Ecosystem services of rivers: What can we exploit now and what are the risks

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Role of rivers

Historical:

- Trails of colonization.
- Protection / fortification.
- Source of water & energy.
- Means of transport.

Recent:

- Recipients of pollution.
- Super exploitation:
  transport, energy, agriculture……

Permanent: **Cultural** and **GLOBAL/PHYSICAL**.

Feedbacks

- Change of landscape – changes of river channel and discharge (incl. year cycle).
- Floods.
- Droughts.
- Epidemics.
- Pollution.
- Upstream / downstream tensions.

Principles of Protection

River oriented systems (Egypt).

Flood protection.

Protection of source:

- energy etc.
- fisheries,
- water as such.

Modern legislation – sice 1876 (?):

- Rivers Pollution Act
- Royal Commission, Report No 8, 1915.

Principles of Protection

- Legal: It is forbidden to pollute river even when already polluted.
- Externalities.
- Polluter Pays Principle.
- Progress of assessment in water and economic sciences.

Water Framework Directive:

- Protection of both water and channel quality.
- Linking upstream and downstream people.
- Modern attitudes to evaluation.
- Economic and legal requirements.
- Wise use / sustainable exploitation.

Ecosystem services (ESS): What is it?

- Services of Mother Nature supporting human activities, e.g.
- Human work and the price of products is only an added value to the „price“ supported by Nature (light, water, soil, energy, raw materials, climate…)
- True price of global ESS is comparable with global GNP.
- People start to perceive ESS only when limitations occur and we should pay.

Classes of ESS. Which could be evaluated?

1. **Supportive** functions and structures:

   Ecological structures and functions that are essential to the delivery of ecosystem services.

2. **Regulating services:**

   Maintenance of essential ecological processes and life support systems for human well-being.

3. **Provisioning services:**

   Provisioning of natural resources and raw materials.

4. **Cultural services:**

   Enhancing emotional, psychological, and cognitive well-being

1. Supportive functions and structures

1.1 Nutrient cycling.
Storage, processing, and acquisition of nutrients within the biosphere.

1.2 Net primary production.
Conversion of sunlight into biomass.

1.3 Pollination and seed dispersal.
Movement of plant genes.

1.4 Habitat.
The physical place where organisms reside.

1.5 Hydrological cycle.
Movement and storage of water through the biosphere.

2. Regulating services

2.1 Gas regulation.

Regulation of the chemical composition of the atmosphere and oceans.

2.2 Climate regulation.

Regulation of local to global climate processes.

2.3 Disturbance regulation.

Dampening of environmental fluctuations and disturbance.

2.4 Biological regulation. Species interactions.

2.5 Water regulation. Flow of water across the planet surface.

2.6 Soil retention.

Erosion control and sediment retention.

2.7 Waste regulation.

Removal or breakdown of nonnutrient compounds and materials.

2.8 Nutrient regulation.

Maintenance of major nutrients within acceptable bounds.

3. Provisioning services

3.1 Water supply.
Filtering, retention, and storage of fresh water.

3.2 Food.
Provisioning of edible plants and animals
for human consumption.

3.3 Raw materials.
Building and manufacturing.
Fuel and energy.
Soil and fertilizer.

3.4 Genetic resources.

3.5 Medicinal resources.
Biological and chemical substances for use
in drugs and Pharmaceuticals.

3.6 Ornamental resources.
Resources for fashion, handicraft, jewelry, pets,
worship, decoration, and souvenirs.

4. Cultural services.

Enhancing emotional, psychological,
and cognitive well-being

4.1 Recreation.

Opportunities for rest, refreshment, and recreation.

4.2 Aesthetic.

Sensory enjoyment of functioning ecological systems.

4.3 Science and education.

Use of natural areas for scientific and
educational enhancement.

4.4 Spiritual and historic.

Spiritual or historic information.

What services of rivers we expect:

Water supply – without extremes:

- for consumption,
- for energetics,
- for navigation.

Recipient of wastes & „self purification“.

Climate regulation.

Aesthetics - urban, country.

Recreation – boating, swimming, angling….

All are endangered today

2.7 Waste regulation.

Removal or breakdown of nonnutrient compounds and materials.

Standard water use:

1. Abstract, treat, distribute, sell,
2. use/pollute it,
3. **collect, treat in WWTP, discharge to the recipient** (& dump the sludge).

What than:

Self-purification in the river – a typical ESS.

The EES question: Reliability, effectiveness, resilience, costs/benefits.

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Costs & Benefits

Costs:

- **Who pays.**
- What they include?
- Risks – are included?

Benefits:

- **Who gains** them.
- When.
- Risks – are included?

RIVERS:

Upstream/downstream and time relations.

Temptations od Ecosystem Services Concept

Drawbacks:

- Temptations to evaluate any „service“.
- Temptations to make simple calculations.
- Evaluations of „present“ and „future“ could be separated.
- Cultural services are underestimated.

General advantages:

- Integrated approach.
- Means of communication.

Pollution abatement in rivers as an ecosystem service

Self-purification is/was a paradigm valid for years, based on organic carbon degradation and oxygen consumption/supply. It worked and works, though with some limits.

NOW:

- Sewage waters are treated, WWTP outflows contain low concentrations of organic carbon, low nitrogen, phosphorus abatement is generally accepted etc.
- Quality of river water has improved dramatically during last 25 years.

Pollution abatement in rivers as an ecosystem service

After the success new problems emerge.

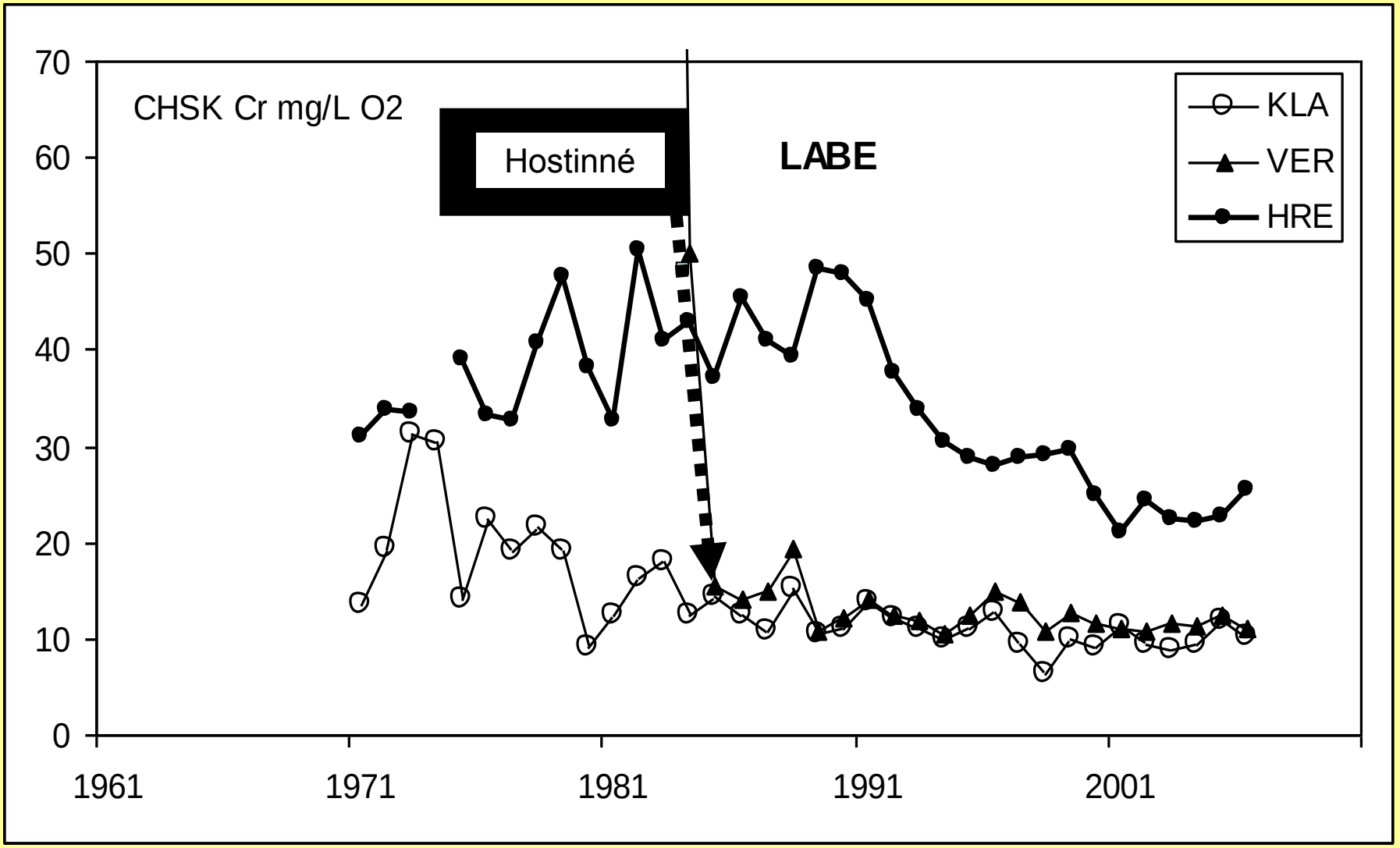
- People perceive ecosystem concepts as a part of the environment.
- Concepts of healthy river ecosystem are accepted, not only those of clean water.
- Concern of ones health is increasing.
- New pollutants appear and the self-purification capacity differs from that in the past.
- Why? Paradox of the lack of degradable organic carbon „supplied“ with wastewater.

New pollutants („emerging pollutants“)

PPCP - Pharmaceutics and Personal Care Products - dischaged from households after use.

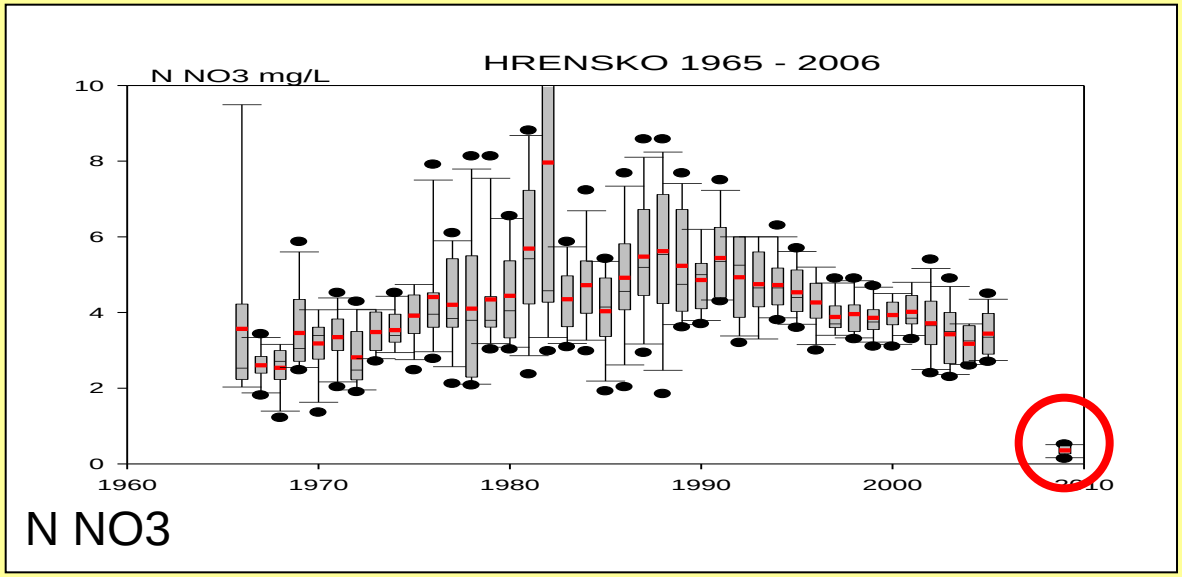
- Domestic wastewaters cannot be controlled as industrial waters.
- Synthetic compounds with high biological activity even in residual concentrations.
- Often high resistance to biological degradation – in both WWTP and river.
- Problems with detection (degradation products).
- Cannot be prohibited.

Typical situation – change in an upstream paper mill (C.O.D.). Downstram a gradual improvement and a sharp decrease after 1995:



Hřensko + Děčín 1877

Czech Elbe downstream



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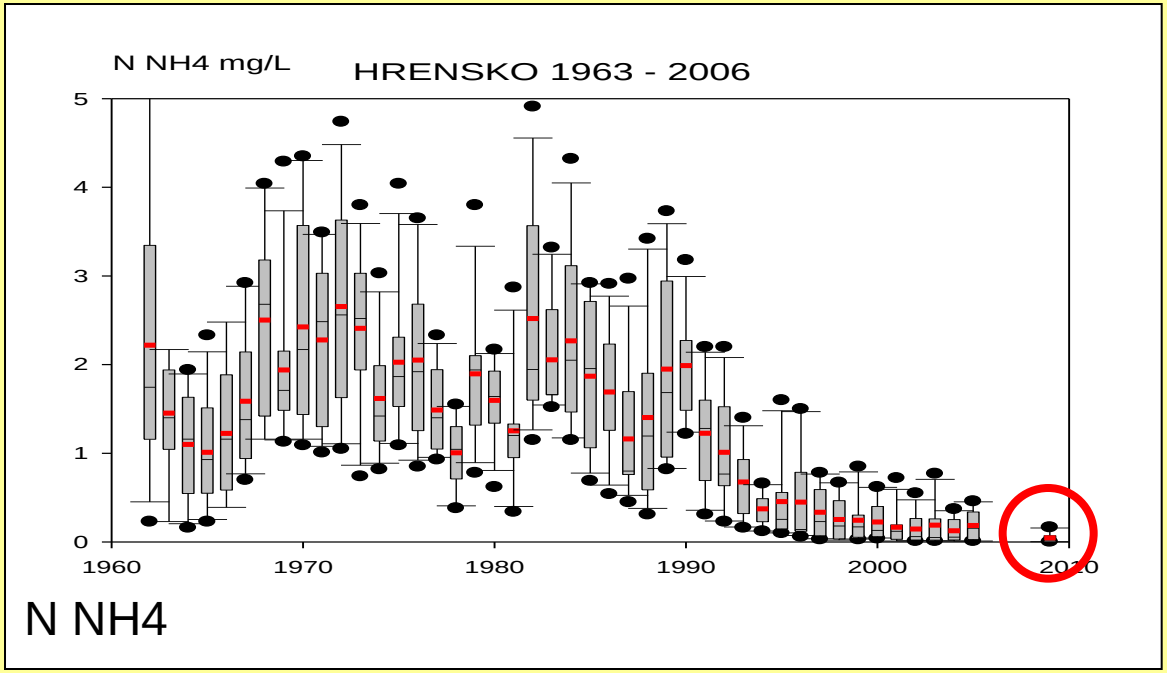

N NH4

Vltava up- and downstream Prague 1971 - 2007

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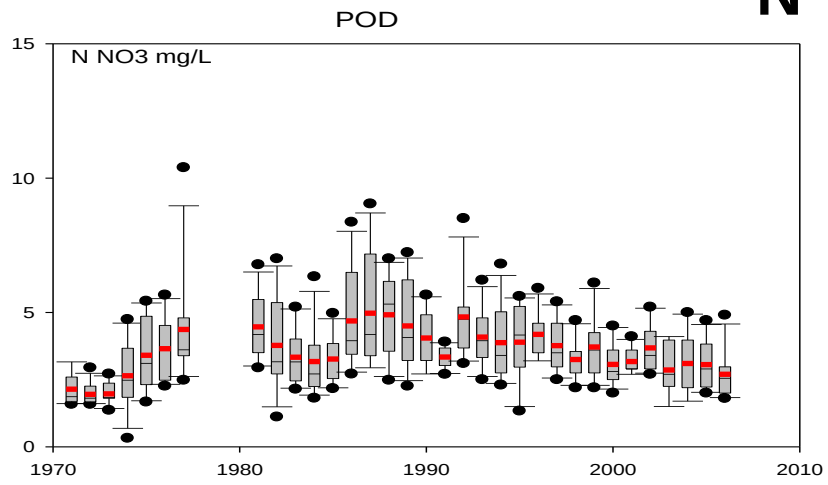

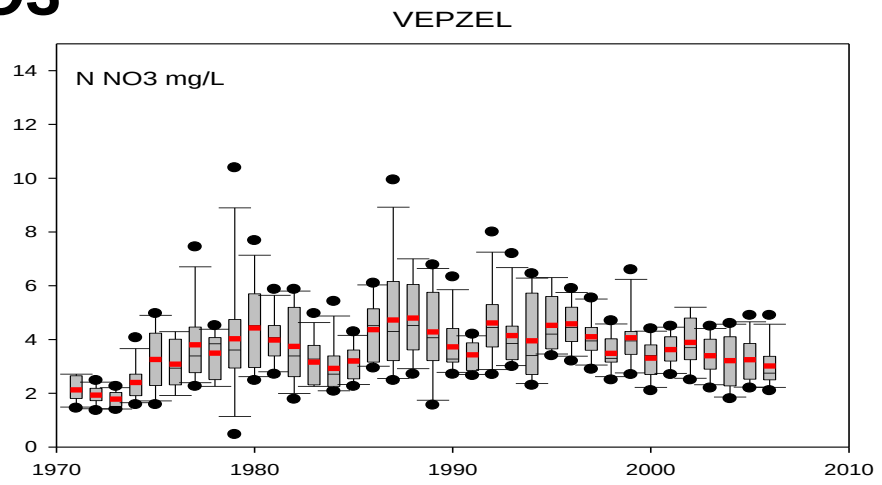

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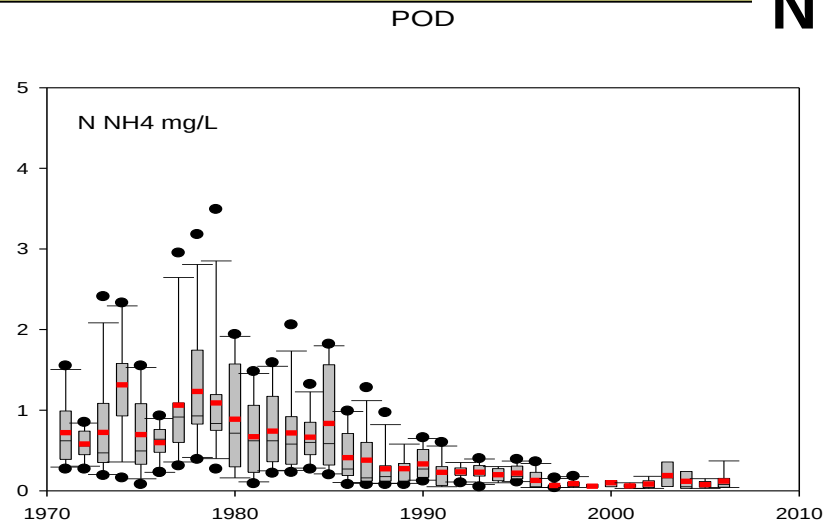

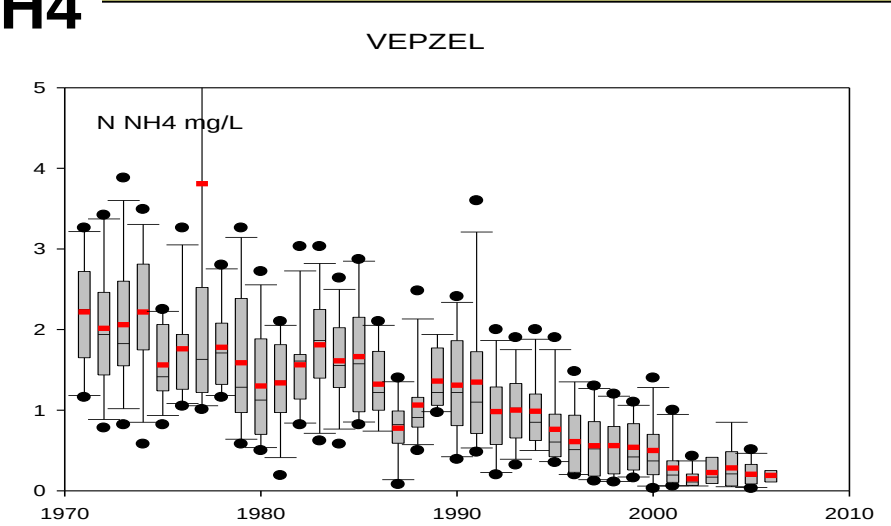

Conclusions:

1. Self-purification is a typical ecosystem service provided by rivers.
2. **Its limits develop** with the development of society – new pollutants, new social awareness.
3. Proposals of further development are not very optimistic (accrual of specific pollutants, climatic change).
4. Investments into WWTP technologies (R&D) are necessary.
5. The „free“ ESS needs more of a direct financial support.


A basic ESS: Rivers reshape the landscape.
They did it and will do it forever.
All other items can be forgotten for a minute.
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