Sustainable Groundwater Management

… safeguards a freshwater resource under changing climatic conditions

Definition, Objective and Description

The importance of groundwater resources is likely to rise due to the immediate effect of climate change on the surface water systems. The future sustainable groundwater management (SGM) will thus have to balance the growing demand against the more restricted supply due to possibly lower aquifer recharge and increasing deterioration within the limits of the respective aquifer.

SGM is to be based on an aquifer-covering, frequent monitoring system, which provides a range of data on the characteristics of the aquifer, foremost on the current groundwater level, but also quantity and quality, etc. This data helps to develop an improved understanding of the aquifer and thus to determine the limits of water withdrawal in view of maintaining the aquifer's buffer and contingency capabilities.

When production rates exceed the natural recharge rates substantially, i.e. when resources are overexploited, the groundwater storage capacity of the aquifer can be severely damaged. Overexploitation may result in geotechnical, architectural and hygienic problems or provoke hydraulic shortcuts, which can lead to salination or other deteriorations of the groundwater. Groundwater thus often acts as or is turned into a finite resource and in many areas peak non-renewable water, i.e. a production decline following a peaking of the water withdrawal, can be observed. Consequently, the resource water is sometimes compared with oil; yet, in contrast to oil, there are needs which can be met by water only.

In addition to this direct anthropogenic impact on the groundwater resources, decision makers and planners working on Integrated Water Resources Management (IWRM) have to take into account the mainly indirect effect of climate change on groundwater. Groundwater is closely interlinked with the surface systems concerning water, land use, vegetation and soil properties. Thus, the increase in temperature which reduces the water content of rivers, lakes, plants and soils therefore entails not only lower groundwater recharge rates but also losses of the aquifers to the surrounding, dried out environment.

Reversely, poor groundwater management can also add to climate change impacts: a significant part of the total annual sea level rise is caused by large-scale groundwater exploitation as the extracted groundwater eventually winds up in the sea, states the Utrecht University (Doi: 10.1029/ 2010GL044571).

SGM can mitigate the damages done and impacts to come on groundwater resources, if it is addressed and put into effect as a decisive part of IWRM. A broad range of efficient short and long-term measures can help mitigate the effects of climate change. Examples include:

- Replacing groundwater – which is often of drinking water quality – by treated grey or rainwater
- Using in-situ rainwater harvesting for securing soil infiltration and recharging aquifers
- Improving irrigation performance by using closed systems or drip irrigation
- Identifying appropriate forms of land use
- Delineating (ground)water protection zones
- Promoting and integrating best practices into water policies

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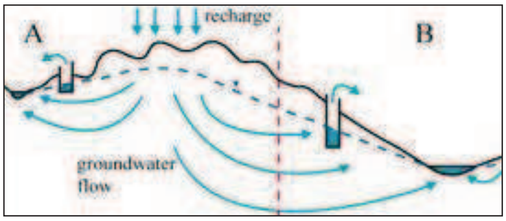
Issues to Consider

The concept of SGM is already embedded into the IWRM, yet it is often neglected due to a lack of awareness and know-how. Thus, the gathering, management and processing of data is one pillar of SGM. Profound assessments combined with applied research in multidisciplinary fields for setting-up calculations or groundwater models are a requisite for good groundwater governance.

Another pillar is the enhancement of communication and dialogue between various institutions and organizations on a national and transnational level. SGM often needs to be addressed on a transboundary level according to the hydrogeological boundaries of aquifers, which frequently cross political borders. As this may provoke discussions and conflicts over water rights and policies, cross-border cooperation shall be supported by peace-building measures, financing mechanisms and institution-building.



Exemplary sketch of a transboundary aquifer (UNESCO)


Groundwater Resources and Climate Change (www.groundwateruk.org)

Advantages

- Widely independent from short-term variations in precipitation and its immediate consequences for discharges or storage in open reservoirs
- Generally consistent chemical and microbial composition of water
- Allows for proper and timely interventions as water quantity or quality changes are detected early
- More cost-effective than aquifer restoration

Challenges

- Controversial demands on water resources have to be balanced: e.g. ecological (e.g. the conservation of wetlands) vs. economic (e.g. industrial water supply)
- Decreasing surface water resources threaten the water supply and increase the stress on the groundwater
- Affordability of high quality water for the poor is at risk as costs for water withdrawal (receding groundwater levels) and water treatment (increasing contamination) raise
- Bridging short-term surface water bottlenecks (e.g. due to seasonally dried-out rivers) by relying heavily on groundwater without damaging the aquifer

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