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ECOSYSTEM SERVICES OF RIVERS: WHAT CAN WE EXPLOIT NOW AND WHAT ARE THE RISKS

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Absract: *Rivers provide basic ecosystem services as sources of water, recipients of pollution, services in the field of trasport and energy production etc., so the services of groups Production and Regulatory. All these services have some limits, of course, which could be partly deduced from the historical development. Exceeding the limits leads to a threat of ecosystem services in the field of direct exploitation, but also in the field of non profit services, e.g. most pf Regulatory and Cultural services. The paper informs on the present state and development, including possible situations proposed by scenarios of the climatic change.*

Keywords: ecosystem services, pollution, river management

PREFACE – ROLE OF RIVERS AND THE CONTROL

Rivers could be considered as a link in the global water cycle, recycling rainwater to the sea, doing also some reshaping of the surface called the erosion. But from the human point they represent main historical routes of colonization of the earth and also the main support to human settlements, up to now. With the increase of settlements and industry the rivers carried out function of recipients of pollution, transporting it downstream. During last 150 years the pollution of rivers reached its maxima and a decrease, being on the very low level now in advanced countries. In the Czech Republic a significant decrease of pollution has been reached in the period 1980 – 2000, simply visible on nearly all bigger rivers and streams. Nevertheless, the process continues and new problems emerge: 1. Dramatic decrease of "classic" pollution made "classic" systems of its control ineffective. 2. Questions of sustainable use of rivers rise beside those of their use as recipients. Present situation is satisfactorily controlled by the Water Framework Directive (60/2000/EC), but for further development new approach is needed. After adoption of externalities concept, for the long term sustainable use the concept of Ecosystem Services (ESS) seems very promising. The ESS concept is based on weighing all particular activities, costs and benefits of the use of the Nature as a part of the success of the human society. Simply said,, our results are only an added value to the ecological service provided by the Nature. ESS are generally not

calculated in the price of goods until approaching some limit and thus leading to an increase of commonly calculated costs. That is the point people start to think of EES, which starts to be a common attitude now. Standard summary of ESS, according to Costanza et al. (1997), Dailly et al. (1997), Millennium (2005) and Farber et al. (2006) is presented in Table 1.

ECOSYSTEM SERVICES STRUCTURE

Division into four groups of services according to impact to the Globe and than to the human activities is a fundamental feature of the ESS design, enabling to join both ecological and economical approach to the ecosystem management. For the Part 3 relatively clear relation to the economy is supposed and valuation of most of ESSs is a common activity today. But even here most externalities are still being neglected. Also the Regulating ESS (Group 2) are often included in economical calculations, in most cases as a threat of uncontrollable changes to the production, which is fully the case with Group 1. The Group 4 is a basic one, though it underestimates issues as welfare and public health, but most of the direct evaluations seem impossible. Activities like the business of the educational and recreational tourism belong probably more to the Production services. Anyway, people could see some issues in various compartments, especially in case of Group 4.

As to the water, beside Group 1 its ESS are directly included in all issues of Group 2 and issues 3.1 and 3.2. In the issue 3.3 the role of water in energetic should be highlighted (direct use of mechanic water energy, cooling etc). For the Group 4, water plays a very important role (beside of rivers also the sea) in all issues. What is the development of ESS of rivers: Their original role as a direct source of drinking water decreases being replaced by centralized waterworks using raw water from more protected sources (groundwater, water reservoirs on rivers upstream). The direct role in energetic industry consists in use of potential energy for production of electricity, generally connected with construction of dams and reservoirs, leading to a significant reshaping of the river valleys and hydrological regime. In the electricity production in thermal power stations (burning or nuclear) the cooling is necessary, leading to changes in thermal regime of rivers. And water power stations remain the main regulating tool compensating fluctuations in power consumption, which leads to an intensive peaking, changing the level in the reservoirs and dramatic daily changes of discharge in rivers downstream the dams. At present that regulating regime is constricted with the flood protection measures on rivers, limiting unregulated filling and emptying the reservoirs. The present dreams on expanding the river navigation out of historical routes should be considered only as an attempt to cover businessmen activities based on taxpayers subsidies by an “ecological fashion”.

Tab. 1: Main ecological services and their basic description.

Ecosystem functions and services	
1. Supportive *functions and structures*	*Ecological structures and functions that are essential to the delivery of ecosystem services*
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	*Maintenance of essential ecological processes and life support systems for human well-being*
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	*Provisioning of natural resources and raw materials*
3.1 Water supply	Filtering, retention, and storage of fresh water
2.2 Food	Provisioning of edible plants and animals for human consumption
2.3 Raw materials	Building and manufacturing Fuel and energy Soil and fertilizer
2.4 Genetic resources	Genetic resources
2.5 Medicinal resources	Biological and chemical substances for use in drugs and Pharmaceuticals
2.6 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

POLLUTION ABATEMENT AS A RIVER SERVICE

But what remains is the role of rivers as the fundamental recipient and transport of pollution. The industrial pollution could be controlled by standard measures, but communal pollution remains a problem of the present and in the future. In nearly all bigger municipalities functional wastewater treatment plans were built in last decades, leading to the abatement of organic carbon and ammonia emissions, but the pollution remains. Why? Beside of new pollutants as pharmaceutics and other specific and resistant substances discharged from households after the use, a paradox appeared: In clean rivers processes traditionally called "SELF PURIFICATION" do not work, because there is not enough organic carbon for the basic activity of bacteria, responsible for most of degradation processes. In combination with reshaping river channels to a more direct and smooth state, most pollutants are transported downstream to the sea untouched. A typical example is given in Fig. 1 for the development of ammonia and nitrate nitrogen concentration in the Elbe in Hrensko, which represents the discharge of ca 50000 km^2 (ca 65 % of the state). Public data (Czech Hydrometeorological Institute) are used and compared with data for 1877 published by Ullik (1881). According to construction of WWTPs discharge of ammonia nitrogen decreased to values reported in 1877, but nitrate nitrogen, nearly at zero levels in 1877, decreased only to a stable level ca 4 mg N-NO3 l^{-1}. The mechanisms are simple in fact. Generally, discharge of ammonia decreased dramatically, and WWTPs discharge much less of nitrogen and only in the nitrate form. But concurrently discharges of organic carbon decreased dramatically. This improved oxygen conditions in rivers, so residual ammonia is oxidized to nitrate and nitrate reduction to gas nitrogen has stopped, because it occurs only in low oxygen conditions. And the nitrate simply travels downstream, as in all European rivers.

CONCLUSION

A typical case of a limit (or failure) of a seemingly reliable ecosystem service of rivers called "self purification" is reported. For the future, the water consumption in households could decrease, but not the sum of production of pollutants discharged to wastewater treatment plants. Scenarios for future, as those of climatic change, propose occurrence of long periods of low discharge in rivers, which could lead to a low dilution of and to a significant damage of river ecosystems and quality as such. What is the solution – look for better technologies, even if more expensive.

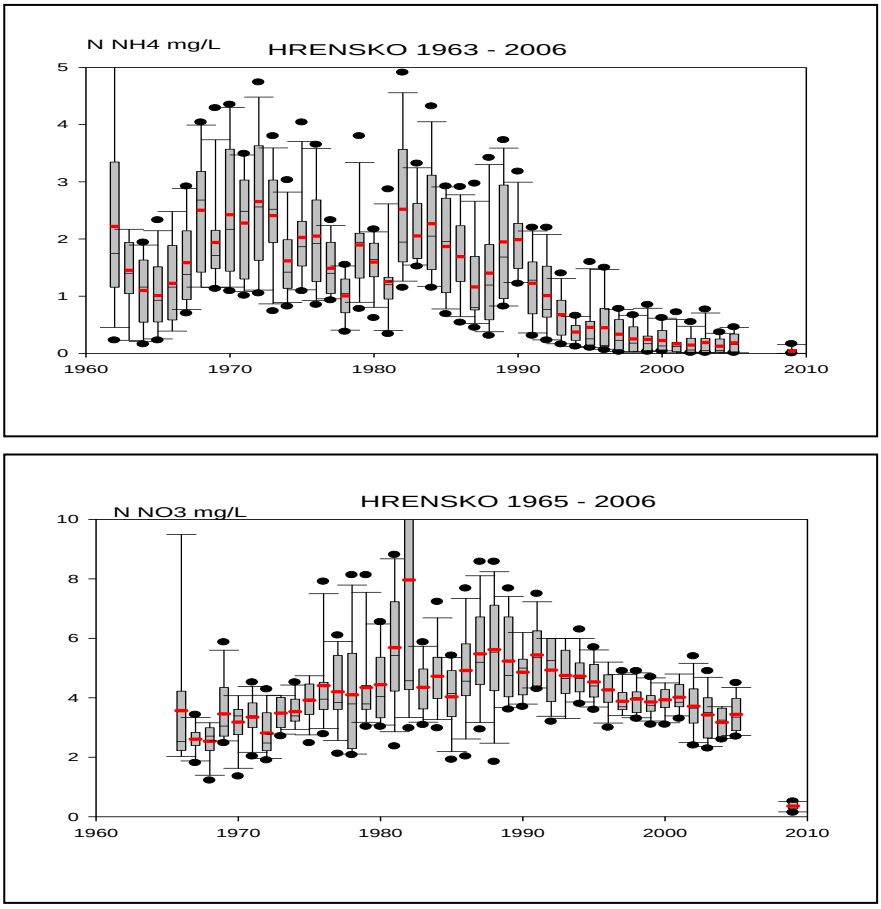

Fig. 1: Concetrations of ammonia and nitrate nitrogen in Elbe (1960 – 2006) in the frontier profile Hrensko. In the far right angle data of Ullik (1881) are placed.

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