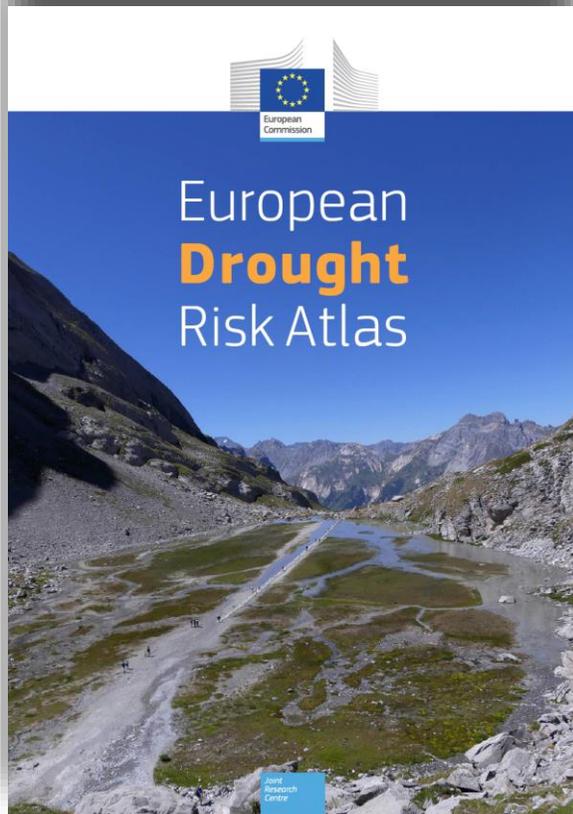


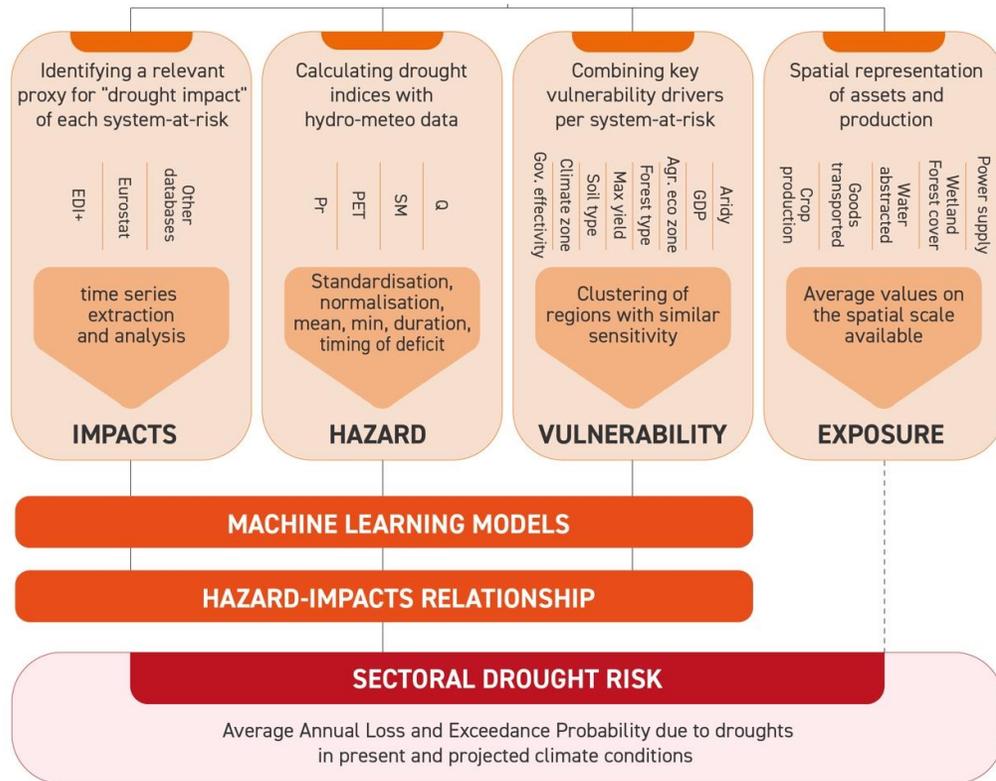
Assessing probabilistic drought risk in Europe



- QUANTIFYING drought risk
- Impact-data driven
- Artificial Intelligence & Statistical methods
- Current and future



Assessing probabilistic drought risk in Europe

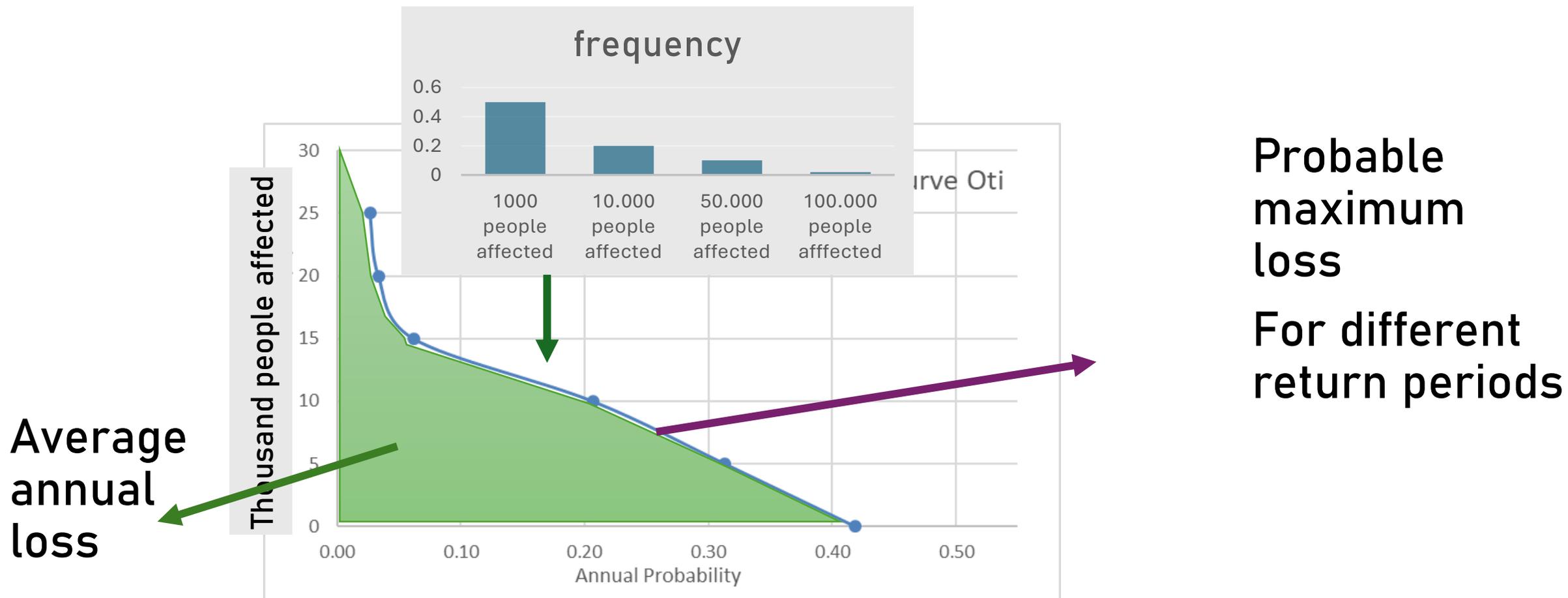


• Which hydro-meteorological conditions lead to impact?

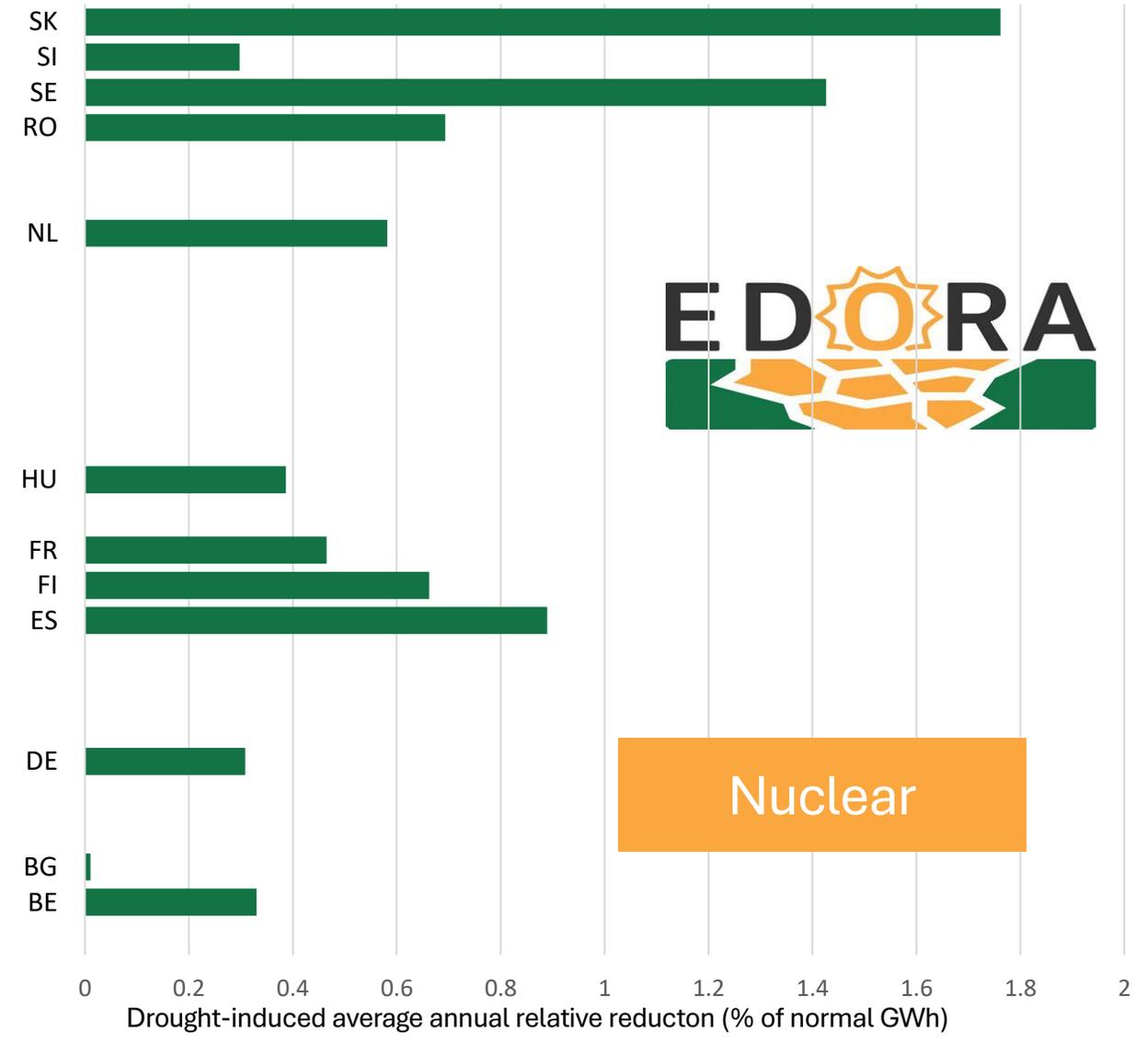
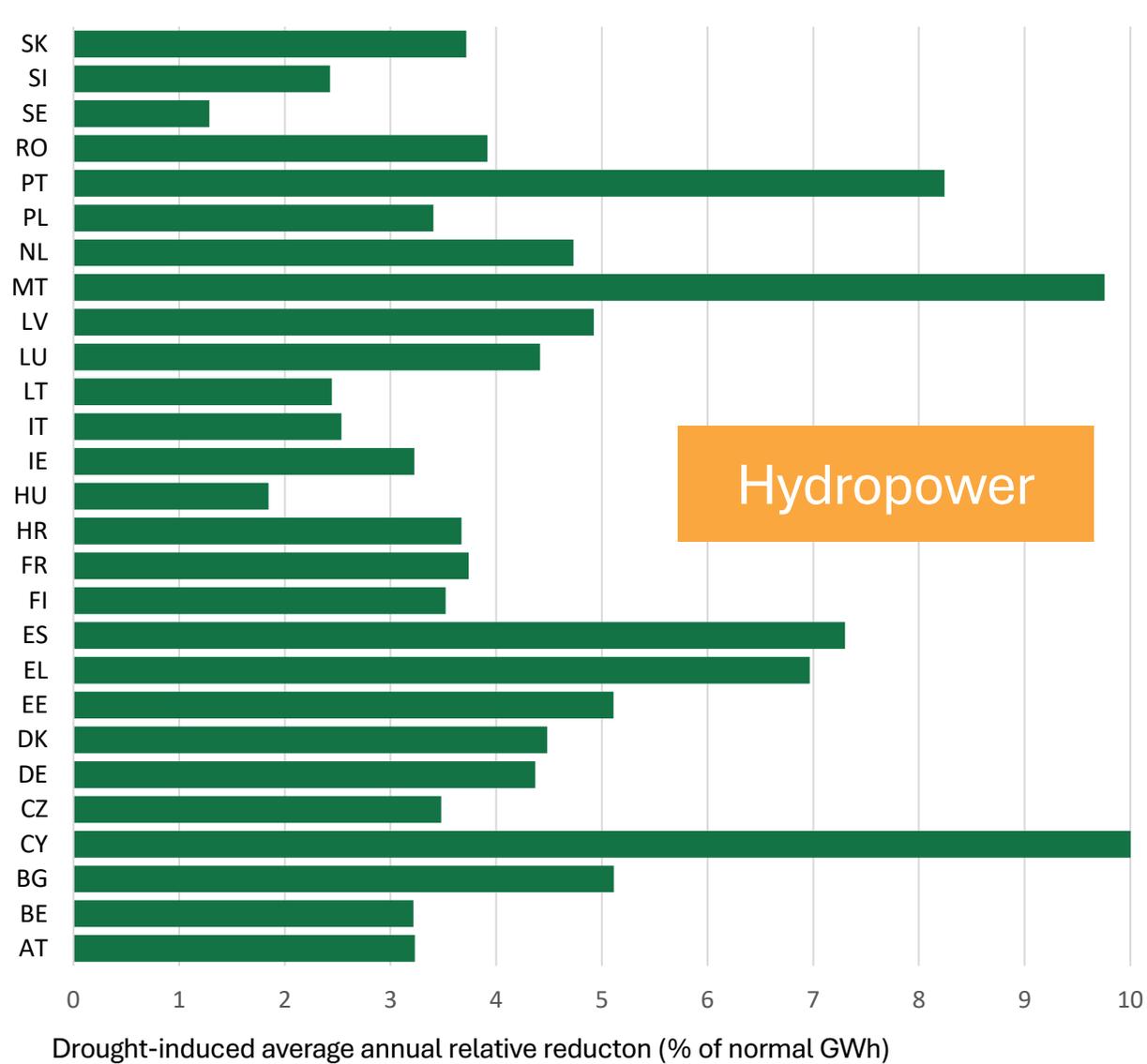
→ Decision tree algorithm using multiple hazard indices

- Per impact type → different hazard drivers relevant
- Per impact severity → non-linearity
- Per vulnerability cluster → different hazard-impact link
- Bootstrapped forest → different pathways to impact
- Impact data quality → optimize on precision or balanced accuracy?

Assessing probabilistic drought risk in Europe

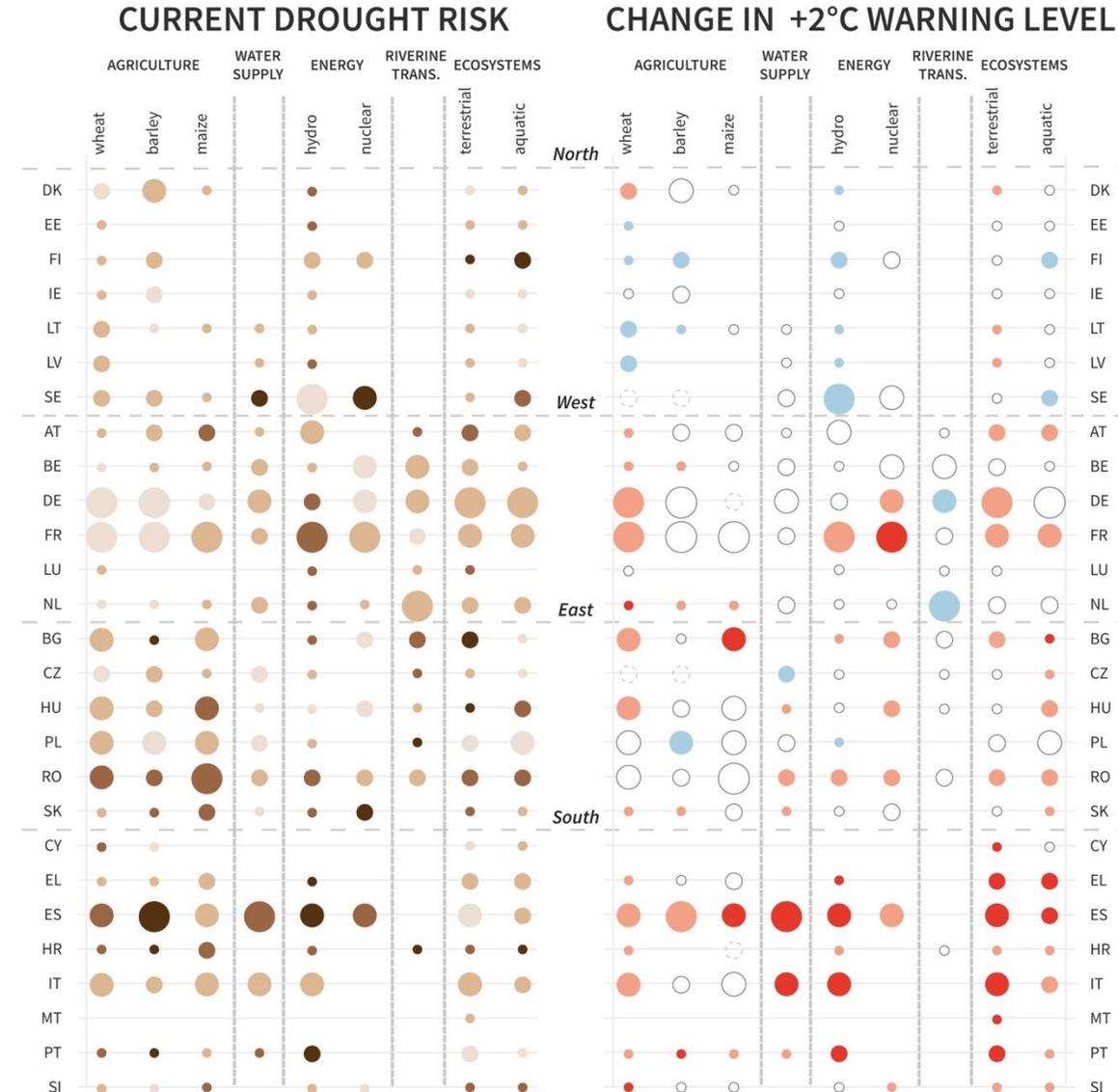
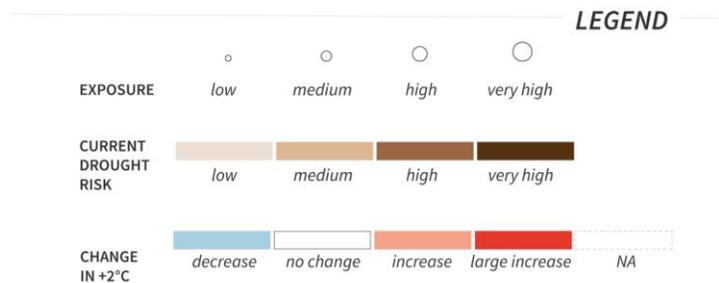


EXAMPLE Drought-induced reduction in power production

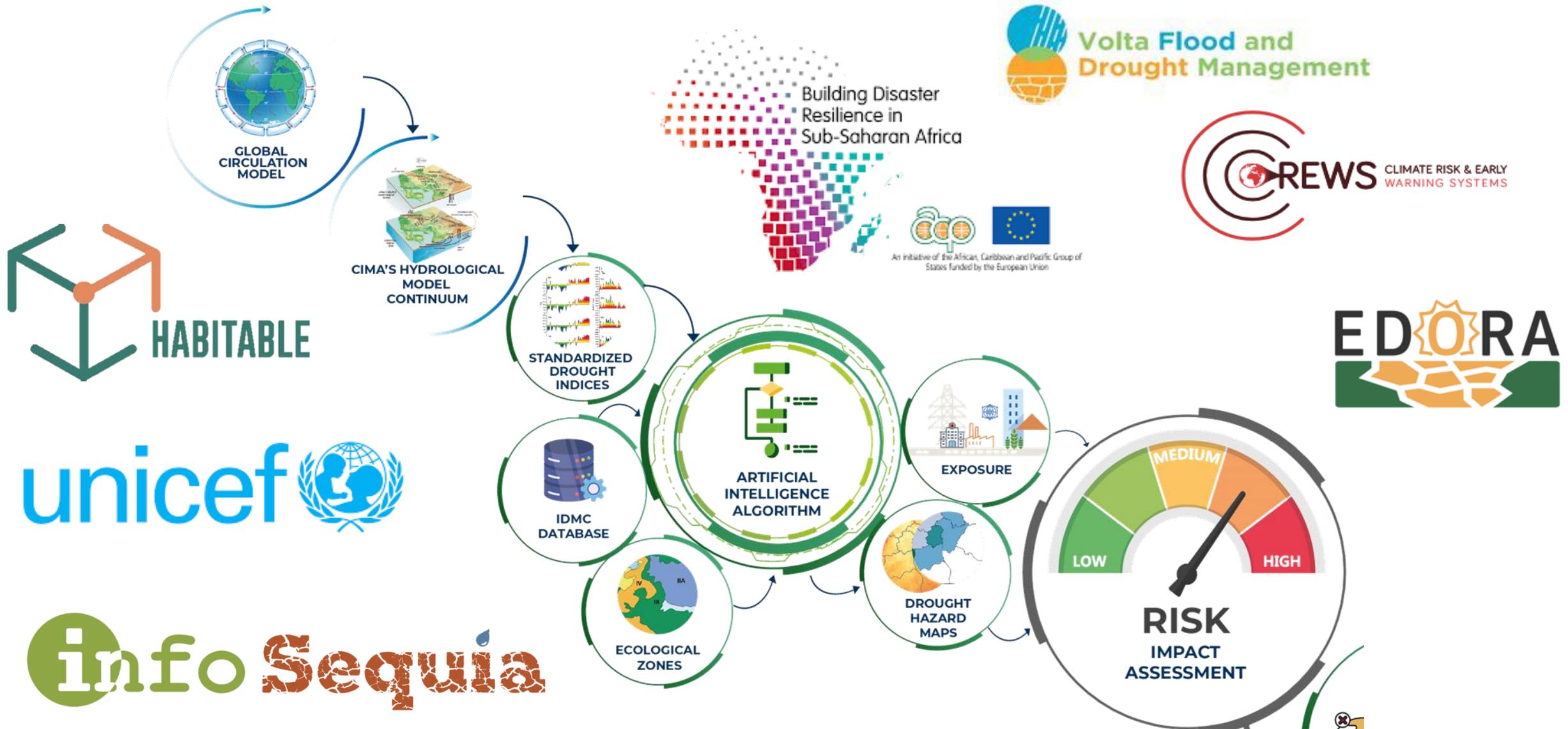


Assessing probabilistic drought risk in Europe

- Droughts have had increasing impacts in the EU in recent years, and are in many instances projected to further increase under worsening anthropogenic climate change.

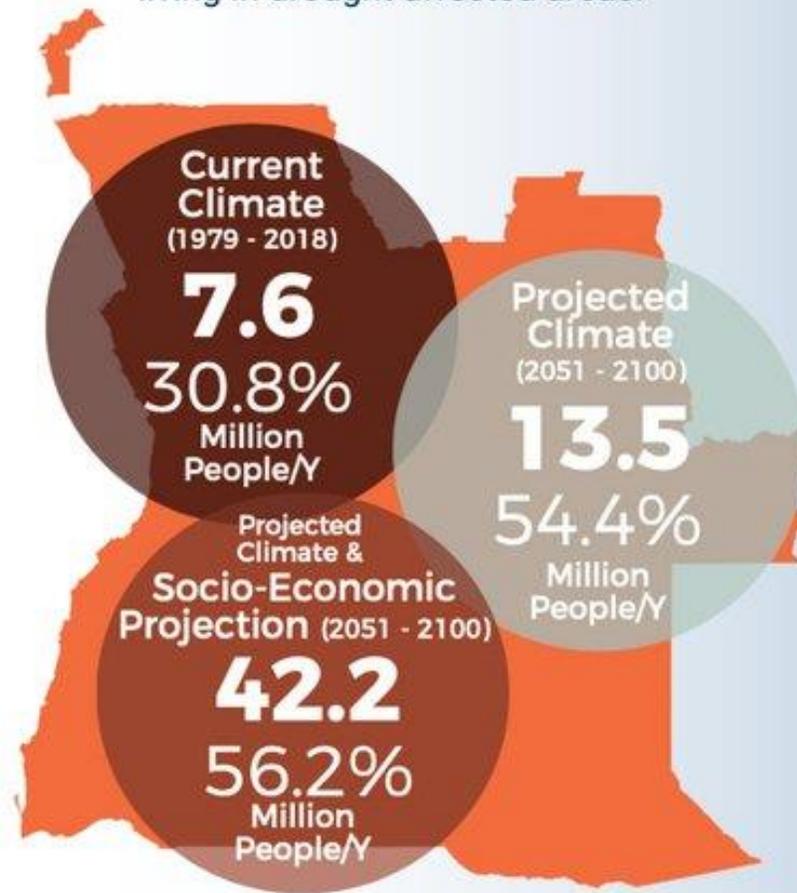


AI for quantifying drought risk in the world



Disaster risk profiles

Annual average number of people living in drought affected areas.



ANGOLA DISASTER RISK PROFILE

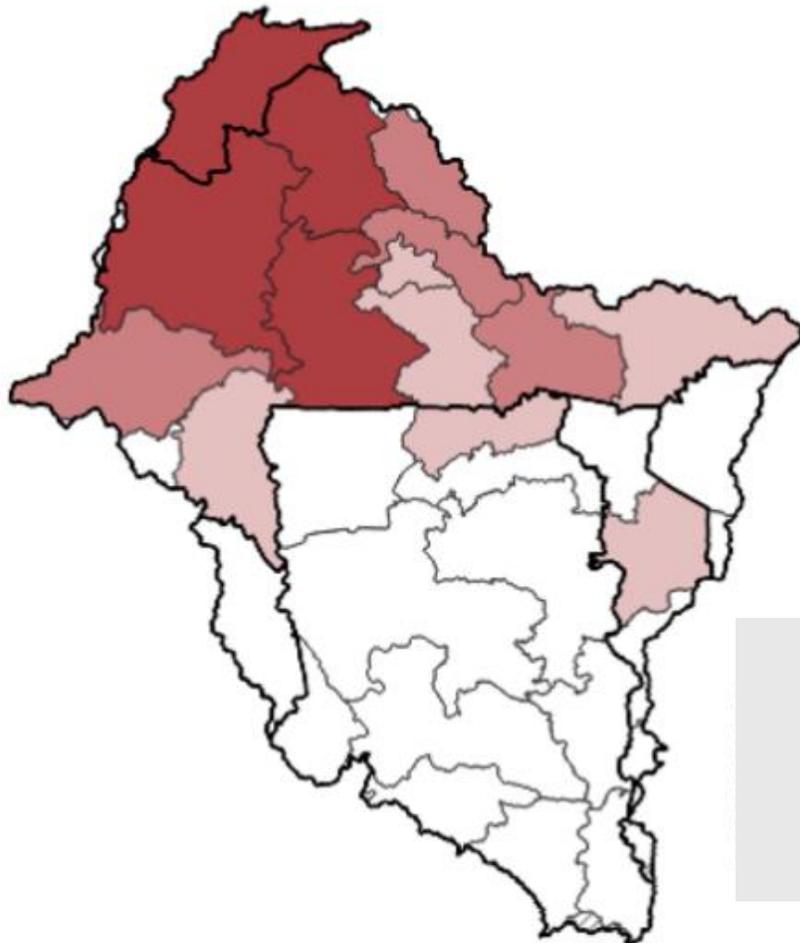
➤ **DROUGHTS**

Absolute Number in Current Climate Conditions

Current risk

Animals [units/y]

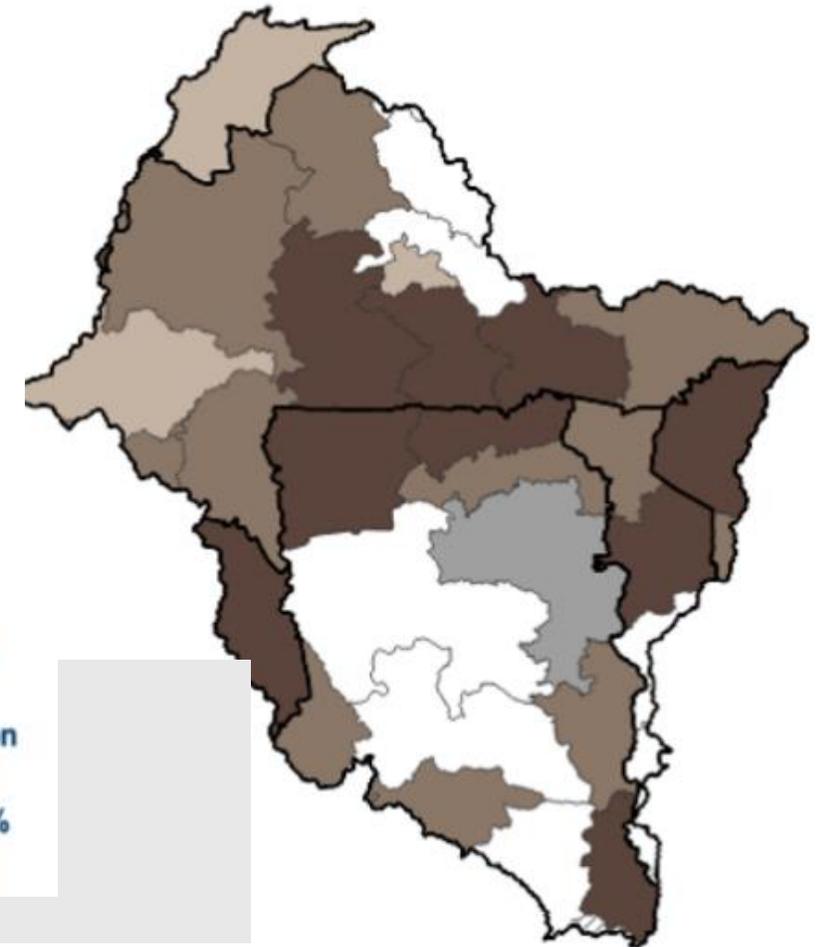
- 0 - 100'000
- 100'000 - 250'000
- 250'000 - 500'000
- 500'000 - 750'000
- 750'000 - 1'500'000



Anomaly in Projected Climate Conditions

Change
RCP6.0

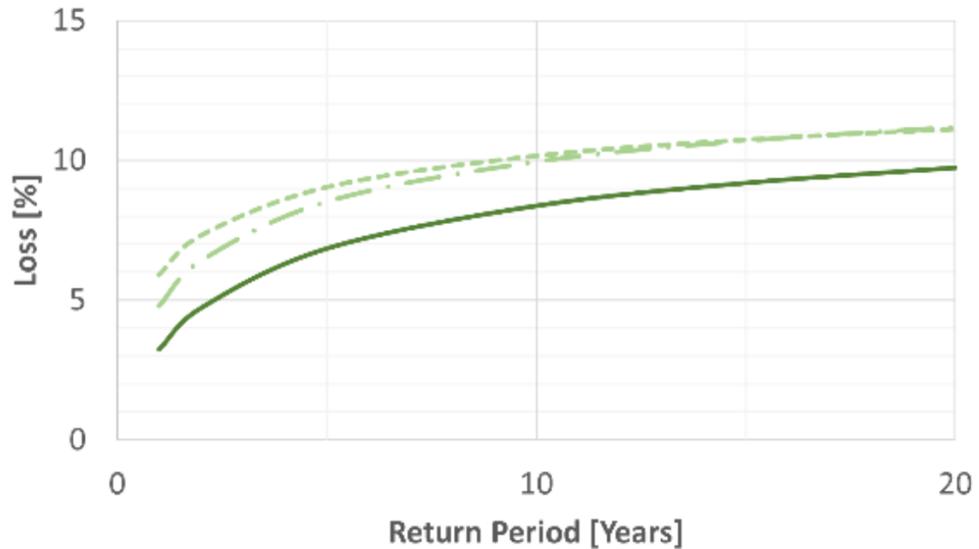
- Reduced by > 100%
- Reduced 50% - 100%
- Reduced 25% - 50%
- No important variation
- Increased 25% - 50%
- Increased 50% - 100%
- Increased by > 100%



CAMBODIA: Drought-induced rice production loss



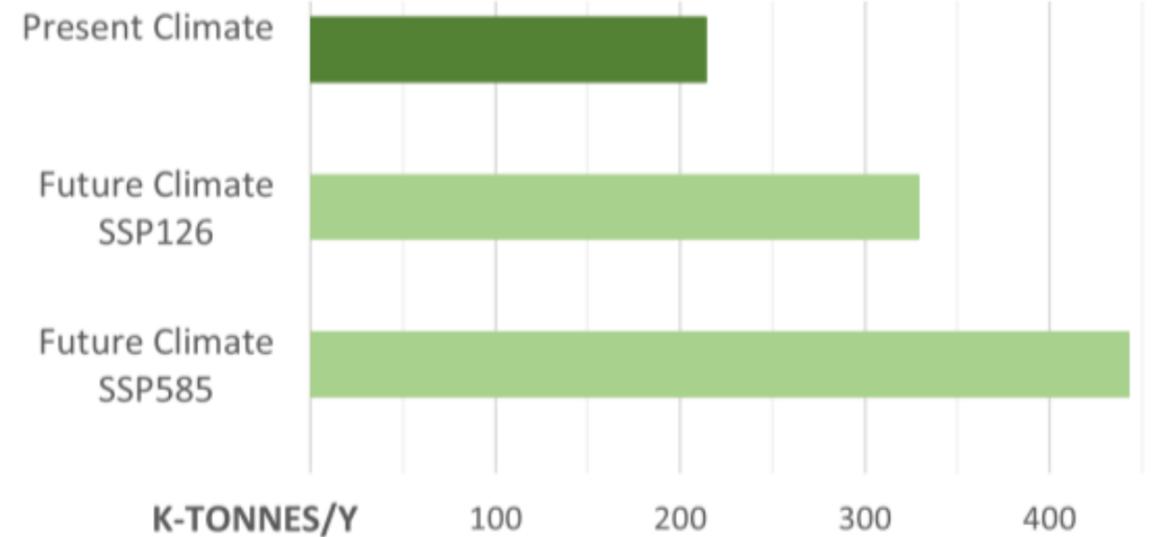
PROBABLE MAXIMUM LOSS CURVE OF RICE YIELD REDUCTION



— POP 2020 - Current Climate
- - POP 2050, SSP126 - Projected
- · - POP 2050, SSP585 - Projected



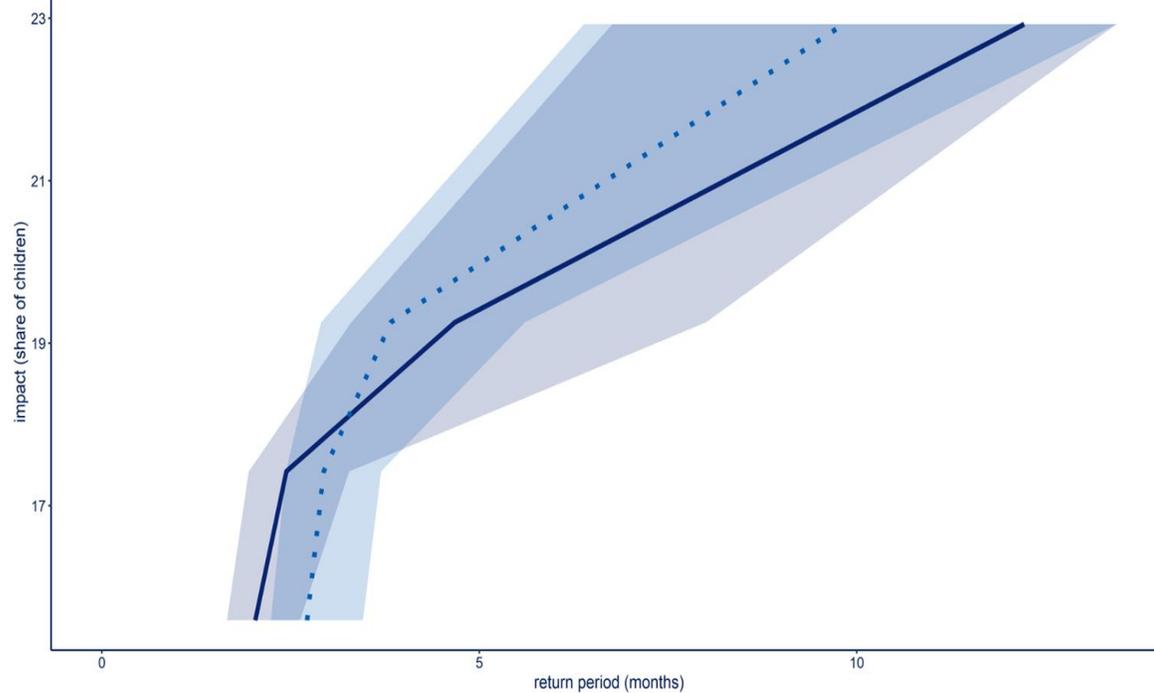
ANNUAL AVERAGE RICE PRODUCTION LOSS



KENYA: Drought risk for children



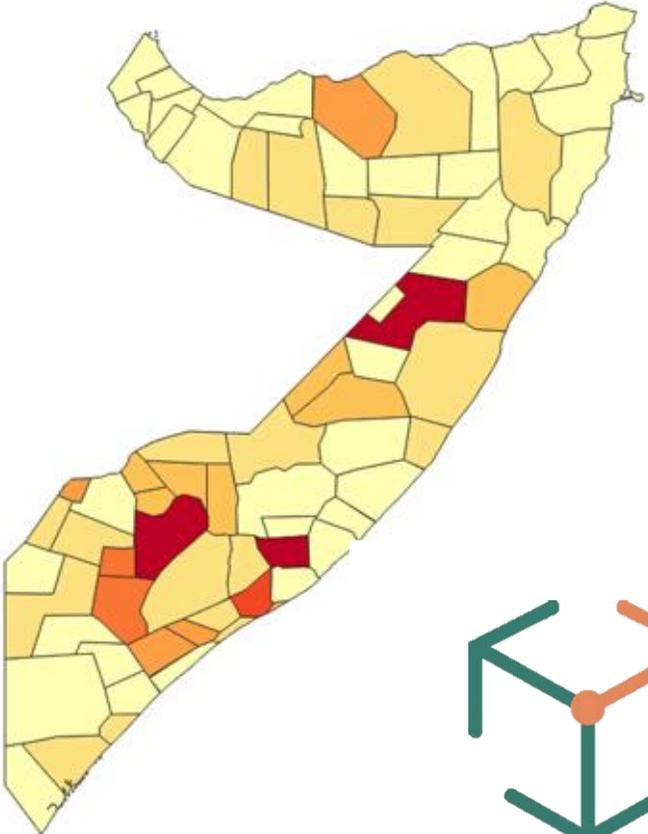
Child malnutrition - increases caused by droughts



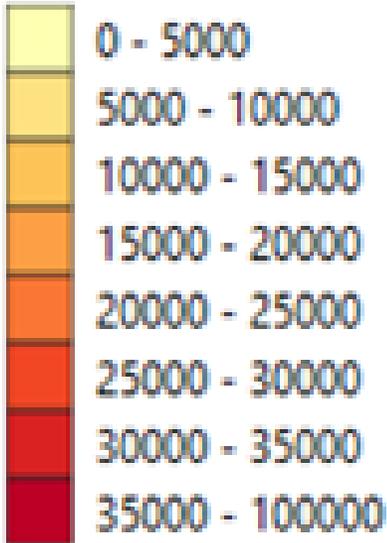
EVERY CHILD SURVIVES AND THRIVES 	EVERY CHILD LEARNS 	EVERY CHILD IS PROTECTED FROM VIOLENCE AND EXPLOITATION 	EVERY CHILD LIVES IN A SAFE AND CLEAN ENVIRONMENT 	EVERY CHILD HAS AN EQUILIBABLE CHANCE OF LIFE
CROP LOSSES 	SCHOOL DROPOUT 	EXPOSED LIVESTOCK AND CONFLICTS 	CHILDREN AFFECTED 	DROUGHT EFFECT ON CHILD MARRIAGE
LIVESTOCK AFFECTED 			WALKING DISTANCES TO WATER SOURCES 	
FOOD SECURITY 			CHOLERA CASES 	
FOOD ASSISTANCE 				

SOMALIA: Drought-induced internally displaced people

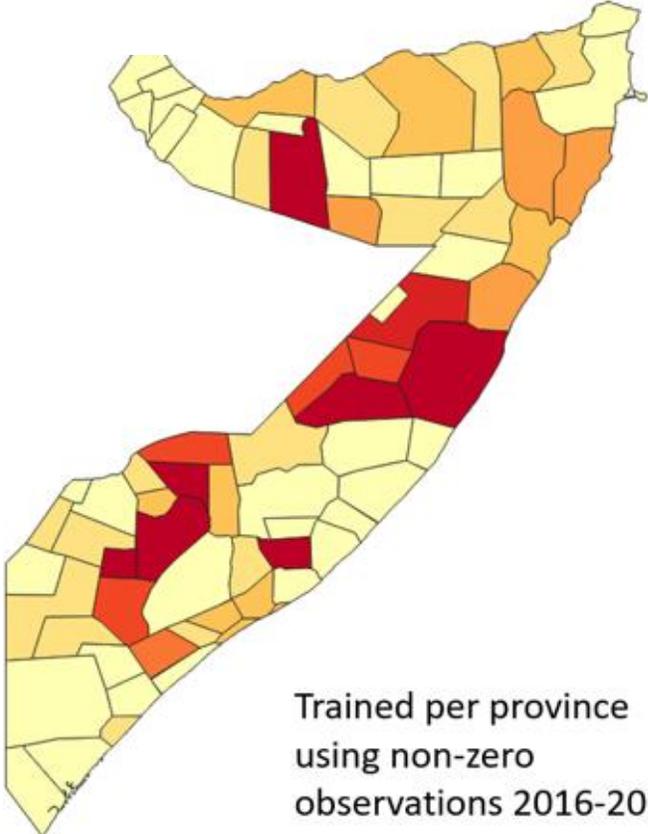
Current climate conditions



No. IDP



SSP585



Trained per province using non-zero observations 2016-2022

Defining drought

- Identifying hydro-meteorological conditions (indicators, thresholds) leading to an **impactful** drought disaster

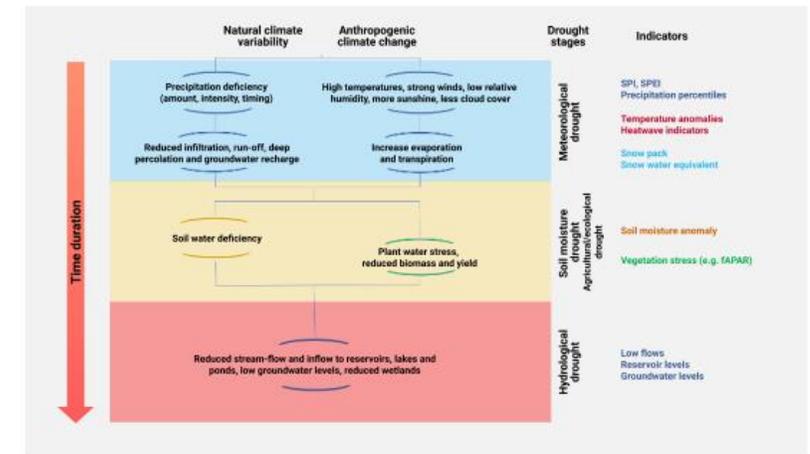
Combine hazard data with binary impact data using Machine Learning

Include effect of both flash and megadroughts

Include local vulnerability

- Historic and future **frequency** of drought-related events known to cause a direct impact (the LOI, likelihood of impact)

Figure 1.1. Schematic representation of drought propagation through the hydrological cycle, related drought stages and key indicators



Quantifying drought impact

❖ Yearly production data E.G. Maize yield kg /

Detrended (technologic development)

Different damages (% reductions)

Check with recorded droughts

❖ Yearly yield loss E.G.

Binary: years with -5%, -15%, -30%

Table 1.4. Main sectors affected by droughts

Environment (e.g. forests, wildfires, wetlands, biodiversity)

Drought affects the environment in many ways. Plants and animals depend on water; under drought conditions, their food supply can shrink and their habitat can be damaged. Sometimes, the damage is only temporary and their habitat and food supply return to normal when the drought is over. But other times, drought impacts on the environment can endure or may lead to permanent land and ecosystem degradation or desertification.

Agriculture (including crop and livestock production) and forestry

Agriculture can be adversely affected if a drought damages crops and other related losses. Farmers may spend more money due to increasing irrigation costs, drilling new wells or feeding and providing water to their animals. Industries linked with farming activities, such as companies that produce tractors and food, may lose business. Forestry is affected by reduced fibre production and increased vulnerability to pests and insect attacks (e.g. bark beetle).

Public water supply

Drought conditions decrease water supply and increase demand for various uses (e.g. industrial, agriculture, residential, sanitation and wastewater management). Co-occurrence with heatwaves can aggravate impacts due to increased demand. Reductions in the available quantity of water can have secondary effects on water quality due to reduced dilution of pollutants.

Power generation: hydro, thermal and nuclear

Hydroelectricity production depends on river flow or water stored in upstream reservoirs. Consequently, the production level can be lower during a drought. Peak demands for electricity then need to be satisfied by other means available (e.g. gas turbines). The amount of losses depends on hydroelectricity infrastructure and drought severity. Reduced availability of cooling water can force the reduction of power generation and even shutdown of thermal or nuclear power plants during droughts.

Buildings and infrastructure

Soils swell and shrink with moisture changes, depending on their composition. Serious damage to buildings and infrastructure can occur if soil shrinkage is pronounced under drought conditions. For instance, in France, soil subsidence has caused as much damage as floods in recent years. The effects of drought can be aggravated due to aquifer overexploitation.

Tourism and recreation

Droughts can bring critical losses, as many activities in the tourism sector are water related. Droughts might affect summer and winter activities.

Commercial shipping

During low-flow conditions, barges and ships may have difficulty in navigating streams, rivers and canals, which affects businesses that depend on water transportation for receiving or delivering goods and materials. People may pay higher prices for food or fuel as a result.

Industry

A water deficit induced by droughts affects production, sales and business in a variety of sectors such as agriculture, energy production and water-intensive industries.

Social impacts

Welfare changes experienced by humans should be included in relief packages to mitigate socioeconomic impacts of drought. The social impacts of drought can affect people's health and safety, lead to a poverty trap, cause conflict between people when water restrictions are required and may result in changes in lifestyle.

Source: Adapted from Voot et al. (2018)

Hazard-impact analysis – decision tree

❖ Binary classification algorithm :
loss (e.g. -10% reduction) vs normal yield

❖ The paths from root to leaf represent classification rules
*if SPEI < -1 and SSFI < -0,5 or
if SSMI < -1,5 then yield loss*

❖ Through entropy reduction, algorithms automatically search for most accurate trees (low misses and false alarms)

