Climate Change Impacts, Adaptation and vulnerability approaches

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Climate change will lead to changes in geophysical, biological and socio-economic systems (IPCC WGII, 2007-2014).

- New and stronger evidence of **observed impacts** of climate change on unique and **vulnerable systems** (e.g. polar and high-mountain communities and ecosystems),

=> increasing levels of adverse impacts as temperatures increase (very high confidence).

- New evidence that **observed climate change** is likely to have already increased the risk of certain **extreme events** such as heatwaves,

⇒ warming has contributed to the intensification of some tropical cyclones, with increasing levels of adverse impacts as temperatures increase (very high confidence).

- The **distribution of impacts** and vulnerabilities is highly **variable within countries**,

=> less-developed areas are generally at greatest risk due to both higher sensitivity and lower adaptive capacity.

Schneider et al., 2007.

Need to provide policymakers with information about climate change impacts and adaptation potential.

Decision makers are increasingly calling upon the research community to provide:

- **good-quality information** on what **impacts** are **occurring now**, their **location** and the **groups** or **systems** most **affected**;
- reliable **estimates** of the **impacts** to be **expected** under **projected climate change**;
- **early warning** of potentially alarming or **irreversible impacts**;
- **estimation** of different **risks** and **opportunities** associated with a **changing climate**;
- effective **approaches** for **identifying** and **evaluating** both existing and prospective **adaptation measures** and **strategies**;
- credible **methods** of **costing** different **outcomes** and **response measures**;
- an adequate **basis** to **compare** and **prioritise alternative response measures**, including both **adaptation** and **mitigation**.

CCIAV Approaches

Assessments of **Climate Change Impacts, Adaptation and Vulnerability** (CCIAV) are undertaken to inform decision-making in an environment of uncertainty.

- An **approach** is defined as the overall scope and direction of an assessment and can accommodate a variety of different methods.

- A **method** is a systematic process of analysis.

Factors that distinguish a particular approach include:

- ✓the purpose of an assessment,
- ✓its focus,
- ✓the methods available,
- ✓how uncertainty is managed.

(IPCC)

CCIAV Approaches

There are five types of approaches:

- **Impact Approach**
- **Adaptation-based Approach**
- **Vulnerability-based Approach**
- **Integrated Approach**
- **Risk-management Approach**

- The first four are conventional research approaches.
- The fifth approach, risk management, has emerged as CCIAV studies have begun to be taken up in mainstream policy-making.

(IPCC)

CCIAV Approaches

'**Topdown**' and '**Bottom-up**' can variously describe the approach to scale, to subject matter (e.g., from stress to impact to response; from physical to socio-economic disciplines) and to policy (e.g., national versus local); sometimes mixing two or more of these.

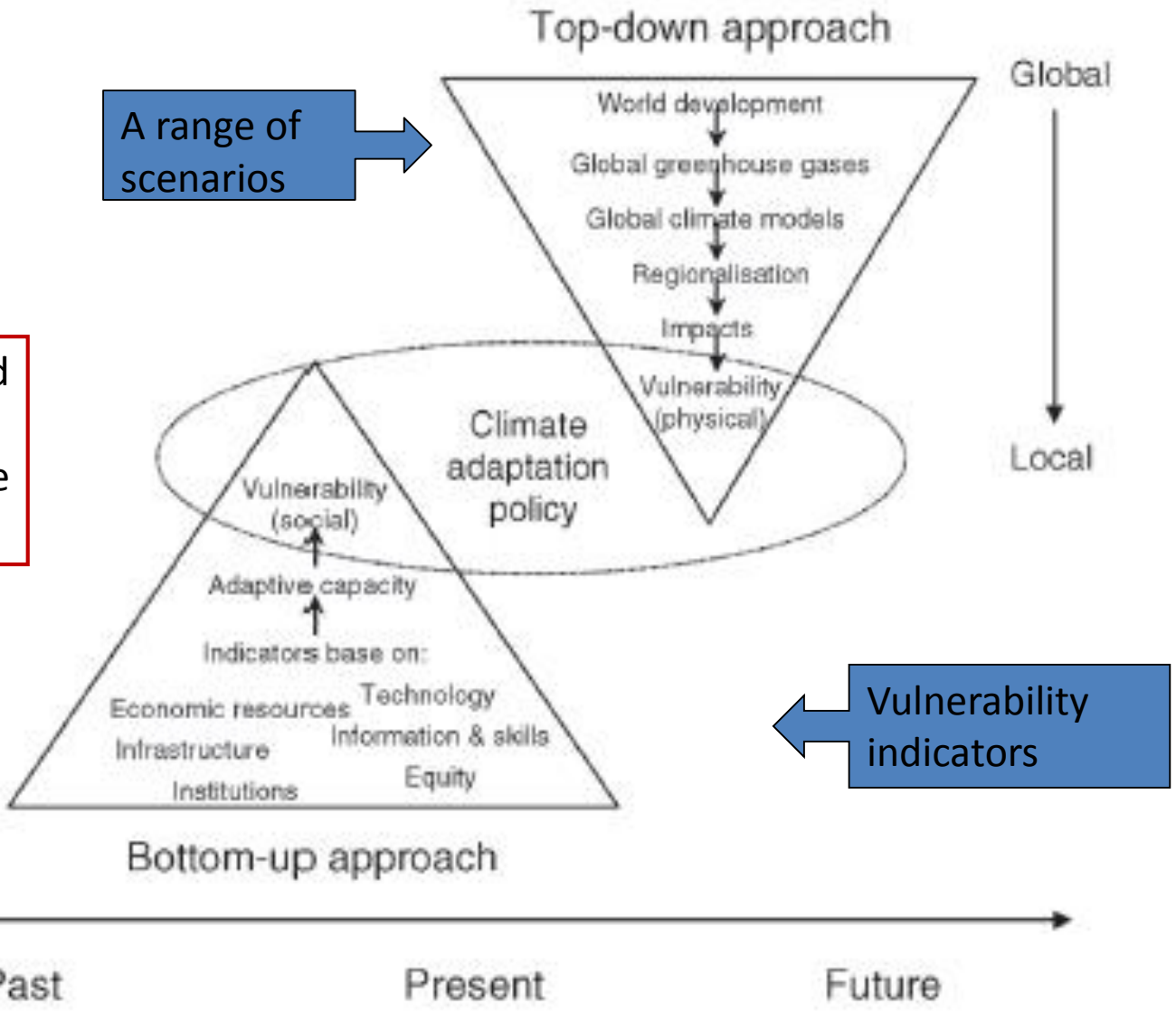
The standard **impact approach is often described as top-down** because it combines scenarios downscaled from global climate models to the local scale.

Adaptation assessment and vulnerability assessment are usually categorised as bottom-up approaches because are those that commence at the local scale by addressing socio-economic responses to climate, which tend to be location-specific.

(IPCC)

Top down & Bottom up

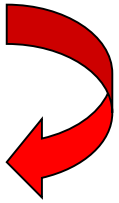
Two opposing and complementary views for climate adaptation policy.



Source: Dessai Hulme 2004

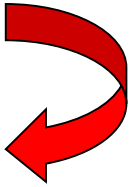
Top down & Bottom up

Top-down:



- **Direct** approach.
- Largely **scenario-driven**.
- The **question posed** is: for a given climate change, what will be the effect?

Bottom-up:



- **Adjoint** approach.
- Focused on the **implied effect**.
- The emphasis is on **vulnerability** of the exposure unit to climate change.

Impact approach

It aims to evaluate the **likely impacts** of climate change under a given scenario and to assess the need for **adaptation** and/or **mitigation** to reduce any **resulting vulnerability** to climate risks.

Often described as **top-down approach** because it combines **scenarios downscaled** from **global climate models** to the **local scale** with a sequence of **analytical steps** that begin with the **climate system** and move through **biophysical impacts** towards **socio-economic assessment**.

Vulnerability-based Approach

It focuses on the **target sensitivity** by concentrating on the propensity to be harmed, then seeking to maximise **potential benefits** and minimise or reverse **potential losses**.

- Vulnerability is highly dependent on **context and scale**, and care should be taken to clearly describe its derivation and meaning, and **to address the uncertainties** inherent in vulnerability assessments.
- Frameworks should also be able to integrate the **social** and **biophysical dimensions** of vulnerability to climate change.
- Since the TAR, the IPCC definition of vulnerability has been challenged, both to account for an expanded remit by **including social vulnerability** and to **reconcile it with risk assessment**.

Adaptation-based Approach

It focuses on **risk management** by examining the adaptive capacity and adaptation measures required to improve the **resilience** or **robustness** of a system exposed to climate change.

Adaptation-based approach shifts its emphasis from a research-driven activity to one where **stakeholders participate** in order to improve decision making.

The **key advance** is the incorporation of adaptation to past and present climate.

Integrated Approach

It includes integrated assessment modelling and other procedures for investigating CCIAV across disciplines, sectors and scales, and representing **key interactions** and **feedbacks.**

- Integrated assessments can involve one or more **mathematical models**, but may also represent an integrated process of **assessment**, linking different disciplines and groups of people.
- Managing **uncertainty in integrated assessments** can utilise models ranging from **simple models** linking large-scale processes, through **models of intermediate complexity**, to the **complex**, physically explicit representation of Earth systems.
- This structure is characterised by **trade-offs between realism and flexibility**, where simple models are more flexible but less detailed, and complex models offer more **detail** and a greater range of **output**.
- Cross-sectoral integration is required for purposes such as **national assessments**, **analysis of economic** and **trade effects**, and **joint population and climate studies**.

Risk-management Approach

It focus directly on **decision-making** and offer a useful **framework** for considering the different research approaches and methods described as well as confronting, head on, the **treatment of uncertainty**, which is pervasive in CCIAV assessment.

- Risk is generally measured as a **combination of the probability of an event and its consequences.**
- **The issues to be addressed** include assessing current adaptations to climate variability and extremes before assessing adaptive responses to future climate, assessing the limits of adaptation, linking adaptation to sustainable development, engaging stakeholders, and decision making under uncertainty.
- The two major forms of climate risk management are the **mitigation of climate change** through the abatement of GHG emissions and GHG sequestration, and **adaptation to the consequences of a changing climate.**

Risk-management Approach

Some of the **standard elements within the risk-management process** that can be adapted to assess CCIAV are as follows:

- A **scoping exercise**, where the context of the assessment is established. This identifies the overall approach to be used.
- **Risk identification**, where what is at risk, who is at risk, the main climate and non-climate stresses contributing to the risk, and levels of acceptable risk are identified. This step also identifies the scenarios required for further assessment.
- **Risk analysis**, where the consequences and their likelihood are analysed. This is the most developed area, with a range of methods used in mainstream risk assessment and CCIAV assessment being available.
- **Risk evaluation**, where adaptation and/or mitigation measures are prioritised.
- **Risk treatment**, where selected adaptation and/or mitigation measures are applied, with follow-up monitoring and review.
- Two overarching activities are **communication and consultation** with stakeholders, and monitoring and review.

	Approach			
	Impact	**Vulnerability**	**Adaptation**	**Integrated**
Scientific objectives	Impacts and risks under future climate	Processes affecting vulnerability to climate change	Processes affecting adaptation and adaptive capacity	Interactions and feedbacks between multiple drivers and impacts
Practical aims	Actions to reduce risks	Actions to reduce vulnerability	Actions to improve adaptation	Global policy options and costs
Research methods	Standard approach to CCIAV Drivers-pressure-state-impact-response (DPSIR) methods Hazard-driven risk assessment	Vulnerability indicators and profiles Past and present climate risks Livelihood analysis Agent-based methods Narrative methods Risk perception including critical thresholds Development/sustainability policy performance Relationship of adaptive capacity to sustainable development		Integrated assessment modelling Cross-sectoral interactions Integration of climate with other drivers Stakeholder discussions Linking models across types and scales Combining assessment approaches/methods
Spatial domains	Top-down Global → Local	Bottom-up Local → Regional (macro-economic approaches are top-down)		Linking scales Commonly global/regional Often grid-based
Scenario types	Exploratory scenarios of climate and other factors (e.g., SRES) Normative scenarios (e.g., stabilisation)	Socio-economic conditions Scenarios or inverse methods	Baseline adaptation Adaptation analogues from history, other locations, other activities	Exploratory scenarios: exogenous and often endogenous (including feedbacks) Normative pathways
Motivation	Research-driven	Research-/stakeholder-driven	Stakeholder-/research-driven	Research-/stakeholder-driven

CCIAV Approaches

Adaptation- and vulnerability-based approaches, integrated assessment, and risk management are **increasingly being incorporated into mainstream approaches to decision making**, requiring a wider range of methods to fulfill objectives such as:

- assessing current vulnerabilities and experience in adaptation,
- stakeholder involvement in dealing with extreme events,
- capacity-building needs for future vulnerability and adaptation assessments,
- potential adaptation measures,
- prioritisation and costing of adaptation measures,
- interrelationships between vulnerability and adaptation assessments,
- national development priorities and actions to integrate adaptation options into existing or future sustainable development plans.

Topics

Definitions of key terms:

- exposure, sensitivity, adaptive capacity, vulnerability, impact, risk.
- Overview of main approaches for:
  - ✓ Impact Assessment
  - ✓ Vulnerability Assessment
  - ✓ Risk Assessment

CLIMATE IMPACT ASSESSMENT

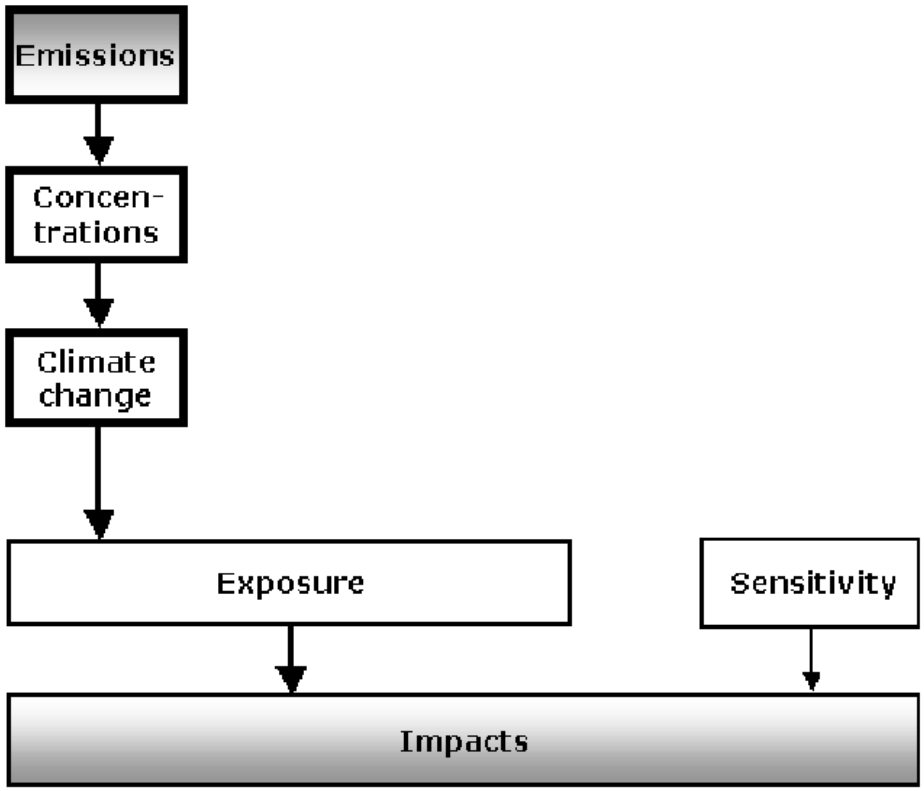
The practice to identifying and evaluating the detrimental and beneficial consequences of climate change on natural and human system.

Evaluate the potential effect of several climate change scenarios, including a (hypothetical) constant climate scenario on one or more impact domains.

Climate change impact studies are necessarily **conjectural**.

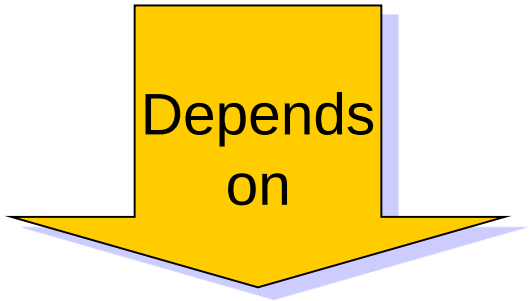
1. **Palaeological**, **archaeological**, or **historical** studies of how climate change and climate variations **in the past** have affected human and/or natural system.
2. Studies of **short term climatic events** (climatic analogies), analogous to the kind of events that may be expected to occur (droughts, floods).
3. Studies of the **impact** of **present day climate** and **climate variability**.
4. **Creation of models** (quantitative) of the relationship between **climatic variables** and selected **impacts sectors** to try to answer the “what if” kinds of question.
5. **Expert judgment** refers to a variety of methods whereby well informed and experienced **specialists** are brought together to develop a consensus view.

Impact assessment



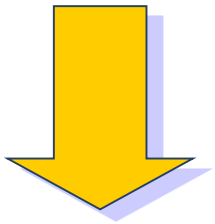
Source: Füssel 2002

EXPOSURE: the nature and degree to which a system is exposed to significant climatic variations.



- Its location.
- The level of global climate change.

SENSITIVITY: the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct or indirect.



It denotes the (multi-dimensional) dose-response relationship between its **exposure** to climate stimuli and the **resulting effects**.

(CLIMATE) IMPACTS: consequences of climate change on natural and human systems.

They are a **function** of the change in the **exposure** of a system to climatic stimuli and of its **sensitivity**.

Potential impacts: determined in assessment where the exposure of a system change but its sensitivity is assumed to be unaffected by climate change.

Residual impacts: explicitly consider adaptation measure.

VULNERABILITY ASSESSMENT

Constitutes an extension of a climate impact assessment.

- IPCC (2001)
- Füssel (2006)
- Australian Government (2005)
- Klein and Nicholls (1999)
- Jones and Boer (2005)
- Schneider et al. (2007)

Purpose of vulnerability assessment

- To produce information that helps to understand how a system is potentially affected by and responds to a change in climatic conditions.
- To contribute to policymaking by presenting this information to stakeholders and recommending adaptation measures, including opportunities for and barriers to their implementation.
- To inform the decision-making of stakeholders about options for adapting to the effects of global change.
- Facilitate sustainable development.

Schröter, Polsky, and Patt 2004. *Mitigation and Adaptation Strategies for Global Change*, next issue. In press.

What is vulnerability to climate change?

- **IPCC CZMS, 1992:** The degree of incapability to cope with the consequences of climate change and sea-level rise.
- **IPCC SAR, 1996:** The extent to which climate change may damage or harm a system; it depends not only on a system's sensitivity, but also on its ability to adapt to new climatic conditions.

IPCC TAR, 2001: 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.**

➔ IPCC TAR (2001)

Vulnerability: potential for harm

exposure

sensitivity

adaptive capacity

potential impact

vulnerability

Vulnerability is a Function of all Three

- More exposure and sensitivity increase vulnerability.
- More adaptive capacity decreases vulnerability.

EXPOSURE

relates to the influences or stimuli that impact on a system.

It represents the background climate conditions against which a system operates, and any changes in those conditions.

In a climate change context it **captures the important weather events and patterns** that affect the system.

it is not possible to give definitive forecasts of the climate conditions that will characterise a region in future years. Forecasts of this type are necessarily uncertain and likely to remain so, even though **levels of uncertainty** can be expected to be reduced over time.

SENSITIVITY

reflects the responsiveness of a system to climatic influences, and the degree to which changes in climate might affect it in its current form.

Sensitive systems are highly responsive to climate and can be significantly affected by small climate changes.

Many systems have a capacity to tolerate adverse climatic effects up to a certain **threshold**, and then exhibit extreme sensitivity to those conditions.

A complete inventory of systems and sensitivities is not available but particular attention must be paid to **systems that are already under stress** from other factors (such as growing population) or are operating near their natural climate limits.

Impact assessment and adaptation assessment

Vulnerability = f (exposure, sensitivity, adaptive capacity), where exposure and sensitivity determine potential impacts.

vulnerability assessment should include both the **assessment of impacts** and the **assessment of adaptation**.

impact assessment can rely on fairly well-established methods.

adaptation assessment requires innovative approaches.

What is adaptation?

- **IPCC SAR, 1996:** Not defined.
- **IPCC TAR, 2001:** Any adjustment in natural or human systems in response to actual or expected impacts of climate change, aimed at moderating harm or exploiting beneficial opportunities.

ADAPTIVE CAPACITY

reflects the ability of a system to change in a way that makes it better equipped to deal with external influences.

A **planned adaptation** is a change in anticipation of a variation in climate. It is an inherently strategic and conscious effort to increase the capacity of a system to cope with (or avoid) the consequences of climate change.

An **autonomous adaptation** is the capacity of systems to improve their ability to cope over time as a reaction to climate pressure.

systems whose autonomous adaptive capacities are unlikely to be capable of dealing with climate pressures may need to supplement these with planned approaches in order to minimise adverse effects.

➔ IPCC AR5 WG2 (2014)

THE COMPONENTS OF ADAPTATION

Resilience:

The capacity of systems **to cope** with a hazardous event or trend or disturbance, **responding or reorganizing** in ways that **maintain their essential function, identity, and structure,** while also maintaining the capacity for adaptation and transformation.

The system maintains the same identity and adapt remaining within critical thresholds.

Transformation:

A **change** in the **fundamental attributes** of natural and human systems. Reflecting strengthened, altered, or aligned paradigms, goals, or values towards **promoting adaptation for sustainable development**, including poverty reduction.

The system transforms becoming a different system crossing thresholds into new development trajectories.

Adaptive capacity

- The ability to plan, prepare for and implement adaptation measures.
- Factors that determine adaptive capacity of human systems include:
  - ✓ economic wealth,
  - ✓ technology and infrastructure,
  - ✓ information, knowledge and skills,
  - ✓ institutions,
  - ✓ equity and social capital.

Forms of adaptation

- Increasing robustness of infrastructural designs and long-term investments.
- Increasing flexibility of vulnerable managed systems.
- Enhancing adaptability of vulnerable natural systems.
- Reversing trends that increase vulnerability (“maladaptation”).
- Improving societal awareness and preparedness.

Thanks for your attention!

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For more information:

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