PROJECT INFORMATION

Project title:	**European Drought Observatory for Resilience and Adaptation (EDORA)**
Project ID:	263
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PROJECT DESCRIPTION

IDENTIFICATION OF DRIVERS OF RISK AND DEVELOPMENT OF IMPACT CHAINS

Drawing on existing literature on sectoral drought risks (from Activity 2.1) and expert consultation (Task 4, Activity 4.3), this activity will identify relevant hydrological, socio-economic, physical, and governance-related drivers of drought risk for different systems and co-develop impact chains specific to these systems. These impact (or cause-effect) chains, will enable understanding better how different hazard, exposure and vulnerability factors interact to co-produce risks for and across different systems by applying a systems perspective (i.e., considering nonlinear interactions, cross-scale effects, feedback loops, etc.). Impact chains will be cross validated by relevant stakeholders during a dedicated "Drivers of risk and impact chains workshop" (ideally back-to-back with the EDO Annual Meeting in year 1 of the project) and with the (draft) impact database and national impact profiles. Impact chains will guide the indicator-based analysis of drought risks in Europe. Since they offer an understanding of the root causes behind relevant drivers of risk, they can also be used to identify possible risk management and adaptation options. It is hence envisaged to proactively reach out to the consortium lead for Lot 2 (Drought Risk Management) to ensure risk management choices identified in Lot 2 are risk informed.

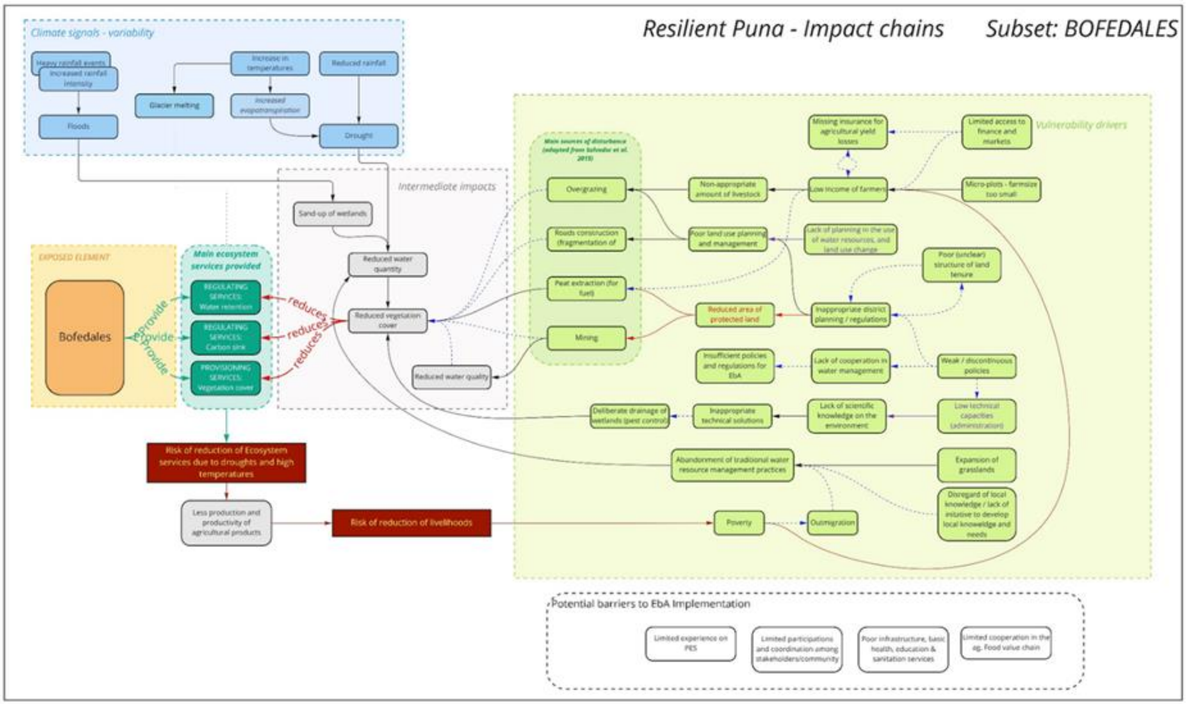
DATA DRIVEN RISK ASSESSMENT METHODOLOGY AND SYSTEMS CONSIDERED

In this activity, we will apply a more holistic risk approach that goes beyond ranking drought risks allowing for more precise representation of drought risks. This entails the evaluation of the relevance of different hazard and vulnerability drivers of drought risk using impact data. Using machine learning techniques to connect drought hazard indicators (i.e. related to SPEI, soil moisture, river flow, etc.) with observed impact data, an objective selection of relevant indices, their duration and intensity thresholds for impact as well as their relative importance can be obtained.

In this section we detail the methodology of the data-driven approach and further method development in more detail and provide argumentation for the systems at risk that are considered. Drought risk in the proposed EDORA analysis (like in PESETA IV) is the likelihood to incur damages and economic losses during and after a drought and depends on the interactions between three dimensions: 1) the magnitude and linked probability of occurrence of different possible drought events, 2) the exposed assets and/or productive systems, and 3) their intrinsic vulnerability / sensitivity to drought events of different magnitudes.

In general, the method (See Figure 1) follows the risk factor approach whereby hazard, exposure and vulnerability are combined to estimate drought risk. Taking up an impact-centric perspective, the first step consists of identifying systems-at-risk for which reliable impact proxies (i.e. observed impact data) are available. Then, hazard is calculated using proxies present in the EDO which are rescaled to the spatial resolution (NUTS level) that matches the exposure data (often NUTS2 or national) and to the temporal resolution (seasons/ years) that matches the observed impact data. Exposure data (see above) consists of the average value or system productivity of the sector-at-risk that is being evaluated. The proposed quantitative risk assessment focusses on direct impacts of drought, therefore multiple sensitivity factors are included to represent vulnerability (but excluding capacity proxies as they often influence indirect, cascading effects). Statistically clustering NUTS regions based on a similar system-specific vulnerability, hazard intensities can be linked with proxies for direct impacts in each cluster to quantify the stressor-response link. This link (assuming it will not change over time) is used as the vulnerability factor in the risk equation, supporting a method that allows to estimate of expected annual damage and probable losses for different return periods, per sector, per region.

The proposed pan-European drought disaster risk assessment method - further detailed below - can be executed on any spatial scale, with as limiting factor the spatial unit of impact data. For EDORA, hazard indices are calculated on NUTS3 level, then aggregated to the exposure/impact data scale (Often NUTS2 or national). Moreover, sufficiently long impact time series should be available to cover the heterogeneous effect of different droughts on systems. Analysis is thus executed over the period with impact information – aware that short time analysis might not capture all potential drought impact severities. Below, the first step is explained, showing the need for detailed impact data.



Example of Impact chain (from PUNA project - Peru high altitude wetlands and peatlands)

1 Identifying systems -at-risk: proxies for drought impact

The suggested drought disaster risk assessment starts from an impact perspective. As such, an impact-specific drought characterization can be done, allowing to create a regional- and system- specific definition of impactful drought events. However, to perform a data-driven drought risk analysis, sufficient data on direct drought impacts from relevant proxies should be available. Several conditions need to be met to be able to predict drought impacts for a system at risk:

1. There is (per system) a clear theoretical link to drought impacts for the system.

2. There is (per system) a quantitative proxy that can be used to determine impacts in the system caused by droughts (either continuous or categorical).
3. There is data available for the proxy impact that covers a sufficiently long time period (decades).
4. The proxy impact time series are at a sufficient spatial level and for locations throughout Europe.

Here, per sector we will assess the above criteria and elaborate on which impact proxy data will be used for different systems at risk. For the selection of viable impact proxies, both the spatial as the temporal resolution needs to be sufficient. For the spatial resolution, the aim was for data on NUTS-2 or even NUTS-3 level, but this often seemed too ambitious. Often, NUTS-1 level/country-level is used. For the temporal resolution, most data is used that has sufficient temporal scale (preferably monthly or quarterly data for 20 years, sometimes yearly data for 10 years).

It proved to be difficult to gather data at high resolution on a pan-European scale. In the following chapters we elaborate on certain choices to either use or not use data for the impact model. We also signify the potential for inclusion in a successful risk analysis of each of the discussed proxies for systems-at-risk (summarized in the main text, chapter 2.3).

1.5 Ecosystems

Both terrestrial and aquatic ecosystems can be impacted by drought events. For terrestrial ecosystems this would be primary by impeded growth of, for instance, trees. This would in turn impact productivity of production forests. However, this impact is not immediately apparent as it takes several decades before a tree is harvested and any reduction in its growth could become documented. An indirect observation could be retrieved from remote sensing (e.g., NDVI type observations). However, validation would be required to estimate which remotely sensed greenness reduction corresponds with an actual (biological, ecological) impact of relevance to the forest. For this, the EDID database from Task 1 can be used. A more comprehensive dataset (in time) is available for Czechia, where foresters fill in weekly surveys (categorizing tree, seedling and shrub health). This dataset spans about 7-8 years. As the quality of the data is highly detailed, the limited spatial extend and relatively small number of years, we evaluate this as medium potential. It should also be noted that results could theoretically only be upscaled to other forests of the same type (e.g., not representative for Mediterranean forests). However, another option could be the use of the detailed ICP Forests database with yearly information on crown conditions, growth and yield, LAI, biodiversity and tree vitality.

Found and searched for proxies for direct drought impact on ecosystems

Proxy	Source	Spatio-temporal scale
Forest health	Czech Globe	selected sites in Czechia, 2015-2022
Crown condition, growth, LAI, ground vegetation	ICP Forests	??