Detecting, understanding and responding to extreme environmental events: Towards a multidimensional useful, usable, and used (U3) data-and-knowledge base

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Context and Motivation

The global agreements, specifically the "Sendai Framework", the "Sustainable Development Goals, SDGs", the "Aichi-Targets", and the "United Nations Framework Convention in Climate Change - UNFCCC", explicitly require scientific evidence to inform decision making, policy, and practice development for addressing the impacts of extreme events. In order to provide this scientific evidence and to support the achievement of the respective 2020 and 2030 targets, a useful, usable and used knowledge-and-data base is needed.

Key research questions

1) **What are the essential "useful, usable and used (U3) variables" for understanding, predicting, detecting, responding, and adapting to extreme events and environments from a societal and scientific point of view (E3S)?**
2) **How to generate a U3-E3S data-and-knowledge base by collating, harmonizing, and integrating multiple relevant sources of data (e.g. environmental, socioeconomic, health, other population data and relevant information), for instance to facilitate deriving impact metrics and scientific evidence for the decision-making?**
   a) How to quality control different *novel* datasets and streams (crowdsourced, citizen science, historical, the *Internet of Things* (IoT)) and how to complement established datasets (e.g. weather records) with these novel datasets and data streams?
   b) How to deal with different spatiotemporal accuracies?
   c) How to achieve appropriate spatiotemporal resolutions for specific applications? For instance, specifying the essential U3 variables for specific cases to address prediction, detection, response, and recovery options.
   d) How to integrate different knowledge networks?
   e) What are the national and international legal and governance implications of e.g. data privacy, data access, IP rights and storage?
3) **How can the U3-E3S data-and-knowledge base enable the multi-dimensional understanding of extreme event causations, impacts, responses, and recovery patterns?**
   a) How can evidence-based methodologies link hazards and impacts, including the interaction of drivers?
   b) How to exploit U3-E3S variables for understanding slow-onset events and lagged effects to address grand societal challenges, such as migration and hunger?
   c) What can historical event and *near-miss* data tell us about vulnerability, resilience, and adaptation?
   d) What are the components of socio-ecological systems that could fail, respond and recover first (vulnerability/ capacity)?

Expected methodologies and disciplines involved

Methodologies (non-exhaustive)**:**

Both inductive and deductive methods are needed – data to challenge theory and data to build the theory:

1) **Creating, curating and sustaining a U3-E3S data-and-knowledge collection, based on existing standards and interoperable solutions**

2) **Improving knowledge on response and early warning through understanding the traditional historical coping strategies.**
3) **Comparative case studies**
4) **Modelling**
5) **Applying a wide range of data analytic methods**
    a) Innovative (meta)data visualization techniques
    b) Data mining techniques
    c) Multivariate time series analyses
    d) Scaling methods for temporal and spatial dimension
    e) Nested analysis approaches: global scale (hot spot detection) – regional to local scale (data integration with specific thematic, temporal and spatial scope)
    f) Network-analysis (knowledge flows and social actors)
    g) Disaggregation by socio-economic status, age, gender, disability and other dimensions of vulnerability

Data sets and data streams (non-exhaustive)**:**

1) **Citizen observations**
2) **Data from social networks**
3) **In-situ environmental measurements**
4) **Earth observation data (airborne and space-born remote sensing data)**
5) **Derived gridded data sets (e.g. climate data, ecosystem properties etc.)**
6) **Socio-economic data**
7) **Historical data and evidence**
8) **Climate and impact model data**

Stakeholders involvement needed

Stakeholder involvement needed throughout the whole research process (from the specific research definition to the take-up of results).

Key stakeholders:

1) Practitioners/policy (decision makers)
2) "Future Earth partners"
3) Intergovernmental organizations (WMO, UNISDR, Sustainable Development Solutions Network, EMDAT stakeholders)
4) (Sub)National authorities
5) Municipality- and city networks
6) Private sector (e.g. re-insurance alliances)
7) Academia / research communities
8) Donors (e.g. national science foundations) and major data holders ("Data donors")

Requirement: Knowledge exchange between science and practice

1) Users of data (researchers from all disciplines)
2) Curators of data

Relevant scale / regions

We propose the assessment of *impact hot spots* at the continental to global scale but also at national and local levels where possible and relevant. Specifically, we propose comparative case studies of specific hot spots (e.g. distributed over the UN geographic regions) to understand the different dimensions and dynamics of risks. Particularly high relevance can be expected for e.g. drought-prone regions and other slow onset extremes. Interregional systemic connections should be explored (e.g. a crop failure in one region leading to a food price increase in other regions).

Expected societal impact

We expect the improvement of disaster risk management through a data-and-knowledge informed multi-dimensional, impact based risk assessment. The societal impact is guaranteed, if we can work towards a prevention and reduction of losses in lives, livelihoods, health and ecosystems through better preparedness and response measures for slow onset events.