EGU25-15279, updated on 12 May 2025
https://doi.org/10.5194/egusphere-egu25-15279
EGU General Assembly 2025


# Combining Climate Projections, Recharge Modeling, and Statistical Forecasts to Assess the FutureState of Regional Groundwater Resources and Their Sustainable Use

**Frederick Höckh**, Michael Finkel, and Olaf Cirpka
Tübingen, Geoscience, Hydrogeology, Germany (frederick.hoeckh@uni-tuebingen.de)

The management of groundwater resources will be challenged by alterations in the water cycle induced by climate change. Projections
show a global decrease in groundwater recharge, with strong regional differences. Water suppliers must adapt their management
strategies to maintain quantitative sustainability and groundwater quality, where the latter is endangered by increased microbial
contamination, rising temperatures, longer droughts, and heavy precipitation events.
A first step toward adaptation is a thorough assessment of the history, current state, and possible future scenarios of a region's
renewable water resources. To facilitate such assessments for broad application, a suitable framework should be simple and avoid
the use of complex and regionally, often unavailable, models.
We propose a framework that assesses the renewable groundwater resources of a water-supply system relying on simple-to-apply
methods and, in most cases, openly available data. The framework consists of identifying the origin of the produced drinking water,
delineating the area of groundwater recharge, and assessing the historical and present demand and availability of water, including
the identification of the main drivers of water demand. These findings are extrapolated into the future using projections of regional
climate and changes in water demand linked to the growth of population, economy, and other water-demanding entities or their
potential establishment (e.g., introduction of irrigation agriculture in response to climate change). Known indicators, such as the
water-exploitation index, are useful to estimate the sustainability of the water supply for given conditions.
We have applied the framework to a regional water supplier in southwest Germany, the Ammertal Schönbuch Gruppe (ASG), which
provides water for about 120,000 people. Demands from industry and energy production are indistinguishable from the overall

demand. Irrigation in agriculture is not applied. Water demand is met by extraction from two different resources, a porous gravel
and a karstified limestone aquifer. Additionally, the supplier relies on a far-distance water supplier, the Bodensee Wasserversorgung
(Lake Constance water supply, BWV).
The scenario-based future developments comprise different degrees of population growth, per capita consumption, as well as
changes in groundwater recharge computed from down-scaled climate projections based on the RCP8.5 pathway. The findings of
the analysis of the historical situation are in good agreement with the reports of the water supplier. First indicators of potential
water stress appear in the years leading up to when the supply situation was reported as "tense".
The evaluation of future projections shows that the supply situation intensifies. Recharge rates are projected to drop to as low as
100 mm/a by 2060 in the 10-year average, from over 150 mm/a between 1990 and 2000 while the demand is projected to rise by up
to 30%. While meeting the average demand is feasible and complications arise only from droughts in most scenarios, contemplation
of the drier scenarios shows that severe water stress might be a permanent issue by the second half of the century.