



Swiss Global Change Day 2011

Water and Global Change in Switzerland *From Understanding to Action*

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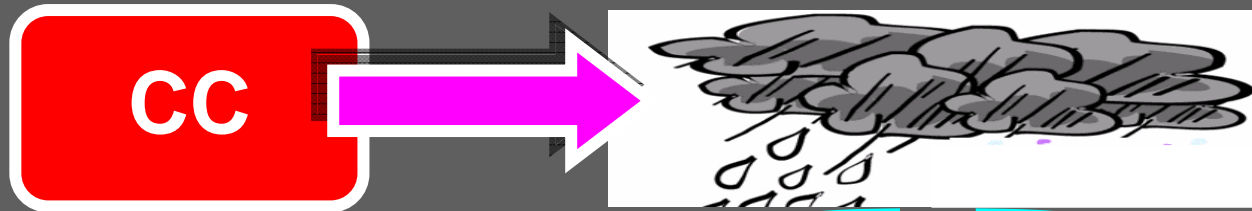
Water and Global Change in Switzerland

From Understanding to Action

Take home messages

- 1) If we want to act, we need transdisciplinary research, including system, target and transformation knowledge
- 2) At different scales we see quite different problems of course different solutions
 - *global*: A drier world causes new challenges for Switzerland
 - *national*: It's only a semi-quantitative understanding of climate change which provides the basis for the Swiss adaptation strategy
 - *local*: Scientific gaps and missing comprehensive views constrain concrete actions. We are, however, privileged not to run out of time.

Water connects cc to people → CC research has to be much more than pure research



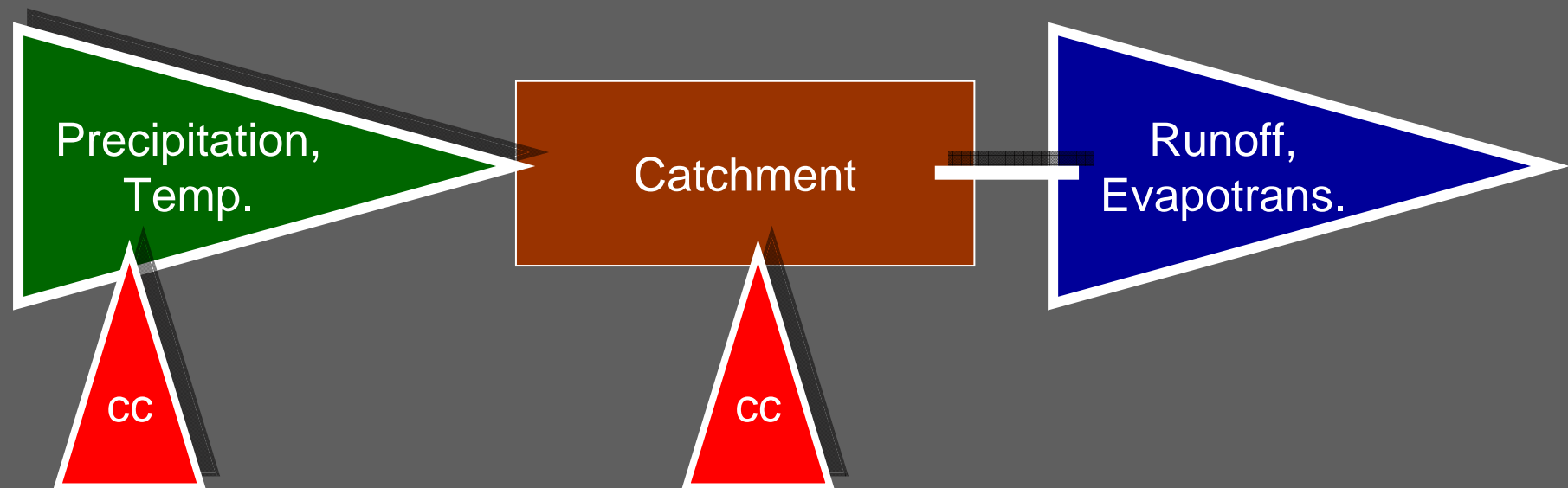
Water availability (resource)



Natural hazards (floods, droughts)

Water connects cc to people → **CC research has to be much more than pure research. We need ...**

System knowledge (of course)



- understanding of how a system (e.g. hydrological system) function today and under future climate (research in a proper sense)

Interdisciplinary research

Water connects cc to people → **CC research has to be much more than pure research. We need ...**

Transdisciplinary research

System knowledge may be sufficient for a scientific paper, but it is not enough for cc research that matters in view of public

+ **target knowledge**

Values that are showing where to go. Views and visions of the inhabitants, politicians and NGOs



+ **transformation knowledge**

- **Options** for changing the system in a certain direction
- Consequences if an option is applied

↓
Actions and measures taken by the political and administrative system

Science

Society
Practice

Transdisciplinary research

Measures

understanding

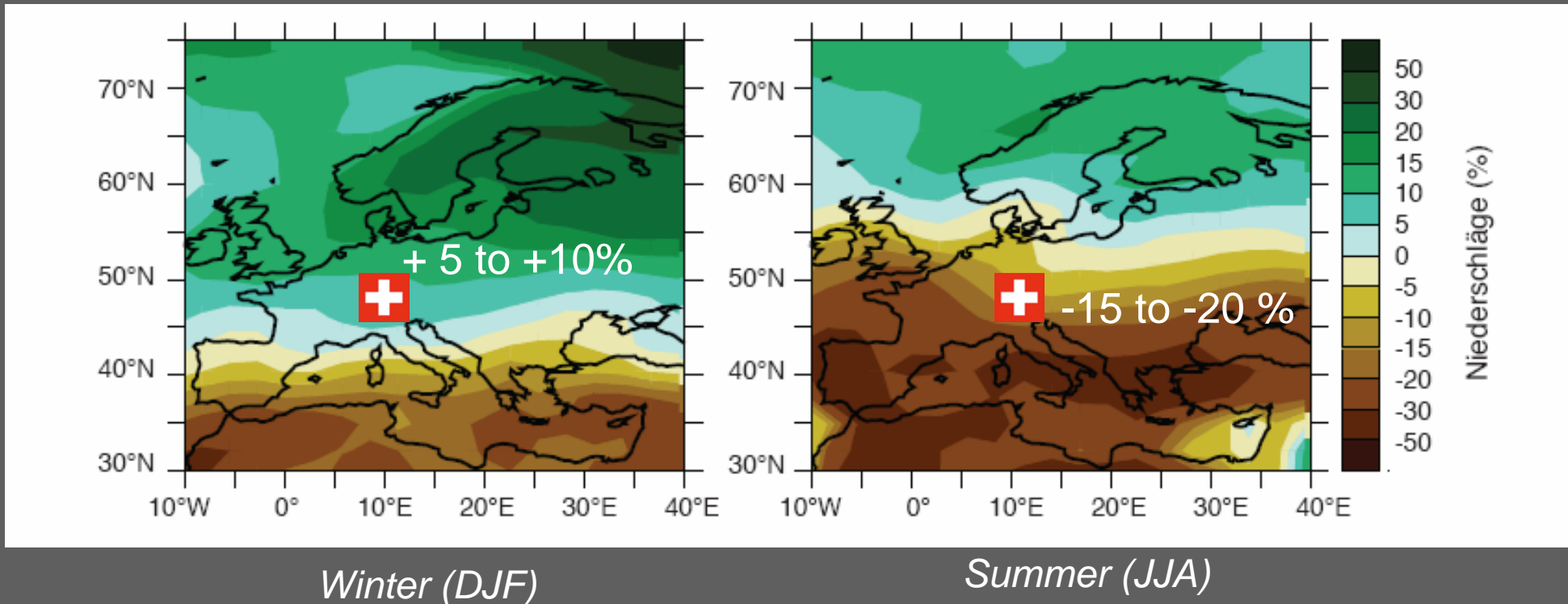
Action

WATER on different scales

- a) Switzerland and the world (**global** scale)
- b) Changes in runoff 1800 – 2100 (**sub-national** to **regional** scale)
- c) CC and hydro power production (**local** scale)

CONCLUSIONS

Precipitation – Changes (%) 2080-2099 to 1980-1999

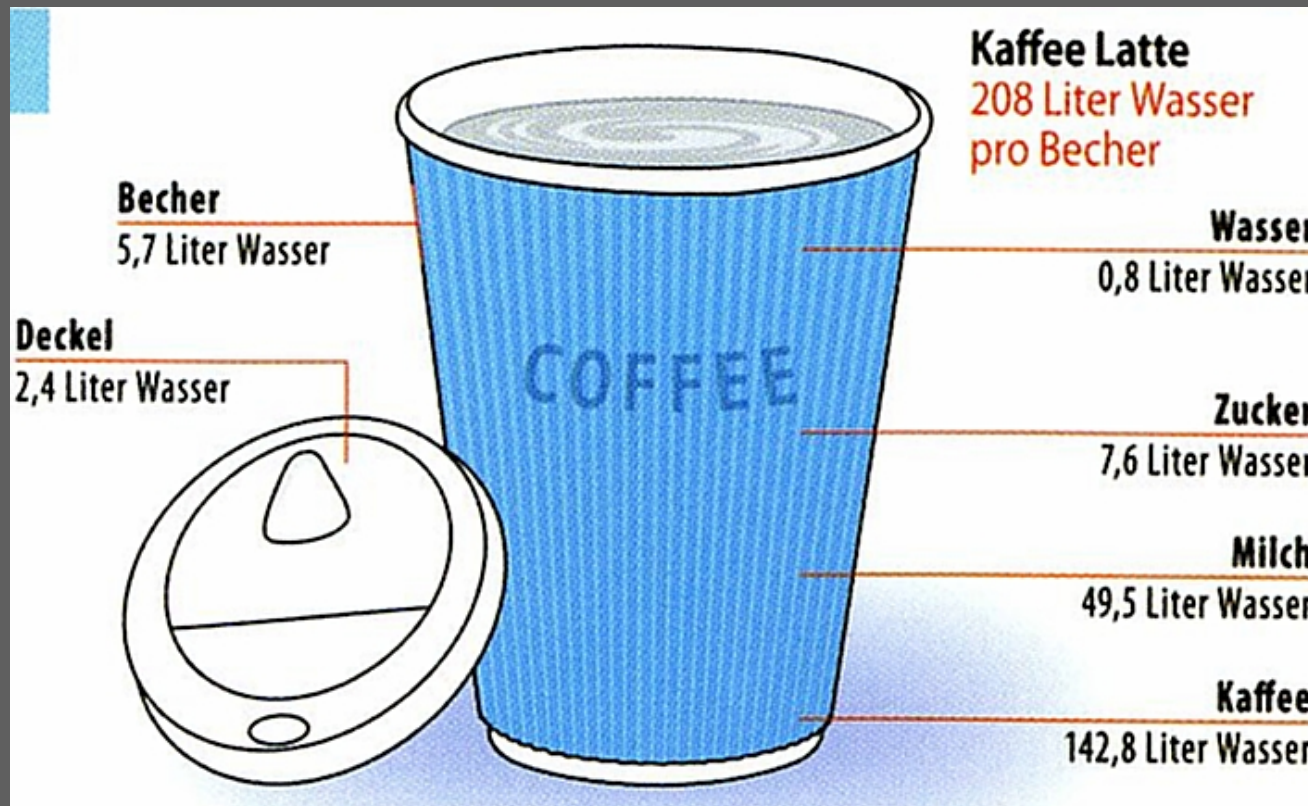


- ≡ No dramatic changes in Switzerland!
- ≡ **What is Switzerland's hydrological role in a drier world?**
 - less water per capita
 - more regions facing water stress



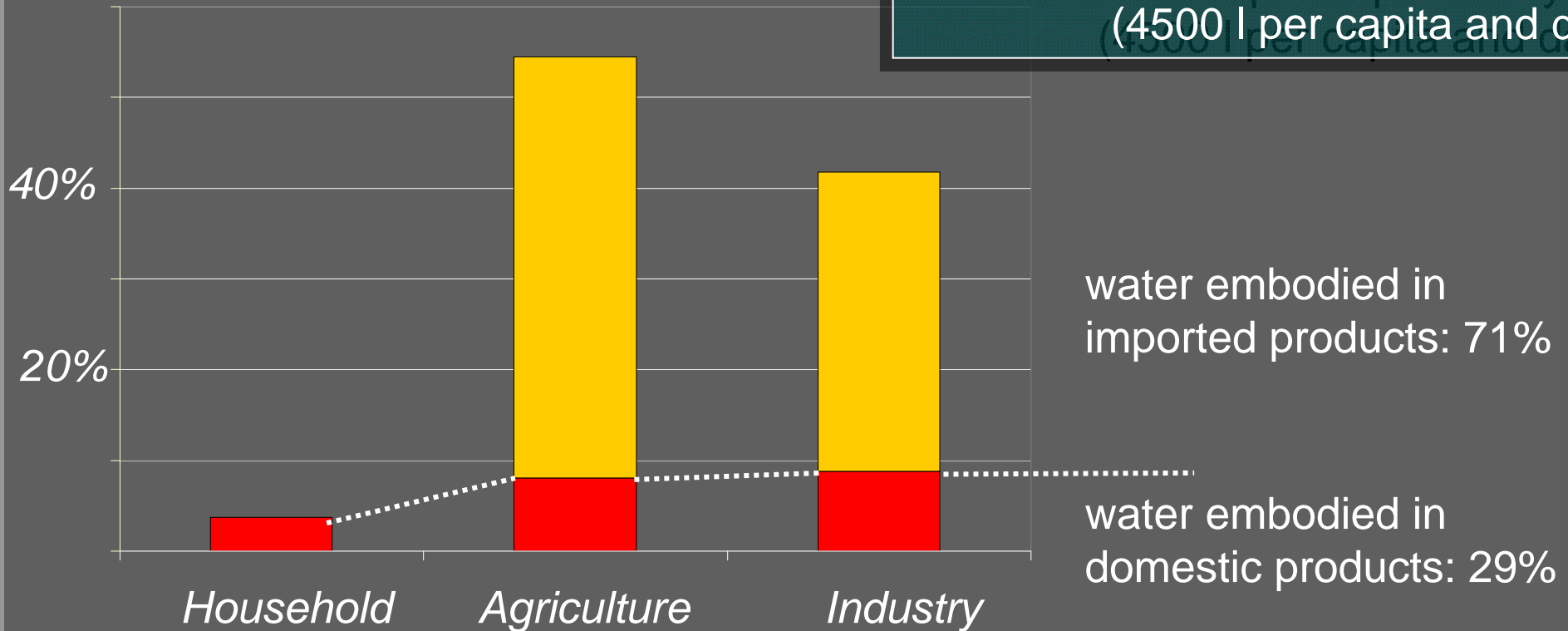
Water footprint of Switzerland

- direct water use (drinking water)
- water use for the production of goods (agriculture, industry)



© Strigl et al. 2010

100% = 1682 m³ per capita and year
(4500 l per capita and day)



Data: Hoekstra und Chapagain (2006)

Switzerland:
The water tower of Europe

Do we really make the
best use of our water?

Perhaps it makes more sense for Switzerland to export more virtual water to a drier world ...

Action

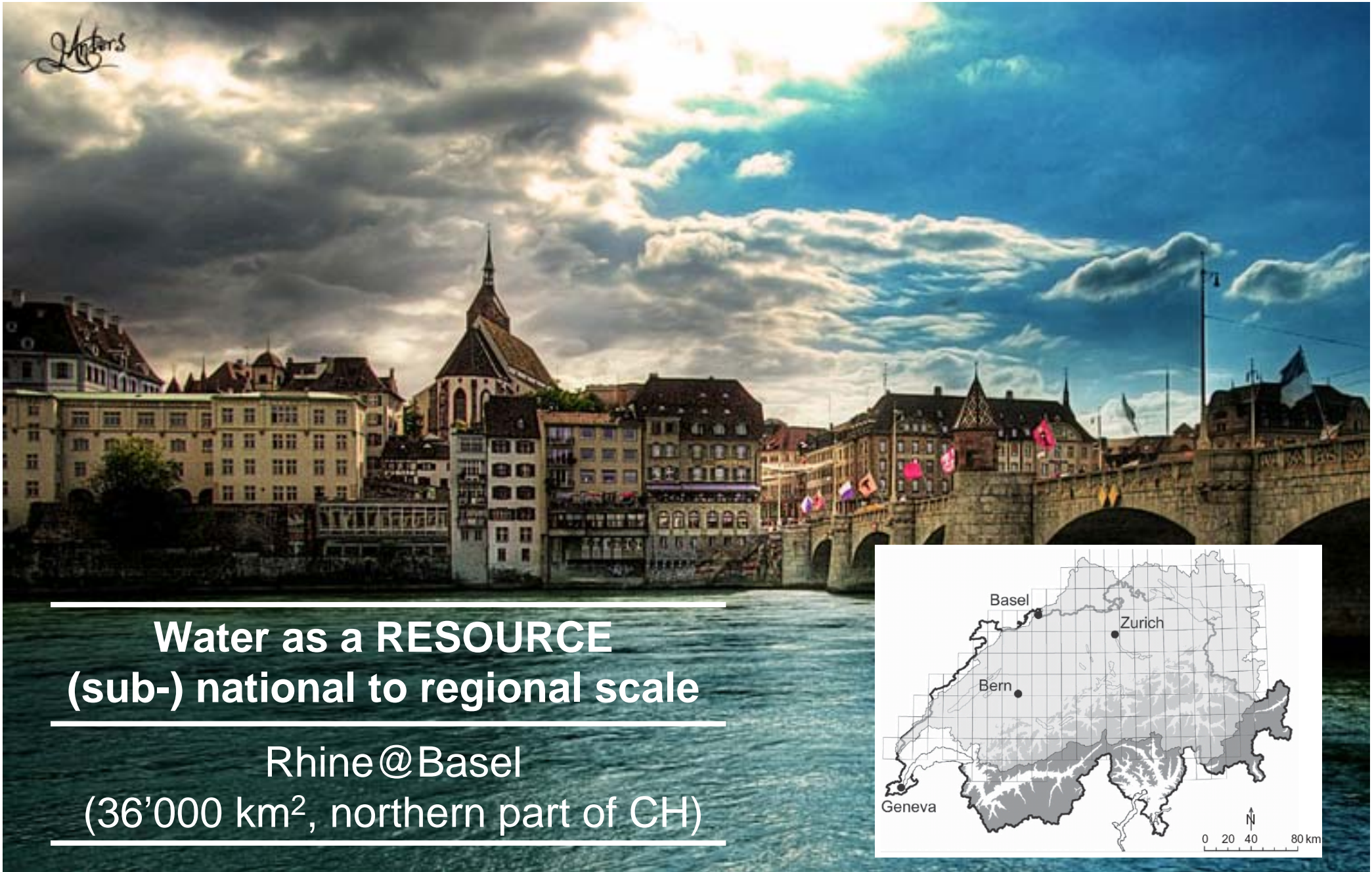
Future



e.g., is the contraction of Swiss agriculture (Auflassung der Landwirtschaft, Rückzug aus der Fläche), i.e. the decline of productivity in agriculture, sustainable and desirable in a global point of view?

Conservation of scarce water resources

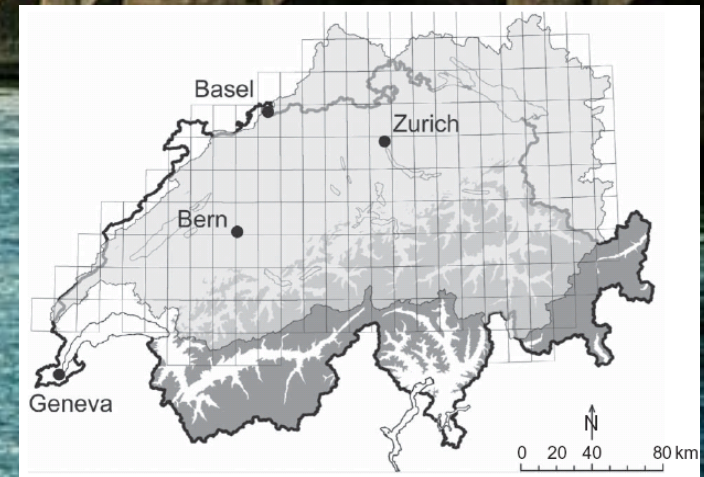
Ubers



Water as a RESOURCE

(sub-) national to regional scale

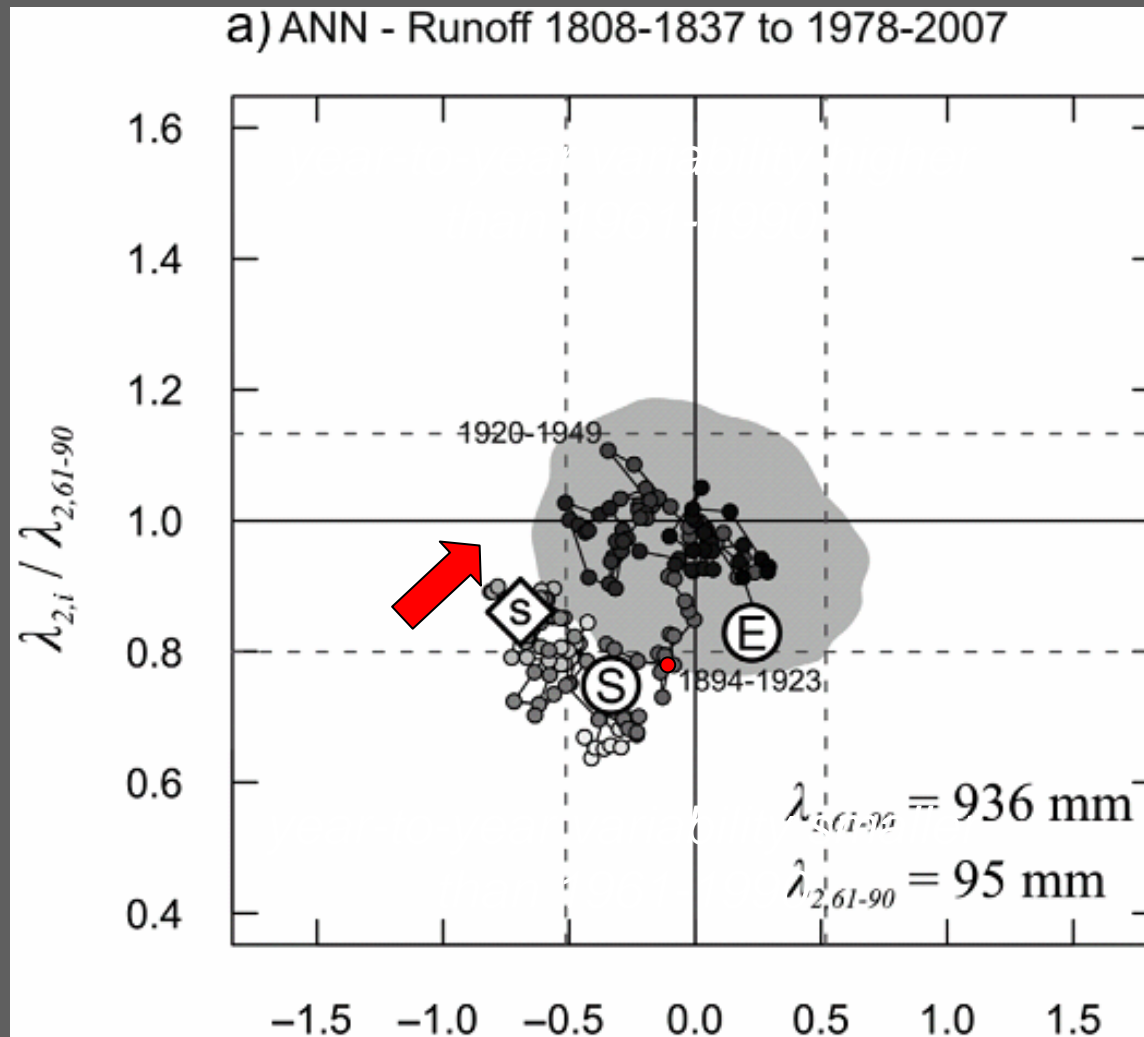
Rhine@Basel
(36'000 km², northern part of CH)



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(Sub-) national scale

Changes in annual runoff 1808 - 2007

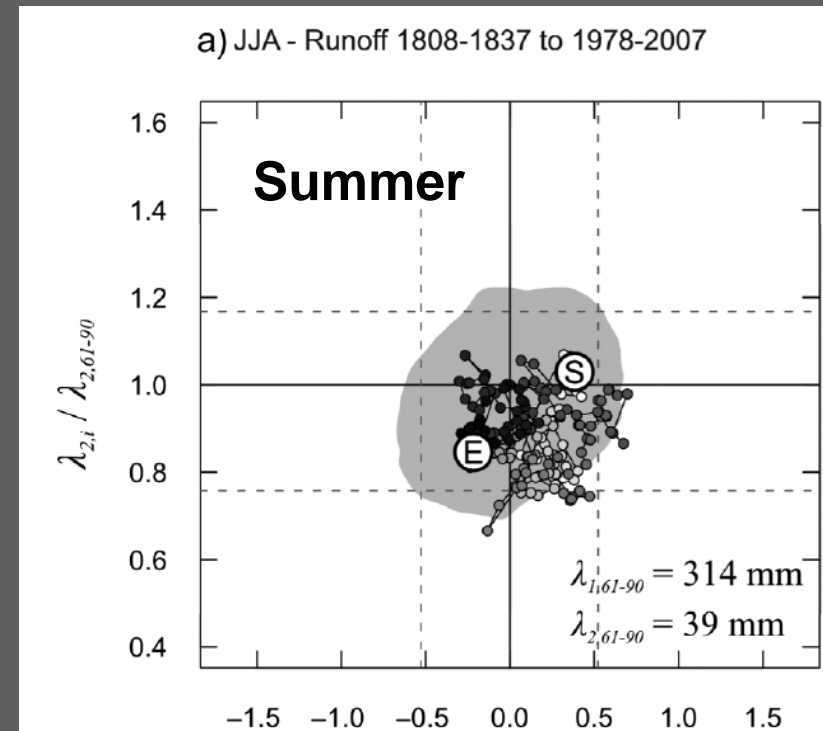
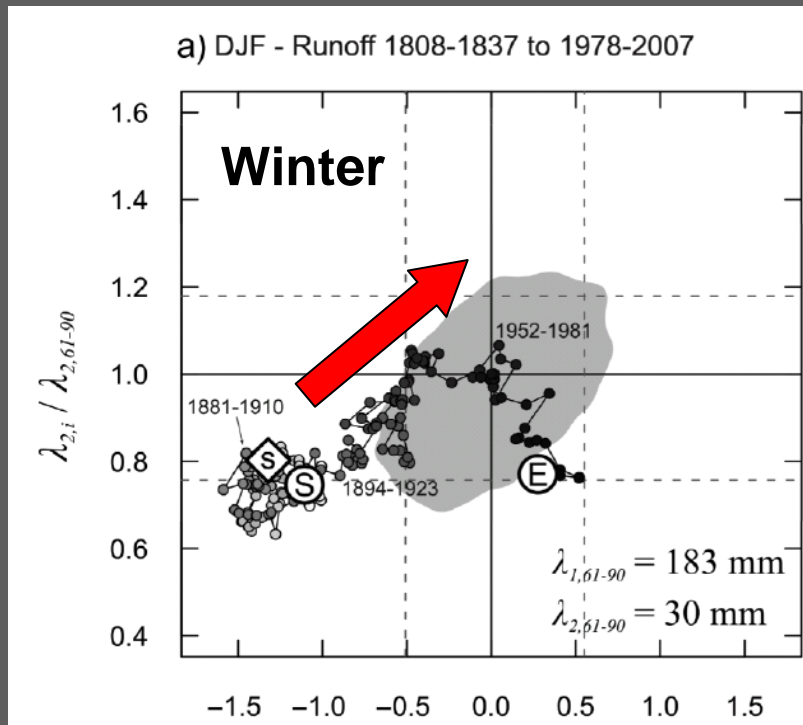


- Ⓢ 1808 – 1837
- ⓔ 1978 – 2003

- ⇒ Increase in both amount and variability over the last 200 yrs
- ⇒ Only slight changes over the last 100 yrs

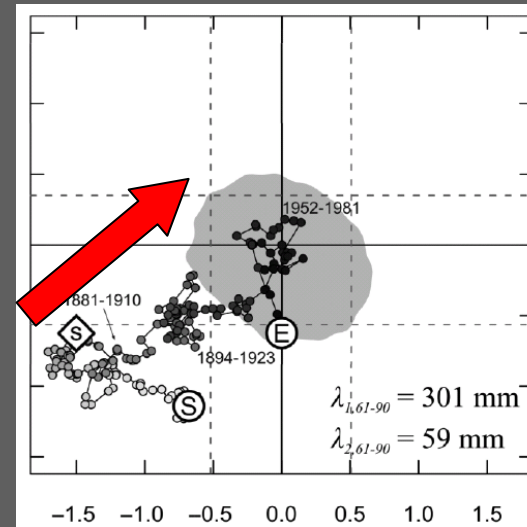
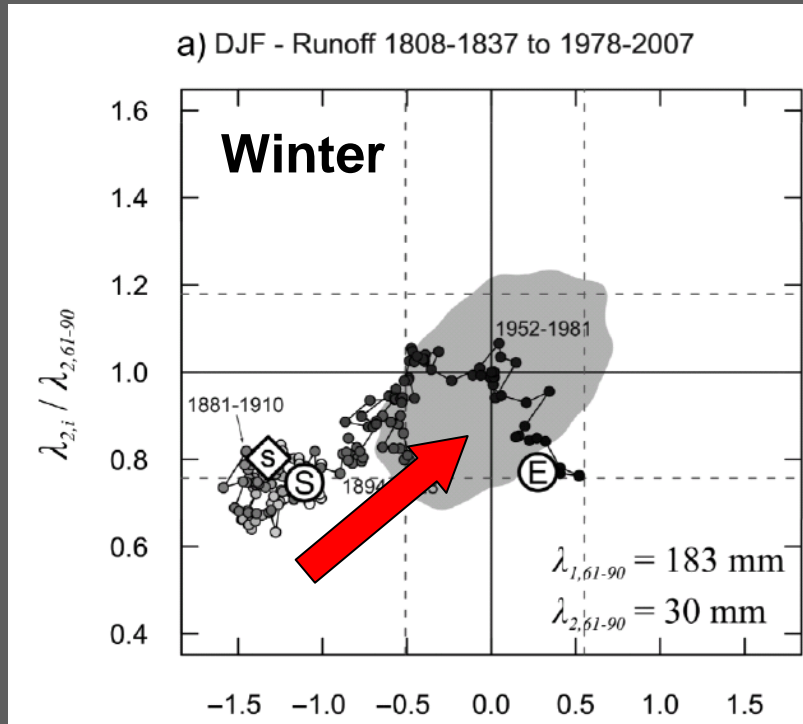
© Haenggi and Weingartner 2011

Changes in winter and summer runoff 1808 - 2007

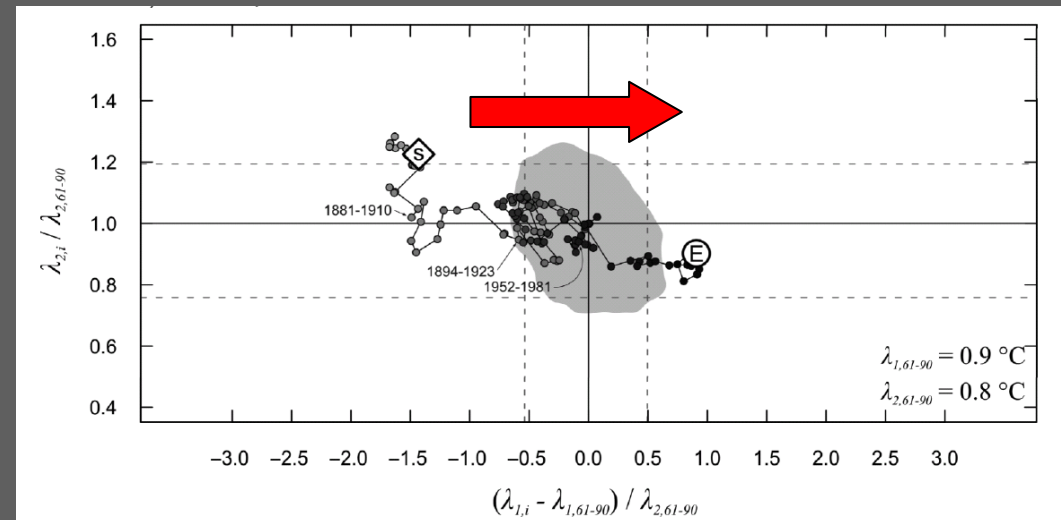


© Haenggi and Weingartner 2011

Changes in winter runoff 1808 - 2007



Precipitation DJF

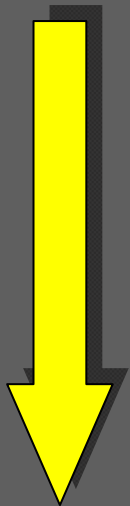


Temperature DJF

© Haenggi and Weingartner 2011

Seasonal runoff may be more affected by climate change → Flow regimes

directly
affected by
cc



Rainfall

Snow

Temperature

Topography, land
use, soils

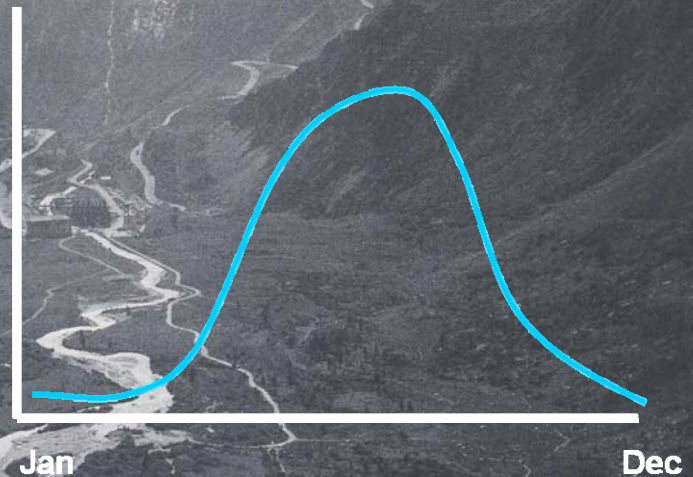
Man

Flow regime is a
sensitive indicator for
climate change



Several factors affect
the seasonal flow
pattern, i.e. the flow
regime

Runoff



Sensitivity study of an **alpine** flow regime to cc: Kander (grey: today)

based on a weather generator combined with a hydrological model

runoff
↑
months →

+20%

δP

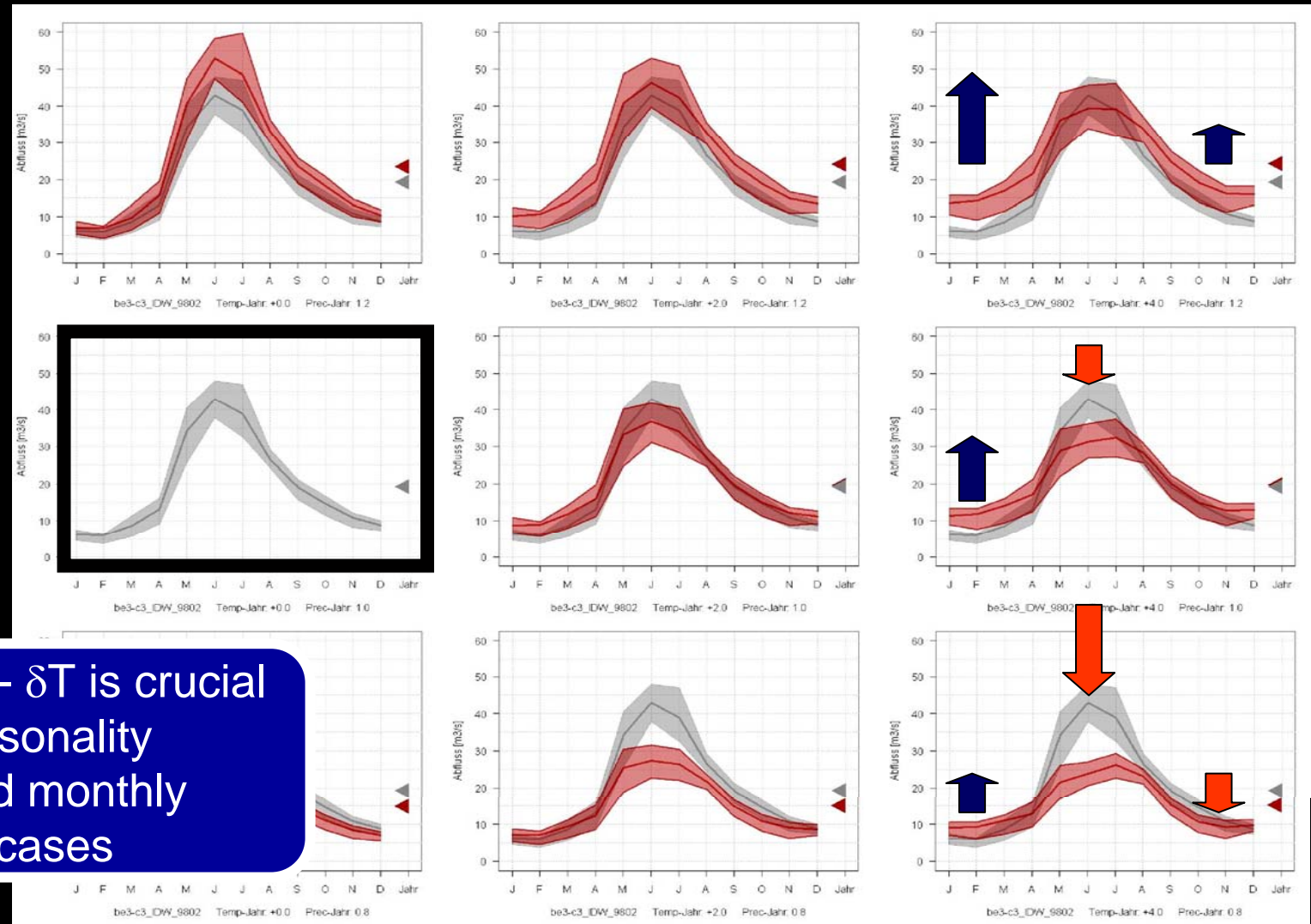
+0%

+0°C

+2°C

δT

+4°C



≡ combination $\delta P - \delta T$ is crucial
 ≡ decrease of seasonality
 (even distributed monthly flows) in many cases

CCHydro: GCM >> RCM >> Hydrological model

Broye - Payerne

© Köplin et al. (in preparation)

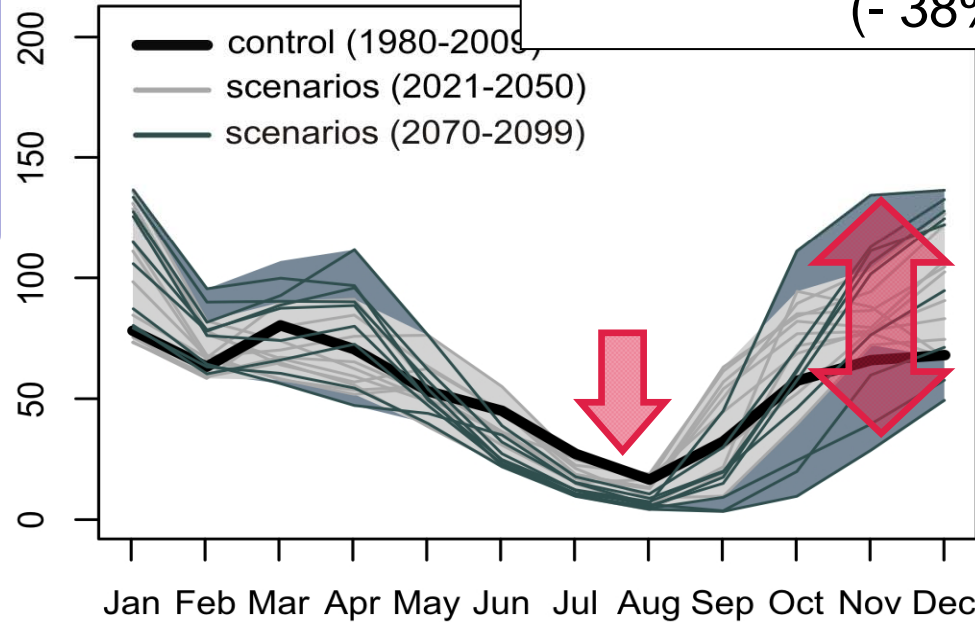
■ study catchments

- Seasonal shifts
- Drier in summer
- Little changes in annual runoff
- Uncertainty

Broye - Payerne
392 km², 710 m a.s.l.

Long term annual runoff
2021-2050: + 11%
(- 14% to + 27%)
2070-2099: + 8%
(- 38% to + 42%)

Mean monthl



Qualitative to semi-quantitative understanding of cc

- ≡ Still large runoff volumes in the future (2050)
- ≡ Seasonal shifts (drier summer periods)
- ≡ Rise in water temperature
- ≡ **Increase of floods particularly outside the Alps**
- ≡ Increase in bedload transport
- ≡ Significance of the Alps as a water tower will increase

(from Schädler 2010)

Floods in the future?

/// cc scenarios not sufficient

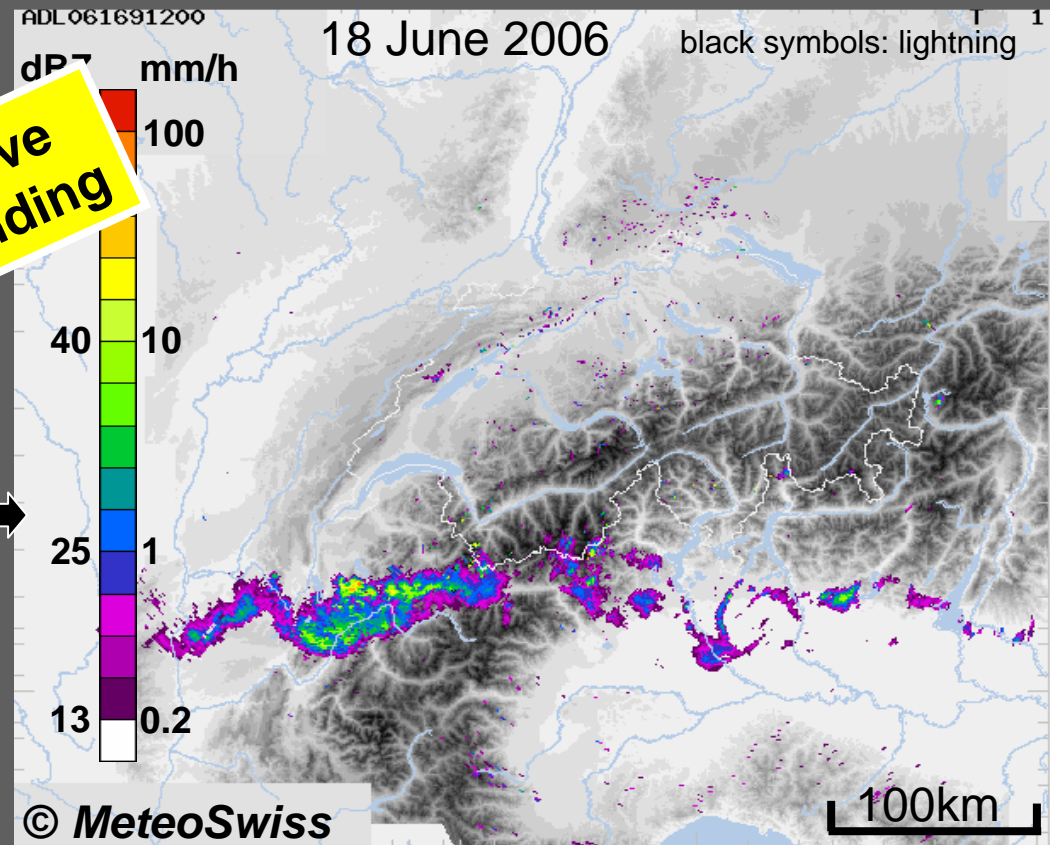
Infrequent and extreme flood events as a combination of

- season
- antecedent soil moisture
- rainfall: amount and intensity
- spatio-temporal projections of storm events
- altitude of 0°C line (rain/snow)
-

We need projections of characteristic events

Quantitative Understanding

Precipitation – MeteoSwiss Radar



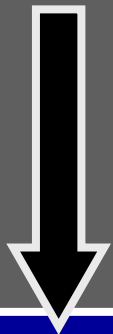
Implementation: M Boscacci © Urs Germann

Qualitative to semi-quantitative understanding of cc

Science: there is still a long way to go

- ≡ Still large runoff volumes in the future (2050)
- ≡ Seasonal shifts (drier summer periods)
- ≡ Rise in water temperature
- ≡ Increase of floods (outside the Alps)
- ≡ Increase in bedload transport
- ≡ Significance of the Alps as a water tower will increase

(from Schädler 2010)



Swiss Strategy for Adaptation to cc

Swiss Strategy for Adaptation for cc

Action

The following main issues were identified

(acc. Aschwanden, Schädler 2010):

- 1) To provide **adequate space for rivers** (*cf. below*)
- 2) To develop **new concepts for storage** and distribution of water
- 3) To enhance **regional collaboration** in water supply
- 4) To develop **new technologies for cooling** in order to anticipate the rise in water temperature

„Mit der Strategie definieren wir Ziele und skizzieren die Stossrichtung zur Zielerreichung; wir formulieren aber noch keine konkreten Massnahmen“
(Roland Hohmann, Sektion Klimaberichterstattung und -anpassung BAFU)

1) To provide **adequate space for rivers**

**Increase of floods → residual risks
can be buffered, profiting from
additional space in flood plains**

Modern flood protection in
Switzerland (Wasserbaugesetz)
already goes in this direction!



Kander@ Schwandi-Ey

© www.kanderwasser.ch

Swiss Strategy for Adaptation for cc

Action

2) To develop **new concepts for storage** and distribution of water

Flood protection

Hydropower

pumped storage hydropower station (to store renewable energy)

How to balance these competing needs through new operating rules?



Warmer winter seasons
- water for artificial snow

Drier summer seasons

- irrigation water
- water supply
- maintain environmental flows
- water for the dry lowlands

swisselectric
research



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE



CANTON DU VALAIS
KANTON WALLIS

Water as a RESOURCE local scale

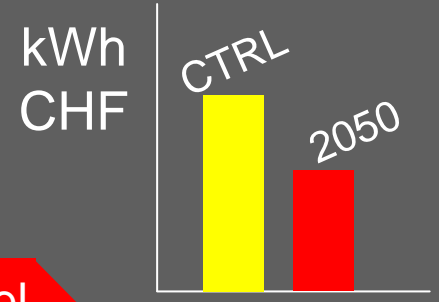
CC and hydropower production

*Will there be a significant change in
electricity production due to cc?*



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Local scale

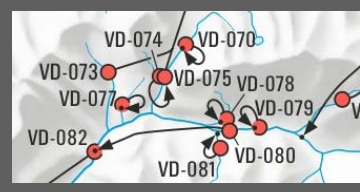


global regional local



Scientific gap

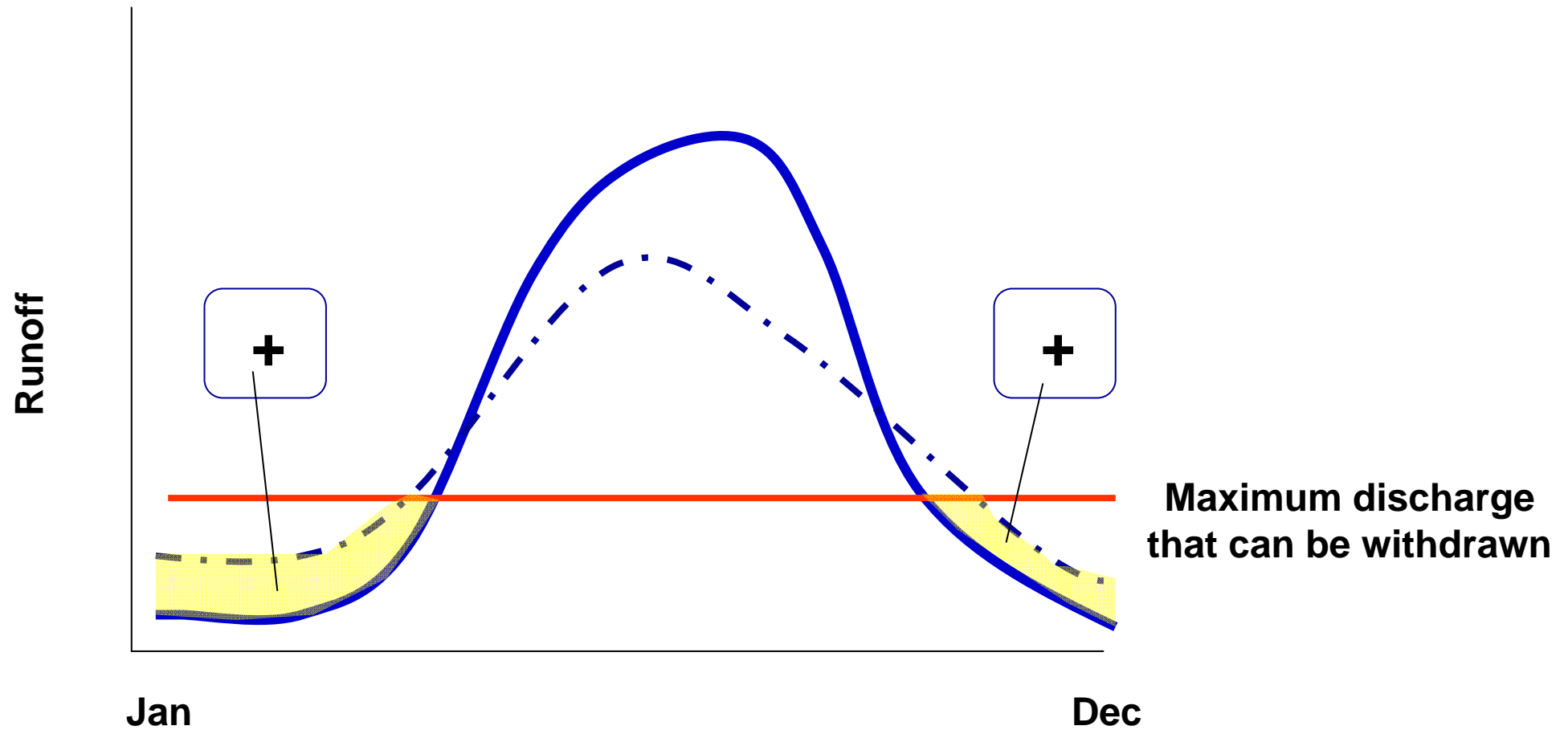
CHALLENGE:
Downscaling to local scale
(uncertainty)



Hydrograph 2050 (dt = 1h)
for each point of water
abstraction

Some quite surprising results:

/// Even a decrease of runoff may lead to an increase of electricity production



- ≡ Even a decrease of runoff may lead to an increase of electricity production
- ≡ To understand the future of hydro power production: the changes in water regime is only one factor among many others!

Action?

- ≡ changes in flow regimes
- ≡ changes in hazards (instability of slopes etc.)
- ≡ changes in operation rules
- ≡ changes in consumption pattern
- ≡ changes in European electricity market
- ≡ development of prices
- ≡

Issue: Story lines are needed

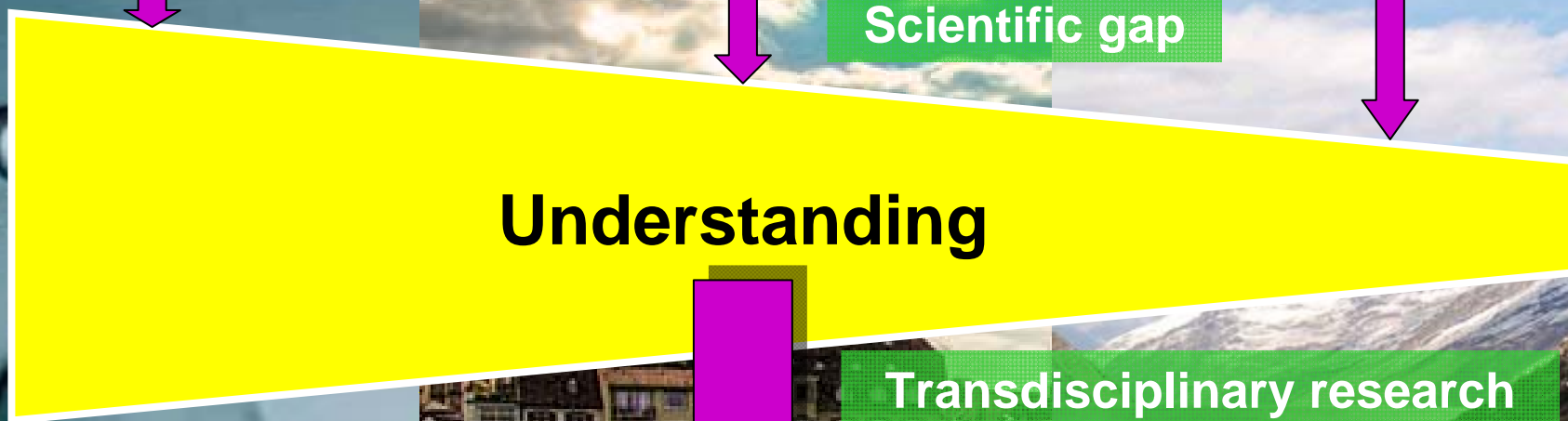
Global

(Sub-) national

Local

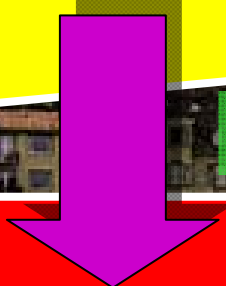


Scientific gap



Understanding

Transdisciplinary research



Action (think globally, act locally)



Political collaboration



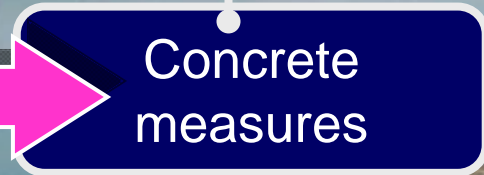
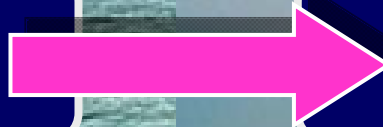
Solidarity



Adaptation Strategy



Holistic approach in water management; Sustainability



Concrete measures



Better understanding!