Title of the Highlight:
Effects of thermal use on groundwater ecosystems

Keywords:
Groundwater resources, ecosystem services, sustainability, aquifer microbes

Central statement of the Highlight in one sentence:
The thermal use of groundwater influences subsurface biodiversity, but poses no likely threat to groundwater quality in pristine aquifers.

Text of the Highlight:
Groundwater is mankind’s most important drinking water resource. At the same time, the use of groundwater for heating and cooling purposes is gaining importance (i.e. groundwater heat exchange, geothermics). However, potential effects of thermal use on aquifer ecosystem functioning, especially potential risks for drinking water production have not been addressed. In this pioneering project funded by the Life-Science Foundation, we have systematically monitored hydrogeochemical, microbiological and faunal parameters at a large-scale industrial heat discharge facility in a pristine, oligotrophic aquifer.

We show that while groundwater heat discharge did not affect any of the monitored physico-chemical parameters, subsurface biodiversity was surprisingly reactive to temperature. The diversity of bacterial communities significantly increased with temperature, while effects were opposed for fauna. Yet, temperature influence accounted for only <10% of total seasonal and spatial biotic variability. We did also not observe an improved survival or growth of coliforms and pathogens with temperature. Therefore, in pristine aquifers as the one investigated, and for the temperature ranges encountered, thermal use
poses no likely threat to GW ecosystem functioning, GW quality and drinking water production. This is an important contribution to a knowledge-based legislation and management practice of groundwater thermal use systems, and to a sustainable use and protection of groundwater resources.

**Publication:**

**Taking account of the HMGU mission:**
Within the research topics relevant for our environmental health mission, the HMGU investigates ecosystems with essential significance for human health. Here, especially groundwater ecosystems deliver important services and goods to our society. The results of this pioneering project funded by the Life-Science foundation have been generated in a direct collaborative effort with groundwater-related authorities and stakeholders and are an essential contribution to the sustainable use and protection of groundwater resources.

**The internal HMGU co-operation partners with whom the Highlight was compiled, if appropriate:**
S-777814-5043-001
Thermal use of groundwater (GW):

- Increasing importance for heating and cooling needs of our society
- e.g. deep geothermics, shallow aquifer heat exchange
- An important ecosystem service!

Important research questions:

- Effects of thermal use on aquifer ecosystem functioning?
- Potential risks for drinking water production?
The AQUITHERM project
(funded by the Life-Science Foundation, http://www.life-science-stiftung.org)

Institute of Groundwater Ecology

Field site:
- An active industrial heat discharge facility close to the Isar River
- A pristine, oligotrophic, oxic, quaternary aquifer with low DOC
  ➔ Relevant for drinking water production

Our approach:
- Time- and temperature-resolved GW sampling
- Monitoring of hydrogeochemical, microbial and faunal parameters

Spatial and seasonal dynamics of the temperature plume and location of sampling wells at the field site.

Brielmann, Griebler, Schmidt, Michel and Lueders (2009)
Effects of thermal energy discharge on shallow groundwater ecosystems. FEMS Microbiol Ecol
Temperature did not affect:
- Any of the monitored physico-chemical parameters
- Total counts of microbial cells and groundwater invertebrates
- Groundwater microbial activities
- Coliform and *E. coli* counts

Temperature did affect biodiversity:
- Diversity of bacterial T-RFLP fingerprints significantly increased
- Diversity of invertebrates decreased
- **But:** Temperature-driven biodiversity effects were inferior to overall spatial and seasonal variability
Conclusions and implications:

- Aquifer thermal use does affect aquifer biotic populations and biodiversity in relatively short time spans (one to several weeks).
- Yet, temperature influence accounted for only <10% of total seasonal and spatial biotic variability. Temperature was identified as the second dominant driver of biotic variation, after surface water influence.
- We did not observe an improved survival or growth of coliforms and pathogens with temperature.

⇒ In pristine aquifers, for the temperature ranges encountered, thermal use poses no likely threat to GW ecosystem functioning, GW quality and drinking water production.
⇒ This is an important contribution to an integrated authorization and facility management practice, and to the sustainable use of groundwater resources.