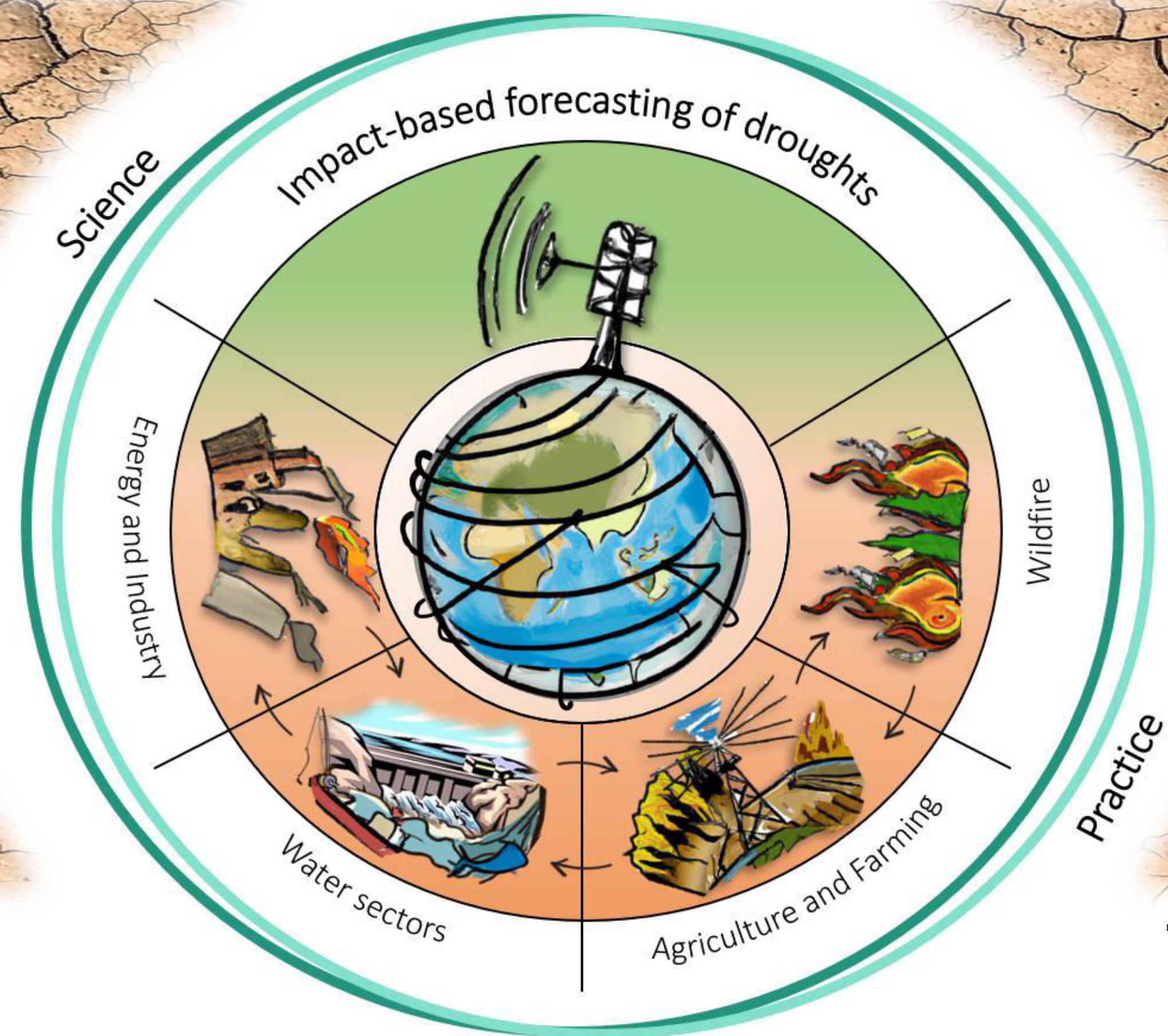




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# Advances and gaps in the science and practice of impact-based forecasting of droughts



Anastasiya Shyrokaya<sup>1</sup>, Giuliano Di Baldassarre<sup>1</sup>, Florian Pappenberger<sup>2</sup>, Gabriele Messori<sup>1</sup>, Ilias Pechlivanidis<sup>3</sup>, Sina Khatami<sup>1</sup>, Maurizio Mazzoleni<sup>4</sup>

<sup>1</sup> CNDS, Department of Earth Sciences, Uppsala University, Sweden;

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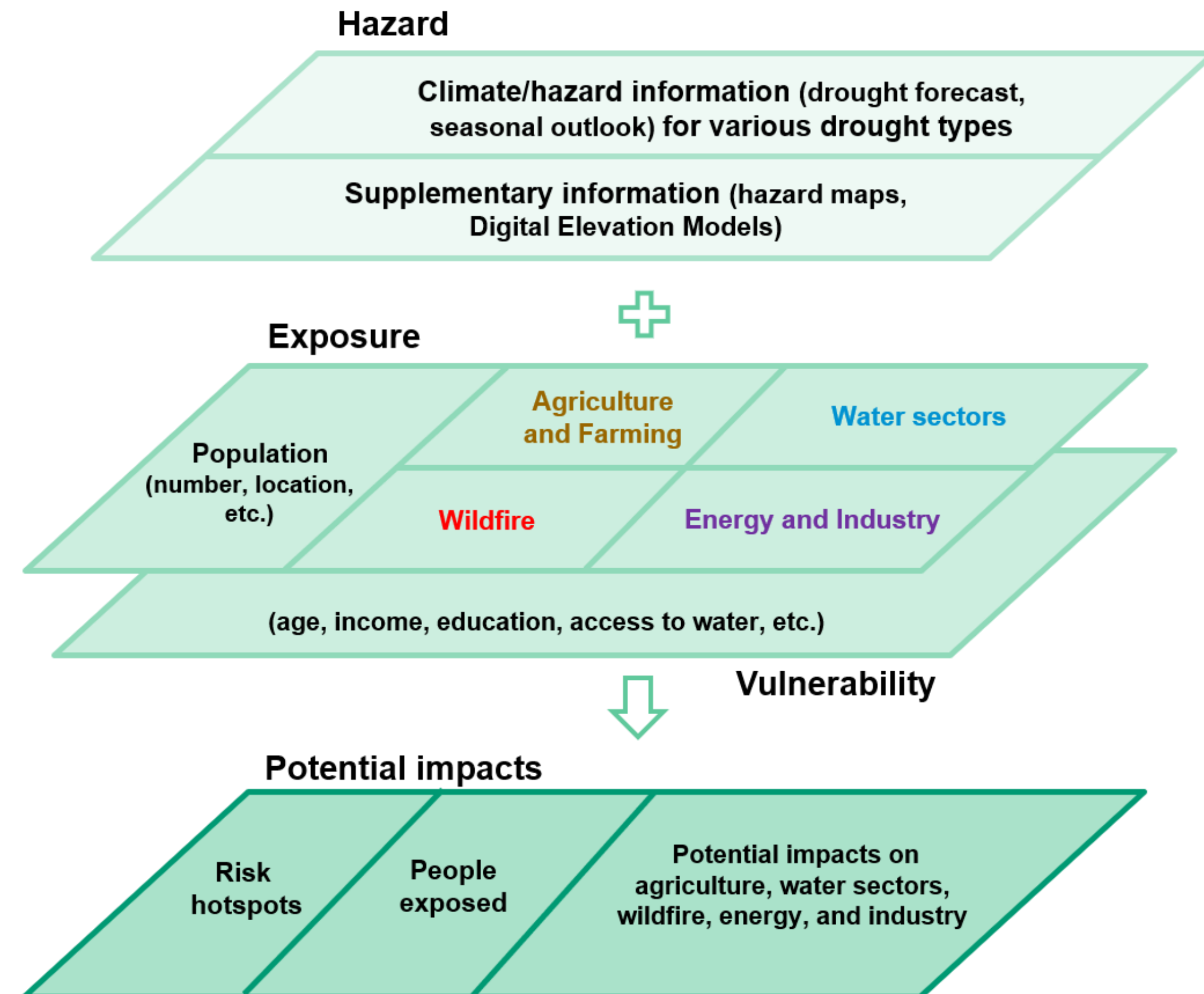
<sup>4</sup> Institute for Environmental Studies, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands;



# Introduction – drought IbF

Impact-based forecasting (IbF) of droughts:

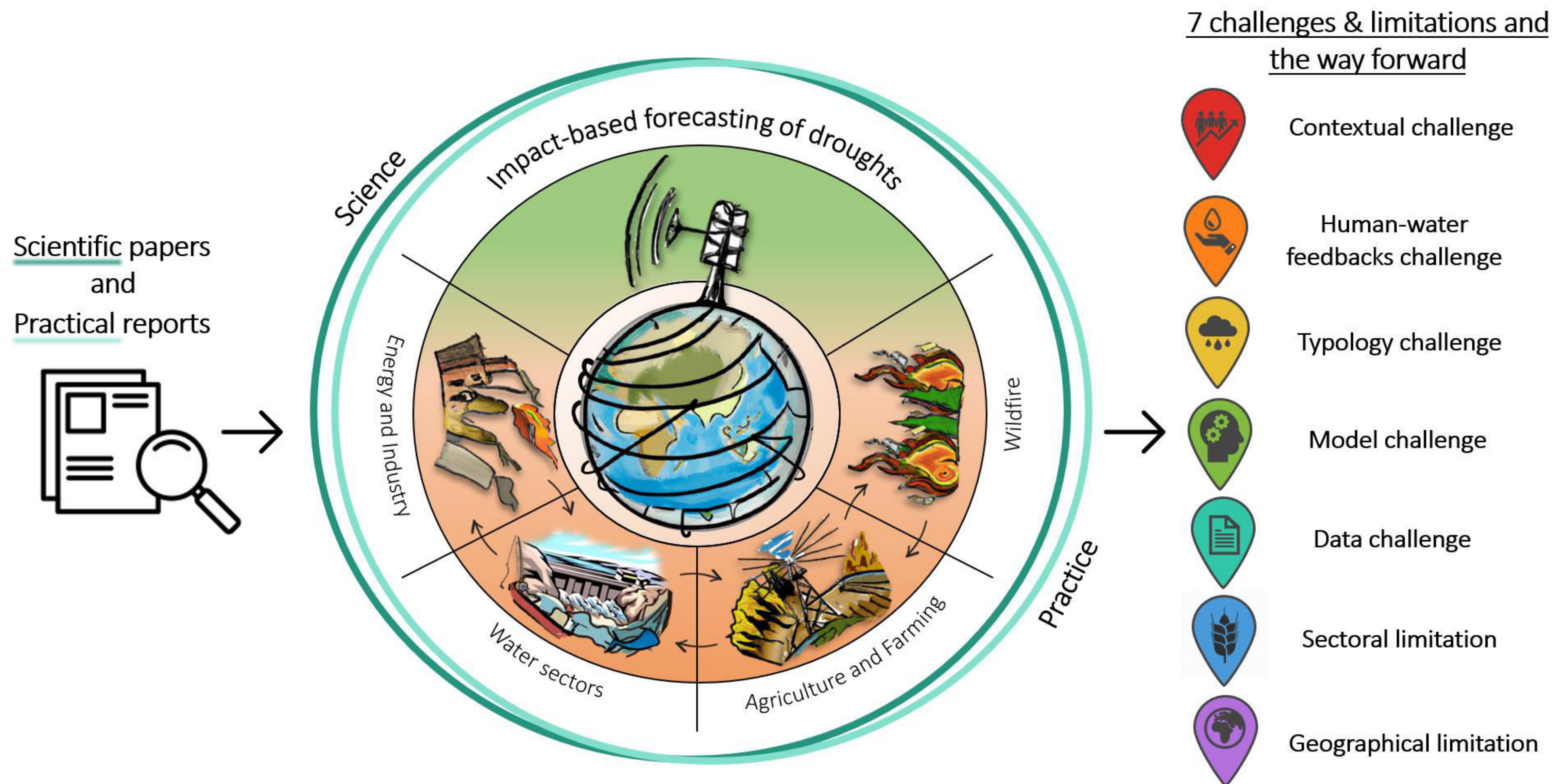
- forecasting impact, not only hazard;
- identify most vulnerable areas and prioritize the aid;
- forecasting of drought impacts is still lacking in DEWSs (Drought Early-Warning Systems);
- IbF emerging field in science & practice;



[ Fig.1, Shyrokaya, A., Pappenberger, F., Pechlivanidis, I., Messori, G., Khatami, S., Mazzoleni, M., Di Baldassarre, G. Advances and gaps in the science and practice of impact-based forecasting of droughts, WIREs Water (*in review*) ]



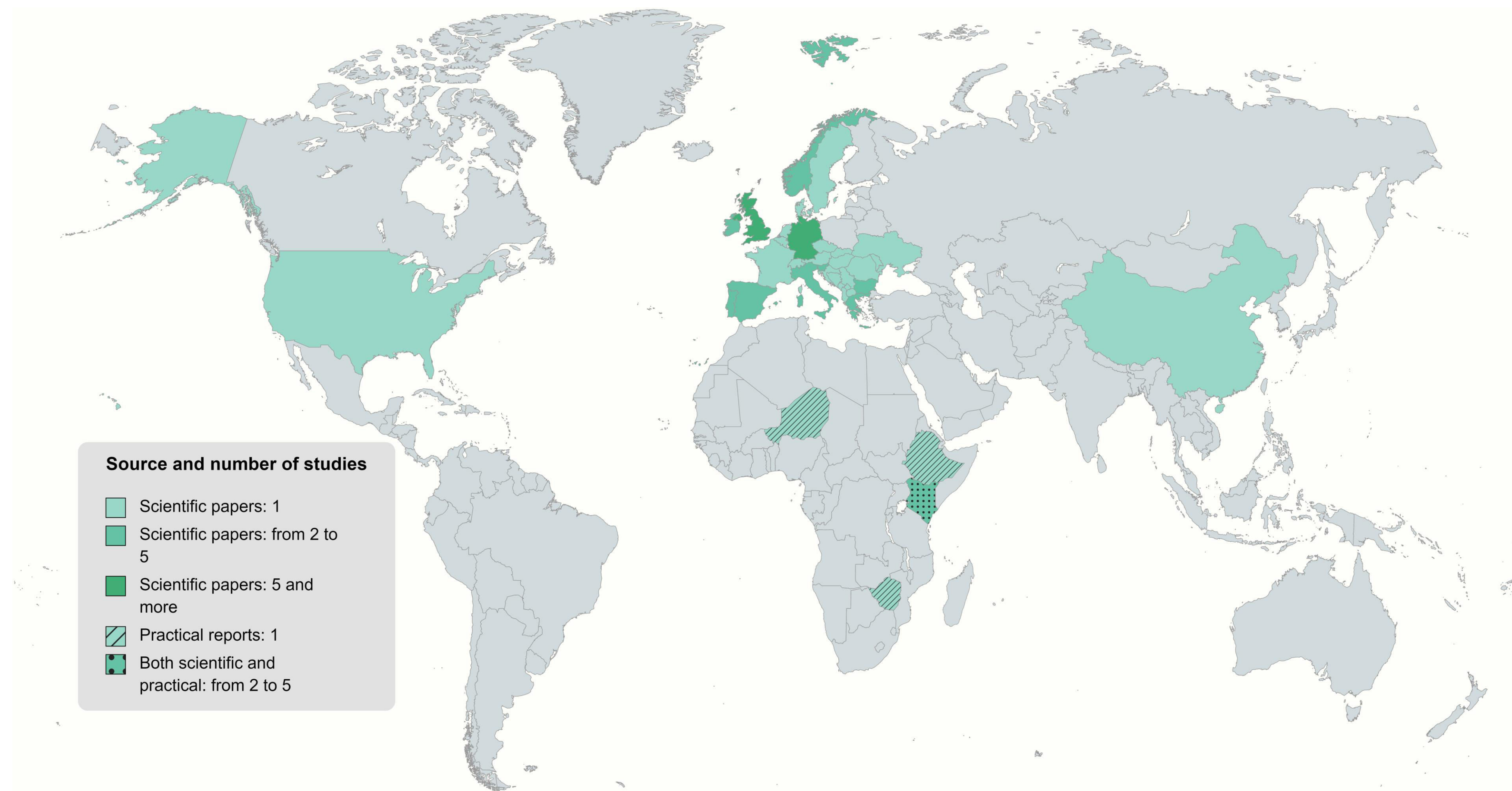
# Overview – drought IbF





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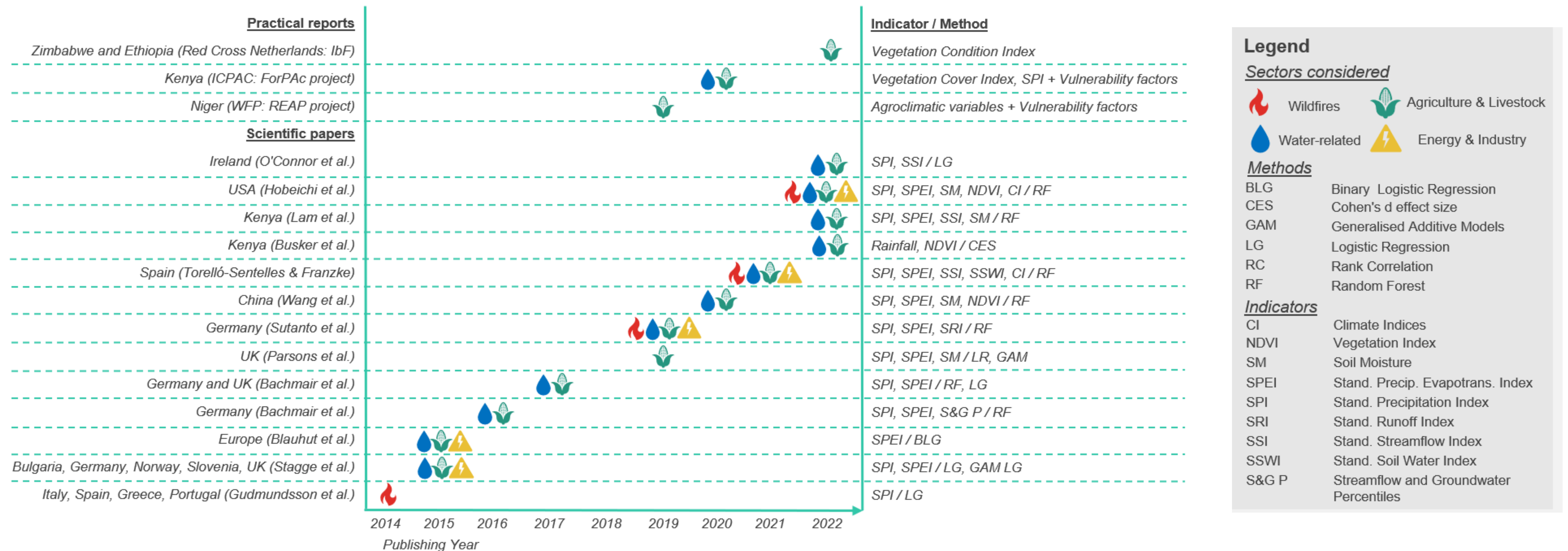
The evolution of the drought IbF in scientific and practical literature across multiple criteria  
(geographical distribution, temporal scale, sectors, IbF methods, drought indices)



[ Fig.2, Shyrokaya, A., Pappenberger, F., Pechlivanidis, I., Messori, G., Khatami, S., Mazzoleni, M., Di Baldassarre, G. Advances and gaps in the science and practice of impact-based forecasting of droughts, WIREs Water (*in review*) ]

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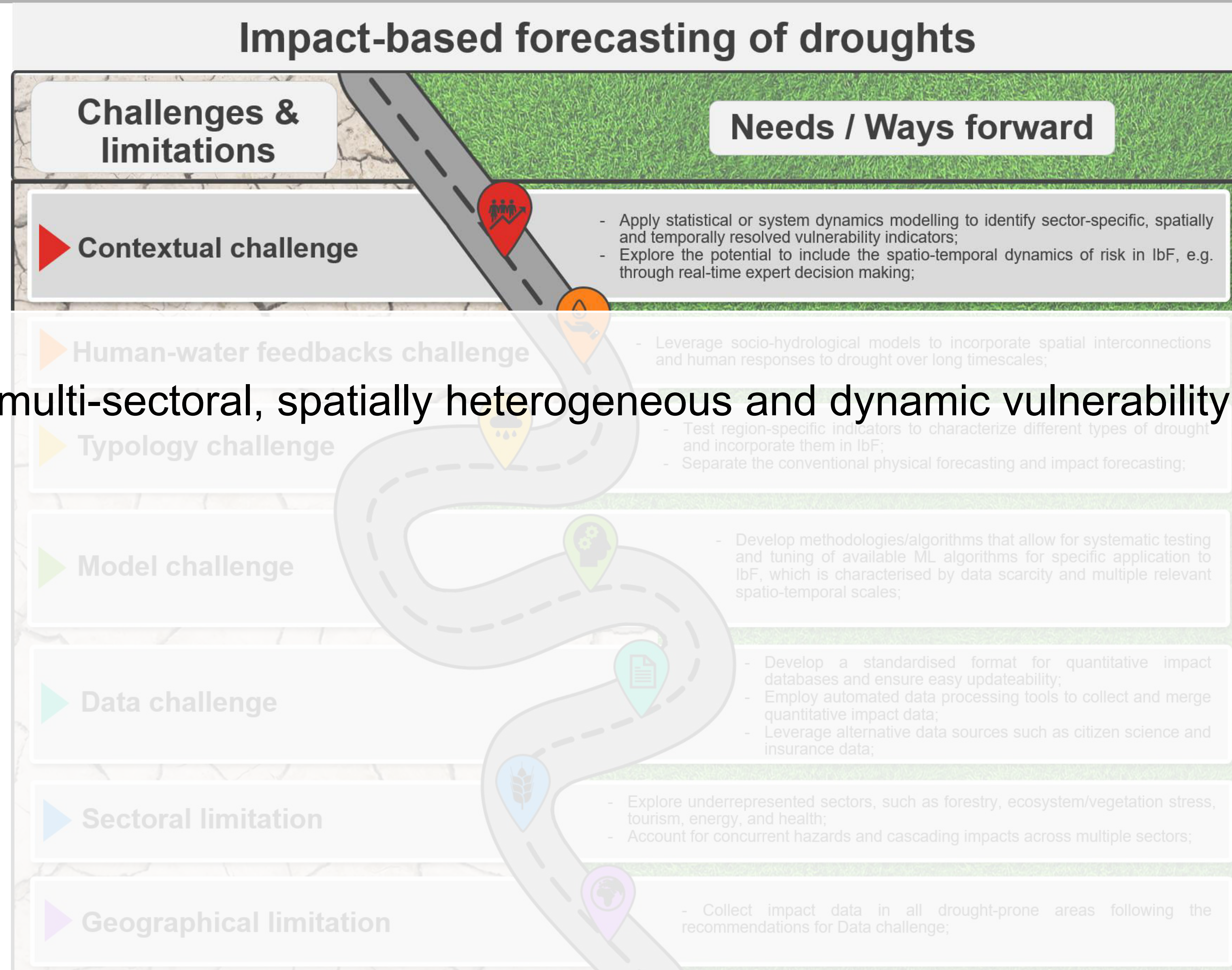
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# Challenges & ways forward – drought IbF



- account for multi-sectoral, spatially heterogeneous and dynamic vulnerability and exposure



# Challenges & ways forward – drought IbF

## Impact-based forecasting of droughts

### Challenges & limitations

### Needs / Ways forward

#### Contextual challenge

- Apply statistical or system dynamics modelling to identify sector-specific, spatially and temporally resolved vulnerability indicators;
- Explore the potential to include the spatio-temporal dynamics of risk in IbF, e.g. through real-time expert decision making;

#### Human-water feedbacks challenge

- Leverage socio-hydrological models to incorporate spatial interconnections and human responses to drought over long timescales;

#### Typology challenge

- Test region-specific indicators to characterize different types of drought and incorporate them in IbF;
- Separate the conventional physical forecasting and impact forecasting;

#### Model challenge

- Develop methodologies/algorithms that allow for systematic testing and tuning of available ML algorithms for specific application to IbF, which is characterised by data scarcity and multiple relevant spatio-temporal scales;

#### Data challenge

- Develop a standardised format for quantitative impact databases and ensure easy updateability;
- Employ automated data processing tools to collect and merge quantitative impact data;
- Leverage alternative data sources such as citizen science and insurance data;

#### Sectoral limitation

- Explore underrepresented sectors, such as forestry, ecosystem/vegetation stress, tourism, energy, and health;
- Account for concurrent hazards and cascading impacts across multiple sectors;

#### Geographical limitation

- Collect impact data in all drought-prone areas following the recommendations for Data challenge;

- consider how human activities influence the propagation of drought



# Challenges & ways forward – drought IbF

## Impact-based forecasting of droughts

### Challenges & limitations

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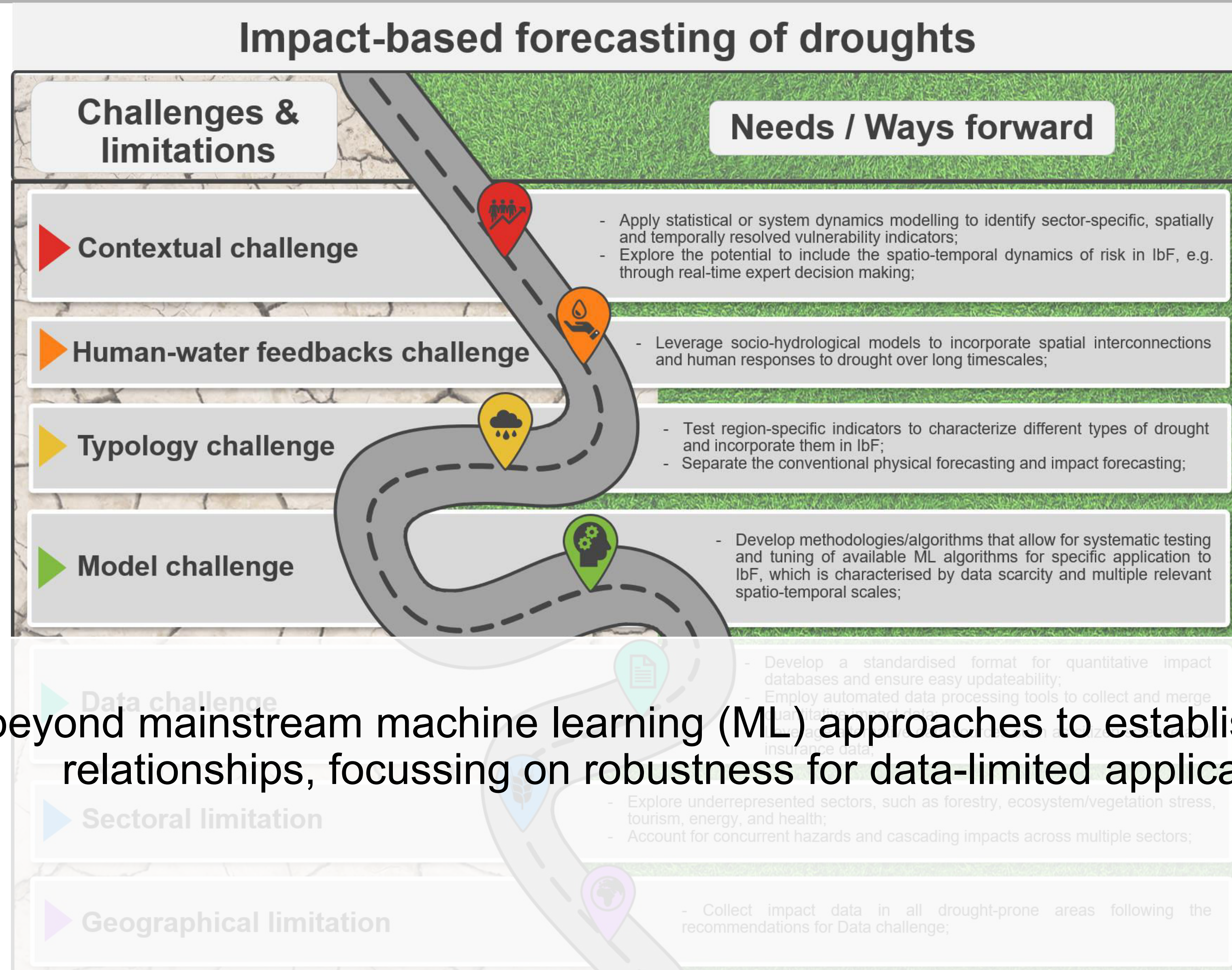
#### Geographical limitation

- Collect impact data in all drought-prone areas following the recommendations for Data challenge;

- avoid oversimplification of drought typology to meteorological drought



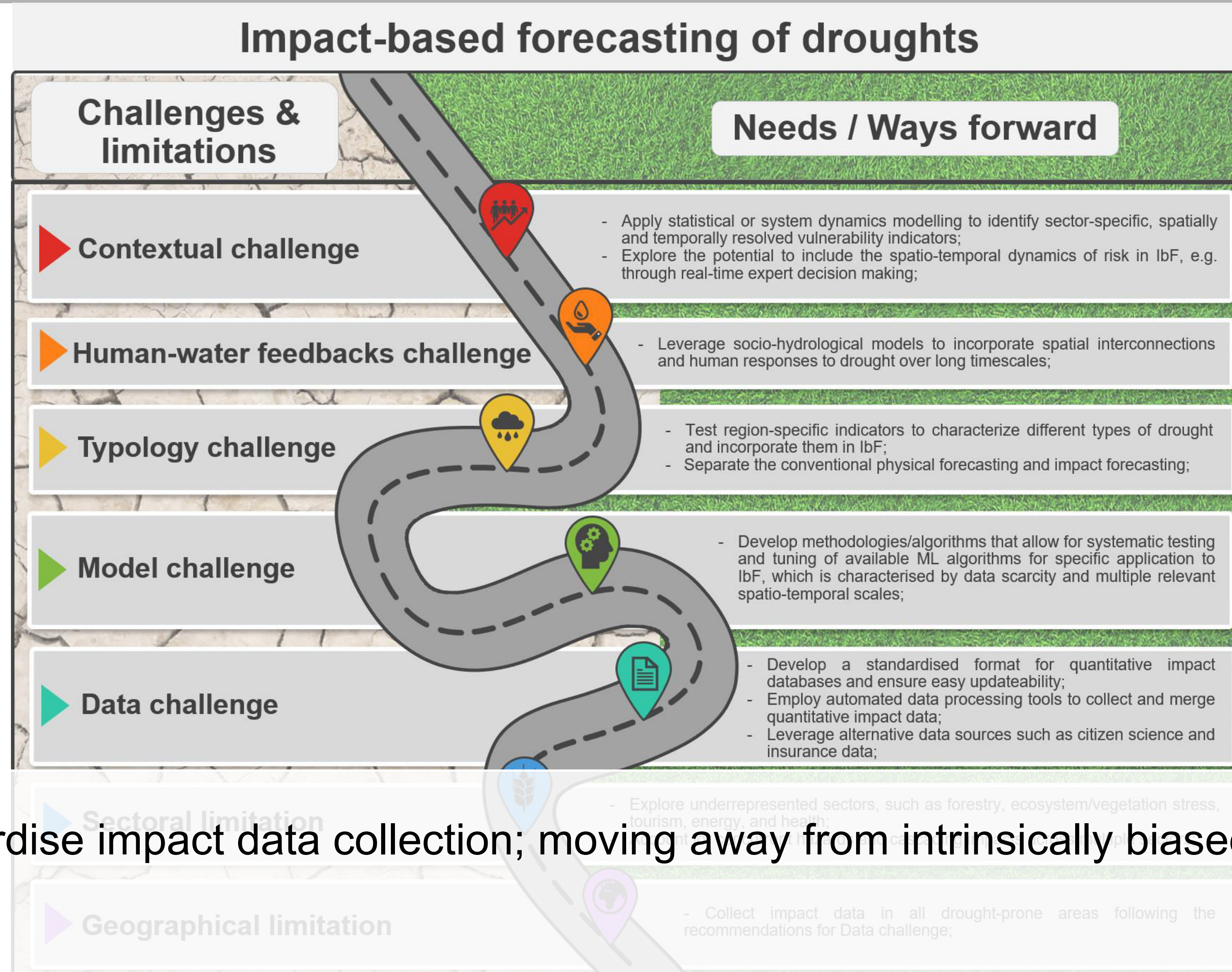
# Challenges & ways forward – drought IbF



- go beyond mainstream machine learning (ML) approaches to establish functional relationships, focussing on robustness for data-limited applications



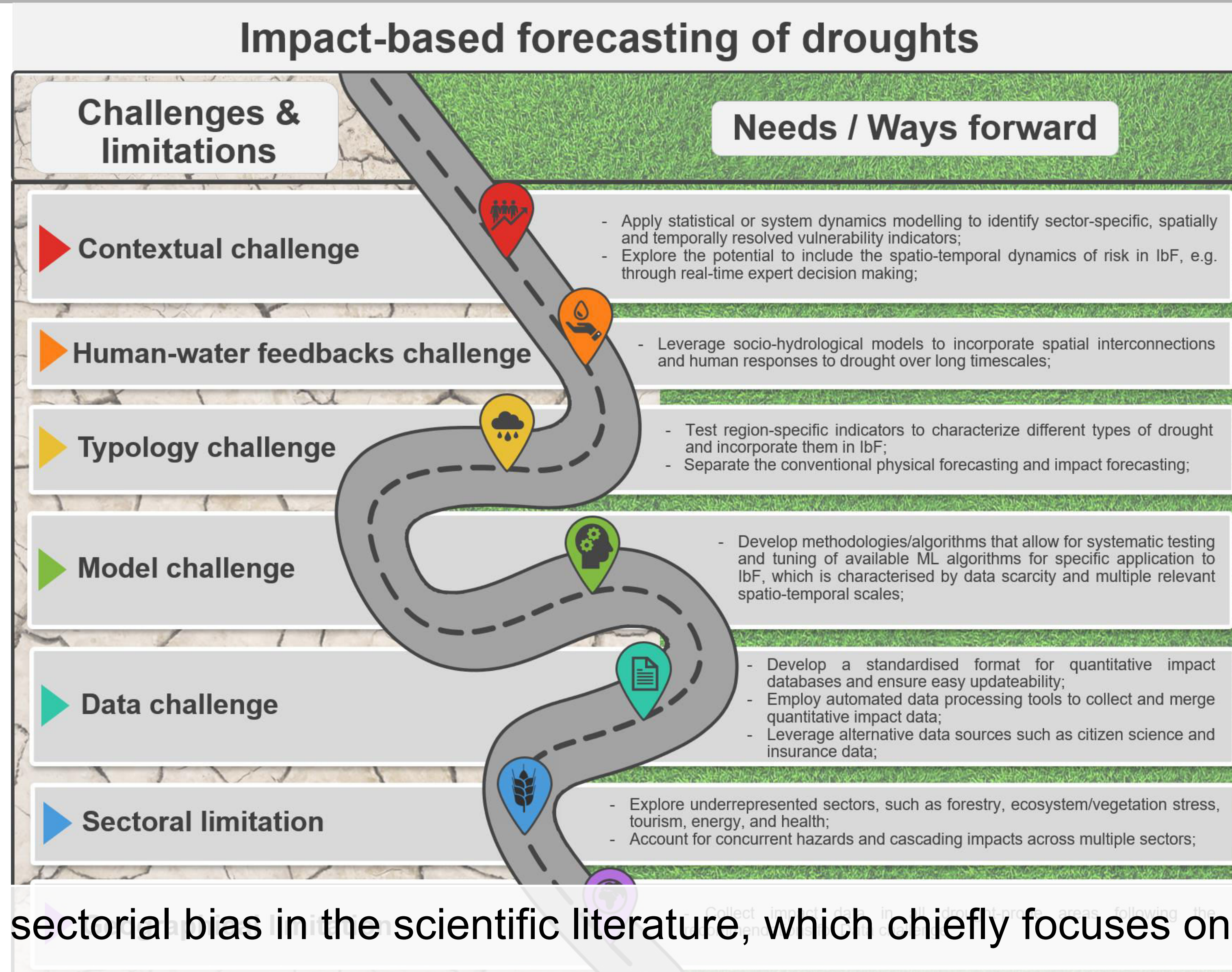
# Challenges & ways forward – drought IbF



- standardise impact data collection; moving away from intrinsically biased impact data



# Challenges & ways forward – drought IbF





# Challenges & ways forward – drought IbF

## Impact-based forecasting of droughts

### Challenges & limitations

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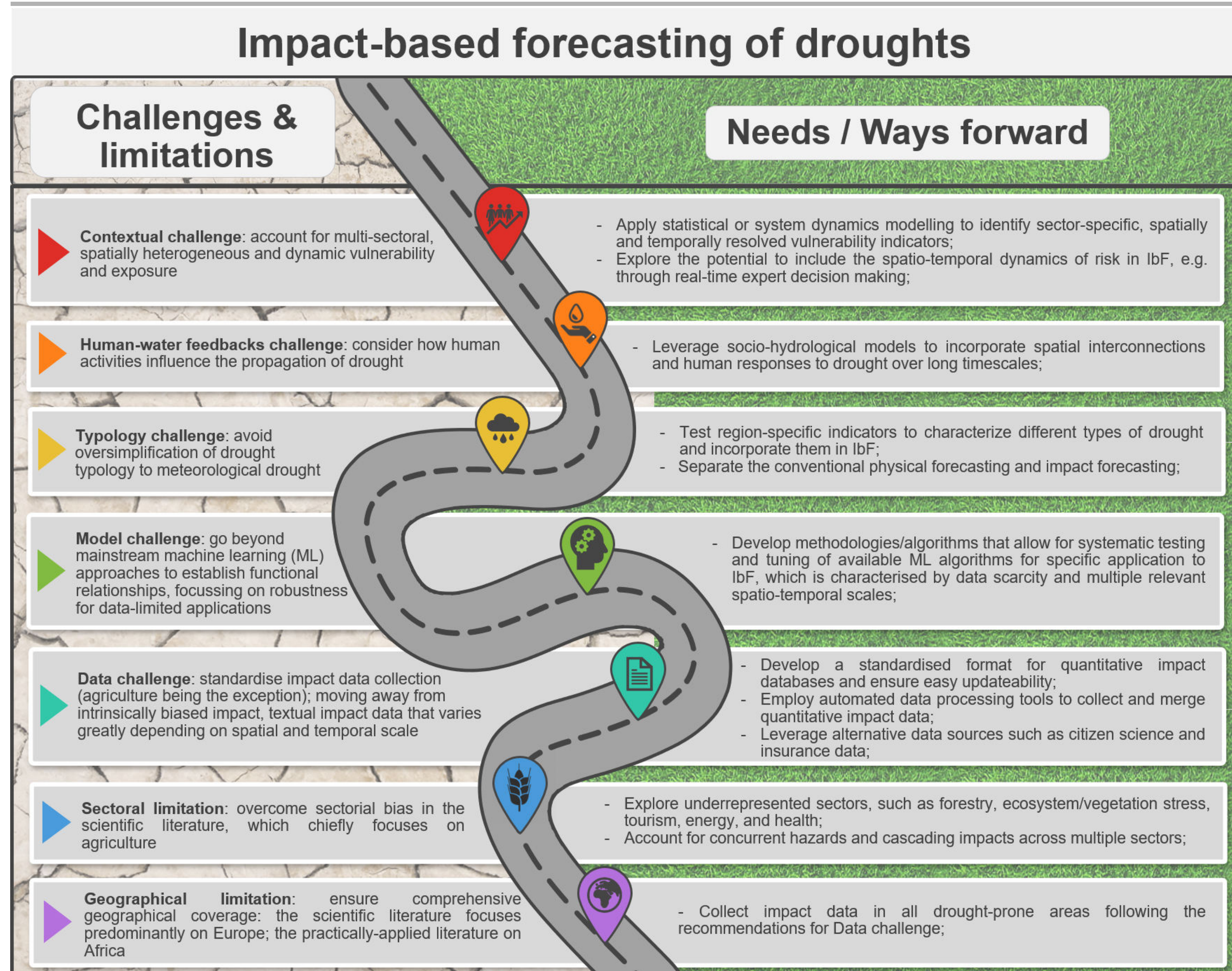
#### Geographical limitation

- Collect impact data in all drought-prone areas following the recommendations for Data challenge;

- ensure comprehensive geographical coverage



# Implications – drought IbF



- bridge the gap between scientific and practical perspectives;
- co-develop prototypes for local IbF;
- cost-benefit analysis for efficient IbF;



develop and integrate IbF practices into DEWSs

[ Fig.3, Shyrokaya, A., Pappenberger, F., Pechlivanidis, I., Messori, G., Khatami, S., Mazzoleni, M., Di Baldassarre, G. Advances and gaps in the science and practice of impact-based forecasting of droughts, WIREs Water (*in review*) ]

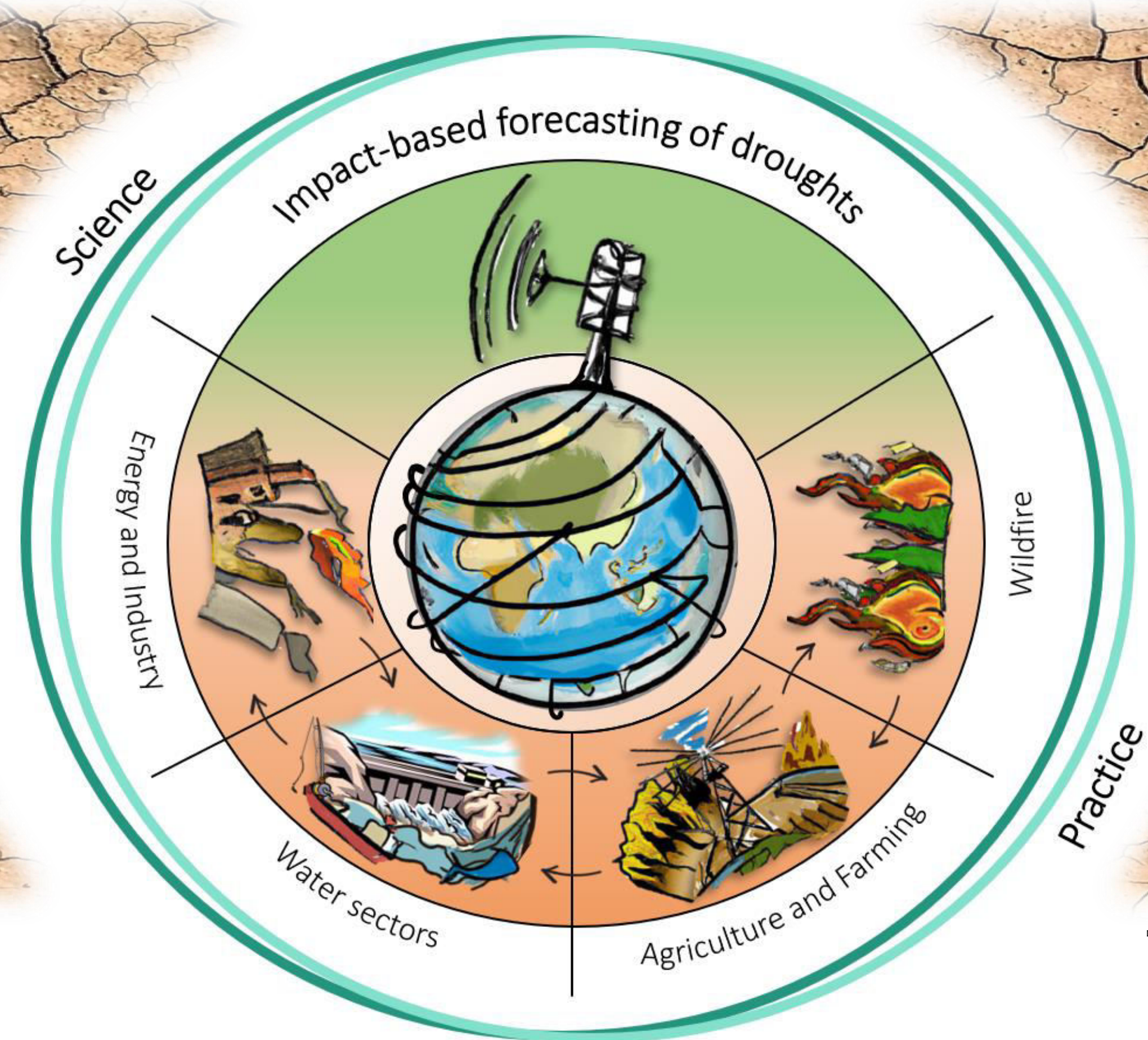




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**Thank you!** email: [anastasiya.shyrokaya@geo.uu.se](mailto:anastasiya.shyrokaya@geo.uu.se)



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