

Climate information services and systematic observation to support improved climate-related data, information and services, and climate risk and impact assessment incorporating different warming scenarios

Peter Thorne

GCOS Vice-Chair, Chair Atmospheric Panel

Chair, Irish Climate Council Adaptation Committee

CLA, IPCC Special Report on Climate Change and Cities



Supported by the European Union



GCOS has defined Essential Climate Variables (ECVs) which are necessary to observe to characterize our changing climate.

These ECVs can be observed from a combination of in-situ platforms and satellite missions



The longest in-situ measurements, taken at the surface extend back centuries (mainly in Europe)

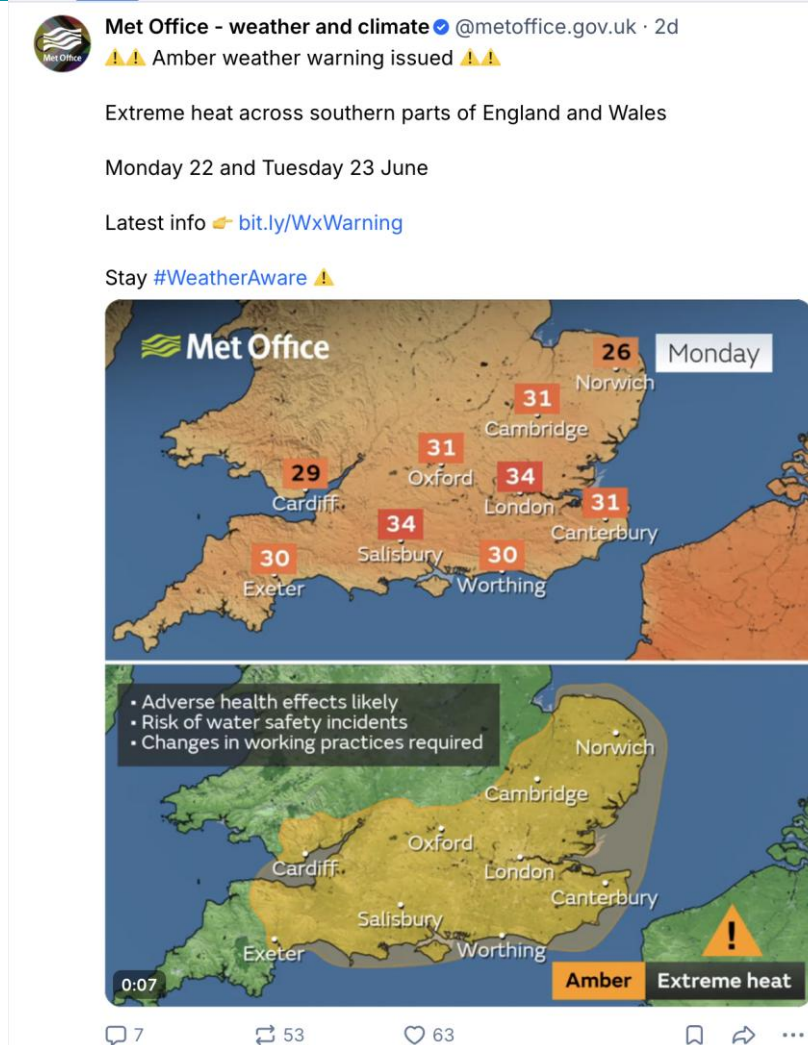
Weather balloons (radiosondes) start in the early to mid 20th Century

Aircraft and satellite data start in the latter half of the 20th Century

Observations capabilities at a crossroads

- Since the second world war we have seen increasing observational capabilities
- The new GCOS Status Report to go to public review in October points out that we are at a moment of great risk with key observations already halted or at risk of halting
- An associated High Priority Action Plan will contain c.10 immediate priority activities that are vital to carry out
- Both documents will be delivered to inform the GST by the end of Feb 2027

The most effective adaptation action is early warnings



Met Office warning issued in June,
subsequently updated and extended

- Early warnings of impending extreme weather allow citizens, businesses and public bodies to prepare and take action to preserve lives and livelihoods
- These warnings depend upon high quality forecasts being produced and their dissemination by trusted entities
 - Numerical Weather Prediction (NWP)
 - Rapidly emerging AI/ML forecasting techniques
- All forecasts in turn depend upon high quality observations made available in near real time (within hours) to forecasting centres
- So ...

If you care about adaptation

Ensure the continued operation and sharing of Key satellite missions for NWP such as:

- Microwave sounders
- Hyperspectral Infrared
- Radio Occultation
- Scatterometers

If you care about adaptation

Ensure the continued operation and sharing of Key satellite missions for NWP such as:

- Microwave sounders
- Hyperspectral Infrared
- Radio Occultation
- Scatterometers

Maintain the in-situ backbone observations:

- Surface synoptic stations
- Radiosondes
- GNSS-PW
- Ships
- Buoys

If you care about adaptation

Ensure the continued operation and sharing of Key satellite missions for NWP such as:

- Microwave sounders
- Hyperspectral Infrared
- Radio Occultation
- Scatterometers

Maintain the in-situ backbone observations:

- Surface synoptic stations
- Radiosondes
- GNSS-PW
- Ships
- Buoys

Fill persistent gaps in observing systems:

- Fully implement GBON
- Fund SOFF for the long-term
- Fill gaps in tropics and over the high poles using tropical and precessing orbital configurations

If you care about adaptation

Ensure the continued operation and sharing of Key satellite missions for NWP such as:

- Microwave sounders
- Hyperspectral Infrared
- Radio Occultation
- Scatterometers

Maintain the in-situ backbone observations:

- Surface synoptic stations
- Radiosondes
- GNSS-PW
- Ships
- Buoys

Fill persistent gaps in observing systems:

- Fully implement GBON
- Fund SOFF for the long-term
- Fill gaps in tropics and over the high poles using tropical and precessing orbital configurations

Adequately support the coordination mechanisms that make the magic happen:

- GCOS will shutter in 2028 without additional funding
- WMO has taken a 21% budget hit and reduced staff
- Other coordination mechanisms also being cut
- The return on investment of these activities is enormous

If you care about adaptation

Ensure the continued operation and sharing of Key satellite missions for NWP such as:

- Microwave sounders
- Hyperspectral Infrared
- Radio Occultation
- Scatterometers

Maintain the in-situ backbone observations:

- Surface synoptic stations
- Radiosondes
- GNSS-PW
- Ships
- Buoys

Fill persistent gaps in observing systems:

- Fully implement GBON
- Fund SOFF for the long-term
- Fill gaps in tropics and over the high poles using tropical and precessing orbital configurations

Adequately support the coordination mechanisms that make the magic happen:

- GCOS will shutter in 2028 without additional funding
- WMO has taken a 21% budget hit and reduced staff
- Other coordination mechanisms also being cut
- The return on investment of these activities is enormous

Invest in reanalyses:

- Rescue and reprocess old satellite missions
- Advocate for the sharing of historical data holdings with global repositories
- Rescue the billions of old observations on paper records
- Ensure operational production of reanalyses

If you care about adaptation

Ensure the continued operation and sharing of Key satellite missions for NWP such as:

- Microwave sounders
- Hyperspectral Infrared
- Radio Occultation
- Scatterometers

Maintain the in-situ backbone observations:

- Surface synoptic stations
- Radiosondes
- GNSS-PW
- Ships
- Buoys
- Aircraft

Fill persistent gaps in observing systems:

- Fully implement GBON
- Fund SOFF for the long-term
- Fill gaps in tropics and over the high poles using tropical and precessing orbital configurations

Adequately support the coordination mechanisms that make the magic happen:

- GCOS will shutter in 2028 without additional funding
- WMO has taken a 21% budget hit and reduced staff
- Other coordination mechanisms also being cut
- The return on investment of these activities is enormous

Invest in reanalyses:

- Rescue and reprocess old satellite missions
- Advocate for the sharing of historical data holdings with global repositories
- Rescue the billions of old observations on paper records
- Ensure operational production of reanalyses

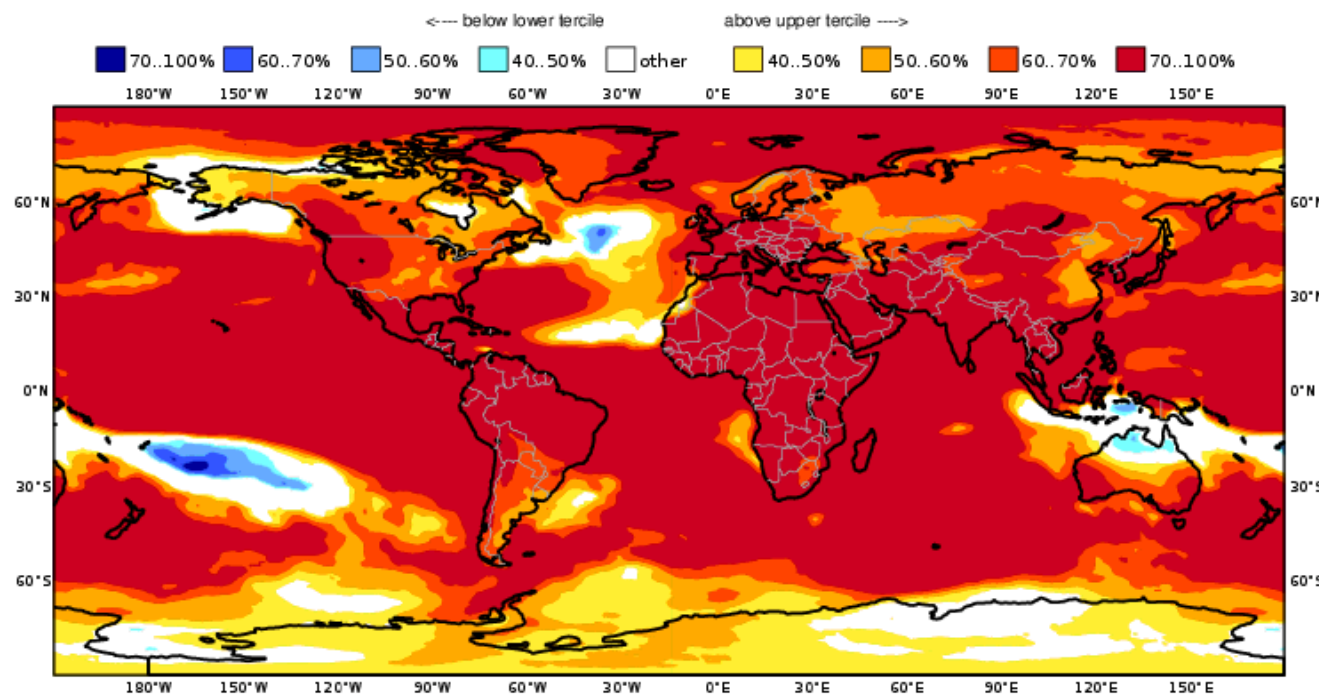
Sweat the small stuff:

- Radio Frequency Interference really matters
- Ensuring exchange mechanisms are operational
- Development of assimilation approaches and models

This also extends to initialized predictions

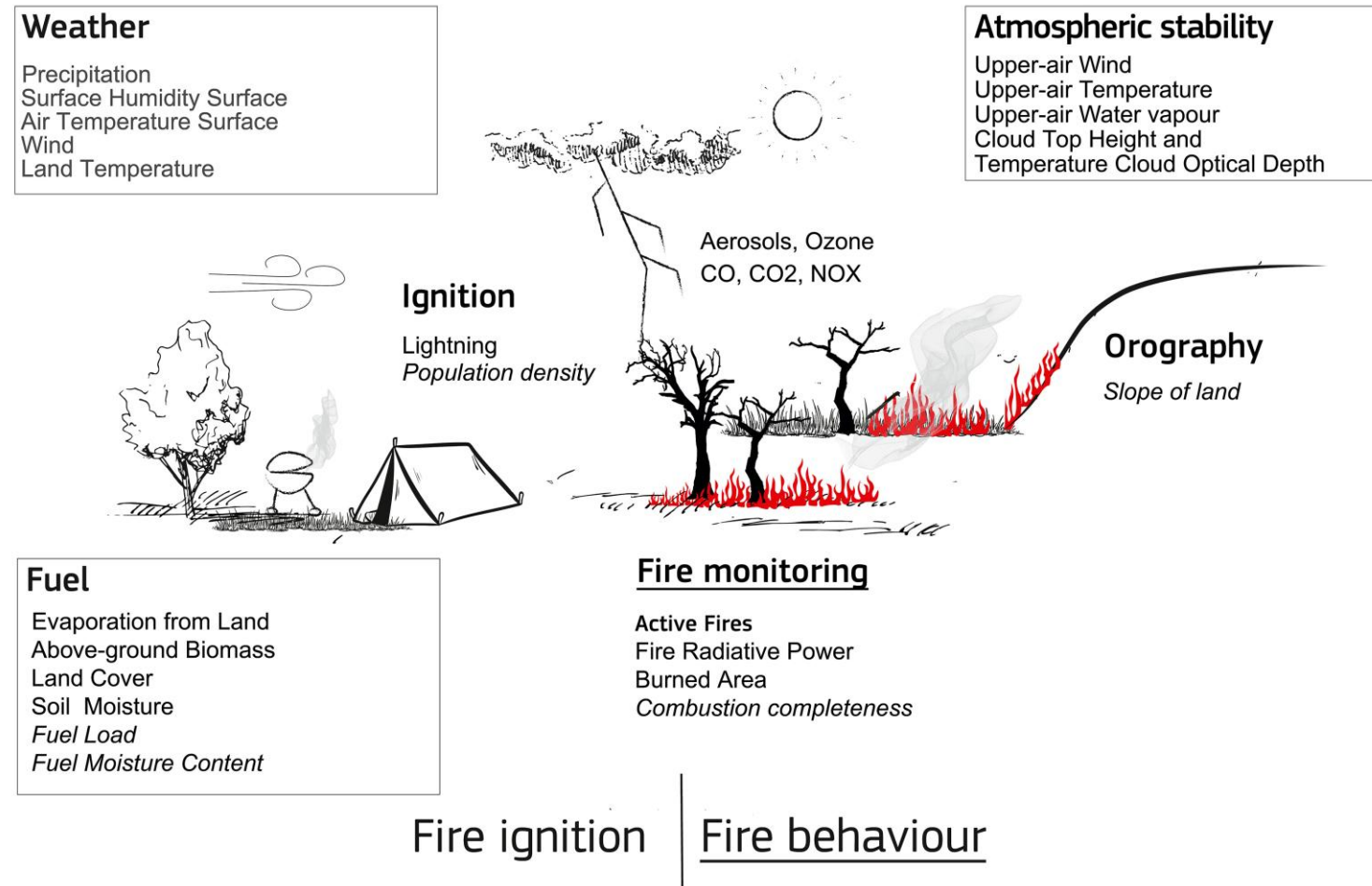
- In much of Sub-Saharan Africa seasonal to decadal forecasts are key to crop planting decisions
- Seasonal to decadal forecasts can aid a range of sectors to plan effectively and minimize risk
- Need for boundary condition observations
 - Stratosphere
 - Ocean state through its depth

C3S multi-system seasonal forecast ECMWF/Met Office/Météo-France/CMCC/DWD/NCEP/JMA/ECCC/BOM
Prob(most likely category of 2m temperature)
Nominal forecast start: 01/06/26
Unweighted mean



GATT (GCOS Adaptation Task Team)

- Cross-panel Task Team 2018-2023
- Looked at 3 case studies:
 1. forest wildfire management;
 2. pluvial flood risk assessment in urban areas;
 3. ocean extremes
- <https://doi.org/10.1016/j.rsos.2025.115082>

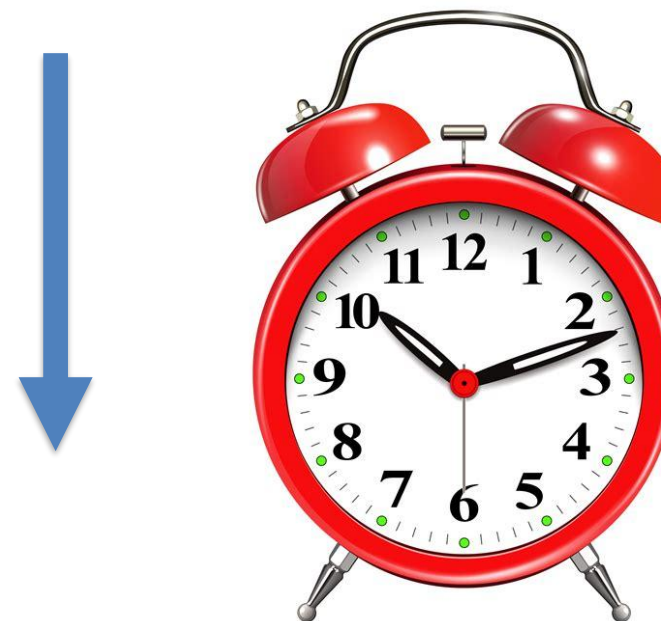


Adaptation consideration generally requires integration of evidence across multiple Essential Climate Variables and observing platform types

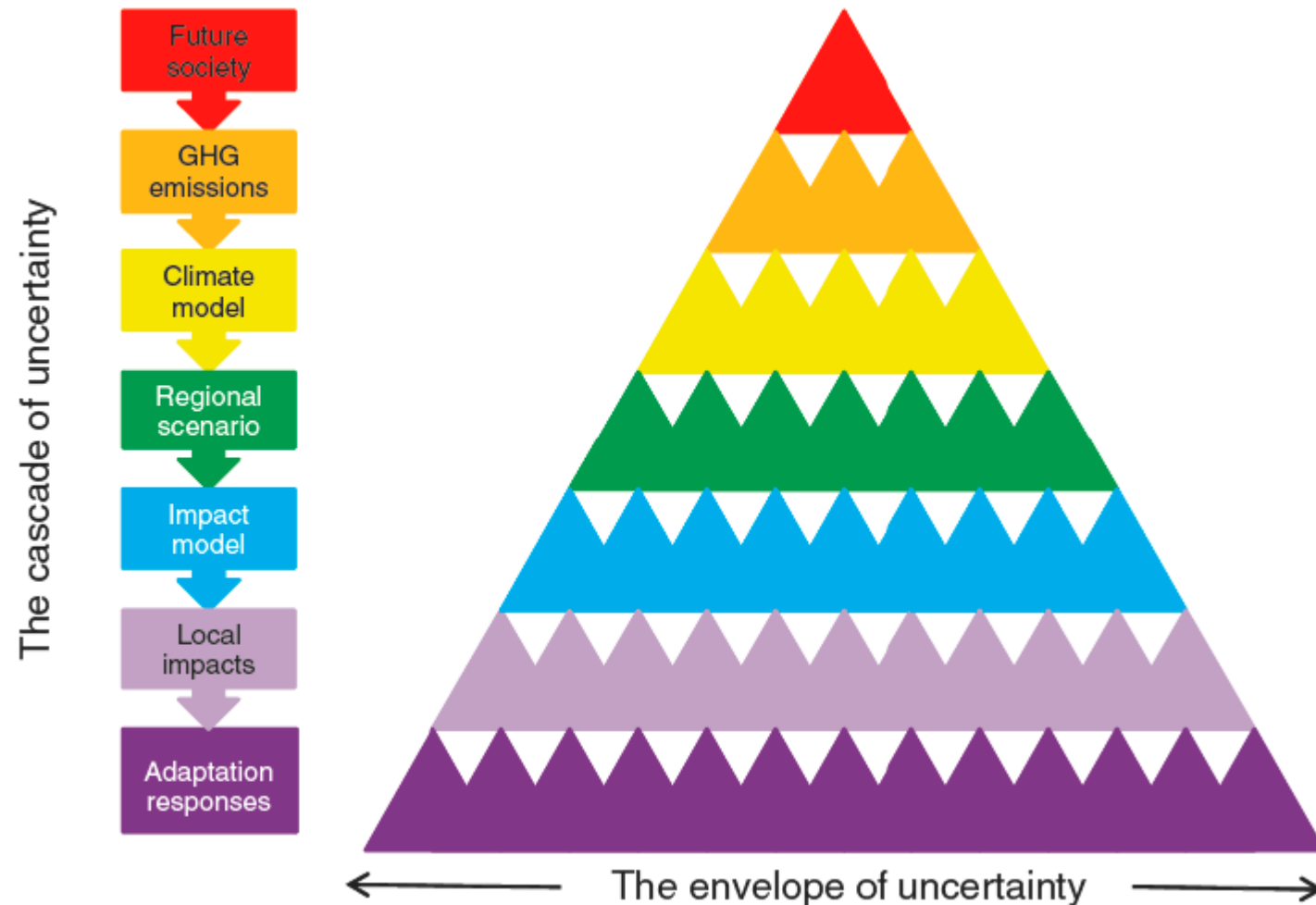
- Reanalysis is an integrator between different sensors and time scales, combining vast amounts of observations into maps without gaps.
- Adaptation requires an understanding of how the climate is likely to change.
- Forecasts/Extremes require operational global data sets available at daily resolution
- Climate predictions/projections: global data sets and historical data are important for validating climate model outputs, as well as projections
- Local, higher resolution, models, as used for adaptation planning, need downscaling from larger scale models, to ensure consistency
- Higher resolution climate datasets (e.g. Daily Climate Data Exchange – DayCli) are particularly relevant for adaptation.

Climate risk under different scenarios

- Perennial (and perhaps intractable) challenges remain around timelag between new scenarios and resulting data suitable for risk assessments
 - WCRP defines new scenarios
 - ESM simulations run
 - Regional downscaling
 - Analysis of risks by experts



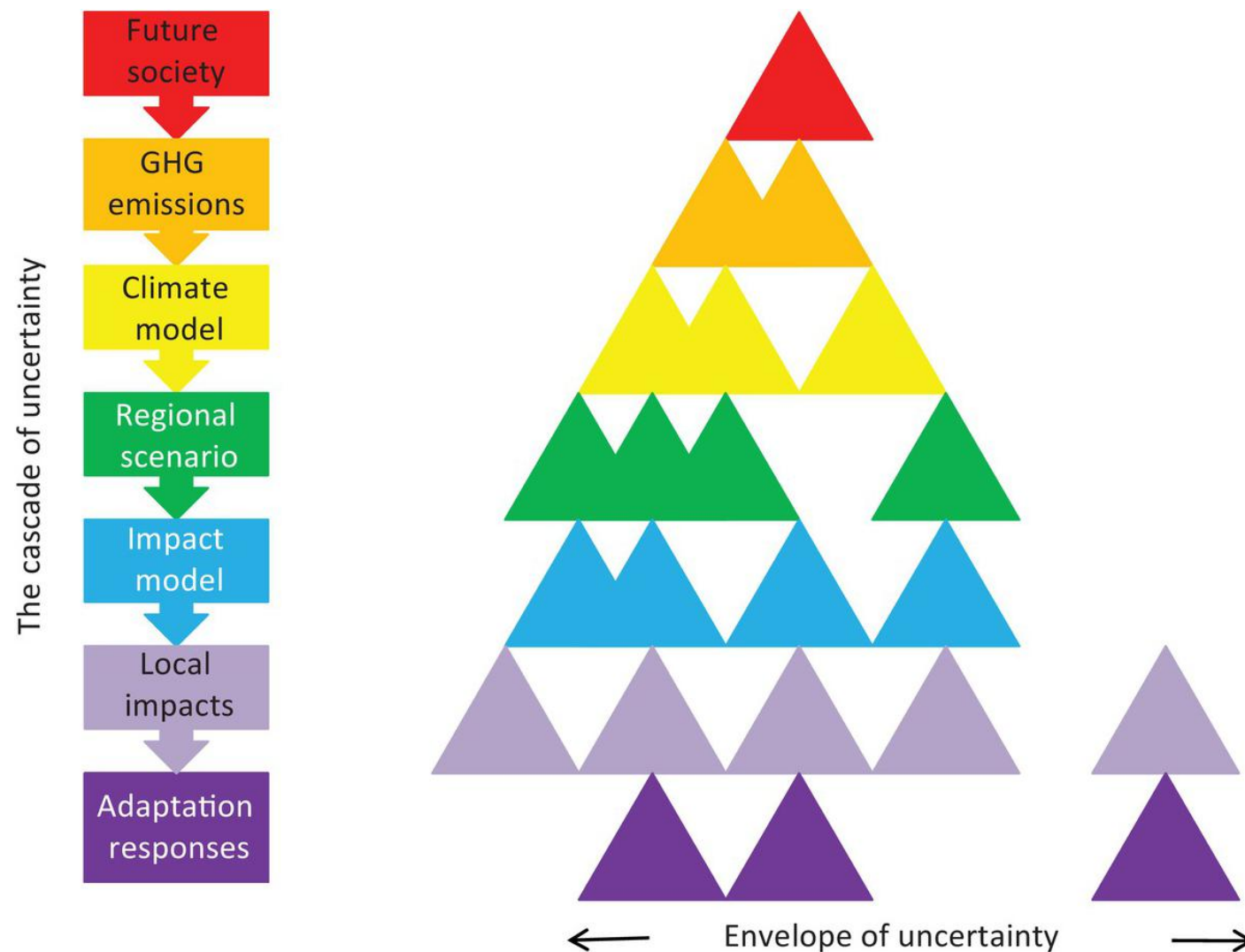
The leaky pipeline



Source: Wilby and Desai,
2010

In an ideal world the full cascade of uncertainty would be explored with all possible outcomes considered

The leaky pipeline



In the real-world we do not fully explore the range of potential outcomes through the chain leading to inevitable underestimation of uncertainty in risk

Lessons from work on burning embers for the IPCC SR

- Risk is inherently context specific even for a narrowly defined hazard
 - In two differently located cities even in the same broad semi-arid context water scarcity risks will hit at different levels of warming
 - Geographical situation
 - Infrastructure
 - And the different context might mean that different adaptation options are available and / or their efficacy differs
 - For an inland city desalination not an option
 - Water conservation efficacy may be constrained by urban function

Thank you



**GLOBAL CLIMATE
OBSERVING SYSTEM**
KEEPING WATCH OVER OUR CLIMATE



Supported by the European Union

