

Forest, Climate and Water Issues in Europe

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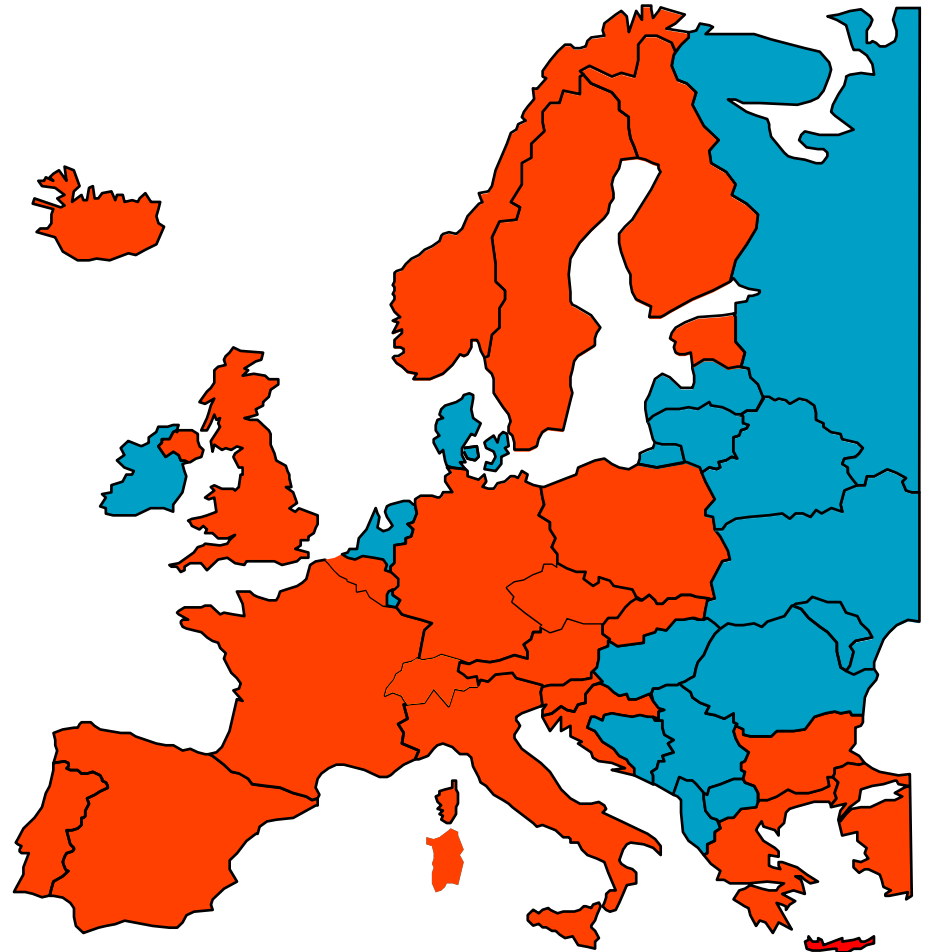
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The particular European perspective - outline

- Amplification of the existing climatic gradients across Europe according to CC scenarios
- Potentials and limitations of forest management in the control of flooding
- Water quality trends in Europe
- A closer look at southeastern Europe and the Mediterranean as hot spots of potential future trouble
- General tradeoffs between forest and water, particularly in the drier environments and high productivity forestations

COST and the „FORMAN“ consortium

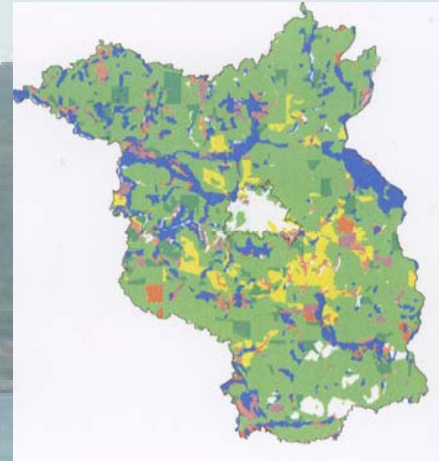
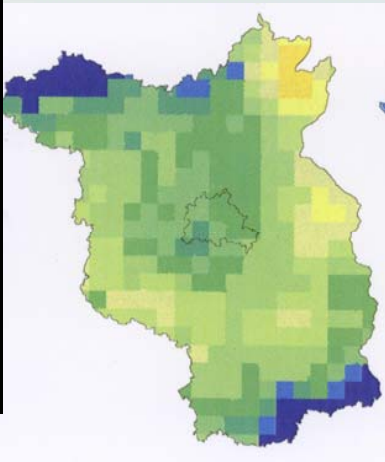
- Longest established science funding scheme of the EU („Cooperation in scientific and technological research“)
- 25 partner countries in FORMAN („Forest Management and the Water Cycle“)
- Running 2007 to 2011
- Springer „Ecological Studies“ book publication scheduled for 2010



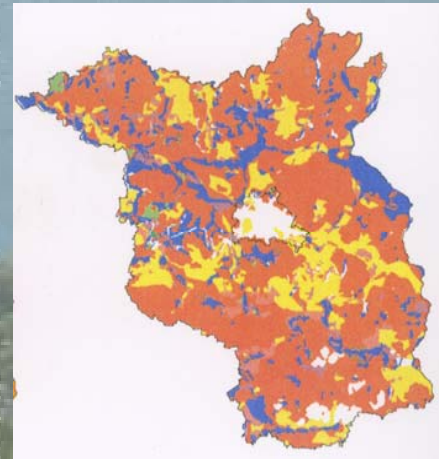
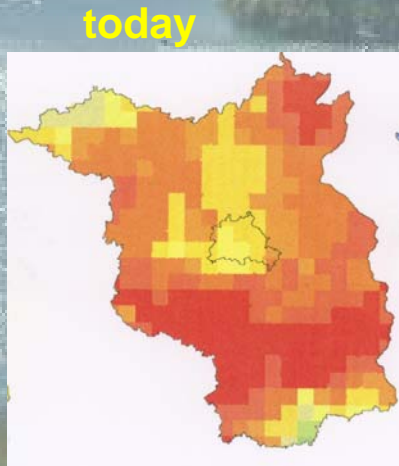
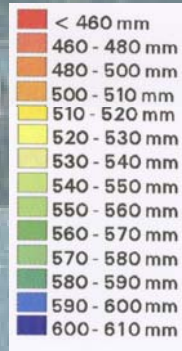
International River Basins of **EUROPE**



Quantification of the effect for Brandenburg, Northwestern Germany



Green = beech and beech/oak



Brown = oak/hornbeam with lime

2050

Koschel et al. 2001

Freitag, 197/34 4190554/00504 5 0 0 3 4
24. August 2007 0,50 €

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NIEDERSACHSEN Flut reißt 1. Haus weg!

Wieder Überschwemmungen in Süd-Niedersachsen: Gestern riss die Flut bei Göttingen ein erstes Haus weg! (Foto) weg! Seite 3

Water Hazards

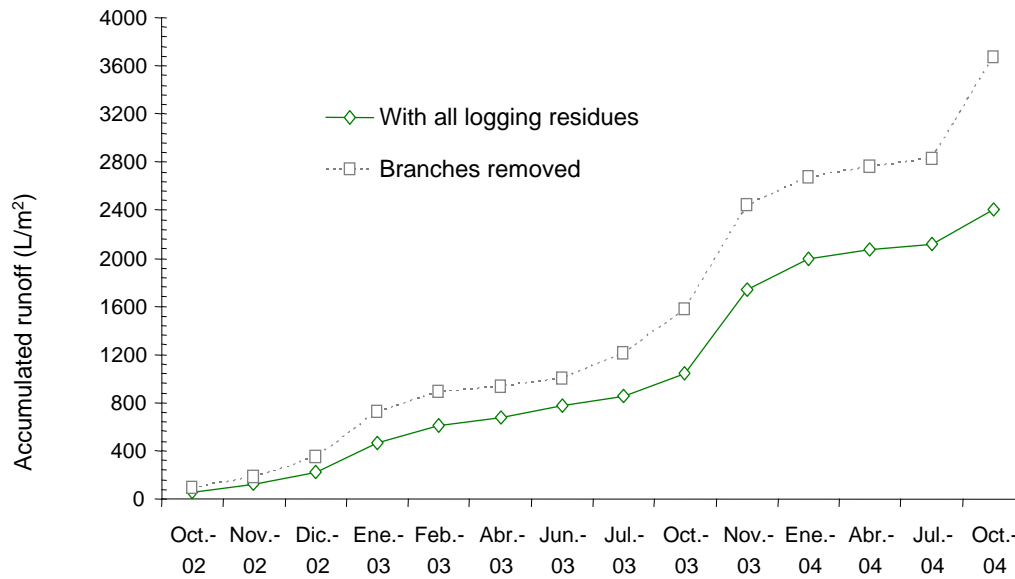


Water Hazards

Commonsense knowledge and truth – or popular myth?!

- Forests provide protection functions with respect to water related hazards
 - Forest usually dominates in headwater catchments, where peak flows first emerge
 - Forests can to an appreciable extent control and mitigate peak flows, due to their specific structural properties (above- and belowground!!)
 - Virtually all forest in Europe is *managed forest* ---> **optimize management!**

Forest management **does affect runoff** – example: Logging residues removal for biomass production in high productive forest plantations in NW Spain



Merino and colleagues,
Spanish FORMAN partners

From G. Schüler,
German FORMAN partner



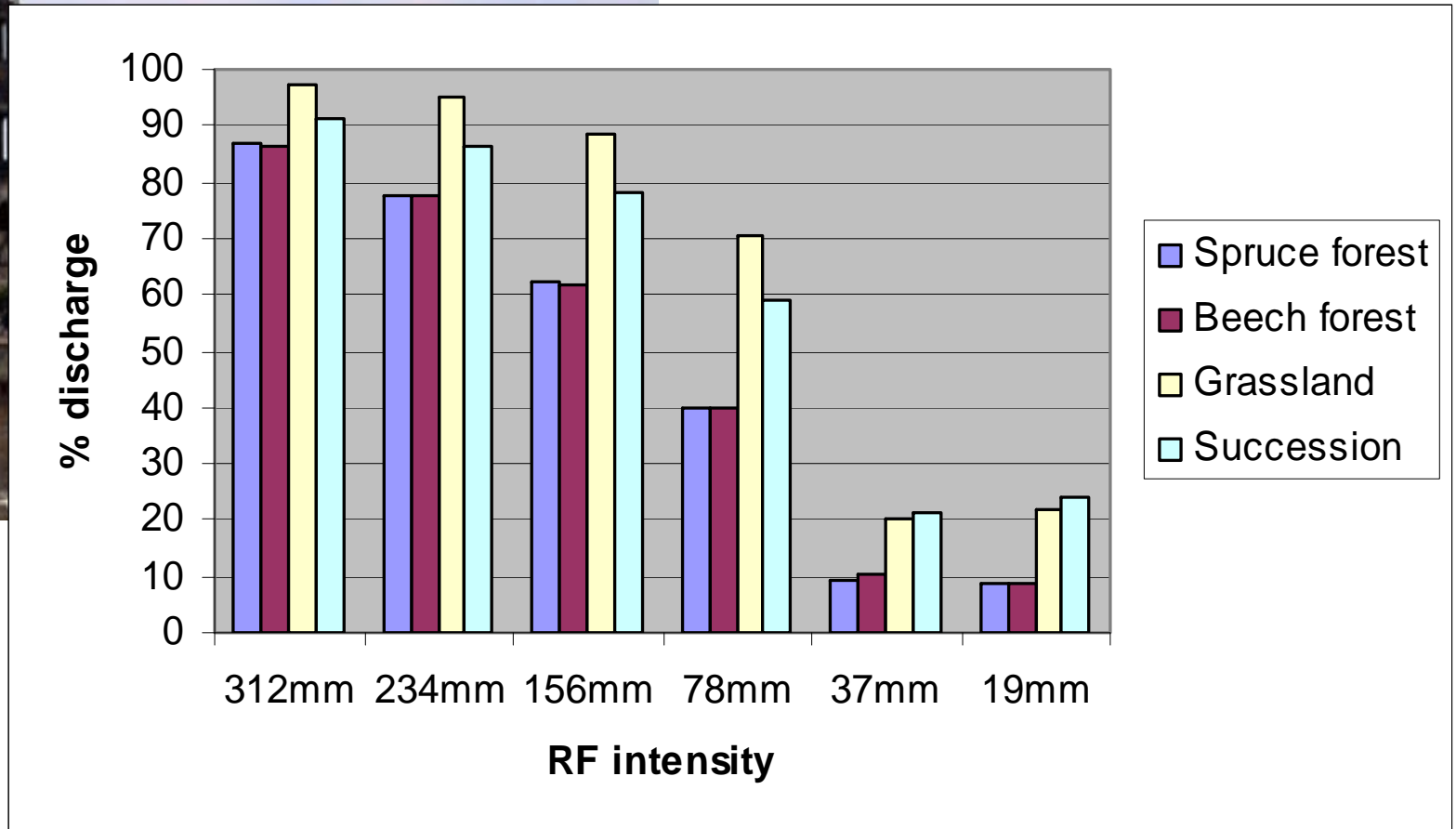
Using heavy machinery on the forest soil surface compacts the soil and reduces pore space, and thus decreases significantly the storage and retention capacity for water.



Heavy machinery **must not be employed across all of the forest site surface**, but restricted to defined lines of operation!!



Limits to the flood mitigation effect



Based on data from Seegert et al. (2003)

A general model of potential and limitations

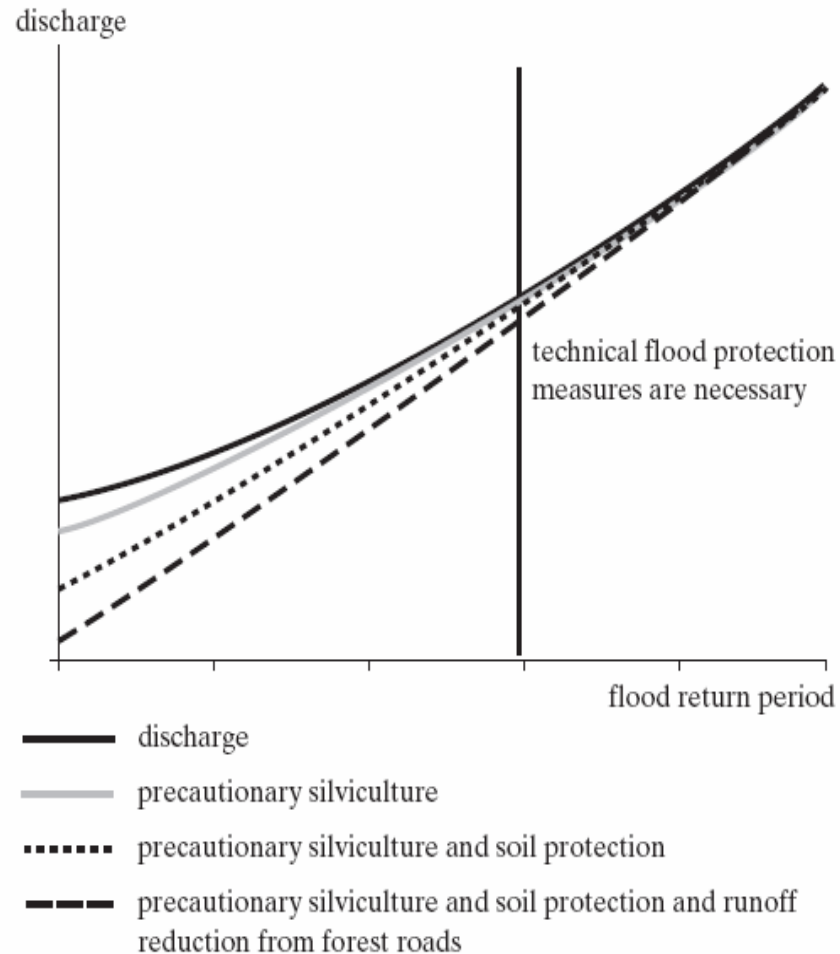


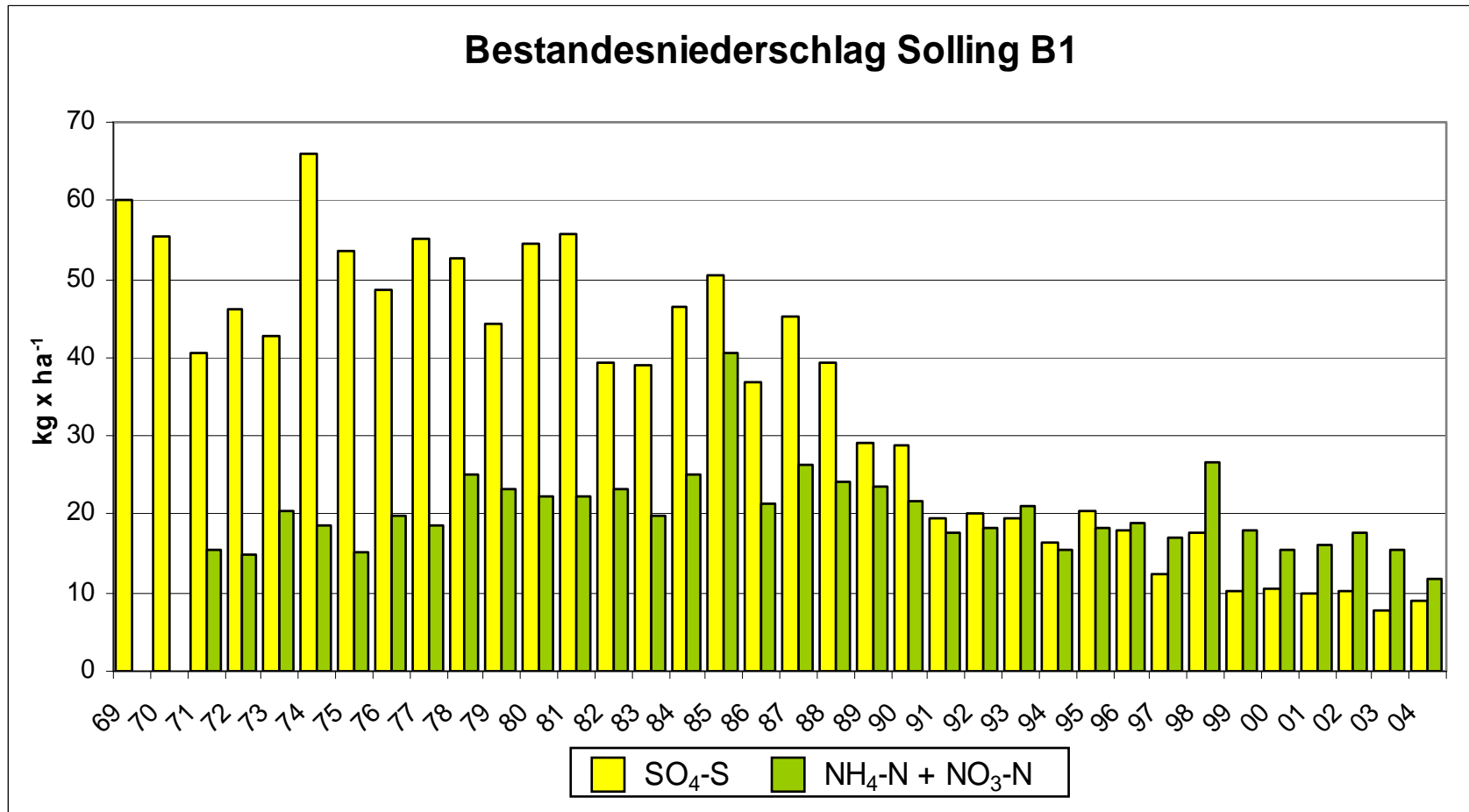
Fig. 5. Effects for discharge reduction by precautionary forestry management are shown in this unscaled graph. Different discharge curves vary according to the site and landscape structures. Intersection points and their assignment to a certain flood return period depend on the particular efficiency of the precautionary measures.

Interim summary – water hazards

- „Forest cover will prevent flooding“ is rather a popular myth than science based knowledge.
- However, forest seems to be the land use form providing best infiltration, water retention and erosion protection.
- The flood control effect gets weaker with stronger rain events and at large scale.
 - General „asymptotic model“ can be proposed.

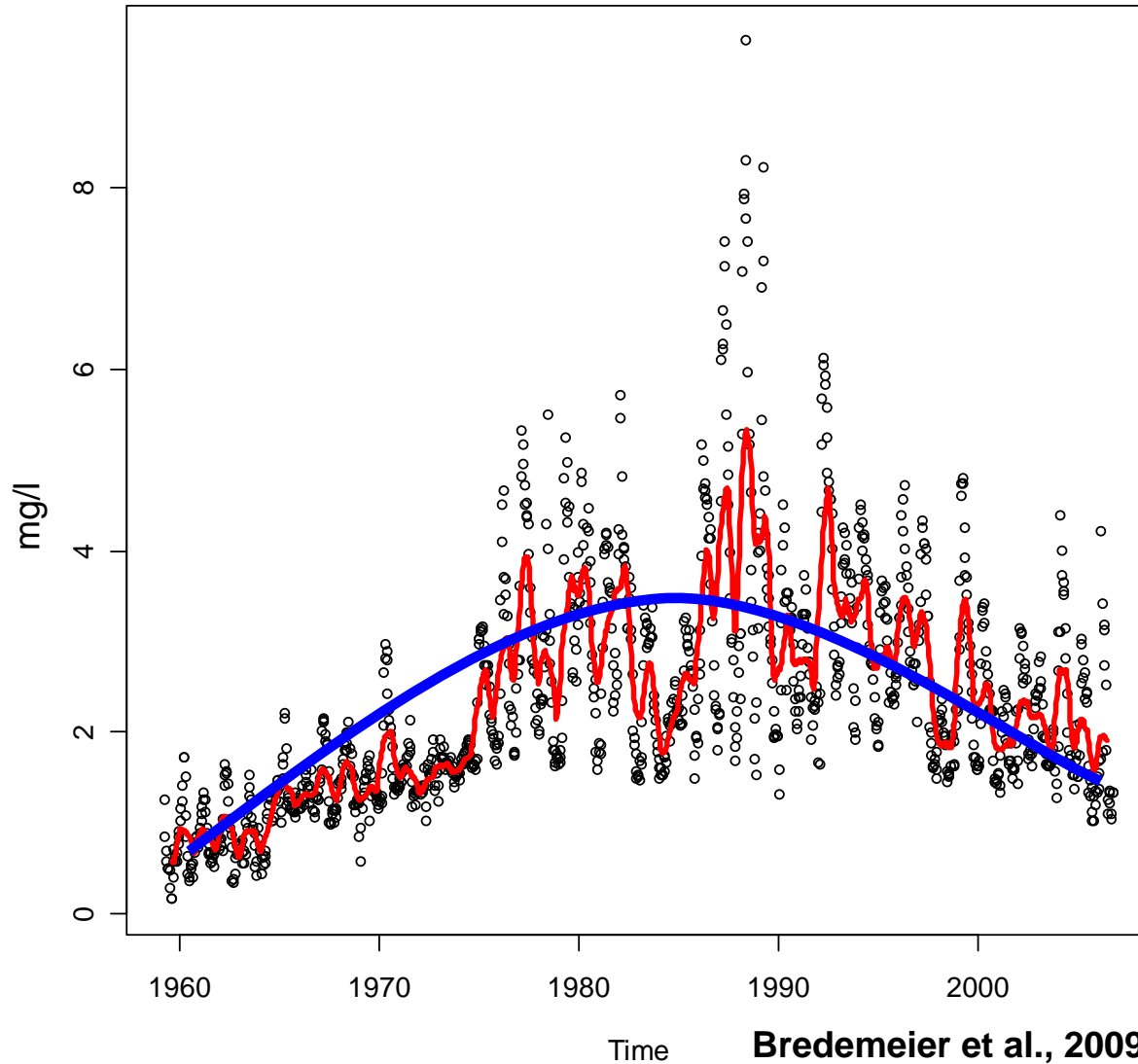
Forests and water quality

Long-term throughfall chemistry in a European Beech forest at Solling, central Germany



Catchments, lakes and reservoirs are spatial integrators

Slapy Reservoir (CZ), Nitrate-N 1959-2007



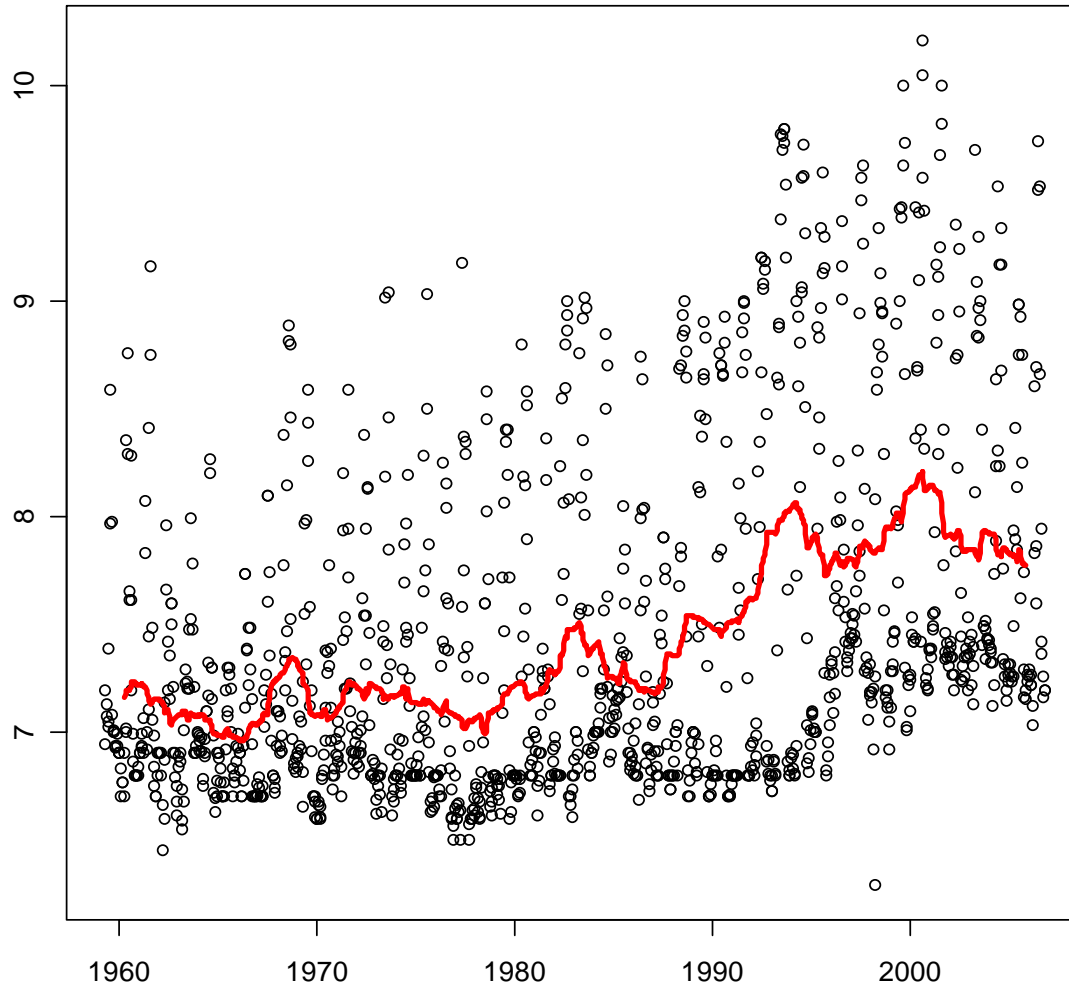
Bredemeier et al., 2009 in prep.

Location and surroundings of the Slapy reservoir, Czech Republic



Recovery of soils and waters from acidification is the actual common feature in many areas which have been strongly affected by acid deposition for decades

Slapy reservoir (CZ), pH 1959-2007

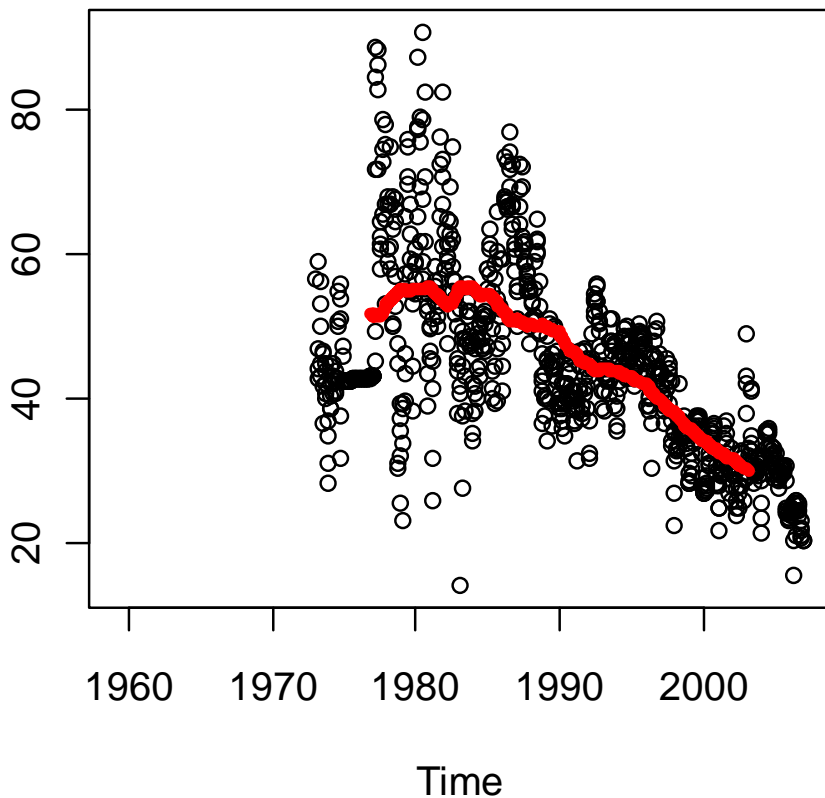


Time

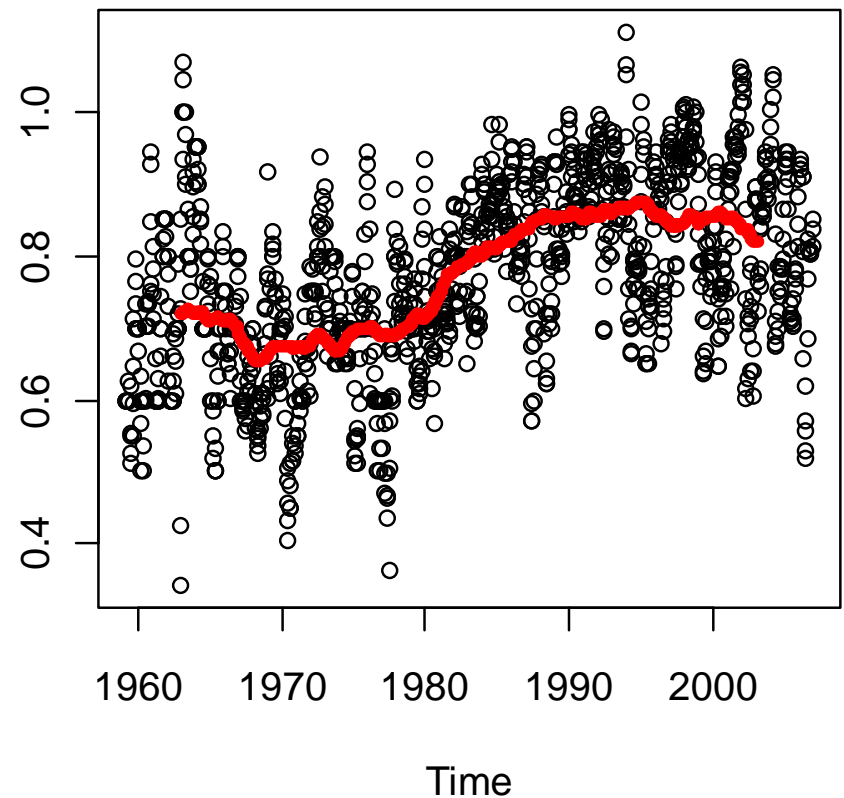
Bredemeier et al., 2009 in prep.

Corresponding opposite long-term trends: strong acid anions and alkalinity

Slapy SO4 with filter k=200

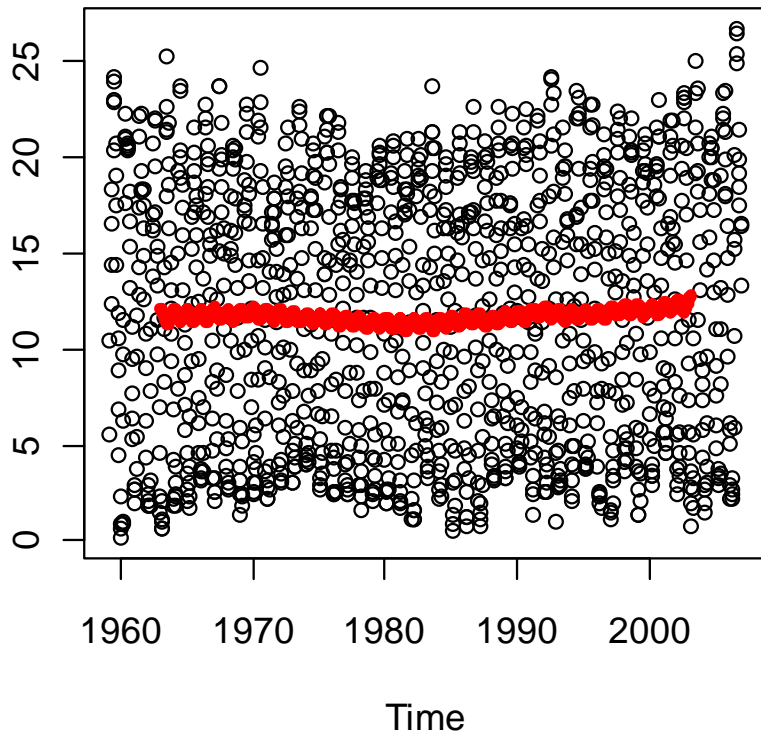


Slapy Alkalinity with filter k=200

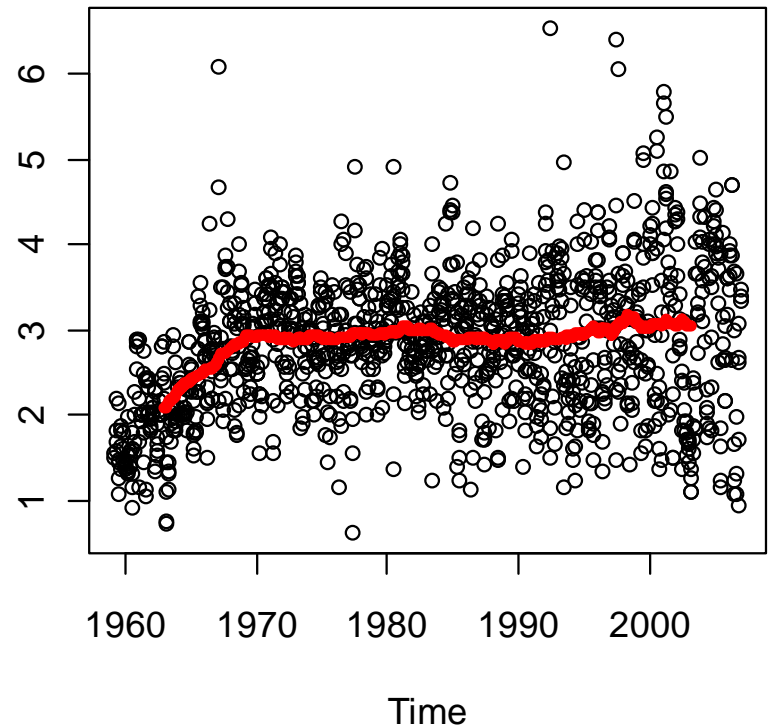


Physical parameters: Temperature and water translucency

Slapy Temp with filter k=200



Slapy Secchi with filter k=200



What is the role of forestry practices in the export of nutrients into water courses and ground water?

The following forestry practices have been identified to increase nutrient load in water courses:

- Cuttings: clear-cutting, (thinning?)
- Soil scarification: ploughing, mounding, disc ploughing, scalping
- Fertilization
- Forest drainage



Fíner and colleagues,
Finnish FORMAN partners

The share of different forestry practices out of the total load in Finland:

	Nitrogen	Phosphorus
Forest drainage, %	0	45
Clear-cutting, upland forests %	56	37
Clear-cutting, peatland forests, %	22	7
Fertilization, %	22	11
	100%	100%



Fíner and colleagues,
Finnish FORMAN partners

Interim summary – water quality

- The big concern in Europe from late 1970s to late 1990s was acidification of forest soils and waters.
 - „acid rain“ and „forest decline (Waldsterben)“
- First signals of recovery from mid-1980s on, consolidated until today
 - demonstrates efficiency of appropriate air pollution legislation and control!
- Nitrogen emissions control not as efficient als sulfur / acidity
- „Commonsense“ view that forest has most significance in ***water quality*** support (FAO)



Water and forests in the Mediterranean

- Mediterranean countries are home to **60% of the world's “water-poor”** population with **less than 1000 m³/inhabitant/year**
- By 2025, **63 million** of Mediterranean population would be **in need of water** (with less than 500 m³/inhabitant/year).
- **Integrated watershed management** need to be given priority in order to preserve and improve the scarce, usable water potential
- The **water and soil conservation measures** taken by foresters help significantly to increase the rainwater holding capacity of the soils and to **reduce erosion** and the silting up of dams.
- However, **tradeoffs between forest growth and water yield** have to be considered (forests transpire water which will be missing in runoff...).





Water exploitation indices (WEI) per basin (2025)

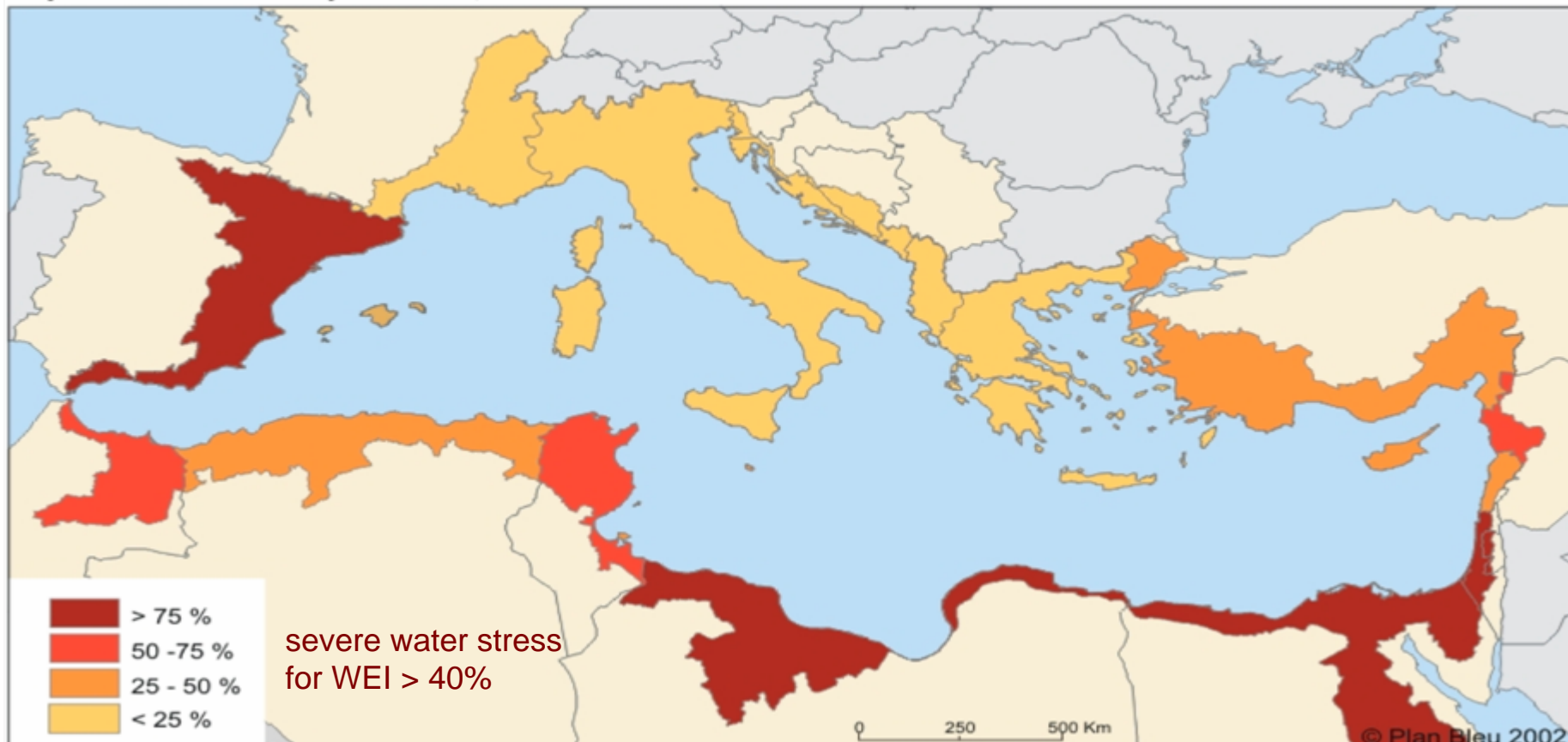
WEI = ratio of withdrawals to average renewable water expressed as a percentage

<http://www.planbleu.org/themes/e05eau02.html>

Source: *Plan Bleu*

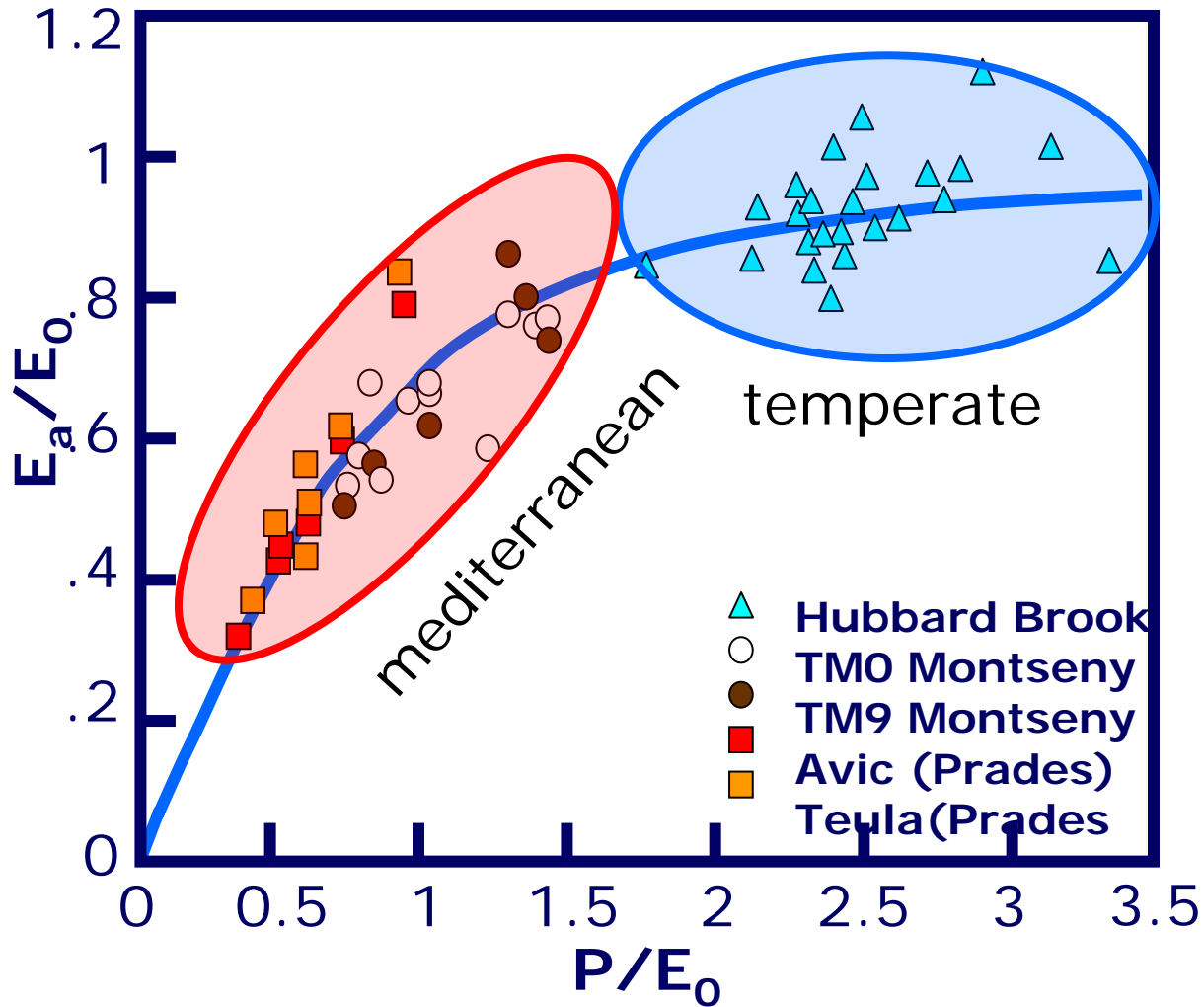
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Exploitation indices per basin, 2025





Looking at water/forest relations from a Mediterranean perspective



The ratio actual ET to PET (E_a/E_o) is highly dependent on the ratio precipitation / PET (P/E_o).

The forest grows under an almost permanent water deficit which will be aggravated under the predicted climate changes for the region.

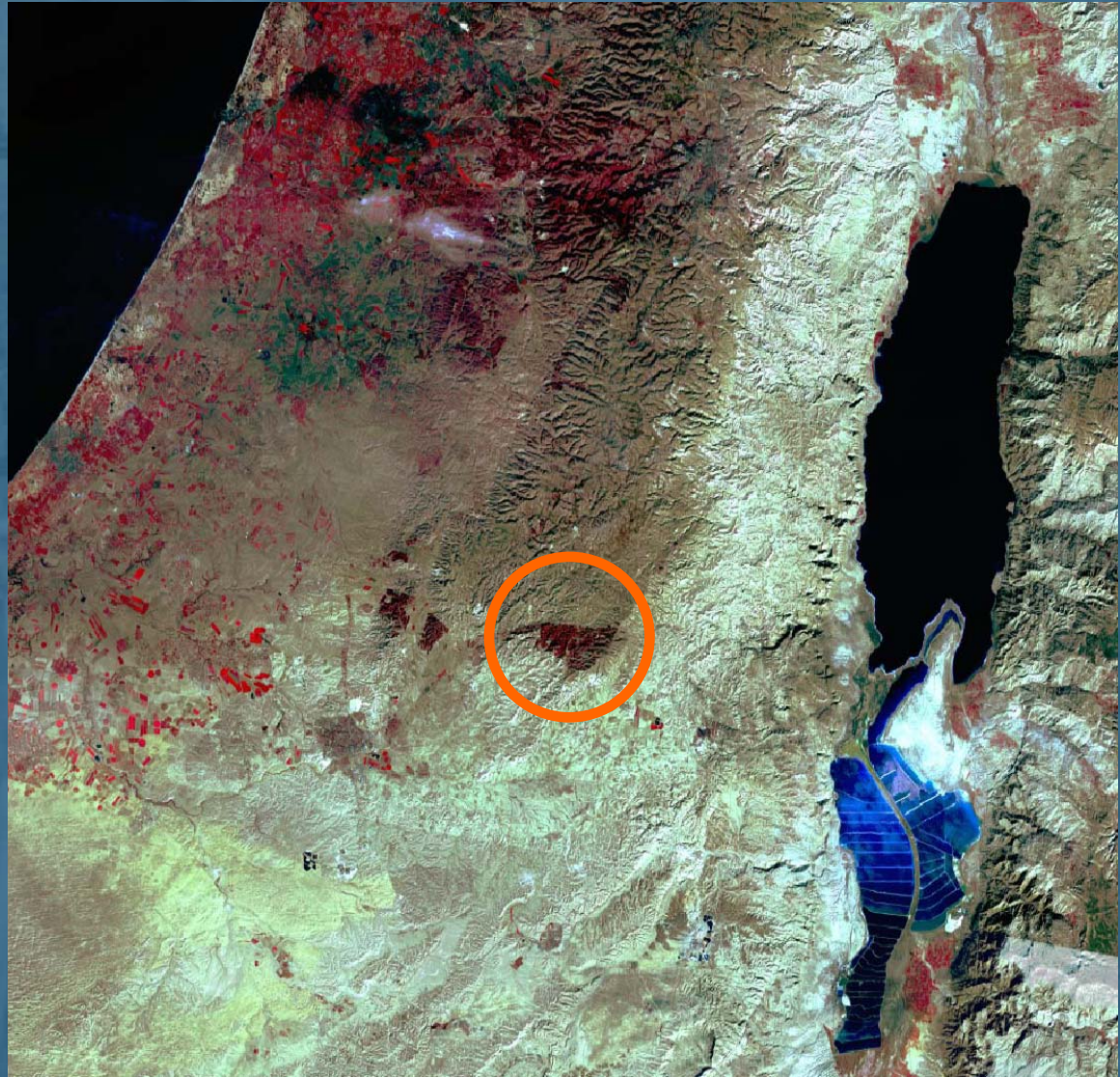
Source: C. Gracia

Interim summary – Mediterranean and SE European perspectives

- At the „dry end“ of the European forest and water (humidity) gradient problems may get worse and even more severe than at the „wet end“
 - Lethal drought events, wildfires, soil salination, ...
- Strong economical and social effects possible, such as abandonement and migration
- Mitigation options through reliance on better adapted species and technologies (such as water harvesting, contact drip irrigation etc.)

Forests in the very dry environments

The Yatir plantation
forest case study
in Israel
(from colleague
Eyhal Rotenberg et al.,
Israeli FORMAN
partners)





Forest eliminating runoff in the Yatir Watersheds

During the years 2001-2004:

22 runoff events in the unforested watershed

1 runoff event in the afforested watershed

Event 20-24 December 2002:

watershed	area km ²	average raindepth mm	peak flow m ³ /sec	specific discharge m ³ /s km ²	volume m ³	runoff mm	runoff coefficient
un treated	0.6	60.1	0.50	0.83	6761	11.3	0.19
treated	2.1	56	0.70	0.33	9438	4.5	0.08
afforested	1.6	78.7	0.01	0.01	10	0.0	0.00

**Rotenberg and colleagues,
Israeli FORMAN partners**

Data source: Shmuel Arbal

Water-Budget

Cahnsdorf

(Initial stage, LAI 1)

[mm], % of Precipitation

Database (2007)

Precipitation

691

100

Transpiration

83

12

Interception

23

3

Evaporation

102

15

± Soil storage
(0-100 cm soil depth)

- 3

Seepage output

485

70

Water tradeoffs in highly productive short-rotation coppice (SRC); Lamersdorf et al., FERC Göttingen

Water-Budget

Cahnsdorf

(> 2 years, LAI 6)

[mm], % of Precipitation

Database (2007)

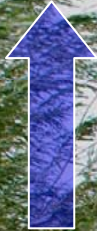
Precipitation



691

100

Transpiration



362

52

Interception



169

25

Evaporation



86

12

± Soil storage

(0-100 cm soil depth)

34

5

Seepage output



40

6

In more continental areas SRF might reduce groundwater recharge to zero

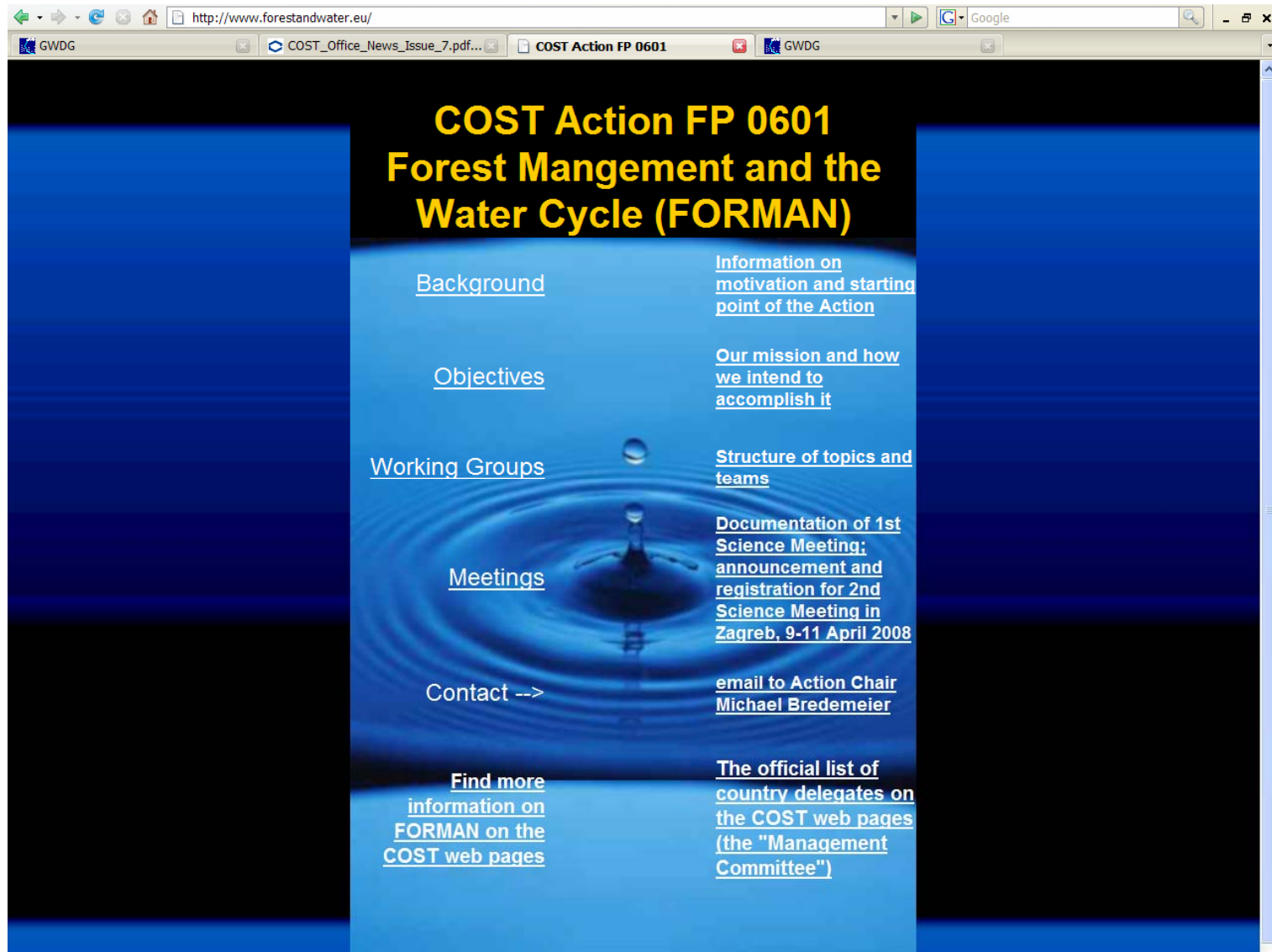
Interim summary – Forest and water ‘tradeoffs’ at the ‘dry end’

- Demonstration studies such as the Yatir forest in Israel show that forest can be maintained under very dry conditions.
- However, tradeoffs between forest growth (resp. the related ET) and seepage/runoff generation are most severe under driest conditions.
- Same applies in principle to very productive forest (such as fast growing energy wood plantations) even under more humid conditions.
- Forest/water tradeoffs require very careful concern!
- „More forest – more water“ is another popular myth ...

Conclusions

- Forest (management) in Europe will probably have to face an intensified gradient wet \leftrightarrow dry.
 - Enhanced risks of flooding at the „wet end“
 - Enhanced risks of drought and fire at the „dry end“
- There is a potential of flood mitigation by forest management, but it has its limitations at high flood intensities.
 - „Forests prevent flooding“ is convenient to say, but not always the truth ...
- Chemical water quality in Europe has in general improved over the past decades
 - Joint effect of air pollution legislation and on-site remediation of acidification of soils and waters
- In the drier environments, there are always **tradeoff effects** between forest and water to consider.

Follow our progress on the Action website www.forestandwater.eu



The screenshot shows a web browser window with the URL <http://www.forestandwater.eu/>. The browser tabs include "GWDG", "COST_Office_News_Issue_7.pdf...", and "COST Action FP 0601". The website content features a central image of a water droplet creating ripples on a blue surface. The text is arranged in two columns around this image.

COST Action FP 0601 Forest Mangement and the Water Cycle (FORMAN)

Background	Information on motivation and starting point of the Action
Objectives	Our mission and how we intend to accomplish it
Working Groups	Structure of topics and teams
Meetings	Documentation of 1st Science Meeting; announcement and registration for 2nd Science Meeting in Zagreb, 9-11 April 2008
Contact -->	email to Action Chair Michael Bredemeier
Find more information on FORMAN on the COST web pages	The official list of country delegates on the COST web pages (the "Management Committee")



**Thank you very much
for the kind invitation
and for your attention!**