UNIVERSITÄT BERN

OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Swiss Water Resources – What is at Stake?

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With input from:
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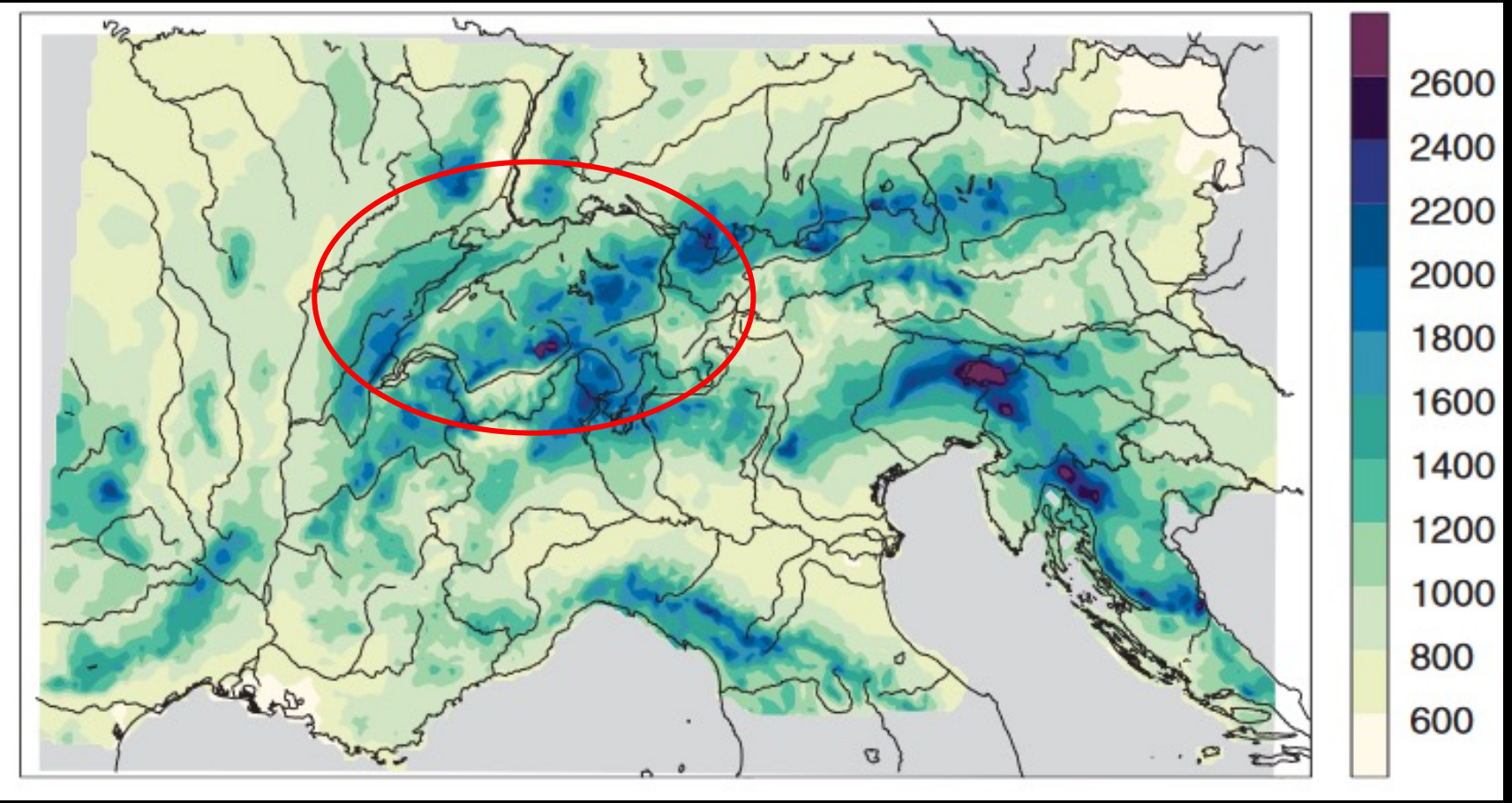
Mario Schirmer, EAWAG, Klaus Lanz, International Water Affairs

Switzerland, the water tower of Europe

Mean annual precipitation (mm/yr) for 1971-2008

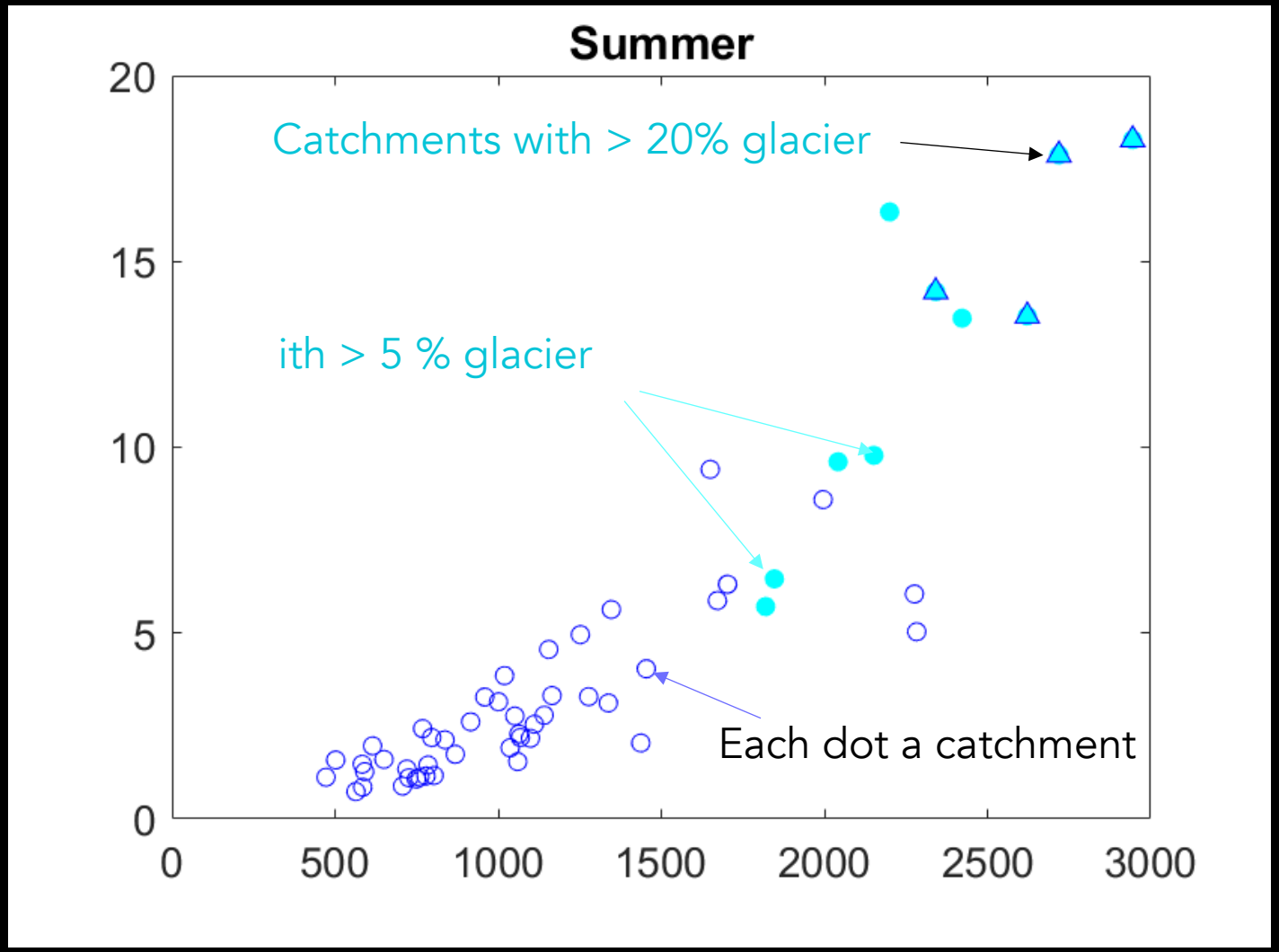


Isotta et al., 2013

Mean daily summer streamflow in Switzerland

Streamflow (mm/d)

Discharge in m^3/s divided by catchment area



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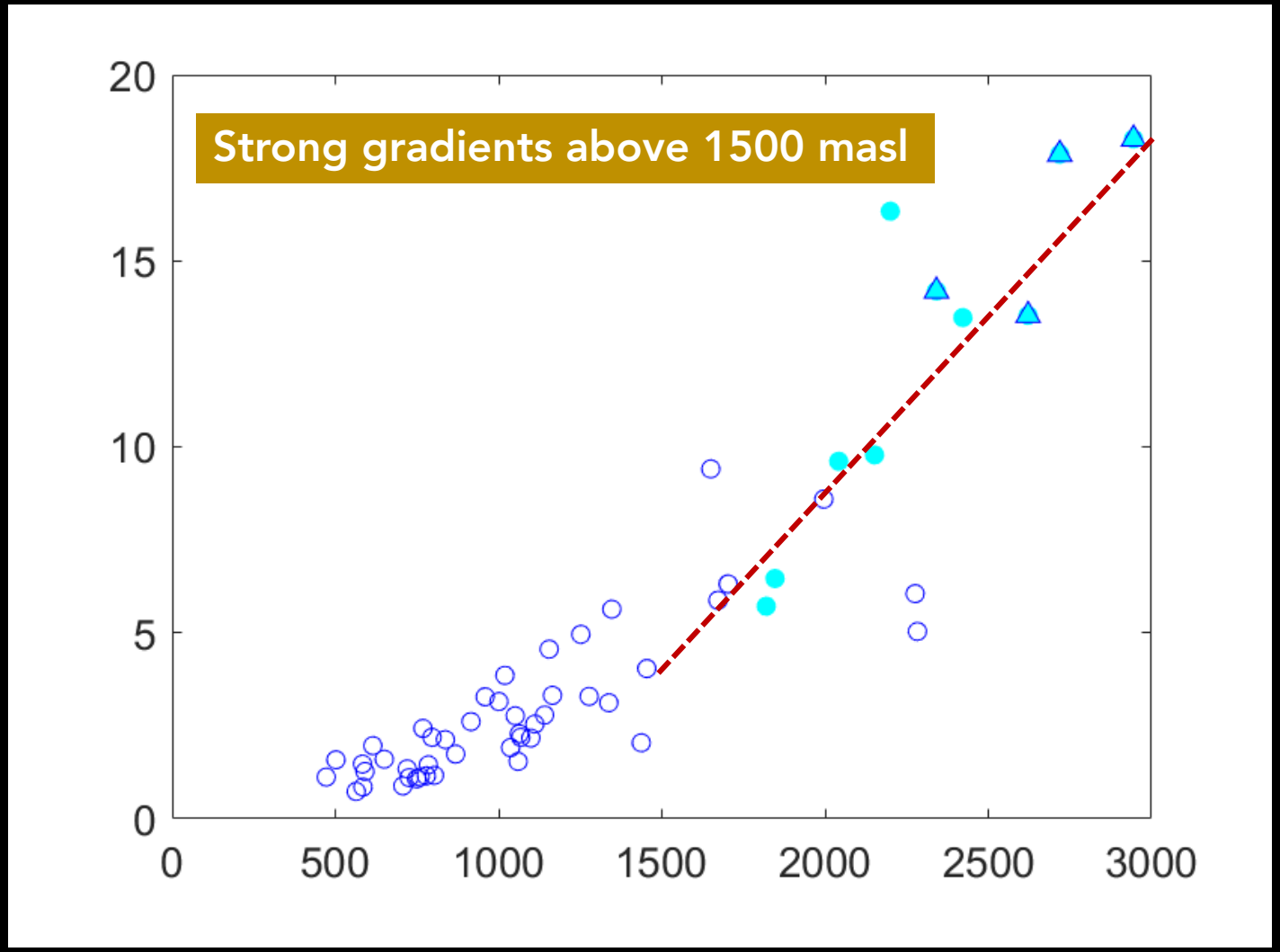
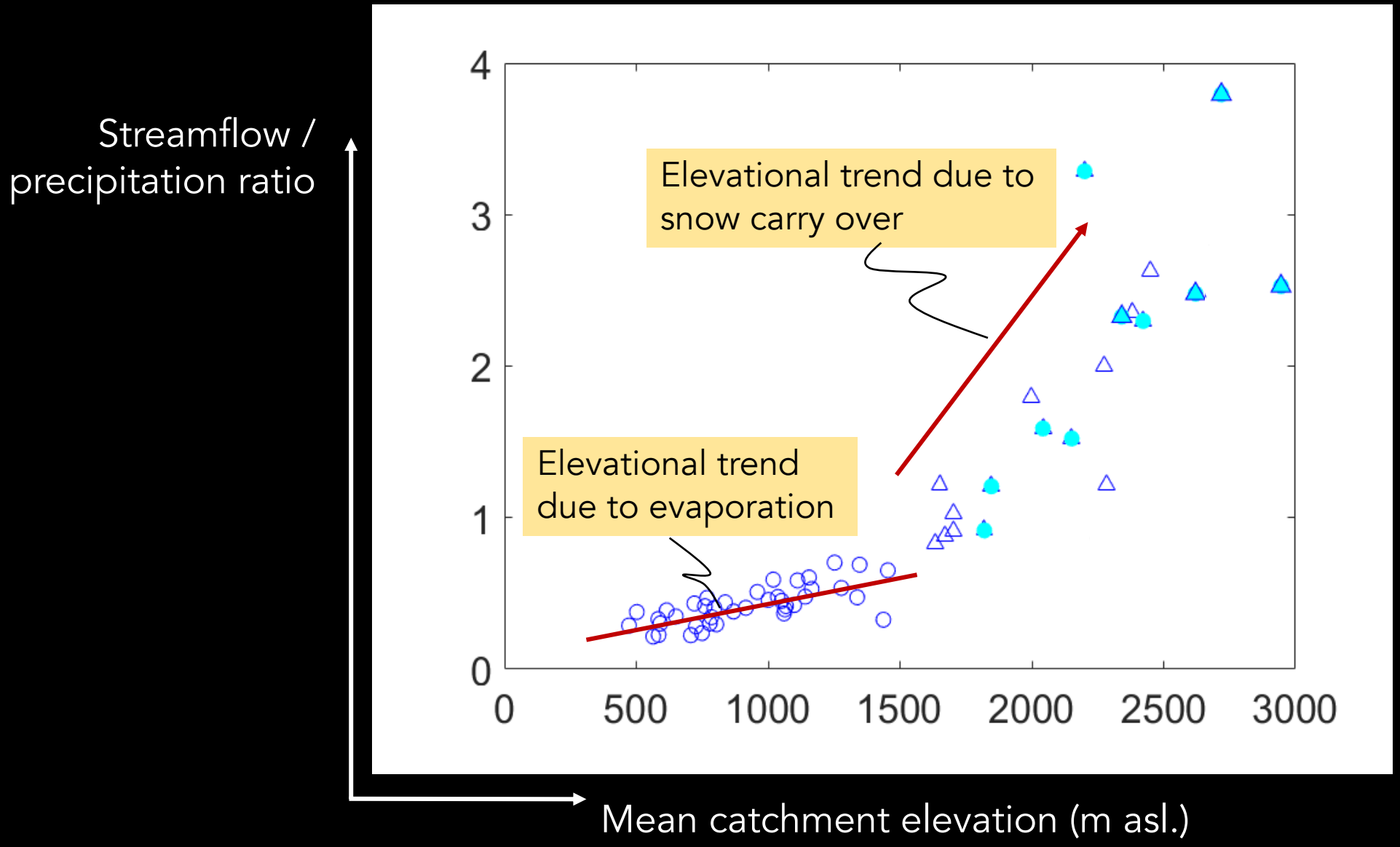


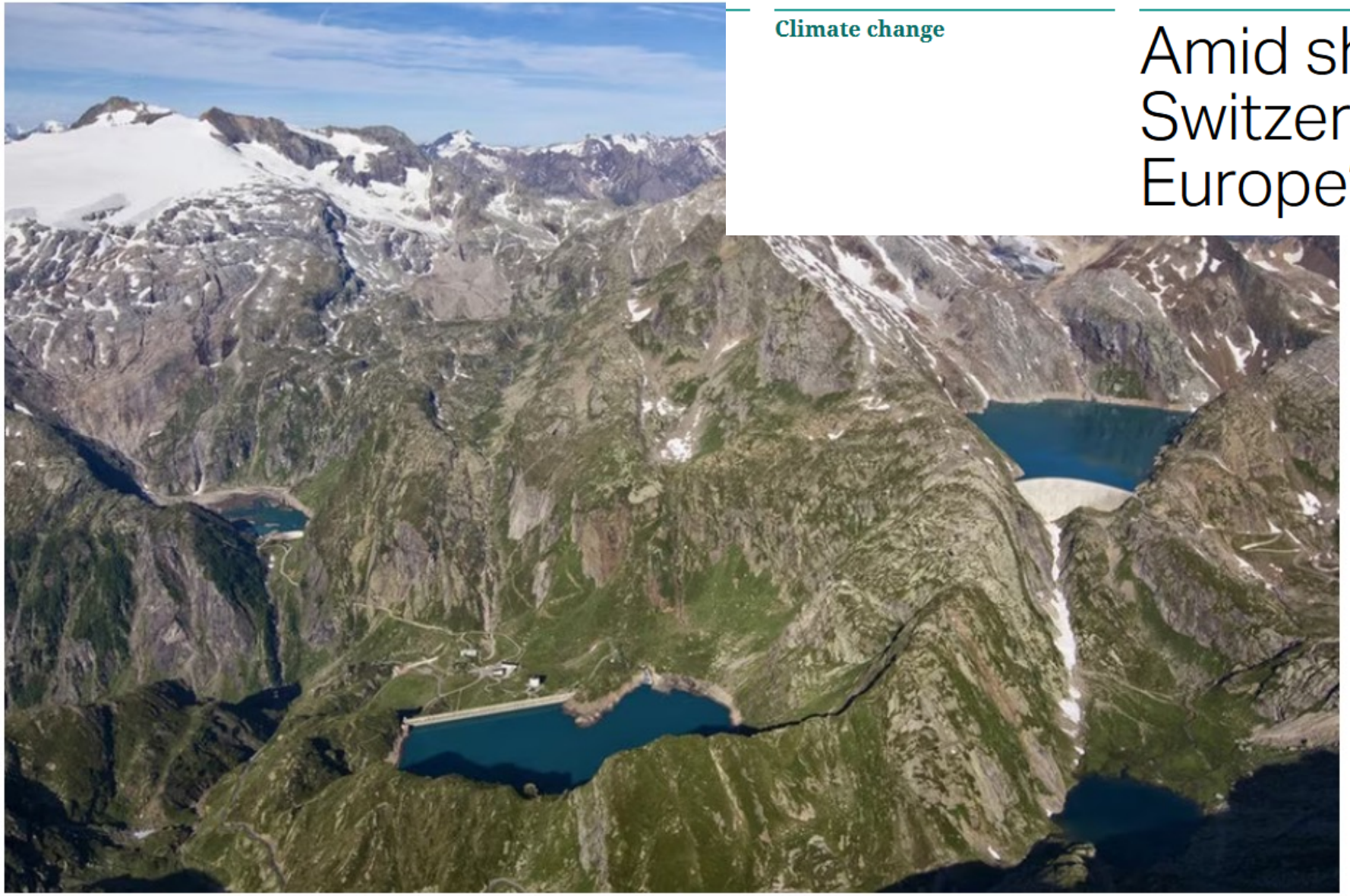
Mean summer streamflow to precip ratio



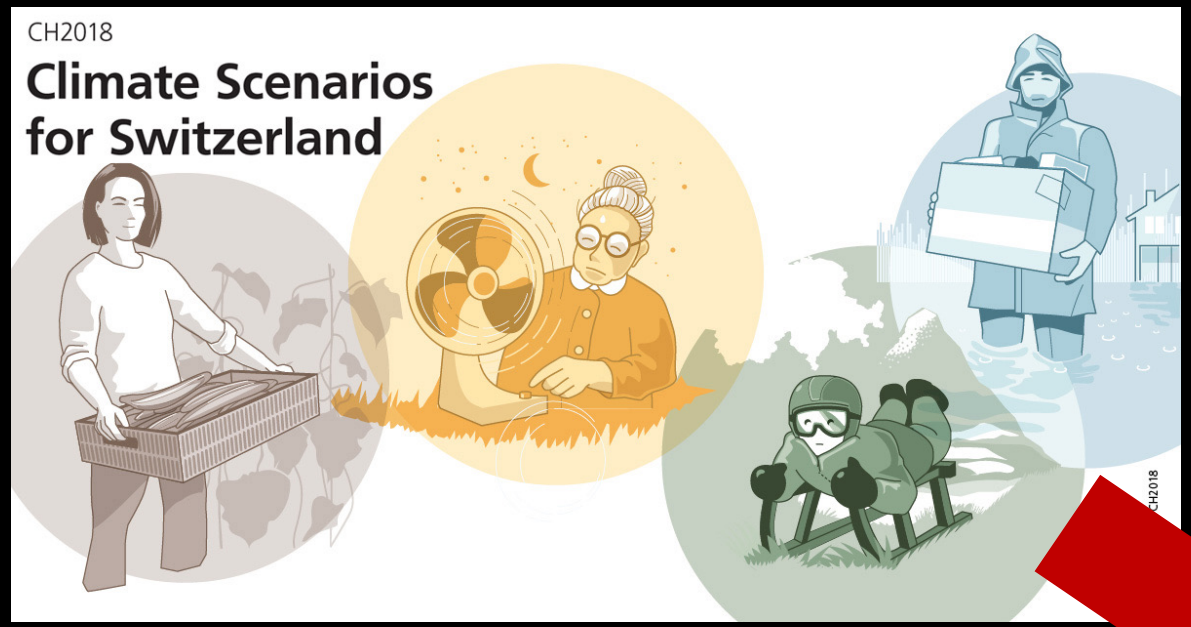
SWI swissinfo.ch

Climate change

Amid shortages, can Switzerland stay Europe's 'water tower'?



▲ Switzerland is home to 5% of the European continent's fresh water reserves. Keystone / Alessandro Della Bella



Hydro-CH2018:
Swiss water bodies in a changing climate

NCCS (Publ.) 2021

Selected key messages from Hydro-CH2018

(end of the century)

Changes in annual streamflow

–10 % without climate change mitigation

–0 % with climate change mitigation

Changes in summer streamflow

–40 % without climate change mitigation

–10 % with climate change mitigation

Daily precipitation, return period 100 yrs

+20 % without climate change mitigation

+5 % with climate change mitigation

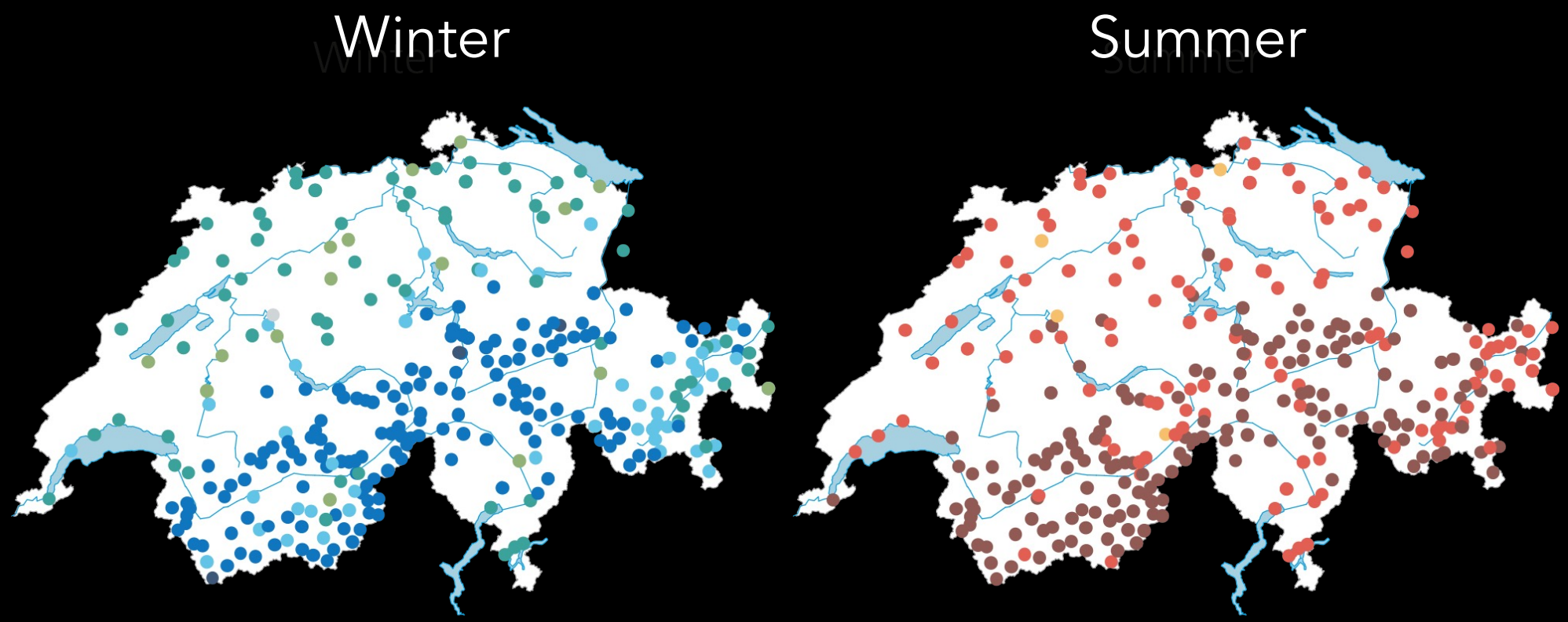
Summer water temperature (streams)

+5.5 °C without climate change mitigation

+2 °C with climate change mitigation

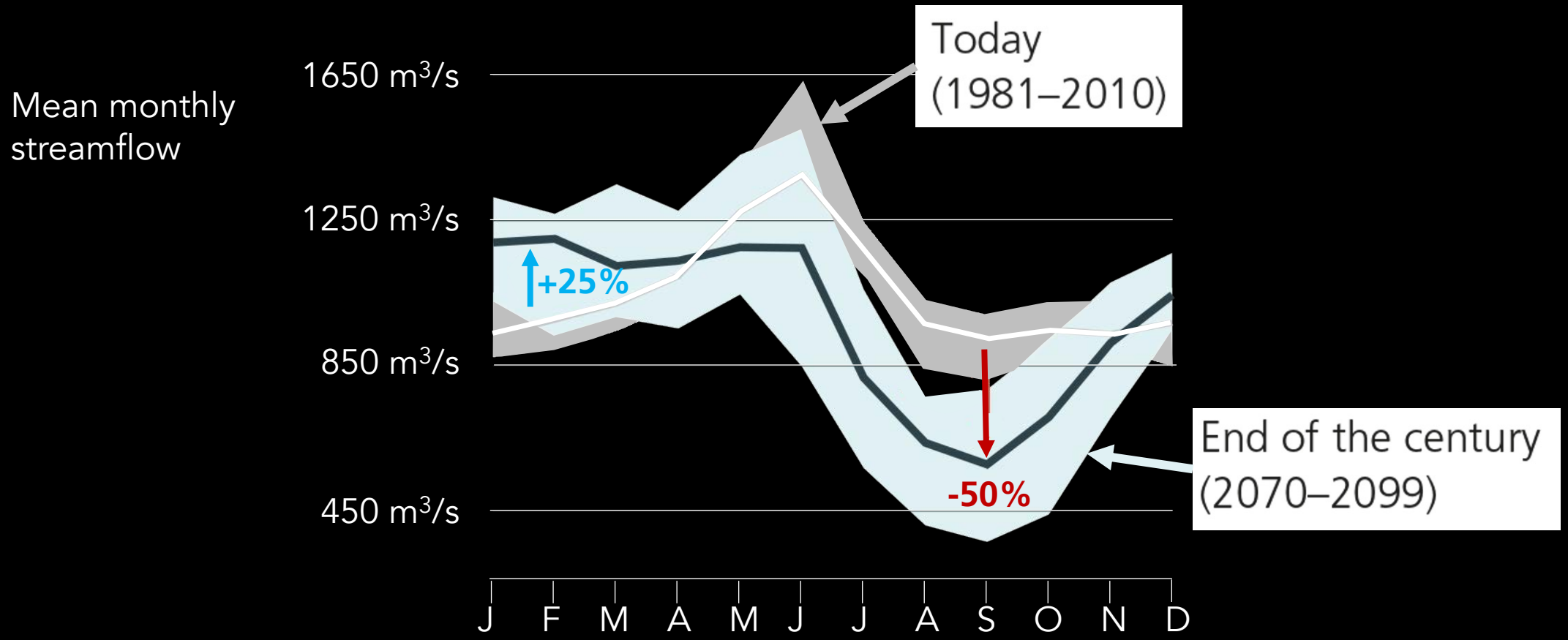
Expected changes in seasonal streamflow

(by end of century, without climate protection)



Example: Mean monthly streamflow Rhine@Basel

(by end of century, without climate protection)



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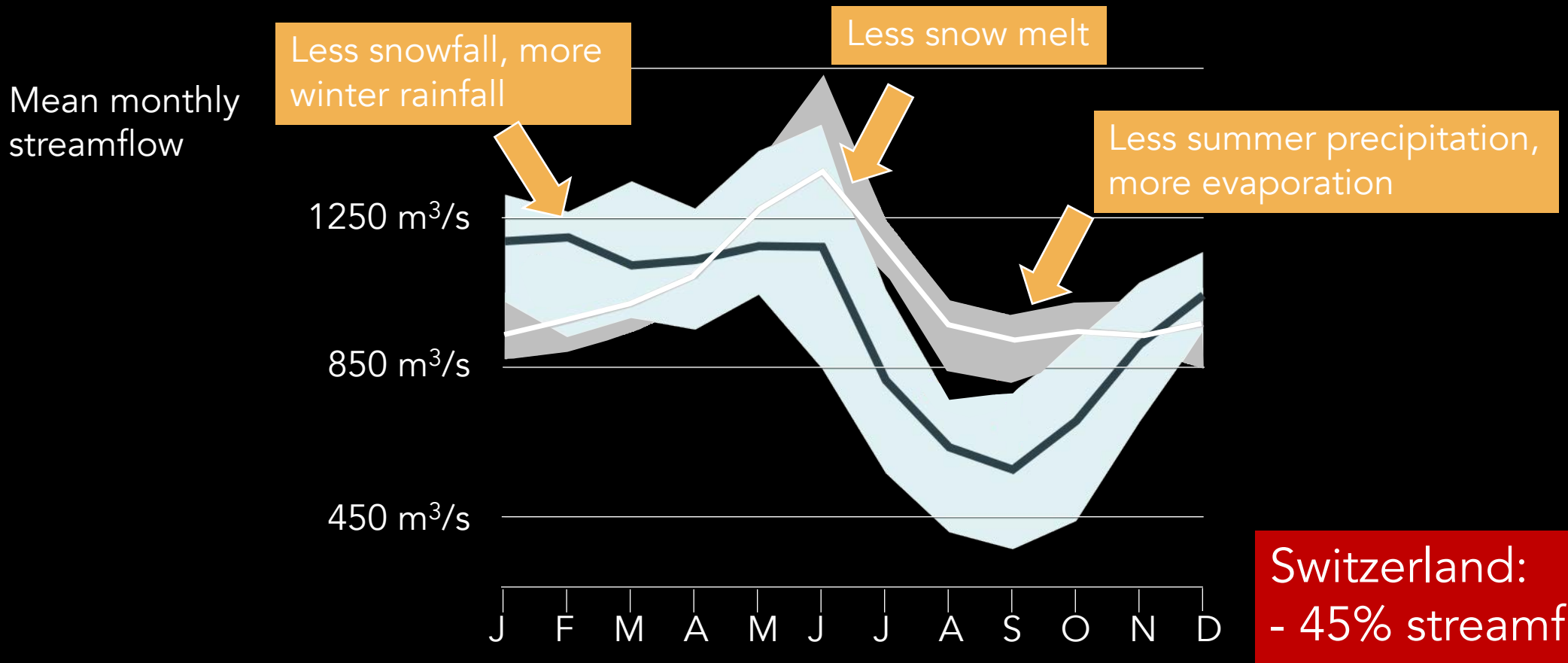
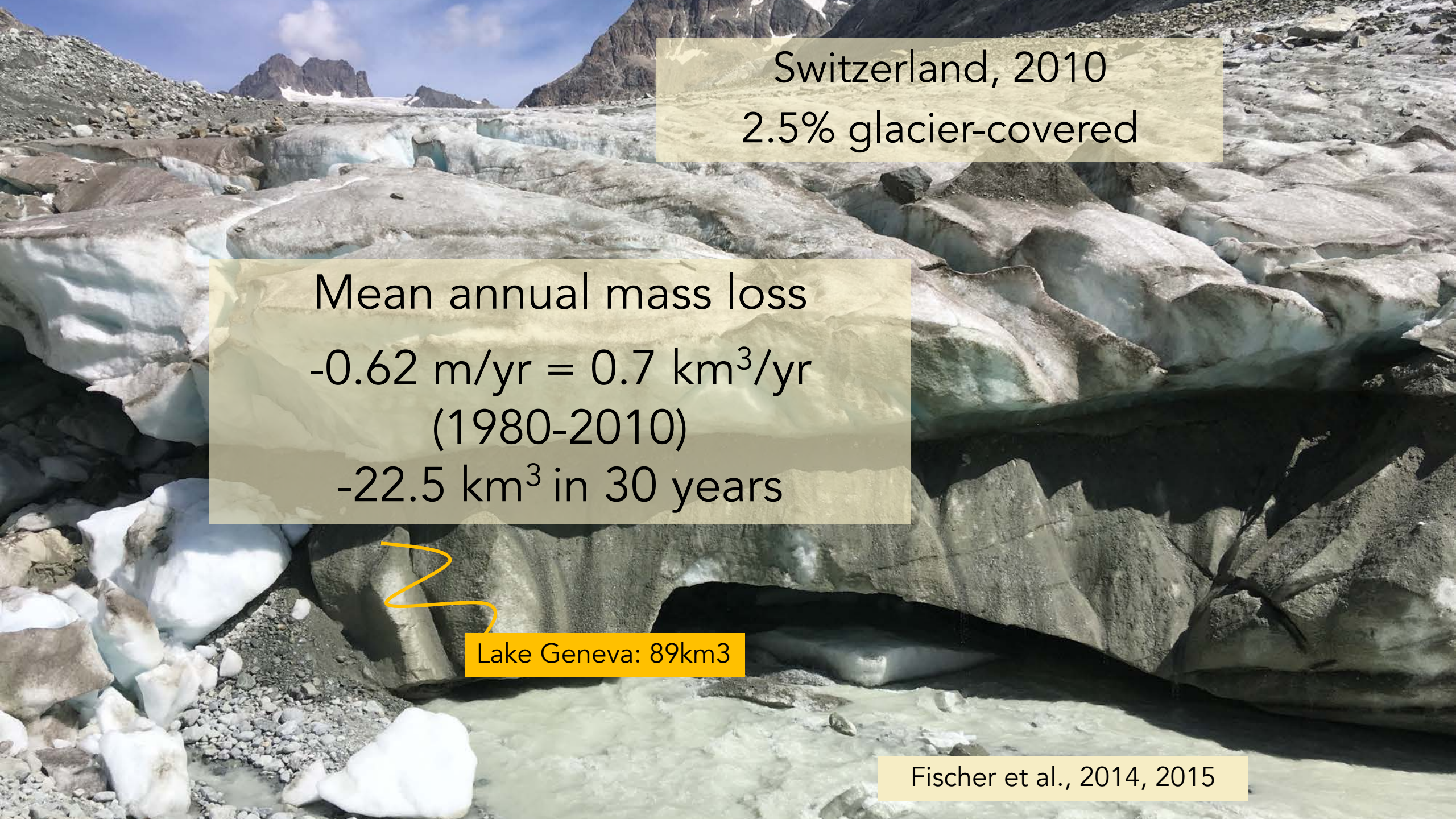
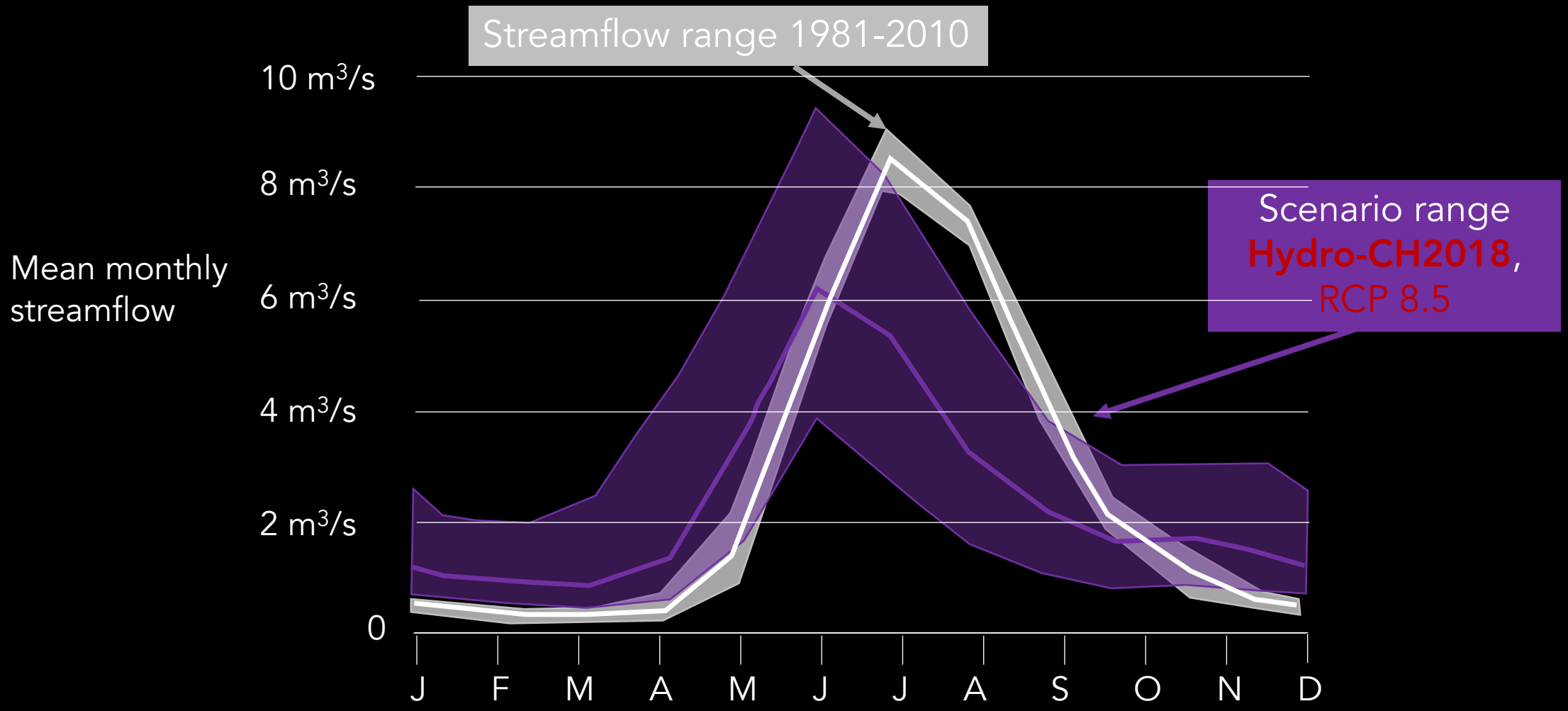


Switzerland:
- 45% streamflow from snowmelt


Switzerland, 2010
2.5% glacier-covered
Mean annual mass loss
-0.62 m/yr = 0.7 km³/yr
(1980-2010)
-22.5 km³ in 30 years
Lake Geneva: 89km3
Fischer et al., 2014, 2015

Example: Mean monthly streamflow Rhone@Gletsch

(by end of century, without climate protection)



Hydromapscc.ch, Data and analysis:
Freudiger et al., UniZH, 2020

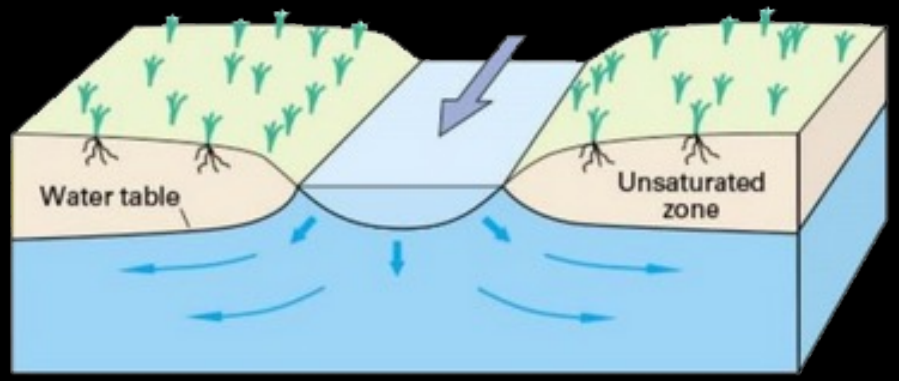
Means also: less groundwater, less drinking water from springs

Changes in summer streamflow

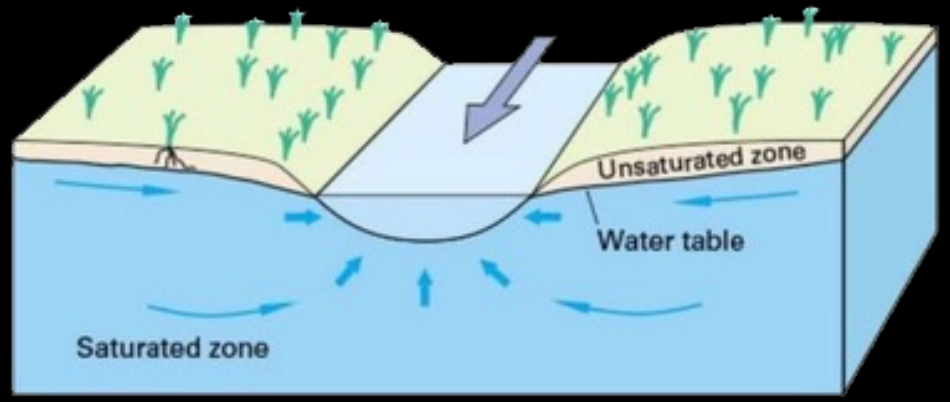
–40 % without climate change mitigation

–10 % with climate change mitigation

Loosing stream



Gaining stream



Source: usgs.gov

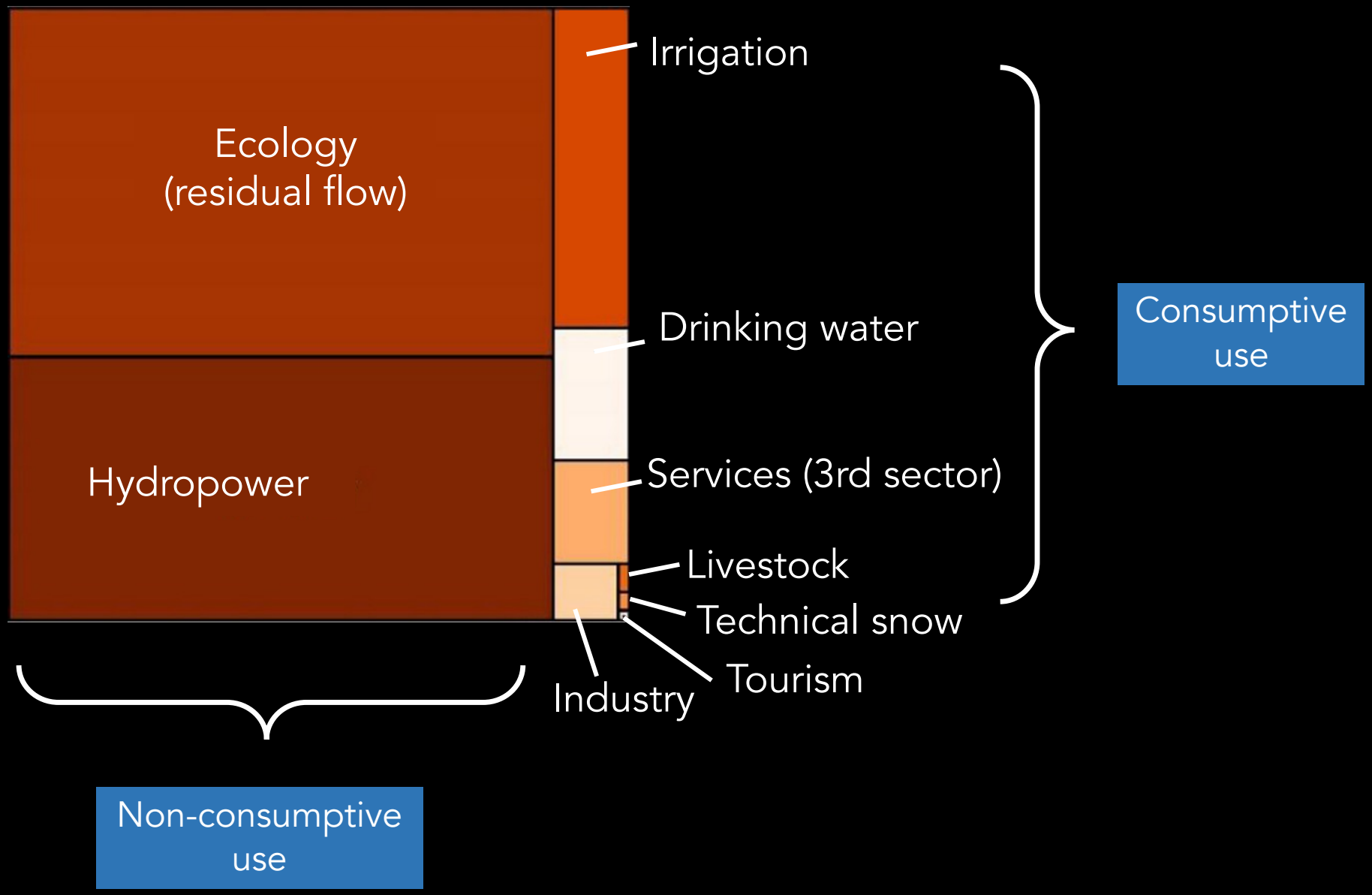
What do we know about the demand side?

Current water demand estimates

Brunner et al., 2019, WEL; 2019 Sci. Tot. Environ.

Total: 15 km^3

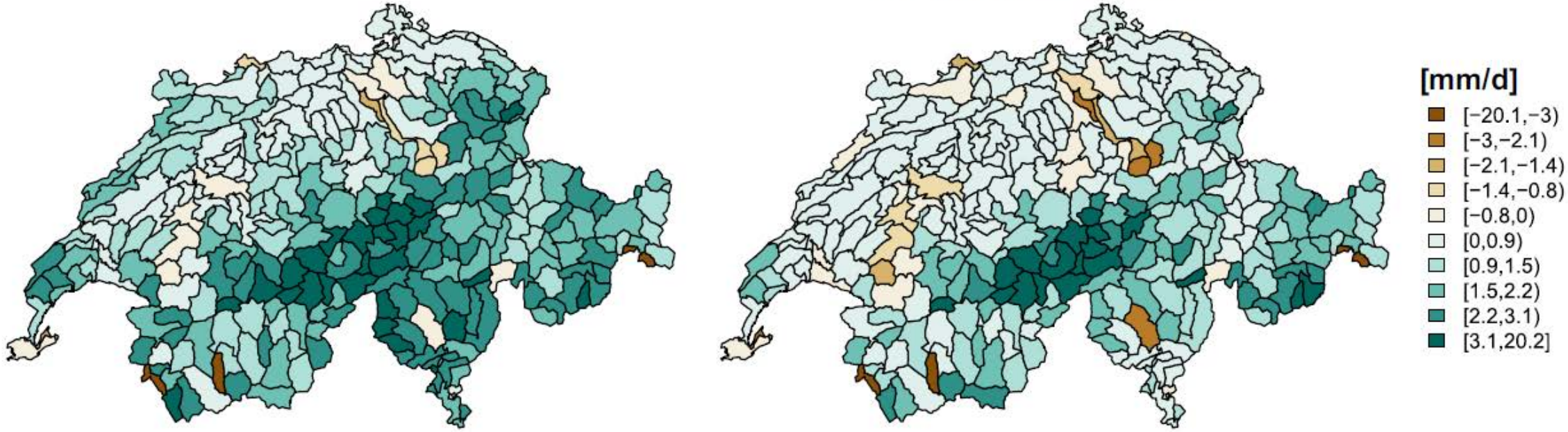
= 375 mm of rainfall over Switzerland



Estimated water surplus / shortage

Current mean conditions (1981-2010)

Extreme conditions: year **2003**

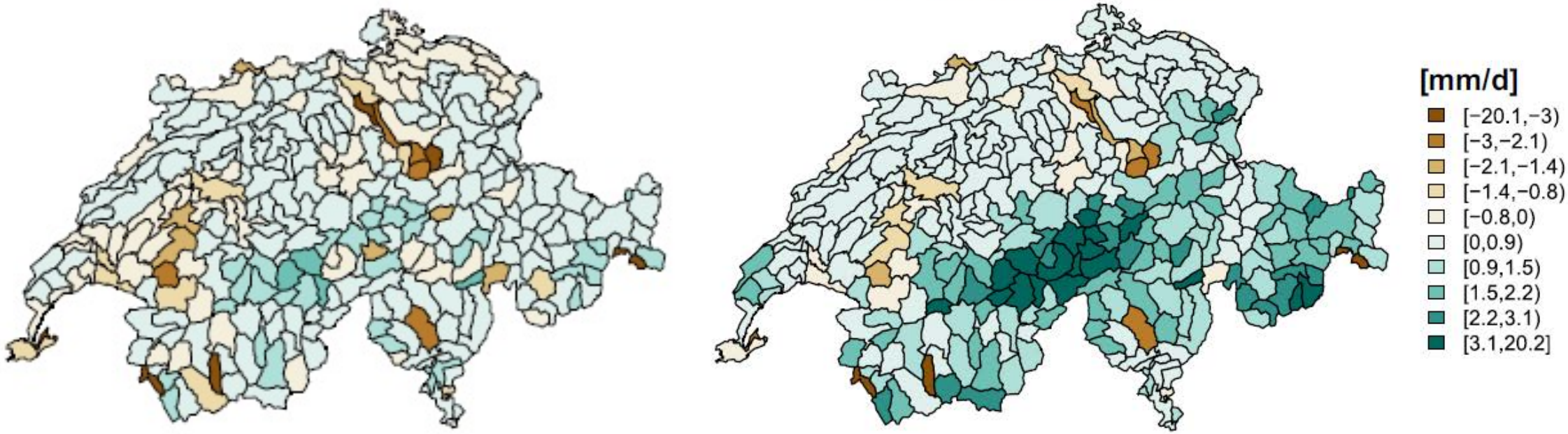


Brunner et al., 2019, Sci. Tot. Environ

Estimated water surplus / shortage

Future extreme year (2071–2100)

Extreme conditions: year 2003

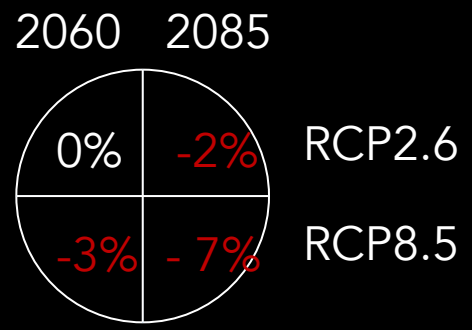


Brunner et al., 2019, Sci. Tot. Environ


How bad is this?
© Pok Rie

Actual impacts on water ressources: Hydropower

Annual production due to streamflow change (21 plants)



Wechsler et al. 2020

Annual production reduction due to glacier mass loss

2040-2060: - 1.5%
2070-2090: - 3%

Schaefli et al., 2019

And besides hydropower ?

Big unknown: consumptive water use

Industry & agriculture

- Largest water users
- Origin: 20% public, 80% **private** (groundwater, surface water)

Private water extraction

- **50%** of all used water
- Often not metered, no statistics

Source numbers & picture: Swiss Association of Professionals of Gaz, Water and Heat

Big unknown: consumptive water use

Uncontrolled **increase** of water consumption ?

⇨ Lack of numbers !

⇨ Regional strategies?

https://www.floraalpina.ch/en/wellness/outdoor-wellness/

Big unknown: consumptive water use

Hypothetic example:

- Villa with irrigated **garden**, 600 m^2
- **Swimming pool** (10 m x 3 m) x 2 m = 60 m^3
  = **100 mm** water relative to garden area
  = **25 mm** evaporation rel. to garden area

- **Irrigation**: estimate of 1.5 mm/d over 100 days
  = **150 mm water**

- Average summer rainfall Bern: 330 mm
  2015: 200 mm

https://www.floraalpina.ch/en/wellness/outdoor-wellness/

Drought potential in Switzerland ?

- Meteorological droughts ⇨ CH2018
  - Lack of precipitation
- Hydrological droughts ⇨ Hydro-CH2018
  - Lack of streamflow / groundwater recharge

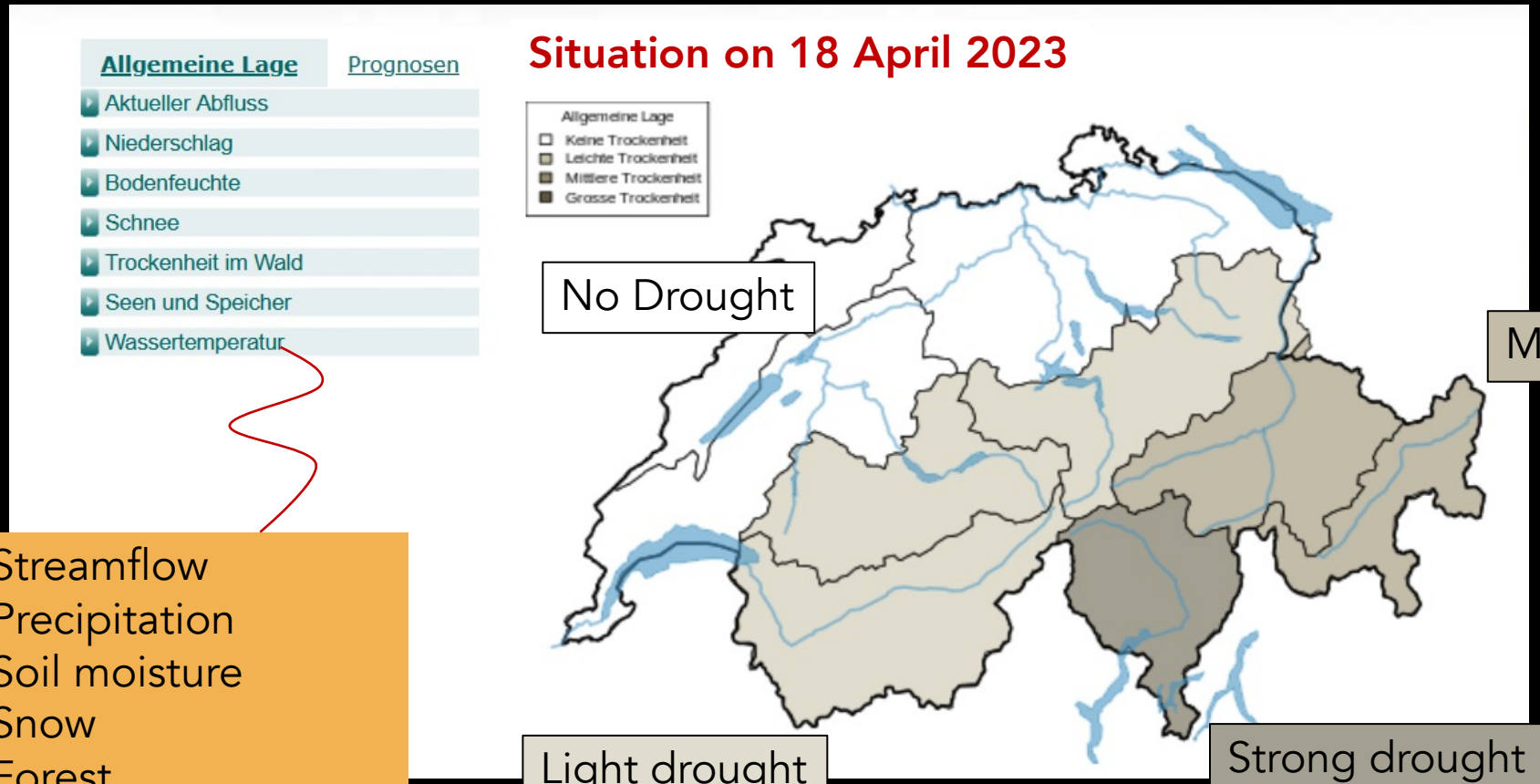
Drought potential in Switzerland ?

- Meteorological droughts ⇨ CH2018
- Hydrological droughts ⇨ Hydro-CH2018
- Agricultural (soil moisture) droughts:
  - Two dimensions:
    - Low-elevation farming: technical & agricultural solutions
    - Alpine cattle farming threatened by lack of snow
  - Research projects ongoing
    - Quantification of future irrigation water needs
    - Adaptation strategies & effect on water balance

DROUGHT.CH

Nachhaltige Wassernutzung
Nationales Forschungsprogramm NFP 61

WSL ETH MeteoSchweiz



- Streamflow
- Precipitation
- Soil moisture
- Snow
- Forest
- Lakes & reservoirs
- Water temperature

Drought potential in Switzerland ?

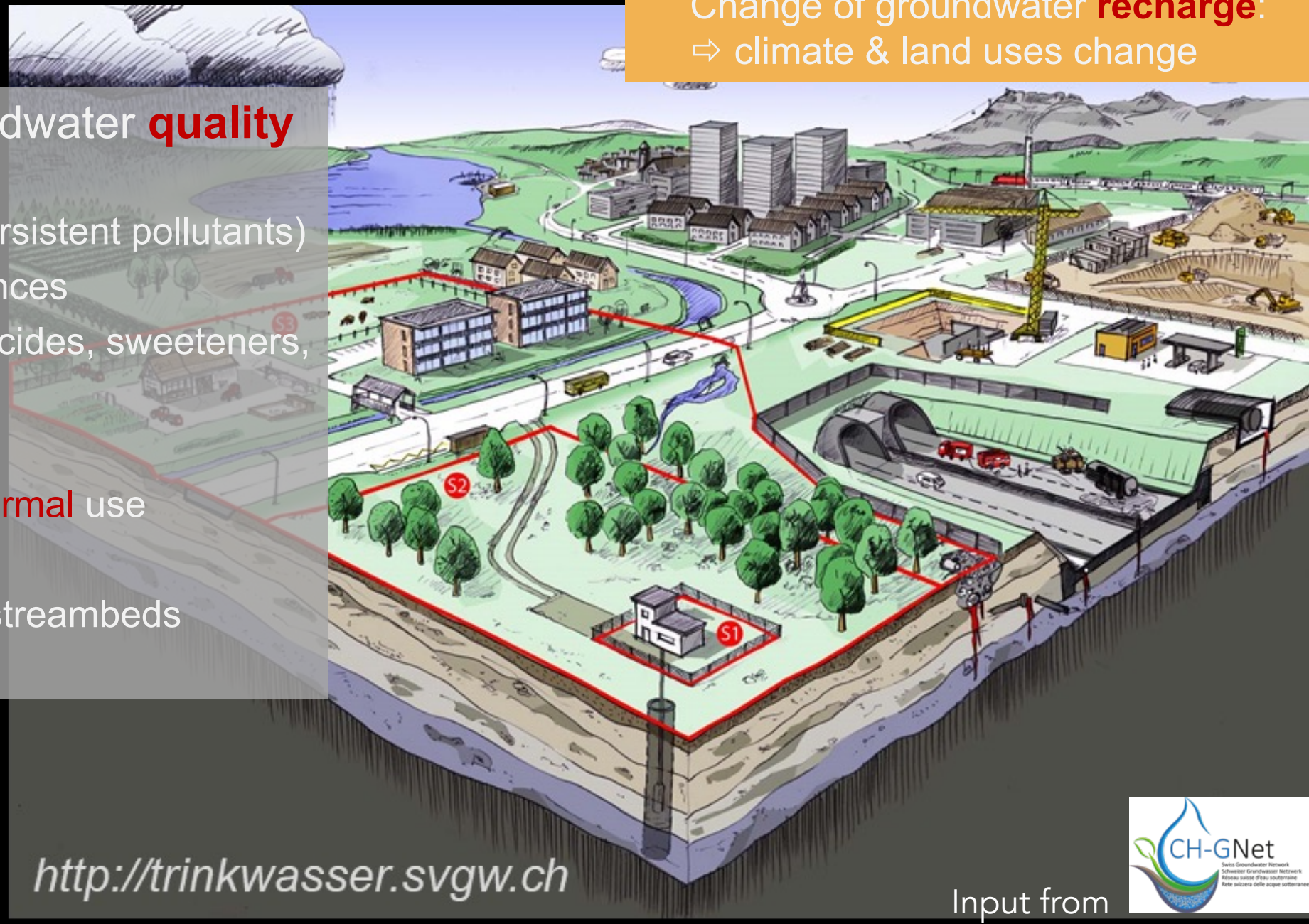
- Meteorological droughts ⇨ CH2018
- Hydrological droughts ⇨ Hydro-CH2018
- Agricultural (soil moisture) droughts:
- Socio-economic (supply) droughts:
  - Drinking water
  - Ecosystems
  - Cooling water
  - Shipping (Rhine)
  - Hydropower

Groundwater under pressure

Change of groundwater **recharge**:
⇨ climate & land uses change

Challenges for groundwater **quality**

- Polluted sites
- Agriculture (nitrates, persistent pollutants)
- «Urban» traces substances (pharmaceuticals, pesticides, sweeteners, hormons, etc.)
- Microplastics
- Constructions & geothermal use
- Groundwater withdrawl
- Degraded structure of streambeds



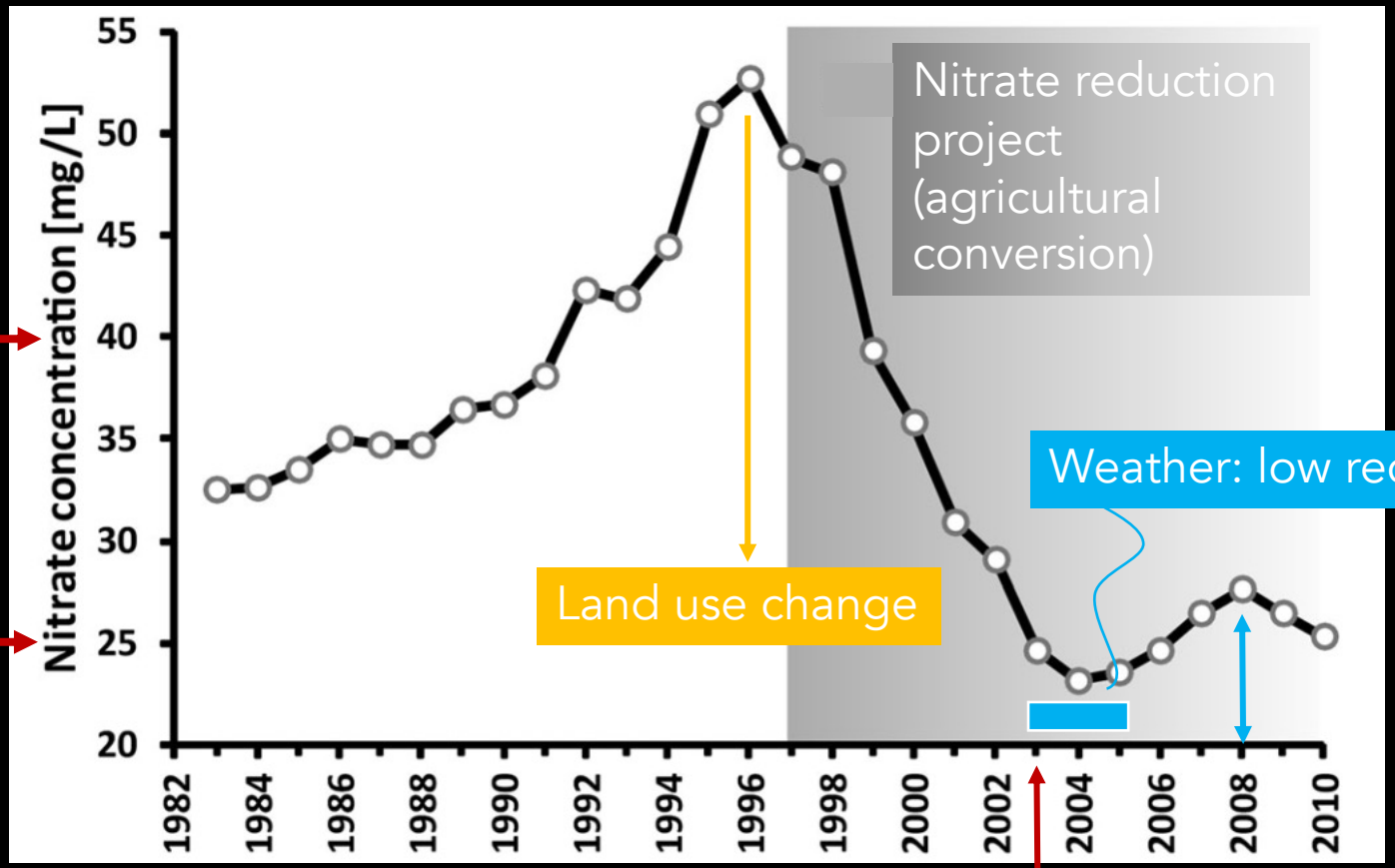
http://trinkwasser.svgw.ch

Input from CH-GNet

Rural groundwater

Challenge: interaction of anthropogenic influences & climate

The Nitrate Project in **Wohlenschwil (Aargau)**



Legal limit for drinking water

Legal limit for groundwater

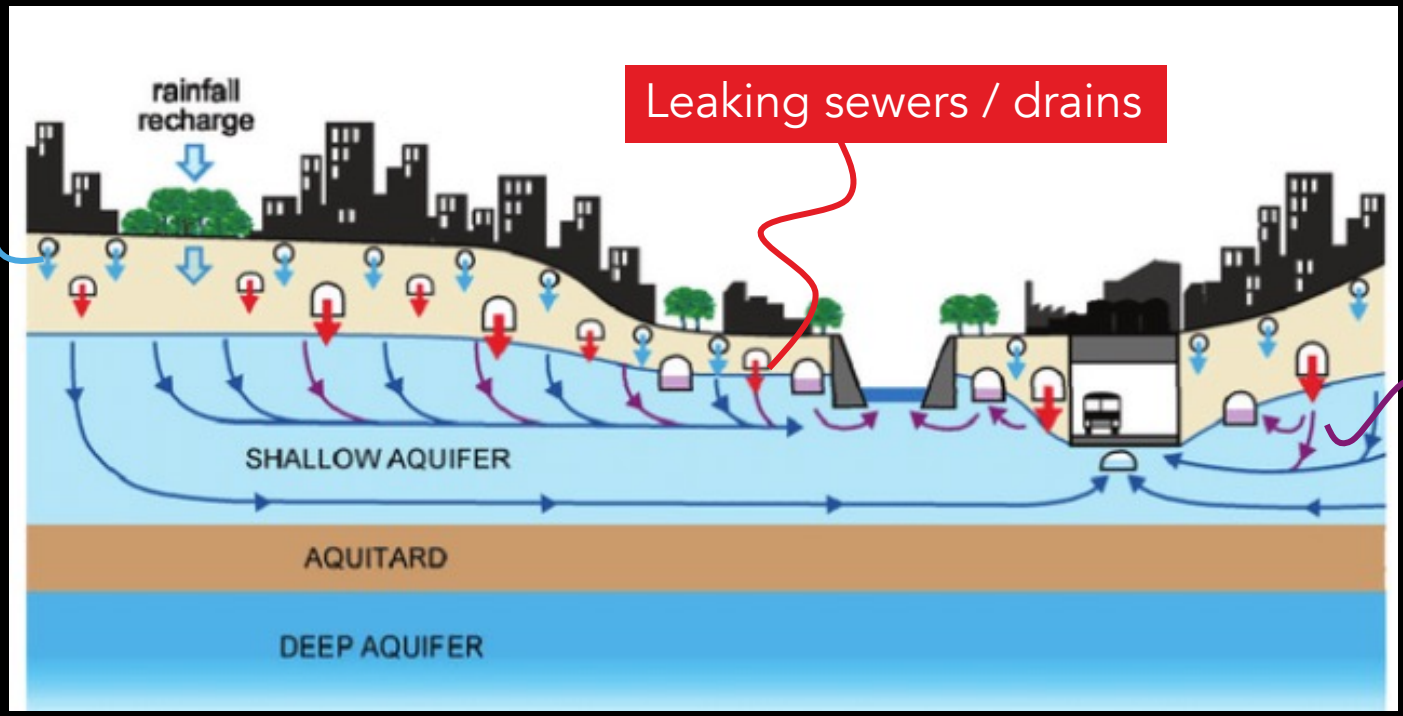
Baillieux et al., 2015. Hydrogeol. J..

Urban groundwater

10 – 20% of water from sewers leaks into aquifers

Schirmer, M., et al. 2013. Adv Water Resour.

Leaking water pipes



Leaking sewers / drains

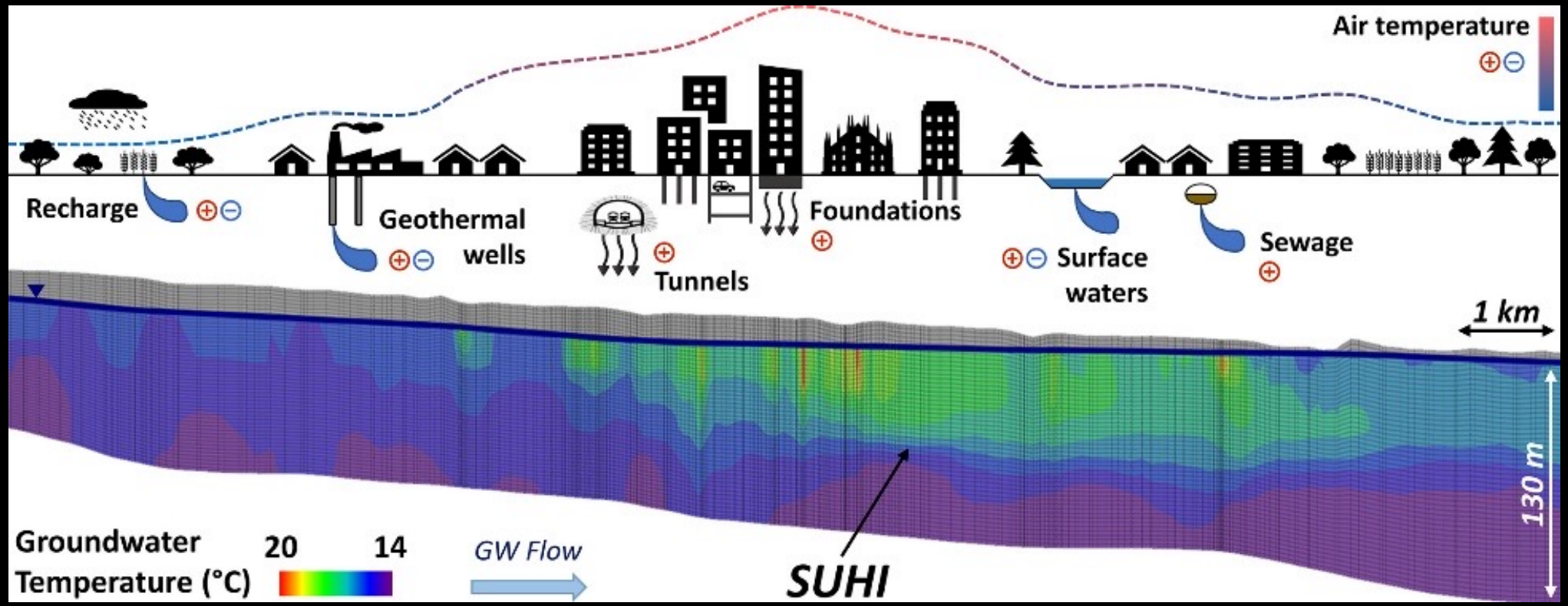
Groundwater exfiltration to sewer

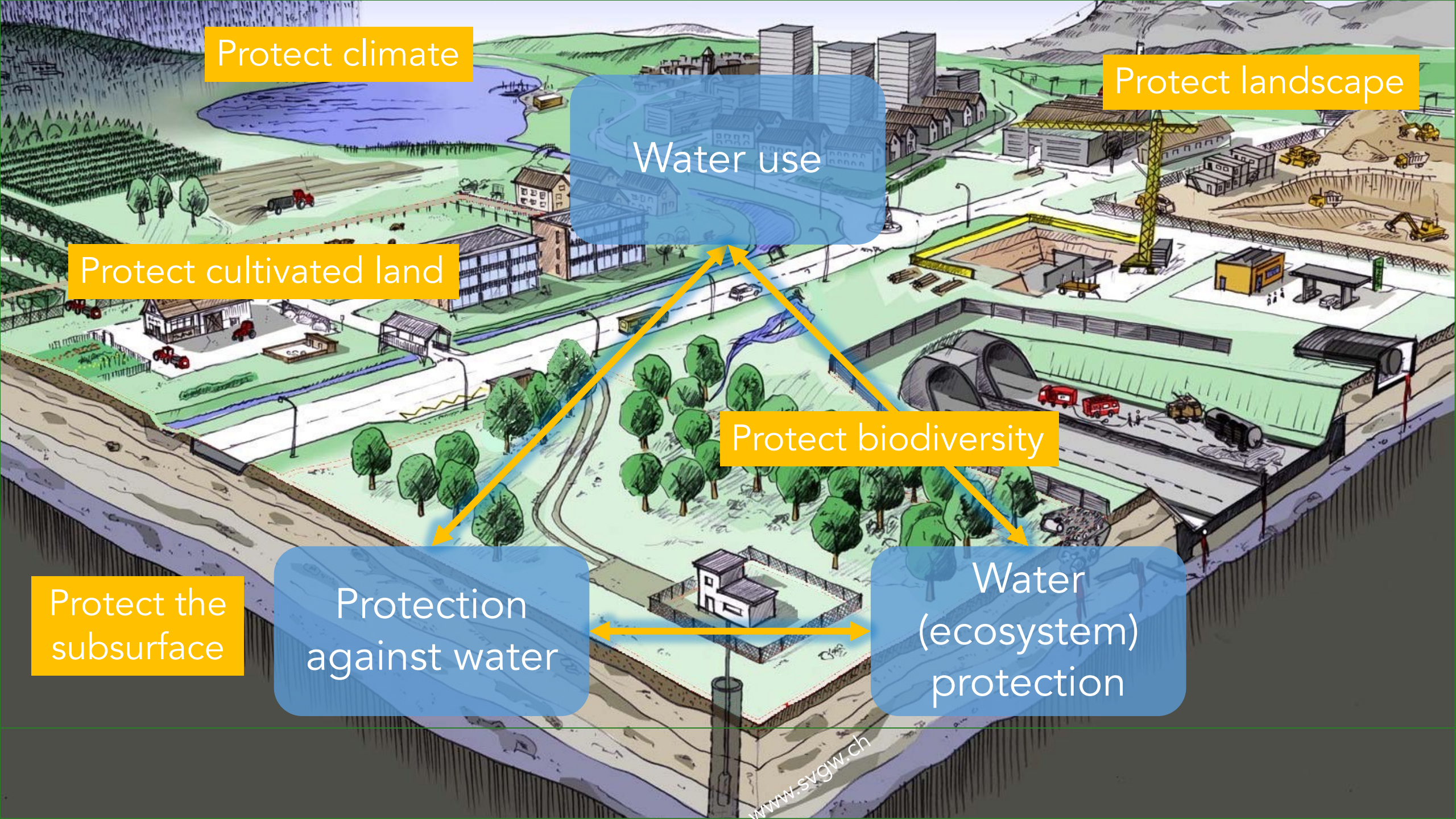
Foster & Vairavamoorthy 2013, Urban Groundwater

Urban groundwater

Are we creating Subsurface Urban Heat Islands ?

Previati, Epting, Crosta, 2021




Protect climate
Water use
Protect landscape
Protect cultivated land
Protect biodiversity
Protect the subsurface
Protection against water
Water (ecosystem) protection
www.svgw.ch

Conclusion

- Decision support tools ✓
- Collaboration with professionals ✓

- Lack of awareness of urban water users
  - Quantity, quality
- Regional, visionary strategies
  - Water use data