# Can we really use El Niño to predict flood hazard?

R. Emerton, H. Cloke, E. Stephens, E. Zsoter, S. Woolnough & F. Pappenberger
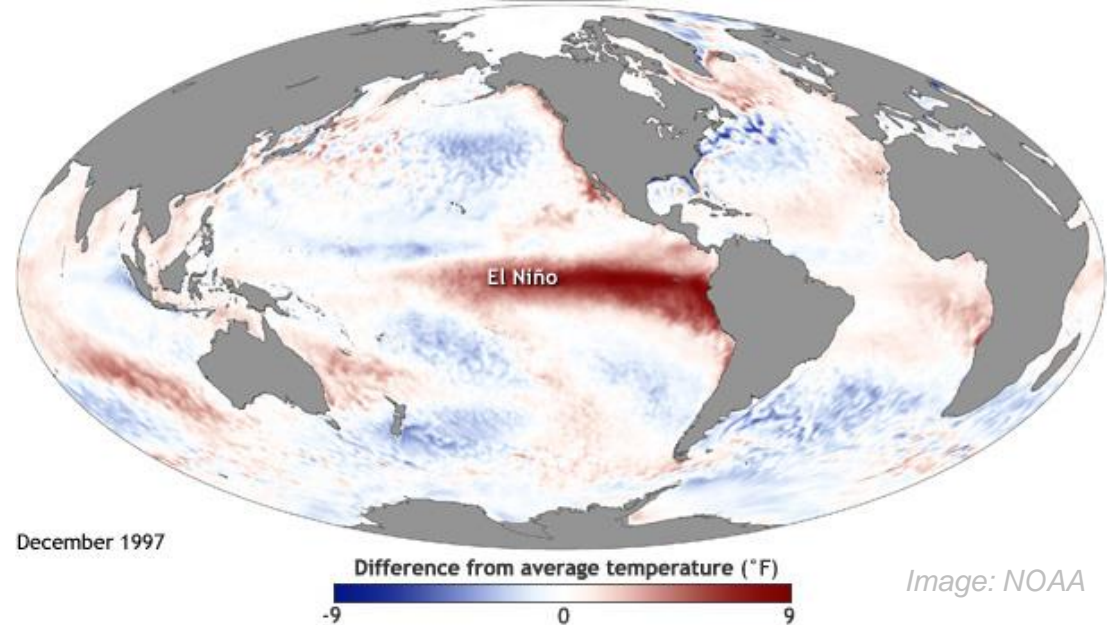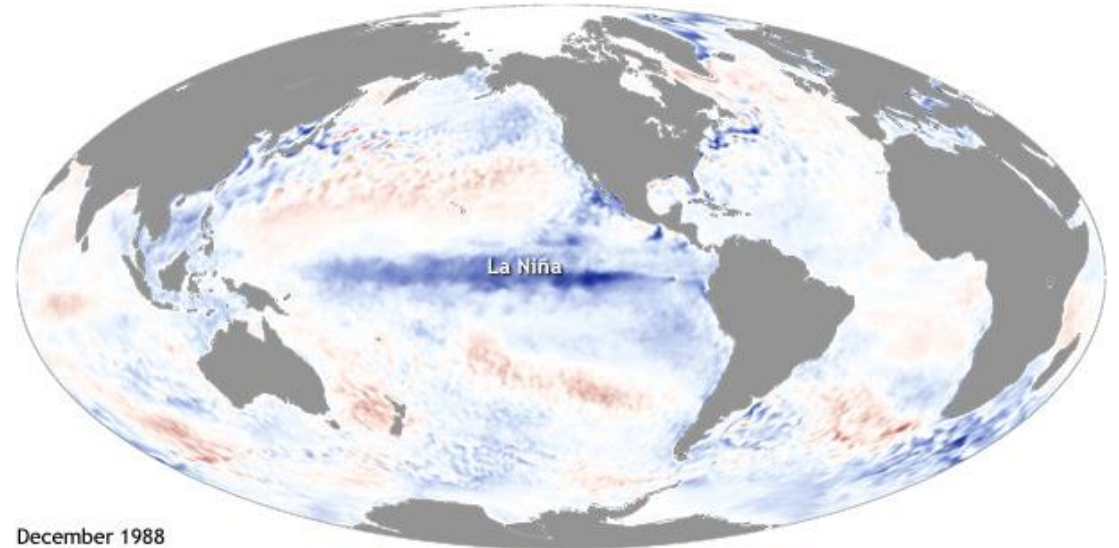
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# Why El Niño?

- Most dominant pattern of climate variability – ENSO

- Pacific Ocean temperatures fluctuate:
  - **La Niña** = abnormally **cool** Pacific ↗
  - **El Niño** = abnormally **warm** Pacific ↘

- Results in changes in atmospheric circulation



December 1988

December 1997

Difference from average temperature (°F)

-9          0          9

*Image: NOAA*

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**El Niño & La Niña affect river flow & flooding around the globe!**

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# Can we use El Niño to predict floods and provide earlier warnings?

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*Photo: Presidencia Perú*

# Why?

- Earlier awareness of floods and droughts could benefit many water-related sectors

- If we can estimate the likelihood of flooding, we can help to prepare for it

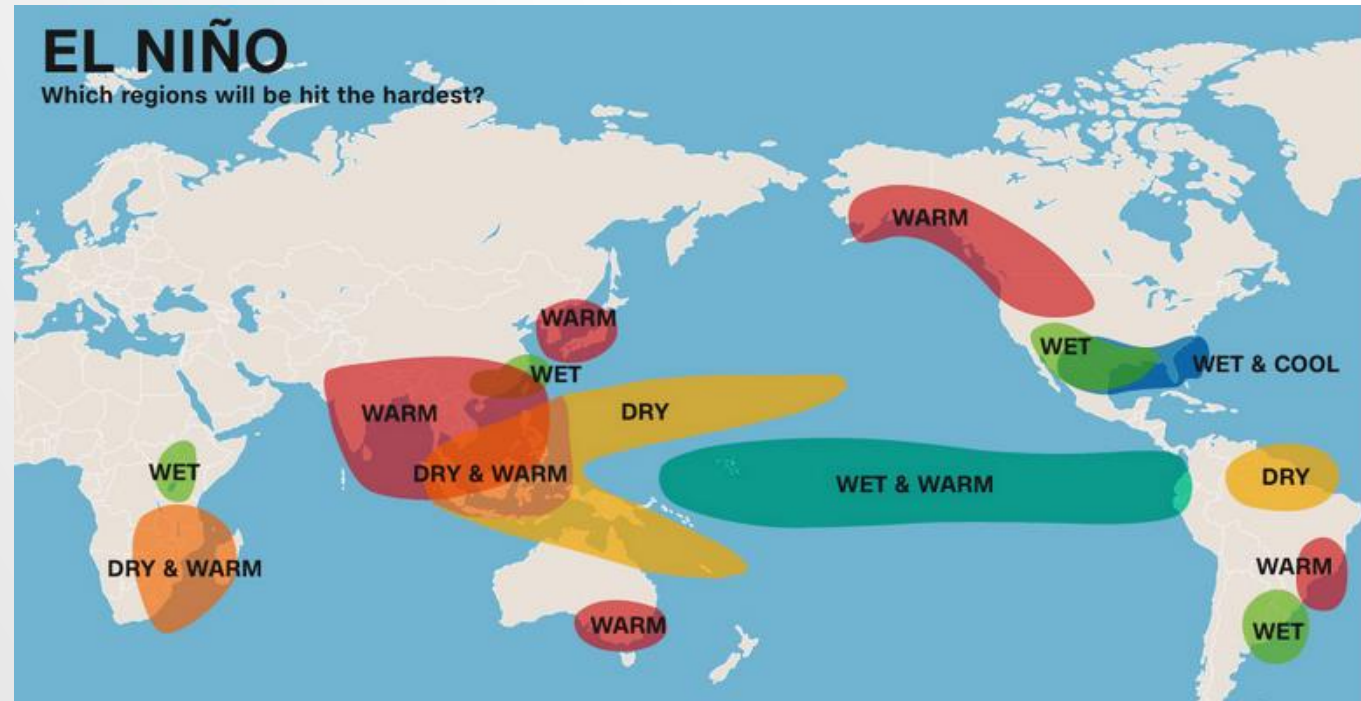- Global overviews are key for organisations working at the global scale

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# Why?

*So how do we estimate the likely impacts of El Niño / La Niña?*

*And how good are these estimations?*

# Historical Probabilities

- Likelihood (%) based on what has happened during past El Niños / La Niñas
- Provide useful information based on **historical evidence**



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# Historical Probabilities

- Typically, historical probabilities of extreme **rainfall** are used as a proxy for flooding
  - Due to a lack of hydrological analyses

- **However...**
- The nonlinearity between precipitation and floodiness highlights the need to estimate these probabilities using hydrological data

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Stephens et al., 2015: **Precipitation and Floodiness**, *GRL*, 42
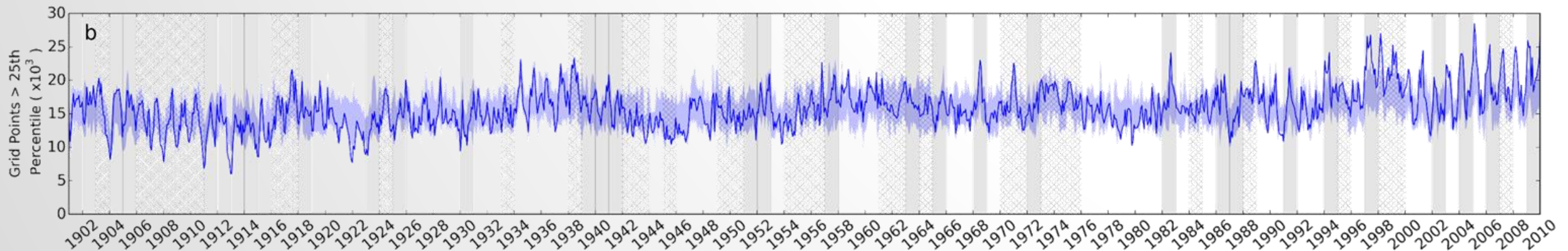
# Historical Probabilities

- Typically, historical probabilities of extreme **rainfall** are used as a proxy for flooding
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- **However…**
- The nonlinearity between precipitation and floodiness highlights the need to estimate these probabilities using **hydrological data**

**The motivation behind our work was to provide similar information, but taking into account the hydrology as well as the meteorology, aiming to answer the question:**
*"what is the probability of flooding during El Niño / La Niña?"*
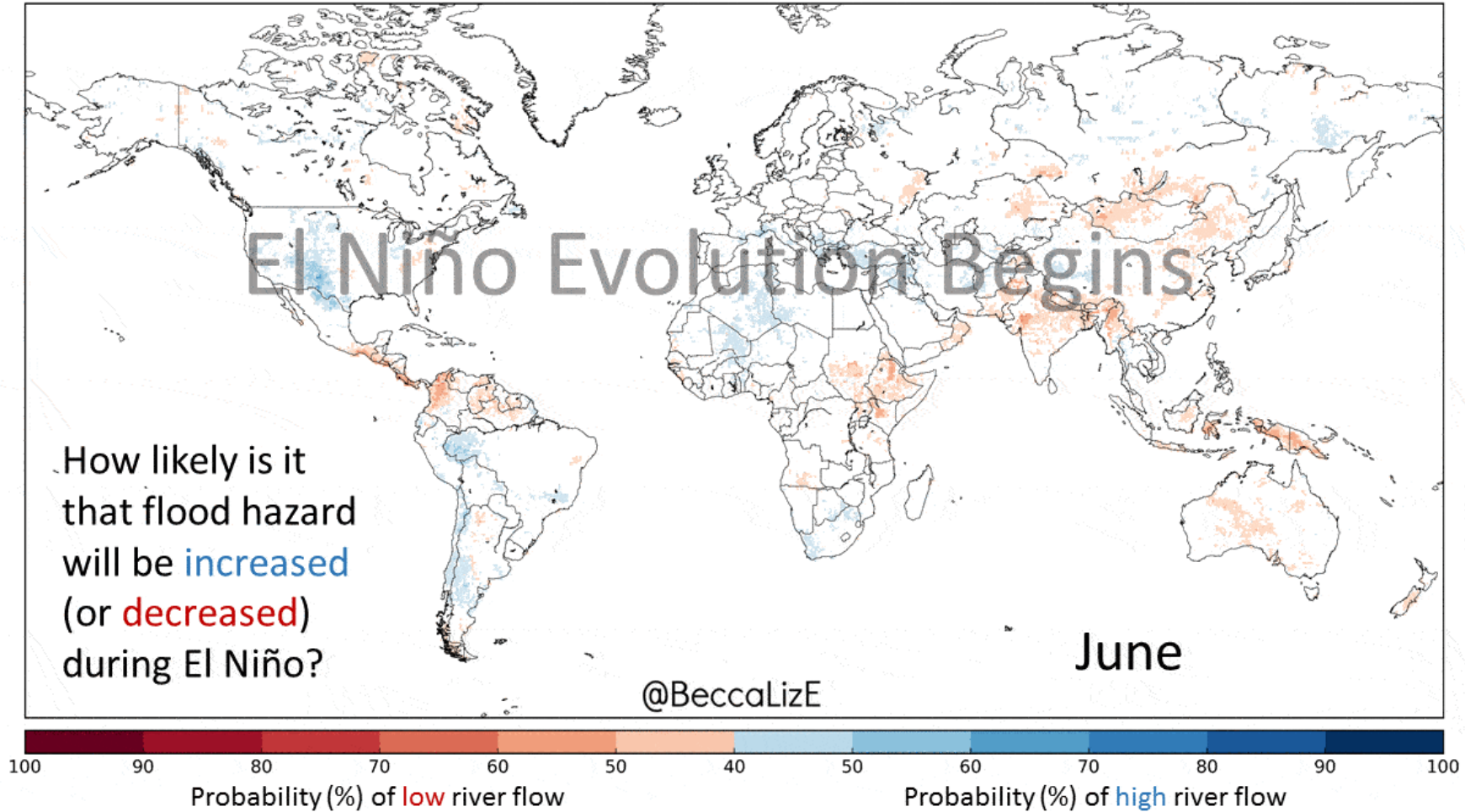
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# Hydrological Data: ERA-20CM-R

**20th Century (1901-2010) reconstruction of daily river flow for the global river network**

- Produced by forcing the CaMaFlood routing model with ERA-20CM
  - 125km horizontal resolution meteorological reconstruction downscaled to 0.5° (~50km)
  - 10 ensemble members representing uncertainty in the data
- Obtained a dataset with consistent global coverage for an extended time period
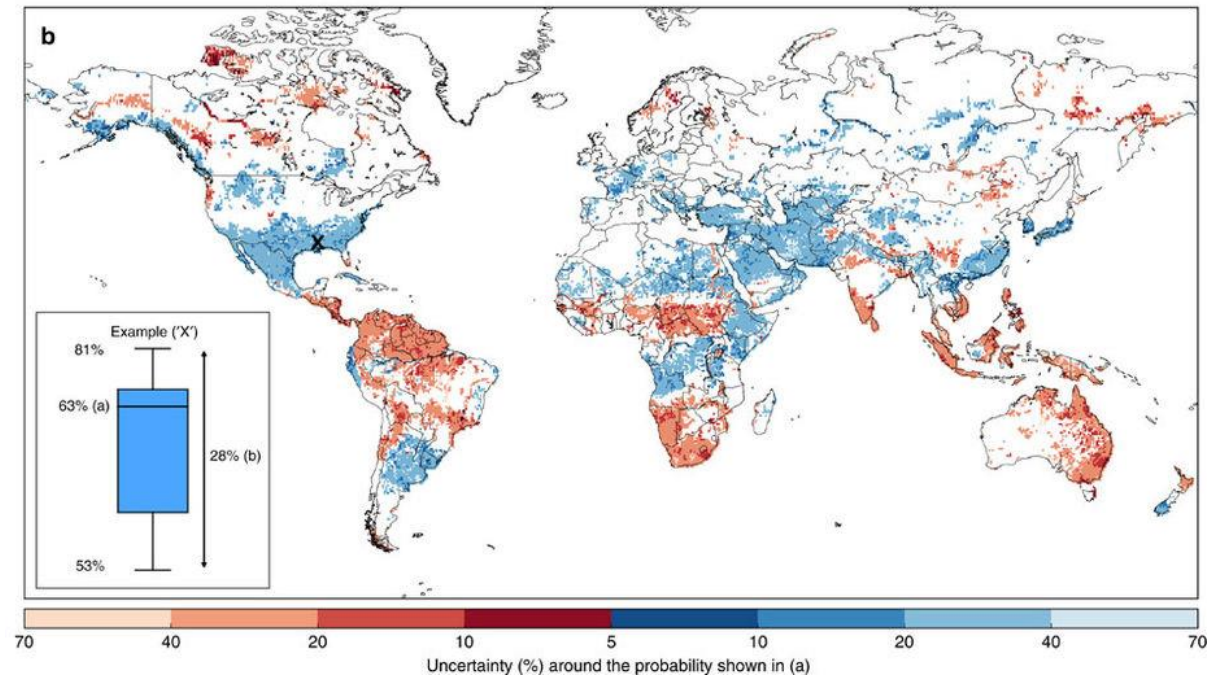  - Containing 30 El Niños, 33 La Niñas



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# Can we use El Niño to predict flood hazard?

How likely is it that flood hazard will be increased (or decreased) during El Niño?

El Niño Evolution Begins

June

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| 100 | 90 | 80 | 70 | 60 | 50 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |

Probability (%) of low river flow

Probability (%) of high river flow

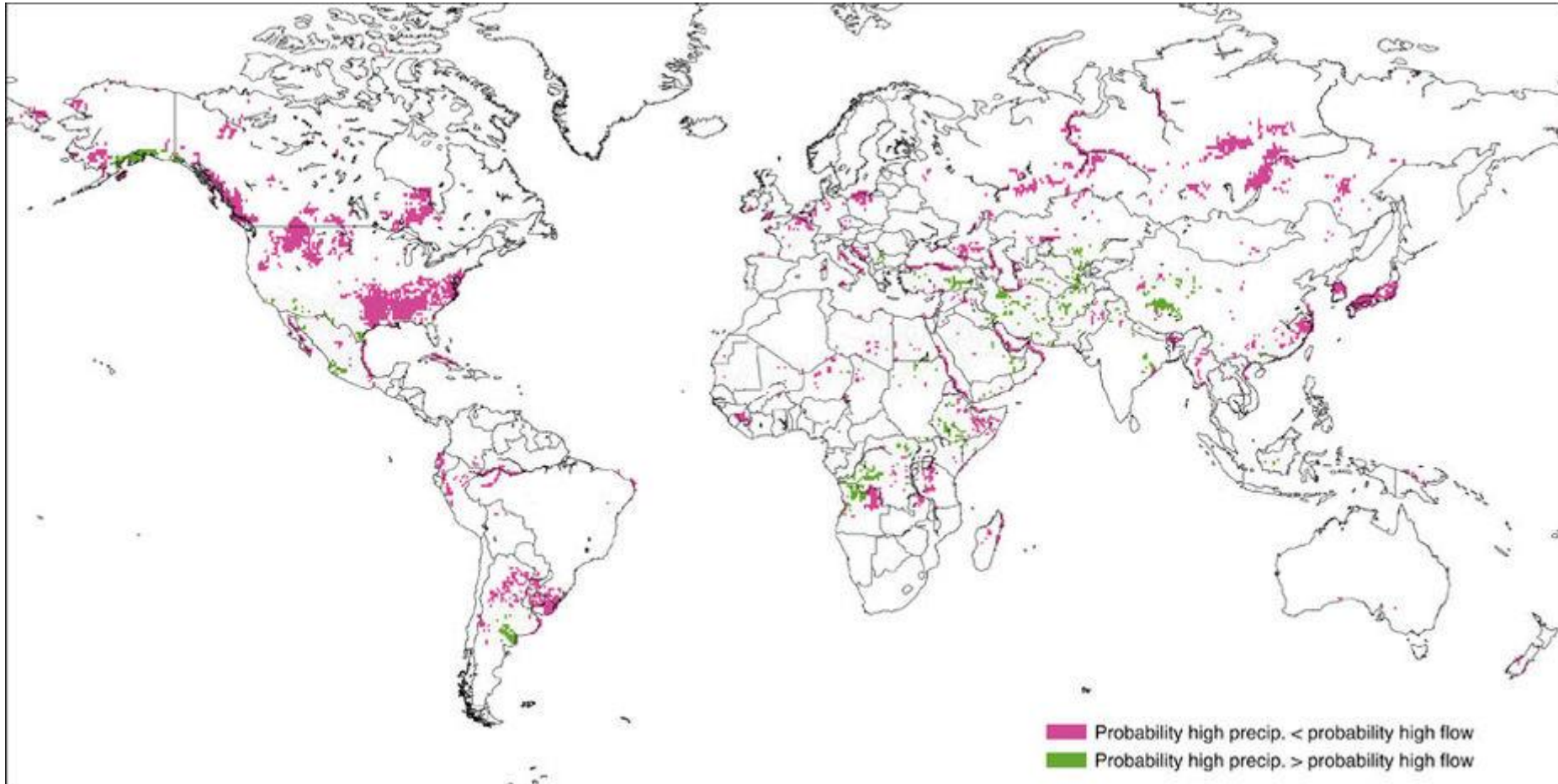University of Reading

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# What about the Uncertainty?

- Uncertainty in the response, vs. uncertainty in the data
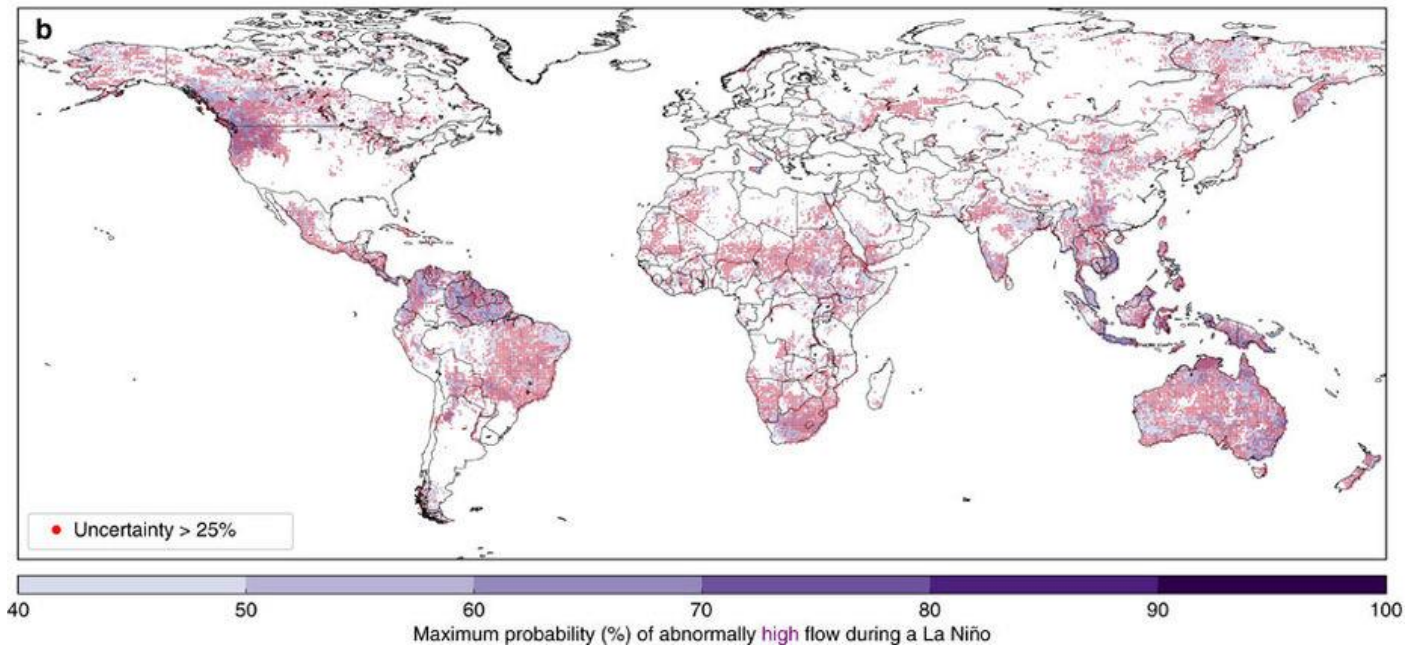
- **How might this impact decision-making?**

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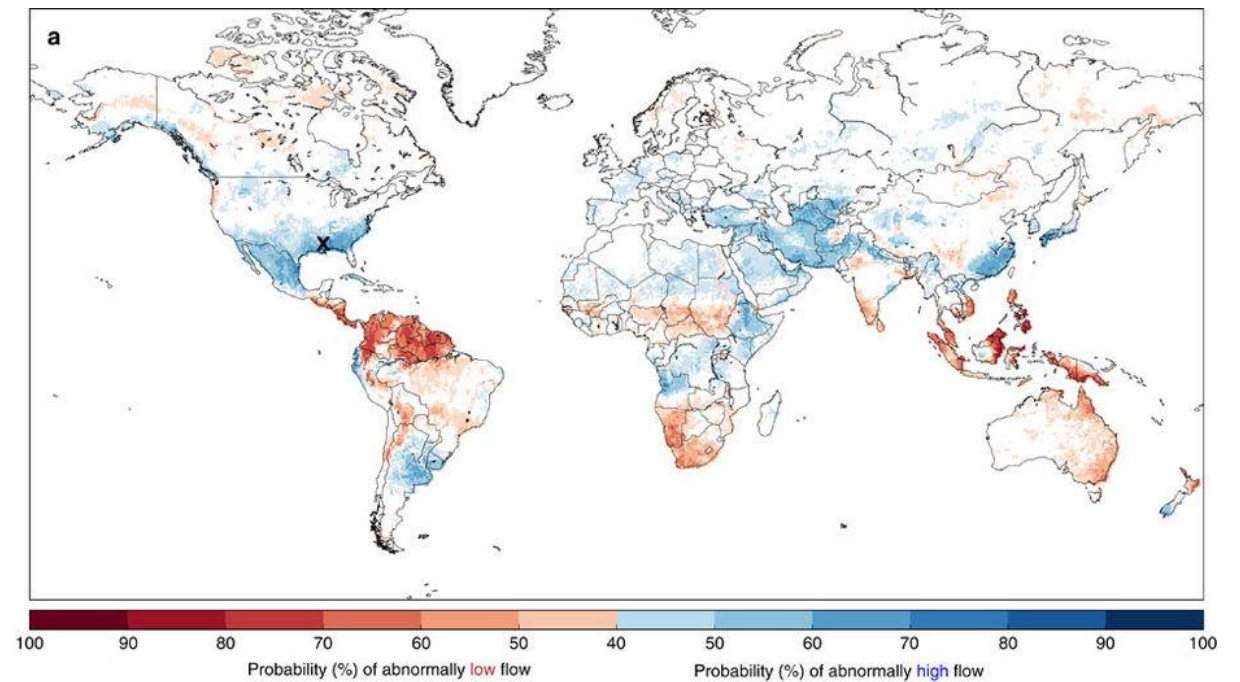
# Importance of the Hydrology



Legend: Probability high precip. < probability high flow (pink); Probability high precip. > probability high flow (green)
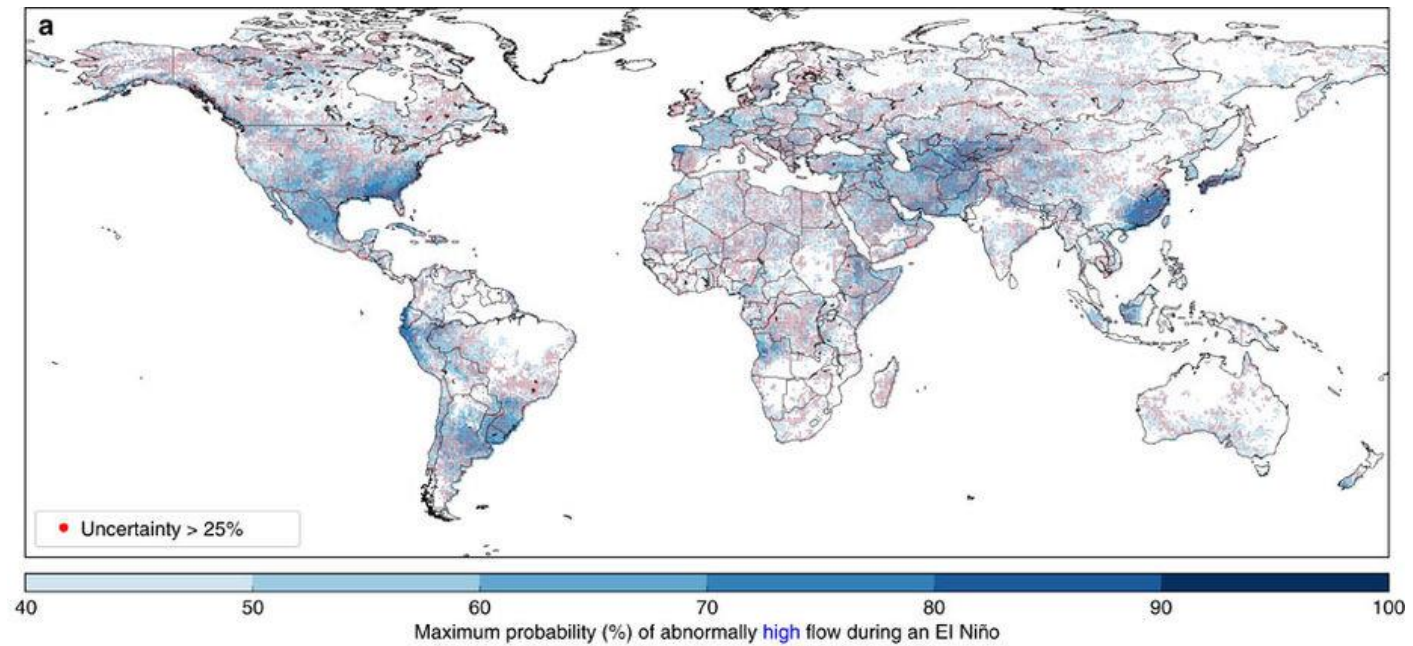
# Maximum Probabilities

- **Quick, global overviews**

- Where is likely to see an influence on river flow during El Niño / La Niña?



a

Uncertainty > 25%

40    50    60    70    80    90    100

Maximum probability (%) of abnormally high flow during an El Niño

b

Uncertainty > 25%

40    50    60    70    80    90    100

Maximum probability (%) of abnormally high flow during a La Niño

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"We conclude that **while it may seem possible** to use historical probabilities to evaluate regions across the globe that are more likely to be at risk of flooding during an El Niño/La Niña…
**the reality is much more complex.**"

Emerton et al., 2017: **Complex Picture for Likelihood of ENSO-Driven Flood Hazard**, *Nature Communications, 8:14796*

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# Thank You!

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