Vulnerability assessment for climate adaptation

Adaptation Planning Framework Technical Paper 3

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Overview

Vulnerability assessment is a key aspect of anchoring assessments of climate change impacts to present development planning. Methods of vulnerability assessment have been developed over the past several decades in natural hazards, food security, poverty analysis, sustainable livelihoods and related fields. These approaches—each with their own nuances—provide a core set of best practices for use in studies of climate change vulnerability and adaptation.

The aim of this technical paper is to present a structured approach to climate change vulnerability assessment. The paper recommends five tasks and suggests appropriate methods suitable for different levels of analysis. The five tasks link a conceptual framing of vulnerability to identification of vulnerable conditions, analytical tools and stakeholders.

Vulnerability varies widely across peoples, sectors and regions. This diversity of the 'real world' is the starting place for vulnerability assessment. Distinguishing between scales helps simplify the conceptual and analytical issues:

- International comparisons of vulnerability tend to focus on national indicators, for example to group less developed countries or compare progress in human development among countries with similar economic conditions.
- At a national level, vulnerability assessments contribute to setting development priorities and monitoring progress. Sectoral assessments provide more detail and targets for strategic development plans.
- At a local or community level, vulnerable groups can be identified and coping strategies implemented, often employing participatory methods.

This paper initially focuses at the national level, while recognizing the need for local to global linkages. Indeed, the 'real world' diversity of resources, economies and societies means that no one approach to vulnerability assessment fits every need. Although we start this technical paper with a straightforward set of tasks, we conclude by identifying further issues that the technical team should consider. Supplementary annexes provide additional material. SA.X.6 presents a flow chart of the tasks and choices that a technical team might work through, with a hypothetical example from an ongoing project in India.

The literature on vulnerability has grown enormously over the past few years. Key articles from a development and sectoral perspective include Bohle and Watts (1993) and Chambers

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(1989). Extensions related to natural hazards are Blaikie et al. (1994), Clark et al. (1998), and Stephen and Downing (2001). Climate change explorations include Adger and Kelly (1999), Bohle et al. (1994), Downing et al. (2001), Handmer et al. (1999), Kasperson et al. (2002), and Leichenko and O'Brien (in press).

Task I: Vulnerability frameworks and definitions

This technical paper proposes a structured process of vulnerability assessment—the emphasis is on the tasks and techniques that a technical team could readily implement. However, one of the recurrent debates is what is vulnerability? The problem is that 'vulnerability' has no universally accepted definition. Even within the IPCC it is used with different meanings.

An initial task of an interdisciplinary team is to clarify the conceptual framework and the analytical definitions that form the core of the assessment. A shared language will facilitate new insights and help communicate to key stakeholders.[7] This task has close links with the overall scoping of the project (see TP1).

The starting point should be to review existing regional or national assessments that relate to vulnerability, for instance national development plans, Poverty Reduction Strategy Papers, environmental sustainability plans and natural hazards assessments. If there is a common approach already in use—for instance in development planning or mapping hazards—then it makes sense to begin with that framework. It may need to be extended to incorporate climatic risks and climate change.

If existing reviews and plans are not available or suitable, then the team will need to develop its own conceptual and analytical framework. Stakeholder-led exercises are valuable at this point. Clarify differences between disciplines, sectors and stakeholders. Work toward a common language, but keep the focus on a working framework and practical steps to be taken rather than a 'final' conceptual model.

Revisit the working framework throughout the project to ensure that the links between the analyses are clear and relevant to the overall objectives. The outputs of this task are a core framework for the vulnerability assessment.

For more information, Supplementary Annex X.1 reviews a sample of conceptual frameworks and definitions. SA.X.2 traces lessons learned in vulnerability assessment for food security and famine early warning.

Task II: Constructing a development baseline and targeting vulnerable groups

The second task is to review present conditions in order to target vulnerable groups and establish a development baseline. Who are vulnerable? To what? Where?

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[7] To facilitate an international language of vulnerability, we suggest formal notation that may be helpful—see SA.X.1 for a complete set of notations. VA-FW signifies the conceptual framework developed as the basis of the vulnerability assessment. This should include the aims and objectives of the VA, conceptual model, definitions and choice of overall methodology.

As above, the starting point should be existing vulnerability assessments. Many developing countries have produced related inventories, such as poverty maps, human development indices, and environmental sustainability indices. The development baseline should incorporate two levels of analysis:

- A comprehensive set of spatial indicators of vulnerability (that we might label VI).
- Identification of target vulnerable groups that are a priority for adaptation policy.[8]

Vulnerability is a relative measure, it does not exist as something we can observe and measure. Therefore, indicators can only be selected based on choices by the technical team, stakeholders and the vulnerable themselves. Referring back to the conceptual framework ensures that the selection is logical and transparent for users.

Developing and using indicators requires awareness of several technical issues, including their sensitivity to change, standardizing indicators for comparison, reliability of the data, mapping of indicators, collinearity between indicators, coverage of relevant dimensions of vulnerability, etc. However, if existing inventories are available, many of these issues will have already been addressed and the literature on indicators provides examples of good practice.

The choice of the target of the vulnerability assessment should be related to the problems identified in scoping the project. An fundamental issue is whether the target is people, resources or economic activities, or regions.[9] Two examples highlight issues to be considered:

- A focus on food security might take as the core analyses the social vulnerability of livelihoods to a range of threats (from climatic, economic and resource changes). But this would need to be placed in an understanding of regional production, exchange and distribution.
- A focus on biodiversity might begin with detailed modeling of ecosystems and species, with a subsequent analysis of the value of lost ecosystem services for a range of economic activities.

One way to picture the choices is shown in Figure 1. The central concern of vulnerability assessment is people—those who should be protected from the adverse consequences of present climatic variations and dangerous climate change. These might be demographic groups (such as young children), livelihoods (urban poor in the informal economy) or populations at-risk from diseases. People are organized into socio-economic groups (whether organizations, sectors or institutions), ultimately dependent on resources (land, water, ecosystems).

In this paper, we prefer to explicitly target vulnerable livelihoods (see SA.X.3) as this provides a direct link to development policy and practice. However, the tasks and techniques suggested here also are relevant to spatial and economic targets. Box 3.1 provides an example of how a local livelihood focus can be related to a spatial assessment of resource and economic indicators at the national level.

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[8] Some frameworks refer to exposure units. We use the term target to indicate a more explicit link to vulnerable peoples and policy. Neither term is entirely adequate—involvement of the vulnerable themselves in an assessment is desirable, suggesting self-subjects rather than an external target.

[9] These might be labeled as Vg, Vs and Vp referring to vulnerable groups, sectors and places.

The output of this task is a set of vulnerability indicators (VI) and identification of vulnerable livelihoods (or other targets), that together form a baseline of present development. The collation of vulnerability indicators underpins the analyses and identification of priorities for adaptation. Issues of aggregating the individual indicators into a composite view of vulnerability are covered in Task V.

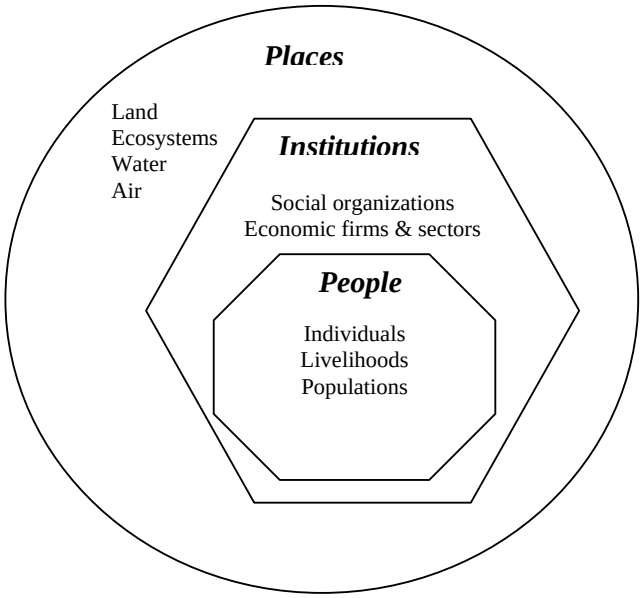

Figure 1. Units of analysis for a vulnerability assessment. The central concern with people is placed within the context of socio-economic institutions and activities and bio-geo-physical resources. A cognitive mapping exercise (basically putting boxes and arrows on a flip chart) can follow this schema to illuminate exposure to climatic variations and to the drivers of socio-economic vulnerability.

Task III: Linking the development baseline to climate impacts and risks

The first two tasks establish present conditions of development; the next step is to refine the analysis and link the development baseline explicitly to climate impacts and risks. In the vulnerability assessment, this might be relatively simple, or more formal and quantitative approaches may be developed through the guidelines in TP 4 and TP5. Here we describe a sequence of choices and methods to establish present climate vulnerability (for convenience labeled cV). Extending the analysis to future climatic risks is relatively straightforward, incorporated in Task IV.

It may well be that risk maps of present climatic variations are already available. Certainly, almost all countries will have national models of agricultural production and hydrological sensitivity to climatic variations, for example. If so, these can be added to the indicator data set.

If quantitative impacts assessments are not available, it should be possible to develop indicators of present climatic risks. These might be relatively simple climatic thresholds

(e.g., probability of drought). Historical episodes, such as the drought of record or extreme rainfall during historical storms can help define at-risk regions.

If formal models of (present) climate impacts and data on climatic risks are not available, expert opinion and case examples from similar countries can be used to develop a suite of plausible impacts scenarios. Such scenarios are exploratory—they are difficult to translate into probabilities—but are often useful in revealing potential vulnerabilities and policy responses. For instance, worst case scenarios are commonly used in disaster planning.

Ideally, the output from this task is an understanding of the present probability of a range of climatic conditions and hazards. The conjunction of the climatic hazards and development baseline comprises the present climate vulnerability. Techniques include constructing aggregate indices, using multi-attribute profiles and clustering (see Task V).

Task IV: Drivers of vulnerability: linking the present and future

At this point the vulnerability database (VI) includes climatic risks and identification of target vulnerable groups (Vg). It is a useful snapshot of present vulnerability reflected in a range of indicators. The next step is to provide a more qualitative understanding of the drivers of vulnerability—what shapes exposure to climatic risks? At what scales? This analysis links the present (snapshot) with pathways of the future--that may lead to sustainable development or further vulnerabilities.

The techniques for 'mapping' the structure of present vulnerability and how it might change in the future are likely to be qualitative in the first instance. Interactive exercises (such as cognitive mapping) amongst experts and stakeholders can help refine the initial VA framework (Task I) by suggesting linkages between the vulnerable groups, socio-institutional factors (e.g., social networks, regulation and governance), their resources and economic activities, and the kinds of threats (and opportunities) resulting from climatic variations. Thought experiments, case studies, in-depth semi-structured interviews, discourse analysis, and close dialogue are social science approaches that have application in understanding the dynamics of vulnerability.

More formal techniques include cross-impact matrices, multi-attribute typologies such as the five capitals of sustainable livelihoods or the characteristics of adaptive capacity (TP 7), and even quantitative approaches such as input-output models, household production functions and multi-agent social simulation. The best strategy is to start with exploratory charts and checklists—which can help identify priorities and gaps—before adopting specific quantitative analyses.

Extending the drivers of present vulnerability to the future typically is based on a range of socio-economic scenarios (see TP6). Existing development scenarios are the best place to start: are there projections for development targets? Or sectoral scenarios may be relevant, as in the World Water assessment. Otherwise, stakeholder led exercises in creating visions of the future (including worst case fears) are worth pursuing (see TP2).

Two technical issues need to be clarified in the VA at this stage:

- Most indicators are snapshots of present status, for example GDP per capita. However, vulnerability is dynamic and indicators that foreshadow future

vulnerability may be useful. For example, future wealth may be correlated with literacy and governance and only weakly correlated with present rates of growth in GDP per capita.

- The common drivers of development need to be related to the target vulnerable groups. National and international trends, for example in population and income, may not map directly onto the nuances of marginalization, local land tenure, markets and poverty that characterize vulnerability. Shocks and surprises have disproportionate effects for the vulnerable—as in the macro-economic failure in Argentina or the prolonged dessication of the Sahel.

While we suggest that scenarios of future vulnerability are best developed at the local to national level, there are cogent reasons to place future socio-economic conditions of vulnerability in a regional to global context. The climate change policy community has its own points of reference (e.g., currently the SRES). The VA may benefit from coherence with such international scenarios, although it is methodologically incorrect to suggest that global socio-economic scenarios can be downscaled to local vulnerability (on theoretical, practical and empirical grounds).

Outputs of this task are qualitative descriptions of the present structure of vulnerability, future vulnerabilities and a revised set of VIs that include future scenarios. The next task brings together the indicators into a meaningful vulnerability assessment.

Task V: Outputs of the vulnerability assessment

The outputs of a vulnerability assessment include:

- A description and analysis of present vulnerability, including representative vulnerable groups (for instance specific livelihoods at-risk of climatic hazards).
- Descriptions of potential vulnerabilities in the future, including an analysis of pathways that relate the present to the future.
- Comparison of vulnerability under different socio-economic conditions, climatic changes and adaptive responses.

The final task is to relate the range of outputs to stakeholder decision making, public awareness and further assessments. These topics are framed in the overall APF design and stakeholder strategy (see those technical papers for relevant notes). Here we review technical issues regarding the representation of vulnerability. The guiding concern is to present useful information, that is analytically sound and robust across the inherent uncertainties.

The first consideration is whether stakeholders and decision makers already have decision criteria that they apply to strategic and project analyses. For instance, the Millenium Development Targets may have been adopted in a development plan. If so, can the set of vulnerability indicators (VI) be related to the MDTs? Is there an existing map of development status that can be related to the indicators of climate vulnerability? It is always better to relate the vulnerability assessment to existing frameworks, terminology and targets than to attempt to construct a new language solely for the climate change issues.

Historically, a common approach has been to aggregate the individual indicators into an overall score (here called an index). For example, the Human Development Index is a

composite of five indicators, transformed into standard scores and differentially weighted (see the UNDP reports on the HDI for guidelines on how to transform individual indices).

Do stakeholders have a formal multi-criteria framework that illuminates the choice of aggregation procedures and weights? If so, than an analogous aggregation of the VI data into a index may be informative for stakeholders.

However, formal multi-criteria approaches are rarely generic and often contentious. The same is true for composite vulnerability indices. As a result, we believe they should be used only with great caution.

A preferable device for communicating the VA is to use multi-attribute profiles. For example, Figure 2 shows the relative scores for three vulnerable groups in northern Ethiopia for twelve common attributes of food security. All of the groups would be considered food insecure, and in times of drought might require external assistance. However, the structure of their vulnerability differs. The corresponding measures to reduce vulnerability are also distinct.

Another aggregation technique is to cluster vulnerable groups (or regions) according to key indicators. For example the climatic risk might be related to different classes of vulnerability. Figure 3 suggests an approach that prioritizes risks to sustainable livelihoods. More formal methods for clustering, such as principal components analysis, are becoming more common as well (see Box 3.1 for an approach used by the World Food Programme).

Finally, the qualitative understanding of vulnerability can be developed as stories. Storylines are part of the many socio-economic scenarios (see the technical paper for examples. Within the scenario storyline, hypothetical stories about representative livelihoods are effective ways to portray the conditions of vulnerability and the potential futures of concern. The communication methods are diverse--articles from future newspapers, radio documentaries and interviews can all be effective.

The output should link to further steps in the Adaptation Planning Framework. The focus on representative livelihoods and multiple scales of vulnerability can form the basis of an analysis of coping strategies. For instance, a multi-level assessment might include an inventory of household coping strategies and their effectiveness in different economic and climatic conditions, how local food markets might be affected by drought, and national contingency planning for drought (including food imports). A consistent analysis across these scales would inform a climate adaptation strategy with specific responsibilities for individual stakeholders.

The indicators in the vulnerability assessment can be used to evaluate adaptive strategies and measures (see the technical paper on adaptation). Vulnerability indicators have also been used as the baseline for monitoring development status (see the technical paper on implementation). The technical team should consider how its outputs can be used over a longer term. A key recommendation is likely to be improved monitoring and collection of specific data on socio-economic vulnerability. A final output might be to revisit the conceptual model. Are there new insights that need to be included? Does the monitoring plan capture the range of vulnerabilities and their drivers? Would the framework need to

altered to apply to different regions or vulnerable groups? Have the priorities for vulnerability assessment changed?

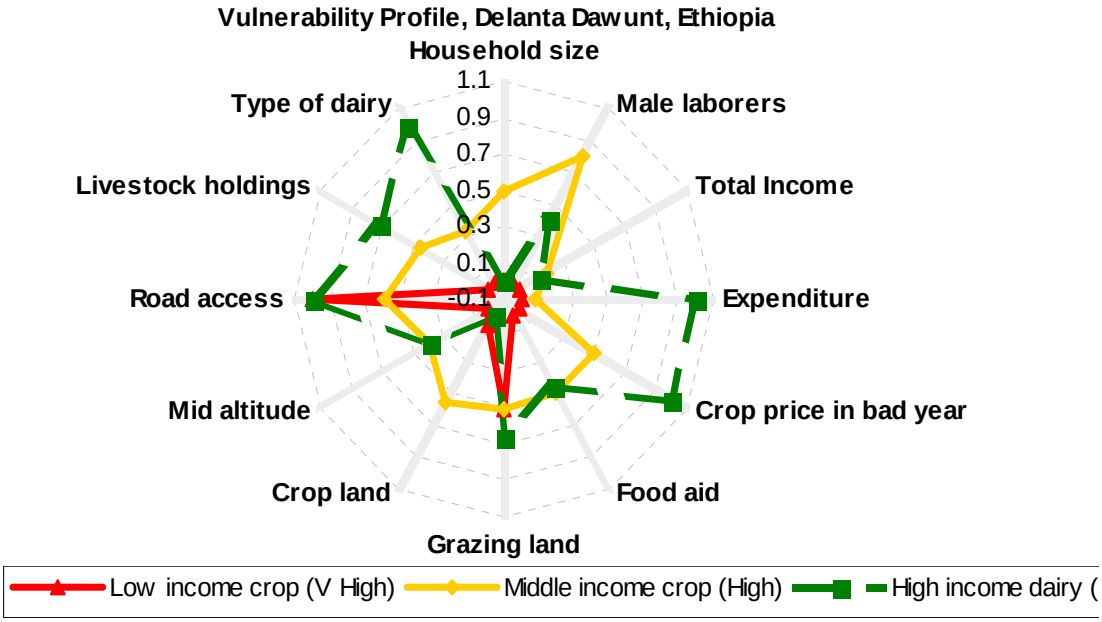

Figure 2. Food security profiles in rural Ethiopia. The dimensions of vulnerability are the spokes of the radar plot—an indicator with a high score (higher vulnerability) is plotted further away from the centre. The three livelihood groups shown have different overall levels of food security (based on a household survey). The figure highlights the different characteristics of their vulnerability. Source: Stephen (2002).

	Adaptive capacity	
Impacts	***Low***	***High***
High	Vulnerable Communities	Development Opportunities
Low	Residual Risks	Sustainability

Figure 3. Clustering climatic risks and present development. The quadrants are clusters of our knowledge of anticipated impacts of climate change and the capacity of livelihoods or regions to adapt to climate change impacts. The clusters have been applied to international data sets, using an early assessment of the economic damages of climate change conducted for the European Union's ExternE project and the Human Dimensions Index as a proxy for adaptive capacity. Indicators targeted for specific livelihoods could be applied at the national or more local level in APF projects**.**

Conclusion

The five tasks suggested here lead to a substantial vulnerability assessment. A national inventory of development status helps prioritize populations and regions at-risk of present and future climate change. The identification of vulnerable groups links directly to more sophisticated analyses of climate sensitivity and coping ranges (see the two technical papers on present and future climate risk). The suite of qualitative, participatory and quantitative methods should be readily available in most technical teams (and are well documented in other material).

Several issues remain that are difficult to handle in a vulnerability assessment or are worth further consideration as the VA progresses. Readers might think of these as frequently asked questions (FAQ—submit yours and we'll try to answer them on the web site):

1. What does the word vulnerability mean? Like many words in English, vulnerability has many definitions, each with nuances of application. We argue in this technical paper that consistency with the policy community (not necessarily the climate change regime) is important, and transparency of concepts and definitions should guide the analysis. We propose that technical teams use qualifiers to be clear, for example: climate vulnerability (cV), vulnerable socio-economic groups (Vg) and vulnerability assessment (VA).
2. Can vulnerability be quantified as the relationship between the hazard and its consequences? In natural hazards frameworks, vulnerability is often translated into an operational definition as a hazard loss equation (or dose-response function in health assessments). In such equations, it is necessary to constrain the inputs (e.g., a climatic index) and outputs (e.g, mortality, morbidity, economic losses, insured losses, psychological and social effects, etc.). The equations are not likely to be generic across socio-economic groups or for different hazards and their consequences. These approaches are consistent with the coping range/threshold methods reviewed in the technical paper on climate risk. The alternative tradition, essentially from poverty, development and food security, is to see vulnerability as a wider description of who is exposed to a range of consequences and why. That tradition underlies this technical paper. However, both approaches have similarities—the planning process and many of the methods are similar.
3. Can we predict vulnerability? No, and we can't even observe it—it is a construct that we (as analysts) create. Often signal events—such as a disaster or recession—will affect vulnerability, sometimes for the better. But we can create imaginative scenarios to illustrate changes in vulnerability, and use them review policy responses.
4. Does vulnerability include ecosystems? We prefer to use the word sensitivity to describe the effects of driving forces and perturbations on ecosystems and natural resources. It implies a distinction between the biophysical processes and effects and the values that people place on those changes. Clearly ecosystem services affect vulnerable livelihoods, so there is a direct link to vulnerability assessment.
5. Isn't vulnerability a product of many drivers and actors? We take the view that vulnerability—as a broad condition of resource use or development—is socially constructed (or negotiated). That is, vulnerability is not just the tail of a probability distribution, it is an essential aspect of social and economic systems. Thus, multi-actor perspectives that analyze stakeholder behavior are essential. Such methodologies focus on understanding adaptive capacity and the means to implement climate adaptation strategies.

This technical paper seeks to encourage teams to being with the current development status as a starting point for making clear linkages between vulnerability to present climatic variations and future adaptive strategies and measures. The methodology recognizes the importance of understanding the drivers of vulnerability at different levels—from international and national assessments to sectoral planning and local development. Efforts to reduce vulnerability, taking this approach, are likely to be consistent with national development plans (for example, to meet Millenium Development Targets) with co-benefits of reducing exposure to a range of future climatic hazards and conditions. The techniques highlighted here are only a sample of the range of methods that are suitable (see the other technical papers and SA.X.4 for more information).

References and resources for further information

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Stephen, L. and Downing, T.E. 2001. Getting the scale right: a comparison of analytical methods for vulnerability assessment and household level targeting. *Disasters* 25(2): 113-135.

Web sites that illustrate the range of applications and approaches include:

- Food systems: World Food Programme Vulnerability Assessment and Mapping: http://www.wfp.org/index.asp?section=5 and www.wfp.org/operations/vamu; US Famine Early Warning System network, FEWS-NET: http://www.fews.net/; an operational workshop report highlighting the uses of a vulnerability assessment in southern Africa: www.sadc-fanr.org.zw/vac/VATC_2.pdf; UN's Food Insecurity and Vulnerability Information and Mapping Systems (www.fivms.org); Save the Children Fund's RiskMap and household food economy approach (http://193.129.255.93/foodsecurity); and CARE's livelihood security framework (www.careinternational.org.uk/reports/livelihoods.html).

- Disasters and natural hazards: An example of a community vulnerability assessment tool, for coastal storms: http://www.csc.noaa.gov/products/nchaz/startup.htm and an index of techniques and tools: http://www.csc.noaa.gov/vata/; an example of a vulnerability assessment for building in Latin America: http://www.oas.org/en/cdmp/document/schools/vulnasst/gre.htm, and the guide for wind hazard vulnerability: http://www.oas.org/en/cdmp/document/schools/wind.htm; the ReliefNet listing of training courses and material on vulnerability assessment: http://www.reliefweb.int/training/kt22.html; a consulting firm emphasising hazards and vulnerability: http://www.allhandsconsulting.com; and the World Bank Disaster Management Facility: http://www.worldbank.org/dmf/
- Livelihoods and vulnerable groups: A focus on Africa: http://www.certi.org/publications/11-01/CERTI%20EWERsurveyN-01.htm; and Sustainable livelihoods: http://www.livelihoods.org
- Global change: A global sea level rise project, SURVAS: http://www.survas.mdx.ac.uk/; the PIK Environmental Vulnerability Assessment group: http://www.pik-potsdam.de/~richardk/eva/; regional projects that include vulnerability include: www.cpacc.org; the US EPA's regional vulnerability assessment programme: http://www.epa.gov/reva/; and the UNEP/TWAS/START GEF project on climate change adaptation, AIACC: http://www.start.org/Projects/AIACC_Project/aiacc.html
- Resource management: An elaborate schema for aquifer vulnerability: http://www.crisp.nus.edu.sg/~acrs2001/pdf/267THIRU.PDF; an interesting overview of vulnerability management: http://www.isn.ethz.ch/crn/extended/workshop_zh/ppt/Gheorghe/; and the World Bank's Poverty Network: http://www.worldbank.org/poverty/ and www.povertynet.org

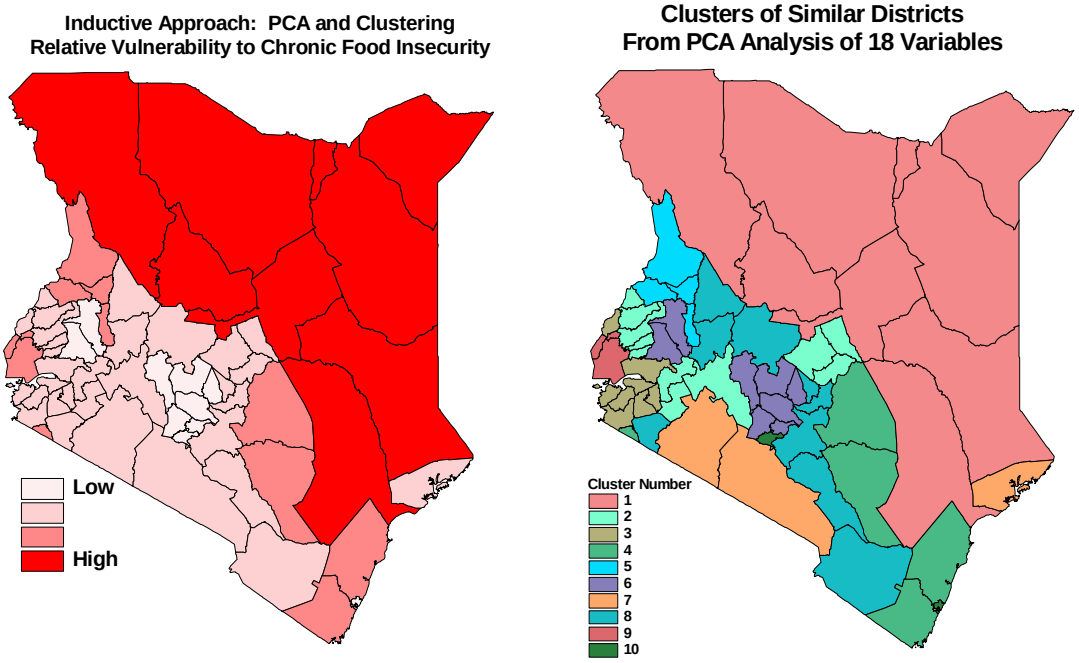
Box 2: Multi-level food assessment in Kenya

Source: Haan, N., Farmer, G. and Wheeler, R. 2001. Chronic Vulnerability to Food Insecurity in Kenya—2001. A WFP Pilot Study for Improving Vulnerability Analysis.

The World Food Programme (WFP) has developed the Standard Analytical Framework (SAF), based on a clear conceptual framework of food insecurity. National assessments begin with a **literature review** to understand contextual issues, enable the study to build from previous research, and identify relevant indicators and data needs.

In Kenya, the **secondary data analysis** sought to: identify relative differences in vulnerability to food insecurity between districts, characterize contributing factors to vulnerability at the district level, and prioritize districts for subsequent community-based analysis. A variety of data sets and techniques were employed, allowing for verification of results and a mixture of interpretations. The Geographic Information System mapped 18 variables at the district level: life expectancy, adult literacy, stunting, wasting, livelihood diversification, access to safe water, livelihood fishing, high potential land, mean vegetation condition variation and persistence (using the NDVI), education, gender development, non-agricultural income, proximity to markets, HIV/AIDS incidence, and civil insecurity.

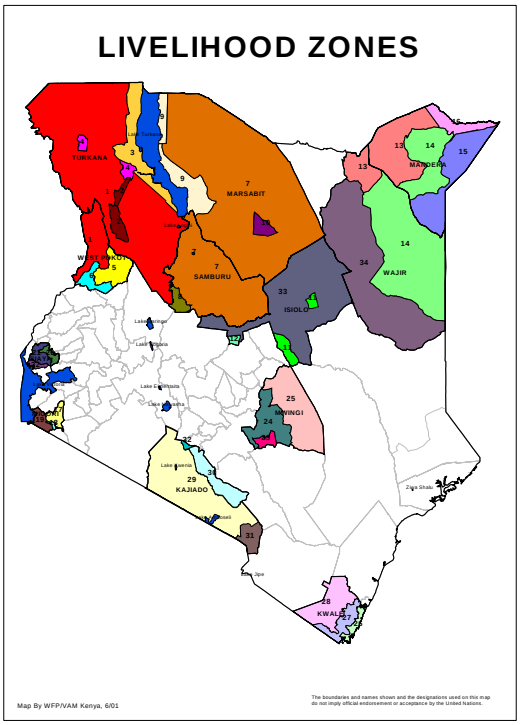
An inductive approach, using Principal Components Analysis (PCA), grouped the district data into clusters of districts with similar characteristics, and then interpreted for relative vulnerability. The PCA (left map) indicates highest levels of vulnerability in the arid and semi-arid districts of northern Kenya. The clustering technique shows groups of similar districts (in terms of food security). This PCA and clustering is helpful to understand some of the dynamics of food insecurity. For example, cluster 1 is strongly and negatively associated with food insecurity characterized by: low adult literacy rates, high wasting, low non-farm income, low market access, low NDVI mean, high annual variance of NDVI, high civil insecurity, and low HIV/AIDS.

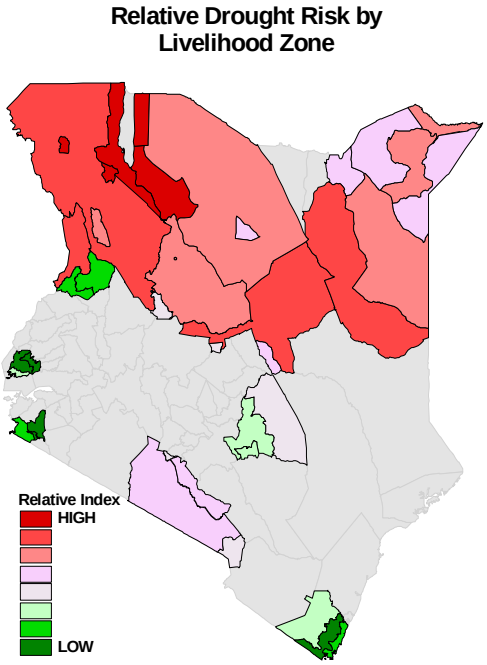


The community-based analysis, called **Participatory Vulnerability Profiles** (PVP), covered 79 villages stratified by livelihood zones in 12 districts selected based on the SDA results and key informant discussions. The goals of the PVP were to: describe relatively homogenous livelihood zones, verify and further disaggregate results of the SDA, characterize community vulnerabilities to food insecurity, characterize and identify proportions of more vulnerable populations, identify both community-level and macro, or structural causes of food insecurity, and identify intervention opportunities.

An important emphasis of the PVP methodology was the direct links between the conceptual framework and the field techniques, enabling the field researchers to understand better the reasons for asking questions in the field. Districts were selected to represent each of the clusters from the national analysis. The field teams, in consultation with district officials, created livelihood zones (LZs) within each district. The definition of LZs as used in this study is: *a relatively homogenous area with regards to four variables including main food sources, main income sources, hazards, and socio-cultural dynamics.* The creation of LZs allows the research to sample only a few villages within a large area and make a statement about the whole area. The third layer of sampling was within each community, and involved focus group interviews with various social groups including the "typical group", the "most vulnerable", women, community leaders, and a mixed representative group.

The analysis revealed broad similarities between the district analysis and the detailed understanding by livelihood zones. Implications of hazards, coping strategies, social dynamics and health on food insecurity led to specific recommendations. For example, one of the main hazards throughout the most vulnerable districts is drought, which is reportedly occurring more frequently. The relative drought risk by livelihood zone shows variation even within the more vulnerable districts.





Supplementary annexes

SA.3.1. Conceptual frameworks, definitions and a formal vocabulary of vulnerability

TE Downing
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The following material was developed as part of a training course on climate change vulnerability and adaptation for the AIACC project (see www.start.org for further details). The objectives of a small group exercise on vulnerability concepts was to:

- Introduce the range of definitions of vulnerability
- Look at range of methods in vulnerability assessment
- Consider ways to apply vulnerability assessment in AIACC projects

The following 'vulnerability diagrammes', drawn from several studies, was used to brainstorm issues regarding the framing vulnerability in the context of climate change and using vulnerability frameworks in research projects. Other sessions covered vulnerability mapping, livelihood approaches, socio-economic scenarios and the use of indicators.

In the small group exercise, the strengths and weaknesses were left blank—to be filled in by the participants. Here I have noted some of the remarks that came up during the training course.

Technical teams in undertaking APF projects may find this exercise useful in providing some background to conceptualising vulnerability. None of the frameworks is 'best', all have attractions as well as weaknesses.

A sample of the many related definitions is provided from a review on vulnerability methods and global change.

A suggested nomenclature for vulnerability is included.

See the technical paper for the references.

Definitions of hazard, vulnerability, risk and disasters

Hazard	**:**	**potential threat to humans and their welfare**
+		
vulnerability	**:**	**exposure and susceptibility to losses**
=		
risk	**:**	**probability of hazard occurrence**
disaster	**:**	**realization of a risk**

✓ *Strengths:*

Simple, widely used, clear definitions of key terms

☒ *Weaknesses:*

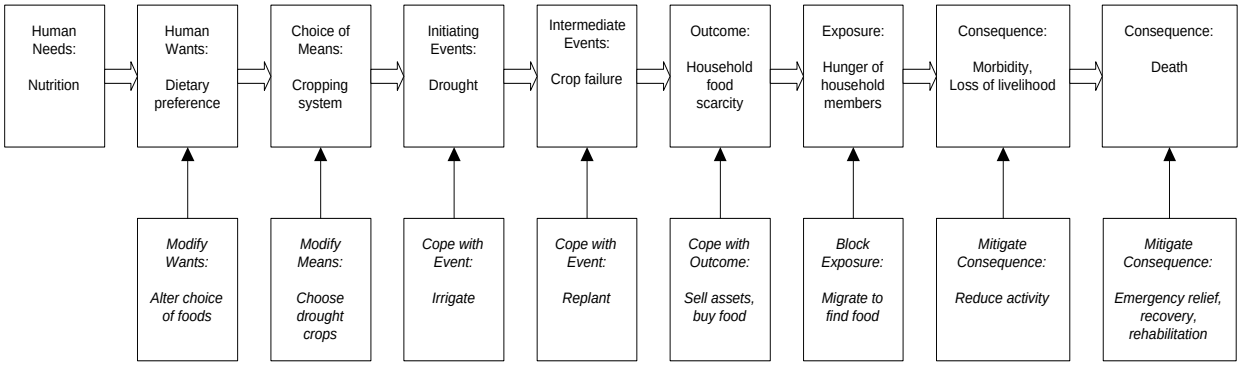
Not very dynamic, doesn't show what causes vulnerability, vulnerability is limited to a hazard-loss equation

🛠 **Techniques**:

Indicators, loss equations

Causal chain of hazard development

Source: after Downing (1991, see also Millman and Kates 1990).



✓ *Strengths:*

Sequence of the drivers of vulnerability, emphasis on upstream causes, explicit ways to reduce vulnerability, multiple consequences

☒ *Weaknesses:*

Too linear, no feedbacks between outcomes and earlier vulnerabilities, no sense of who chooses options to modify the vulnerabilities, limited environmental forcing—to only one place in the sequence

🛠 **Techniques**:

Linked models, e.g., food systems and crop model, indicators

Vulnerability and capability

RESOURCES	VULNERABILITY	CAPABILITY
Physical/material		
Social/Organizational		
Motivational/attitudinal		

Source: Anderson and Woodrow (1989).

✓ *Strengths:*

Simple, flexible, brings in local knowledge, shows capability and opportunities, not just physical, includes social capital, intended for rapid use during disasters

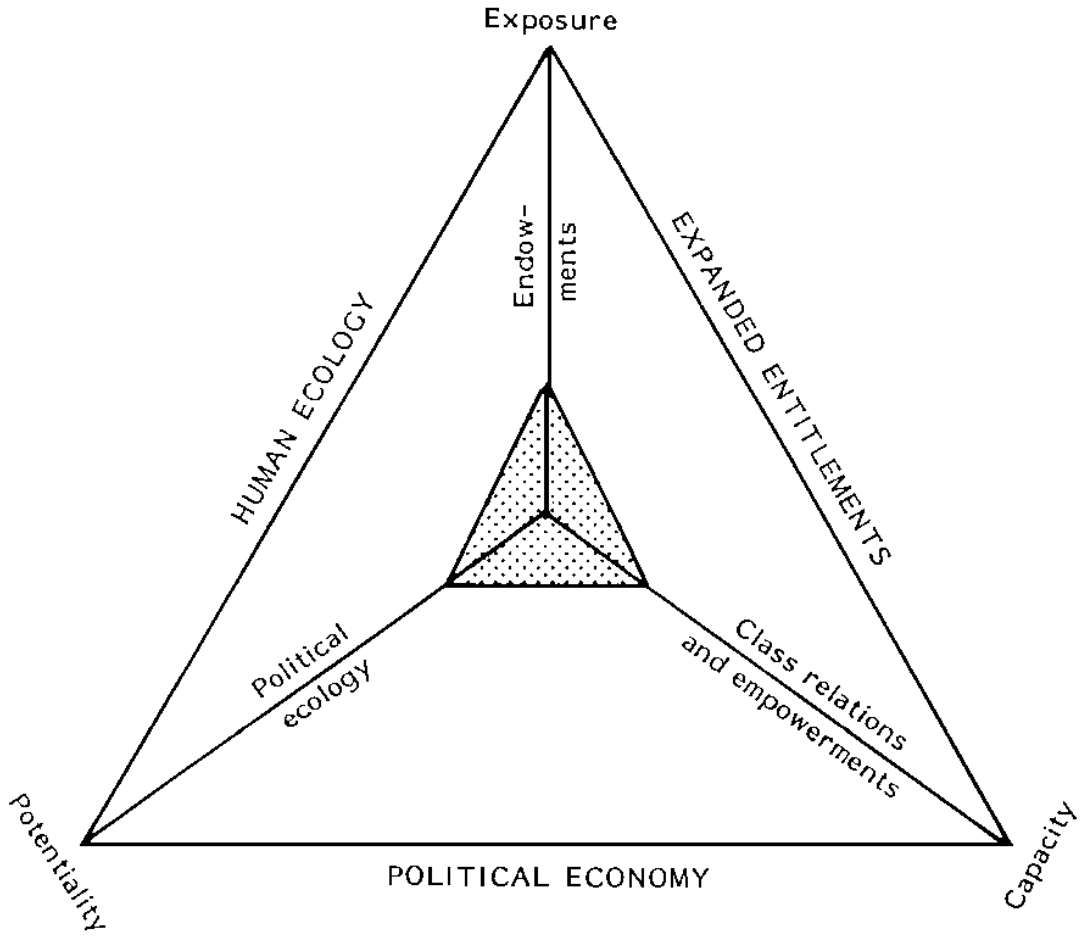
☒ *Weaknesses:*

Nothing filled in—no sense of what the major issues are, not clear it would help identify vulnerable groups on its own, no drivers or assessment of future risks

🛠 Techniques:

Surveys, expert judgement and key informants

Three dimensions of vulnerability



Source: after Bohle *et al.* (1994).

✓ *Strengths:*

Leads to complex and comprehensive typology of what vulnerability is, the major drivers, brings in socio-institutional factors—economic class, political ecology, triangle implies more than one dimension of vulnerability and the need to locate vulnerable groups according to different causes

☒ *Weaknesses:*

Pretty academic, not words in common usage, three dimensions are not orthogonal—hard to convert to an analytical method, what does the shaded centre mean?

🛠 Techniques:

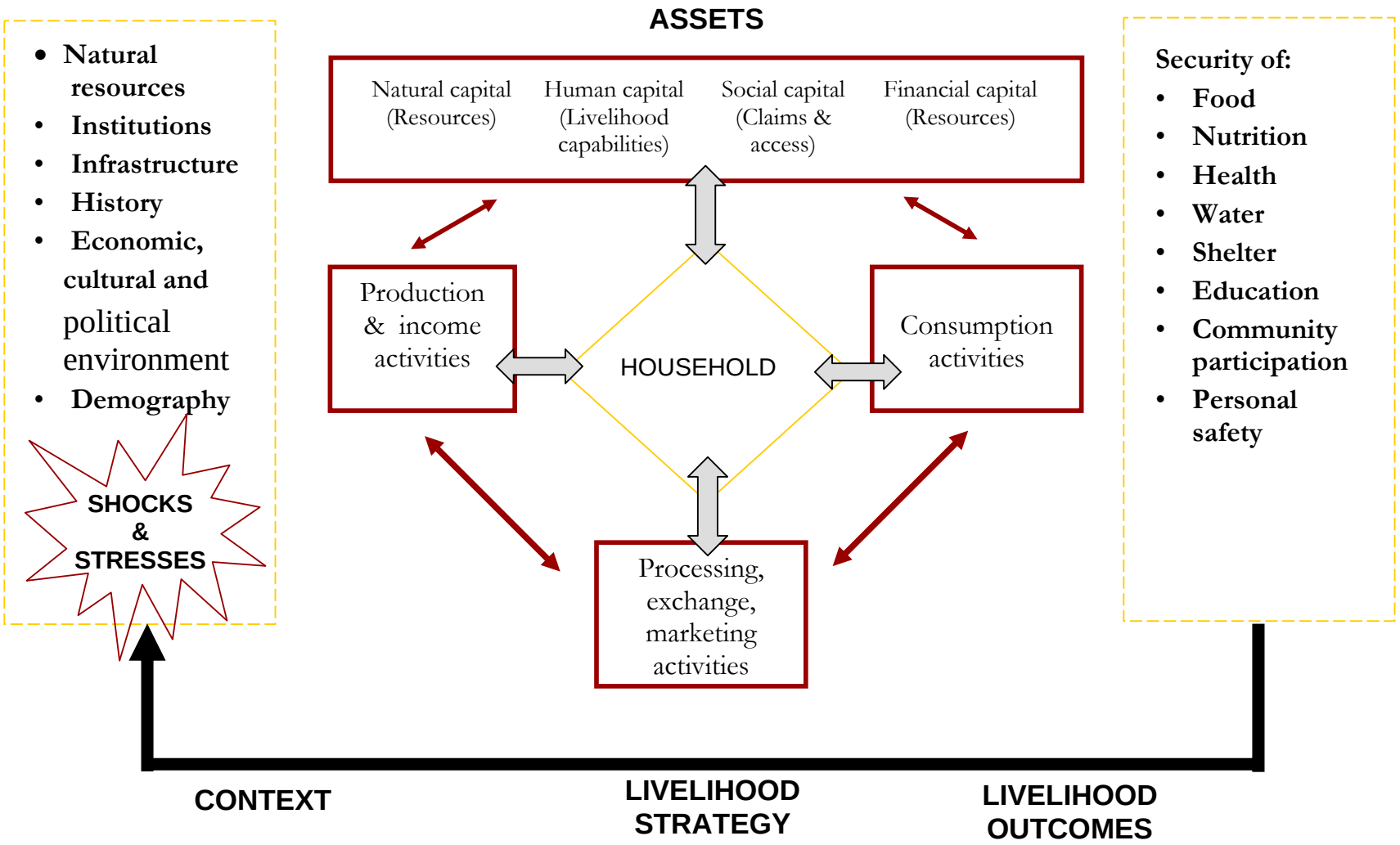
Indicators, descriptive analysis

PROGRESSION OF VULNERABILITY									
ROOT CAUSES	⇒	*DYNAMIC PRESSURES*	⇒	**UNSAFE CONDITIONS**	⇒	***DISASTERS***	⇐	**HAZARDS**
Limited access to		**Lack of**		**Fragile physical environment**				**Earthquake**
Resources		Institutions		• Dangerous locations		**RISK**		
Structures		Training		• Unprotected structures				**Wind storm**
Power		Skills				=		
		Investment		**Fragile local economy**				**Flooding**
Ideologies		Markets		Livelihoods at risk		**HAZARD**		
Political systems		Press freedom		Low income				**Volcano**
Economic systems		Civil society				+		
				Vulnerable society				**Landslide**
		Macro-forces		Groups at risk		**VULNERABILITY**		**Drought**
		Population growth		• Little capacity to cope				
		Urbanisation						**Virus and pest**
		Arms expenditure		**Public actions**				
		Debt repayment		Lack of preparedness				**Heat wave**
		Deforestation		Endemic disease				
		Soil degradation						

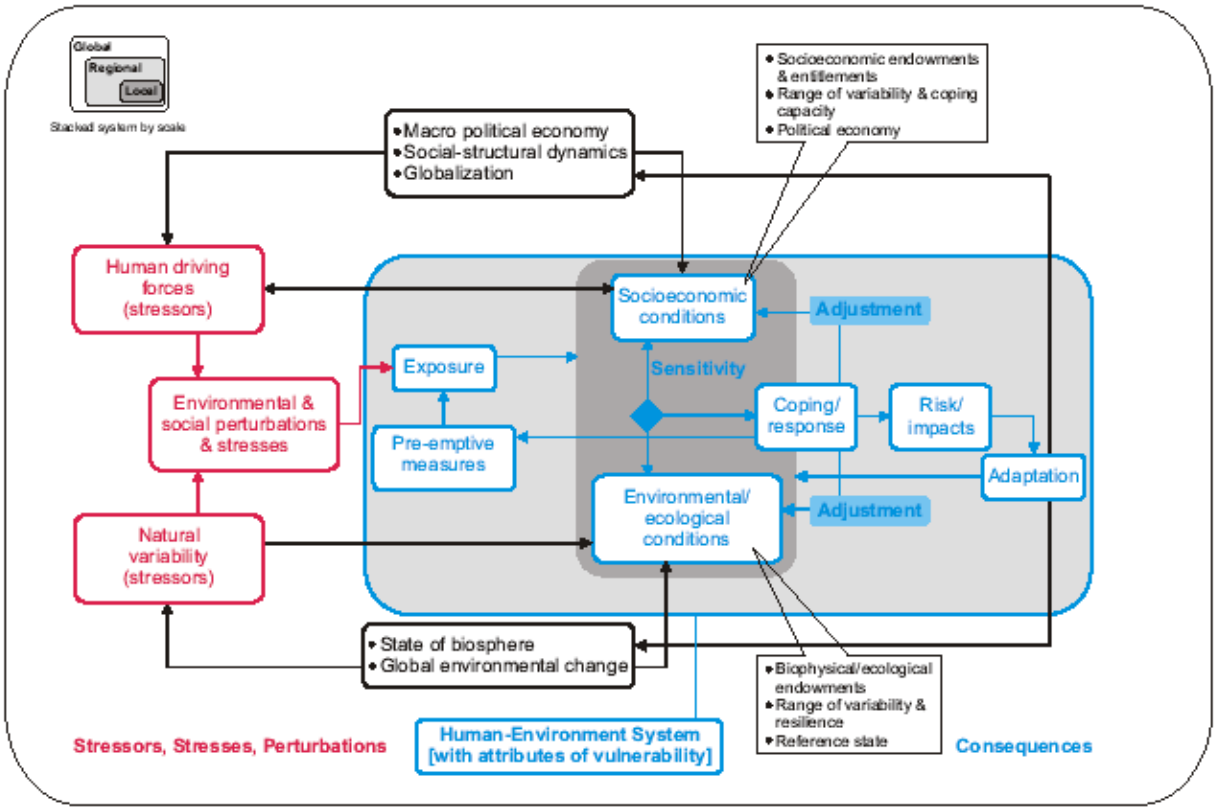
Structure of vulnerability and disasters. Source: Blaikie *et al.* (1994).

✓ **Strengths:** *Detail on causes, comprehensive, understandable* ☒ **Weaknesses:** *More descriptive than analytical*
🛠 **Techniques:** *Inventories, indicators*

CARE'S LIVELIHOOD SECURITY FRAMEWORK



Environmental vulnerability



Source: Kasperson, et al.

✓ *Strengths:*

Comprehensive with relevant boxes, three scales are important, understandable to systems analysts (such as ecologists)

☒ *Weaknesses:*

Not clear how the dynamics at the local scale (sensitivity, adjustment, coping/response) really are linked to the larger scales, would need additional material to implement

🛠 **Techniques**:

Dynamic simulation, choice of indicators

Glossary of Terms for Vulnerability Framework

Adaptation
A system response to perturbation or stress that is sufficiently fundamental to alter the system itself, usually shifting the system to a new state. Adaptations are commonly but not necessarily long term in their development and implications. See the distinction below with "adjustment". Adaptation and adjustment are commonly fused in the literature and do not have standard definitions.

Adjustment
A system response to exposures that does not fundamentally alter the system itself. Adjustments are commonly but not necessarily short-term and involve relatively minor system modifications.

Coping/Response
The wide-ranging set of mechanisms used or actions taken (by ecosystems or people) in reaction to threats or impacts. Coping/response includes preemptive measures, as well as more reactive adjustments and adaptations.

Coping/response capacity
The potential of a system to reduce impacts from stresses or perturbations, not necessarily the actual coping actions taken in response to a stress. Actual coping can be markedly less than the capacity for coping, depending on system goals and priorities, institutional and informational obstacles, and timely access to coping resources, all of which vary across the human and ecological components of the system. The literature often uses the term "adaptive capacity" in reference to coping/response capacity as defined here.

Coupled human-environment system
A system composed of interacting and partially integrated social and ecological elements and processes, usually coalescing in a particular place.

Endowments
The assets, resources, and qualities, both human and ecological, that determines system capacities for and constraints on responding to stresses and perturbations. These qualities for ecosystems include soil characteristics, species diversity, landscape connectivity, and nutrient cycling, among others; for humans, included are rights, resources (land, skills), information, opportunities, and so forth.

Entitlements
The totality of rights and arrangements (both formal and informal) an individual or group in society can draw upon to establish command over sets of resources and commodities. Entitlements result from endowments, and reside at critical points in the chain of creation or avoidance of social vulnerabilities.

Exposure
The contact between a system, or system component, and a perturbation or stress. Exposure is a function of both the magnitude and scope of the perturbation, and of the system with which it comes into contact (e.g., its location).

Exposure unit
Any system or part of a system that comes into contact with a perturbation or stress. In practice these units include individuals, groups, economic sectors, places, and various parts of ecosystems.

Impact
The consequence(s) of exposure to a perturbation or stress on a system. System consequences can refer either to the *risk* of impact or the actual impact experienced.

Hazard

The threat of a stress or perturbation faced by a system.

Mitigation

A type of coping mechanism utilized or action taken to reduce exposure or sensitivity, or to reduce the harm resulting from such exposure. Mitigation is often used to mean an anticipatory action. Alternatively, mitigation can be used to mean a coping strategy or mechanism (e.g., insurance systems) used after immediate harm or impact has occurred, designed to ameliorate longer-term consequences. Because of these different uses of the term, mitigation is not employed in the current vulnerability framework.

Perturbation

A disturbance to a system resulting from a sudden shock with a magnitude outside the normal range of variability. Perturbations may arise from human driving forces, ecological (natural) events, or combinations of the two. Furthermore, perturbations may arise from within or outside of the exposure unit.

Preemptive measure

A type of coping mechanism utilized or action taken (by ecosystems or people) to reduce exposure or sensitivity to a stress. Preemptive measures in human systems are anticipatory or preparedness actions. We use preemptive measure in place of one of the meanings often ascribed to "mitigation."

Resilience

The ability of a system to absorb perturbations or stresses without changes in its fundamental structure and function that would drive the system into a different state (or extinction).

Risk

The conditional probability of harm attendant on exposure to a perturbation or stress.

Sensitivity

The extent to which a system or its components are likely to experience harm due to an exposure to perturbations or stress.

Stress

Cumulating pressure on a system resulting from processes within the normal range of variability, but which over time may result in disturbances causing the system to adjust, adapt, or to be harmed.

Stressor

An agent and process – human or ecological (and arising either internally or externally to the system) – that creates stresses or perturbations on an exposed system.

Vulnerability

The degree to which an exposure unit is susceptible to harm due to exposure to a perturbation or stress, and the ability (or lack thereof) of the exposure unit to cope, recover, or fundamentally adapt (become a new system or become extinct).

Source: Kasperson, et al. (2002)

Suggested nomenclature for vulnerability definitions

If we accept that there are always going to be many and conflicting definitions of the word 'vulnerability', perhaps what is needed is a nomenclature—a way of systematically referring to vulnerability in typologies and analytical exercises. Here is a suggestion—extending the minimum of terms proposed in the APF technical paper.

$$ {}^{T}V_{s,g}{}^{c} $$

Where:

T=threat

s=sector

g=group

c=consequence

E.g.: climate change vulnerability in agriculture

for farmers' economic welfare

This nomenclature would results in examples such as:
climate change vulnerability (T=climate change, no other terms specified)
drought (T) vulnerability for food systems (s)
drought (T) vulnerability for smallholder (g) agriculturalists (s)
drought (T) vulnerability for smallholder (g) agriculturalists (s) at risk of starvation (c=health effects of reduced food intake)

The process of conducting a vulnerability assessment can be labelled, VA.

If the indicators are mapped, this is extended to a vulnerability assessment map (VAM)

The data base of indicators used in a VA (or VAM) can be labelled VI. Individual indicators (VI_x) might carry their own nomenclature, to specify:
t = time period (historical, present or specific projection)
g = group of people if specific to a vulnerable population
r = region (or geographic pixel)
* = transformed indicators, as in standard scores

SA.3.2. Eight Lessons from Food Security for Understanding Adaptation to Climate Change

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Extended abstract from an article to be published in a volume of papers on climate change vulnerability and adaptation edited by Joel Smith and Richard Klein: Downing, T.E. (2002) Lessons from Famine Early Warning and Food Security for Understanding Adaptation to Climate Change: Toward a Vulnerability/Adaptation Science? See also: Downing, T.E. 2002. Protecting the vulnerable: Climate change and food security. In J.C. Briden, and T.E. Downing, eds. *Managing the Earth. Oxford*: Oxford University Press, 157-178.

Famine early warning systems, and food security research more generally, were developed to address a specific problem—supporting local livelihoods and national economies to prevent widespread adverse effects. This experience, over two decades, provides insight into some of the challenges, and potentially solutions, in adaptation to climate change. Progress toward a vulnerability/adaptation science has been significant, but a dynamic understanding of vulnerability and adaptation pathways will require a change in paradigm.

Here, I take as the starting point eight "lessons" learned in the practice of food security and famine early warning and their relevance to climate change adaptation.

1. Beyond Hoovering: Conceptualizing Vulnerability

The early models of famine early warning systems adopted the approach of gathering all possible (or measurable) indicators, adding them up and deducing vulnerability. This was termed the hoovering approach—vulnerability was the weight of the bag after vacuuming up everything in sight (hoovering is the British word for vacuuming). The dangers are that many indicators are correlated with each other, some have weak or delayed connections to emerging vulnerability and indicators that are difficult to measure may be ignored. Subsequently, analysts emphasized logical, conceptual approaches to vulnerability and used conceptual models to choose relevant indicators.

In contrast, the climate change community has not reached consensus on the conceptualization of vulnerability. The Intergovernmental Panel on Climate Change (IPCC) created a distinct definition of vulnerability; essentially the residual impacts of climate change after adaptation measures have been implemented. This approach confines vulnerability to long-term changes driven by climate change. It is difficult to operationalize since it mixes present vulnerability, long-term scenarios of climate change and multilevel processes of adaptation.

2. Baseline Exposure: Who, to What, When?

Monitoring emerging famine conditions requires an appropriate baseline of vulnerability. Much early discussion revolved around whether vulnerability was socioeconomic or geographic (who?), structural or episodic (to what?), and long term or short term (when?).

Vulnerability is more characteristically about people rather than places. That is, vulnerability is a social phenomenon relevant to particular social groupings, whether demographic (elderly, young), economic (livelihoods, entitlements) or political (marginalized). It is people who are exposed (ultimately) to climatic extremes, and to longer term climate change.

3. An Integrated Measure of Exposure

Vulnerability integrates exposure at the level of vulnerable groups; therefore vulnerability must span sectors and sources of shocks. The concern in famine early warnings is with an outcome—food security. The sources of insecurity may be differentiated, but the key focus is preventing loss of life, assets and livelihoods regardless of the source of stress. Sen's (1981) work on entitlements marked the end of the single stress-impact era of food security work (that is, the linear construction of famine as drought → crop failure → production decline → famine). Similarly, sustainable livelihoods approaches rely on a multidimensional understanding of vulnerability.

In contrast, most climate impact studies start with the assumption that climate stresses are foremost. The most common framework remains: climate change scenario → impact model → climate change impact. Modest variations to this linear view include the use of analogue events (e.g., a signal drought) and changes in variability (and therefore risk) in addition to changes in climatic means.

4. A Relative Assessment

Vulnerability is not an external characteristic that can be universally described and observed. Rather it is a way of addressing complex problems and deciding on a course of action—whether mobilizing aid to prevent famine or mapping underlying food insecurity to target food aid programs. The analyst must choose indicators, aggregation models and relevant thresholds for action.

5. Targeting: Scale and Specificity

Early food security assessments that focused on food deficits may have missed the impacts of economic shocks—the motivation for Sen's (1981) entitlement system. Preventing famine requires targeting the most vulnerable groups, at least to use the existing resources efficiently. To support livelihoods (rather than send a lot of food aid), increasingly sophisticated food security assessments are necessary—for instance taking on local pockets of deprivation, understanding the role of local markets within regional economies and anticipating changes in remittances and household expenditures. Scale and specificity are inherent in climate change adaptation.

6. Capturing Dynamic Pathways and Multilevel Processes

Vulnerability changes quickly, the product of changes at several scales. Most assessments focus on current situations, in order to recover from a disaster or anticipate a crisis. The baseline of recent vulnerability is likely to vary from a few years (e.g., trends in household income) to a few months (e.g., crop failure) or even the past few days (as in situations of armed conflict). While the dynamism of vulnerability is recognized, there has been relatively little progress in capturing evolving pathways or projecting vulnerability into the future.

Representing climate impacts and adaptation as dynamic pathways is also a challenge for climate change studies. It may turn out that the fixation on scenarios – as static snapshots of futures that have little connection to the present -- has impeded more creative development of dynamic representations of environmental change and social learning.

7. Response Orientation

Vulnerability assessment grew out of a need to trigger relief, and still keeps a close connection with at least an implied decision making framework. Within applications to climate change adaptation, a response orientation requires an actor-oriented approach and recognition as to the relative nature of vulnerability. It also requires identification of criteria for evaluation strategies and options.

8. Standards

Recently, the Sphere Project (2000, 2001) has worked to create and implement a series of standards for disaster relief. While not universally accepted, the process and experience around the world is proving helpful to discuss ways of promoting effective disaster aid. At the same time, methods in famine early warning systems have converged (see the FIVMS web site at www.fivms.org).

The experience in climate change impacts research is less coherent. The early dominance of the "seven steps" (Carter et al., 1994) tended to narrow the range of research, and often led to inappropriate methods that ignored present vulnerability. Certainly, the progression from impacts to adaptation has challenged the IPCC approach. And the climate change community does not appear to be very close to adopting standards, or even a common paradigm and analytical language.

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SA.3.3. A vulnerability toolkit for climate adaptation

TE Downing, with others
Version: Habana 13-sep-02

Introduction

Five kinds of studies are appropriate for understanding climate vulnerability and adaptation:

- What if (WIf) studies are often the starting place for raising awareness among a wide variety of audiences about potential sensitivity to climate change.
- Vulnerability assessments and sustainable livelihood (VASL) approaches begin with present risks, and overlays climate change through a guided process of risk assessment.
- A focus on stakeholders and their decision making regarding threats and opportunities (STO) leads to strategies for adapting to climate change over a range of planning periods.
- Where specific decisions need to be made, processes for evaluating additional climatic risks have been formulated in climate impacts management (CIM) studies.

Vulnerability Assessment and Sustainable Livelihoods

Vulnerability mapping begins with a snapshot of the present situation—whether applied to a specific hazard (e.g., hurricanes), generic disaster risks or poverty. In this approach, climate risks—both present and future—are placed in context of present vulnerability. Further elaboration provides indications of relative risks and strategies to support sustainable livelihoods.

The approach includes:

- Vulnerability mapping: ideally starting with the concepts and assessments conducted in the course of hazard management or development planning. An increasing number of such exercises have been conducted, providing a good starting place for climate change studies.
- Relating livelihoods to their exposure to risks. Often vulnerability maps do not explicitly recognize livelihoods—the exposure of specific populations to threats and opportunities. Once identified, a matrix of their exposure to development and climate risks helps to focus on the most sensitive livelihoods and those threats that can be managed.
- Description of coping strategies for the identified livelihoods. A qualitative assessment, through interviews, secondary literature, focus groups, workshops, etc., will provide a rich context for considering the relative risks of climatic variations and potential response strategies.
- For selected livelihoods and risks, quantitative models can be constructed—following the approach that Jones terms coping ranges or more dynamic decision models (as in agent based systems).
- The qualitative and quantitative assessments can be tested against a range of scenarios of the future (including socio-institutional changes as well as climatic risks).
- It may be desirable to relate the scenario exercises to the initial vulnerability assessment. This might be simply looking at overlays of the present vulnerability and future risks. However, developing innovative techniques to deal with spatial data and relatively long time frames would be worth pursuing.

The main output of this approach should be a relatively robust presentation of present vulnerability and scenarios of future risks—accompanied by a rich understanding of coping strategies for different livelihoods. The integration of climate risk in development planning is a main goal—adopting existing development frameworks and concepts is a key strength.

The key analytical tools are vulnerability mapping and dynamic simulation of sustainable livelihoods. However, the broader techniques of stakeholder participation and risk assessment are essential.

The following table suggests further tools that may be important, with an indication of their suitability according to the following criteria:

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 readily participate in the application of the tool

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 modelling			✓		?	✓	?
2. Bayesian analysis				✓			
3. Brainstorming	✓	✓	✓	✓	✓	✓	✓
4. Checklists/ multiple attributes	✓			✓		✓	✓
5. Cost-effectiveness (CBA)			✓	✓			
6. Cross-impact analysis			✓	✓			
7. Decision conferencing			✓	✓			
8. Decision/probability trees				✓			
9. Delphi technique	✓		✓	✓		?	?
10. (Strategic) environmental impact assessment			✓	✓	✓		?
11. Expert judgement	✓	✓	✓	✓	✓	✓	
12. Focus groups	✓	?	✓	?		?	✓
13. Indicators/ mapping	✓		?			?	?
14. Influence diagrams/ Mapping tools	✓		✓		✓		✓
15. Monte Carlo analysis				✓			
16. Multi-criterion analysis				✓			
17. Ranking/dominance analysis/pairwise comparisons	✓		✓	✓			✓
18. Risk analysis			?	✓			
19. Scenario analysis	?	?	✓	?	✓	✓	✓
20. Sensitivity/Robustness analysis			✓	✓			
21. Stakeholder consultation	✓	✓	✓	✓		✓	✓
22. Stakeholder Thematic Networks	✓	?	✓		?	✓	
23. Uncertainty radial charts				✓			
24. Vulnerability profiles	✓	?	?			✓	✓

Tools

1. **Agent-based simulation modeling** – formalism of agents and their interactions at multiple levels
2. **Bayesian analysis** – use to re-assess probabilistic data in light of new data. Statistical analysis.
3. **Brainstorming** – free-flowing lists/diagrams of all ideas and options
4. **Checklists** – matrix
5. **Cost-effectiveness/ Cost-benefit/ Expected value** – econometric techniques
6. **Cross-impact analysis** – test robustness of risk-assessment and dependencies between events
7. **Decision conferencing** – quantitative analysis of options incorporating the uncertainties in interactive modes
8. **Decision/probability trees** – charts of relationships between decision modes; helpful for generating expected value
9. **Delphi technique** – range of views of experts through iterative written correspondence
10. **Environmental assessment/Strategic environmental assessments** – consideration of all environmental impacts taken into account before deciding on development
11. **Expert judgement** – the assessment of experts in the field on specific propositions
12. **Focus groups** – groups of stakeholders that discuss their opinions on certain topics
13. **Indicators/ mapping** – compilation of indicators into aggregate indices, often mapped
14. **Influence diagrams/ Mapping tools** – graphic identification of options when there are a number of decisions
15. **Monte Carlo analysis** – computer based analysis that explicitly assesses uncertainty
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. **Scenario analysis** – fuller picture of implications of uncertainty gained through simultaneous variation of key uncertainties
20. **Sensitivity analysis/Robustness analysis** – identify which variable contribute most towards uncertainty
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. **Uncertainty radial charts** – assessment of the potential uncertainty of options
24. **Vulnerability profiles** – mapping of the different indicators of vulnerability for different groups

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SA.3.5. Illustrative steps in planning a vulnerability assessment

TE Downing, with others
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The following charts illustrate the process of planning and implementing a vulnerability assessment for climate adaptation. This illustration is not a protocol—it does not include all of the possible choices and methods. Rather, it illustrates the five tasks outlined in the technical paper with specific choices and 'pathways' through planning a project.

In the diagrammes, a solid arrow indicates a positive result (a Yes). A dotted arrow indicates alternatives approaches in the absence of previous information (a No). The outputs on the right side of the diagrammes link from top to bottom. In fact, not all of the potential linkages are shown. Most importantly, the process is almost certain to be iterative. Tasks feed back to the scoping and data activities with further refinement of the information available and required.

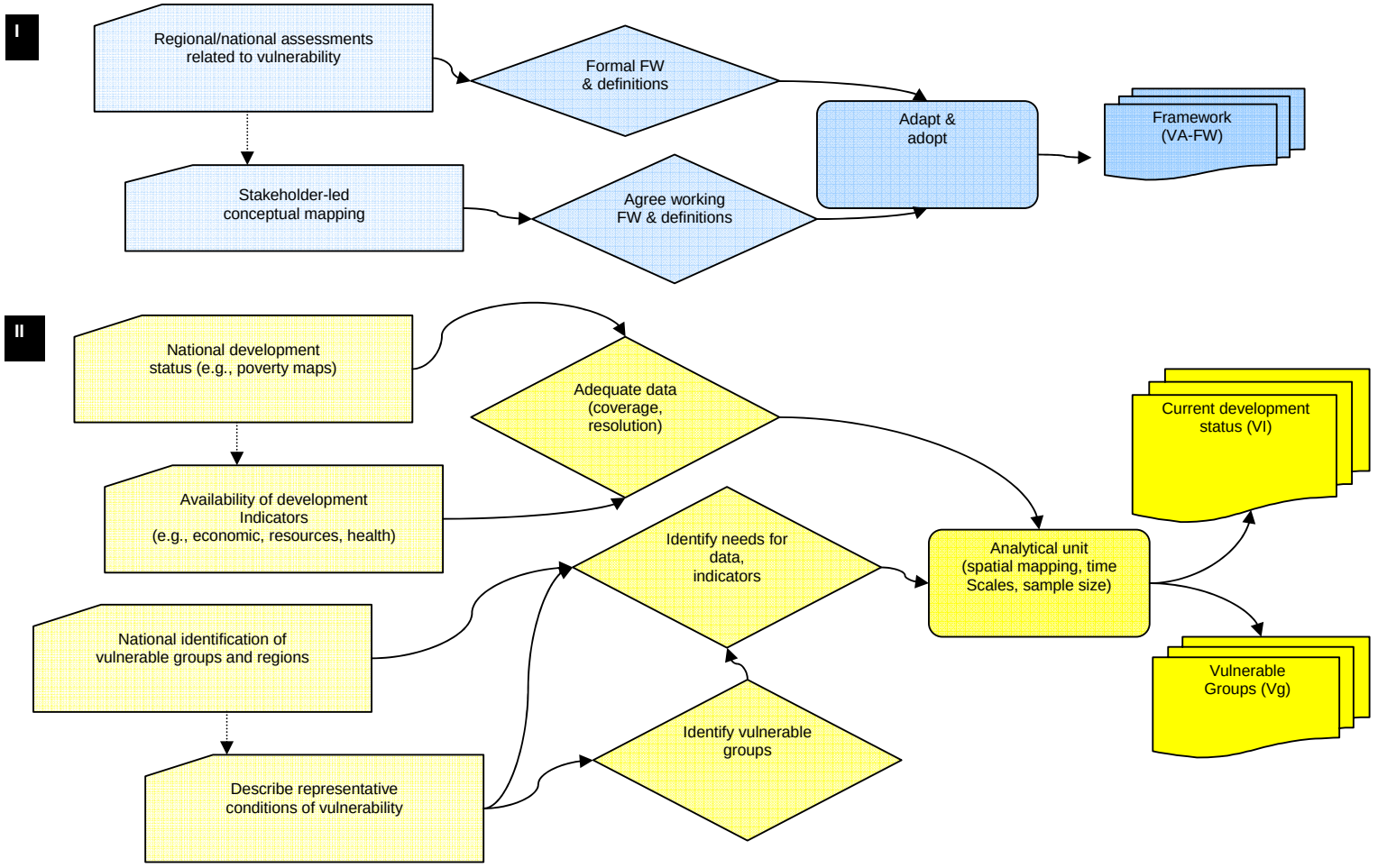
The first pane shows the first two tasks. Scoping the technical details of the vulnerability assessment begins with a review of existing frameworks in use by national planners. If the existing development plans, poverty assessments, strategic environmental plans and the like are not adequate for framing the climate vulnerability assessment, then a stakeholder-led exercise in conceptual mapping is helpful.

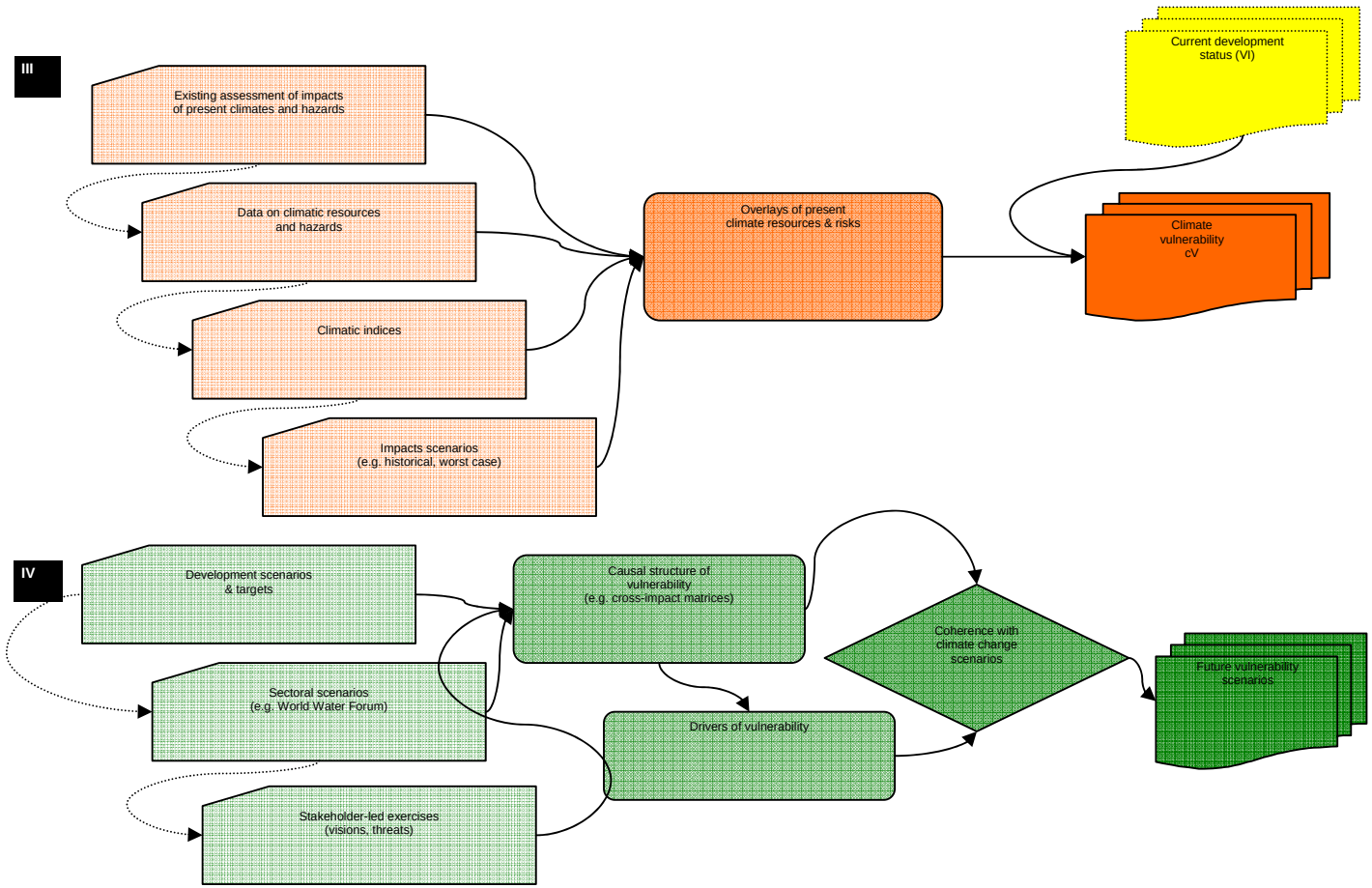
The first pane also shows choices in compiling a database of indicators, initially of development conditions. This task also identifies the vulnerable groups that are to be the target of the assessment. Thus, a two-level approach is recommended.

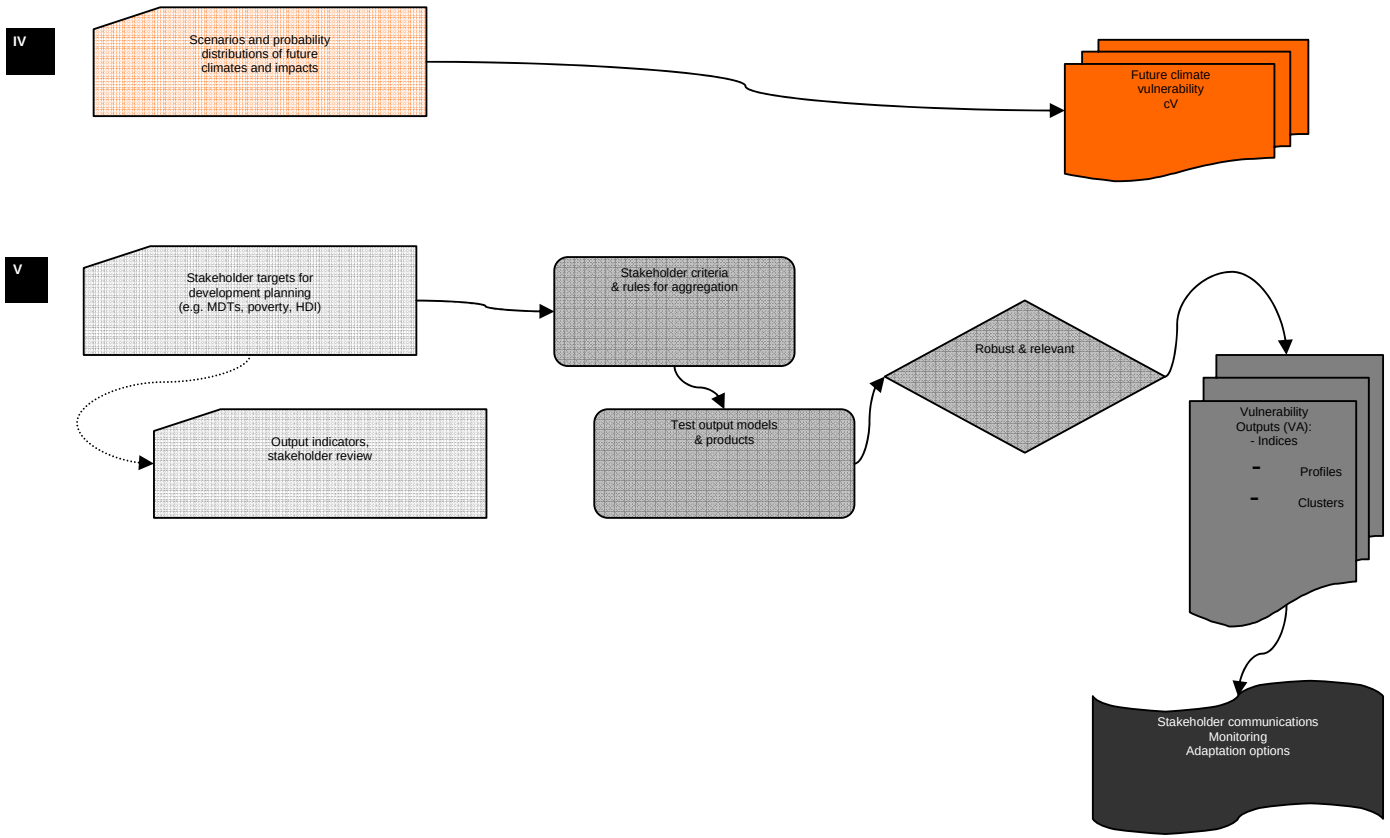
The second pane shows choices in characterizing present climate risks, resulting in a climate vulnerability assessment. With the addition of scenarios of future socio-economic conditions, the set of vulnerability indicators (VI), the descriptions of their drivers and relationships to specific socio-economic groups (or vulnerable livelihoods) becomes the data engine for the vulnerability assessment.

The third pane adds in characterizations of future climate risks. This is not treated in detail in the diagramme. Essentially the same choices as for Task III are appropriate.

The output of the vulnerability assessment requires some attention. It should be part of the scoping process—linking the VA data with stakeholder decision making, identification and evaluation of adaptation strategies and the requirements for implementing adaptation policy.


I
Regional/national assessments related to vulnerability
Formal FW & definitions
Adapt & adopt
Framework (VA-FW)
Stakeholder-led conceptual mapping
Agree working FW & definitions
II
National development status (e.g., poverty maps)
Adequate data (coverage, resolution)
Current development status (VI)
Availability of development Indicators (e.g., economic, resources, health)
Identify needs for data, indicators
Analytical unit (spatial mapping, time Scales, sample size)
National identification of vulnerable groups and regions
Vulnerable Groups (Vg)
Identify vulnerable groups
Describe representative conditions of vulnerability


III
Existing assessment of impacts of present climates and hazards
Data on climatic resources and hazards
Climatic indices
Impacts scenarios (e.g. historical, worst case)
Overlays of present climate resources & risks
Current development status (VI)
Climate vulnerability cV
IV
Development scenarios & targets
Sectoral scenarios (e.g. World Water Forum)
Stakeholder-led exercises (visions, threats)
Causal structure of vulnerability (e.g. cross-impact matrices)
Drivers of vulnerability
Coherence with climate change scenarios
Future vulnerability scenarios


IV
Scenarios and probability distributions of future climates and impacts
Future climate vulnerability cV
V
Stakeholder targets for development planning (e.g. MDTs, poverty, HDI)
Stakeholder criteria & rules for aggregation
Output indicators, stakeholder review
Test output models & products
Robust & relevant
Vulnerability Outputs (VA): - Indices
- Profiles
- Clusters
Stakeholder communications
Monitoring
Adaptation options