Effects of Water Abstractions on River Low-Flows

Universiteit Utrecht

Inge de Graaf, Rens van Beek, Yoshi Wada, Marc Bierkens

i.e.m.degraaf@uu.nl, Dept. Physical Geography, Utrecht University

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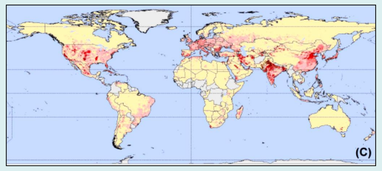
1. Objective

This study focuses on:

- The effects of abstractions on trends in low-flow conditions.
- The effects of water return flows on river regimes.

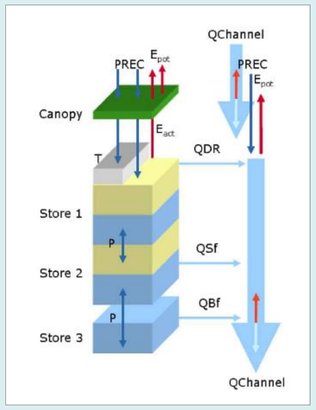
2. Methodology

Input: Global water demand



- Groundwater plus surface water abstractions, for irrigation (Irr) and industrial & domestic (I&D) use[2].
- Runs done with ERA-40 climate forcing for 1960-2000.
  1) No-abstractions,
  2) Abstractions 1960,
  3) Abstractions 1960-2000

Model: PCR-GLOBWB[1]



- Daily time steps, 0.5° resolution, built with global datasets

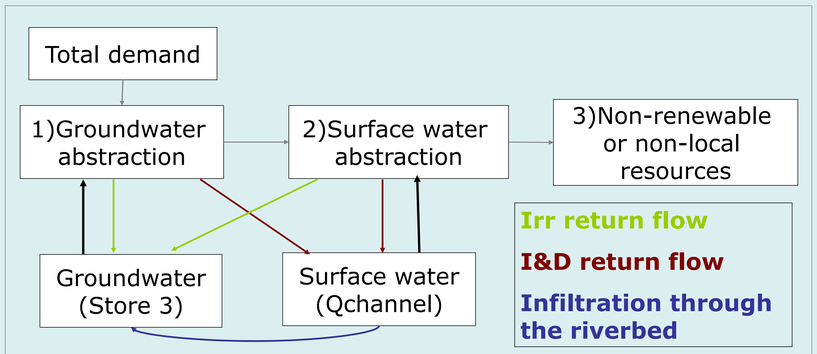


Figure 1: Included return flows, and distribution of demand over water resources. Total demand is first abstracted from groundwater, secondly form surface water, and thirdly from non-renewable or non local resources. Low-flow conditions of no-abstraction scenario limit surface water abstractions.

3. Results

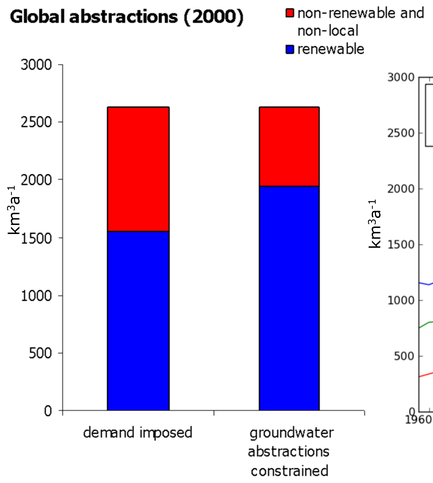


Figure 2: A comparison of global total abstractions of this study (left) and Wada et al. (2011)(right). Doll et al (2011) calculated 1179 km^3a^{-1} renewable abstraction.

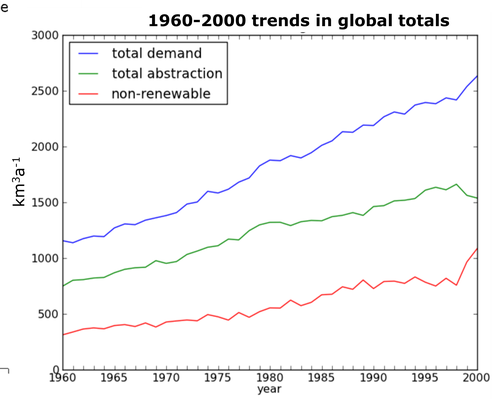


Figure 3: 1960-2000 trends. Non-renewable abstractions almost tripled since 1960 (400-1080 km^3y^{-1}), and is likely to increase further in the near future.

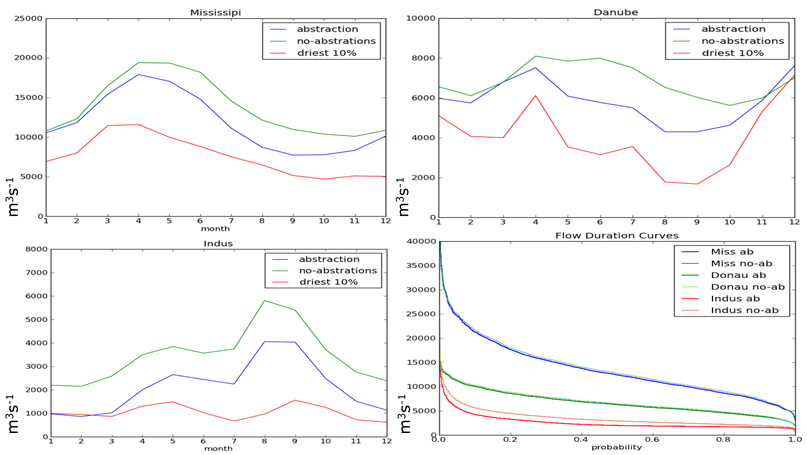
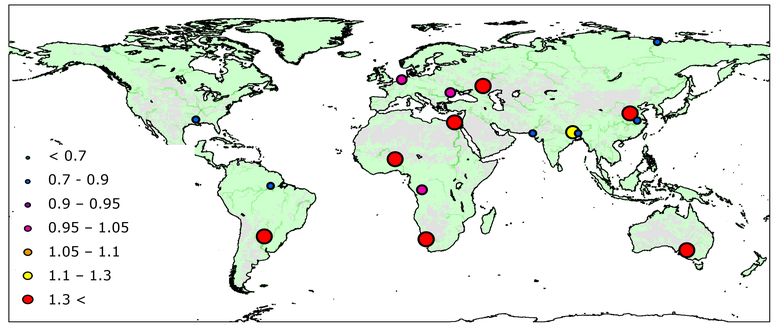


Figure 4: Regime curves and flow duration curves of three rivers for the no-abstraction- and abstraction scenario, and driest 10% of the period 1960-2000. Stream flows get lower due to abstractions and low-flow frequency increases. Timing and magnitude of low-flows change due to return flows.



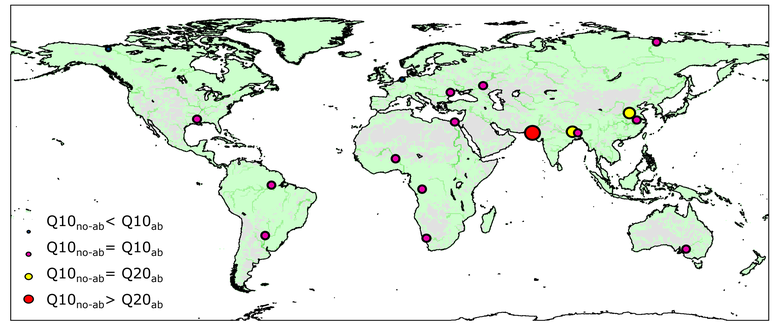


Figure 4: A: Measured average discharge compared with simulated values. Simulated values compare well with measured data **B**: Change of low-flows (Q10%) when abstractions are left out. Biggest changes are found for dry areas with large demands.

4. Conclusions

- Effects of water abstractions on river discharges are evident at the global scale, particularly on frequency of low-flow conditions.
- Return flows are important and influence magnitudes and timing of low-flows.
- The global non-renewable plus non-local abstraction is 1080 km^3yr^{-1} for the year 2000, which is 30% of the total demand. This amount almost tripled during 1960-2000.

5. Next steps

- Desalinated water uses will be included. This increases water availability.
- Total demand will be distributed over groundwater and surface water resources in more realistic proportions.

References

1. Van Beek et al. (2011) Global monthly water stress: I water balance and water availability, Water Resour. Res, 47, W07517
2. Wada et al. (2011) Modeling global water stress of the recent past: on the relative importance of trends in water demand and climate variability, *Hydrol. Earth Syst. Sci,* 15, 3785-3808