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Co-designing flood risk assessment framework: Integrating local and scientific knowledge in a multi-risk evaluation context

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UNDERSTANDING FLOODS

What are floods?

Floods are major climate-related events that can have severe **social and ecological impacts**.

Their frequency and intensity are rising due to **climate change** and are driven by more intense rainfall, melting snow and ice, and sea level rise.

In addition, **land use changes** and **growing urbanisation** further exacerbate flood risk. These changes intensify runoff, reduce natural water retention, and increase pressure on drainage and river

Flood impacts



Damage to residential and commercial buildings



Disruption of transport and public services



Losses in agriculture and industry



Long-term deterioration of environmental quality

Type of floods



Result from prolonged rainfall or rapid snowmelt

Affect floodplains and settlements along rivers



Caused by intense rainfall

Drainage and river systems are overwhelmed

More pronounced in urban areas



Driven by storm surges, high tides, and sea-level rise

Impact low-lying coastal zones

How floods happen?

Flooding occurs when **water accumulates faster than the natural environment and built systems can absorb, store, or convey it**. This typically happens when intense or prolonged precipitation falls on already saturated soils, increasing surface runoff.

In urban areas, **sealed surfaces** and **limited soil infiltration** accelerate water flow, placing additional pressure on drainage networks and river channels. When these systems exceed their capacity, water spreads across the surrounding land.

Coastal and riverine processes, together with **meteorological conditions** and **land use**, influence how floodwaters develop and propagate across urban and rural areas.



UNDERSTANDING FLOODS

Key concept of flood risk

Flood risk is defined as the potential for adverse consequences resulting from the interaction between **hazards**, **exposure**, **vulnerability**, and **response**. Risk does not depend solely on the intensity of a flood event, but also on the characteristics of the affected area and the community's capacity to cope with and recover from impacts.



Source: *Framework for complex climate change risk interaction, adapted from Simpson et al. (2021, <https://doi.org/10.1016/j.oneear.2021.03.005>) and IPCC (2023, https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf).*

HAZARD

Potential **occurrence** of a physical event or process that may cause harm.

In the context of floods, hazards include **intense rainfall**, **rising river levels**, **storm surges**, and **extreme sea-level events**.

Presence of people, infrastructure, economic activities, ecosystems, and other assets in locations that can be affected by floods.

The concentration of population and assets in flood-prone areas directly increases potential impacts.

EXPOSURE

VULNERABILITY

Vulnerability refers to the **predisposition of the potentially affected area to suffer damage**.

It depends on **physical, social, economic, and environmental factors**, as well as on the capacity to cope with and adapt to flood events.

Actions and measures taken to prevent, manage, and recover from flood events.

It includes **flood protection infrastructure, nature-based solutions, early warning systems, emergency response planning, and long-term adaptation strategies**.

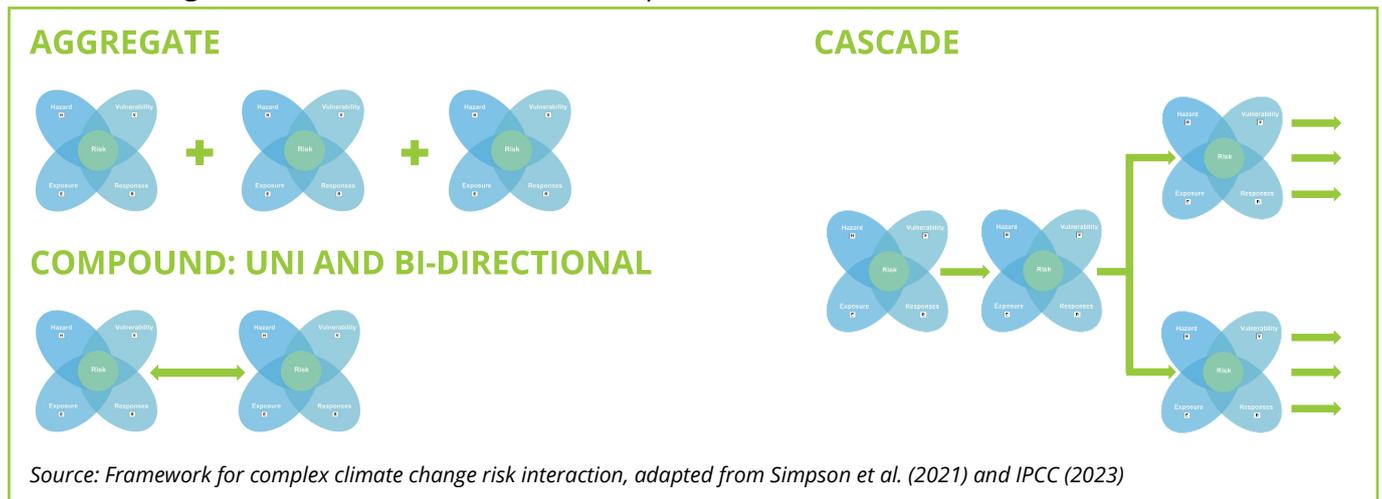
RESPONSE

In its Sixth Assessment Report, the IPCC introduced for the first time the concept of **RESPONSE** into the risk framework. Responses encompass policies and measures whose impacts may include unintended consequences, trade-offs, or negative side effects on other societal objectives when they fail to achieve their intended goals. Risks may therefore emerge from uncertainties related to the implementation, effectiveness, or outcomes of climate policies, climate-related investments, technological development or uptake, and broader system transitions (IPCC, glossary). Incorporating responses into risk assessments strengthens understanding of the links between climate risk and resilience, as responses play a central role in governance and in shaping feedbacks within social-ecological systems (Simpson et al., 2021).



FRAMEWORK FOR COMPLEX CLIMATE CHANGE RISK INTERACTION

Risk can emerge from various pathways and is shaped by the interaction of drivers. Understanding risks and their severity needs recognising the web of interactions stemming from natural processes, climate change or human-induced events and pressures.



The multi-risk concept emphasises how interacting **risk drivers can compound one another**, resulting in more severe impacts than when risks are assessed in isolation. By highlighting cascading effects and interconnected risks, multi-risk approaches underscore the need for integrated solutions, collaboration, and co-creation. Together, these developments represent a significant step forward in understanding and addressing the complex nature of climate change impacts.

Adaptation options	The measures : structural, institutional, ecological or behavioural used to reduce vulnerability or enhance coping capacity.
Compound risks	Risks that arise when multiple hazards occur together or in sequence , or interact across systems, amplifying overall impacts.
Impacts	The realised effects of risk, when hazards affect exposed and vulnerable systems, producing damage or losses to people, ecosystems, assets and services.
Risk management	Strategies, policies and actions designed to reduce the likelihood or severity of adverse consequences based on assessed or perceived risks.
Adaptation	The process of adjustment in human or natural systems to current or expected climate conditions, aiming to reduce harm or exploit opportunities.
Resilience	The capacity of systems to absorb disturbances , continue functioning, and adapt or transform while maintaining core identity and services.

Table: Other definitions underpinning multi-hazard risk assessment as defined by the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2023)

