Human Influence on the Runoff Regime and Runoff Extremes of the River Thur?

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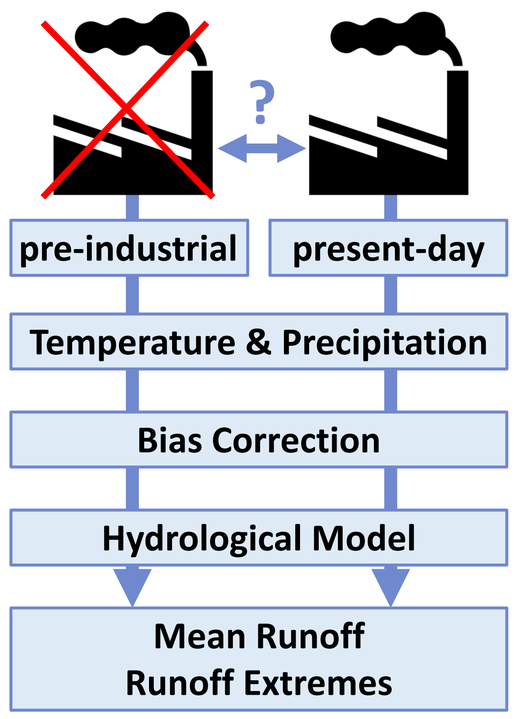
Introduction

Assessing the influence of anthropogenic greenhouse gas (aGHG) emissions on the hydrology is essential to understand current climate change and its impacts. In this study, we compare present-day river runoff with pre-industrial river runoff to investigate the human influence on the runoff of the river Thur. This attribution study may support the management of climate-related risks by assessing the human influence on:

- the **runoff regime** affecting many sectors (agriculture, water management, etc.)
- the **runoff extremes** potentially leading to devastating damages

Data & Methods



Data: Global Climate Model simulations including a present-day scenario (2'039 simulations) and a pre-industrial scenario (14'609 simulations) without the emission of aGHGs running from April 2000 to March 2001 (Pall et al. 2011)

Methods:
Bias correction method: empirical quantile mapping
Hydrological Model: Cemaneige-GR4J
Runoff regime: mean runoff as indicator
Runoff extremes: change in probability of occurrence (PR) defined as:

$$PR = \frac{P_{present\ day}}{P_{pre\ industrial}}$$

$P_{present\ day/pre\ industrial}$: % of present-day/pre-industrial simulations exceeding a given threshold (empirical return period)

Runoff Regime

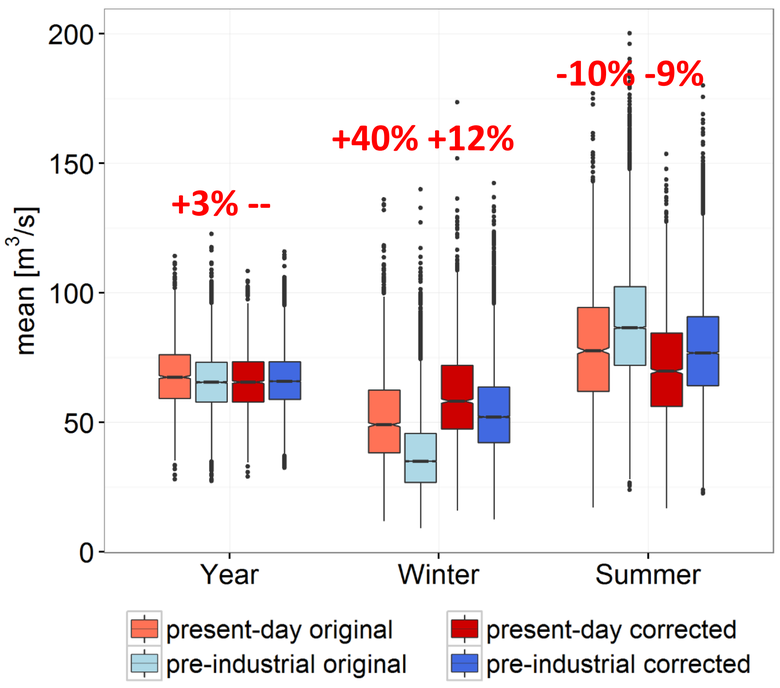


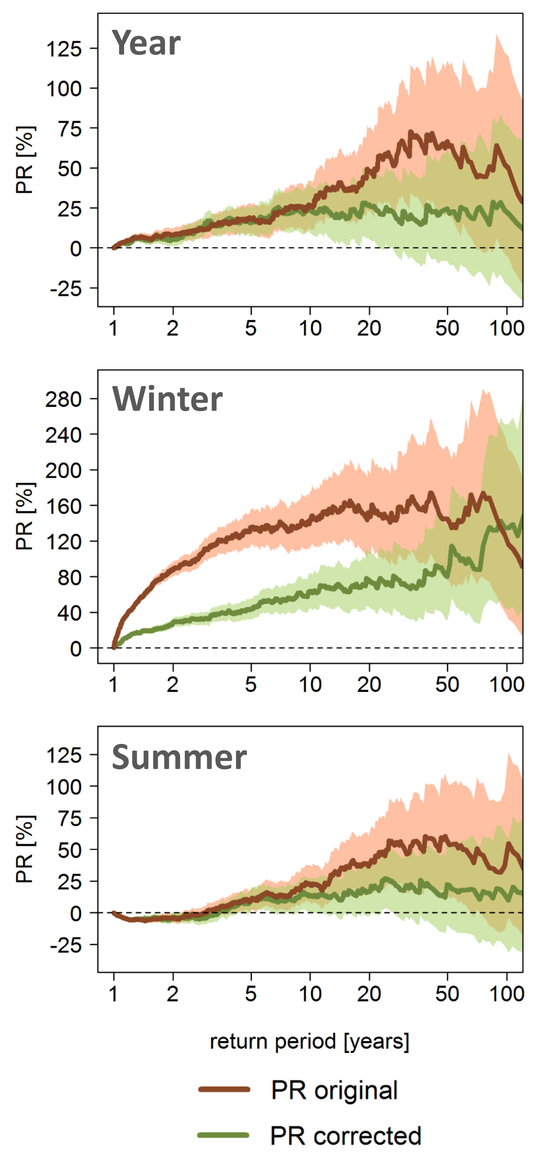
Figure 1: mean runoff of the river Thur for the full year, winter, and summer

Winter runoff: present-day scenario **>** pre-industrial scenario due to more precipitation, higher temperatures, enhanced snow melt, reduced snowfall and snow accumulation

Summer runoff: present-day scenario **<** pre-industrial scenario due to less precipitation, higher temperatures and enhanced evapotranspiration reducing the available amount of water

Yearly runoff: present-day scenario ≈ pre-industrial scenario

Runoff Extremes



General:

- Positive PR values for extreme events
- PR increases with higher return periods
- $PR_{original} > PR_{corrected}$

→ Extreme runoff events more likely due to aGHG emissions

PR for 10-100 year events:

Year: +20-25% corrected
+25-65% original

Winter: +60-135% corrected
+115-145% original

Summer: +10-30% corrected
+20-60% original

Figure 2: change in probability (PR) of occurrence due to the emission of anthropogenic greenhouse gases for the full year, winter, and summer.

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References: Pall, P., et al. (2011). Anthropogenic greenhouse gas contribution to flood risk in England and Wales in Autumn 2000. Nature, 470:382–385.

Conclusions

The emission of anthropogenic greenhouse gases has changed the runoff regime and runoff extremes of the river Thur!

- Shift in runoff regime towards higher winter runoff and lower summer runoff
- Extreme runoff events more likely and more frequent due to aGHG emissions
- Original simulations overestimate human influence → bias correction recommended