From hydrological forecasts to adapted water management

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Dr. Klaus Lanz
International Water Affairs
Evilard, Switzerland

INTERNATIONAL WATER AFFAIRS

Hydro-CH2018: Water Management Study

- One of several targeted literature studies
- Focus on utilization of water and and its effects on water systems
- How fit is current water management for climate change?
- Is the current utilization of water in tune with natural water systems?
- Potential new conflicts arising from climate change?
- Need for adaptation?
- One chapter on each relevant category of water use (societal water demand)

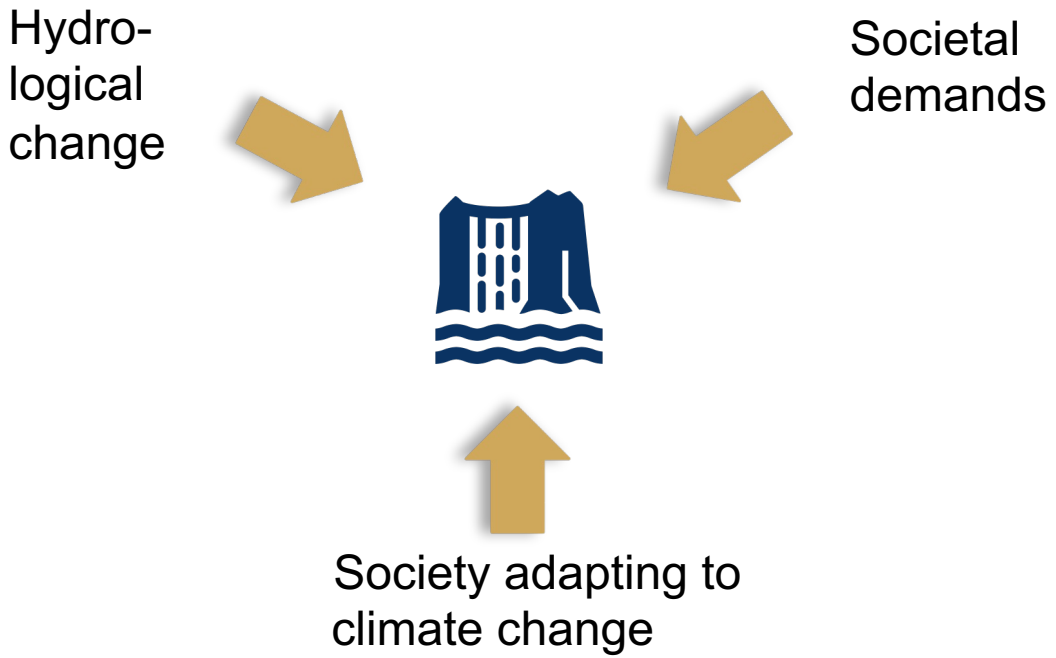
Societal demands concerning water

- Drinking water supply
- Wastewater management and urban drainage
- Industrial water use
- Agricultural irrigation
- Thermal use of water resources
- Tourism (Reynard et al.)
- Hydropower (Lanz and Wechsler)
- Flood protection
- River and lake ecology
- International water management

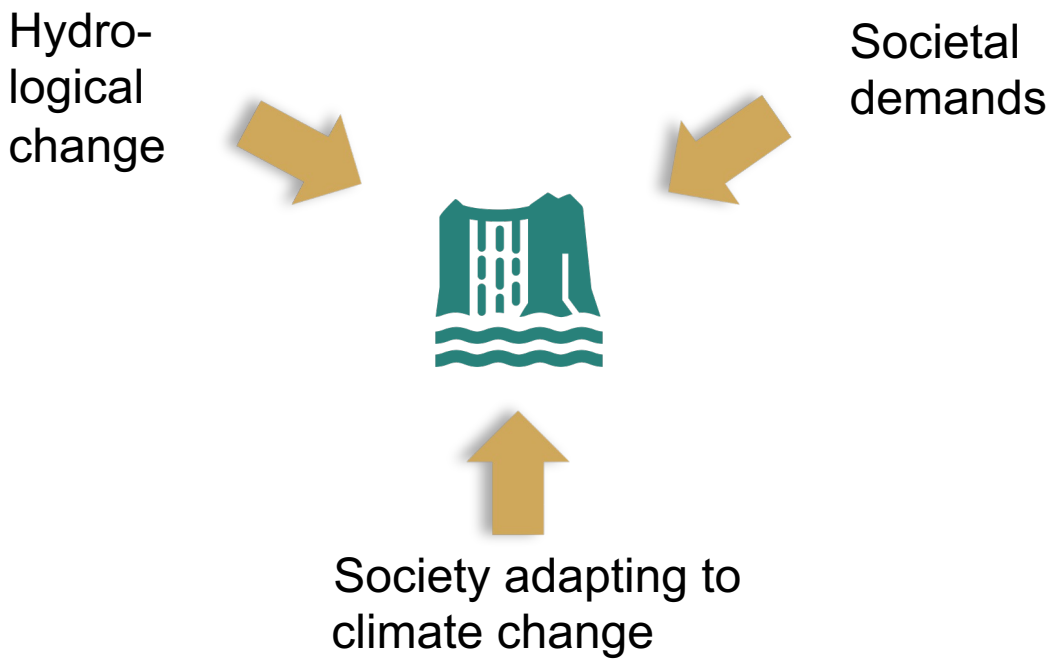
Identical chapter structure

- **1a** Status quo: water uses and water demands today
- **1b** Status quo: effects of current demands on natural water systems
- **2** The future: a) expected effects of climate change (hydrology)
  b) expected effects of evolving societal demands, potential conflict
- **3** Potential new conflicts and/or synergies
- **4** Potential measures to secure future use and integrity of natural water systems
- **5** Open questions, data requirements, research needs

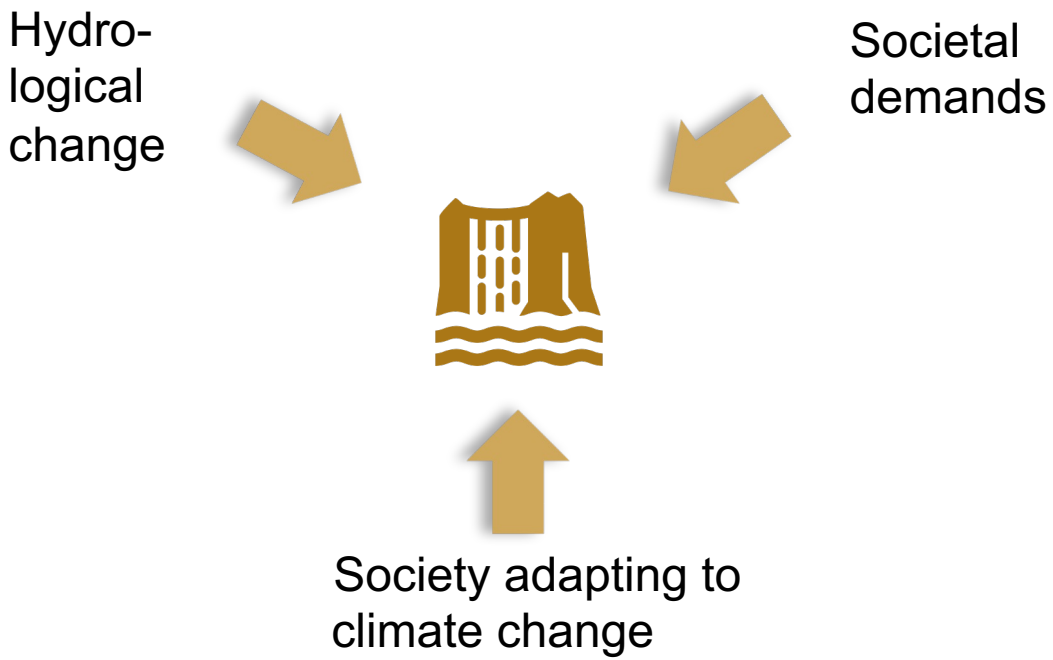
Effects on natural water systems



How to limit effects on water systems



How to prevent destructive outcomes



Societal demands concerning water

- **Drinking water supply**
- Wastewater management and urban drainage
- **Industrial water use**
- **Agricultural irrigation**
- Thermal use of water resources
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- International Water Management

Future of drinking water resources

Less reliable resources

Hydro-logical change

Societal demands

Considerable pressure
- pollutants
- encroachment
- competing uses

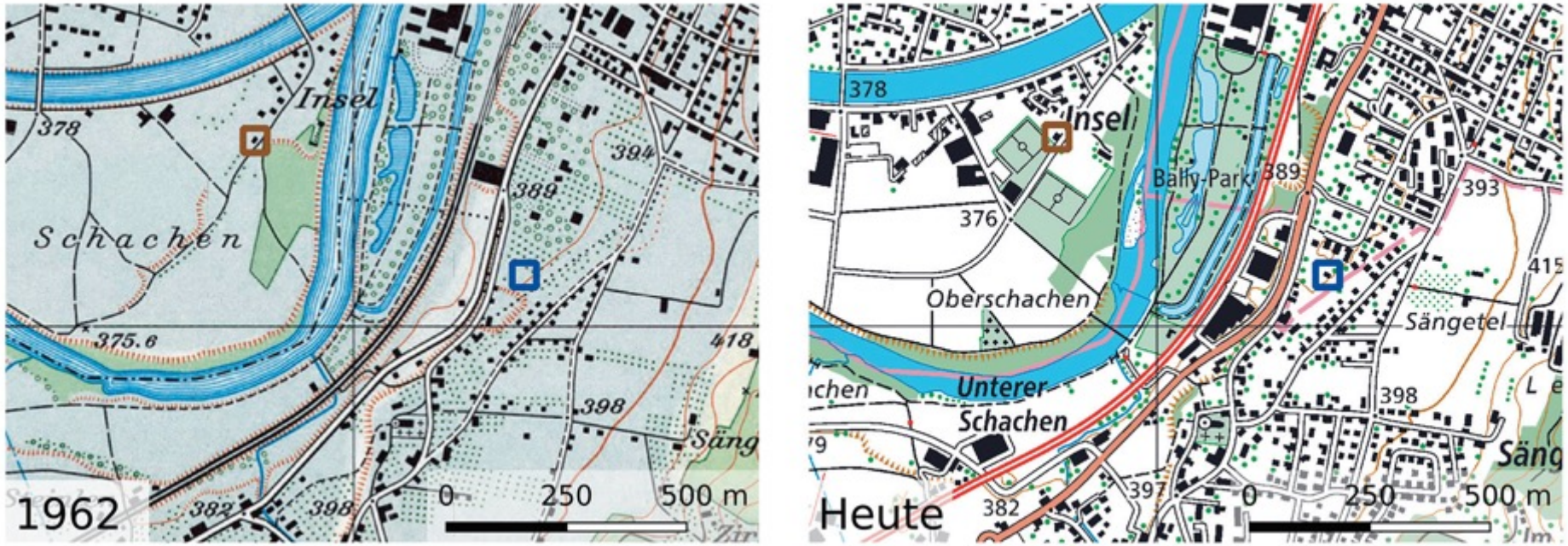
Society adapts to climate change

Higher household consumption: garden irrigation, showers, pools

Pollutants | Encroachment | Competing uses

- 80% of drinking water supply from groundwater (springs, pump wells)
- Groundwater abstracted in heavily utilized river plains
  - Contaminants from agriculture, roads, residential and industrial areas
- Drinking water quality requires safety zones around pump wells
  - Often «in the way of» housing development, industrial expansion, infrastructure

Conflict urban growth | water protection



Once established in undisturbed areas, pump wells are now close to residential areas. Pump wells Niedergösgen (brown), Schönenwerd (blue). Adequate groundwater protection is no longer safeguarded.

Aus: Hug et al. (2017): Regionale Wasserversorgungsplanung im Kanton Solothurn am Beispiel Olten Gösgen. (Kartenquelle: Swisstopo)

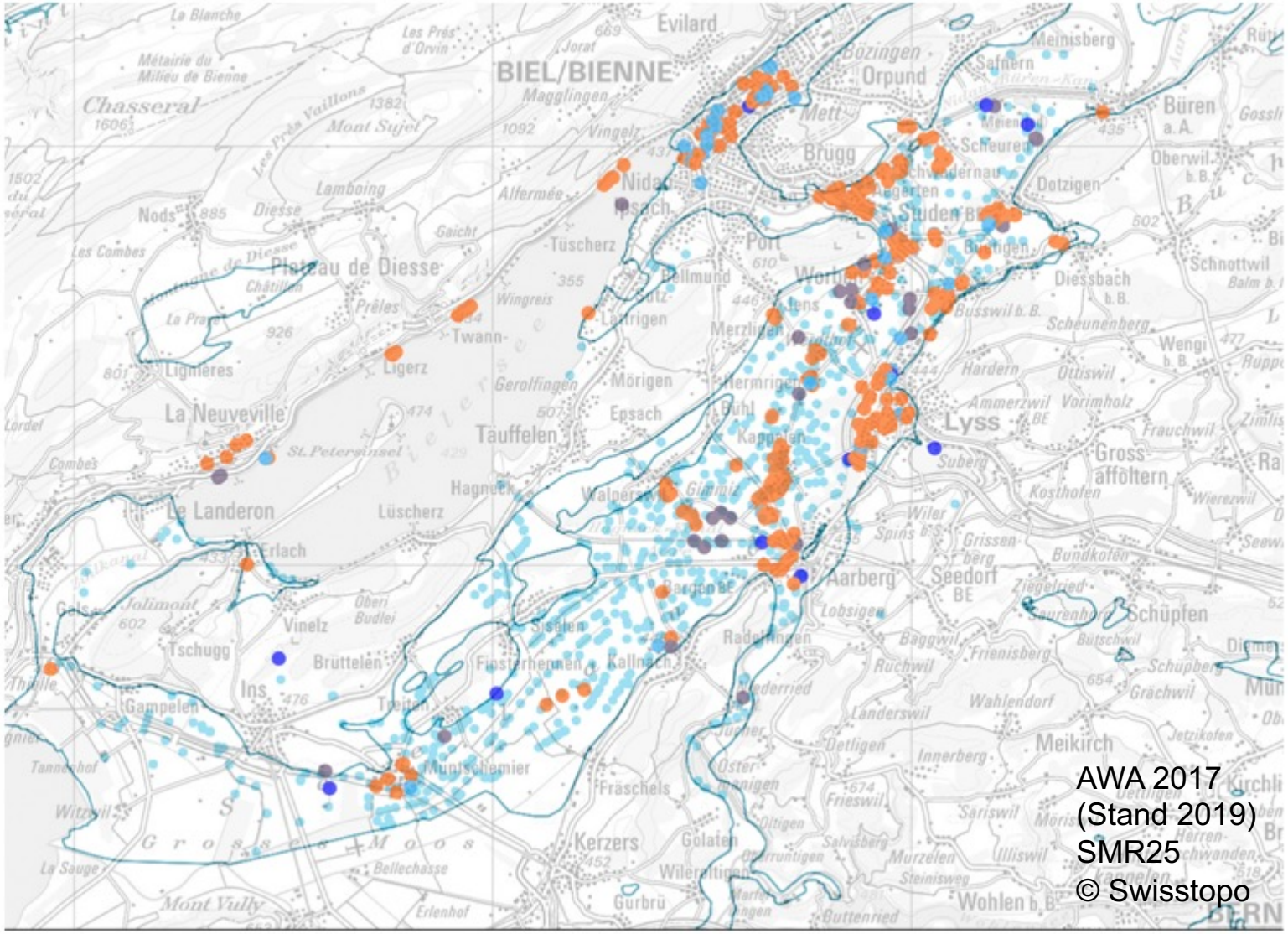
Encroachment of urban development into protection zones

Pollutants | Encroachment | Competing uses

- 80% of drinking water supply from groundwater (springs, pump wells)
- Groundwater abstracted in heavily utilized river plains
  - Contaminants from agriculture, roads, residential and industrial areas
- Drinking water quality requires safety zones around pump wells
  - Often «in the way of» housing development, industrial expansion, infrastructure
- Competition from groundwater heating systems, agricultural irrigation (local)

Competing groundwater uses

Importance of heat pumps and irrigation for groundwater use in Seeland (canton Berne)



Lanz et al. 2020

AWA 2017
(Stand 2019)
SMR25
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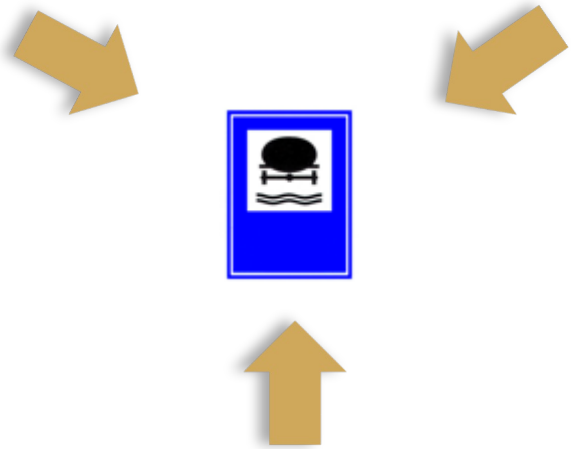
Challenges for drinking water supply

Hydro-logical change

Societal demands



Society adapts to climate change

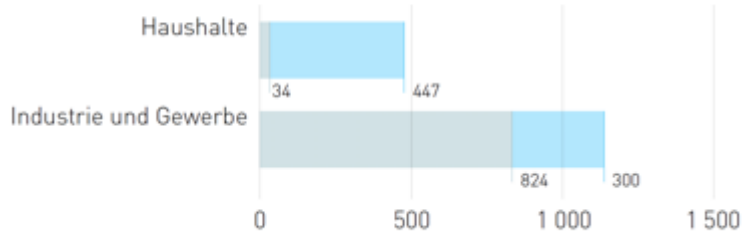
Pre-existing problems exacerbated by hydrological effects of climate change

Challenge of controlling external influences
- pollutants
- encroachment
- competing uses

Not sufficient to assess the effects of climate change on hydrology!

Industrial and commercial water use

- Industrial water use is often overlooked, yet important
- Potential competition for resources of public supply
- Water use by industry is substantial (2.3x households)
- Latest figures from 2006, mostly «private» concessions
- Current use unknown, yet rising consumption in canton BL
- Untapped resource? Potential of reallocating (unused) industrial water concessions to public supply?



Umfang der Wassernutzung durch Industrie und Gewerbe sowie Haushalte im Jahr 2006 mit Anteil der Eigenversorgung, in Mio. m^3 (Freiburghaus 2009)

Eigenversorgung

Bezug aus öffentlicher Wasserversorgung

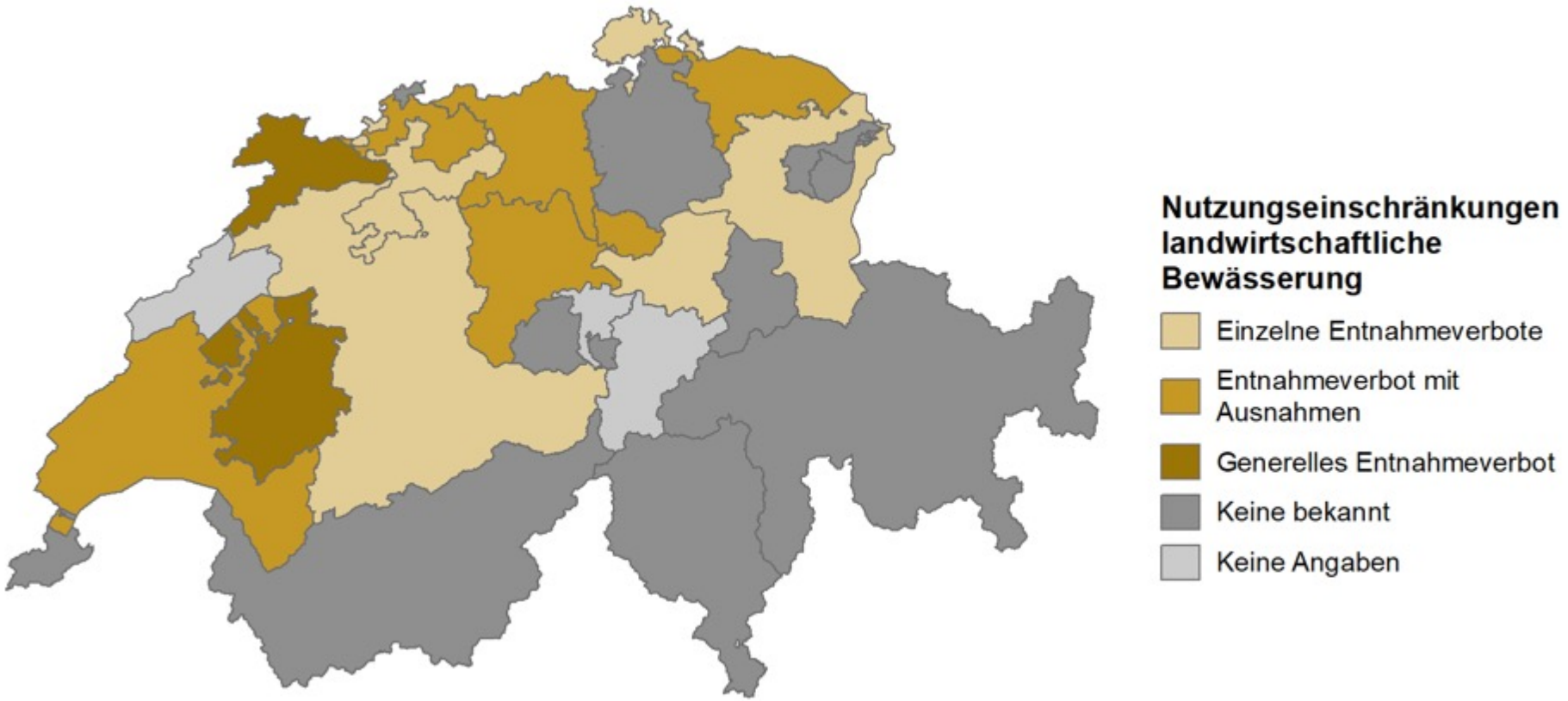
Agricultural irrigation

- Climate change is increasingly affecting agriculture (higher temperature, drier soils)
- Recommendations to cope with drier conditions:
  - conservative soil management in order to improve retention of moisture
  - switching to crops and crop varieties suited for drier and warmer conditions
  - shift of certain crops to more favorable locations (e.g. elevated, cooler regions)
- Overall objective: securing production, yet without major increase of water consumption
- In essence, a strategy of water **demand management**

Current trends in irrigation

- Current trends are running contrary to the recommended adaptation strategy:
  - Extension of irrigated area and water use
  - Vegetable area +24% from 2012-2017 (almost all irrigated)
  - Investment in more intensive fruit orchards requiring constant irrigation
- Numerous projects for new irrigation infrastructures (e.g. Thurgovia, Furt valley ZH, Seeland BE/FR, Valais, LU, Rhine valley SG)
- Plans to extract additional water from rivers, lakes, reservoirs (VS), groundwater
- Strong emphasis on extending water availability (rather than adapting agricultural practices)
  → in essence a strategy of water **supply management**
- Underlying reason: most irrigation projects geared towards coping with extreme drought (not just climate change)
- However, in most locations, water resources are not sufficient to continue irrigation during extreme drought

Lack of water for irrigation 2018

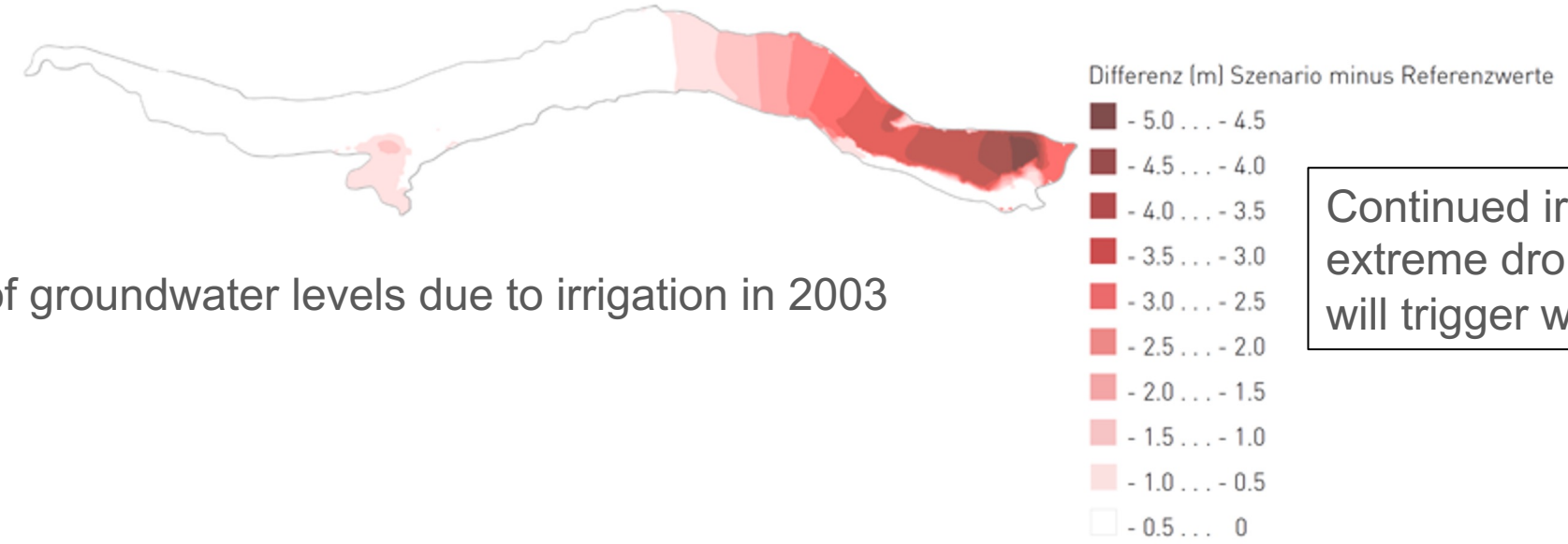


BAFU 2019: Trockenheit im Sommer und Herbst 2018

No solution for extreme drought

Groundwater levels in Thur Valley, Thurgovia, calculated from groundwater model (Lanz et al. 2020, adapted from Gmünder 2017)

Lowering of groundwater levels due to irrigation in normal years



Lowering of groundwater levels due to irrigation in 2003

Continued irrigation under extreme drought conditions will trigger water use conflicts

How to handle prolonged drought

- Agronomic rationale: farm income ought be secured at all times, even in times of drought
- Water resources rationale: prevention of over-abstraction, especially in times of drought
- Solution for both agriculture *and* water resources: **insurance** system for extreme drought
  - → prevents economic losses of farmers
  - → prevents over-abstraction of water (because insured farmers no longer need to irrigate)
- In essence, increased irrigation is **not a solution for handling extreme drought**
- Usually possible to adapt agriculture to “normal” climate change (including some irrigation)
- Handling extreme drought ≠ adapting agriculture to climate change → different tasks requiring different approaches

Study‘s key observations

- Switzerland has an extremely high land-use intensity and economic activity
- Intensive land-use also affects water systems by
  - water abstractions
  - emissions of micro-pollutants and nutrients
  - drainage of wetlands
  - impaired hydromorphology of river and lake shores
- Legislation is aiming to limit effects on water systems and ecology

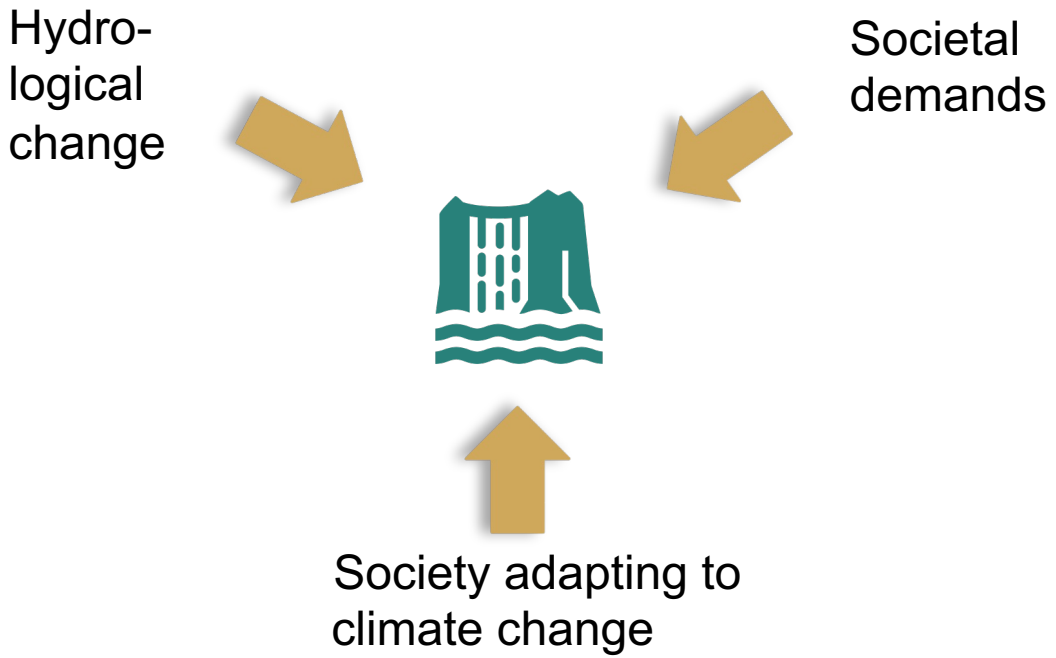
Legacy of intensive use

- Despite legislation, rivers, lakes, and groundwater seldom achieve legal objectives
  - Partly because of legal transition periods (2030, 2040, 2090)
  - Partly because of lack of enforcement of existing legislation
  - Partly because of opposition (or obstruction) by key stake-holders
- Reality of not yet fully protected and restored rivers, lakes, and groundwater which is further complicated by climate change
- Hydrology is rapidly changing in response to climate change, and aquatic life will have to adapt to higher temperature and more volatile run-off regimes
- Key question: Are we quick enough to prepare our water systems for adaptation?

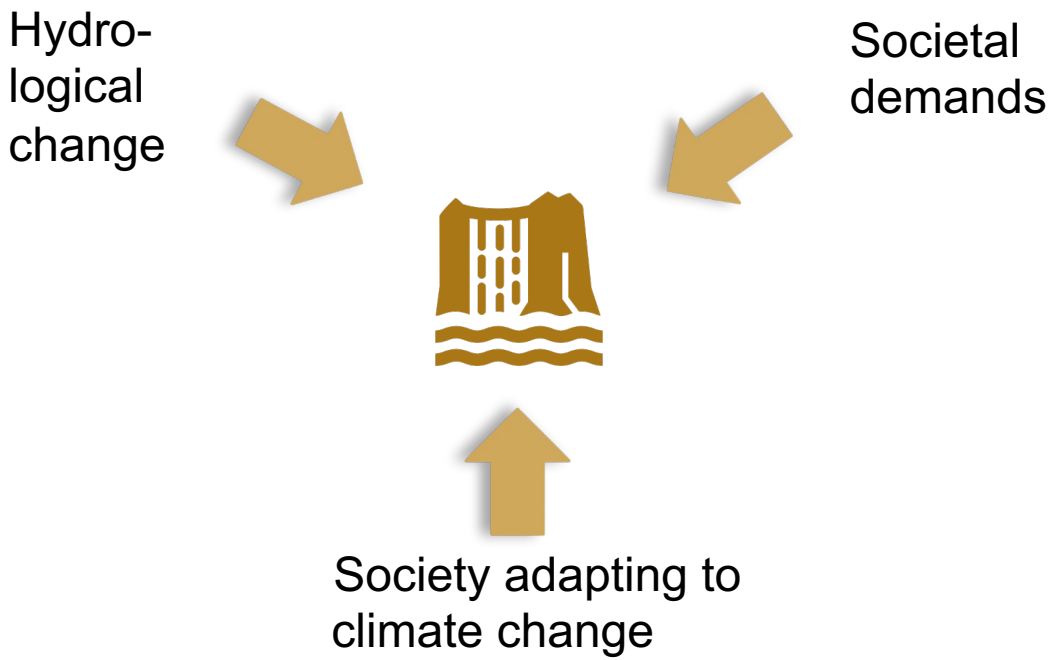
Water systems under stress

Societal demands

A triple challenge



Over-all objective



What does it take?

- Overall objective: make sure that climate change **does not** undermine utilization of water nor the integrity and livelihood of our water systems
- Taking due account of climate change requires that the consequences of
  - all **water uses** will have to be reassessed
  - all **pollutant emissions** will have to be reassessed
  - all **hydro-morphological impairments** will have to be reassessed
- Also, water protection laws may need an overhaul
  - to make sure they are still adequate to maintain water utilization and healthy water systems in times of climate change

Considerable push needed

- Switzerland not alone
- Every country world-wide is facing the same monumental task of adjusting water management and water protection to the hydrology of climate change
- Requires an advanced combination of hydrological, water management and ecological approaches
- Requires developing an over-arching view and holistic understanding of
  - how Swiss water resources are transiting into a new ecological state
  - the present and future impact of water-relevant activities on water systems

Open questions

- Hydrology and future of hydrological regimes: well defined (Hydro-CH2018) ✓
- Sustainably available water quantities: still some work to do ✓
- Fundamental lack of knowledge regarding current uses:
  - ✗ how much water is effectively utilized for irrigation, cooling, industry, and heating?
  - ✗ which chemicals are discharged directly into the environment (e.g. buildings, traffic)?
  - ✗ no register of pesticide and fertilizer application (substance, quantity, location)
- Without detailed knowledge of water consumption and sources of potential pollution, efficient water management and protection cannot be achieved
- **Some serious homework**: complimentary to the vast knowledge elaborated under Hydro-CH2018, we need to fully understand **societal pressures on water systems**
- Our study is a first attempt in that direction, and an invitation to others to get involved


Thank you for your attention!
For questions and feedback:
mail@klaus-lanz.ch
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