Economy vs. Ecology? - How to reach nutrient emission reduction goals in the most international river basin: the Danube river basin

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Background

The Danube river basin (DRB) covers a total area of 810,000km² and collects water from the territories of 19 countries in Central and South-Eastern Europe. The size of the catchment and the number of contributing countries lead to a large variety in the geo-physical and socio-economic characteristics, within and among the different regions of the DRB. In the DRB, precipitation ranges from 1300 mm/yr in the mountainous / upper basin countries and 550-600 mm/yr in the low lands and lower basin countries. Also land-use intensities vary between the countries, indicated by a TN surplus in agricultural areas from 90 kg/ha/yr in Germany and often less than 20 kg/ha/yr in many of the Eastern-European countries. Although the countries in the upper basin are economically prosperous, the countries in the lower basin are among the poorest in Europe (ICPDR, 2009) (Figure 1).

In the period from 1990s to 2005 the nutrient emission in the DRB decreased from 890,000 t/yr (TN) and 78,000 t/yr (TP) down to 760,000 t/yr (TN) and 59,000 t/yr (TP), by 13% (TN) and 24% (TP) (ICPDR, 2009). After the fall of communism with the beginning 1990s most Eastern-European countries suffered from a brake down of their industries, which let also to dramatic decrease of nutrient emissions from agriculture. Despite the reduction of emissions and the loads in the surface waters, an additional nutrient emissions reduction was targeted by the ICPDR, in order to return to the ecological status of the 1960s. This additional reduction amounts to 14% for TP and 40% for TN. This equals a reduction of the total TN emissions from 7.8 kg/ha/yr to 4.7 kg/ha/yr and a reduction of the total TP emissions from 58 kg/km²/yr to 50 kg/km²/yr.

Methods

For the modelling of the nutrient emissions, the in-stream retention and the resulting load the semi-distributed model MONERIS (Venohr et al. 2010; Venohr et al., 2011) was used. The model delivers annual results on a hydrological sub-catchment level (analytical units). Input data, e.g. land-use, soil-type, elevation, population, precipitation, etc were taken from European- or world-wide GIS maps. Country specific data (i.e. run-off, connection rate of inhabitants to sewer systems, etc.) were provided by the countries.

To model the effect of measures to reduce emissions the scenario manager implemented in MONERIS was used. The potential costs arising from the implementation of the measures were calculated on basis of the approach developed by Grossmann (unpublished), which was integrated in MONERIS. In cooperation with the ICPDR and the contributing countries a combination of measures for a baseline and a more ambiguous vision scenario were developed. Different approaches were tested to identify hot spot areas, either contributing above average specific emissions, contributing a high share on the loads to the Black Sea, being located in vulnerable areas, or where observed concentration in surface waters demand a reduction of emissions.

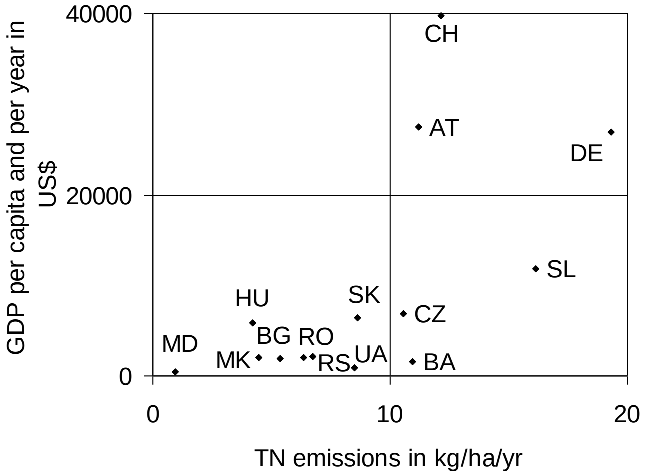

Figure 1: Comparison of specific TN emissions in kg/ha/yr and the Gross domestic Product (GDP) in $ for the countries in the DRB (GDP data: World bank, for the year 2005, see also ICPDR (2009)).

Results

For TP the targeted reduction goals can almost be reached with the baseline scenario (12% reduction) if a total ban of phosphates in detergents is fulfilled. Considering further measures to reduce soil loss an additional reduction of 5-10% is feasible. For TN reduction goals will not be reached with considered scenarios. By the baseline scenario a total reduction of 11% was calculated. A reduction of emissions by changes in N-surplus will only amount to 1-2% as for most of the lower Danube countries in future an intensified agriculture, with increased N-surplus is assumed. A reduction of N-surplus by 10 kg/ha/yr for the entire DRB would result in annual costs of 300-500 Mio. €. A reduction of the atmospheric deposition by 10 % would approximately cost 100-150 Mio. € per year. These two measures only represent a fraction of possible measures but already show that immense costs will arise from the implementation of these measures. Assuming mean costs between 15 and 25 €/kg/yr in total the implementation of the measures to reach a 40% reduction of TN emissions would sum up to 4.8 to 8.1 Billion € per year.

The critical point will not only be to achieve the reduction of the emissions but even more how to distribute the costs between the countries. Figure 1 suggests a strong link between economic welfare (expressed in GDP) and high nutrient emissions. How will the likely increase of GDP in lower Danube countries influence their emissions? Is a reduction of emissions in countries with high GDP linked to their GDP? Is a reduction of the emissions by 40% achievable by quantitative changes or is a qualitative change in agricultural practices needed?

References

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