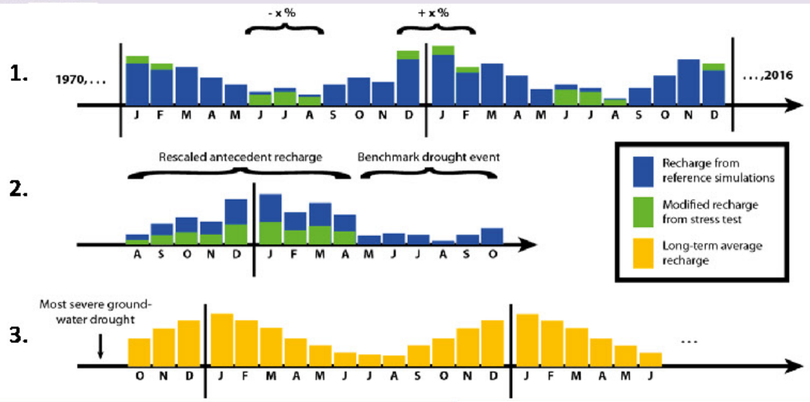
UNI FREIBURG

The large porous aquifers could face more severe groundwater droughts following prolonged meteorological droughts.
Baseflow is more prone to shorter droughts.

STRESS-TESTS

Three types of stress-tests are applied to a gradient-based groundwater model for Germany (resolution of 1 km²):

1. a **seasonal shift** of groundwater recharge (less in summer, more in winter);
2. a reduction of recharge according to specific return periods prior to historical **drought events**;
3. **recovery** from a severe groundwater drought using typical local recharge dynamics.



EGU21-10511

Stress-testing groundwater and baseflow drought sensitivity to recharge

Jost Hellwig, Michael Stoelzle, Kerstin Stahl

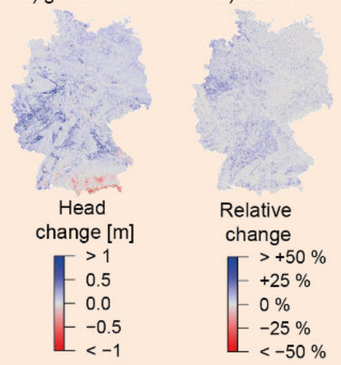
Chair of Environmental Hydrological Systems, Albert-Ludwigs-University of Freiburg
jost.hellwig@hydrology.uni-freiburg.de
www.hydsys.uni-freiburg.de

Publication: Hellwig et al. 2021, HESS

1. SEASONAL SHIFT

For the stress-test of a seasonal re-charge shift groundwater heads in Germany (map) generally increase except in the alpine south. Changes of groundwater heads are smaller during drought than for median conditions. Differences between the seasons are negligible.

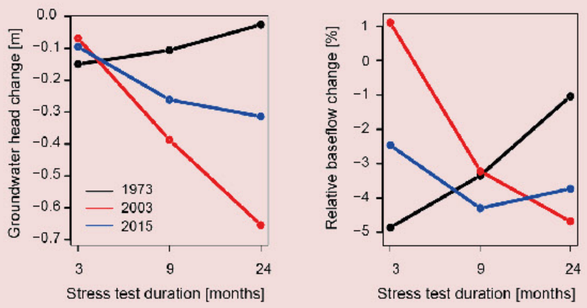
Change of winter droughts across Germany due to seasonal recharge shift
a) groundwater b) baseflow



Changes of baseflow are less consistent throughout the year with increases in winter and decreases in the southern parts during summer. Changes are less pronounced for drought conditions.

2. DROUGHT EVENTS

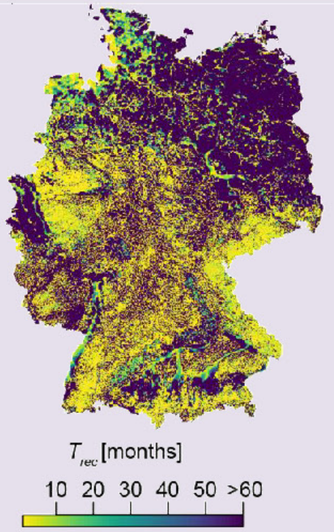
The groundwater drought events of 1973, 2003 and 2015 would have been more severe if antecedent recharge conditions had been drier.



For example, the 2003 event can be characterized as a short-term summer drought. For groundwater and baseflow it could have been more severe given larger recharge deficits in the proceeding years (stress test duration of 24 months in the plots).
Responses of groundwater and baseflow differ as baseflow usually responds faster to drought compared to water tables.

3. RECOVERY

For average recharge conditions the recovery time T_{rec} is shorter than 10 months in large parts of Germany (map). On the contrary, for some large porous aquifers, heads will still not recover after up to 60 months of average recharge. In these regions, average recharge is not enough to terminate a severe groundwater drought.



In the large porous aquifers groundwater responds to long-term recharge characteristics. Accordingly, the 24-months duration or changes in the annual average recharge sum cause the strongest responses and reveal the potential for more severe groundwater droughts. Contrasting, in the fractured aquifers intra-annual recharge dynamics are much more relevant, demonstrated by the stronger responses to 3-months stress tests.

CONCLUSION

- Spatial patterns of groundwater stress during drought are driven by hydrogeology.
- The duration of recharge stress is most relevant for the groundwater heads during drought.
- Baseflow is not linearly related to changes of groundwater heads and is more prone to intensified drought event conditions on a shorter time scale.