Development of a global-scale multi-sectoral forecasting system for drought hazards

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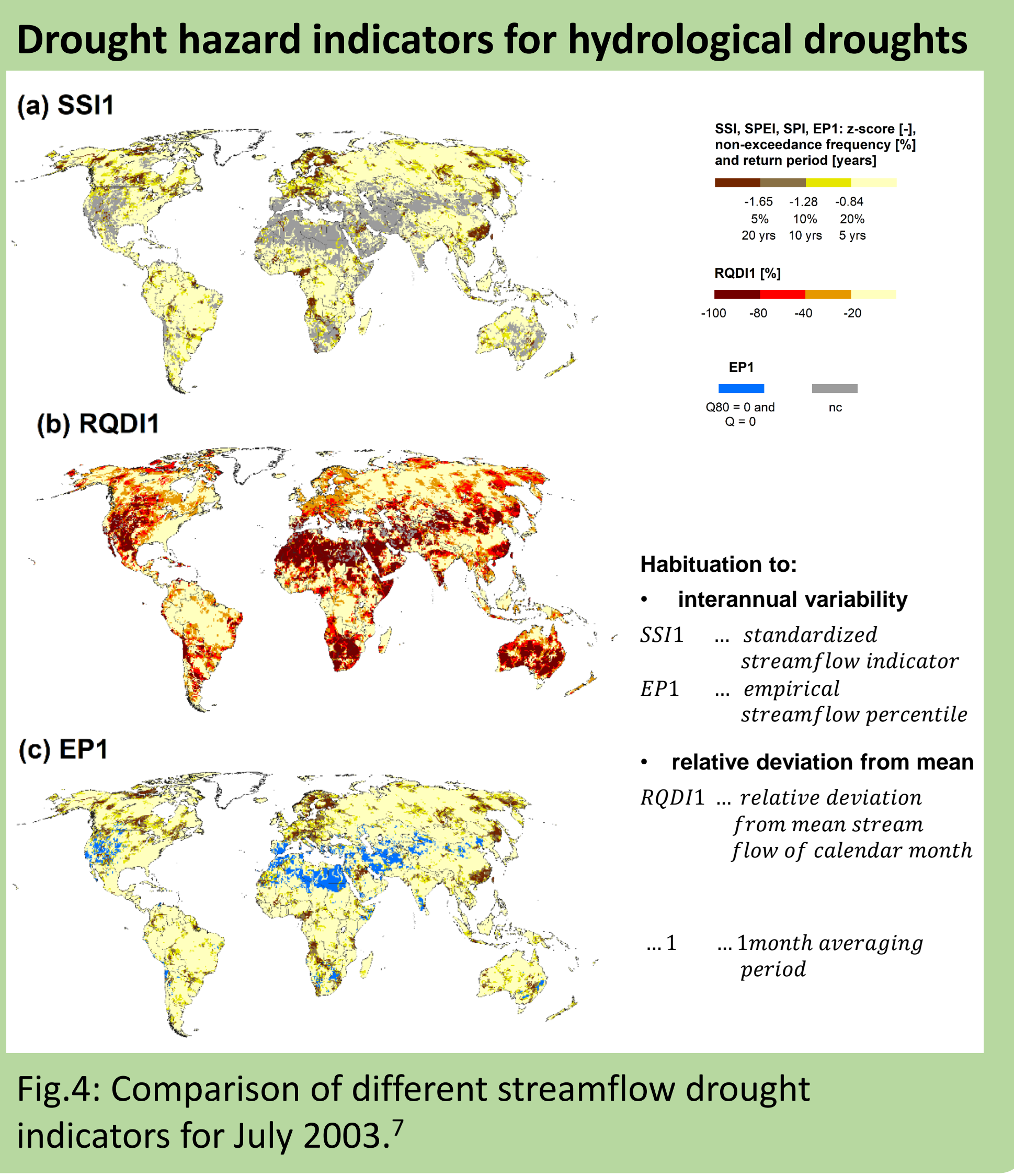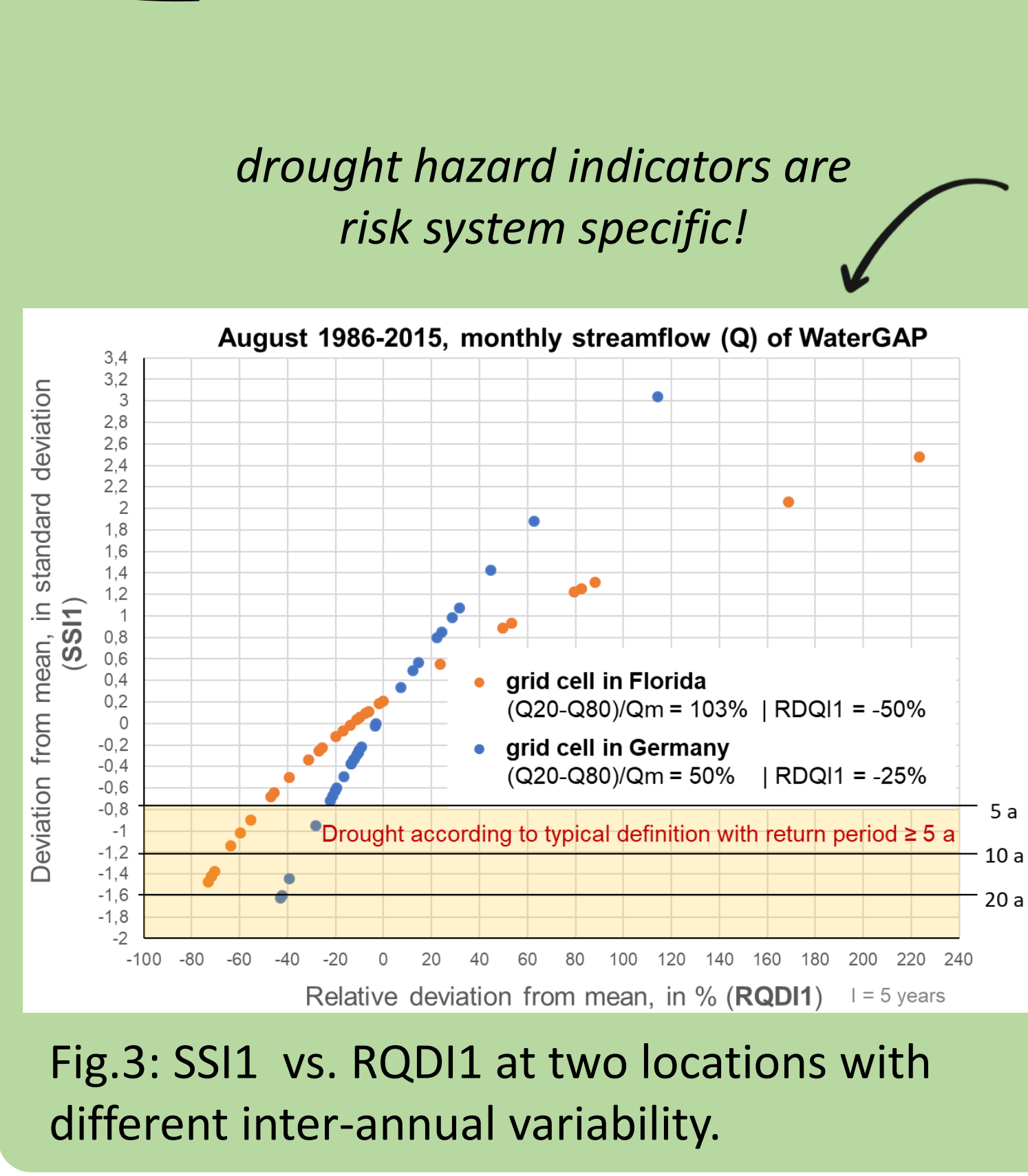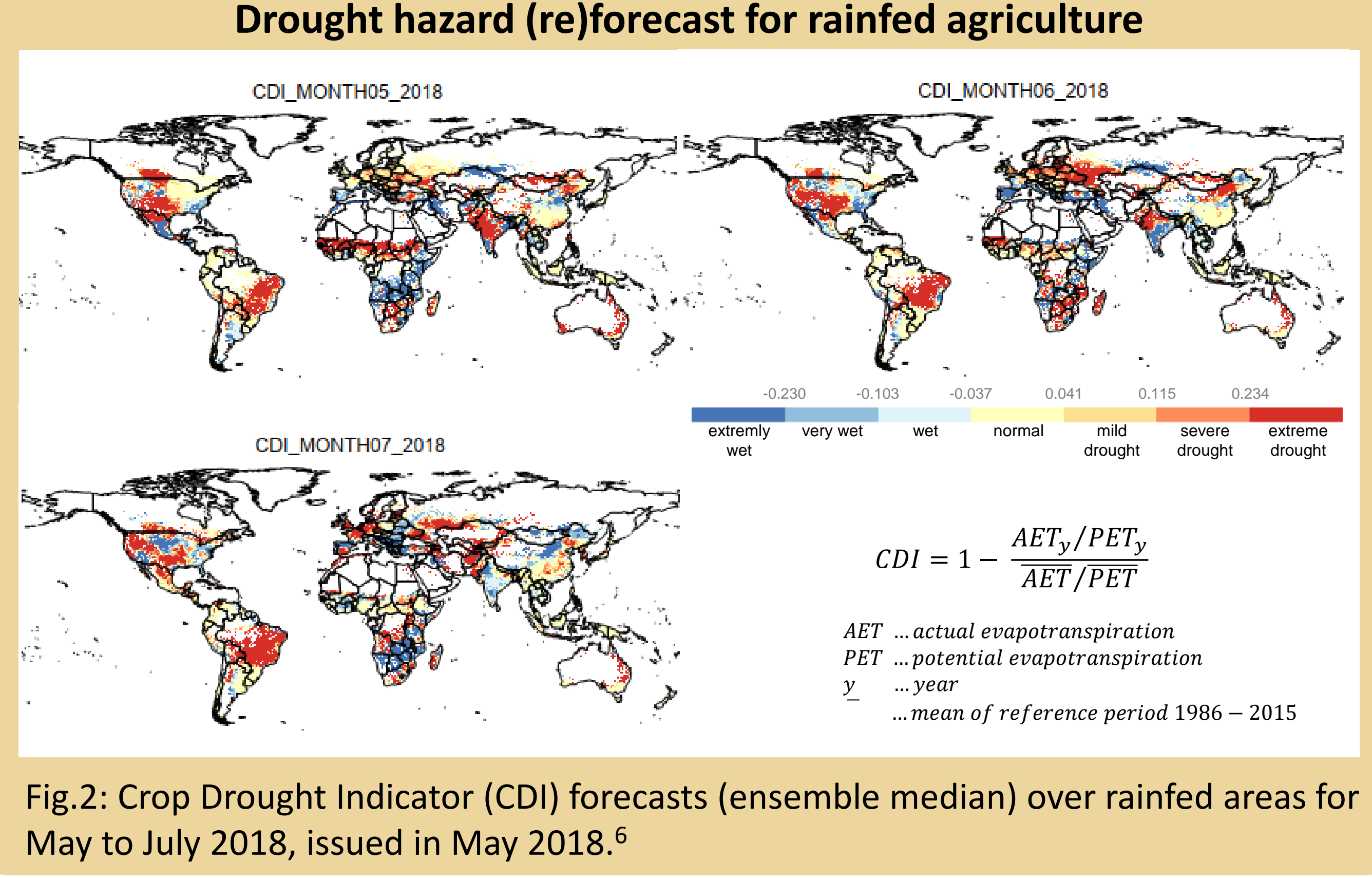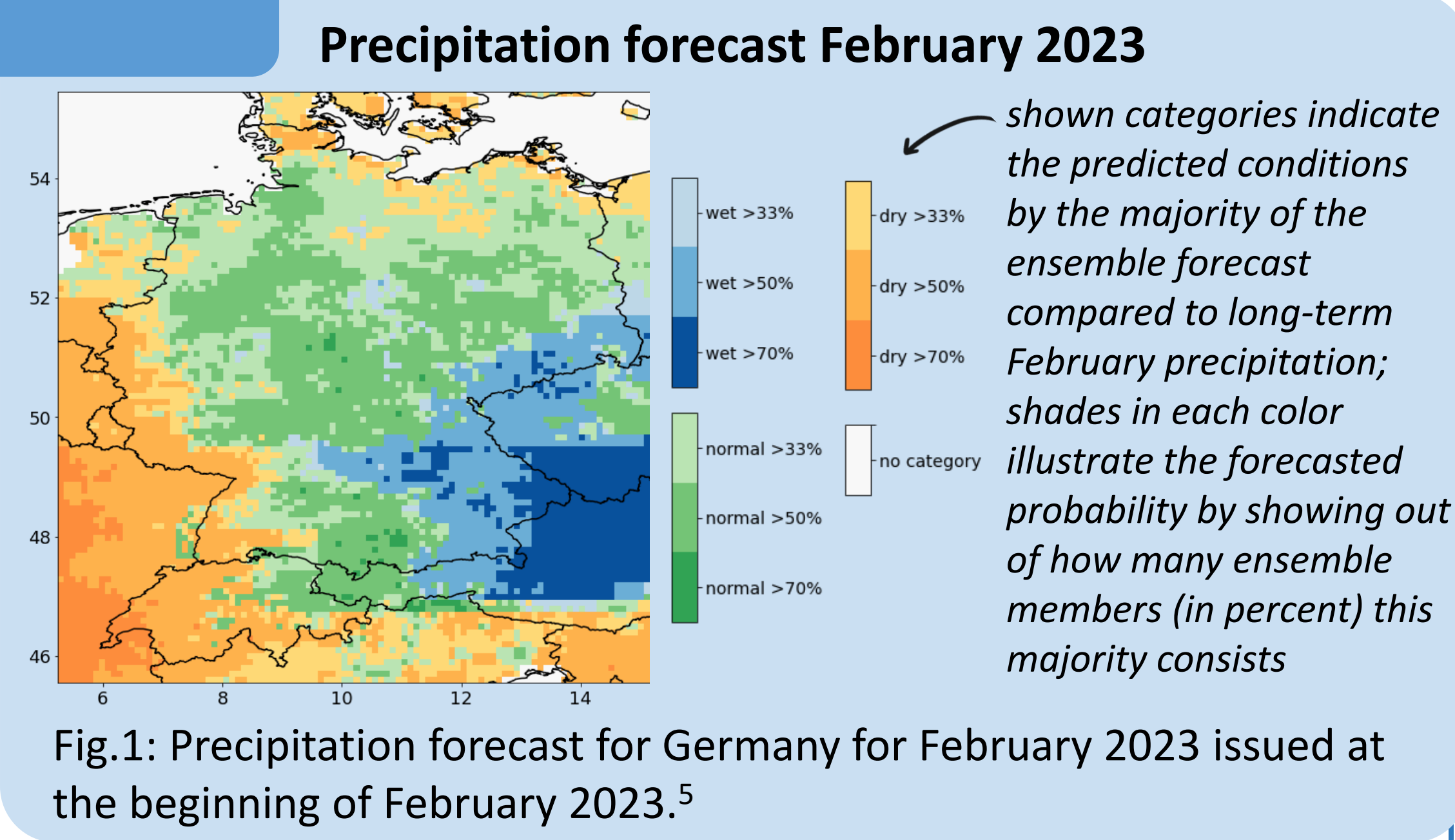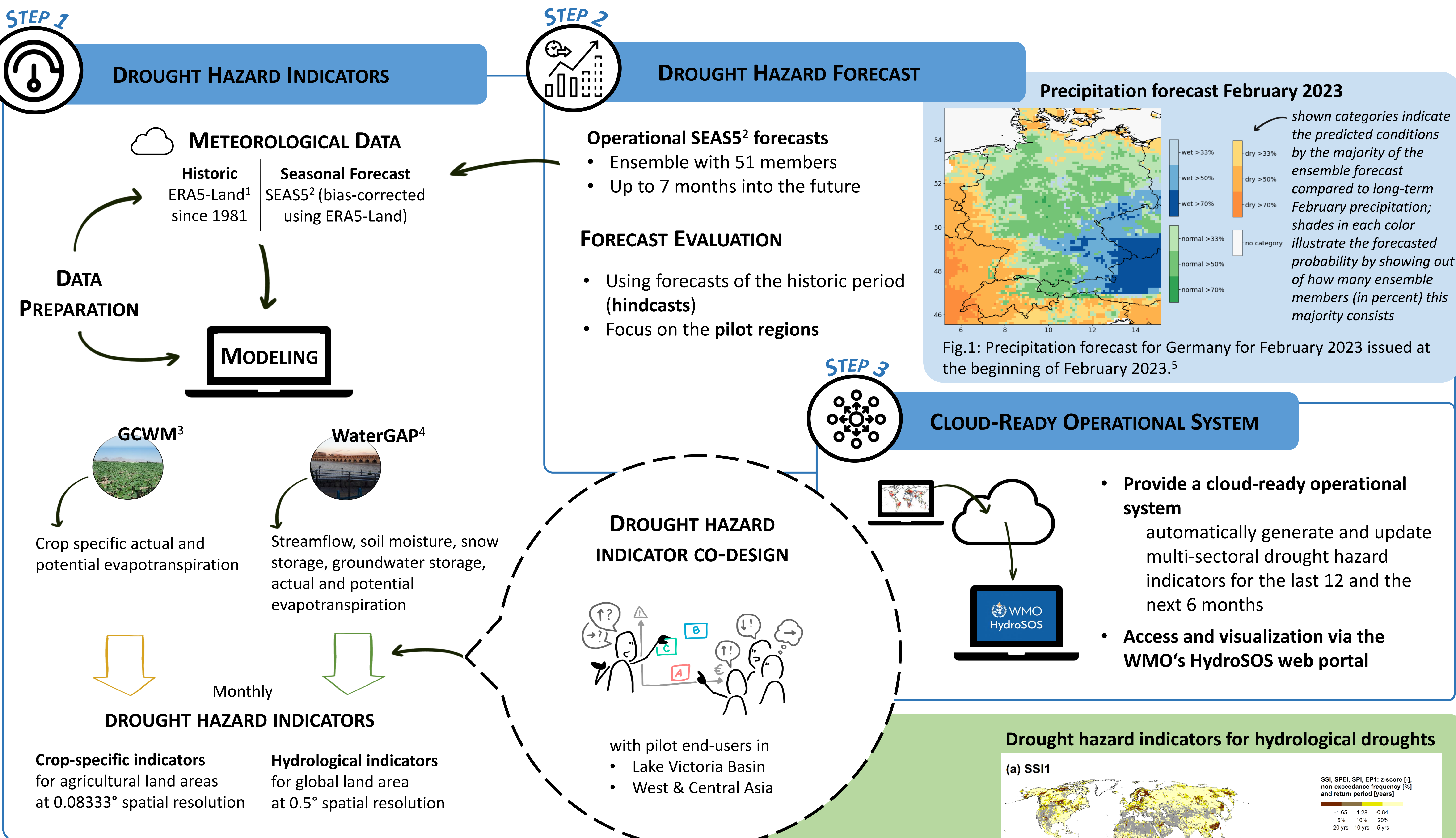
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BACKGROUND

Drought = less water than normal AND less water than required

- **Drought events have become more common** in recent years across all continents
- Drought affects water supply, agriculture, but also terrestrial and aquatic ecosystems
- **Information** on droughts in the last and upcoming months can support drought managment but **is not available in data-scarce and vulnerable regions**

OBJECTIVE

- Develop the first **global, multi-sectoral and operational drought forecasting system** to quantify drought hazards in

  1) Water supply
  2) Riverine ecosystems
  3) Non-agricultural land ecosystems
  4) Rainfed agriculture
  5) Irrigated agriculture

- Implement the system **as component of the Global Hydrological Status and Outlook System (HydroSOS)** of the World Meteorological Organization (WMO)

STEP 1

DROUGHT HAZARD INDICATORS

METEOROLOGICAL DATA

Historic
ERA5-Land[1]
since 1981

Seasonal Forecast
SEAS5[2] (bias-corrected using ERA5-Land)

DATA PREPARATION

MODELING

GCWM[3]

WaterGAP[4]

Crop specific actual and potential evapotranspiration

Streamflow, soil moisture, snow storage, groundwater storage, actual and potential evapotranspiration

Monthly

DROUGHT HAZARD INDICATORS

Crop-specific indicators
for agricultural land areas
at 0.08333° spatial resolution

Hydrological indicators
for global land area
at 0.5° spatial resolution

STEP 2

DROUGHT HAZARD FORECAST

Operational SEAS5[2] forecasts
- Ensemble with 51 members
- Up to 7 months into the future

FORECAST EVALUATION

- Using forecasts of the historic period (**hindcasts**)
- Focus on the **pilot regions**

Precipitation forecast February 2023

shown categories indicate the predicted conditions by the majority of the ensemble forecast compared to long-term February precipitation; shades in each color illustrate the forecasted probability by showing out of how many ensemble members (in percent) this majority consists

Fig.1: Precipitation forecast for Germany for February 2023 issued at the beginning of February 2023.[5]

DROUGHT HAZARD INDICATOR CO-DESIGN

with pilot end-users in
- Lake Victoria Basin
- West & Central Asia

STEP 3

CLOUD-READY OPERATIONAL SYSTEM

- **Provide a cloud-ready operational system**
  automatically generate and update multi-sectoral drought hazard indicators for the last 12 and the next 6 months
- **Access and visualization via the WMO's HydroSOS web portal**

Drought hazard indicators for hydrological droughts

(a) SSI1
(b) RQDI1
(c) EP1

Habituation to:
- **interannual variability**
  SSI1 ... standardized streamflow indicator
  EP1 ... empirical streamflow percentile
- **relative deviation from mean**
  RQDI1 ... relative deviation from mean stream flow of calendar month

... 1 ... 1month averaging period

Fig.4: Comparison of different streamflow drought indicators for July 2003.[7]

Drought hazard (re)forecast for rainfed agriculture

$$CDI = 1 - \frac{AET_y/PET_y}{\overline{AET/PET}}$$

AET ... actual evapotranspiration
PET ... potential evapotranspiration
y ... year
$\overline{}$ ... mean of reference period $1986 - 2015$

Fig.2: Crop Drought Indicator (CDI) forecasts (ensemble median) over rainfed areas for May to July 2018, issued in May 2018.[6]

drought hazard indicators are risk system specific!

Fig.3: SSI1 vs. RQDI1 at two locations with different inter-annual variability.

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