ Theory on and indicators of vulnerability will continue to change.
 - ▶ “The dynamic nature of vulnerability”, indicators need to be updated regularly (Eriksen and Kelly, 2006)
 - ▶ Vulnerability is context specific and the context needs to be continuously redefined (O'Brien et al., 2006)

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- ▶ Specificity
 - ▶ The more specific we get the more meaningful it is to build theories and indicators.
 - ▶ Factors that create adaptive capacity are different for different risks (Tol and Yohe, 2007).

Implications for policy

Policy should

- ▶ Narrow down the problem and be as specific as possible.
 - ▶ What is the purpose of the vulnerability indicator exercises?
 - ▶ Define objectives and targets and then indicators.
- ▶ Evaluate, learn and redefine the problem.

If the purpose of indicators is ... (1)

- ▶ to identify particularly vulnerable regions/people
 - ▶ By and large, we know this.
 - ▶ Indicators will not reveal anything new.
- ▶ to raise awareness
 - ▶ We take the studies that we have and communicate them nicely.
 - ▶ Take the experiences from risk communication on board.
 - ▶ ATEAM: stakeholders were not interested in adaptive capacity indicator (Schröter et al., 2004).

If the purpose of indicators is ... (2)

- ▶ to allocate money to particular vulnerable regions or group of people.
 - ▶ Negotiate a short-list of the main issues.
 - ▶ *E.g.*, water scarcity in the Mediterranean, coastal protection
 - ▶ Negotiate a normative agreement on money allocation.
- ▶ to monitor adaptation policy.
 - ▶ Develop adaptation policy for specific issues.
 - ▶ Define objectives, targets and then indicators.

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