SCCER SoE

SWISS COMPETENCE CENTER for ENERGY RESEARCH
SUPPLY of ELECTRICITY

Drivers for change: socio-economics, climate change, and environment

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Schweizerische Eidgenossenschaft
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Commission for Technology and Innovation CTI

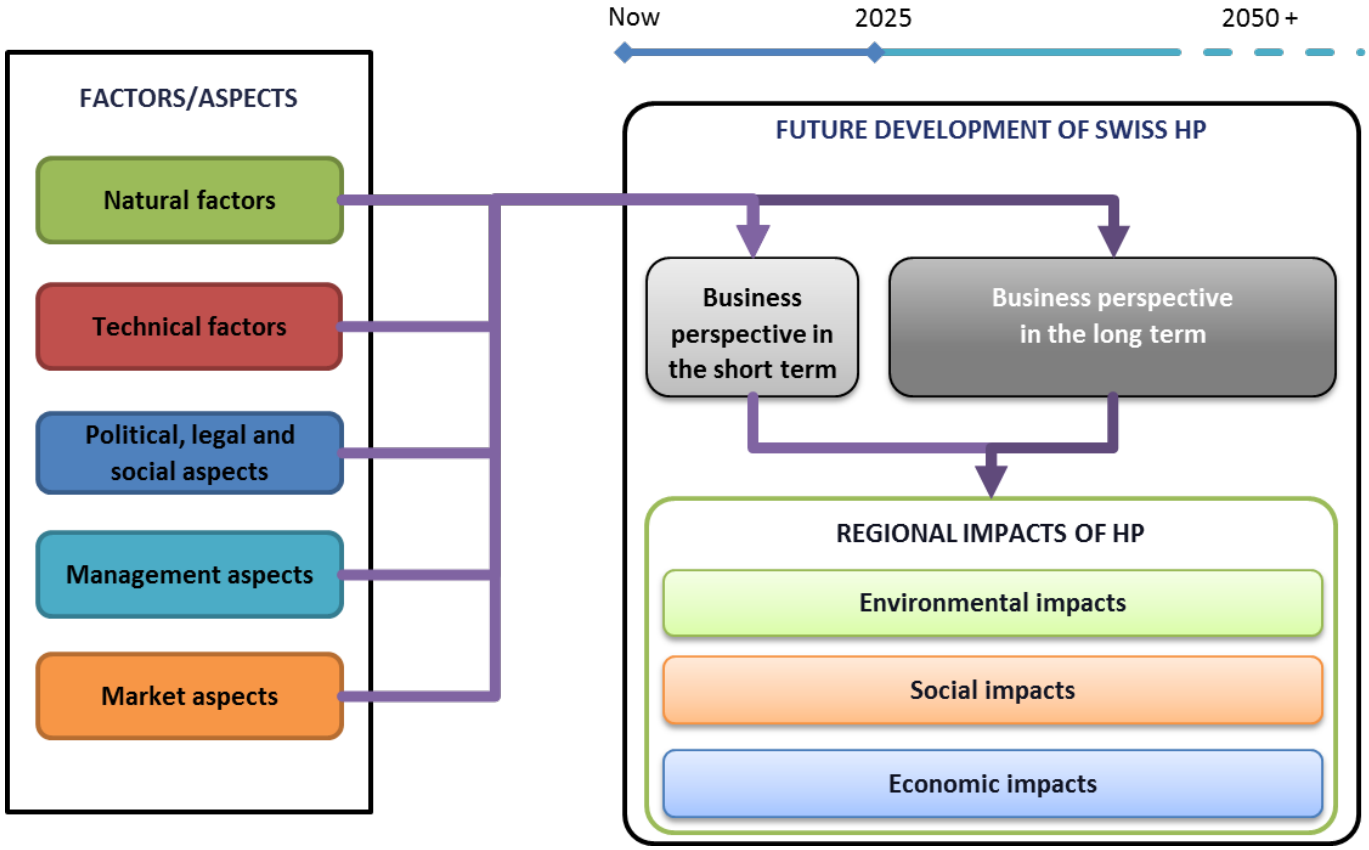
Agenda

Socio-Economic Drivers

Environmental Drivers

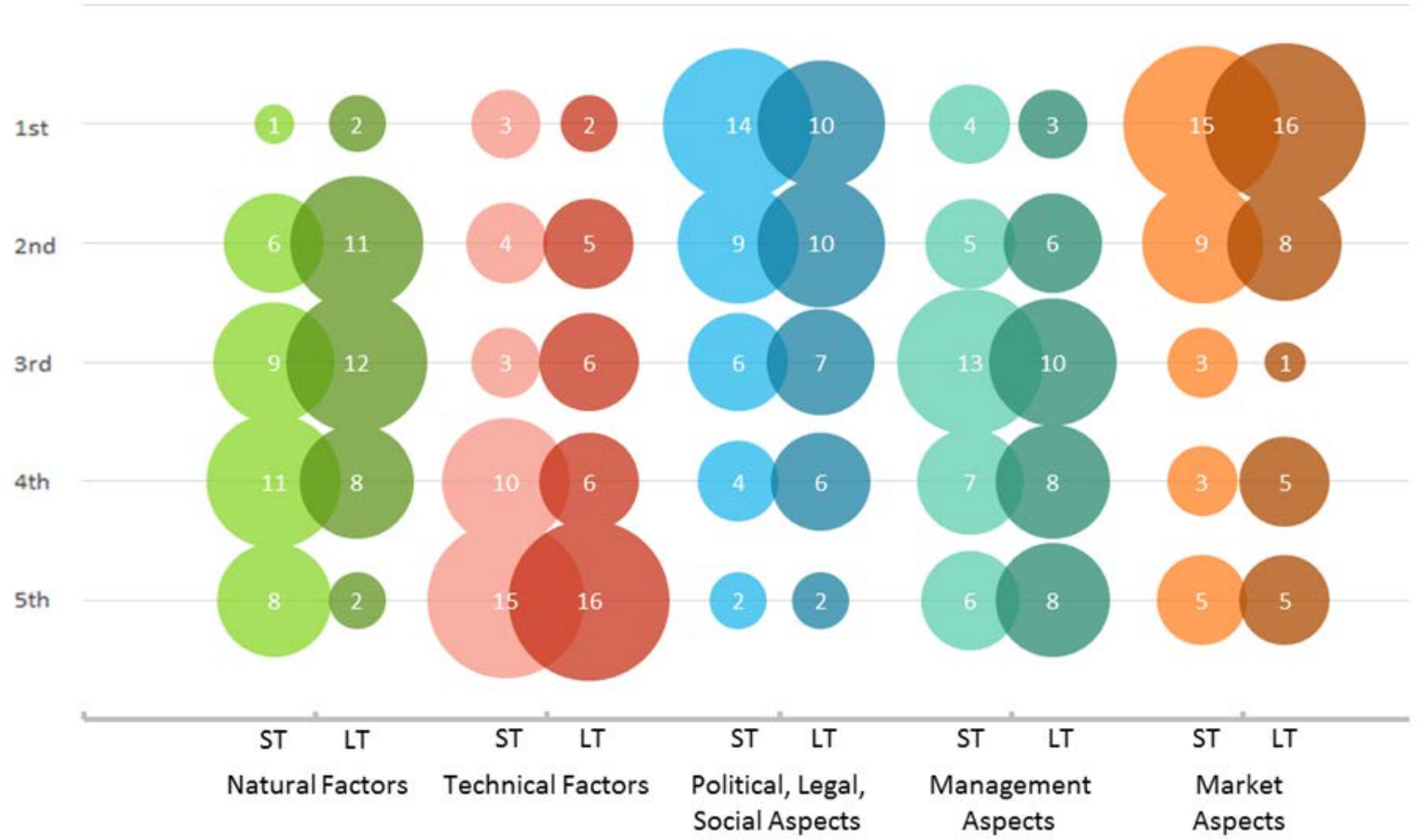
Climate Change Impact

Identifying Main Drivers



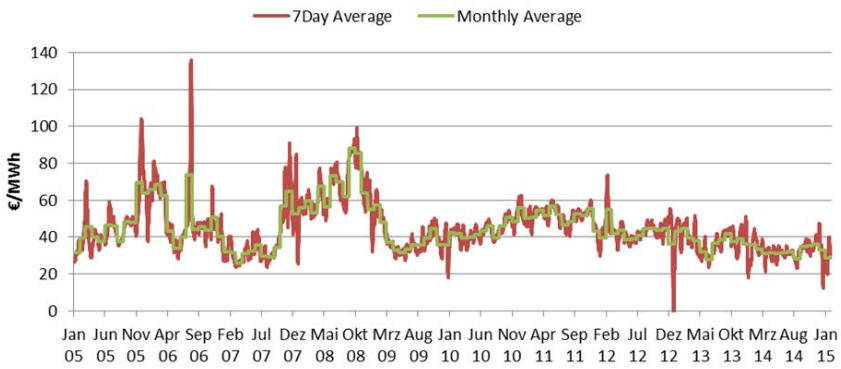
Swiss HP faces multiple challenges both in the short and long run
That feed back to the regional socio-economic development

The Stakeholder's Perspective



Market and Policy aspects are the current main concerns

The Two Sides of the Swiss HP Dilemma



Market Price Decline:

- Low CO2 price
- Low coal prices
- High RES injection

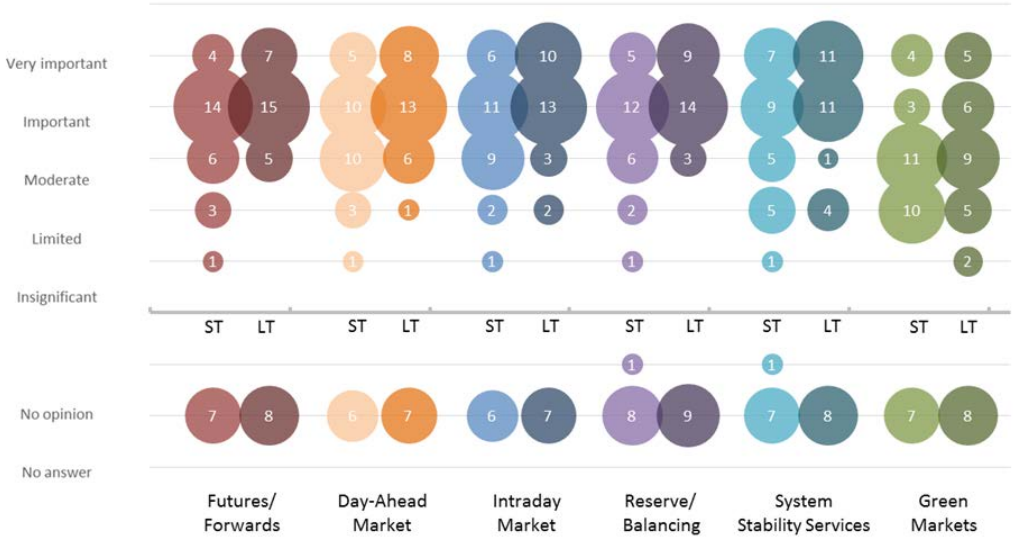
High Production Costs:

- Swiss Price Level
- Investment Costs
- Fees and Concessions

The trend is likely to remain stable for the coming years!

Changes will take time!

The Market Side

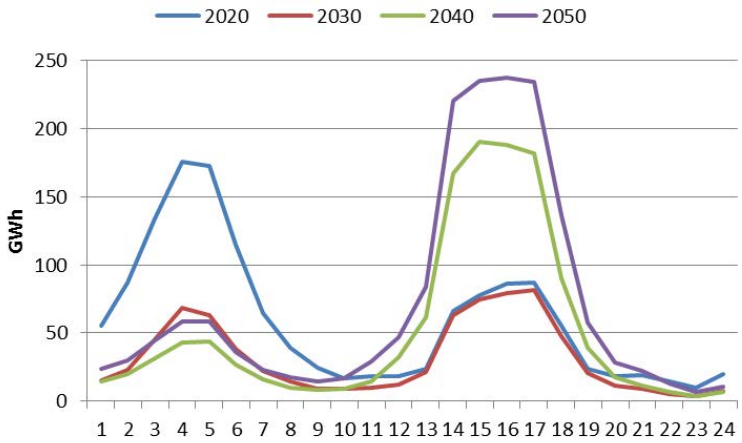


Swiss HP must take into account all possible market alternatives

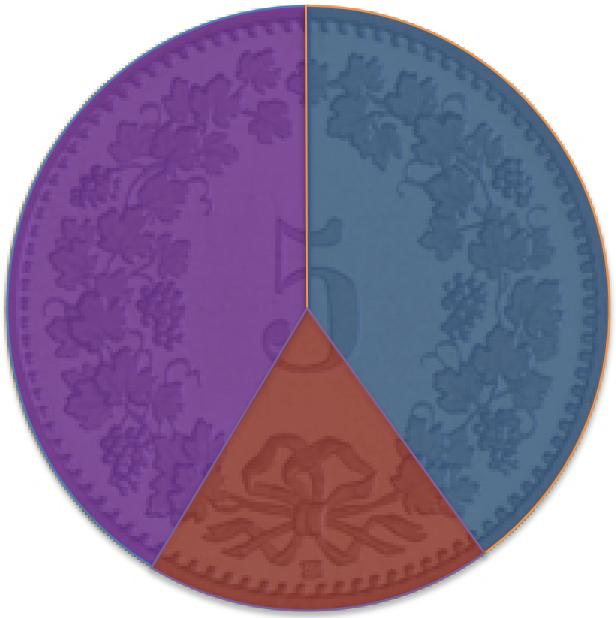
→ Ongoing model evaluation of the impact of different markets for HP profitability

Long term uncertainty big challenge for investment decisions

→ Deriving new investment evaluation approaches for future scenarios



The Policy Side



Operation Costs:

Efficiency gains possible? Int. competition in a harmonized market?

Investment Costs:

Depreciation rules designed for non-market environment → need to be adjusted for risky, cyclical dynamics of liberalized markets

Fees, Concessions:

Also designed for non-market environment → Adjustment process highly political (different stakeholder groups, federal vs. local interests), new designs need to be developed (i.e. royalties) and assessed

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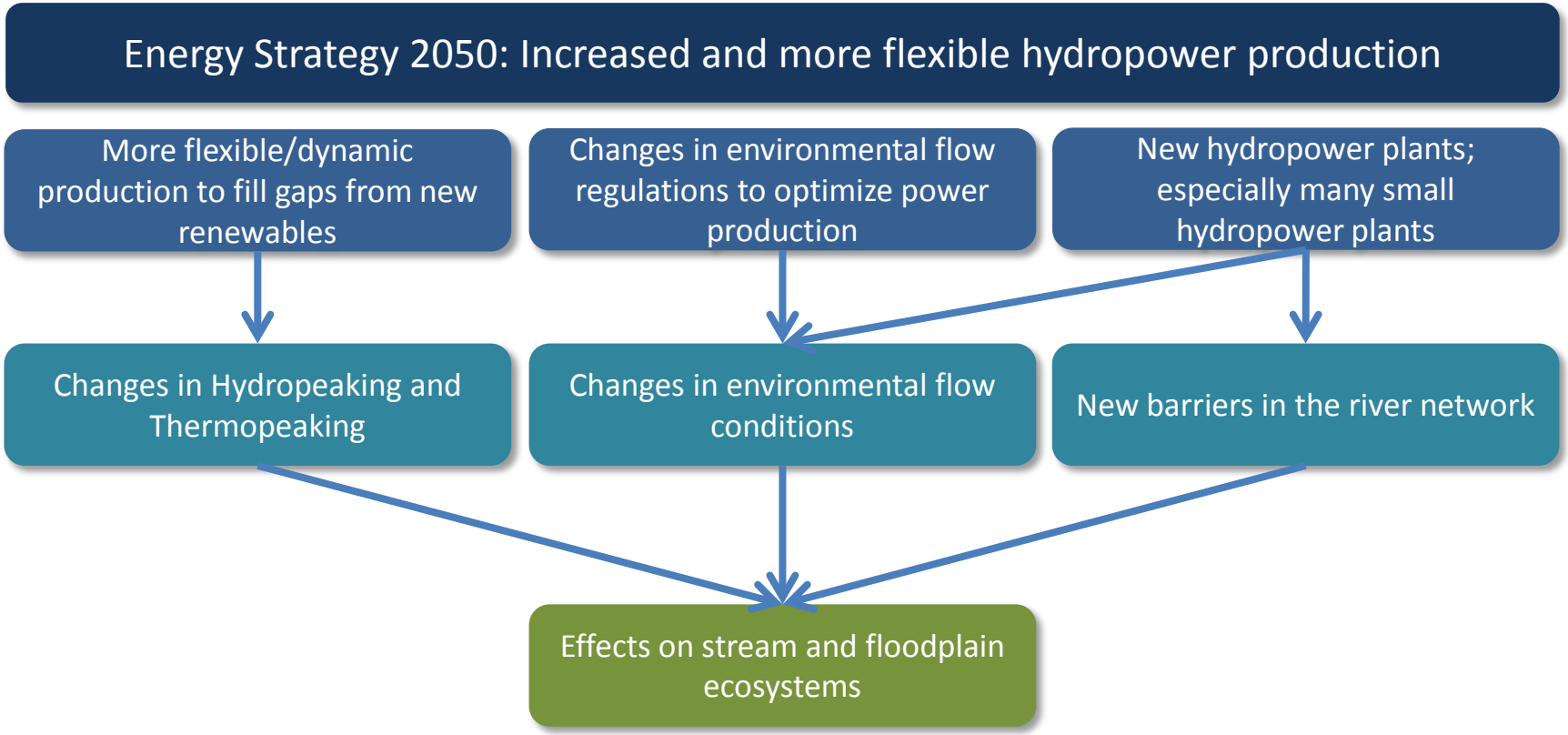
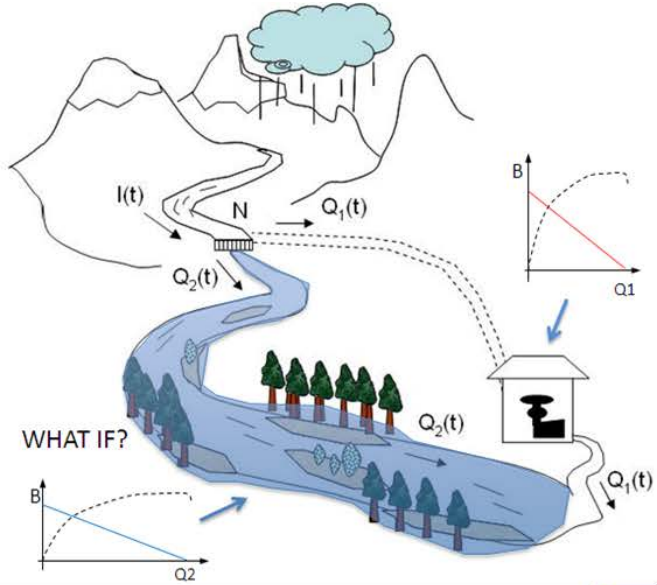
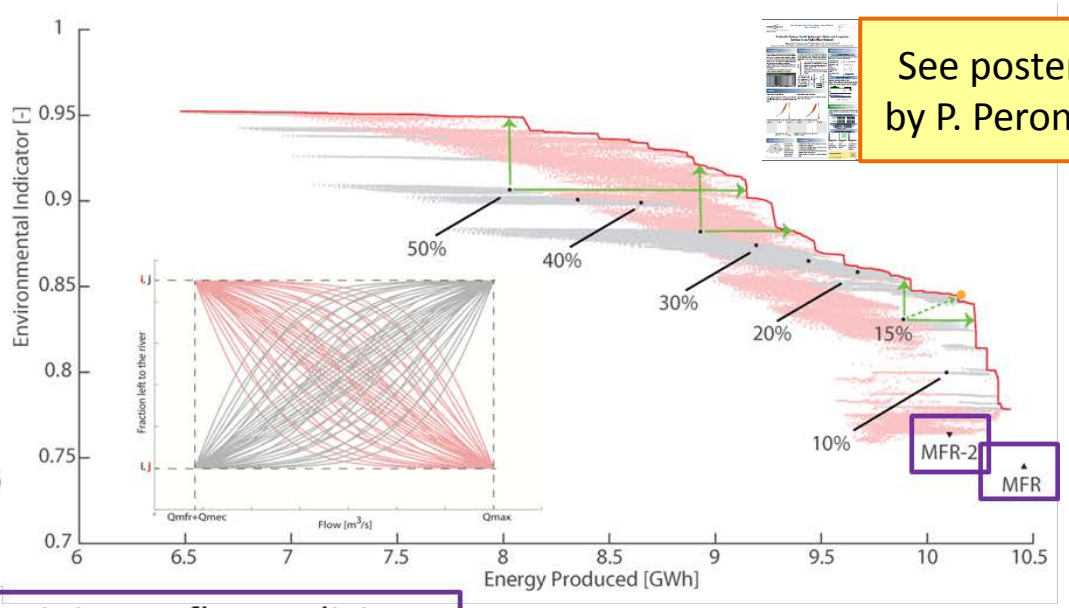
Environmental Impacts of Increased Hydropower Production



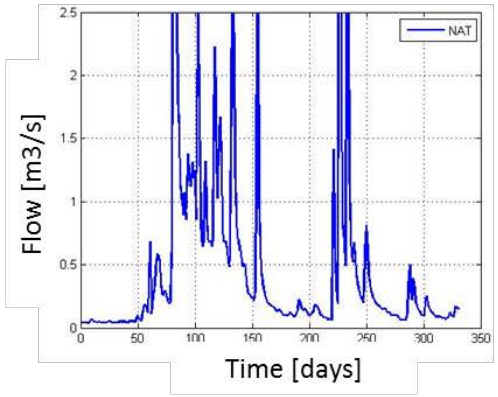
Example:
Optimization of Environmental Flows



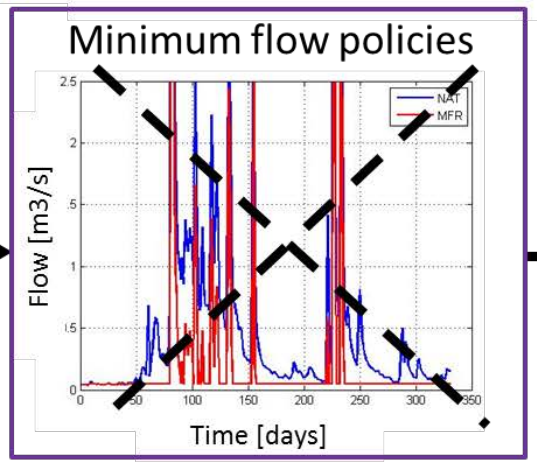


See poster by P. Perona

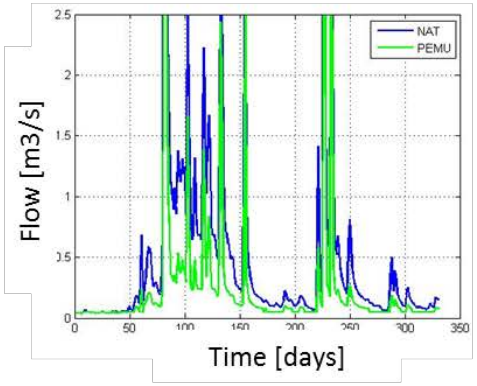
Natural flow



Minimum flow policies



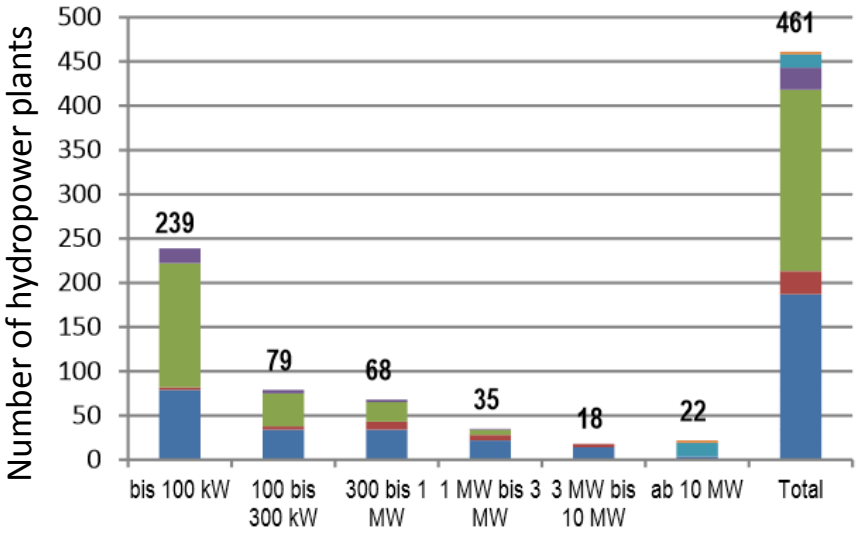
Dynamic flow policies

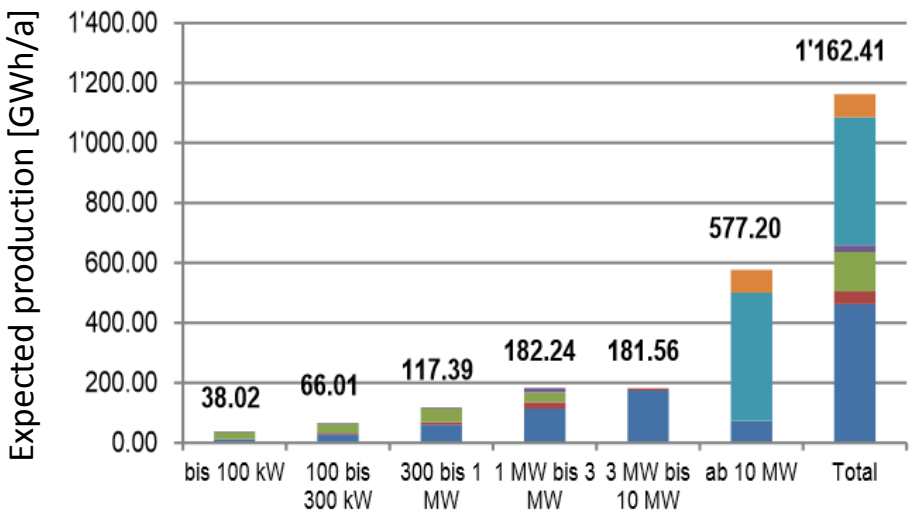


Figures: P. Perona, L. Gorla

Large Number of (Subsidized) Small Hydropower Plants

New hydropower plants in Switzerland 2006-2014





- New hydropower > 10 MW
- Modified hydropower > 10 MW
- Infrastructure (without KEV)
- Infrastructure (with KEV)
- Small hydropower (without KEV)
- Small hydropower (with KEV)

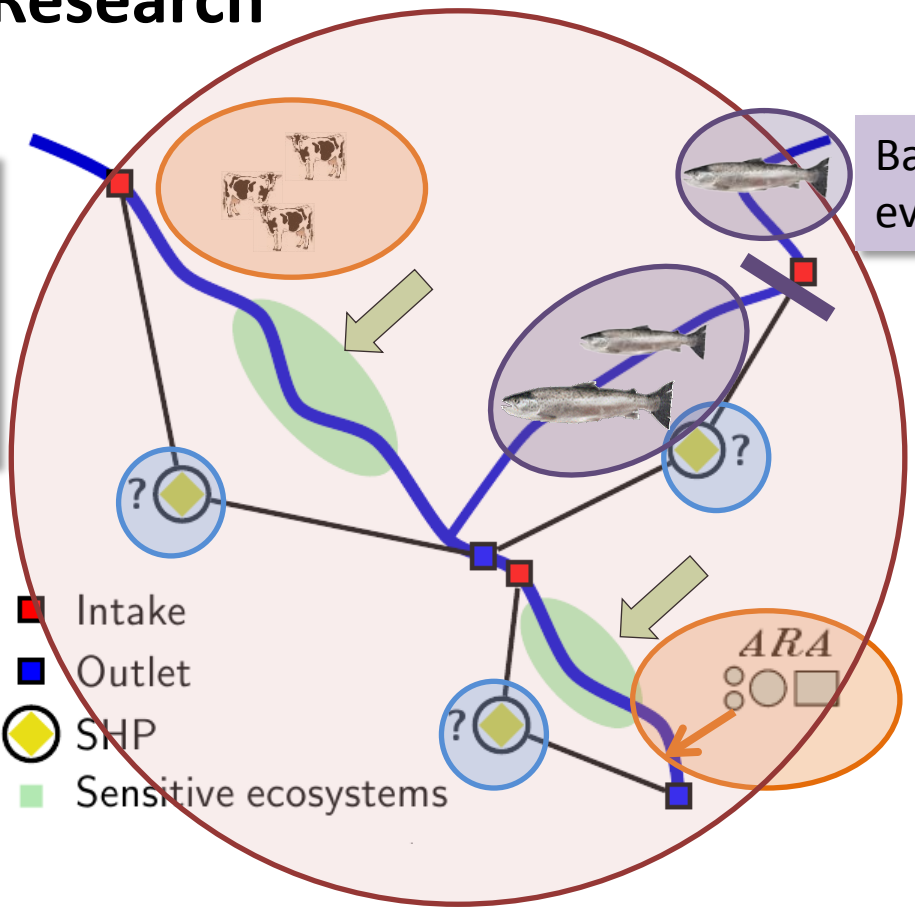
KEV: Feed-in remuneration at cost

Figure: Wasser-Agenda 21

Five Challenges in Ecological and Evolutionary Research

Mechanistic understanding of local ecosystem function (primary production, metabolism, food web)

Barriers as drivers of evolutionary processes



Implications of multiple barriers (network perspective)

Interactions among multiple anthropogenic stressors

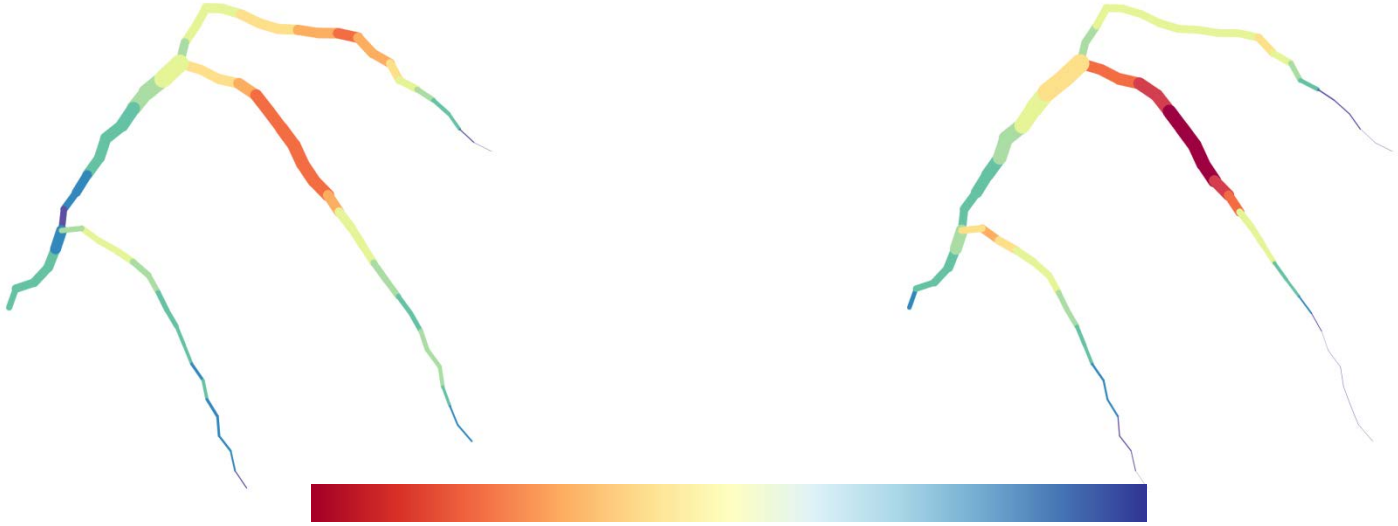
Importance of spatial arrangement and connectivity of habitats

See posters by K. Lange

Example: Positioning of Small Hydropower Plants in a River Network

Optimal solutions using lumped (local) objectives

Optimal solutions using also network-based objective



hydrology strongly modified

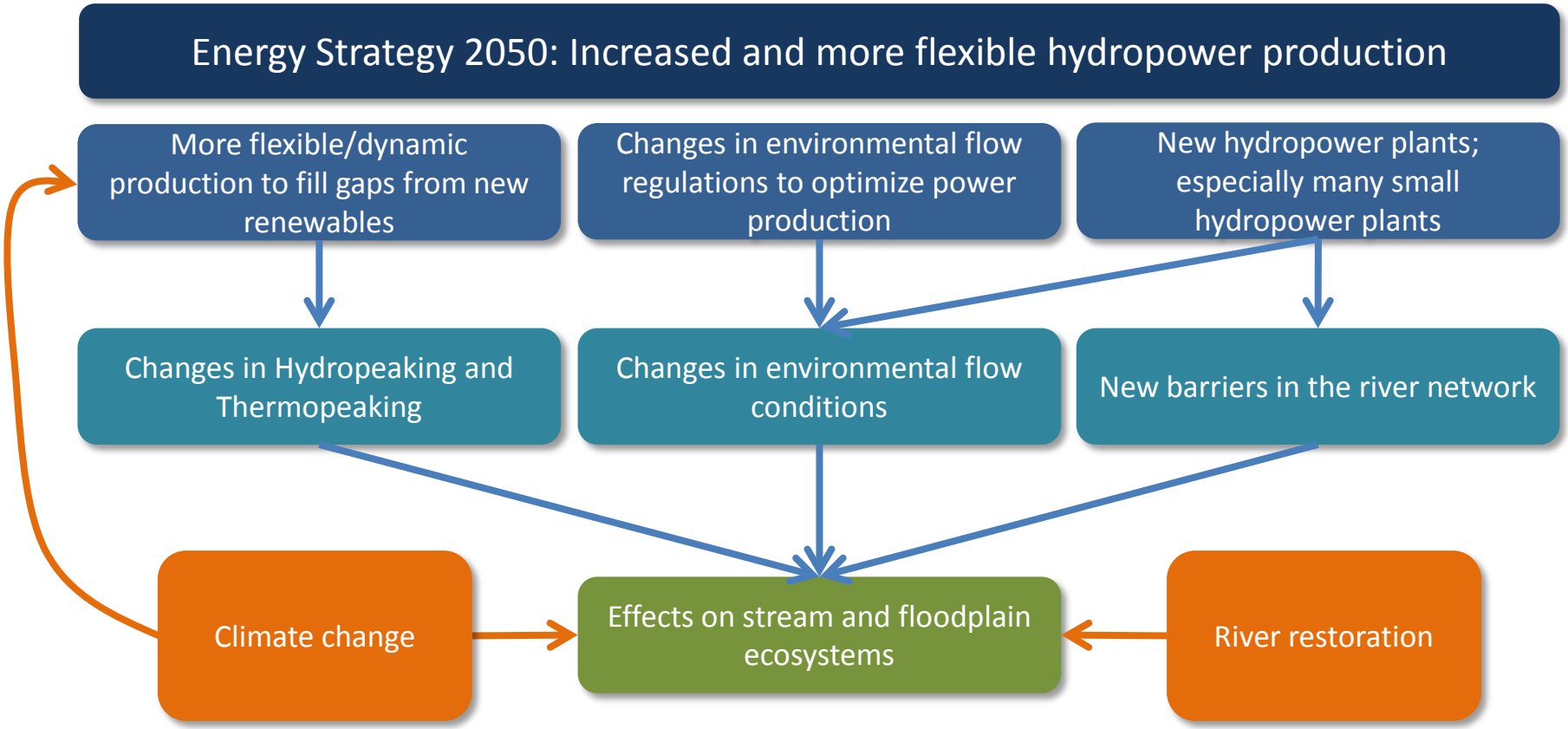
hydrology near natural

Line thickness: Fraction of „optimal“ solutions where a specific river stretch is a residual flow stretch

Importance of selecting „good“ objectives and of considering the network perspective

See poster by P. Meier

Environmental Impacts of Increased Hydropower Production



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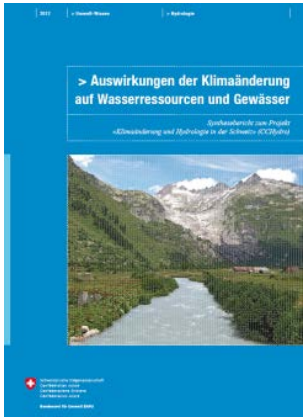
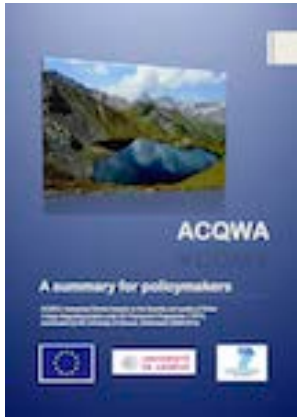
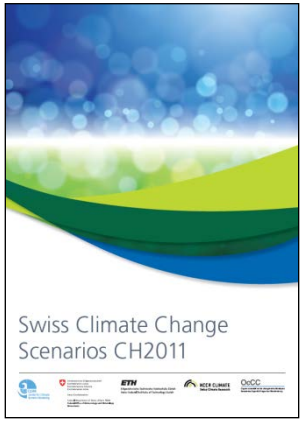
Pespectives for water resources in Switzerland -2100







The general trend is well-known.

SwisselectricResearch study (2011):

Change in mean annual production (2021-50): **+0.9% to -1.9%**

summer: **-4.4% to -6.3%**

winter: **+10.1%**

Hänggi, Weingartner and Balmer, WEL, 2011/4

Forecasts / perspectives at different temporal scales

Time scale	Type of forecast	Relevance for hydro-power operation	SCCER research and projects
< 1 day	Now-casting	Flood management; sediment management	1
1-10 days	Short-term forecasts	Regular operation of HP plants	2
1-3 months	Seasonal forecasts	Production planning	3
1-10 years	Decadal forecasts	Decisions on investments	4 5
10-100 years	Long-term perspectives	Long-term strategies; concessions	6 7

1. Sediment transport measurement system Albula – Solis (WSL, BAFU)
2. OPT-HE: Hydrological high performance forecast for hydropower production – hydrological modelling (LCH-EPFL, e-dric.ch, et al.)
3. HEPS4Power: Extended-range Hydrometeorological Ensemble Predictions for Improved Hydropower Operations and Revenues (WSL, MeteoSchweiz, e-dric, Alpiq)
4. Decadal hydro-glaciological forecasts for the Swiss hydropower sector in high mountain catchments (WSL, VAW-ETHZ, Alpiq)
5. Mapping of alpine glaciers using helicopter-borne radar - a comprehensive analysis of Swiss alpine glaciers (VAW-ETHZ, SGPC)
6. Generation of very high-resolution climate scenarios for hydropower projection – addressing climate uncertainty and extreme events (C2SM, ETHZ)
7. Studio sugli effetti dei cambiamenti climatici riguardo l'idrologia dei bacini idroelettrici Ticinesi (WSL, Elettricità della Svizzera Italiana)

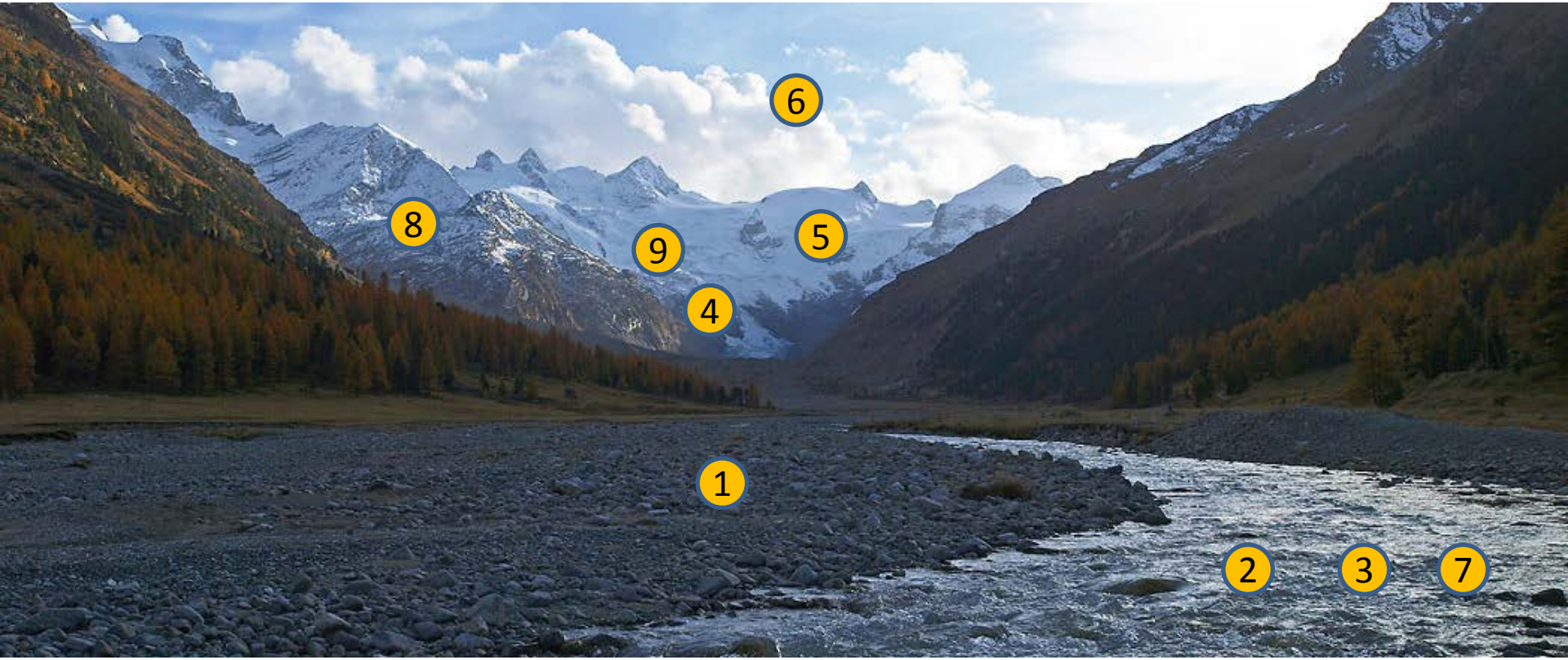
Example

Spring 2015: Installation of new sediment transport measurement system Albula (Tiefencastel) above HP dam Solis.

Short-term: Operation of sediment by-pass tunnel (ewz)

Long-term: Knowledge about the climate-related change in sediment delivery

Hydro-geomorphic controls of HP production



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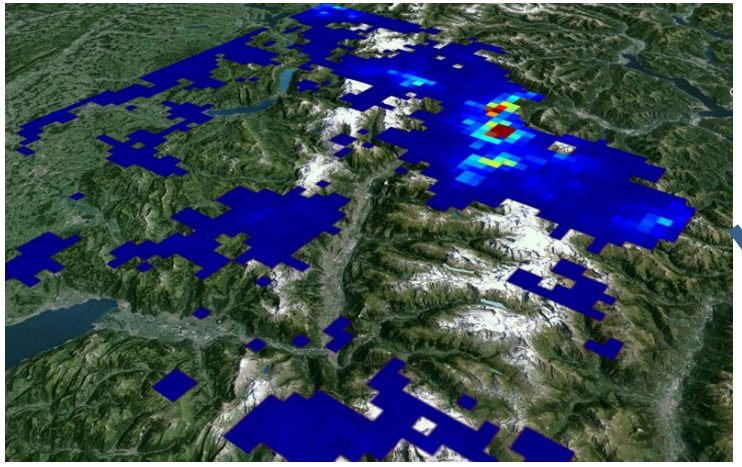
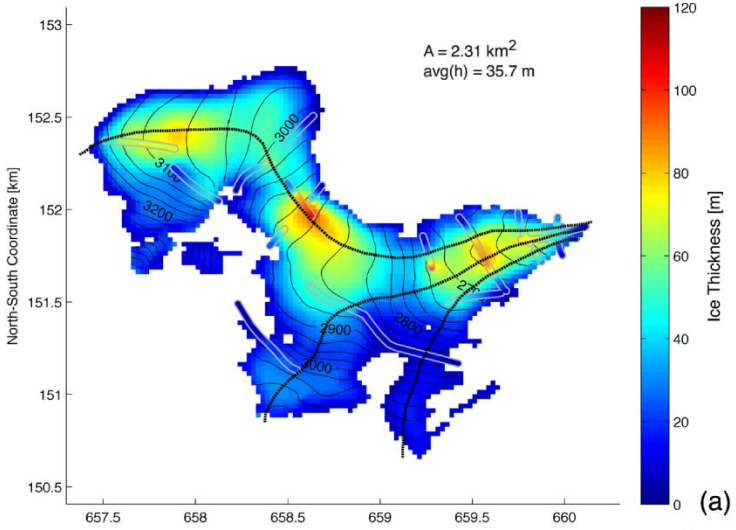
8. Water balance of Alpine ski resorts (SLF)
9. Potential for future hydropower plants in Switzerland: a systematic analysis in the periglacial environment (VAW-ETHZ)

Synthesis

Stochastic weather generator
(Peleg et al., *C2SM, HWRM-ETHZ*)



Swiss glacier ice volume
(Rabenstein et al., *VAW-ETHZ*)



Sediment transport measurements
(Rickenmann et al., *WSL*)

Update of perspectives for water ressources and sediment transport

planned for 2017/18

Conclusion: Drivers for change

- Essential knowledge base for HP industry
- Not primarily for immediate return, but indispensable for long-term investments and strategies
- The potential for improvements of forecasts/ predictions in this field is considerable