Management of water bodies in the changing environment

Brienz / Glyssibach
22 Aug 2005
Ole Seehausen

Alfred J. Wüest

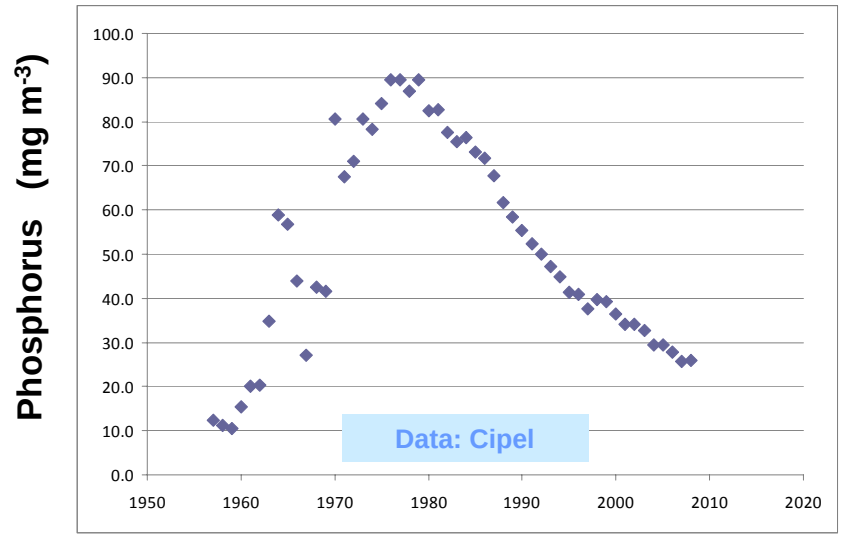
17 Sep 2010 – 30 years of FA Forel

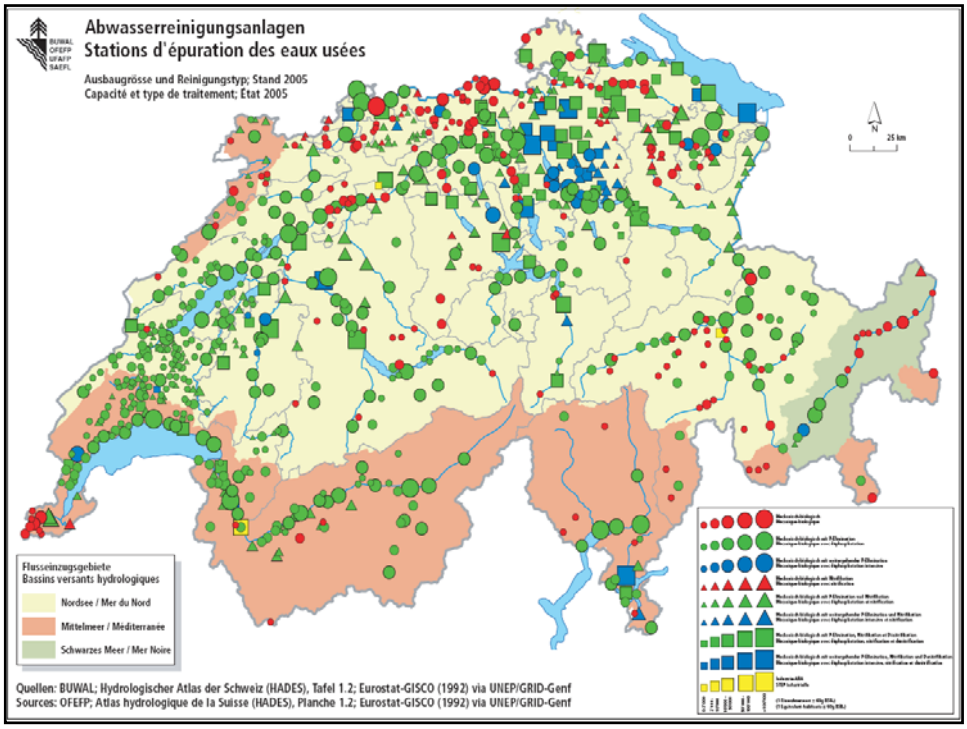
eawag aquatic research

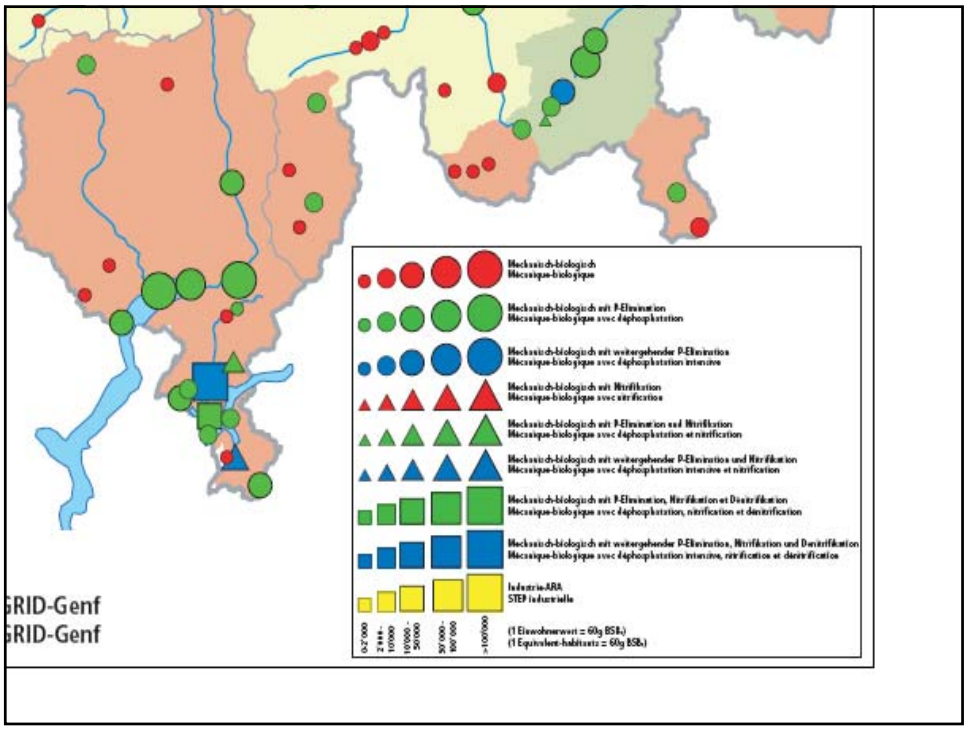
Content

1 Willingness to pay?
2 Do we want this ~2% of electricity?
3 Struggling with little space
4 “Climate” or “global” change?
5 Enough water for food AND power?
6 Conclusions

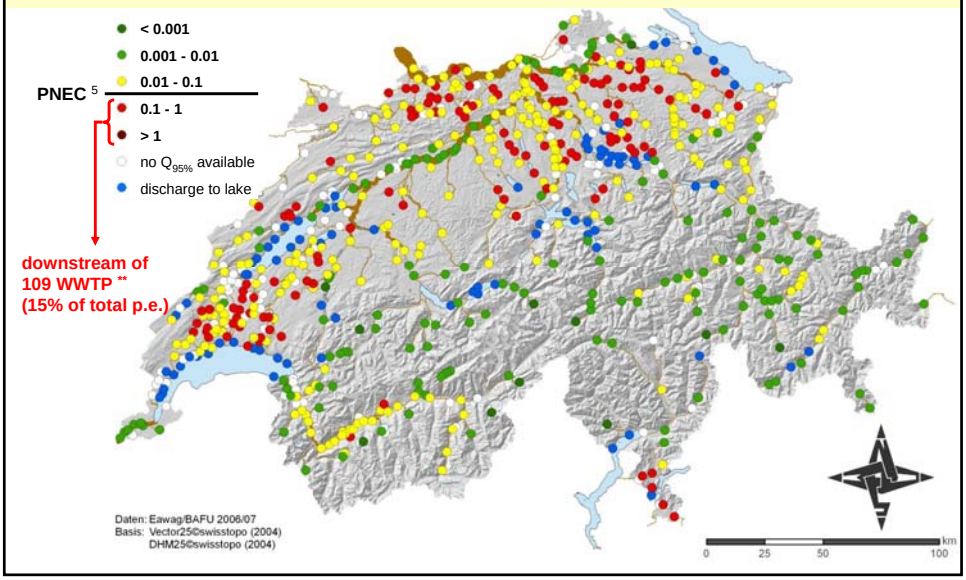
Eutrophication cycle – Lac Leman



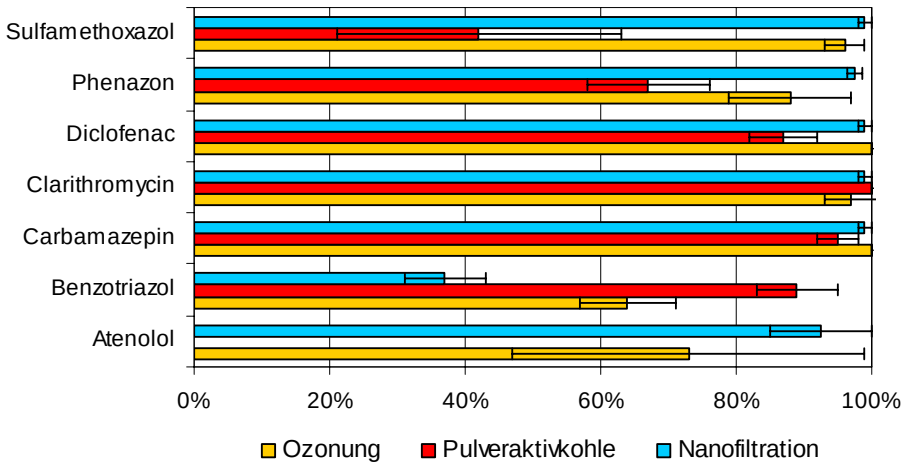

Abwasserreinigungsanlagen
Stations d'épuration des eaux usées
Ausbaugrösse und Reinigungstyp; Stand 2005
Capacité et type de traitement; Etat 2005
Flusseinzugsgebiete
Bassins versants hydrologiques
Nordsee / Mer du Nord
Mittelmeer / Méditerranée
Schwarzes Meer / Mer Noire
Quellen: BUWAL; Hydrologischer Atlas der Schweiz (HADES), Tafel 1.2; Eurostat-GISCO (1992) via UNEP/GRID-Genf
Sources: OFEFP; Atlas hydrologique de la Suisse (HADES), Planche 1.2; Eurostat-GISCO (1992) via UNEP/GRID-Genf


GRID-Genf
GRID-Genf

Diclofenac in our waters (µg/L)



MICROPOL - removal efficiency



Datengrundlage: Pilotversuch Regensdorf (OZ), Pilotanlage Eawag (PAK und NF)

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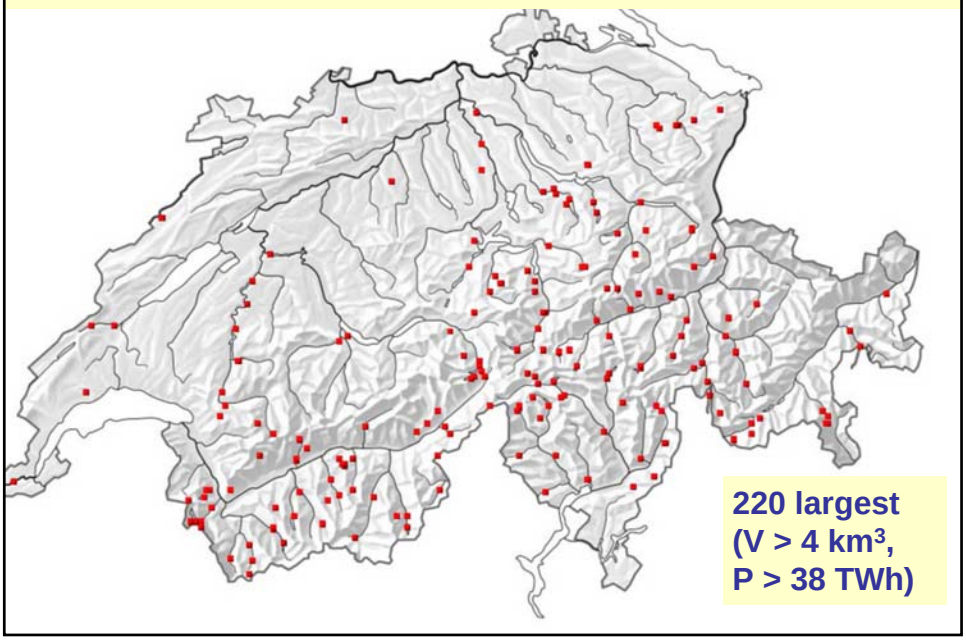
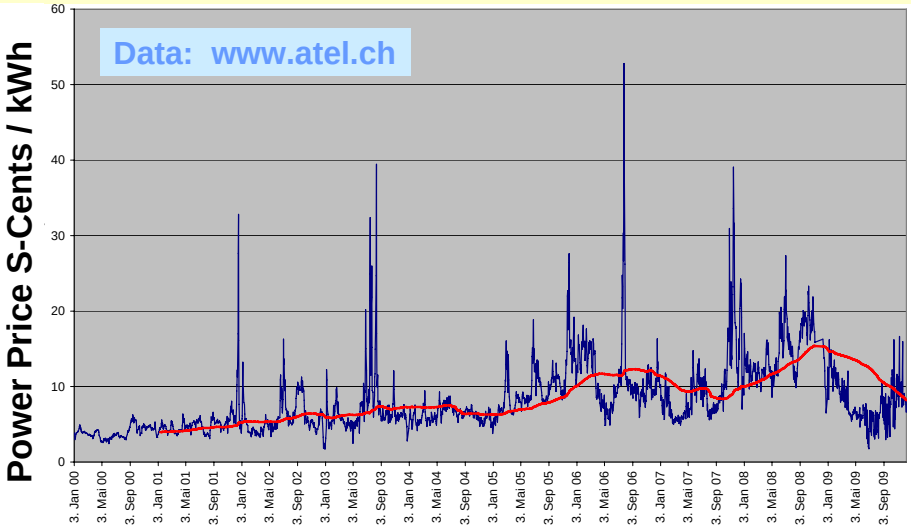
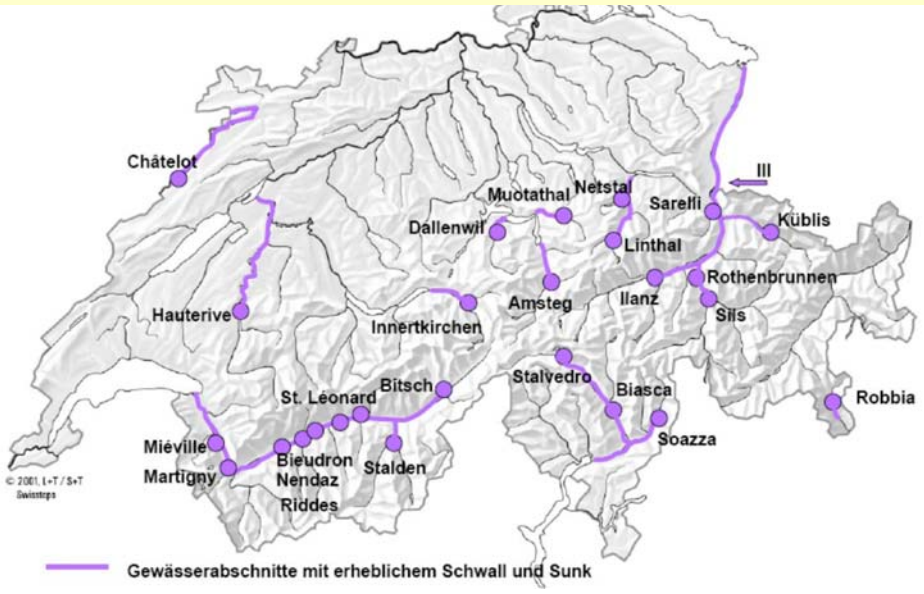
Reservoirs in Switzerland



„Right“ time is money



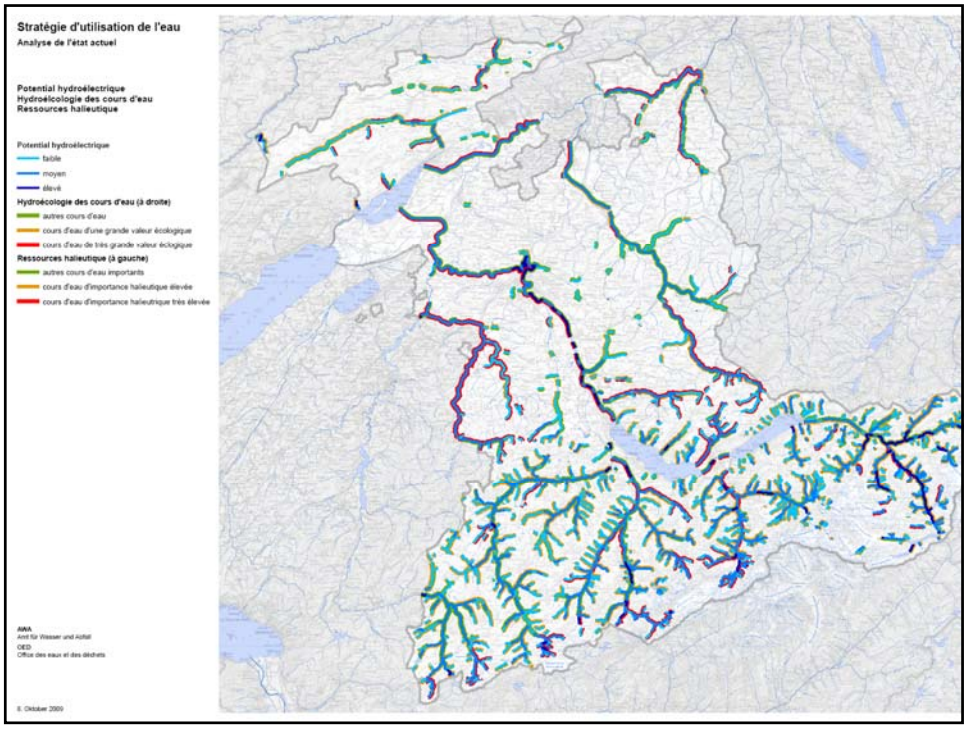
25% of production causes hydro-peaking

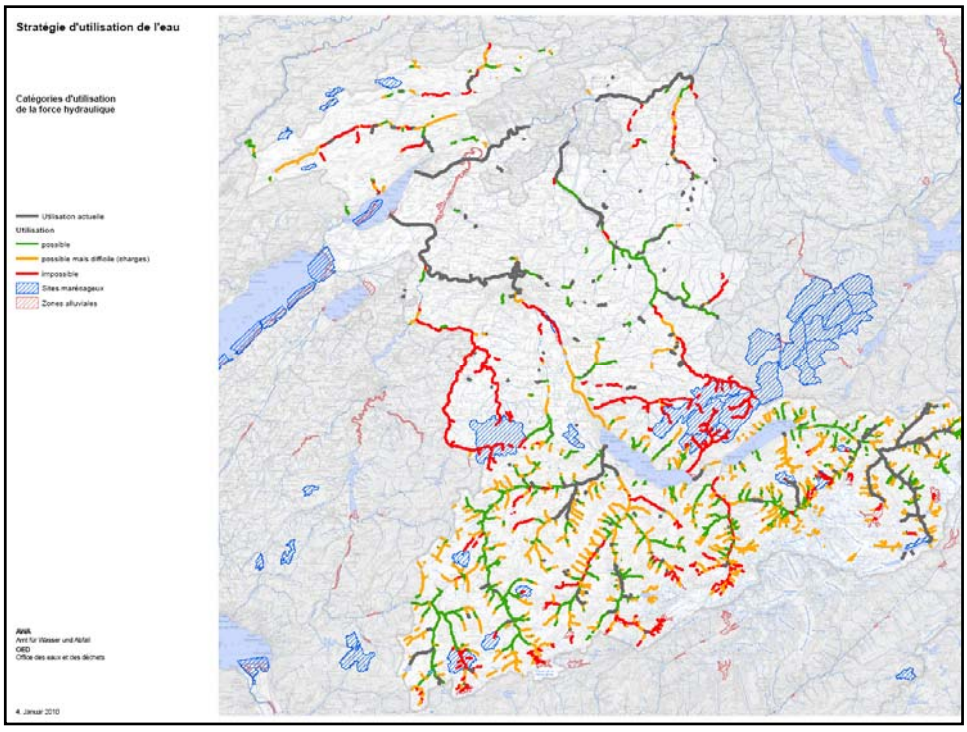


Do we need more small-scale hp plants?

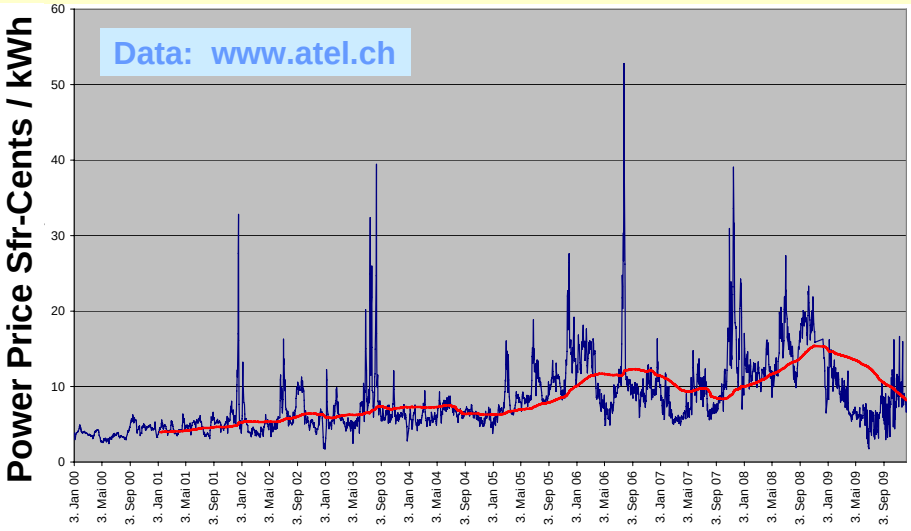
Kostendeck. Einspeisevergütung **KEV**

- Parliament: 5,400 GWh/yr more renewable electricity
- 500 Mio CHF for KEV (0.9 Cents/kWh)
- Huge interest - but only 1,910 GWh (620 proposal by April 2009)
- Long waiting lists (photovoltaic)


Stratégie d'utilisation de l'eau
Analyse de l'état actuel
Potential hydroélectrique
Hydroécologie des cours d'eau
Ressources halieutique
Potential hydroélectrique
faible
moyen
élevé
Hydroécologie des cours d'eau (à droite)
autres cours d'eau
cours d'eau d'une grande valeur écologique
cours d'eau de très grande valeur écologique
Ressources halieutique (à gauche)
autres cours d'eau importants
cours d'eau d'importance halieutique élevée
cours d'eau d'importance halieutique très élevée
AWA
Amt für Wasser und Abfall
OED
Office des eaux et des déchets
6. Oktober 2009

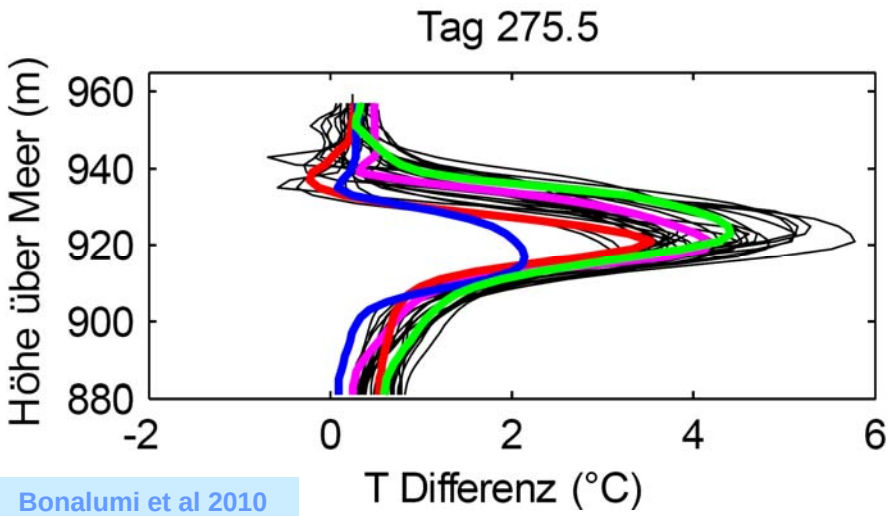

Stratégie d'utilisation de l'eau
Catégories d'utilisation
de la force hydraulique
Utilisation actuelle
Utilisation
possible
possible mais difficile (charges)
impossible
Sites marécageux
Zones alluviales
AWA
Amt für Wasser und Abfall
OED
Office des eaux et des déchets
4. Januar 2010

„Right“ time is money



Lago Poschiavo	Lago Bianco
H = 962	2234 m
V = 110	22 Mio m^3
Res-time = 40 to 90	10 to 30 d
(natural: ½ yr)	(natural: 1 yr)

Temperature effects by pump storage operation



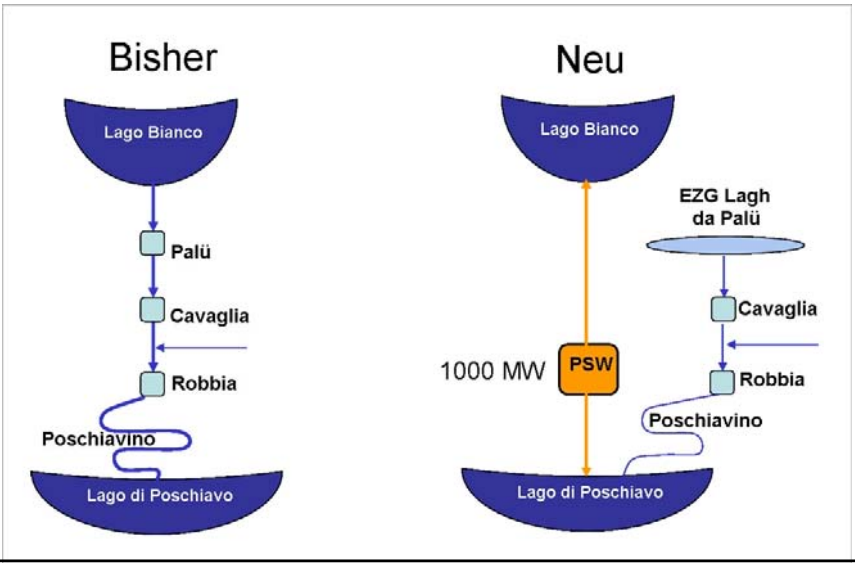
Bonalumi et al 2010

What is in the book?

Art. 42 Entnahme und Einleitung von Wasser oder Abwasser

1 Wird bei einem natürlichen See Wasser entnommen oder eingeleitet, so dürfen sich dadurch die Schichtungs- und Strömungs--verhältnisse im See nicht **wesentlich** verändern, und es dürfen keine Spiegel-schwankungen auftreten, die zu Beein-trächtigungen im Uferbereich führen können.

A dilemma for the NGOs?



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Swiss river – morphological deficits

•14,000 km of streams / rivers are highly degraded (22%)

• 4,000 km are in culverts (7%)

• below 600 m asl: 50% of streams / rivers → poor morphology

Artificial barrier

• 100,800 artificial barriers > 0.5 m (average migrating distance is ~645 m)
• Several 100,000 artificial barriers < 0.5 m
• many tributaries are disconnected

Directions by our Parliament

- **Reduction hydro-peaking**
- **Sediment budget**
- **Fish connectivity**

- Finances: 60 mio CHF/yr x 80 yr (from 0.1 Cent/kWh)
- Cantons provide priorities until 2014

Vision Gewässer Schweiz 2100

Fliessgewässer

Seeufer

- Naturnahe Fliessgewässer, typische Eigendynamik
- Naturnahe Uferbereiche von Stillgewässern
- Standorttypische Lebensgemeinschaften
- Ökosysteme mit Fähigkeit zu Selbstregulation
- Gewässer als naturnahe Landschaftselemente

„Schutz und Nutzung der Gewässer"

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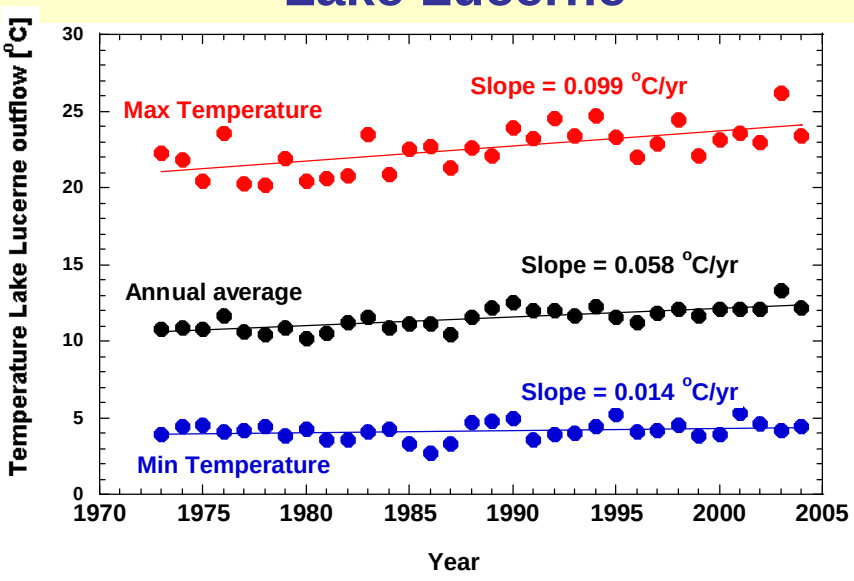
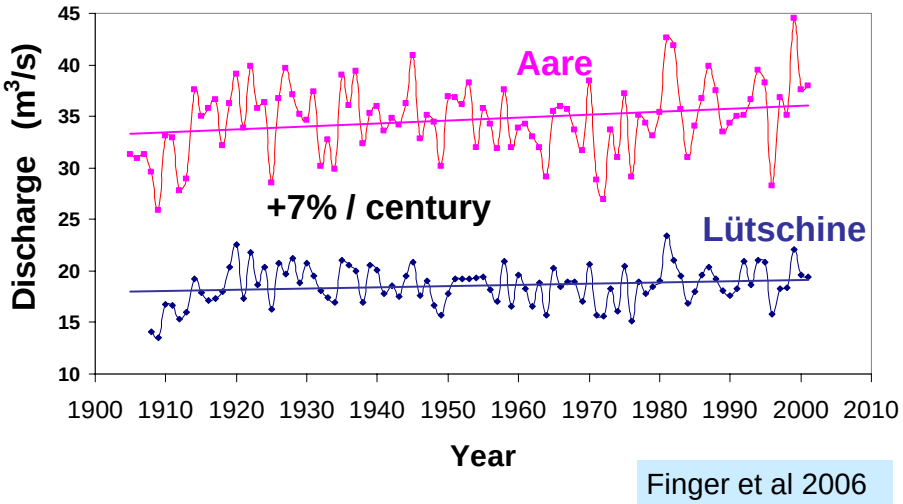
Surface temperature – Lake Lucerne



Observed evidence

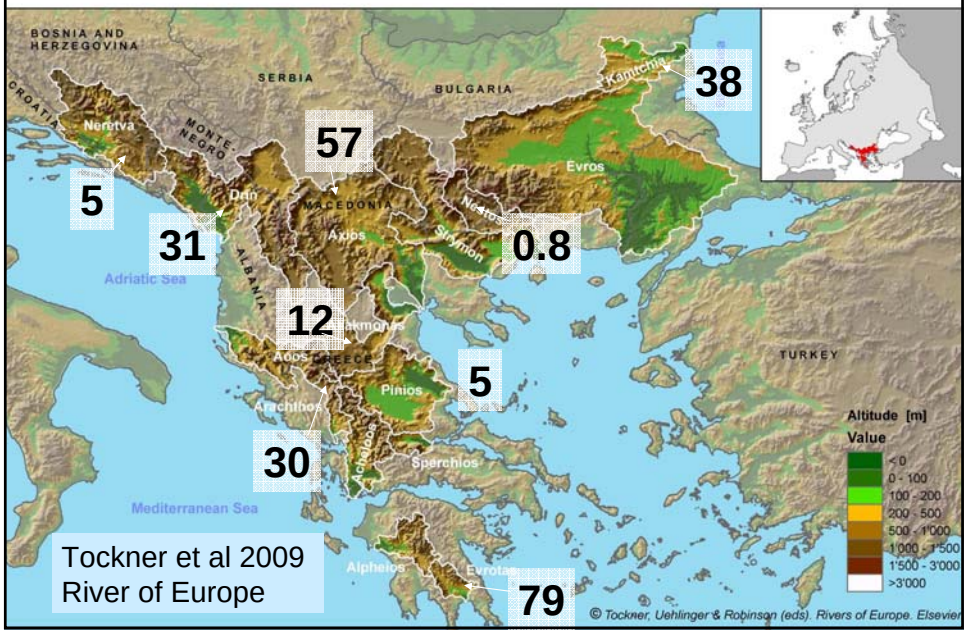
- Warming of ~1 (global) to ~2 ^{o}C (northern land, esp. arctic) over last century
- Less cold extremes; more warm extremes
- More precipitation > 30 ^{o}N; decrease in tropics (incl. Mediterranean)
- Increase in heavy precipitation
- More droughts in tropics and subtropics
- Slight (unclear) increase of westerly winds
- Intensified tropical cyclone activity
- Reduction in glacier and snow caps

Annual Alpine river flow - Aare and Lütschine



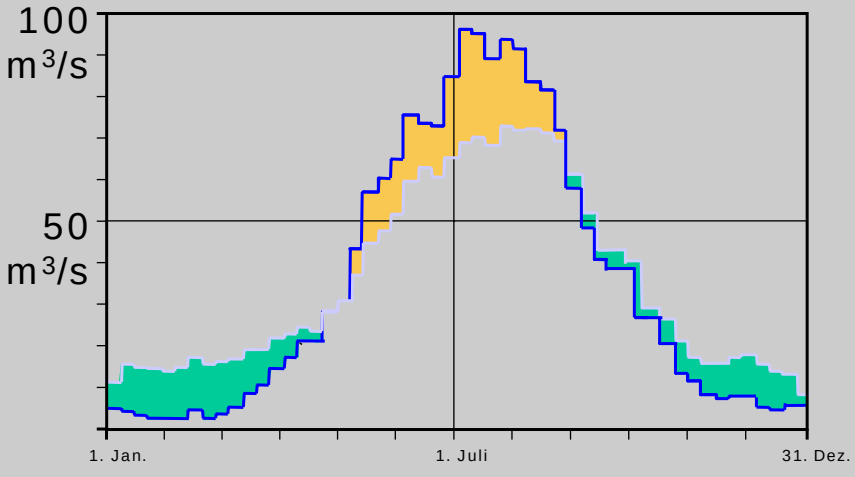
Finger et al 2006

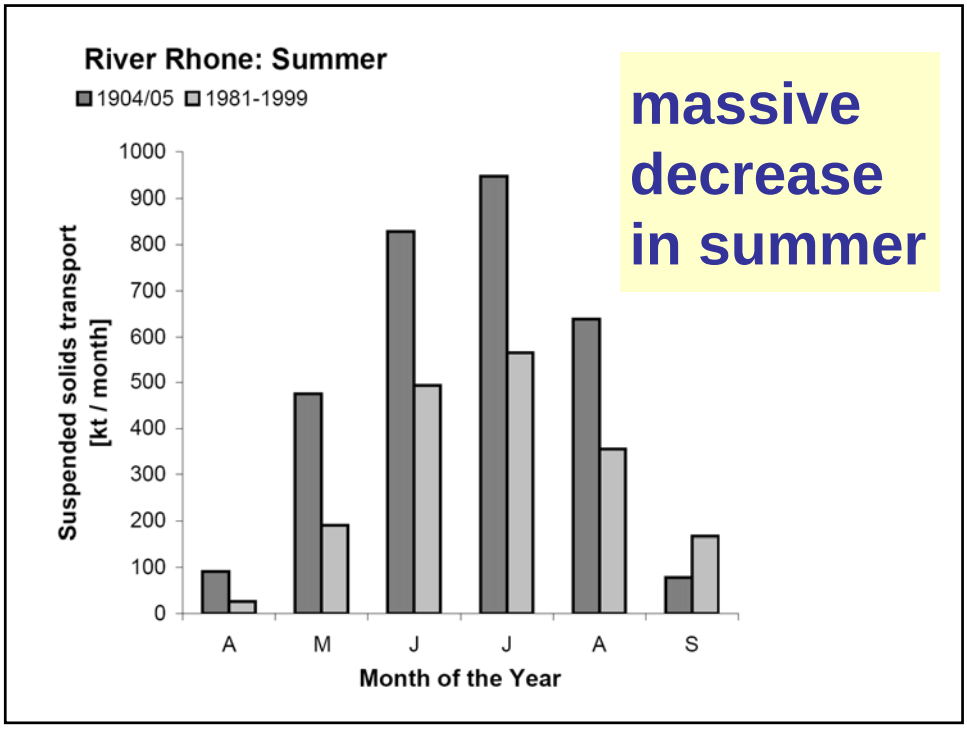
Decrease (%) annual flow (>1970)

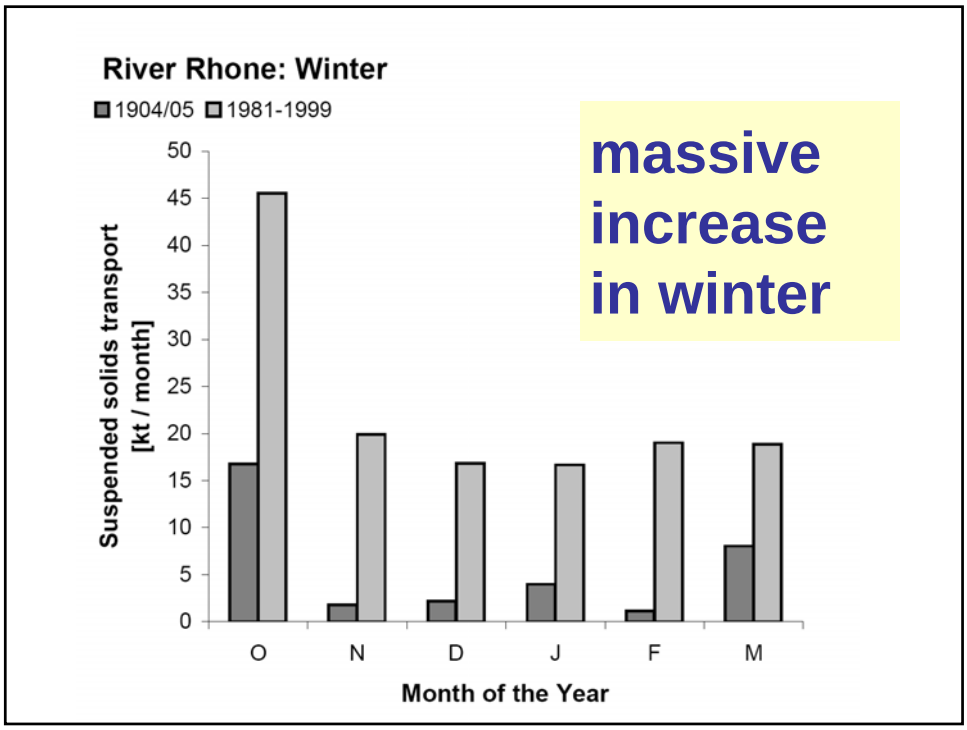


Tockner et al 2009
River of Europe

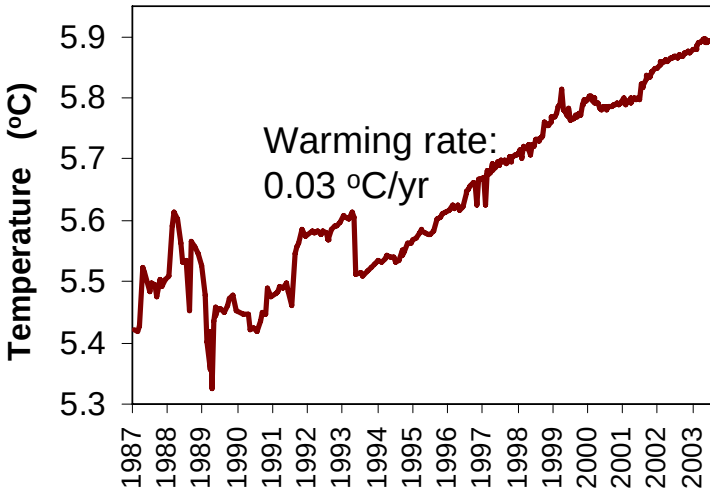
Discharge Aare: shift from summer → winter



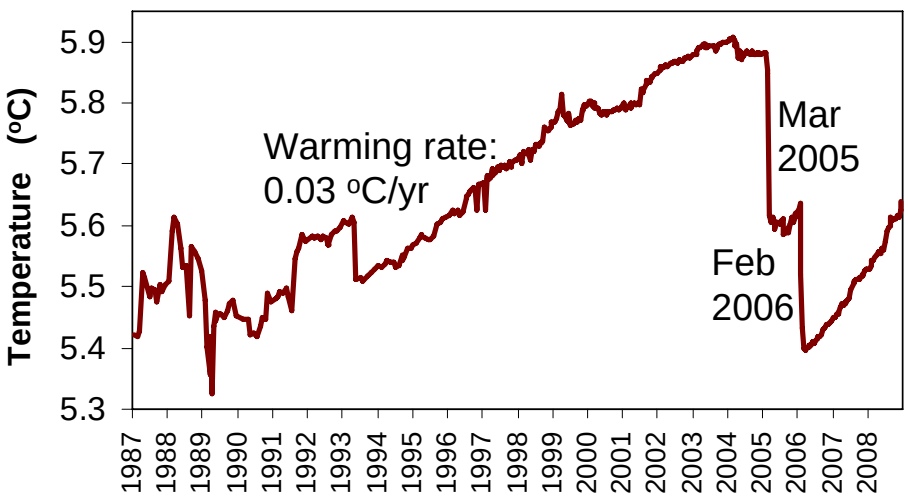

River Rhone: Summer
1904/05
1981-1999
Suspended solids transport [kt / month]
1000
900
800
700
600
500
400
300
200
100
0
A
M
J
J
A
S
Month of the Year
massive decrease in summer


River Rhone: Winter
1904/05
1981-1999
Suspended solids transport [kt / month]
50
45
40
35
30
25
20
15
10
5
0
O
N
D
J
F
M
Month of the Year
massive increase in winter

Deep water temperature Lake Lugano



Deep water temperature Lake Lugano

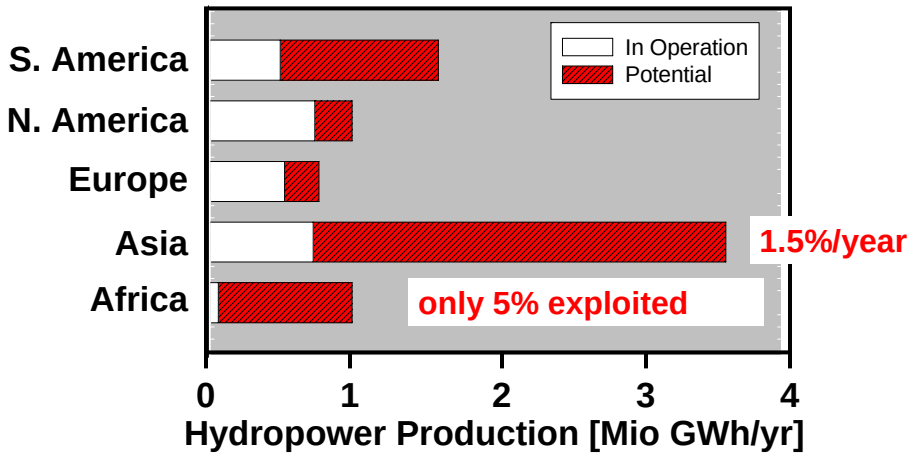


Conclusion - climate

- Warming of 1 to 2 ^{o}C over last century is well documented
- Temperature-related changes (stratification, ice, seasonal convective mixing, deep-water oxygen depletion) are interpretable
- Warming affects fish habitats: trout region moved up by 100 to 200 m. Until 2050 salmonids will loss 20 to 25% of their living room
- Other climate-driven changes are usually masked by eutrophication, damming and water diversion.

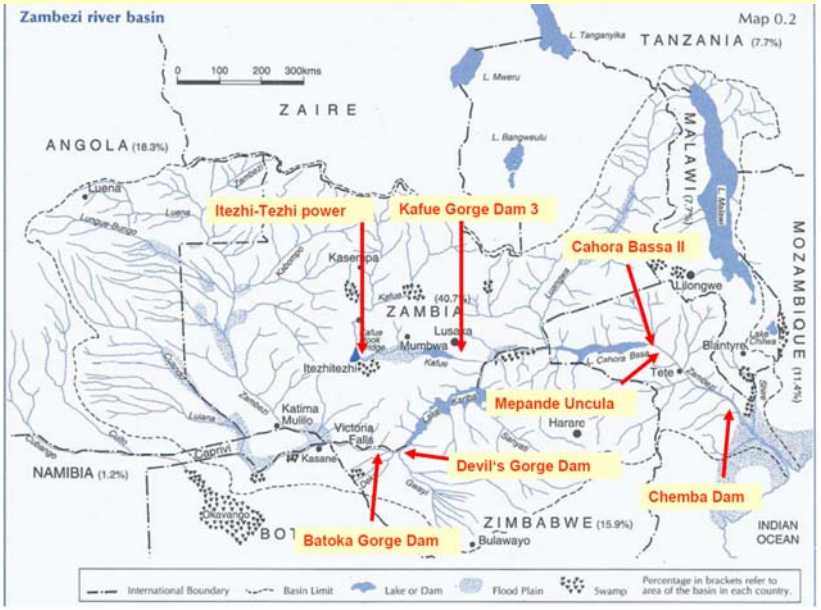
Content

Hydropower production Africa



J. of Hydropower and Dams
World Atlas and Industry Guide

Goals hydropower ZRB



Conclusions

- It will need great effort to convince the society to pay 4+ b$/yr despite good water quality
- We should not sacrifice small rivers/stream for only little more power → photovoltaic!
- “Politically”-accepted revitalization is well affordable. The struggle over space will remain
- Direct anthropogenic changes to the waters >> then climate change for decades to come
- Globally: food for all is possible but at an enormous expense on the aquatic ecosystems

We wish FA Forel a prosperous future, nice people, fascinating discoveries

Lake Baikal in April 2009
Russian Ministry of Resources