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Internationale Regierungskommission Alpenrhein

Discharge forecast for the Alpine Rhine river – the influence of the hydropower plants

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Discharge forecast model for the Alpine Rhine river

Agenda

1. Why do we need a discharge forecast model for the Alpine Rhine river?
2. Caracteristic of the catechment basin
3. The structure of the discharge model
4. modeling the discharge of the basins of the hyrologic powerplants
5. Summary

Why a discharge forecast model?

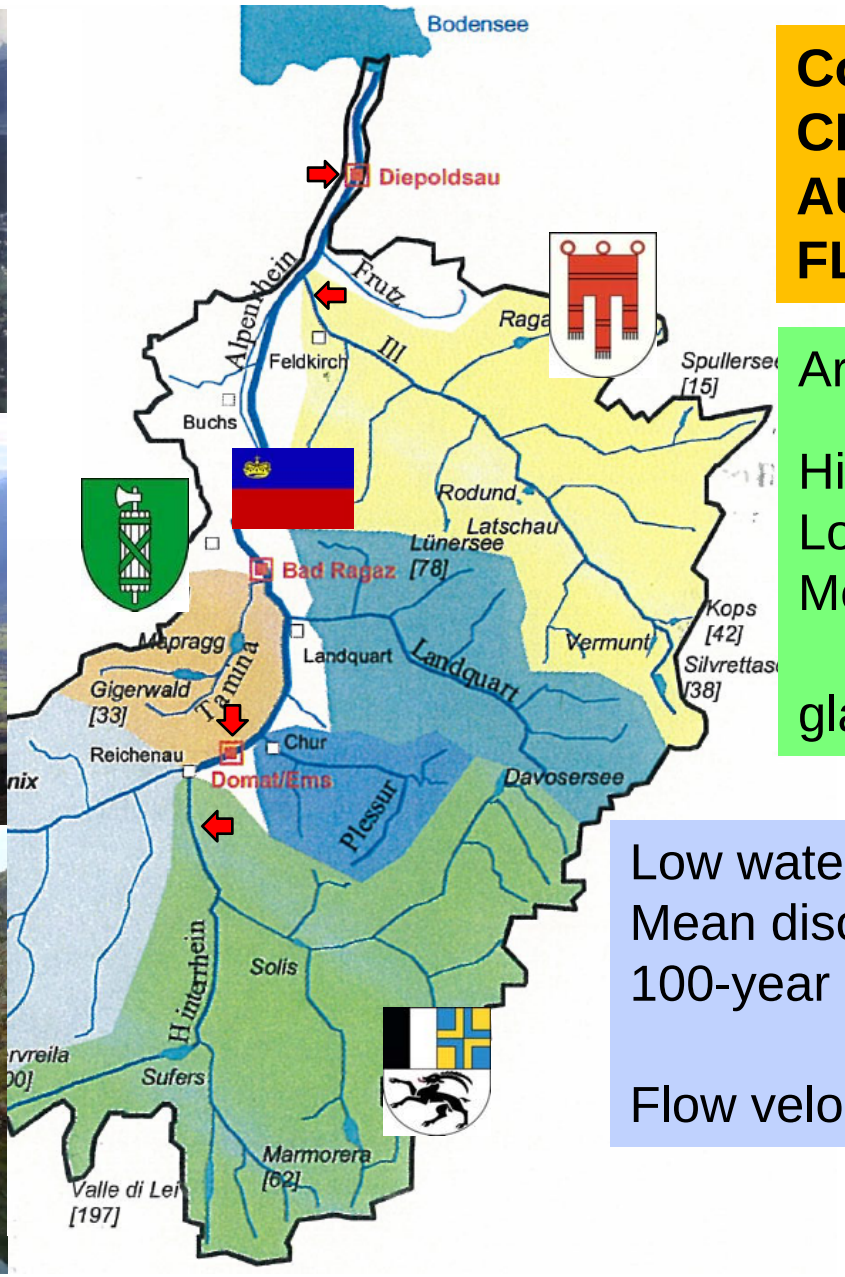
The Alpine Rhine river ist not navigable!

- The Alpine Rhine river is the biggest mountain river in Europe.
- Flood protection: The Alpine Rhine river has along a distance of 65 km on both sides flood embakements for a HQ100 (3100 m^3/s)
- High vulnerability:
  500‘000 Inhabitants, 250‘000 work places
- Flood warning: In Switzerland a must since 2011.
- The Alpine Rhine river ist the biggest inflow of the lake of Constance (Basin for drinking-water preparation for more than 6 Mio persons)

The Alpine Rhine river – a big mountain river

We prevent together!

Caracteristic of the catchment basin (I)



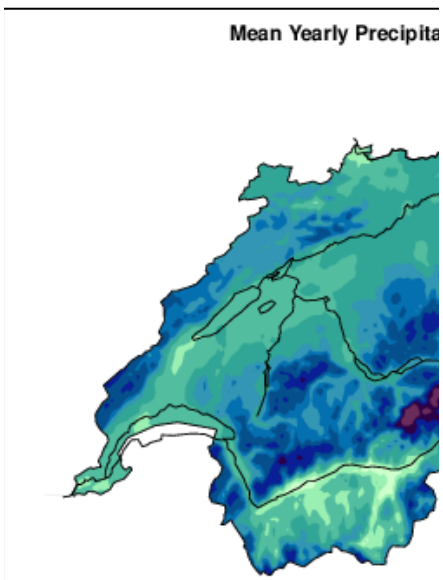
Countries:
CH (GR, SG)
AUT (Vorarlberg)
FL

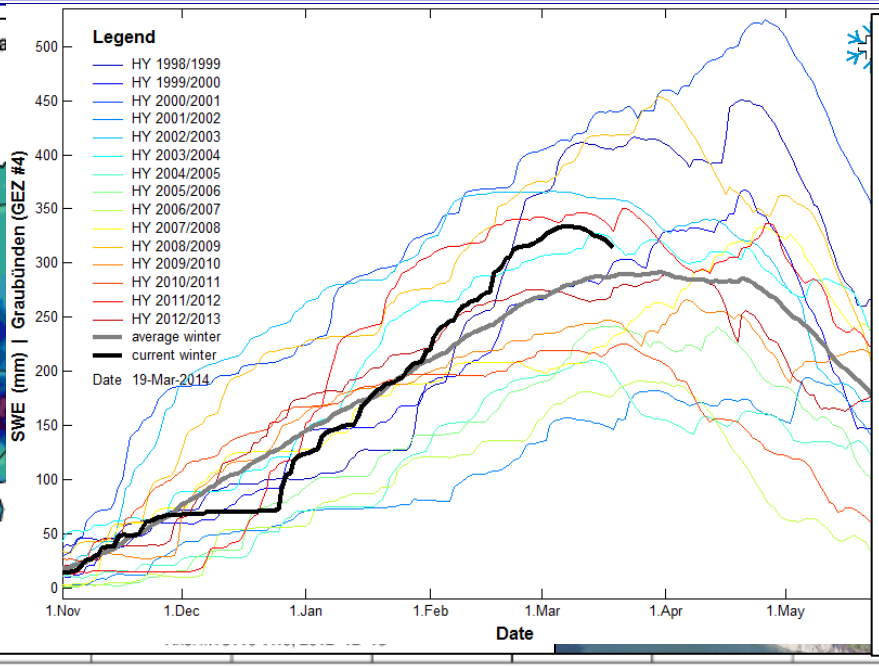
Area of the basin: 6119 km^2

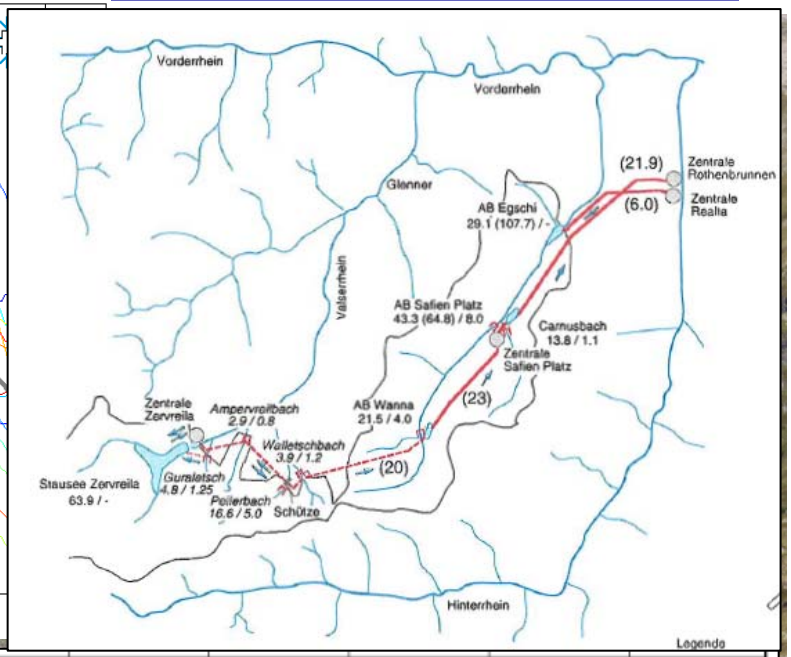
Highest point:	3400 müM
Lowest point:	400 müM
Mean altitude:	1800 müM
glaciered:	1.4%

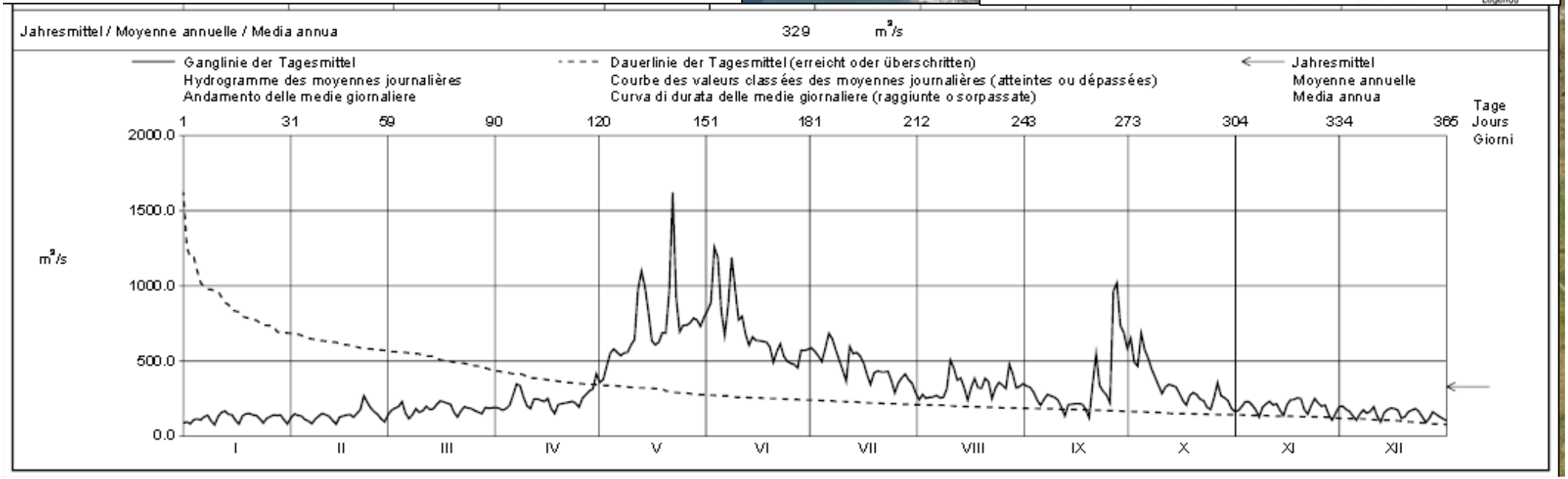
Low water discharge	40 m^3/s
Mean discharge:	250 m^3/s
100-year flood (HQ100)	3100 m^3/s
Flow velocity:	1-5 m/s

Caracteristic of the catchment basin (II)



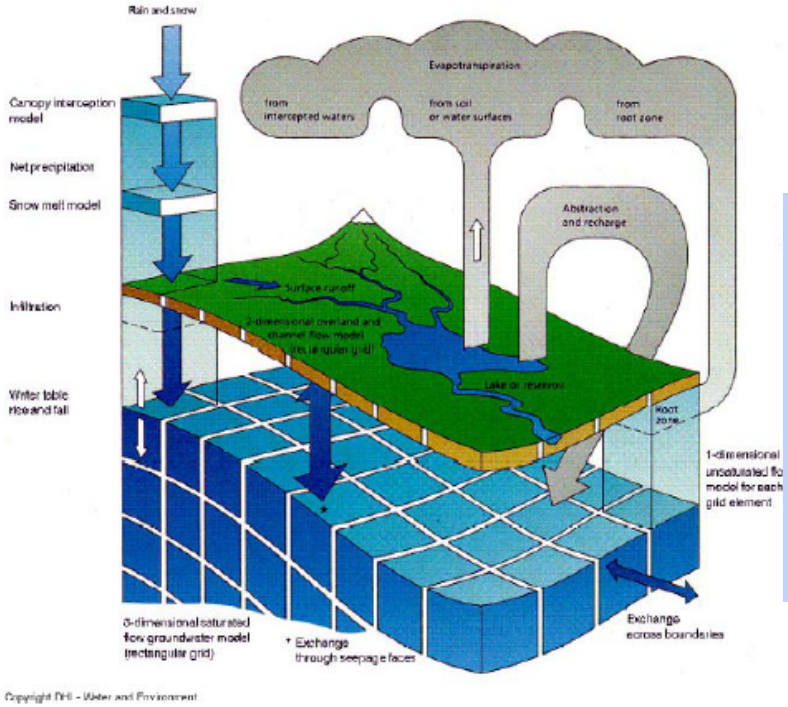






Informations to the structure of the discharge model

Physikalisch begründete Modelle



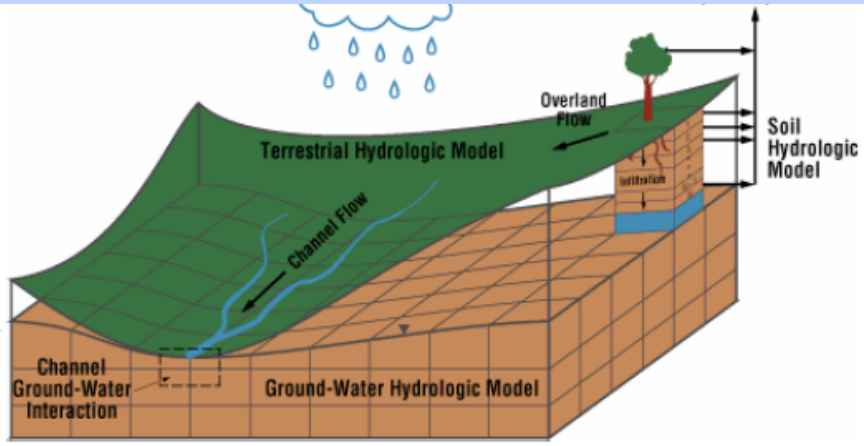
SHE – European Hydrological System — Systeme Hydrologique Europeen
© DHI – Water and Environment

Used hydrological model:

WaSiM-ETH

Grid (500 x 500m)

Daily forecast by CH/FOEN (BAFU)

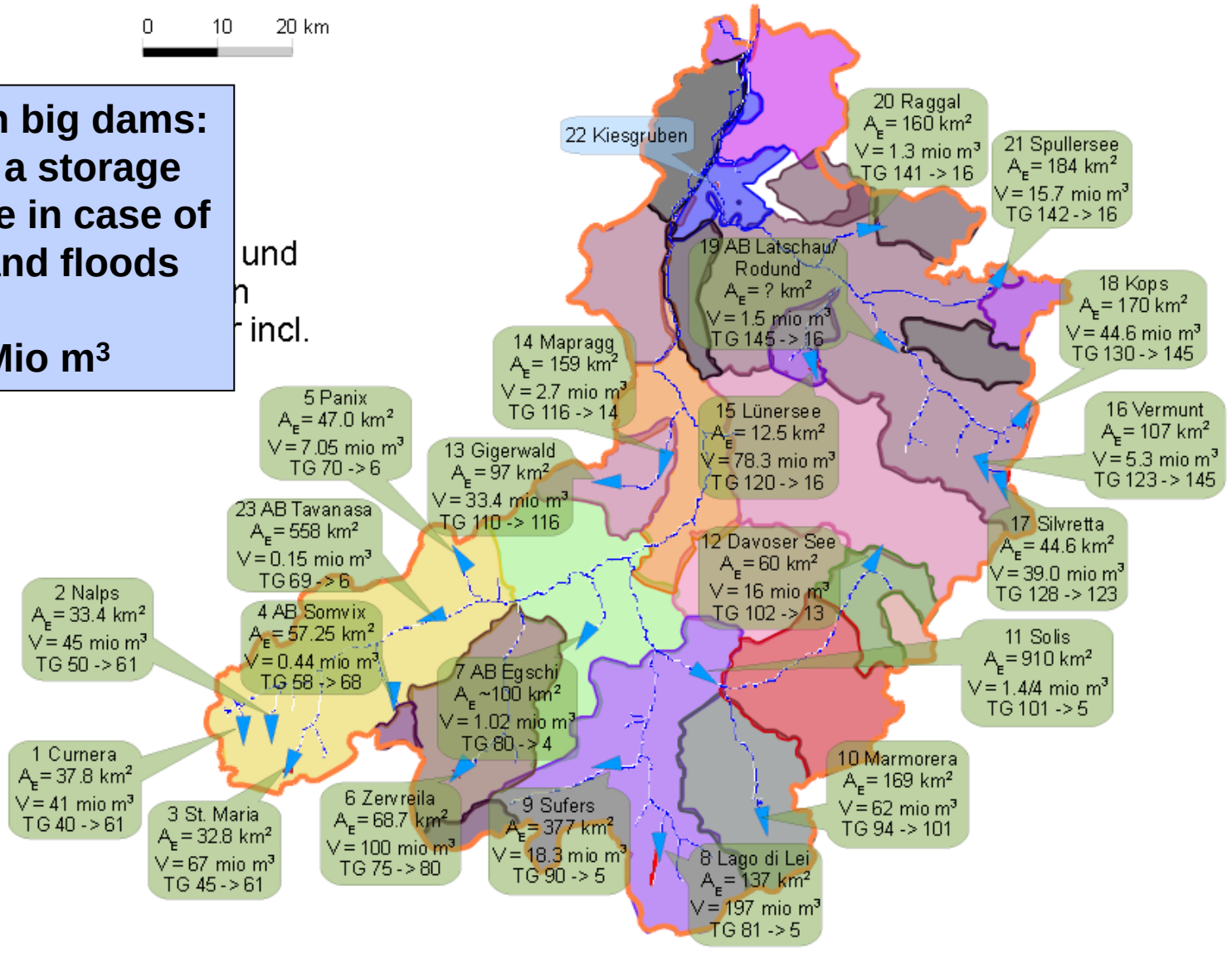


HMS – Hydrologic Model System
Pennsylvania State University
© PSU, 1998

Reservoirs of hydroelectric powerplants

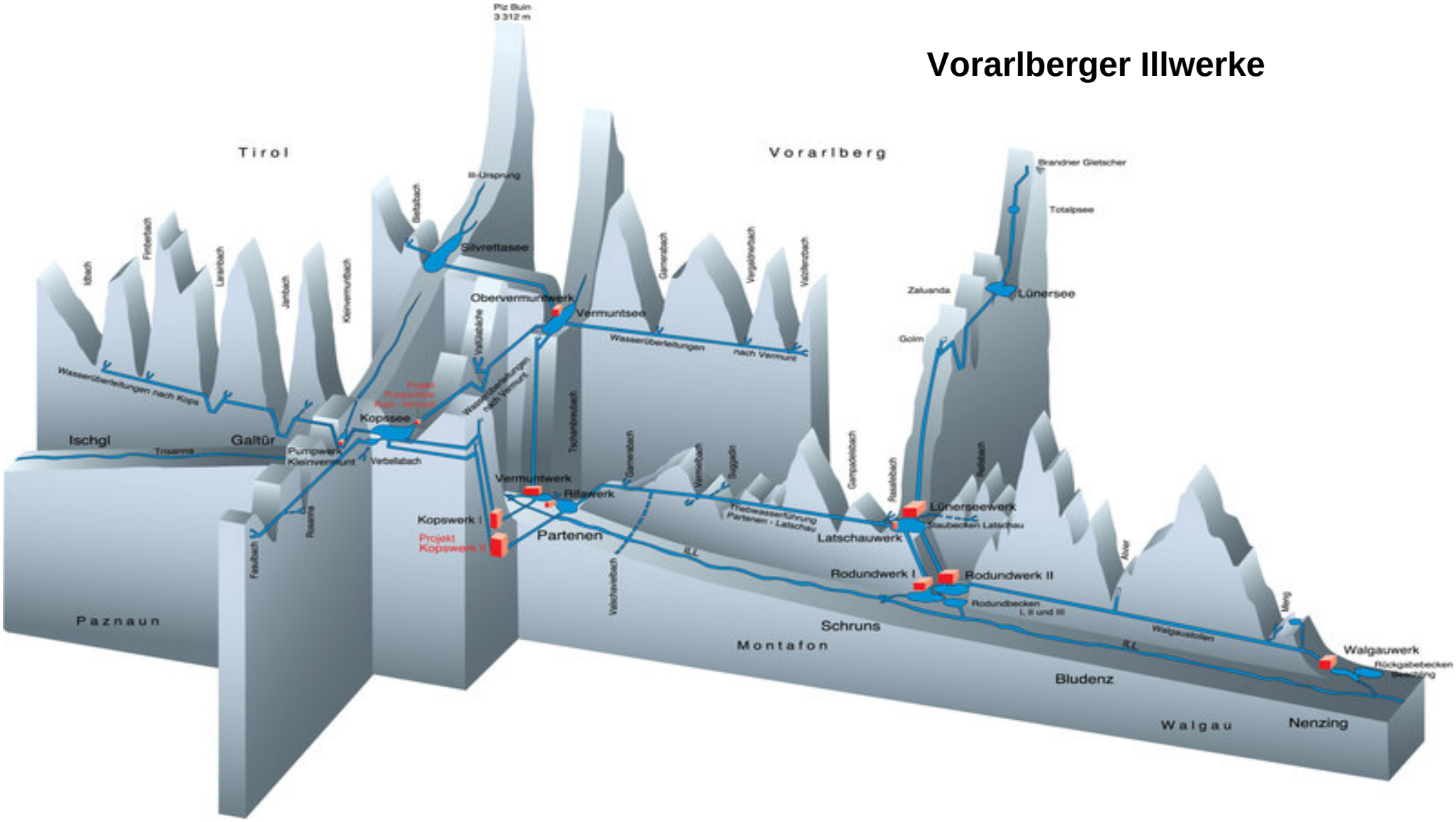
22 reservoirs, 14 with big dams:
→ 14 reservoirs with a storage volume with evidence in case of heavy precipitation and floods

Volume total: : 727 Mio m³



Structure of hydroelectric powerplants / pumped storage

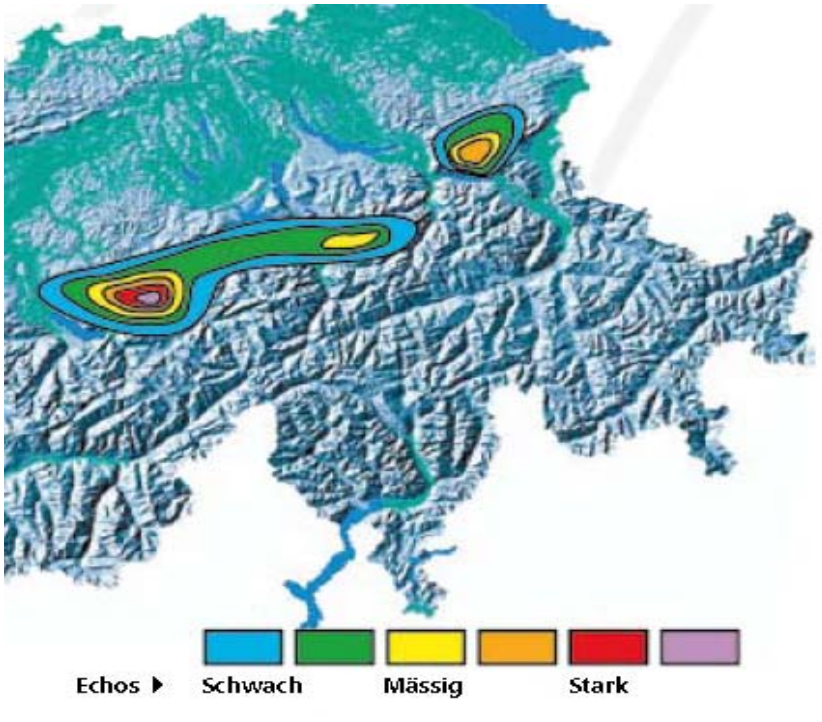
Vorarlberger Illwerke



Discharge model: online data input

Measured data: (CH: Meteo CH / BAFU / SLF / BFE; AUT: ZAMG, Vlbg)

- air temperature
- amount of precipitation
- air moisture
- air pressure
- wind velocity
- snow cover
- discharge
  - *water level of the reservoirs*



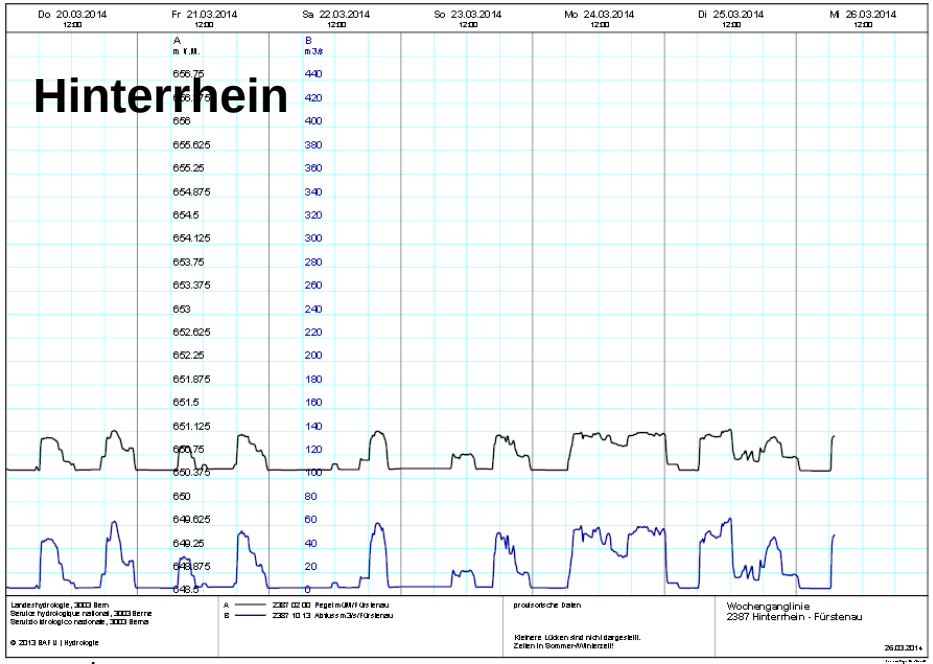
Hydro powerplants

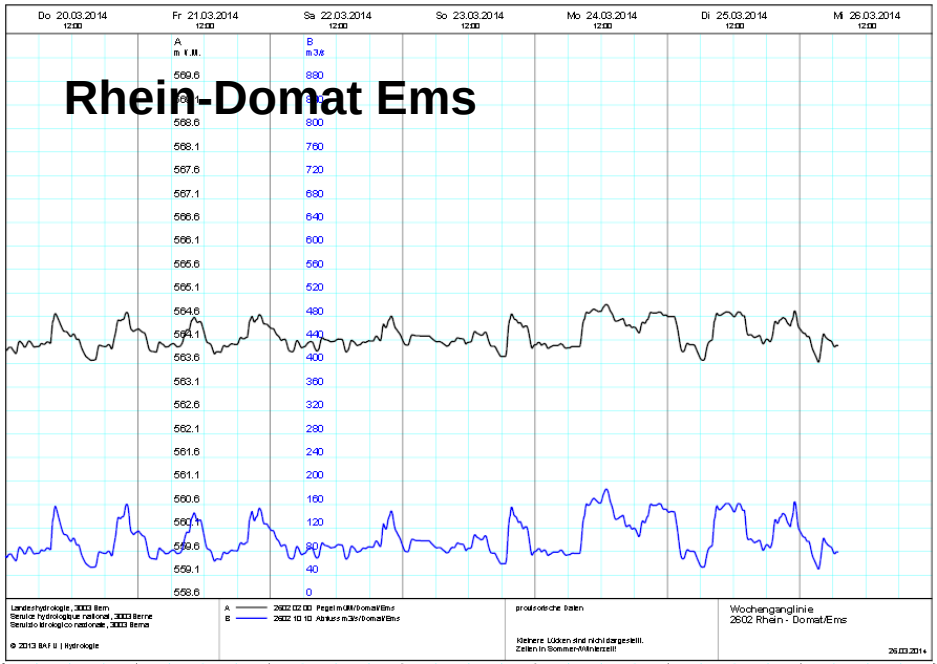
- drain and catechment of streams
  - working condition (production / storage)

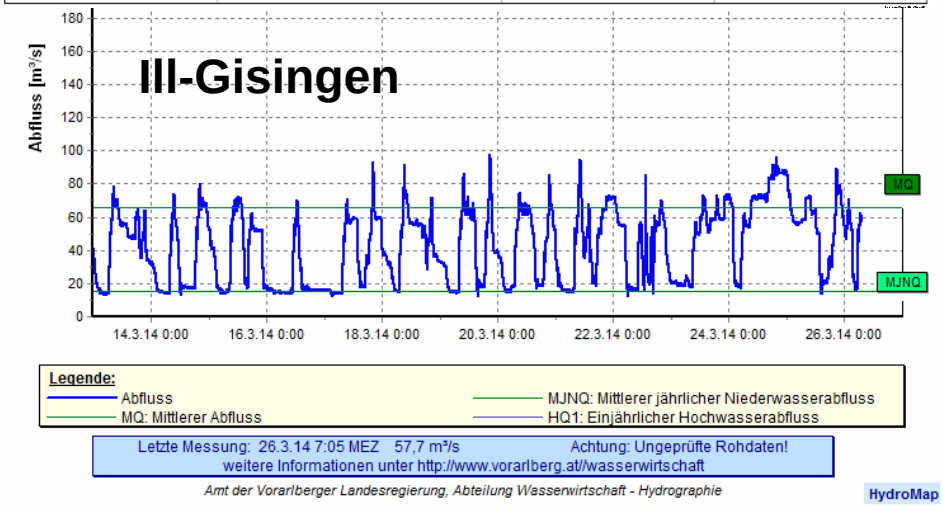
forecasting

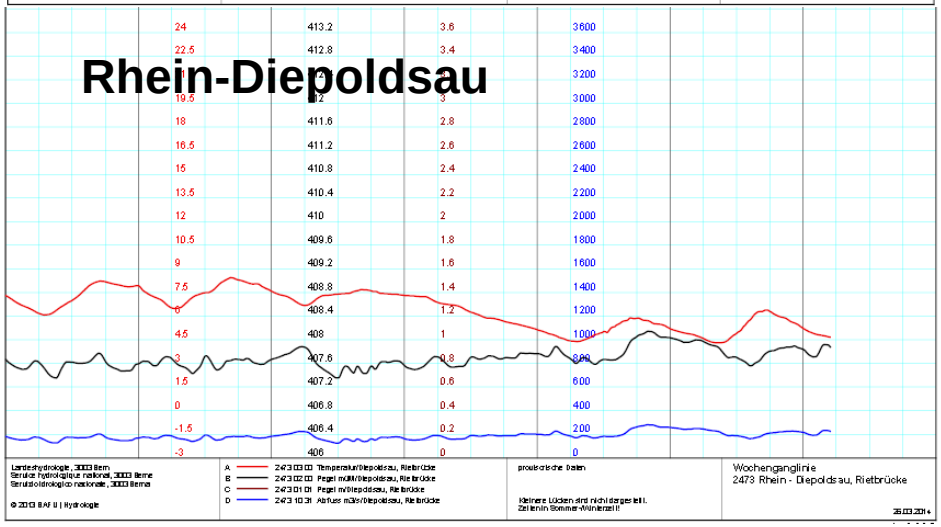
- forecast of preciptiation (COSMO-2, COSMO-7, COSMO-LEPS)
- forecast of temperature (rain / snowfall / snowmelt)

Observed discharge: Influence of Hydropower



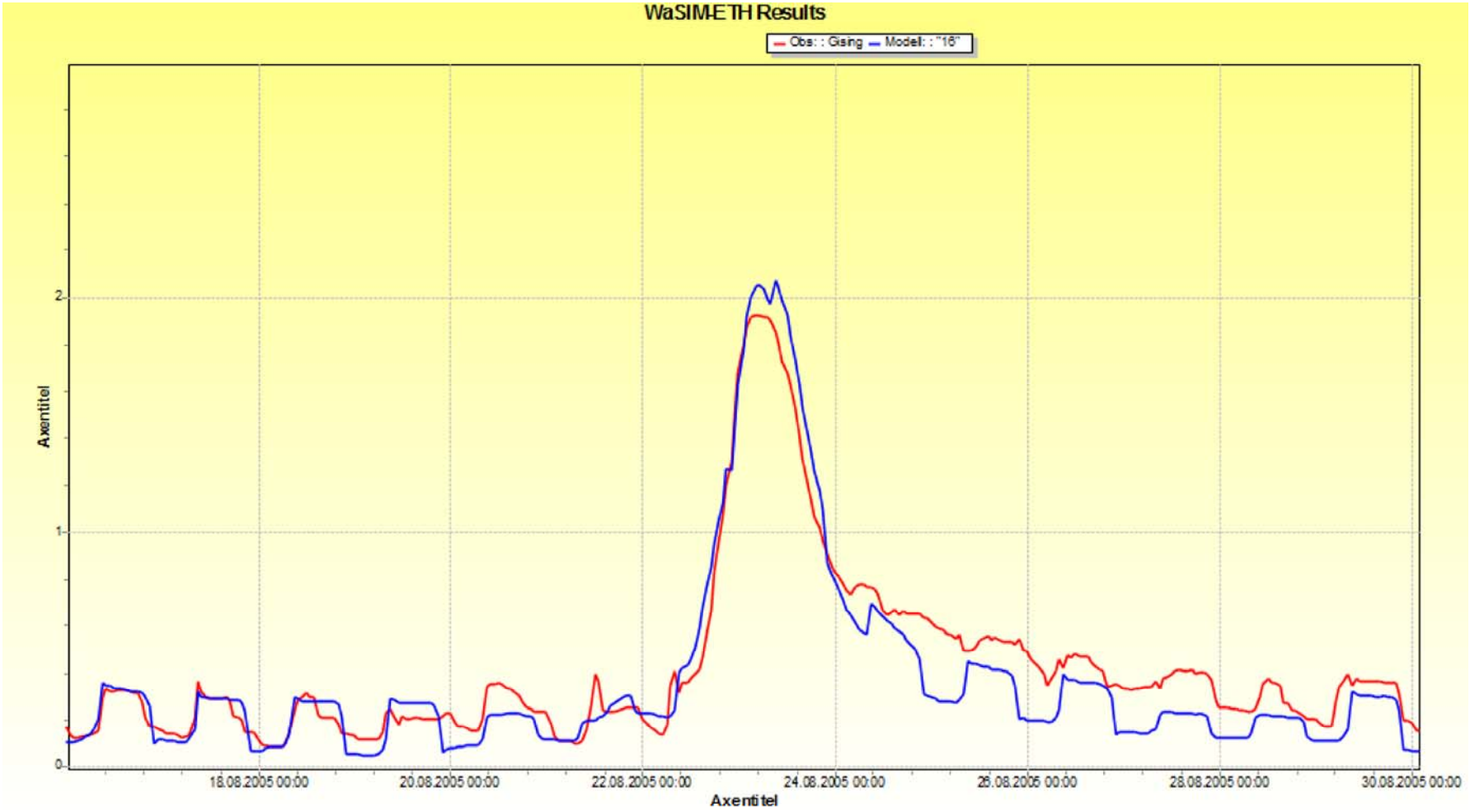






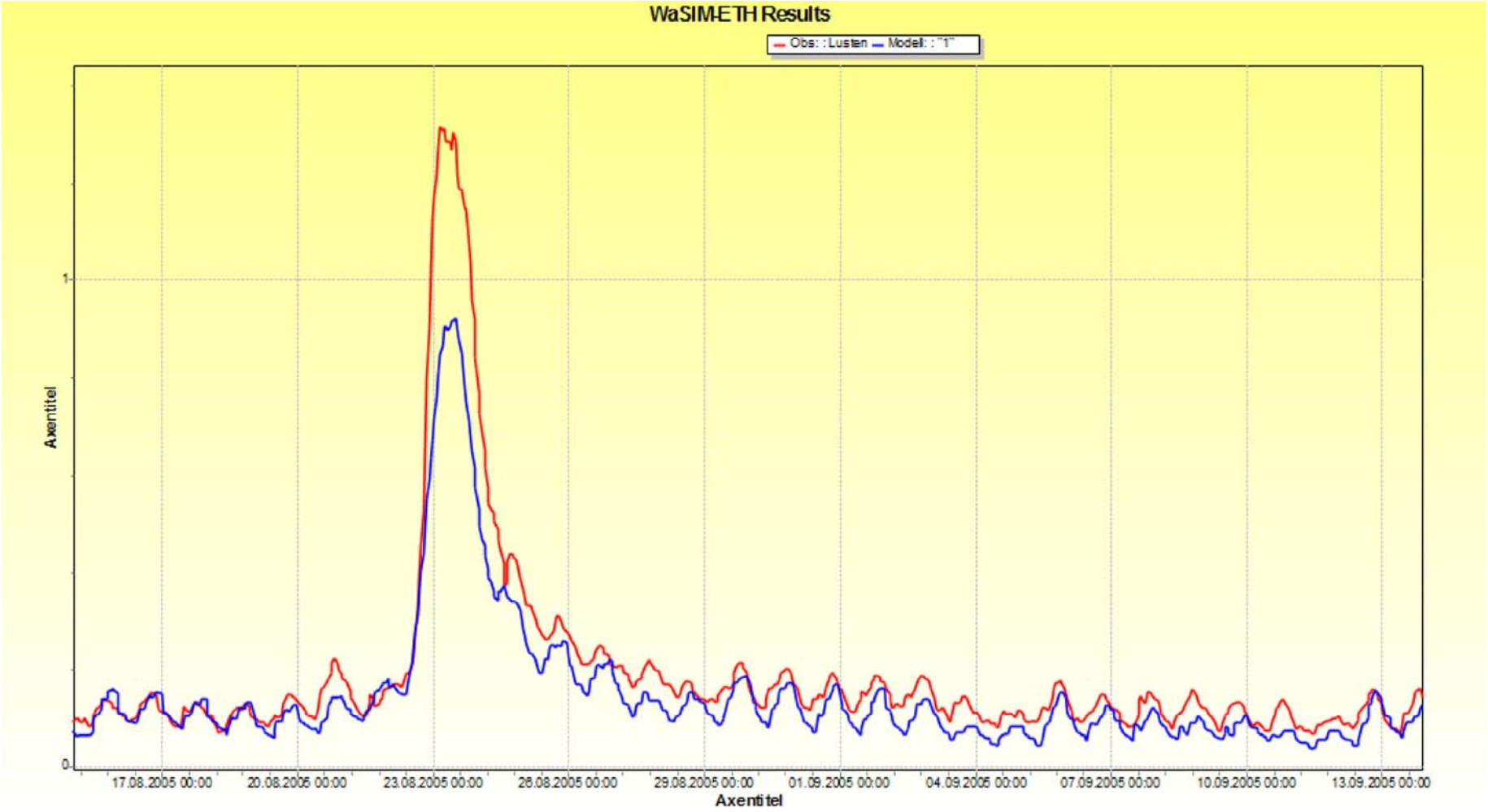
Discharge model WaSiM: Influence of Hydropower (I)

Discharge August 2005: Ill-Gisingen



Discharge model WaSiM: Influence of Hydropower (II)

Discharge August 2005: Rhein-Diepoldsau



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Hydrological model WaSiM: Influence of the powerplants

- **The morphology of the drainige system of the powerplants can be represented in WaSiM.**
- ***Energy production yesterday:***
  Discharge modeling was possible, because of rather clear daily patterns (difference workdays/weekend)
- ***Energy production today:***
  Discharge modelling is nearly impossible. Very flexible operation of the alpine powerplants dependent of the energy market.
- ***Influence of the energy production to the discharge:***
  ***about* +/- 150 m^3/s → Sunk/Schwall: very bad for the oecologic system (fish population)**
- ***Influence of the energy production by flood discharge:***
  A reduction of the discharge up to 400 m^3/s is possible, when powerplants ar pumping and the upper reservoirs are low.
- ***Filling / Water level of the reservoirs:***
  we don‘t have online data for the hydrologic model. Updating only once a week.

Hydrological model WaSiM: Influence of the powerplants

- **Today it is not possible to represent the actuel energy production of alpine hydropower plants in a hydrologic discharge model.**
- **The hydrologic model WaSiM in the basin of the Alpine Rhine river is not usable for low water levels.**
- **The dataexchange between the powerplants and the forecast institutions must be improved.**
- **Extrem flood events are possible at any time, even under conditions of climatic change.**
- **We can imagine, that the alpine reservoirs of the powerplants will have a higher filling in summertime than today.**

Discharge forecast model for the Alpine Rhine river

Thank you for your attention!

Kanton St. Gallen
Rheinunternehmen
RU

Wasserwehr

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra