

End-user focused evaluation and development of ensemble flood forecasts

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Motivation

- Concern over why forecasts (e.g. Typhoon Haiyan) have not been acted upon
- There are a number of forecast-based actions that could be taken to drastically reduce the impact of the hazard before it occurs
 - Prepositioning supplies (e.g. water purification tablets)
 - Evacuation
 - Hygiene campaigns
- But currently disaster response is only scaled up *after* the hazard strikes

What can be done to develop the use of forecasts for humanitarian response?

*** Three Challenges ***

Using ensemble forecasts for humanitarian-actions: where are we now?

Ideally:

Maps showing the impact and progression of the flood over the next 20 days

- **Linked with hydraulic modelling for accurate mapping of inundation**
- **No uncertainty: no false alarms or missed events, even with longer lead times**
- **All relevant impacts data is nicely collated and accessible**
- **Cost of decisions easy to quantify**
- **Politics plays no role, solely a quantifiable decision**

Developing the Global Flood Awareness System

Currently:

- Running ensemble predictions forced by the ECMWF model out to 20 days
- Issue 'medium', 'high' and 'extreme' warnings at 2yr, 5yr and 20yr return period thresholds
- Much like EFAS, hydrographs can be accessed for critical locations
- Interest from humanitarian end-users, and an obvious appetite for uncertainty information: “ensembles provide us with more credibility”
- **Lots of two-way feedback and interaction**

Challenge 1: Understanding the model world

Currently GloFAS uses a model climatology approach for 2 reasons:

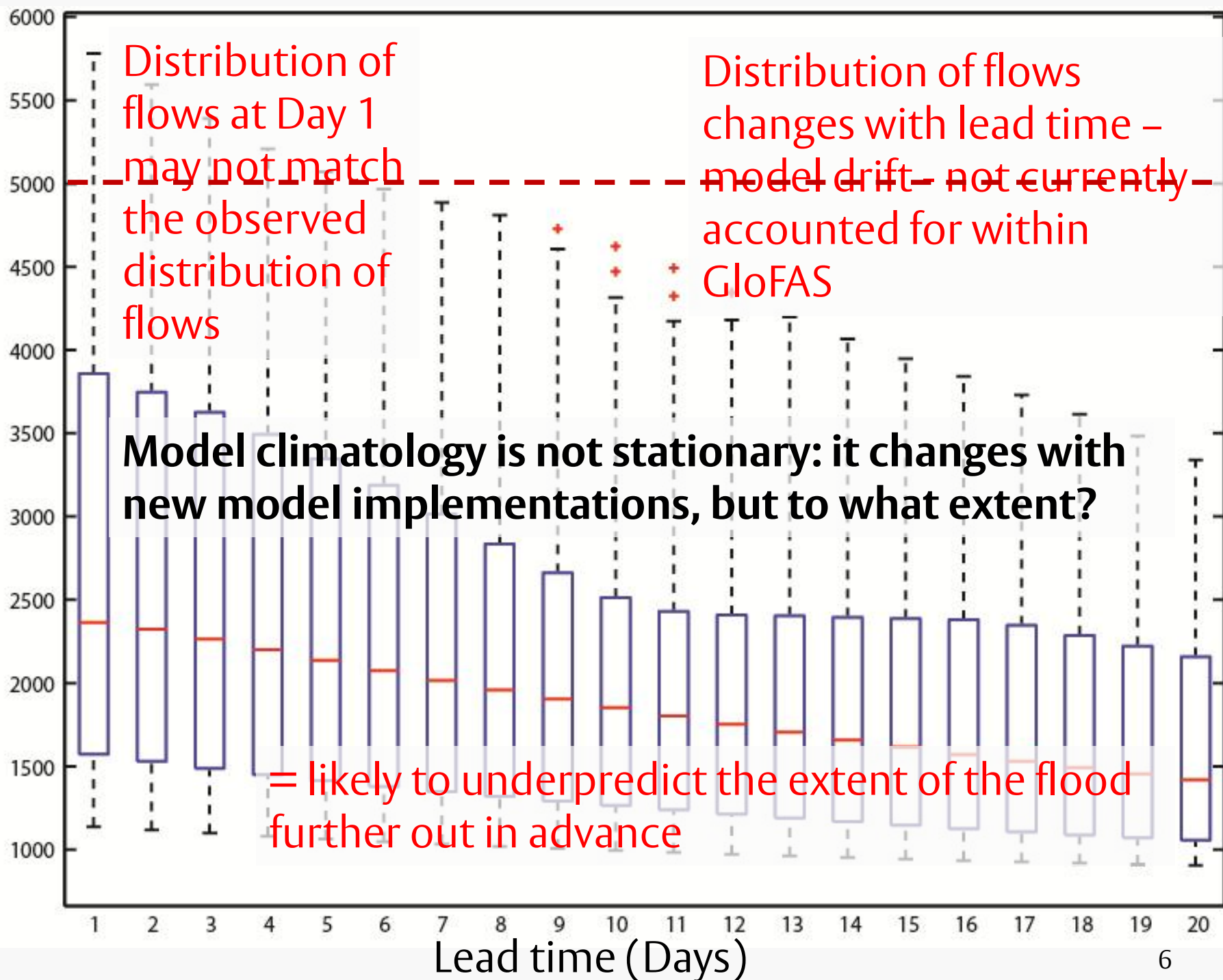
1. Lack of information on channel structure (width / depth) to understand critical flows – constantly being improved
2. Meteorological model not predicting the correct magnitude of rainfall

Though exact magnitude may be wrong, a model climatology approach assumes that a 1 in 100 year flow within the model world will equate to a 1 in 100 year flow in the real world

Important to:

1. Use reforecasts to characterise the model climate / world
2. Communicate to users the limitations of the model

Flow at Tete (Mozambique)



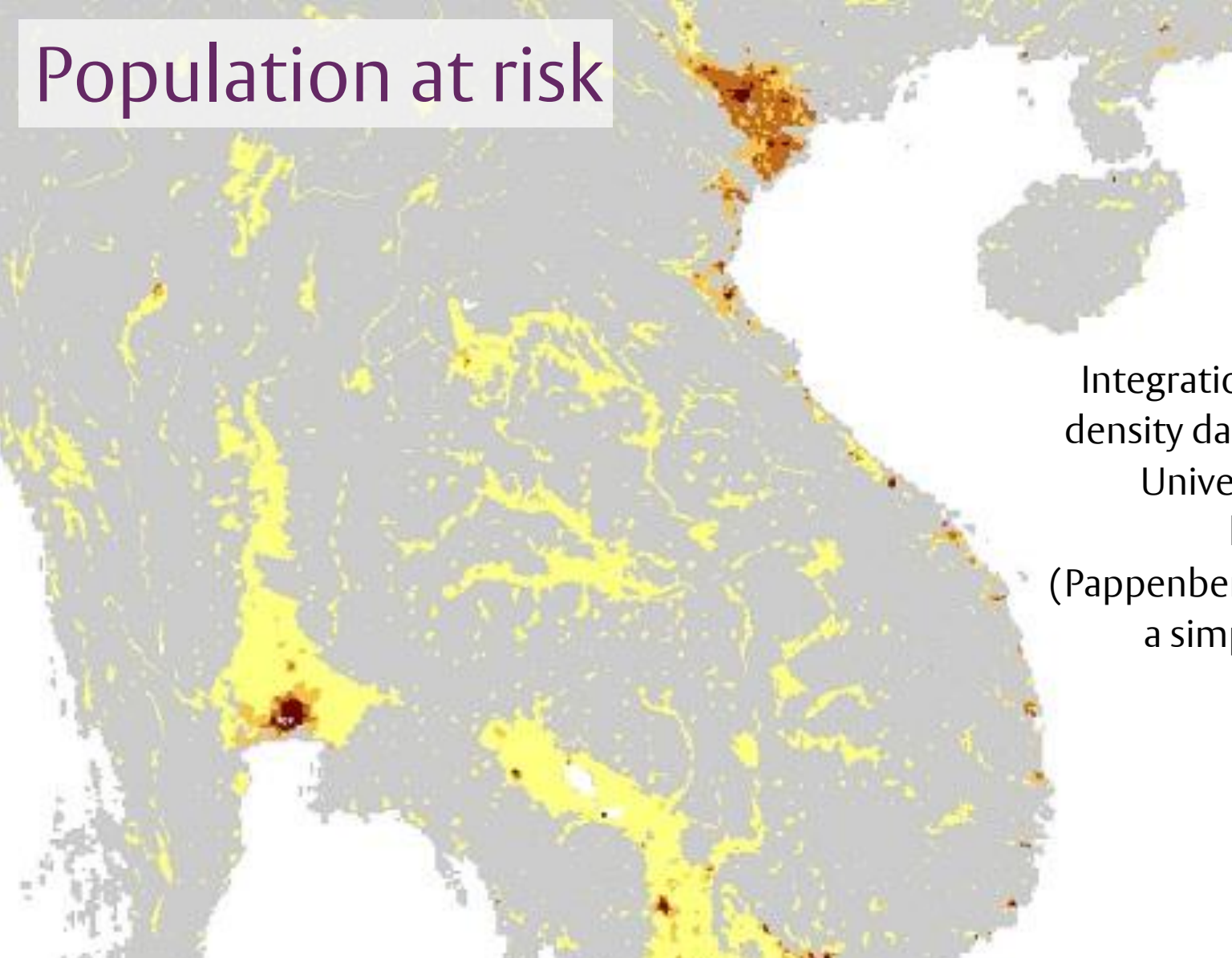
Challenge 2: Linking with hydraulic models for inundation predictions

For organisations that do not have the capacity to translate hydrographs into decisions, need to be able to produce warnings that reflect their decision-making needs.

Challenge 1 also poses a challenge for predicting the flood inundation:

1. Coupling with a hydraulic model would be unlikely to produce the correct magnitude flood inundation
2. Instead, need to ensure an adequate offline coupling of the forecasts to hydraulic modelling – using the same model climatology approach
 - Has assumptions: e.g. that forecast model climatology is derived from the same dataset as in the hydraulic modelling
 - Also sacrifices information about timing of flood
 - Linking reanalysis derived climatology to real world will introduce a large amount of uncertainty

Population at risk



Integration of population density dataset (Columbia University) with flood hazard mapping (Pappenberger et al.) gives a simple indication of vulnerability

Population density inside the 1 in 100 year fluvial flood outline, SE Asia

Pappenberger, F., Dutra, E., Wetterhall, F., & Cloke, H. L. (2012). Deriving global flood hazard maps of fluvial floods through a physical model cascade. *Hydrology & Earth System Sciences*, 16(11).

Challenge 3: Understanding how decisions are made

It is being increasingly recognised that the successful use of a forecast is not solely related to the skill of the forecast itself.

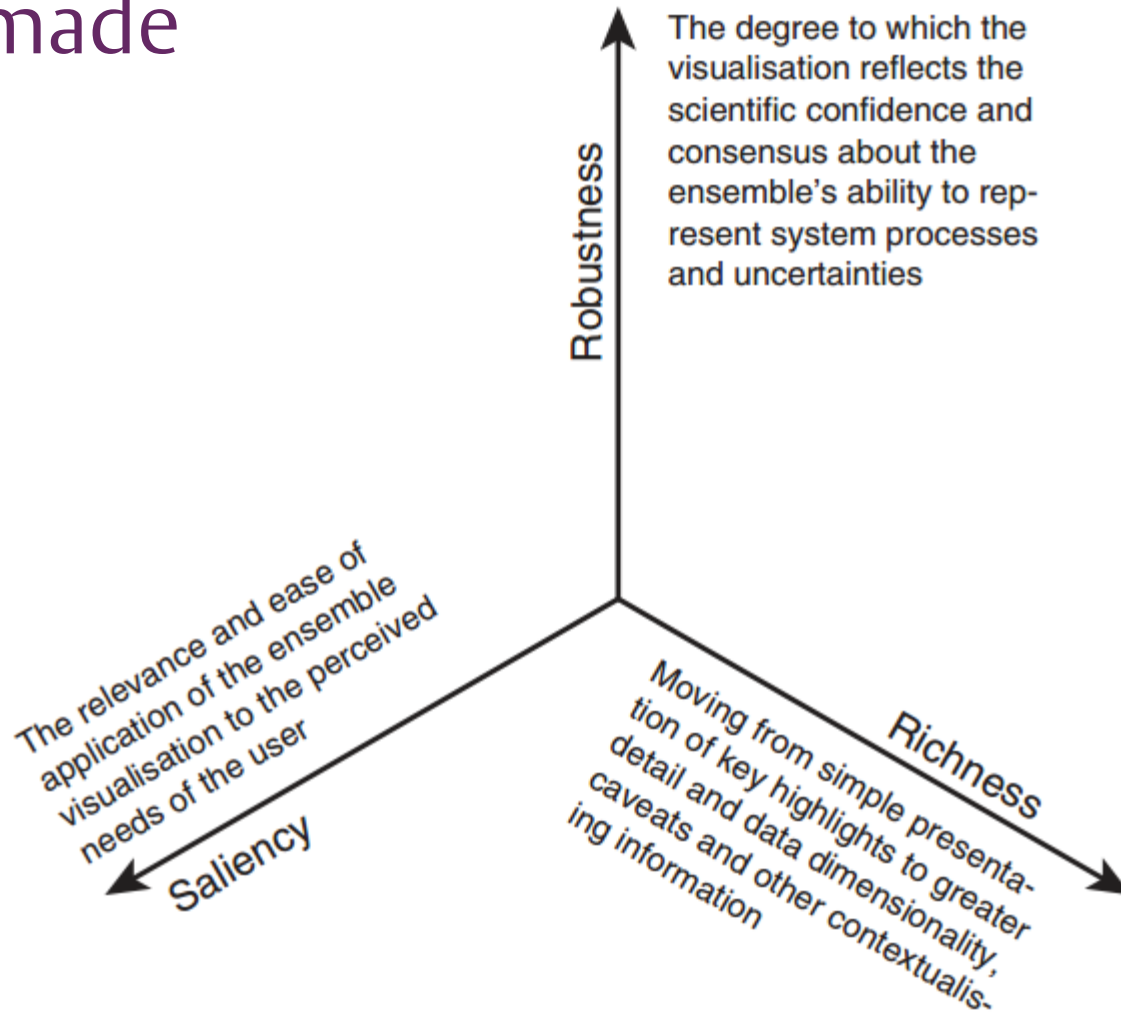
Need to understand how a forecast is to be used to properly understand how to develop and evaluate it

- How will the forecast be disseminated and translated for decision-making?
- Who will undertake these roles? What is their expertise?
- What are their responsibilities? How does the organisation view uncertainty?

Challenge 3: Understanding how decisions are made

- What forecast information is critical for decision-making?
 - Exceedance thresholds (return period, particular flow)
 - Important lead times
 - Probability for action
- Often lack of datasets are a problem
 - Warnings require catchment-level knowledge of impacts
 - Users could be interested in impacts as diverse as food security to hygiene
- How should forecasts be communicated?
 - Hydrographs and / or warnings?
 - Spaghetti plots or high/ medium / low?

Challenge 3: Understanding how decisions are made

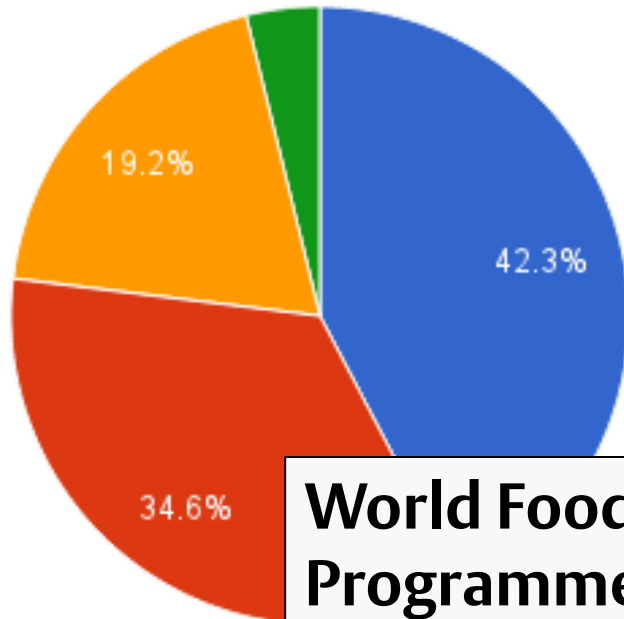


Three imperatives for visualisation

Stephens, Elisabeth M., Tamsin L. Edwards, and David Demeritt. "Communicating probabilistic information from climate model ensembles—lessons from numerical weather prediction." *Wiley Interdisciplinary Reviews: Climate Change* 3.5 (2012): 409-426.

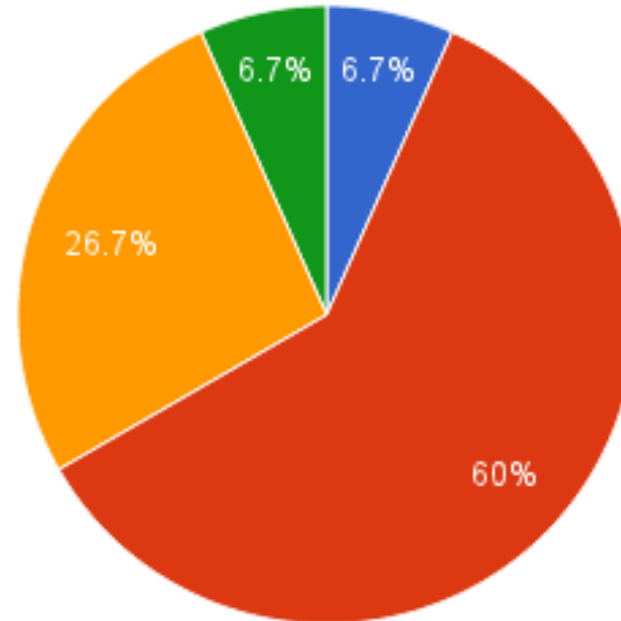
Challenge 3: Understanding how decisions are made

Humanitarian Response / Civil Protection



**World Food Programme:
5000 people affected**

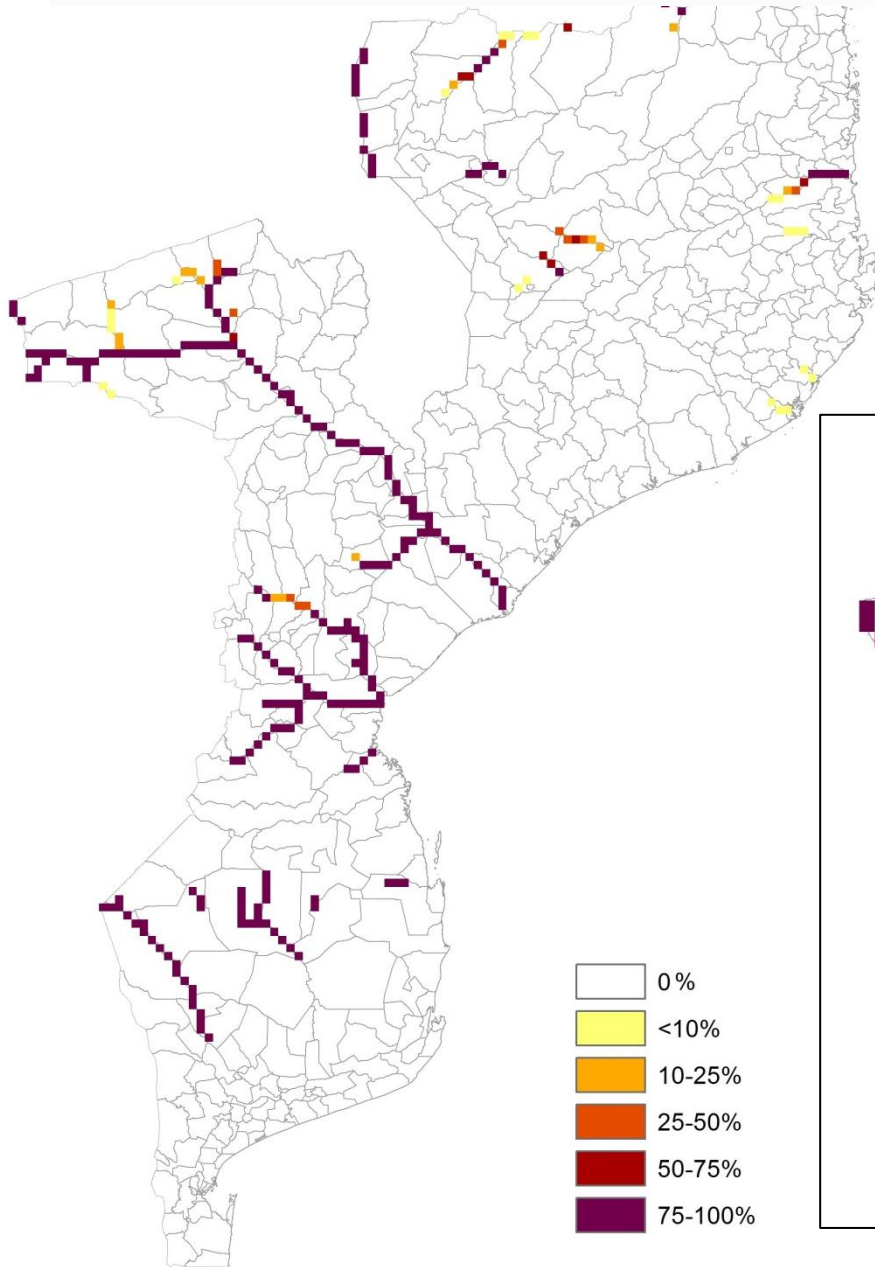
Forecasting / modelling



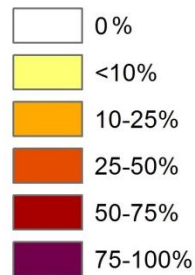
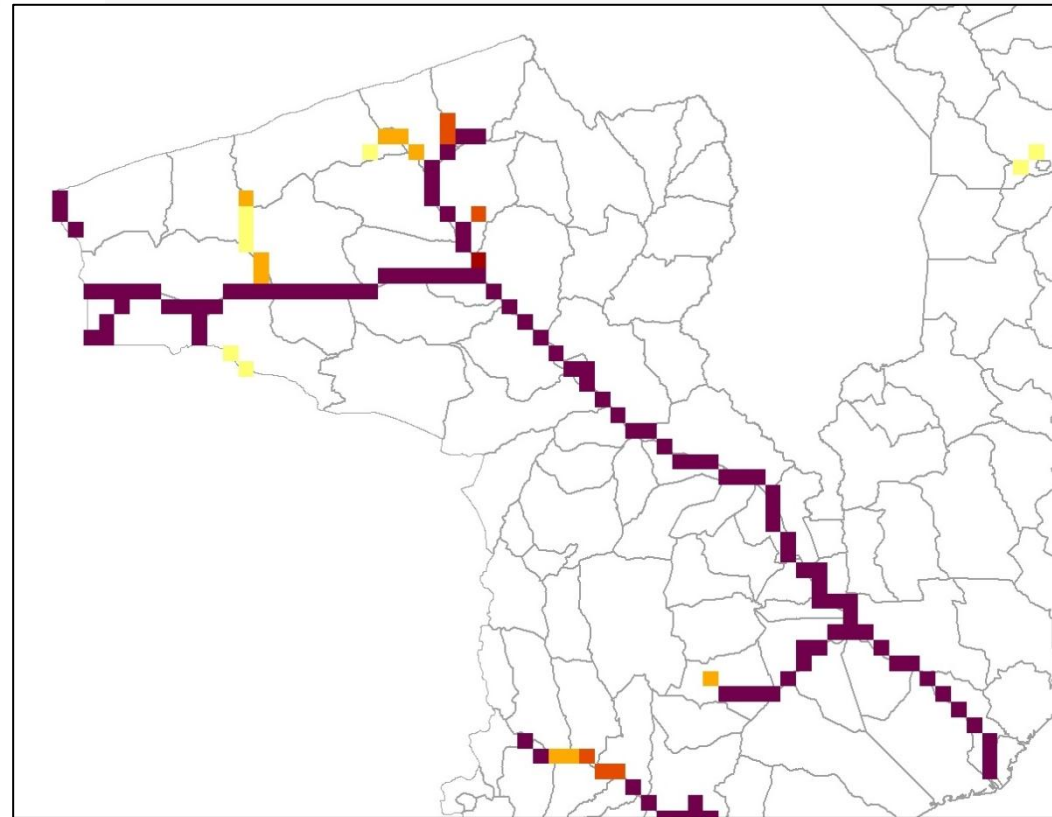
- When a certain number of people are affected
- When a river goes out of bank / the sea inundates the land
- When a particular return period flow / event is recorded (e.g. 1 in 20yr)
- When a particular financial loss is recorded

“What best describes how your organisation defines a flood?”

River pixel to flood area

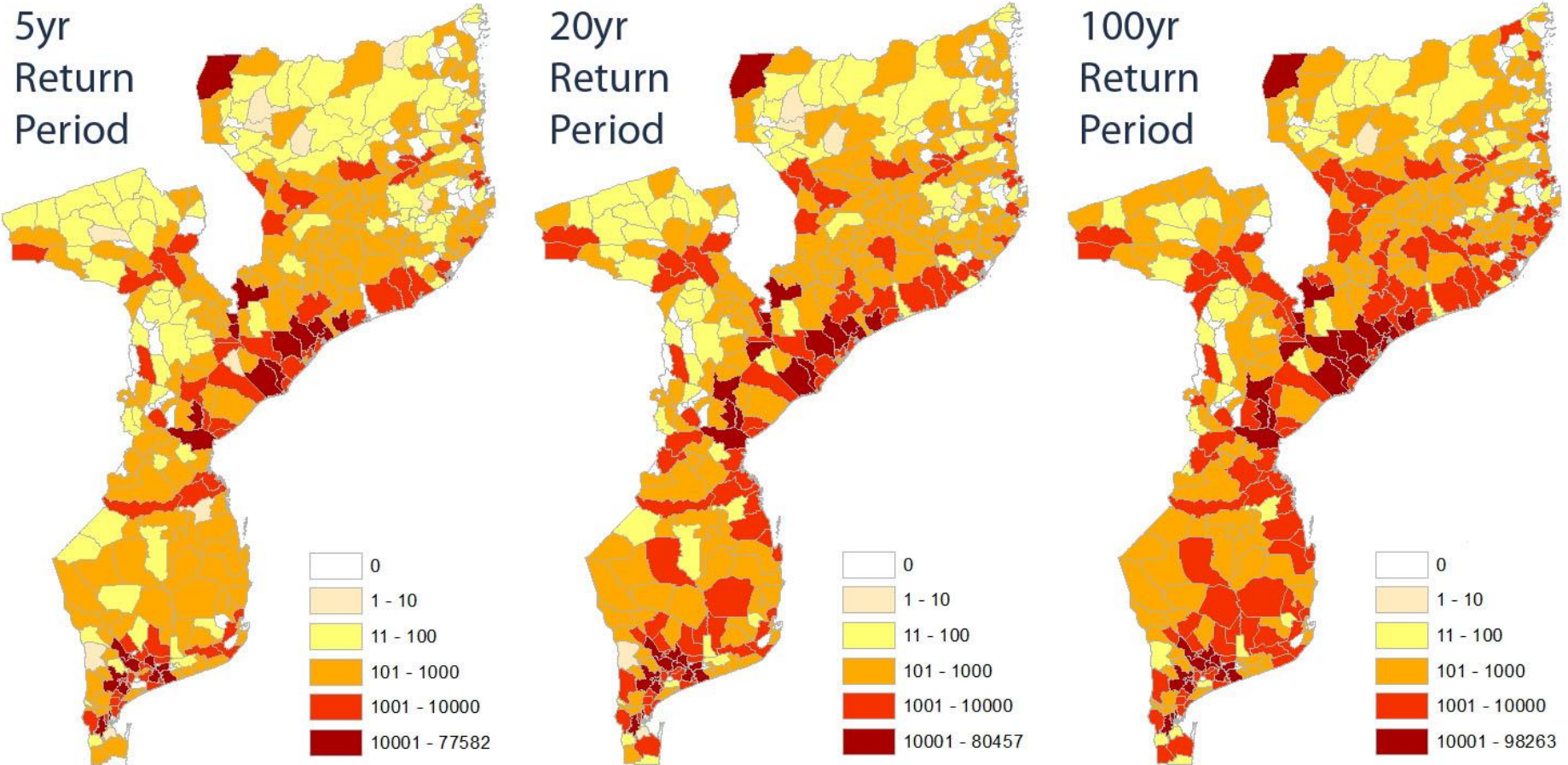


Ensemble members exceeding medium (2yr threshold) forecast on 29th January 2014 for one day ahead.



Calculating population at risk

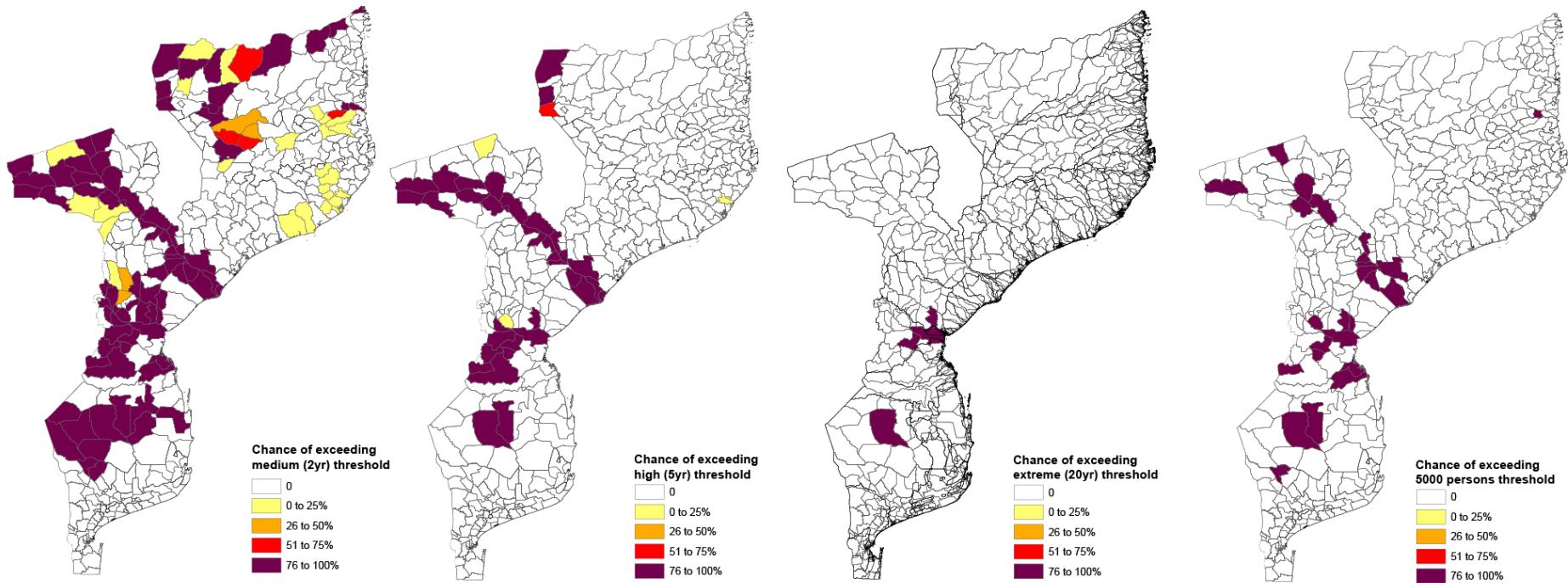
...in each global administrative area for a number of return periods



Linked to the size of the administrative area as well as flood hazard and population density.

Applying new threshold

How does the new 5000 person threshold influence the warnings map?



Incorporating information on the decision-making process changes how forecast output is processed and visualised

Where will we be by the HEPEx 20 year anniversary?

Discussed three important challenges in this talk, but there is clear guidance from the Red Cross:

“Further pilots and research to quantify the value added of forecast-based financing schemes is needed to provide the evidence base for forecast-based funding”

Coughlan de Perez et al., 2014