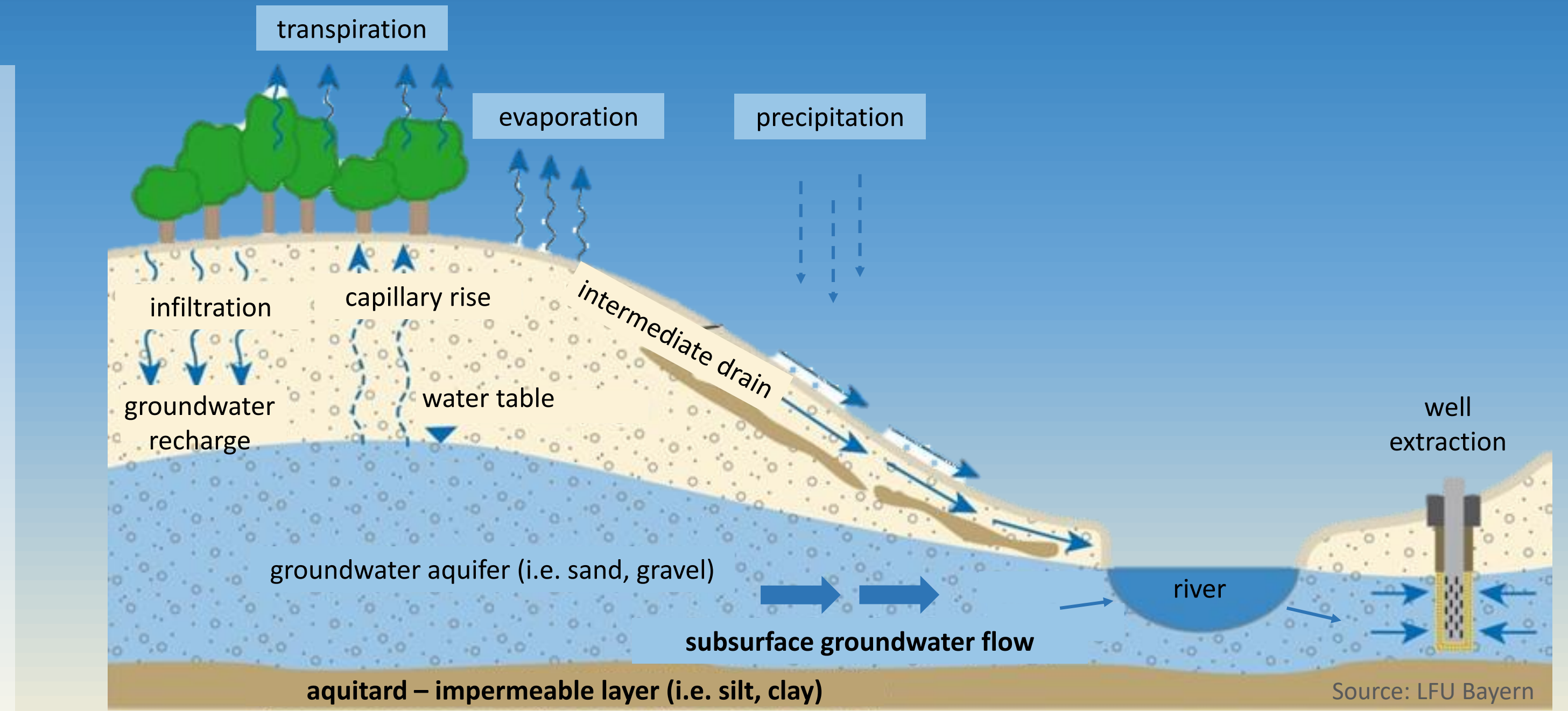




## Motivation

Not seen but hopefully always there – Groundwater is one of the key actors in the balance of the water cycle. With its variable use cases from drinking water to energy source its value for human kind is undisputed and must be protected from harmful influences in quality and quantity. Especially in urban areas the subsurface space is filled with anthropogenic infrastructure interacting and interfering with the dynamic groundwater, leading to new challenges in times of global warming



## Factors **stressing** the groundwater

### Urban infrastructure

- Surface sealing
  - Increase in surface temperature
  - Increase in surface runoff
  - Decrease in infiltration
- Subsurface buildings
  - Increase in groundwater temperature
  - Retain / divert groundwater flow

### Agriculture & Industry

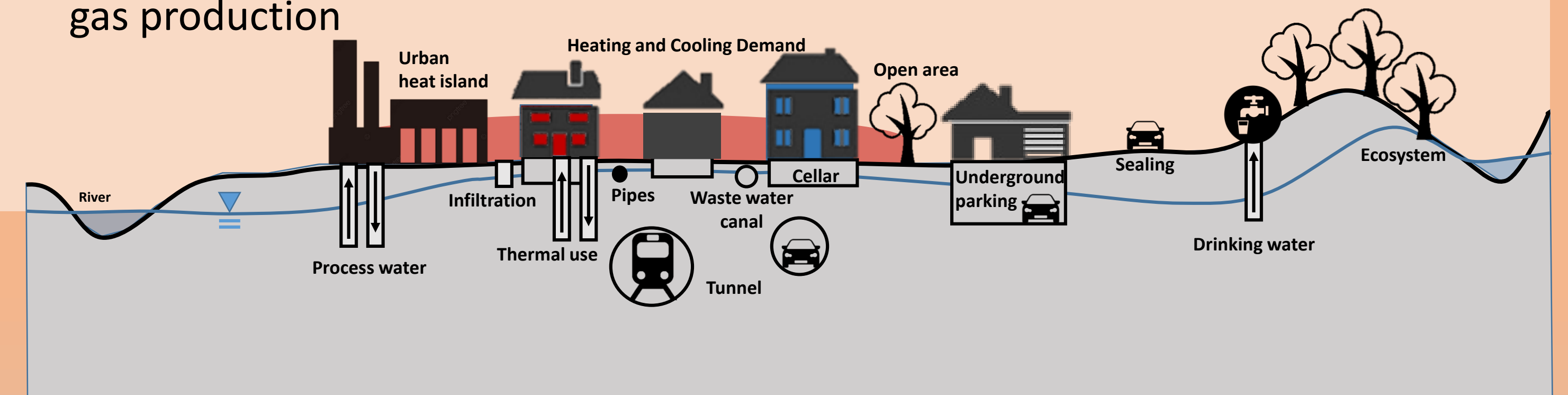
- Drawdown of water table
- Soil densification
- Intrusion of mineral and organic fertilizer
- Contamination i.e. with industrial pollutants

### Resource exploitation

- Drawdown of water table
- Mining of mineral products i.e. Gravel, Sand, Clay
- Cross contamination from oil & gas production

### Climate Change

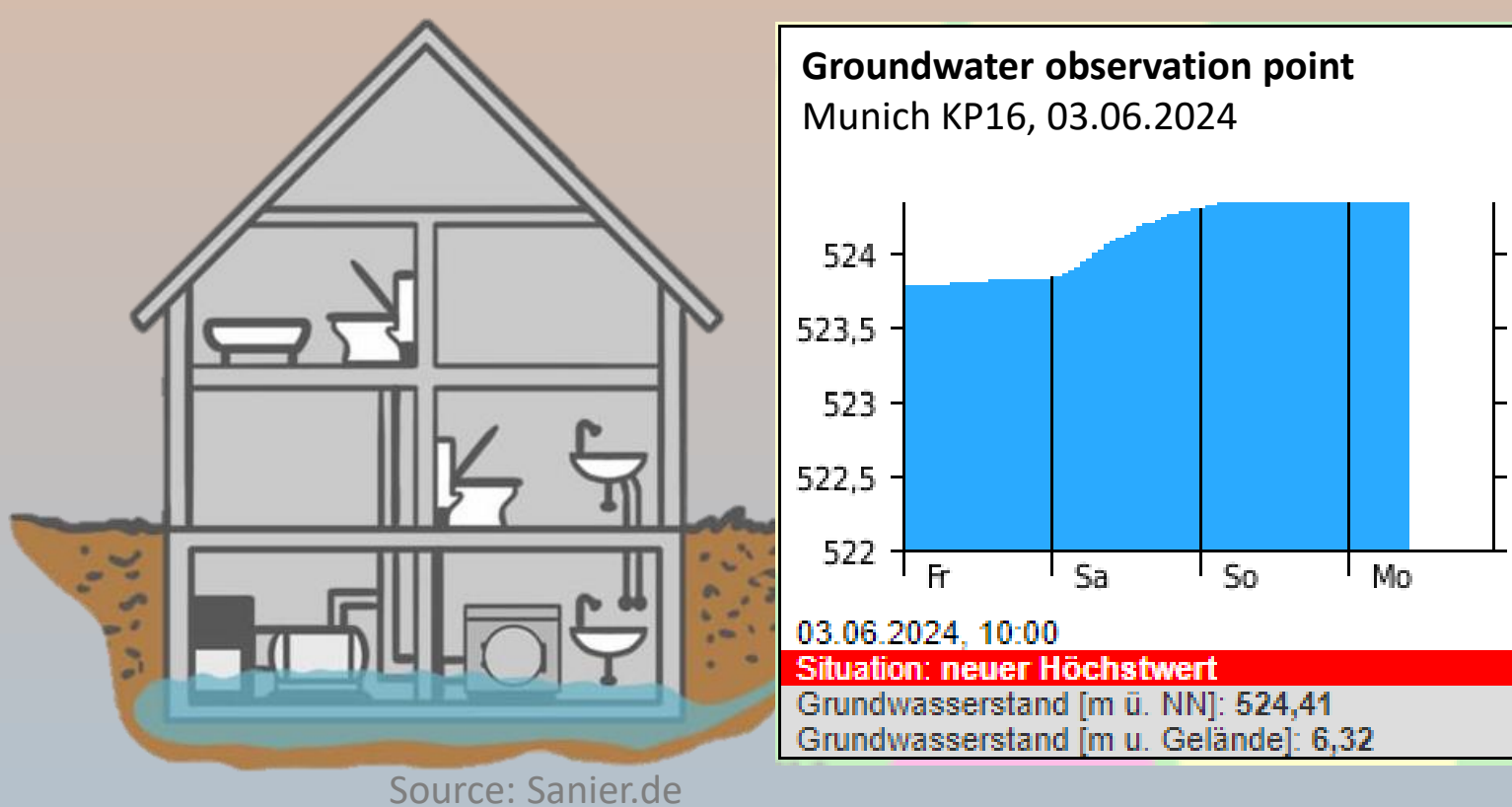
- Change in precipitation patterns in amount, intensity, distribution
- Increase in air temperature



## Impact on groundwater quantity:

### extreme groundwater level – too high

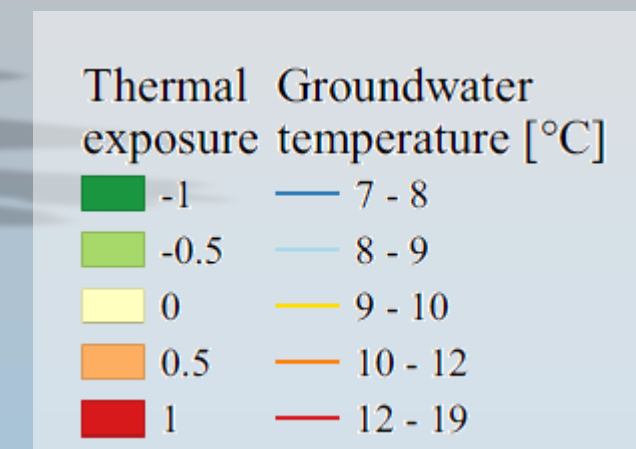
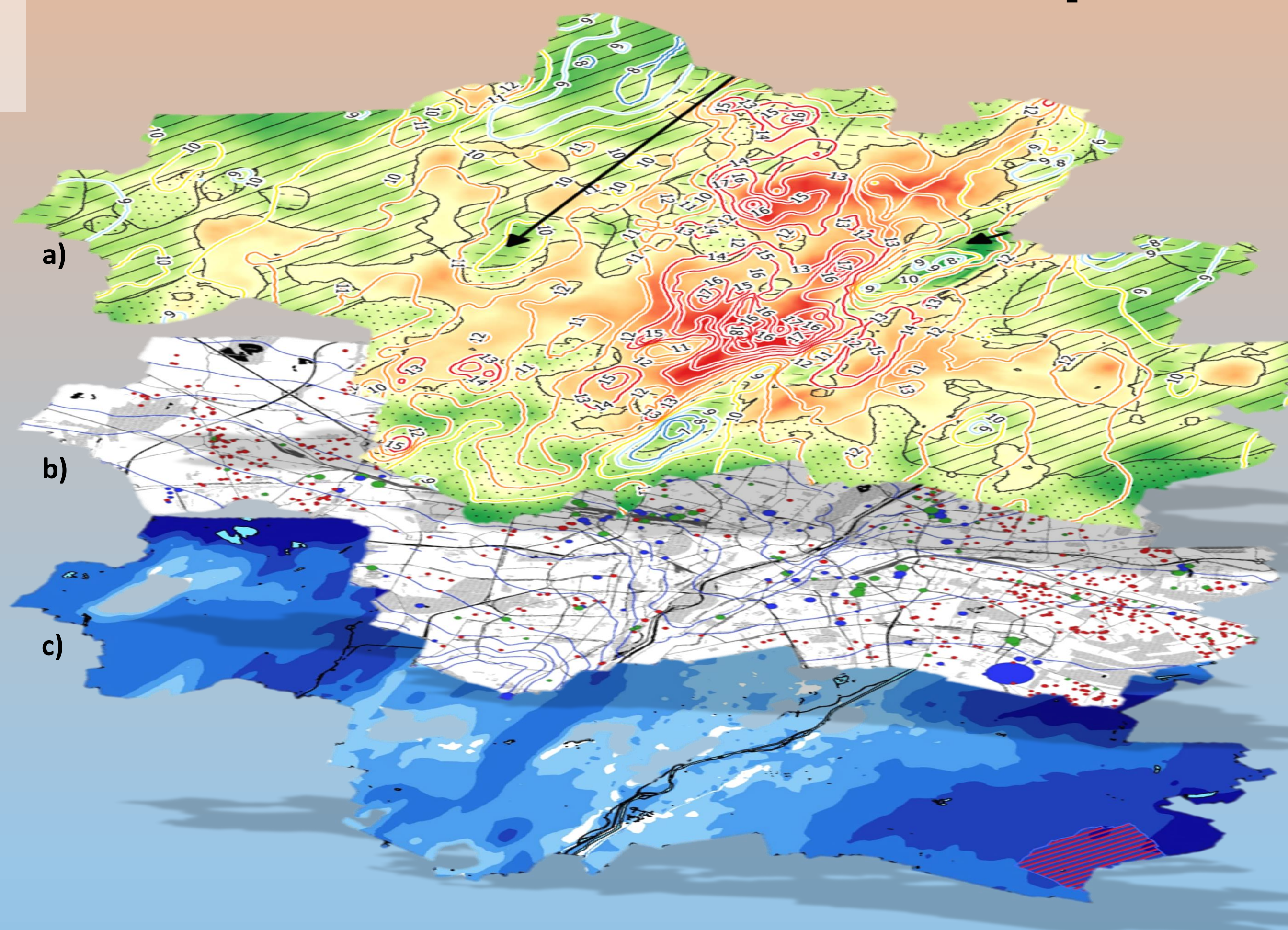
- Infiltration of water in cellars
- Damage by increasing water pressure
- Mobilization of water soluble pollutants



## Impact on groundwater quality:

### extreme groundwater temperature

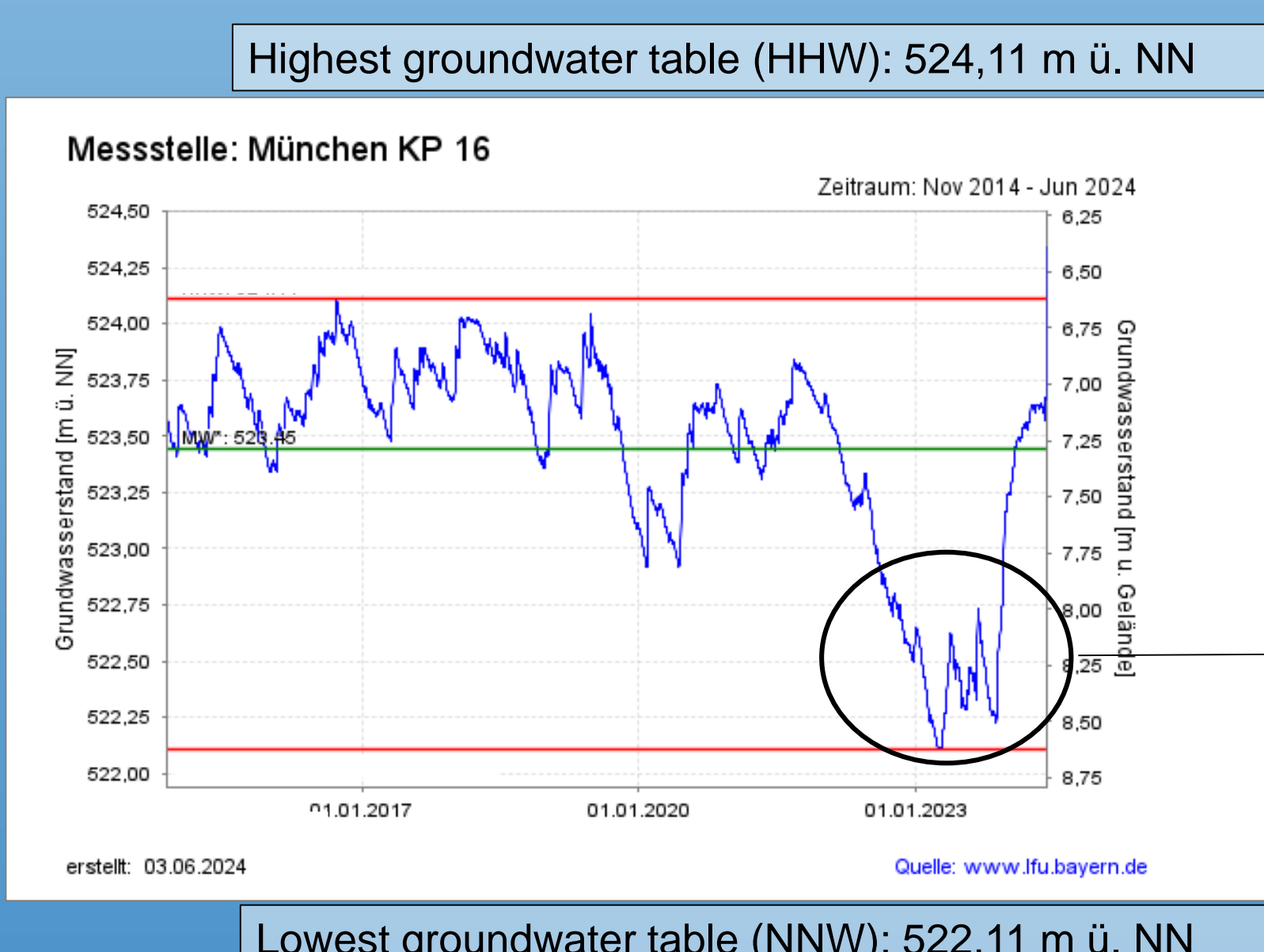
- **Subsurface Urban Heat Island (SUHI):** Increase of the groundwater temperature by more than 5°C in Munich city centre
- Negative impact on flora and fauna in water and soil
- Change in water chemistry (dissolved oxygen, CO<sub>2</sub>, pH-value...)



- a) Groundwater exposure and temperature
- b) Groundwater use, position of wells
- c) Aquifer thickness

### extreme groundwater level – too low

- Drinking water wells and other water extraction wells run dry
- Local soil-settlement of the ground
- Transport of oil-phase pollutants in deeper zones



Missing snowfall in Winter 2023 resulting in low groundwater recharge

### decrease in chemical groundwater quality

- Decreasing oxygen level leading to a change of the micro- and makrobiom of the subsurface
- Intrusion of pesticides damaging the natural organic balance
- Saltwater intrusion
- Precipitation of manganese and iron leading to scaling of groundwater wells
- Additional treatment for drinking water quality

