2000 year drought dataset for present-day and 2K temperature increase

Niko Wanders[1], Karin van der Wiel[2], Frank Selten[2], Marc Bierkens[1]

1 Department of Physical Geography, Utrecht University, The Netherlands

2 Royal Netherlands Meteorological Institute, KNMI, The Netherlands

HIWAVES3

Introduction

There is growing evidence that climate change will alter global water availability. Here, we investigate how hydrological droughts are affected under 2K global warming. Due to the extreme nature of hydrological drought, we need longer timeseries to accurately estimate distributions of drought characteristics. Within the HiWAVES3 project we aim to quantify the changes and teleconnection in extreme droughts events, using the new HiWAVES3 large ensemble simulations.

Material and Methods

The fully coupled dynamical model EC-Earth was used to generate 2000-year simulation of meteorological variables, both for a present-day climate and a 2K warming scenario. The present-day period is defined as the period in the model in which the global mean near-surface temperature is equal to that observed for the period 2011-2015.

For the global simulation of discharge, we use the global hydrological model PCR-GLOBWB 2 (Fig. 1), that includes human water interactions. The model produces discharge for the 2000-year period at a daily temporal resolution and 0.5-degree spatial resolution.

We computed the return periods of extreme drought events based on the coupled simulation to assess changes in extreme drought events under 2K warming

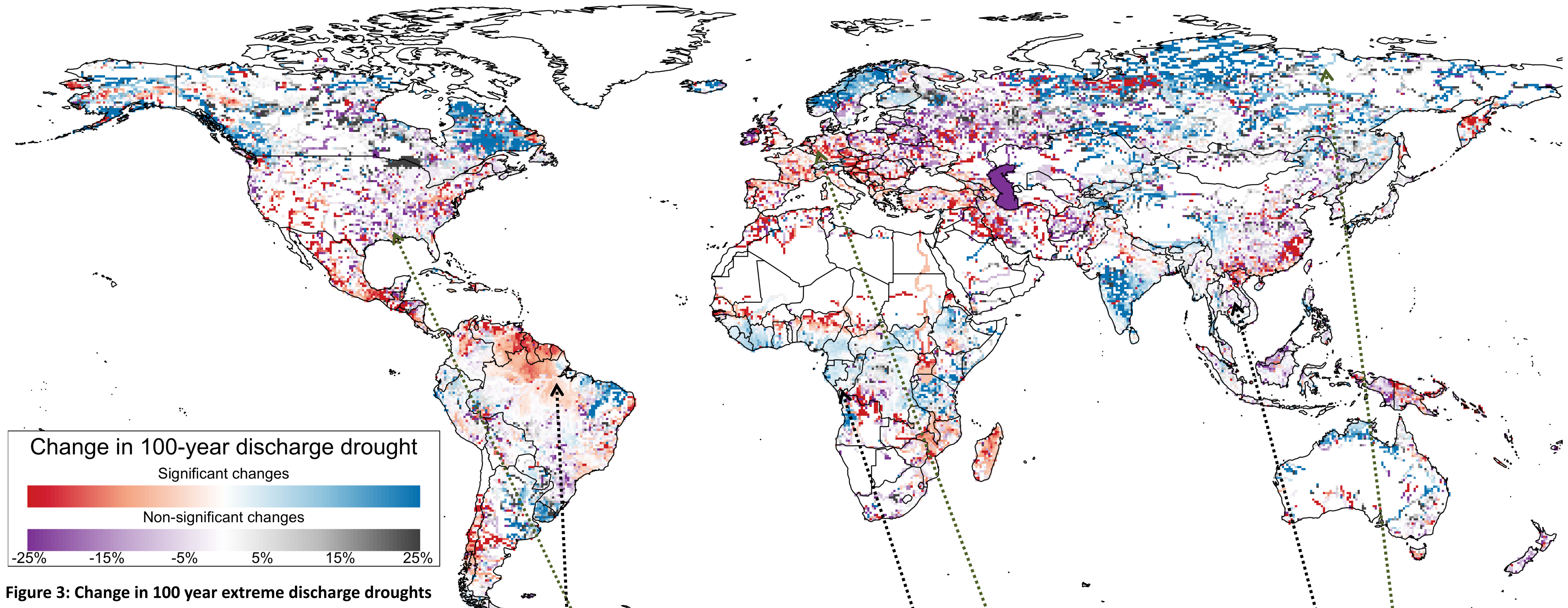

Figure 3: Change in 100 year extreme discharge droughts

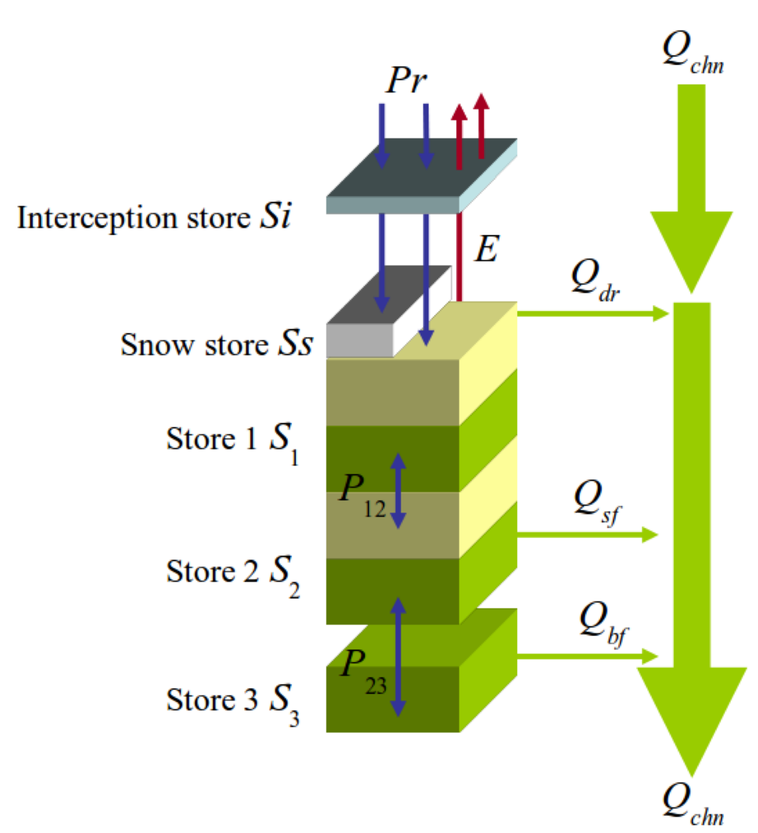

Figure 1: Model concept of PCR-GLOBWB
Left: layers describing soil hydrology including the canopy, snow cover, soil layers and groundwater reservoir, as well as the exchange between them.
Right: specific local runoff components, routed as discharge along the channel

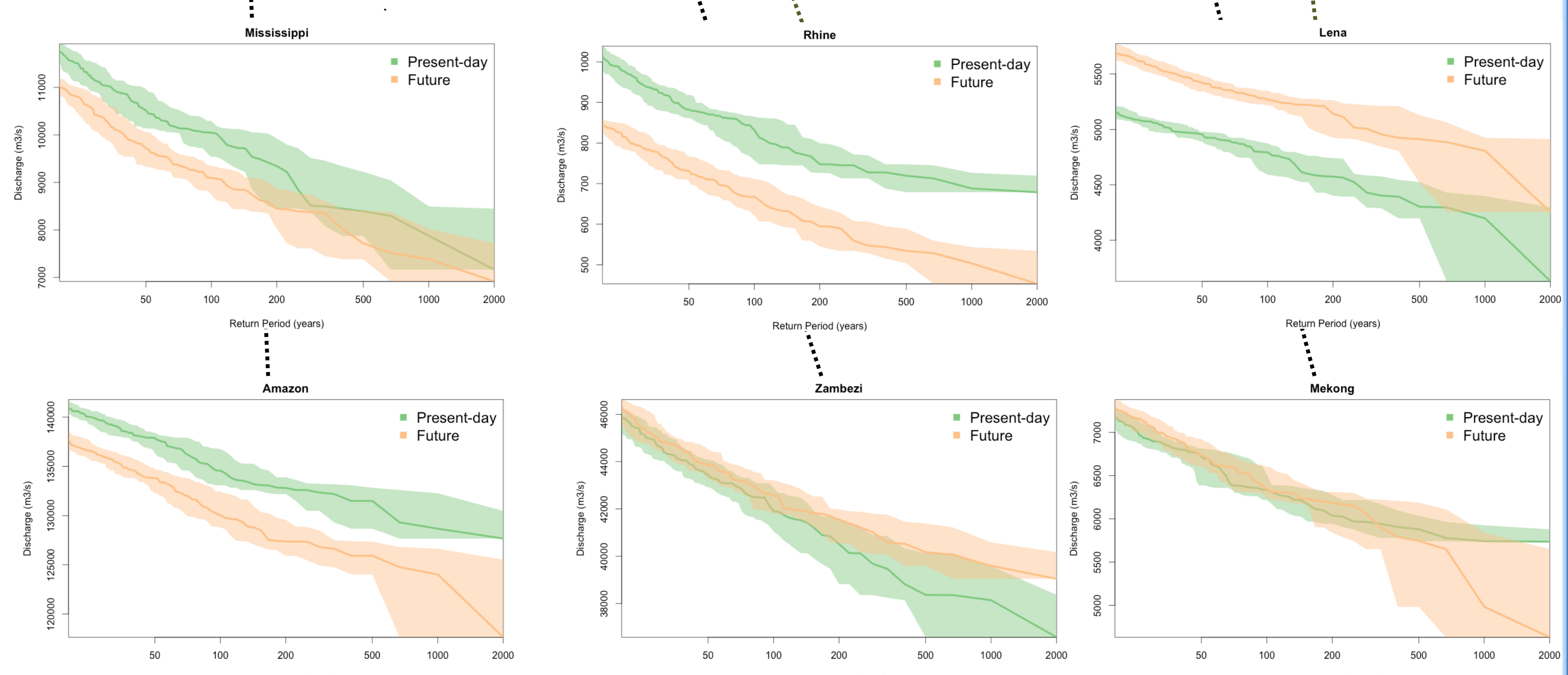

Figure 2: Change in extreme droughts for selected rivers. Bootstrapping is used to define the confidence of the forecasted changes in extreme drought events. A 100 samples were generate to compute the confidence intervals for each of the return periods. The bold lines indicates the median values.

Results

The results show significant changes in extreme drought events (Fig. 2 & 3). 21% of the world shows significant negative trends in 100-year drought frequency (e.g. Fig. 2, Rhine, Amazon), while 31% shows similar non-significant negative trends (e.g. Mekong). Significant positive trends (e.g. Lena) are only found in 22% of the world. When looking at more extreme event we observe that the significant trends are only found in 26% of the world, with similar spatial patterns. Regions most impacts by 2K warming are the boreal forests, Tropics and Mediterranean.

Conclusion and future work

- This study shows that the approach of large ensemble climate and hydrological modelling provides improved estimates of the risk of extreme drought events.
- The use of large ensemble simulations allows for novel analysis of drought extremes across the globe.
- Extrapolation of the extreme values will not be sufficient to capture the changes in extreme drought events.
- The use of a large ensemble approach for any future assessments of the impact of climate change on future drought characteristics is highly recommended.

Universiteit Utrecht

European Geosciences Union General Assembly 2018
9 – 13 April 2018, Vienna, Austria

NWO
Netherlands Organisation for Scientific Research