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Coevolution of the Political and Conceptual Frameworks for Climate Change Vulnerability Assessments

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1. Introduction

The last two decades have witnessed extensive research on potential and observed impacts of climate change on all kinds of natural and social systems (see McCarthy *et al.,* 2001 for a recent review of the literature). The ultimate goal of this research is to support the formulation and implementation of policies that limit adverse impacts of anthropogenic climate change. In the absence of a consensus definition of the term *climate change vulnerability assessment*, it shall be understood rather broadly in this paper as *"any assessment of how projected changes in the Earth's climate could influence natural and human systems or activities, and/or how human actions could reduce adverse effects of climate change on those systems or activities, with the aim of assisting policy–makers to adequately respond to the challenge of climate change".*

This paper discusses the interplay between the political framework, the conceptual framework and the practice of climate change vulnerability assessment. Figure 1 illustrates the main links. On the one hand, the political framework (e.g. the international legal framework and the financial provisions for aided country studies) and the conceptual framework (e.g. the formulation of the assessment goals) determine the practice of vulnerability assessments (**a**, **b**). On the other hand, the results of and experiences with actual vulnerability assessments are used to further develop the relevant political and conceptual frameworks (**c**, **d**). Furthermore, the political framework influences the development of the conceptual framework (e.g. by directing financial resources to specific types of vulnerability assessments; **e**).

'Vulnerability' is a central concept in this paper. However, this term is used in many different ways by various research communities, such as those dealing with global climate change, natural hazards and disasters, secure livelihoods, and famine. The conceptualization of vulnerability adopted by the Intergovernmental Panel on Climate Change (IPCC) is applied in this paper. Other conceptualizations are briefly discussed in Section 4.2.

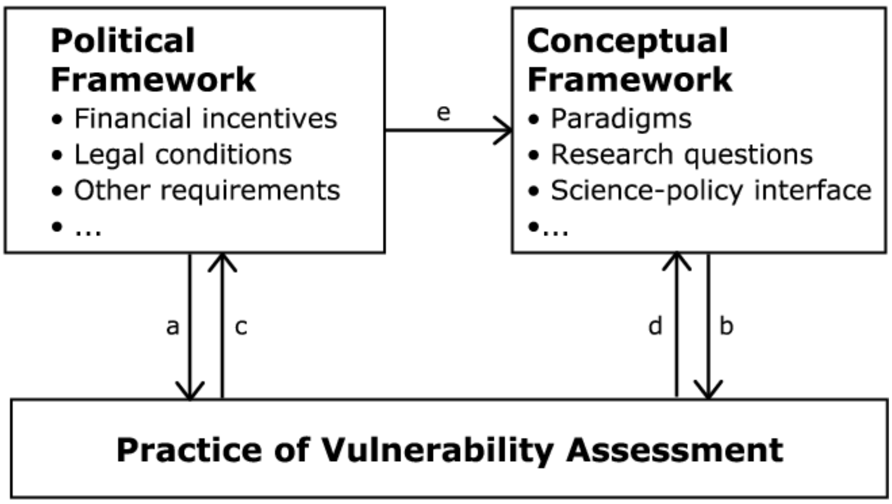

Figure 1. Interplay between the political framework, the conceptual framework, and the practice of climate change vulnerability assessment

Figure 2 shows a generic framework for vulnerability and its assessment, which is applicable beyond the climate change topic. Its development has been motivated by the adaptation frameworks presented in Smithers & Smit (1997) and Smit *et al.* (2000). The framework presents a vulnerable **system** that is exposed to various **stressors**, which cause a variety of **effects** on that system (depicted by solid arrows with full heads). The stressors to the system can be associated with certain **root causes**, which are attributable

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either to human activities or to natural variability. Purposeful human **actions** can affect all components of this causal chain (depicted by dashed arrows). Cross–cutting issues are the temporal and spatial scale of the assessment, the treatment of various kinds of uncertainty, and the availability of resources. The thin arrows with open heads illustrate that the set of response actions considered in an assessment is largely determined by the root causes, stressors, systems and effects addressed.

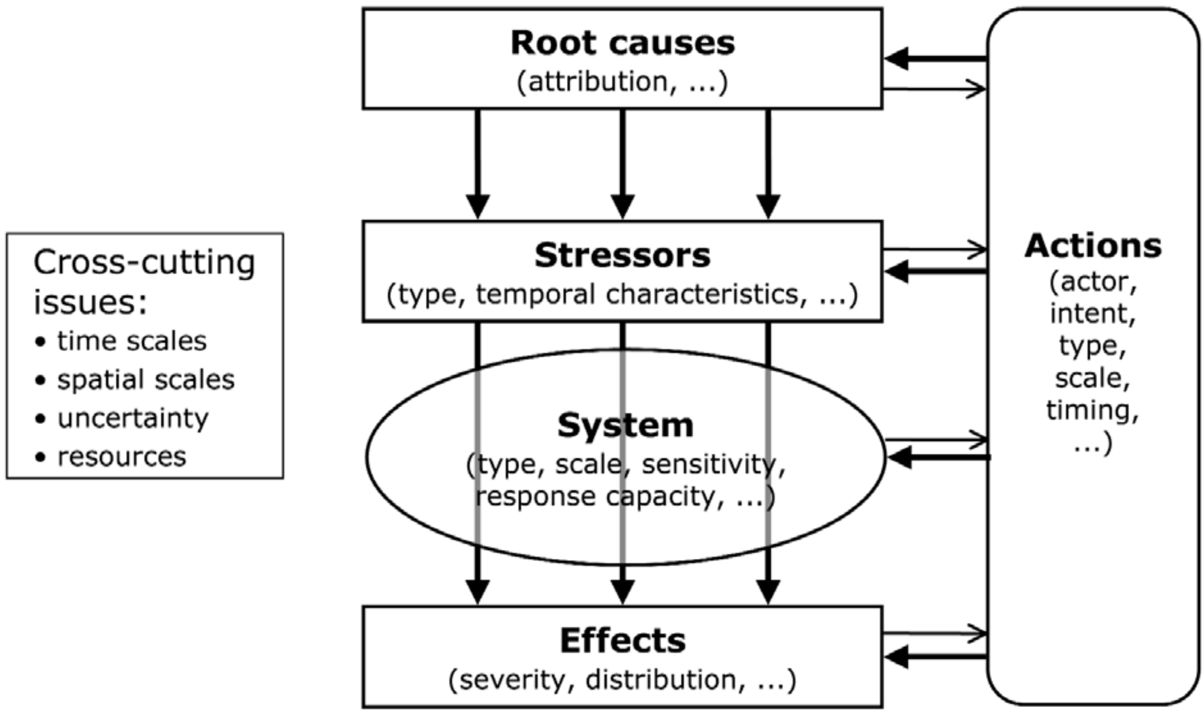

Figure 2. Generic framework for vulnerability and its assessment

The framework in Figure 2 can be used to frame, describe, and distinguish various categories of vulnerability assessments. Table 1 shows an application to the climate change topic. The last column lists examples for each component of the generic framework, whereby only those elements shown in **boldface** are

Dimension	Question	Potential choices
System	Who or what is vulnerable?	A community, a geographic region, an economic sector, a natural system
Root causes	What causes the vulnerability?	**Greenhouse gas emissions**, other anthropogenic driving forces
Stressors	Vulnerable to what?	**Anthropogenic climate change**, natural climate variability, atmospheric composition, other non-climatic factors
Effects	What is at risk?	Ecosystem viability, food security, human health, economic assets, other valued goods and services
Actions	What can be done?	Mitigation of climate change, adaptation to climate change
Time scale	Which time horizon?	Few decades, many centuries
Spatial scale	Which region?	River catchment, coastal strip, country, continent
Uncertainty	How to treat uncertainties?	Single best guess, multiple scenarios, sensitivity analysis, probabilistic assessment
Resources	Which resources are available?	Scoping study, detailed vulnerability assessment

Table 1. Application of the framework from Figure 2 to climate change vulnerability assessments

common to all climate change vulnerability assessments. Obviously, the differences are more numerous than the commonalities.

The fundamental distinction of actions that reduce the vulnerability to climate change is between mitigation and adaptation. Mitigation refers to limiting global climate change through constraining the emissions of greenhouse gases (GHGs) and enhancing their sinks. Adaptation aims at moderating the adverse effects of climate change through a wide range of actions that are targeted at the vulnerable system. Table 2 gives an overview of many relevant aspects in which mitigation and adaptation differ from each other.

	Mitigation of climate change	**Adaptation** to climate change
Target systems	All systems	Selected systems
Effectiveness	Certain	Less certain
Scale of effect	Global	Local to regional
Time until effect	Decades	Immediate
Duration of effect	Centuries	Years to centuries
Secondary benefits	Sometimes	Often
Polluter pays?	Yes	Not necessarily
Monitoring	Relatively easy	More difficult

Table 2. Characteristics of mitigation and adaptation

Mitigation has traditionally received much greater attention than adaptation in the climate change community, both from a scientific and from a policy perspective. Important reasons for the focus on mitigation are, first of all, that mitigating climate change helps to reduce impacts on all climate-sensitive systems whereas the potential of adaptation measures is limited for many systems. It is, for instance, difficult to conceive how the population of certain Pacific coral atolls could 'successfully' adapt to substantial levels of sea–level rise. Second, the beneficial effects of mitigating climate change are certain, since they inevitable reduce the root cause of the climate change problem. The effectiveness of an adaptation measure, in contrast, may depend on other factors, which introduces additional uncertainties. Third, reducing GHG emissions applies the polluter–pays principle whereas the need for adaptation measures will be greatest in developing countries, which have contributed relatively little to climate change. Fourth, GHG emission reductions are relatively easy to monitor quantitatively, both in terms of their absolute amount and as deviation from an established baseline. It is much more difficult to measure the effectiveness of adaptation in terms of impacts avoided, or to ensure that international assistance to facilitate adaptation would be fully additional to existing development aid budgets.

In spite of the urgent need for mitigation there are also convincing arguments for a more comprehensive consideration of adaptation as a response measure to climate change. First of all, given the amount of past GHG emissions and the inertia of the climate system, we are already bound to some degree of climate change that can no longer be prevented even by the most ambitious emission reductions. Second, the effect of emission reductions takes several decades to fully manifest whereas most adaptation measures become effective immediately. Third, adaptations can be implemented on a local or regional scale, and their efficacy is less dependent on the actions of others. Fourth, adaptation to climate change typically also reduces the risks associated with current climate variability. Climate–related hazards constitute a significant threat in many parts of the world already today.

The increasing interest in adaptation to climate change is reflected in the recent development of the theory and practice of climate change vulnerability assessments as well as in the related political, legal, financial, and scientific frameworks. This paper sketches this evolution by presenting four stages of vulnerability assessments, which are described by means of a conceptual framework that defines key concepts of the assessment and their analytical relationships.

A central objective of climate vulnerability assessments is to estimate climate impacts subject to certain assumptions. The comparability of these estimates is often hampered because different studies have used different assumptions on adaptation. Figure 3 explains key terms that are important in this context. The diagram depicts hypothetical trajectories for the level of climate–related impacts over time (due to anthropogenic climate change as well as natural climate variability) on a climate–sensitive system. The lowest trajectory denotes the reference case of an undisturbed climate where variations in the level of impacts are solely caused by changes in non–climatic factors such as demographic and economic development. The other trajectories present the impacts associated with the same climate change scenario but for four different assumed scenarios of adaptation. They include (in order of descending impact levels) the 'dumb farmer', who does not react to changing climate conditions at all; the 'typical farmer', who adjusts their practice in reaction to persistent climate changes only; the 'smart farmer', who uses available information on expected climate conditions to adjust to them proactively; and the 'clairvoyant farmer', who has perfect foresight of future climate conditions and faces no restrictions in implementing adaptation measures. Clearly the metaphorical names used to characterize the different assumptions on adaptive behaviour can be applied to any impacted agent. They are employed here due to their frequent use in the adaptation literature (Smit & Pilifosova, 2001). The bars on the right–hand side of Figure 3 illustrate various interpretations of the term 'climate impacts'. The different assumptions on adaptation and the associated concept of 'climate impacts' can be related to the different stages of vulnerability assessment presented in Section 4.

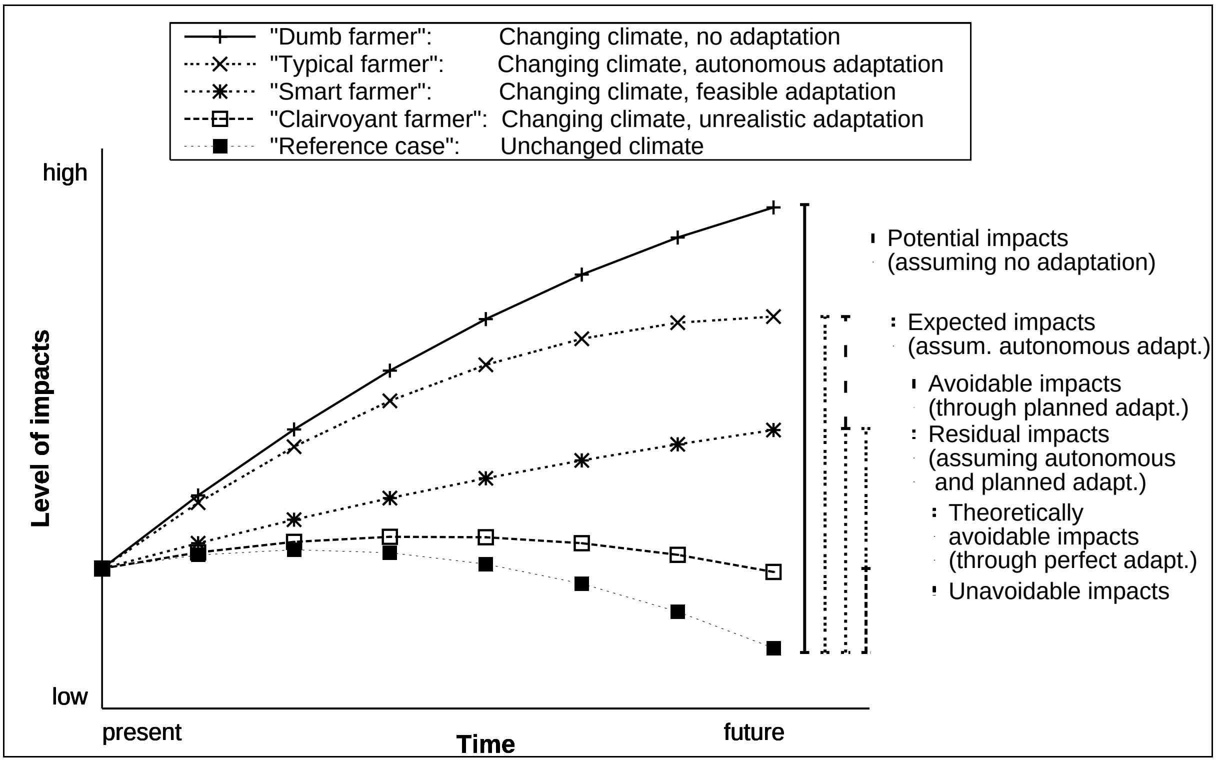

Figure 3. Different concepts for impacts and vulnerability

This section presented a generic model for vulnerability assessment; it introduced mitigation and adaptation as the basic response strategies to global climate change; and it explained several terms that are important in later sections. Section 2 sketches the development of the political framework for climate change vulnerability assessments that is being established in the context of the United Nations Framework Convention on Climate Change (UNFCCC). Section 3 reviews key developments in the practice of climate impact and vulnerability assessments identified in the IPCC assessment reports. Section 4 delineates the evolution of the theory of vulnerability assessment by presenting conceptual frameworks for four different assessment stages, in line with the evolution of the political framework. Section 5 concludes this paper.

2. Political framework for vulnerability assessment

Climate change vulnerability assessments, as defined in Section 1, comprise a broad set of activities: from purely scientific analyses of the relationship between specific climate variables and certain ecosystem properties to policy–driven assessments of how a climate–sensitive economic sector in a country can be made more resilient to all kinds of climate variations, regardless of their attribution. Consequently, climate change vulnerability assessments are conducted in a variety of contexts, and for a diverse group of orderers motivated by rather different concerns.

The brief review in this chapter focusses on the development of the political, legal, and financial provisions for vulnerability assessments under the UNFCCC. The UNFCCC is the main body for international decision–making on the climate change problem, and its role for framing vulnerability assessments is two–fold. First, it has established a framework for conducting and financing vulnerability assessments in developing countries. This framework reflects the specific needs of developing countries, thus focussing on current climate-related vulnerabilities and how they may change in the future. Second, the UNFCCC serves to highlight key issues of the international policy community that are likely to influence the funding practice of other public entities.

The remainder of this chapter is devoted to the analysis of selected clauses from the text of the UNFCCC and from the decisions of the Conference of the Parties (CP) to the UNFCCC as to their relevance for the conceptualization and practice of vulnerability assessment. Whenever possible, pertinent political decisions are related to the categorization of vulnerability assessments that will be presented in Section 4, which distinguishes climate impact assessments, first–generation vulnerability assessments, second–generation vulnerability assessments, and adaptation policy assessments.

UNFCCC Article 2: Objective (1992)

> The ultimate objective of this Convention ... is to achieve ... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time–frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The ultimate objective of the UNFCCC, as stated in Article 2, is the prevention of 'dangerous anthropogenic interference' with the climate system through the 'stabilization of greenhouse gas concentrations in the atmosphere'. An operational understanding of Article 2 requires a broad range of research on the vulnerability of natural and human systems across the world to climate change. Assessments of potential adaptations can be an important component of these vulnerability assessments, but only insofar they assist the decision–making on the level and time–frame for GHG stabilization. Applying the categorization of vulnerability assessments proposed in Section 4, the respective assessments are most likely to fall into the categories *impact assessment* or *first–generation vulnerability assessment*.

UNFCCC Article 4: Commitments (1992)

> All Parties ... shall: ...
>
> 1. (b) Formulate, implement, publish and regularly update ... programmes containing measures to mitigate climate change ..., and measures to facilitate adequate adaptation to climate change. ...
>
> (e) Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods. ...
>
> 3. The developed country Parties ... shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article ....
>
> 4. ... The developed country Parties ... shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects. ...

Article 4 of the UNFCCC mentions (planned) adaptation to climate change as an important response option to the climate change problem, in addition to mitigation. All Parties are called to formulate and implement programmes for adaptation, and to cooperate in preparing for adaptation. Developed countries shall provide financial resources, among others, for mitigation and adaptation assessments in developing countries. They shall also assist 'particularly vulnerable' developing countries in meeting the costs of adaptation.

The implementation of these commitments poses significant challenges for vulnerability research. Article 4.4, if fully implemented, would put 'particularly vulnerable' (developing) countries in a preferential position with respect to financial aid under the UNFCCC. The decision which countries should be considered 'particularly vulnerable' requires comprehensive vulnerability assessments that are comparable across countries if it is to be based on scientific rather than on political arguments. Such assessments are described as *second–generation vulnerability assessments* in Section 4. In addition to biophysical determinants of vulnerability, they also consider the socioeconomic capacity of countries to formulate and implement adequate adaptation to climate change.

The formulation of national programmes of action and of integrated plans for the management of selected climate–sensitive sectors, as called for in Article 4.1(b) and 4.1(e), respectively, requires adaptation assessments to proceed from positively assessing which adaptations are likely or feasible to normatively assessing which adaptations are recommended. In the terminology of the present paper, Article 4.1 calls for *adaptation policy assessments*.

Decision 11/CP.1: Initial guidance on policies, programme priorities and eligibility criteria to the operating entity or entities of the financial mechanism (1995)

> 1. ... (d) Regarding adaptation, the following policies, programme priorities and eligibility criteria should apply: Adaptation to the adverse effects of climate change, as defined by the Convention, will require short, medium and long term strategies which ... should be implemented on a stage–by–stage basis in developing countries ...:
>
> - Stage I: Planning, which includes studies of possible impacts of climate change, to identify particularly vulnerable countries or regions and policy options for adaptation and appropriate capacity-building;
>
> - Stage II: Measures, including further capacity–building, which may be taken to prepare for adaptation, as envisaged by Article 4.1(e);
>
> - Stage III: Measures to facilitate adequate adaptation, including insurance, and other adaptation measures as envisaged by Article 4.1(b) and 4.4. ...

Decision 11/CP.1 establishes a staged approach to adaptation in developing countries. Broadly speaking, Stage I involves first–generation or second–generation vulnerability assessments whereas Stage II requires adaptation policy assessments. Stage III eventually facilitates the implementation of the adaptations recommended in Stage II.

Decision 5/CP.7: Additional guidance to an operating entity of the financial mechanism (2001)

> The Conference of the Parties ...
>
> 7. Decides that the implementation of the following activities shall be supported through the Global Environment Facility ... and other bilateral and multilateral sources: ...
>
> (b) Vulnerability and adaptation: ...
>
> (v) Establishing pilot or demonstration projects to show how adaptation planning and assessment can be practically translated into projects that will provide real benefits, and may be integrated into national policy and sustainable development planning, on the basis of ... the staged approach endorsed by the Conference of the Parties in its decision 11/CP.1; ...
>
> (vii) Strengthening existing and, where needed, establishing early warning systems for extreme weather events in an integrated and interdisciplinary manner to assist developing country Parties, in particular those most vulnerable to climate change;
>
> 8. Decides that the implementation of the following activities shall be supported through the special climate change fund (in accordance with decision 7/CP.7) and/or the adaptation fund (in accordance with decision 10/CP.7), and other bilateral and multilateral sources:
>
> (a) Starting to implement adaptation activities promptly where sufficient information is available to warrant such activities, inter alia, in the areas of water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems, including mountainous ecosystems, and integrated coastal zone management; ...

Decision 5/CP.7 provides further guidance for the funding of adaptation activities in developing countries. Particularly relevant in the context of this paper is the call for the integration of adaptation planning and assessment into national policy and sustainable development planning. This decision also acknowledges the link between the vulnerability to future climate change and the vulnerability to current climate variability and extremes, by explicitly mentioning early warning systems for extreme weather events as eligible for funding. Both issues are reflected in the conceptualization of *adaptation policy assessments* in Section 4.4.

Decision 28/CP.7 (Annex): Guidelines for the preparation of national adaptation programmes of action (2001)

> A. Introduction
>
> 1. National adaptation programmes of action (NAPAs) will communicate priority activities addressing the urgent and immediate needs and concerns of the least developed countries (LDCs), relating to adaptation to the adverse effects of climate change. ...
>
> D. Guiding elements
>
> The preparation of NAPAs will be guided by the following:
>
> (a) A participatory process involving stakeholders, particularly local communities;
>
> (b) A multidisciplinary approach; ...
>
> E. Process
>
> 8. (b) The NAPA team will assemble a multidisciplinary team: ...
>
> (ii) To conduct a participatory assessment of vulnerability to current climate variability and extreme weather events, and to assess where climate change is causing increases in associated risks; ...

Decision 28/CP.7 establishes guidelines for the preparation of national adaptation programmes of action (NAPAs) in the least developed countries. Key characteristics of the vulnerability and adaptation assessments on which the NAPAs are based are a participatory approach involving stakeholders, a multidisciplinary approach, and assessments of the vulnerability to current climate variability and extreme weather events. These issues, some of which were already raised in Decision 5/CP.7, are also reflected in the evolution of the conceptual framework in Section 4.

Summarizing the development of the political framework for vulnerability assessment under the UNFCCC, we observe a clear tendency towards emphasizing adaptation as an important response option to climate change, in particular in highly vulnerable developing countries; towards assessing vulnerability to future climate change in connection with vulnerability to current climate variability and extremes; and towards the integration of climate change issues with other policy objectives, which is done in a participatory process involving stakeholders. These developments are in line with the observations about the practice of vulnerability assessment reported in Section 3. They are also reflected in the evolution of the conceptual framework for vulnerability assessment presented in Section 4.

3. Practice of vulnerability assessment

Assessments of the potential or likely impacts of climate change, of the vulnerability of nations, social groups and economic sectors, and of potential response actions apply a variety of methodological approaches. The suitability of a specific approach depends, among others, on the sector or system analyzed, on the specific climatic and non–climatic stressors that this system is exposed to, on the degree of uncertainty about future changes in these stressors, on the biophysical and social effects potentially caused by these stressors, on the societal response actions considered, on the time scale and spatial scale of the assessment, and on the resources available for the assessment (cf. Figure 2).

The author does not suggest that the development of climate change assessments has followed a single trajectory in the past. However, certain trends can be clearly observed. The detection of these trends is facilitated by the exceptional circumstance that the complete body of scientific knowledge on climate change, associated impacts, and potential response mechanisms is regularly synthesized in the reports of the Intergovernmental Panel on Climate Change (IPCC). The IPCC was jointly established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Union (WMO). The IPCC unites the various academic communities that are dealing with climate–change related problems. Membership is open to qualified specialists named by governments from any country. For an overview of its history and mission, see Bruce (2001).

The primary task of the IPCC is to assess and synthesize the policy–relevant results of peer–reviewed published research. Even though the IPCC does not conduct research itself, its prominent position at the science–policy interface gives it an important role for identifying important research gaps, for channelling requests from the policy community to the scientific community, and for shaping the research agenda.

The IPCC has produced three comprehensive assessment reports so far. The three working groups (WGs) of the IPCC contributed one volume each to these reports. Some important developments in the practice of climate change assessments can already be derived from changes in the thematic structure of the WGs II and III, as shown in Table 3.

Assessment	Year	WG I	WG II	WG III
First	1990	Science	Impacts	Response Strategies
Second	1995	Science	Impacts, Adaptations, and Mitigation (Scientific–Technical Analyses)	Economic and Social Dimensions
Third	2001	Science	Impacts, Adaptations, and Vulnerability	Mitigation

Table 3. Scope of the IPCC working groups in the major IPCC assessments

Since the inception of the IPCC, WG II has focussed on the impacts of projected climate change. In the First Assessment, climate impacts were exclusively addressed by WG II, with a clear focus on biophysical impacts. In the preparation of the Second Assessment, the need for an assessment of the economic and social dimensions of climate change was clearly recognized. The scientific–technical analysis of impacts, adaptation, and mitigation was assigned again to WG II, whereas WG III focussed on the economic and social dimensions. Despite the explicit integration of socioeconomic aspects into the IPCC assessment, WG II and WG III were still partitioned along disciplinary boundaries. For the Third Assessment, the WGs were rearranged in a problem–oriented manner rather than by disciplinary tradition. WG II assessed the environmental, social, and economic dimensions of climate impacts, the vulnerability to climate change across systems, sectors, and regions, as well as potential adaptations to reduce adverse impacts. WG III addressed the technical and economic dimensions of mitigation actions, which can be analyzed largely independent of adaptation.

The preface of the WG II contribution to the IPCC Third Assessment Report highlights the main differences compared to earlier WG II assessments, namely:

- efforts to address a number of cross–cutting issues, such as sustainable development, equity, and scientific uncertainties;
- the emergence of changes in climate extremes and in climate variability as key determinants of future impacts and vulnerability;
- increasing emphasis on the many interactions of climate change with other stresses on the environment and human populations; and
- the expanded analysis on the value of adaptation measures to diminish the risk of damage from future climate change and from present climate variability alike.

Summarizing the development of vulnerability assessments presented in the IPCC reports, a clear trend can be recognized towards interdisciplinary assessments of the potential consequences of climate change; towards the integration of impacts and adaptation assessments; and towards the integration of climate change with other stresses and concerns.

4. Conceptual framework for vulnerability assessment

Section 2 sketched the evolution of the political framework for climate change vulnerability assessments. in response to changing stakeholder needs. Section 3 reviewed the most important developments of the assessment practice, which were also based on scientific advances in a range of relevant disciplines. Building on this analysis, a conceptual framework for four different stages of climate change vulnerability assessment is presented in this section.

For the sake of clarity, each of the four assessment stages is described in contrast to the previous one. However, the development of vulnerability assessments rarely proceeds in a linear way, and actual assessments often combine features from more than one stage. The presented classification should therefore not be interpreted to the effect that all but the final stage have become obsolete. For instance, as long as there are important gaps in the scientific knowledge, research on the links between climatic changes and certain biophysical processes remains important. However, stakeholders have increasingly expressed their need for assessments that incorporate uncertain knowledge about past and future climate change to support decisions that have to be made today. This gradual shift from science–driven assessments that estimate potential climate impacts to policy–driven assessments that recommend specific adaptation measures has important consequences for:

- the degree to which non–climatic factors are included,
- the consideration of the effects of current climate variability and extremes,
- the temporal and spatial scales of analysis,
- the treatment of uncertainty,
- the integration with other policy goals,
- the relative importance of positive versus normative elements, and

	Impact assessment	First–generation vulnerability assessment	Second– generation vulnerability assessment	Adaptation policy assessment
Analytical approach	Positive	Positive	Positive	Normative
Main result	Potential impacts	Pre–adaptation vulnerability	Post–adaptation vulnerability	Recommended adaptations
Consideration of adaptation	Little	Partial	Full	Full
Integration of natural and social sciences	Low	Low – medium	Medium – high	High
Illustrative research question	Which biophysical impacts are expected from climate change?	Which socioeconomic impacts are expected from climate change?	What is the vulnerability to climate change, considering feasible adaptations?	Which adaptations are recommended to reduce the vulnerability to climate change

Table 4. Characteristic properties of different stages of vulnerability assessment

- the degree of stakeholder involvement.

Table 4 summarizes key characteristics of the four different assessment stages distinguished in this paper. For a more detailed discussion of these issues, the reader is referred to Rothman & Robinson (1997), Smith (1997), Klein & MacIver (1999), Klein *et al.*. (1999), and Smit *et al.* (1999).

In the sequel of this paper a conceptual framework is presented to illustrate the approach towards each of the four stages of vulnerability assessment. The purpose of this conceptual framework is twofold. First, it conveys the prevailing understanding of the climate change community in general, and as presented in the IPCC in particular, on key concepts related to vulnerability and adaptation to climate change, and on their analytical relationships. The framework is widely applicable, although some adjustments may have to be made when applying it to particular impact sectors. Second, the four stages of vulnerability assessment sketch the development of the underlying theory over time, in line with the observations presented in Section 2 and 3.

Natural and social sciences follow rather different approaches in the study of human-nature system interactions. The natural sciences focus on the physical flow of matter and energy between system components. The social sciences, in contrast, emphasize the flow of information between different actors that determines social decision-making. Obviously, considering the decision process of relevant actors is central for any attempt to influence the `physical' part of the system through purposeful policy decisions. The adoption of either view has important implications for the visual representation of the considered system. The primary goal of *system-dynamics diagrams*, as applied in the natural sciences, is to clarify the behaviour of complex systems whereas *influence diagrams* (and the social science models based upon them) are developed for helping people to make decisions.

The staged `box-and-arrows' diagram that illustrates our conceptual framework is a hybrid of a system-dynamics diagram and an influence diagram. Its elements include climate change, climate variability, exposure, sensitivity, impacts, adaptive capacity, vulnerability, mitigation, and adaptation. These terms refer to rather different types of concepts, such as flow variables (e.g. emissions) and state variables (e.g. concentrations) at different spatial and temporal scales, complex probabilistic properties of a system (e.g. climate variability), spatiotemporal events (e.g. exposure), functional relationships between other elements (e.g. sensitivity), and human actions (e.g. adaptation). The diversity within the elements of the framework gives rise to a substantial diversity in the relationships between them. Figure 4 explains the main elements of the conceptual framework and their relationships. Whilst distinguishing between the different types of boxes and arrows enables a closer examination of the analytical relationships in the framework, the main features of each stage of vulnerability assessment are still comprehensible without doing so.

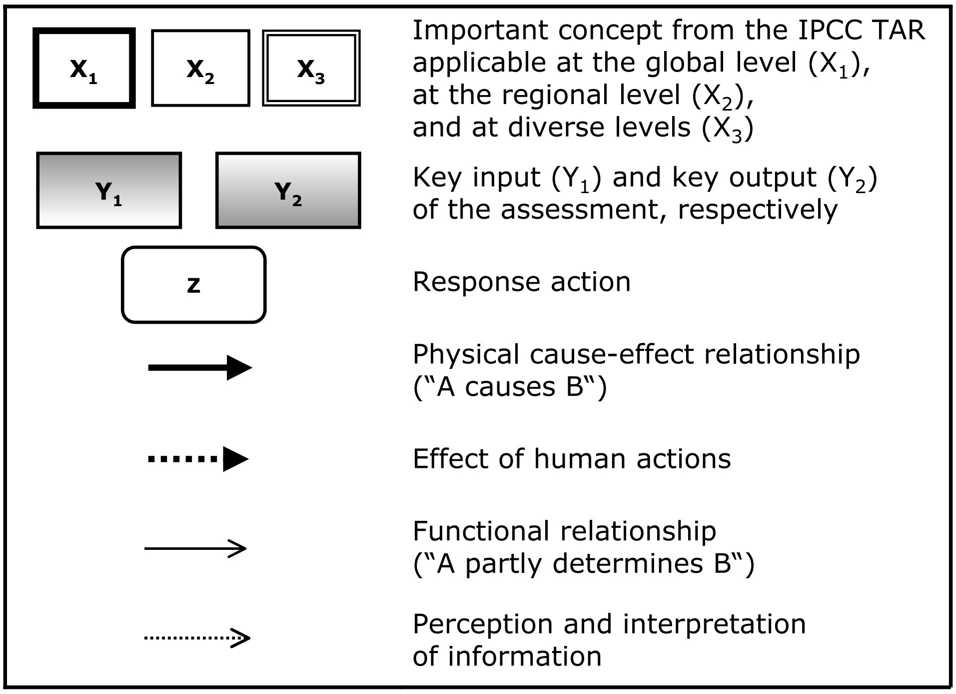

Figure 4. Symbols used in the conceptual framework

Any mental model highlights some aspects of the considered system at the expense of others. The most important topics that are *not* explicitly addressed in our framework are the dynamical aspects of the considered processes, the spatial scales of the considered systems and cross-scale relationships, the uncertainty associated with different elements of the framework, and the actual process of policymaking.

4.1. Impact assessment

The climate change community, in large part because of its intensive co–operation within the IPCC, is developing a common terminology, although definitions are still being debated. Since a number of important terms are used differently in other scientific communities, the definitions from the latest IPCC glossary (McCarthy *et al.,* 2001; Houghton *et al., 2001*), are provided in separate boxes, whenever available.

> ***(Climate) impact assessment:*** *The practice of identifying and evaluating the detrimental and beneficial consequences of climate change on natural and human systems.*

Impact assessments evaluate the potential effects of several climate change scenarios, compared to a (hypothetical) constant climate scenario, on one or more impact domains. In so doing, they contribute to the identification of *"[levels of] greenhouse gas concentrations [...] that would prevent dangerous anthropogenic interference with the climate system"* as called for in Article 2 of the UNFCCC. The main concepts considered in a climate impact assessment and their relationships are depicted in Figure 5.

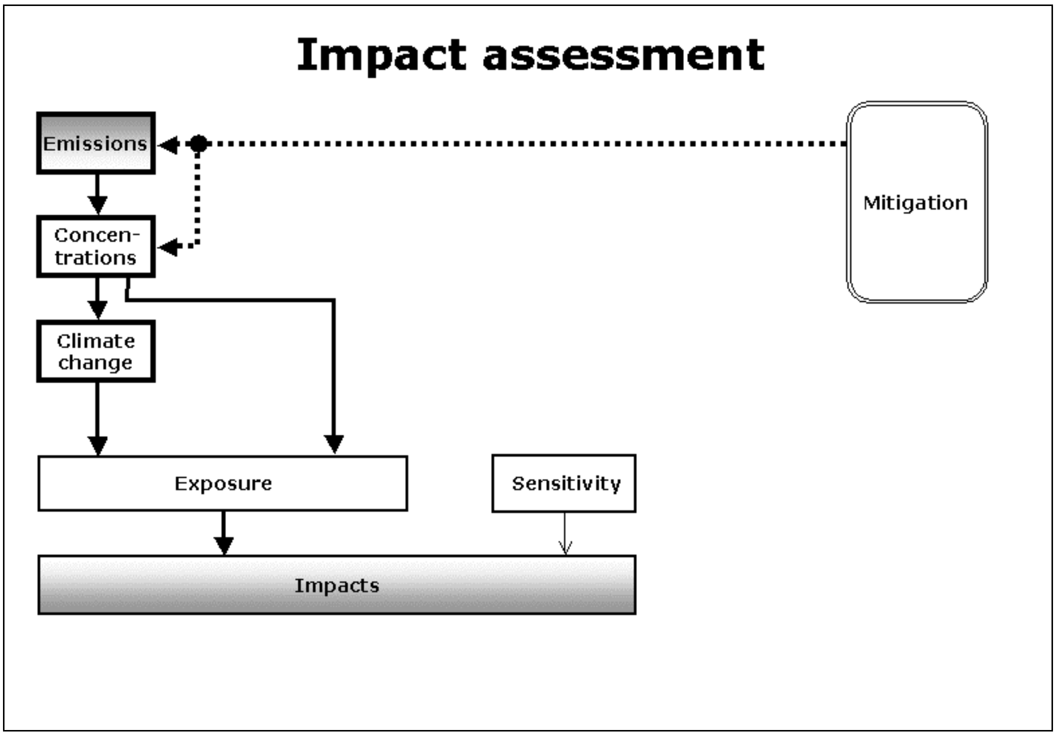

Figure 5. Conceptual framework for a climate impact assessment

The assessment starts from scenarios of either **emissions** or atmospheric **concentrations** of greenhouse gases and radiatively active particles, such as the often-assumed 2xCO_2 case.

> ***Climate change:*** *A statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. [...]*

Projections for the magnitude of anthropogenic **climate change** and for its spatial and temporal variability are then determined through the application of appropriate climate models. Climate is a multi–dimensional phenomenon that exhibits variations on different time scales. Burton (1997) suggests a hierarchy of weather and climate phenomena (denoted as type 1, 2, and 3 variables) to distinguish single climate variables (such as local temperature), specific weather events (such as a convective storm), and long–term processes (such as anthropogenic climate change). Impact assessments often focus on long–term changes in average climate conditions (such as annual mean temperature, precipitation, and sea–level rise) because these results are most readily available from climate models.

> ***Exposure:*** *The nature and degree to which a system is exposed to significant climatic variations.*

The **exposure** of a system to climate stimuli depends on the level of global *climate change* and on the location of the *exposure unit*. The link from *concentrations* to *exposure* in the conceptual framework indicates that some exposure units are directly affected by the level of radiatively active gases. Well–known examples include the direct effect of carbon dioxide on plant physiology and the combination of local air pollution and high temperatures in causing respiratory diseases in humans. It should be noted that this extended conceptualization of exposure is not fully consistent with the IPCC definition, which includes only climatic factors.

> ***Sensitivity:*** *The degree to which a system is affected, either adversely or beneficially, by climate–related stimuli. [...] The effect may be direct [...] or indirect [...].*

The **sensitivity** of a system denotes the — generally multi–dimensional and dynamic — dose–response relationship between its exposure to climatic stimuli and the resulting effects.

> ***(Climate) Impacts:*** *Consequences of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential and residual impacts. [...]*

Climate **impacts** are a function of (the change in) the system's *exposure* to climatic stimuli and of its *sensitivity* to these stimuli. *Potential impacts* are determined in assessments where the *exposure* of a system changes but its *sensitivity* is assumed to be unaffected by climate change. The determination of *residual impacts* requires assessments that explicitly consider adaptation measures (see Figure 3 for a graphical illustration).

It is interesting to note that the IPCC definitions for 'exposure' and 'impacts' are not fully consistent. Whereas the former includes all climatic variations, the latter only considers those aspects that are due to anthropogenic climate change. Climate science does not presently provide tools that can clearly separate (regional) climate variability according to natural and anthropogenic causes. However, this distinction has major policy consequences, especially because only adaptations to anthropogenic climate change are currently eligible for funding through the mechanisms of the UNFCCC and the KP (Klein, 2002).

> ***Mitigation:*** *An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.*

Mitigation refers to actions that limit the level and rate of climate change. The two basic mitigation options are the reduction of gross GHG *emissions* (e.g. through fuel switching in the energy sector) and the reduction of their *concentrations* through enhancing the sink capacity of biological and other systems.

The bold borders around the boxes for *emissions* and *concentrations* of greenhouse gases and for the level of *climate change* in Figure 5 indicate that these concepts are applicable at the global level. The *exposure* and the *sensitivity* to climatic stimuli as well as the resulting *impacts* can only be analyzed for specific exposure units, as indicated by the thin borders around the respective boxes. *Mitigation* is implemented at the regional level whereas its effects on greenhouse gas concentrations can be aggregated to the global level. The double border around the respective box indicates that this concept is relevant at different spatial scales.

The main policy response addressed in impact assessments, as understood here, is mitigation. They do not explicitly address adaptation, thereby implementing the 'dumb farmer' assumption (see Figure 3). Their use for policy formulation is limited to longer–term climate impacts and, in particular, to raising awareness of the potential scale and magnitude of climate change impacts. Examples include many ecological studies as well as country studies conducted within, for instance, the United States Country Studies Program (USCSP). Selected references are Monserud *et al.* (1993), Leemans & van den Born (1994), Kwadijk & Middelkoop (1994), Nicholls & Leatherman (1995), Rosenzweig & Parry (1994), Martens *et al.* (1995), and Martens *et al.* (1997). This approach is also typical for many integrated assessment models of global climate change, e.g. IMAGE (Alcamo *et al.,* 1998), ICLIPS (Toth *et al.*, 2002; Füssel & van Minnen, 2001), CLIMPACTS (Kenny *et al.*, 1995), and MIASMA (Martens, 1998). These models present spatially referenced projections for (mainly biogeophysical) impacts of different emission scenarios on various impact sectors.

4.2. First–generation vulnerability assessment

A vulnerability assessment constitutes an extension of a (climate) impact assessment. Major differences between the two assessment types will be discussed later when the concept of 'vulnerability' as understood by the IPCC is introduced. Interestingly, the term 'vulnerability assessment' itself is not defined in the IPCC glossary. Two generations of vulnerability assessments are distinguished in this paper. Figure 6 depicts the framework for a first–generation vulnerability assessment. Compared to Figure 5, a number of components have been added.

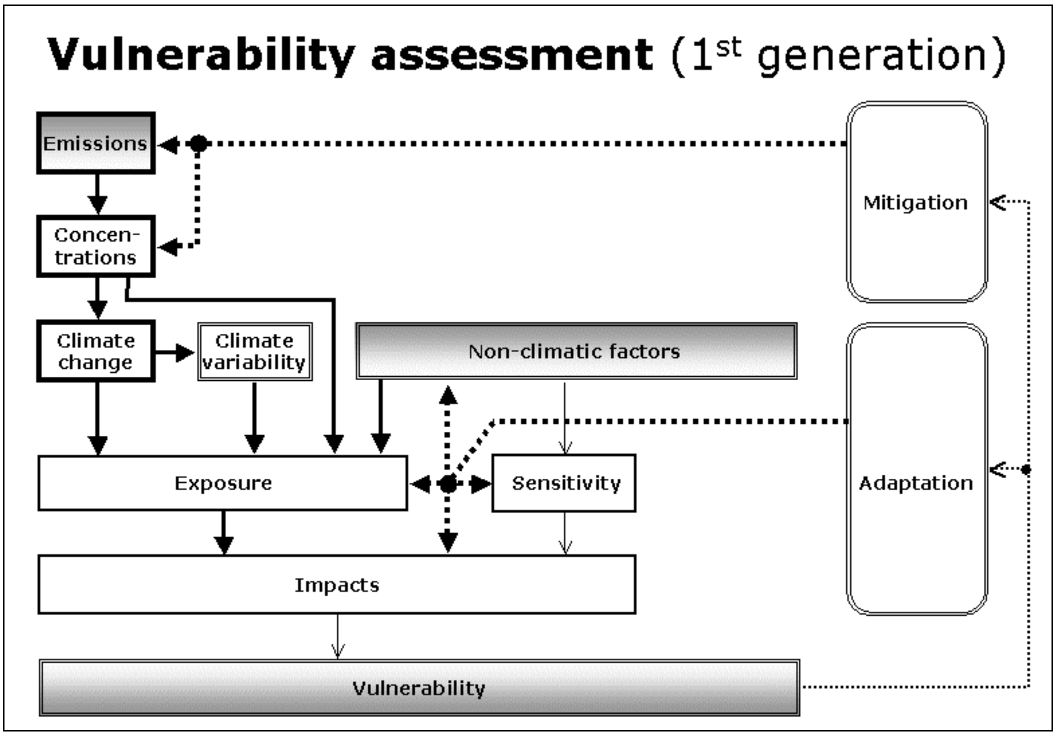

Figure 6. Conceptual framework for a first–generation vulnerability assessment

> ***Climate variability:*** *Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).*

Climate variability constitutes an important component of a system's *exposure*, and it is generally accepted that *climate change*, understood as changes in the mean climate on a global scale, will affect regional *climate variability,* including the frequency, intensity, and location of extreme events. However, consideration of *climate variability* and its future changes in model–based impact assessments is hampered by the often substantial disagreement between different climate models. A notable exception concerns the intensity of precipitation events where the majority of climate simulations suggest that heavy rains will increase in a warming world (Cubasch *et al.*, 2001).

Non–climatic factors denote a wide range of factors that affect the vulnerability of a system or society to climate change. They include ecological, economic, social, demographic, technological and political conditions. *Non–climatic factors* may be affected by *mitigation* activities. For instance, improved building designs aimed at minimizing energy consumption may also influence the ability of buildings to protect people from heat waves and other extreme weather events. In the conceptual framework, *non–climatic factors* can affect the *sensitivity* as well as the *exposure* of a system to climatic stimuli. The latter link is particularly relevant for mobile *exposure units*. For instance, if a person or a community relocates due to some external stress, their *exposure* to climatic variations obviously will change.

Definitions of vulnerability vary considerably among different analysts. One school of thought, which prevails in social geography and political ecology, regards (social) vulnerability as the response capacity of a household or a community to external stresses, as determined by socioeconomic and political factors (Blaikie *et al.*, 1994; Bohle *et al.*, 1994). Pertinent studies suggest a causal structure that concentrates on the differential abilities of communities to cope with external stress. Vulnerability according to this view, seen as the socioeconomic causes of differential sensitivity and exposure, corresponds closely to the *non–climatic factors* in our framework. A second school, which is characteristic for the risk, hazards, and disasters literature, conceptualizes vulnerability as the dose–response relationship between an exogenous hazard to a system and the associated risk of adverse effects (UNDHA, 1993; Dilley & Boudreau, 2001). A third school, which is predominant in global change and climate change research, uses vulnerability as an integrated measure of the expected adverse effects to a system that originate from certain external stressors (McCarthy *et al.*, 2001; Cutter, 1993; Boughton *et al.*, 1999). For a comprehensive review of alternative conceptualizations of vulnerability, the reader is referred to Cutter (1996), Kelly & Adger (2000), and Dilley & Boudreau (2001).

> ***Vulnerability:*** *The degree to which a system is susceptible to, or 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 variation to which a system is exposed, its sensitivity, and its adaptive capacity.*

The IPCC definition of vulnerability is shaped by the third school. In this conceptualization, the *vulnerability* of a system to climate change includes both an external dimension, which is represented by its *exposure* to climate variations, and an internal dimension, which comprises its *sensitivity* to them and its *adaptive capacity* (Bohle, 2001). However, the inclusion of *'or'* in the first part of that definition seems to indicate a lingering persistence of the view that external shocks and inherent coping ability are alternative definitions of vulnerability rather than co–factors (Brooks, 2002). Connecting these co–factors with *'and'* would thus be more appropriate. The distinction between an external and an internal dimension of vulnerability is similar to the one between biophysical and social vulnerability, as applied in the 'hazards of place' model of vulnerability developed by Cutter (1996).

Vulnerability is a broader concept than potential *impacts*, although the two are closely related. The double border of the 'vulnerability box' indicates that this concept is applicable at, and may differ between, different scales. For isntance, even if the overall vulnerability of a country to climate change is low, certain subgroups of the population may still be strongly affected. The arrow that points from *impacts* to *vulnerability* differs from the arrows used in the conceptual framework for an impact assessment (cf. Figure 5). This thin arrow depicts that the impact potential is an important *determinant* for the vulnerability of a system. However, it does not suggest that impacts *cause* vulnerability.

The main distinctions between impacts and vulnerability, as understood by the IPCC, can be explained using the framework for vulnerability shown in Figure 2:

Stressors: The concept of vulnerability relies on a realistic representation of the main stressors to a system, which often means to include threats in addition to climate change, and to explicitly consider the uncertainty of climatic and non–climatic scenarios. Reilly & Schimmelpfennig (1999) emphasize the stochastic nature of vulnerability by defining it as the "probability–weighted mean of damages and benefits".

System: Most importantly, the concept of vulnerability to gradual changes, such as anthropogenic climate change, considers the dynamic nature of a vulnerable system or society, in particular its ability to adapt to changing conditions over time. Vulnerability assessments often pay attention to socioeconomic factors that determine the differential vulnerability of communities to external stresses.

Effects: The concept of vulnerability relies on a — partly normative — evaluation of projected impacts. A system is only considered vulnerable if goods and services are adversely affected that are valuable to society as a whole or to certain subgroups. Vulnerability assessments thus link natural with socioeconomic analysis.

Actions: Vulnerability assessments are often framed with a specific set of potential response actions in mind. Those determinants of vulnerability that cannot be affected by actions from the portfolio of the orderer of the assessment thus tend to receive limited attention.

Not all these differences between impacts and vulnerability are already relevant for *first–generation* vulnerability assessments, and some of them cannot be adequately shown in the conceptual framework. Another difference between impacts and vulnerability relates to their quantifiability. Climate impacts can often be described by changes in biophysical indicators, such as the primary productivity of an ecosystem, or in socioeconomic indicators, such as the revenues from ski–tourists. However, no agreed metric exists to describe the vulnerability of an ecosystem or a ski resort to global climate change.

Recognition of the *vulnerability* of valued systems to climate change is likely to trigger policy responses at different levels. This potential for human agency is indicated by the thin dashed arrows in the framework diagram from vulnerability to mitigation and adaptation.

> ***Adaptation:*** *Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. [...]*

Adaptation, as defined by the IPCC, comprises a broad range of activities. Alternative definitions have sometimes restricted the use of this term to adjustments in social systems, to deliberate changes, to major structural changes in a system, or to a subset of climatic stimuli (Smit *et al.*, 2000).

The conceptual framework distinguishes **adaptation** measures between those that are targeted directly at the vulnerable system and those that affect *non–climatic factors* influencing the system. The various links from *adaptation* to other components of the conceptual framework are illustrated here by examples referring to climate impacts on human health. Vaccination against climate–sensitive vector–borne diseases and early–warning systems for heat waves and floods are examples for *adaptations* that aim at reducing the *sensitivity* and *exposure* of people to climate-related health hazards, respectively. The treatment of persons who already fell ill (denoted as 'reactive adaptation' or 'tertiary intervention' by the climate change and public health communities, respectively) directly alleviates the *impacts* of climate change. An improvement of the nutritional conditions of children to enhance their immune status illustrates how *adaptation* can reduce stressful *non–climatic factors* that, in turn, affect their *sensitivity* or *exposure* to climate change.

First–generation vulnerability assessments raise awareness of the (potential) vulnerability of sensitive systems to climate change. They may also assess the relative importance of various non–climatic factors. In so doing they help to prioritize further research and determine the need for mitigation and adaptation measures to reduce adverse effects. Depending on the level of adaptation assumed, assessment results may fall anywhere in the range spanned by the 'dumb farmer' and the 'clairvoyant farmer' trajectories in Figure 3. However, as long as the feasibility of implementing adaptations is not analyzed, the assessment does not provide a full picture of the vulnerability of the considered system. For a more detailed discussion of unrealistic adaptation assumptions and for examples of studies that would be regarded as first–generation vulnerability assessments in our classification, see Smithers & Smit (1997) and Smit & Pilifosova (2001). Most initial national communications to the UNFCCC produced by developing countries are also first–generation vulnerability assessments (Lim, 2001).

4.3. Second–generation vulnerability assessment

The step from climate impact assessments to first–generation vulnerability assessments is characterized by the inclusion of non–climatic determinants of vulnerability and by the evaluation of potential impacts in terms of their relevance to goods and services that are important to society. The resulting broader view on the potential consequences of climate change also helps to assess adaptation needs. The requirements for, and limitations to, implementing adaptation measures are more thoroughly assessed in *second–generation* vulnerability assessments. The corresponding conceptual framework in Figure 7 includes a few new elements.

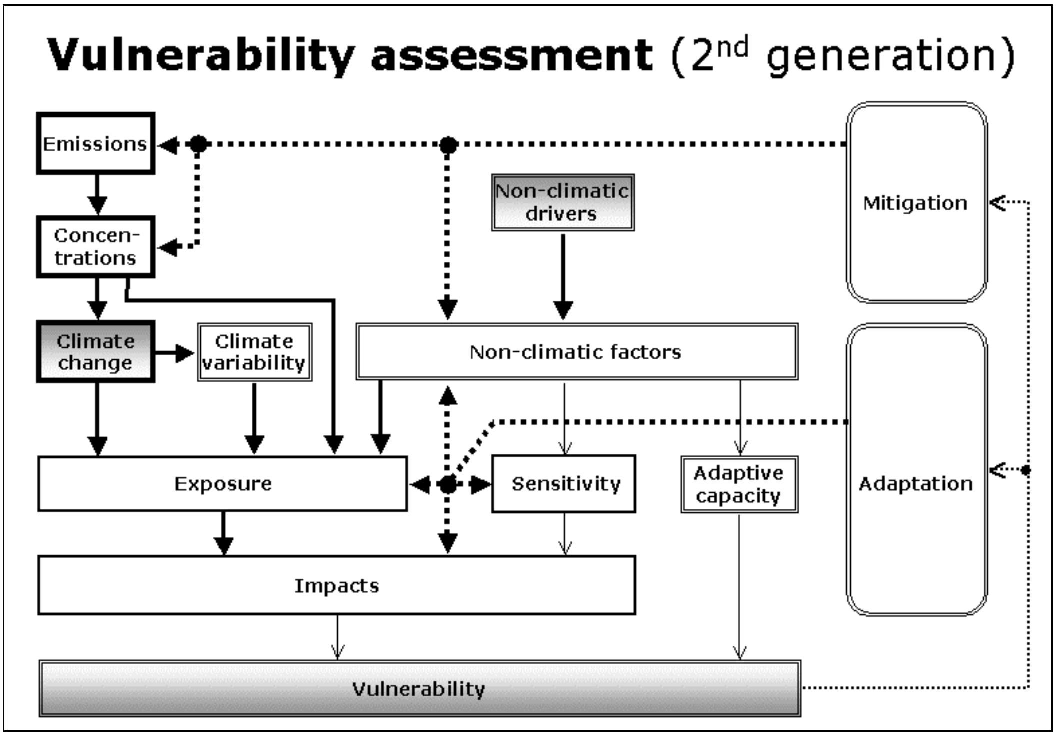

Figure 7. Conceptual framework for a second–generation vulnerability assessment

> ***Adaptive capacity (or adaptability):*** *The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.*

The **adaptive capacity** of a system or society determines its potential to reduce or cope with adverse effects of climate change. Under *ceteris paribus* conditions, *adaptive capacity* and *vulnerability* are therefore negatively correlated. It should be noted that the IPCC definitions for *adaptive capacity* (as well as of *adaptation* and *vulnerability*) refer to social and natural systems alike. The *adaptive capacity* of social systems is determined by many *non-climatic factors* such as economic resources, technology, information and skills, infrastructure, institutions, and equity (Smit & Pilifosova, 2001; Yohe & Tol, 2002). Since the ability of a system to cope with current climate variability is an important indicator for its capacity to adapt to future climate change, analyses of vulnerability across systems or regions to current climate variability can provide important lessons for adaptation science.

Vulnerability assessments often focus on the multiple stresses to a valued system property rather than the multiple effects of a particular stress such as climate change (Ribot, 1995). An important element in many second–generation vulnerability assessments is therefore the explicit consideration of non–climatic driving forces affecting a system, in particular of large–scale processes that are associated with global change. Assessments may include demographic, economic, sociopolitical, technological, biophysical, and other drivers that affect a system or society by impacting, for instance, on the degree of economic diversification, the level of education, the strength of social networks, and the overall health status of a population. The possibility of simultaneously assessing the effects of multiple driving forces (e.g. climate change and economic globalization) is reflected in the conceptual framework by the addition of **non–climatic drivers**, which influence *non–climatic factors*. Further distinctions between different types of *non–climatic drivers* (e.g. into primary and proximate drivers) are omitted here because this framework focuses on vulnerability to *climate change*.

Multi–factorial vulnerability analyzes rely heavily on the availability of consistent scenarios for all stressors considered, in particular when the different stressors are causally related to each other. An important contribution to this end is the development of the latest set of IPCC emission scenarios (Nakicenovic & Swart, 2000). These so–called SRES scenarios aim at being consistent in terms of emissions and non–climate drivers (mainly economic and demographic development). The SRES scenarios are often used, and sometimes even elaborated, in second–generation vulnerability assessments and in adaptation policy assessments. The importance of consistent multi–dimensional scenarios is also acknowledged in other advanced vulnerability assessments. The most prominent example is the Millennium Ecosystem Assessment (MA), a global effort to analyze on a global, regional, and local scale the state of ecosystems, their capacity to provide goods and services, the multiple stresses that they are facing, and the potential for human actions to protect ecosystem goods and services by moderating these stresses (Gewin, 2002; Ahmed & Reid, 2002). The assessment team of the MA is divided into four working groups, one of which exclusively addresses the development of consistent scenarios for a comprehensive set of driving forces.

Second–generation vulnerability assessments are conducted to estimate realistically the vulnerability of different regions or sectors, and to assess the potential of adaptations to reduce the adverse impacts of climate variability and change. In so doing they help to prioritize the allocation of resources for adaptation measures. The identification of limits of adaptation for valued systems would provide important information for the determination of critical levels of climate change. The results of assessments that consider the implementation of feasible adaptations correspond to the 'smart farmer' trajectory in Figure 3.

Second–generation vulnerability assessments are not yet commonplace, in absence of a clear methodology. More than first–generation assessments they require the involvement of social scientists in a multidisciplinary research group. In addition, second–generation assessments require a stronger involvement of stakeholders and, focusing more on adaptive capacity, rely more heavily on qualitative data. The project *"Assessments of Impacts of and Adaptation to Climate Change in Multiple Regions and Sectors"* (AIACC), which is implemented by the United Nations Environment Programme (UNEP) and supports the development of scientific and technical capacity amongst developing country scientists to address gaps in knowledge about climate change impacts, vulnerability, and adaptation, includes a number of subprojects that could be considered second–generation vulnerability assessments.

4.4. Adaptation policy assessment

The ultimate purpose of any climate change vulnerability assessment is to improve the knowledge base for climate policy, which includes *mitigation* as well as *adaptation* measures. Owing to major differences in the characteristic temporal and spatial scales and in the relevant actors (see Table 2), mitigation and adaptation policies are formulated largely independent of each other. This separation is also reflected in the structure of the IPCC Third Assessment Report, where mitigation and adaptation are addressed by different working groups (cf. Section 3).

> ***Adaptation assessment:*** *The practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility.*

Figure 8 depicts the conceptual framework for an *adaptation policy assessment*. This term is preferred over the term 'adaptation assessment' from the IPCC glossary to emphasize that its main purpose is to contribute to policymaking by providing specific recommendations to planners and policymakers on the enhancement of adaptive capacity and on the implementation of anticipatory adaptation measures. Employing the language introduced in Figure 3, adaptation policy assessments are about preventing 'avoidable impacts' by turning 'typical farmers' into 'smart' ones. Achieving this objective requires a closer look at the available response options. This includes considerations as to the feasibility of their implementation and to their integration with existing policies and practices on resource management, disaster reduction, economic development, public health, etc.

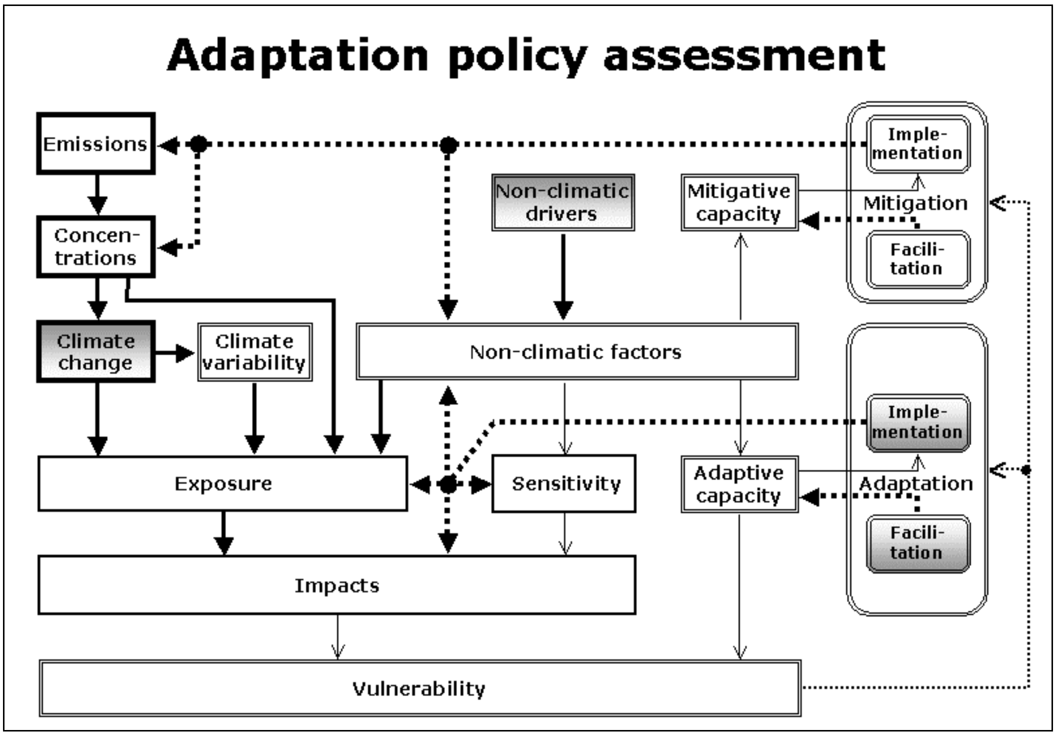

Figure 8. Conceptual framework for an adaptation policy assessment

Figure 8 distinguishes two types of *adaptation*. **Facilitation** refers to activities that enhance *adaptive capacity*, thereby improving the conditions for the implementation of adaptation measures. Such activities include awareness raising, capacity building, and the establishment of institutions, information networks and legal frameworks. **Implementation** refers to actually avoiding adverse climate *impacts*, either directly by reducing a system's *exposure* or *sensitivity* to climatic hazards or indirectly by moderating relevant *non–climatic factors* (for examples see Section 4.2). The relationship between *adaptive capacity* and *adaptation* is twofold. On the one hand, the *adaptive capacity* of a community determines the feasibility of *adaptation* of the *implementation* type. On the other hand, the *adaptive capacity* can be influenced by *adaptation* of the *facilitation* type.

Even though the focus of Figure 8 is on adaptation, mitigation actions are also included for the sake of completeness. The same classification is used for *mitigation* as for *adaptation*. The establishment of a carbon-trading scheme, for instance, constitutes a *facilitation* measure that enhances the **mitigative capacity** of a region. The possibility for trading carbon permits may make the replacement of an old power plant by a less carbon–intensive one economically viable, which would be regarded as an *implementation* measure. The concept of *mitigative capacity*, which is also affected by *non–climatic factors*, has been introduced into the literature only very recently (Yohe, 2001).

It is generally more efficient to develop response strategies that reduce the vulnerability of a system to multiple stressors simultaneously than to formulate independent adaptation strategies for each of them. Hence, adaptation to climate change and variability needs to be embedded in the existing policy context. The development of feasible adaptation strategies requires an intensive dialog with relevant stakeholders throughout the assessment process. Key objectives of such a dialogue are to identify the needs and priorities of stakeholders, to establish trust in the assessment team and methodology, to facilitate mutual learning, and to ensure that suggested policies are compatible with other policy goals such as sustainable development, economic diversification, and biodiversity conservation. Existing uncertainties about future climate change should be an important topic in the stakeholder dialogue and in the formulation of robust adaptation strategies. This topic is explored further in Pittock & Jones (2000).

To date, there is little guidance for full–blown adaptation policy assessments. An important initiative to advance the state of the art is the development of an *Adaptation Policy Framework* for Stage II adaptation under decision 11/CP.1 of the UNFCCC under the guidance of UNDP–GEF (Lim, 2001). One example of an adaptation policy assessment is the project *Climate Change and Adaptation Strategies for Human Health in Europe* (cCASHh), which aims to assess the status and to facilitate the enhancement of adaptation possibilities of communities to climate–related impacts on human health in Europe. cCASHh is implemented within the Fifth Framework Programme of the European Union and executed by an international and interdisciplinary team of researchers directed by the World Health Organization (WHO).

5. Summary

This paper started by presenting a scheme for characterizing and classifying climate change vulnerability assessments. Based on that scheme, the evolution of the political and conceptual frameworks for climate change vulnerability assessment and of the assessment practice was investigated. The analysis was largely based on the history of decision–making by the Conference of the Parties to the UNFCCC and on the reviews of the assessment literature in the pertinent IPCC reports.

The key developments identified in this analysis lead to the formulation of a hierarchy of climate change vulnerability assessments, which distinguishes four assessment stages. The evolution of vulnerability assessments is reflected by an increasing vertical integration (along the chain of causation) and horizontal integration (involving interactions across different sectors and disciplines), a shift in the analytical purpose from science–driven to policy–driven assessments, and a shift in focus from the effects of climate change alone to the multiple stresses that threaten a particular system or society. Each assessment stage was illustrated by an influence diagram that provides a visual glossary to the key concepts considered and their analytical relationships.

The first stage is represented by *impact assessments* that superimpose the results of climate models for specific emission scenarios on an otherwise constant world to estimate the (predominantly biogeophysical) impacts of anthropogenic climate change on various climate–sensitive systems. *First–generation vulnerability assessments* account for important non–climatic determinants of vulnerability, including current climate variability, and they acknowledge the potential of adaptation measures to reduce adverse impacts. *Second–generation vulnerability assessments* pay particular attention to the capacity of a system or society to adapt to climate change. Even though second–generation vulnerability assessments consider climate change and the potential response options in a wider context, their analytical purpose is still a positive one, namely to estimate the vulnerability of a system or community to climate variability and change. A fundamental shift occurs in the fourth stage, represented by *adaptation policy assessments*. They contribute to policymaking by recommending specific anticipatory adaptation measures. This goal requires a more detailed analysis of the process and the actors of adaptation, and of the integration of adaptation measures with existing policies. Characteristic features of such policy–oriented assessments are an intensive involvement of stakeholders, an emphasis on the link between current and future vulnerability to climatic variations, and the formulation and evaluation of response strategies that are robust against uncertain future developments. Compared to impact assessments that focus on long–term climate impacts, sometimes with a global scope, adaptation policy assessments tend to have a shorter time horizon and a more restricted geographical focus.

The climate change problem is a highly politicized topic that is characterized by strong interactions between the scientific and the policy communities at all levels. This paper shows that the international political framework, the conceptual framework, and the practice of climate change vulnerability assessment have evolved in a coevolutionary manner. In a nutshell, the political framework has influenced the conceptual framework and the assessment practice. The outcomes of the assessments have been used, in turn, to further develop the political and conceptual frameworks.

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