The assessment of climate change related vulnerability in the agricultural sector: Reviewing conceptual frameworks

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Outline of the presentation

- **Context**
- **The components of vulnerability**
  - Exposure, sensitivity, adaptive capacity
- **Alternative concepts of vulnerability: the relative role of natural and social science**
  - Outcome and contextual vulnerability
  - Relationship among different vulnerability concepts
- **The time dimension: current and future vulnerability**
- **Methods for assessing vulnerability: top-down or bottom-up**
- ⇨ **Framework table for climate change related vulnerability assessments**

Context

- **Why looking at vulnerability?**
  - Vulnerability and resilience can be seen as separate concepts, but:
  - There are linkages between vulnerability and resilience, especially with regard to adaptive capacity.

⇨ Greater emphasis from a combined perspective can help to assess adaptive capacity.

Source: modified from Engle (2011, p.652)

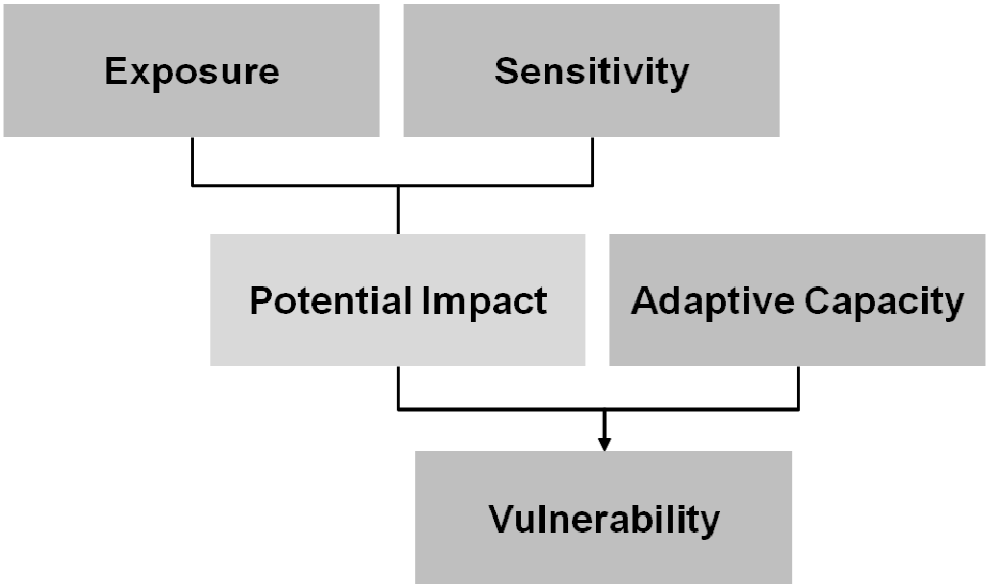
The components of vulnerability

- **Many definitions of vulnerability in the literature**
  - Depending on the disciplines of their origin
  - It is essential to first clarify and understand what is meant when vulnerability is spoken and written about in the climate change context
  - A consistent terminology facilitates the collaboration between different researchers and stakeholders, even if there are differences in the conceptual models applied.

- **IPCC (2007) definition of vulnerability:**
  - "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is *exposed*, its *sensitivity,* and its *adaptive capacity*".

The components of vulnerability

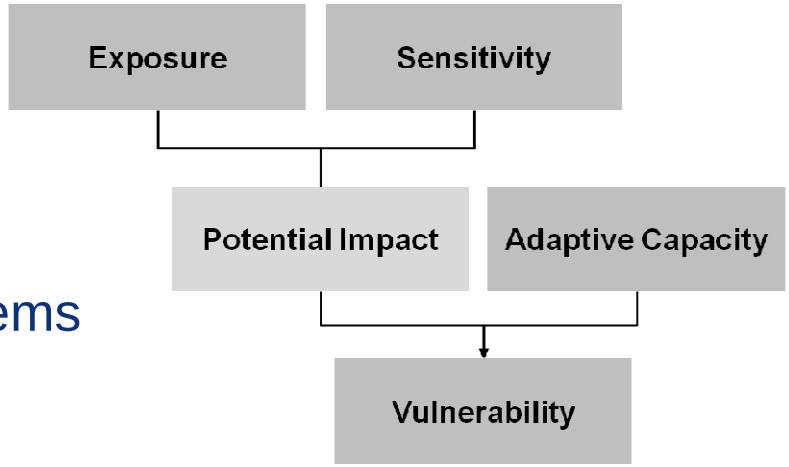
- **The IPCC (2007) definition of vulnerability implies:**
  - A system is vulnerable if it is exposed and sensitive to the effects of climate change and at the same time has only limited capacity to adapt.
  - On the contrary, a system is less vulnerable if it is less exposed, less sensitive or has a strong adaptive capacity.



Source: modified from Allen Consulting (2005, p.20)

The components of vulnerability

- **Exposure:**
  - relates to "the nature and degree to which a system is exposed to significant climatic variations" (IPCC, 2001).
- **Sensitivity:**
  - relates to the "degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise)" (IPCC, 2001).
- **Exposure + Sensitivity =**
  - *Potential impact* that climate change can have on a system,
  - but: highly exposed and/or sensitive systems are not necessarily vulnerable.



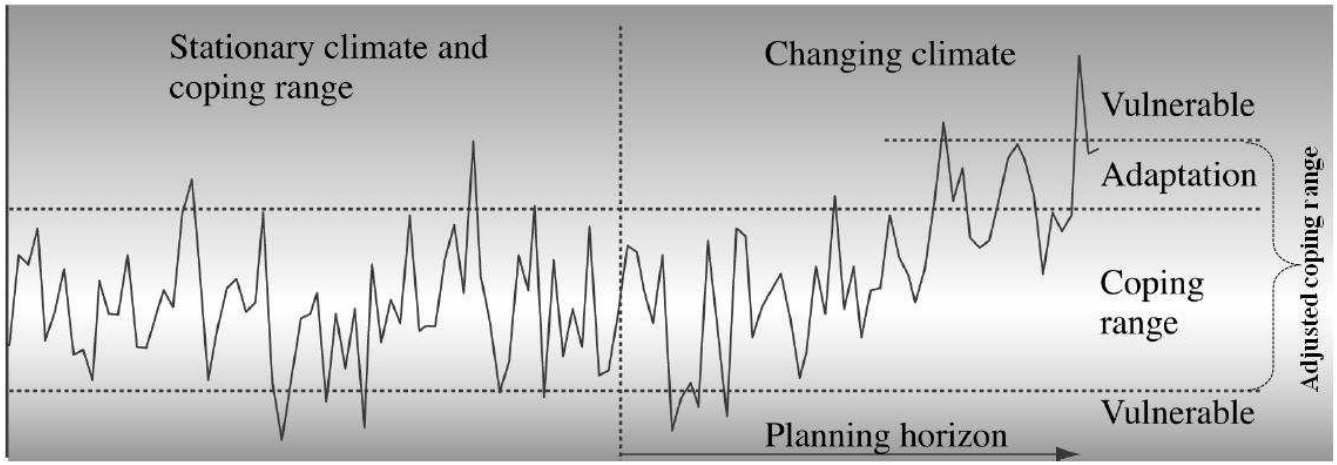
Source: modified from Allen Consulting (2005, p.20)

The components of vulnerability

- **Adaptive capacity:**
  - the ability (or potential) of a system to successfully adjust to climate change (including climate variability and extremes) to (i) moderate potential damages, (ii) to take advantage of opportunities, and/or (iii) to cope with the consequences (IPCC, 2007, Glossary).
  - Adaptive capacity comprises adjustments in both behaviour and in resources and technologies.
  - Socio-economic factors are important for the adaptive capacity of a system; integral role of institutions, governance, and management in determining the ability to adapt to climate change.
  - Some socio-economic determinants of adaptive capacity are generic (e.g. education, income and health), others are specific to particular climate change impacts such as floods or droughts (e.g. institutions, knowledge and technology).
  - ⇨ The more adaptive capacity a system has, the greater is the likelihood that the system is able to adjust and thus is less vulnerable to climate change and variability.

The components of vulnerability

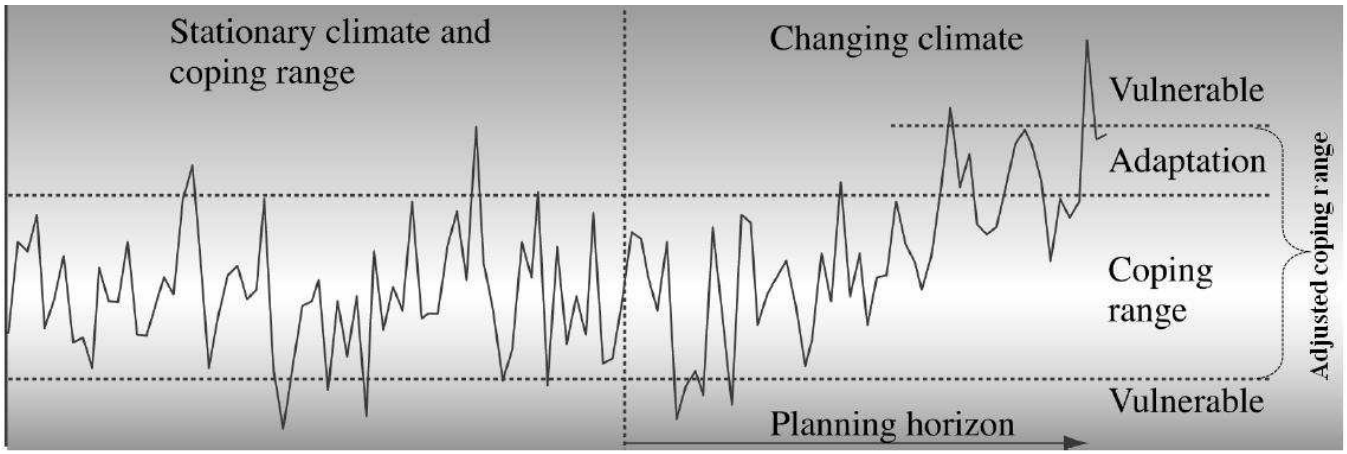
- **Adaptive capacity versus coping range:**
  - Both concepts are associated with different time scales and represent different processes.
  - The capacity of a system to accommodate deviations from “normal” climatic conditions describes the “coping range”, which can vary among systems and regions.
  - Beyond the coping range (i.e. beyond the vulnerability or critical threshold) the tolerance of the system is exceeded and it runs into a vulnerable state.



Source: slightly modified from Jones and Mearns (2005, p.132)

The components of vulnerability

- **Adaptive capacity versus coping range:**
  - Understanding the coping range and vulnerability thresholds of a system is a prerequisite for the assessment of likely climate change impacts and the potential role of adaptation.
  - Adaptive capacity represents the potential of a system to adapt rather than the actual adaptation.
  - In turn, adaptation represents the adaptation actually realised or aimed at to be realised in the future. This implies that through adaptation the coping range of a system can be expanded (or adjusted).

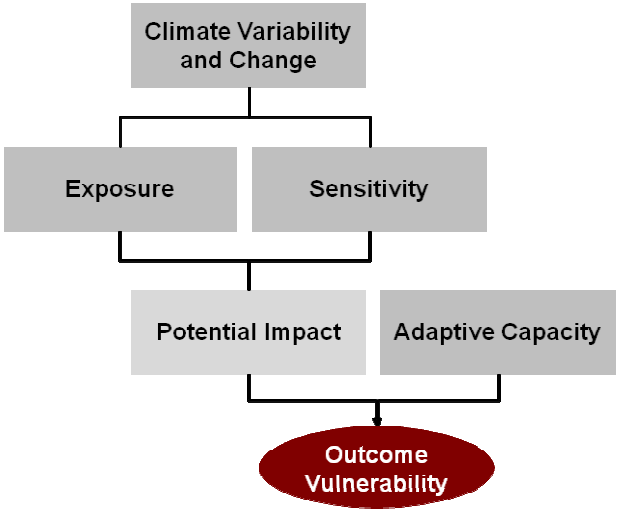


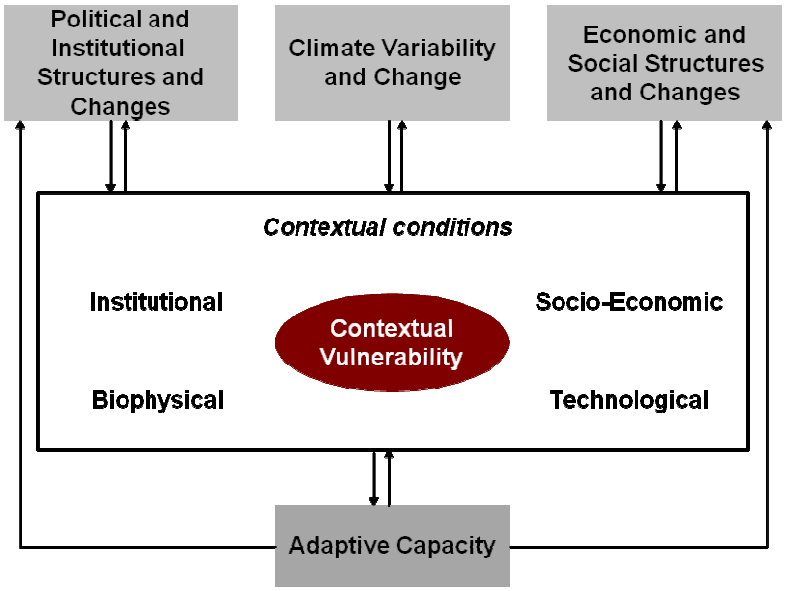
Source: slightly modified from Jones and Mearns (2005, p.132)

  - Thus, the adaptive capacity goes beyond the actual coping range,
  - and any adaptation can only take place within the adaptive capacity of a system.

Alternative interpretations and concepts of vulnerability: The relative role of natural and social science

- **Vast variety of interpretations and alternative concepts of vulnerability in the literature.**
- **Most prominent concepts: outcome and contextual vulnerability**
  - They differ mainly due to their interpretation of vulnerability being the end-point or the starting point of the analysis.
  - Also: different relative roles of natural and social science within the concepts.

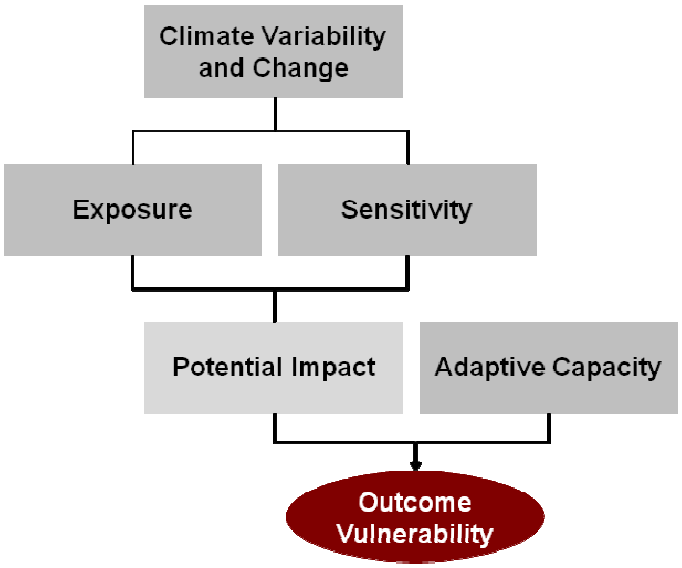




Source: adjusted from Allen Consulting (2005, p.20) and O'Brian (2007, p.75)

Alternative interpretations and concepts of vulnerability: The relative role of natural and social science

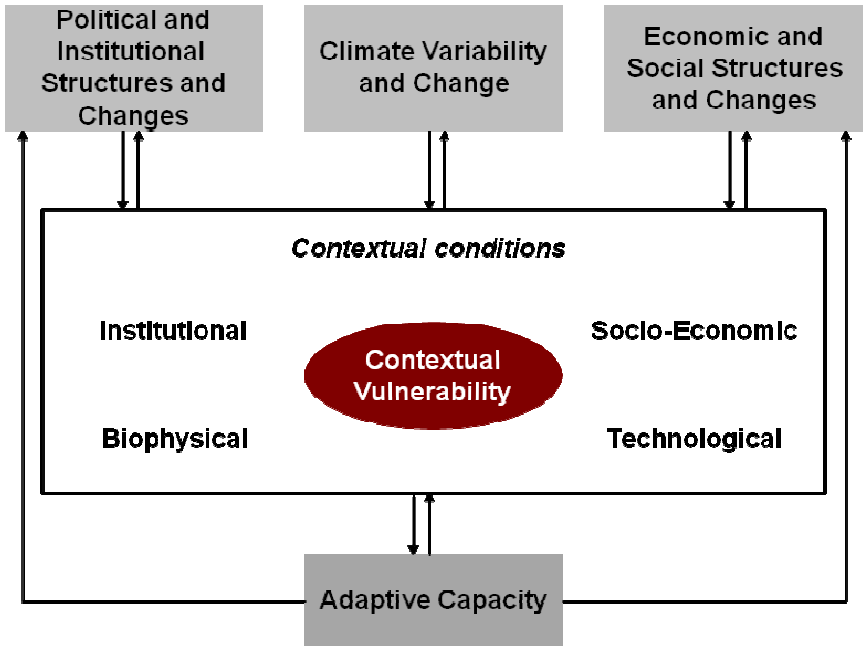
- **Outcome vulnerability (also known as the "end-point" interpretation)**
  - = A concept that considers vulnerability as the (potential) net impacts of climate change on a specific exposure unit (which can be biophysical or social) after feasible adaptations are taken into account.
  - – Based on *natural science* and *future* climate change model scenarios; focusing more on biophysical changes.
  - – Regarding adaptive capacity most emphasis is given to biophysical components.
  - – Typically focusing on technological solutions for adaptation and mitigation strategies to minimize particular impacts of climate change
  - – E.g. vulnerability of agricultural yields to CC; typical technological solutions for adaptation include e.g. the use of different crop seeds, production techniques or water management.



Source: adjusted from Allen Consulting (2005, p.20)

Alternative interpretations and concepts of vulnerability: The relative role of natural and social science

- **Contextual vulnerability (also known as the "starting point" interpretation)**
  - = A concept that considers vulnerability as the present inability of a system to cope with changing climate conditions.
  - – Based on *social science*, contextual vulnerability approaches typically focus more on the *current* socio-economic determinants or drivers of vulnerability, i.e. social, economic and institutional conditions.
  - – The current vulnerability to climatic stimuli determines the adaptive capacity of a system.
  - – Vulnerability can be reduced by modifying the contextual conditions in which climate change occurs so that individuals and groups are enabled to better adapt to changing climatic stimuli.



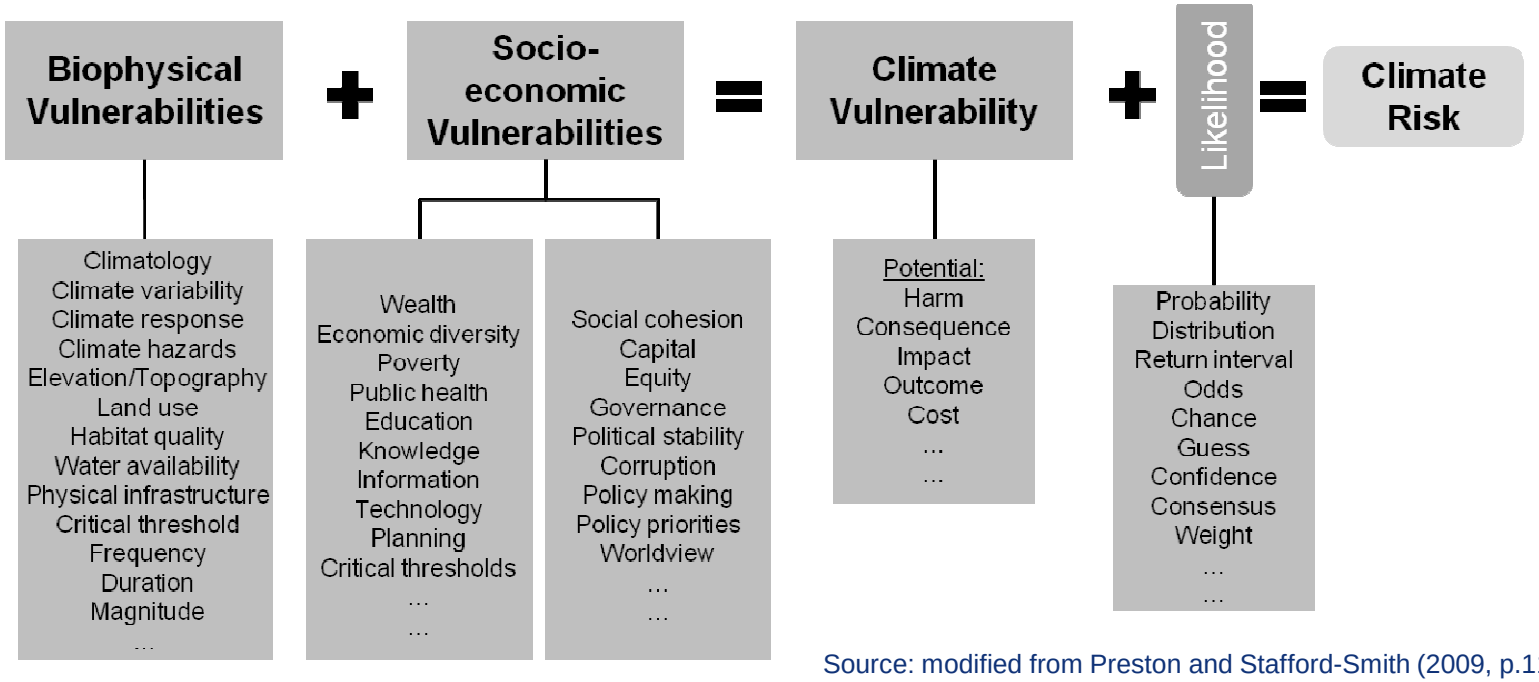
Source: adjusted from O'Brian (2007, p.75)

Alternative interpretations and concepts of vulnerability: The relative role of natural and social science

- **Alternative concepts and interpretations of vulnerability**
  - ⇨ Reflect the fact that vulnerability is context and purpose specific, and also specific to place and time as well as to the perspective of those assessing it.
  - – Thus, none of the vulnerability concepts can be considered as being better or worse than the other.
  - – The two approaches are complementary, assessing vulnerability from different perspectives and both are important to understand the relevance of climate change and respective responses .
  - – Moreover, in recognizing that any complex system commonly involves multiple variables (physical, environmental, social, cultural, and economic), it seems imperative to assess the vulnerability of a system by using an integrated or multidimensional approach in order to capture and understand the complete picture of vulnerability in the context of climate change.

Alternative interpretations and concepts of vulnerability: The relative role of natural and social science

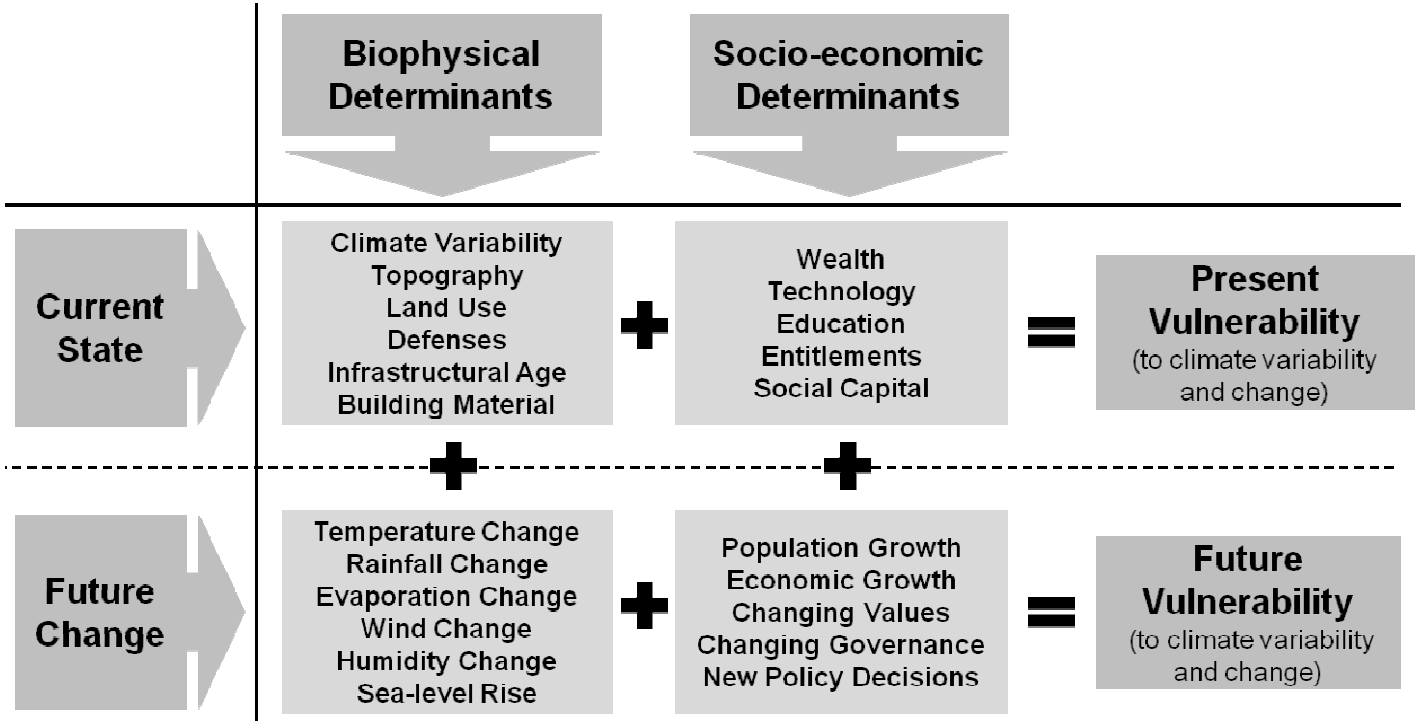
- **The relationship among different concepts associated with climate change vulnerability and risk**
  - In summary: climate vulnerability is characterized as a function of both biophysical and socio-economic vulnerabilities, with each defined by the three dimensions exposure, sensitivity and adaptive capacity.
  - When combined with specific likelihood of occurrence climate vulnerability becomes climate risk.



Source: modified from Preston and Stafford-Smith (2009, p.11)

The time dimension: further characterisation of current and future vulnerability

- **Relationships between current and future determinants of vulnerability to climate variability and change**
  - non-climatic (socio-economic) factors can strongly modify the climatic impacts of climate change, which implies that future vulnerability also critically depends on present adaptation processes.



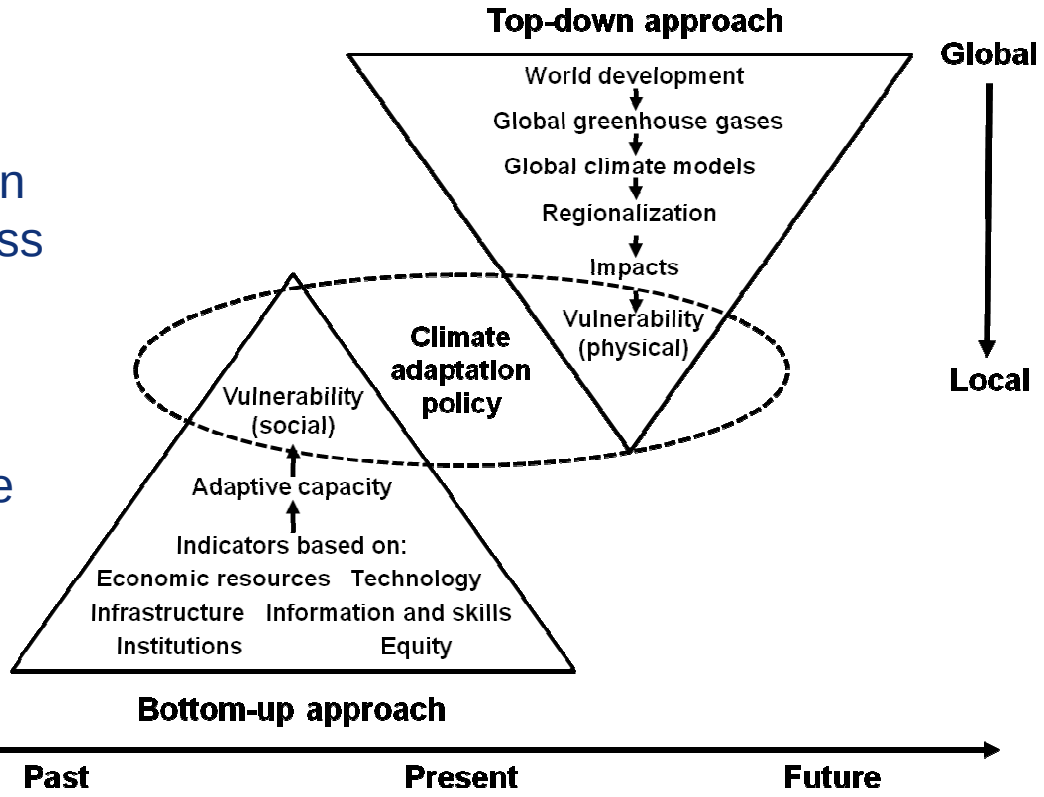
Source: modified from Preston and Stafford-Smith (2009, p.18)

  - To obtain a complete picture: both time horizons need to be combined with biophysical and socio-economic vulnerability determinants.

Methods for assessing vulnerability to climate change

- **Many different methodological approaches and tools**
  - Which vulnerability assessment approach for the agricultural sector, production system and/or region is most appropriate?

- **Top-down and bottom-up approaches to inform climate adaptation policy:**
  - Top-down: typically proceed from global climate projections, which can be downscaled and applied to assess regional impacts of climate change.
  - Bottom-up: typically involve the population and stakeholders of the system in identifying climate change stresses, impacts and adaptive strategies.



Source: slightly adjusted from Dessau and Hulme (2004, p.112)

Elements of a framework for climate change related vulnerability assessments in the agricultural sector

- **Remarks:**
  - Assessments in the climate change area are usually characterized by collaboration of researchers and stakeholders with different backgrounds and knowledge.
  - Thus it is important to identify the thinking behind specific vulnerability concepts and highlight the major differences in alternative vulnerability interpretations.
  - Alternative concepts reflect the fact that vulnerability is context and purpose specific, and also specific to place and time as well as to the perspective of those assessing it.
  - It seems important to assess vulnerability by using an integrated or multidimensional approach in order to capture and understand the complete picture of vulnerability in the context of climate change.

⇨ **Framework table for climate change related vulnerability assessments** (to operationalize the issues outlined).

Elements of a framework for climate change related vulnerability assessments in the agricultural sector

- **Framework table:**

Assessment type, purpose and target audience	
Study name	Full name
Specific research questions	Indicate the specific research questions addressed by the analysis
Emphasis and approach of the assessment	Main orientation (climate risks, adaptation, global policy analysis) and main approach (vulnerability, but could be also impact, adaptation, integrated)
Target audience	The intended target audience and other potential interested parties (e.g. researchers, policy makers, affected farmers, communities, other stakeholders)

Source: adapted from Carter and Mäkinen (2011)

Elements of a framework for climate change related vulnerability assessments in the agricultural sector

- **Framework table (contd.):**

Dimensions of the assessment	
System of interest (sectoral/ thematic focus)	Thematic focus of the assessment (agricultural productivity, food security, water resources, rural livelihood, etc.). Indicate if other sectors than agriculture (specific population groups or communities, etc) are considered
Regional scope	Region(s) for which the analysis is carried out and results are valid
Spatial scale	Spatial scale of the analysis (farm, local, national, regional, global level) for which the analysis is carried out and results are valid
Temporal reference	Indicate if the focus is on current and/or future vulnerability Indicate if past, current and/or future perspectives are included in the analysis
Biophysical aspects considered	Indicate the biophysical aspects considered in the analysis
Socio-economic aspects considered	Indicate the socio-economic aspects considered in the analysis

Source: adapted from Carter and Mäkinen (2011)

Elements of a framework for climate change related vulnerability assessments in the agricultural sector

- **Framework table (contd.):**

Methods and participation	
Methods and tools	Specific analytical methods and tools applied in the assessment as well as details of their application
Involvement of stakeholders	Yes/No (in the case of yes, indicate key stakeholder groups who have formally contributed to the assessment and the format of their involvement)

Information management	
Data and scenarios	Data and methods applied to characterize the past, present and future in an assessment (e.g. for climate, other environmental, land-use, socio-economic and technological conditions)
Data constraints	Indicate data constrains (e.g. availability, quality, applicability)
Treatment of uncertainty	Sources of uncertainty (due to e.g. problems with data, models, underlying assumptions) and their treatment

Source: adapted from Carter and Mäkinen (2011)

Elements of a framework for climate change related vulnerability assessments in the agricultural sector

- **Framework table (contd.):**

Assessment outputs	
Metric(s)	Specific measures/measurements and units in terms of which results are presented (e.g. change in crop yields, farm income, or indicators)
Presentation of results	Approach for displaying and documenting results, background information, methods and conclusions to users (use of narratives, maps, charts, tables)
Documentation & publications	Peer reviewed articles, technical reports, other reports, web descriptions, etc.

Source: adapted from Carter and Mäkinen (2011)

Framework table for climate change related vulnerability assessments

- **Framework table:**
  - Elements of a framework for climate change related vulnerability assessments in the agricultural sector.

- **The framework table could be:**
  - a useful reference for those actually doing the vulnerability assessment, as well as for stakeholders, policy makers and further users of the respective vulnerability analysis;
  - helpful in presenting main elements of a vulnerability analysis by reducing complexity and thus easing comparison, understanding and communication of approaches and results of vulnerability assessments.

Thank you for your attention!

For a complete list of references please refer to the respective paper!

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