Restoration of wetlands and their nutrient removal potential: Danish experiences

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Abstract

In 1998, the Second Action Plan on the Aquatic Environment passed the Danish parliament, and one of the measures was to restore 16000 ha of freshwater wetlands in order to remove 5600 tonnes nitrogen, i.e. on average 350 kg N ha^{-1} $year^{-1}$. The wetland restoration programme was meant to take place during the years 1998 to 2003. Total costs was imputed to DKK 500 million (EURO 67 million) with DKK 400 million allocated to compensation and construction works, and DKK 100 million to preliminary investigations, administration and monitoring.

At the mid-term evaluation of the Second Action Plan on The Aquatic Environment it appeared that only 90 ha wetland had been restored (Grant et al., 2000). The two main reasons were that in most cases the maximum compensation of DKK 25.000 per hectare was too low and that carrying out a restoration project was much more complicated and time consuming in practice than expected. Consequently a new governmental notice (no. 784, 1 September 2001) was issued allowing exemption from the maximum compensation of DKK 25.000 as well as exemption from the minimum nitrogen removal rate of 200 kg N ha^{-1} $year^{-1}$. In 2003 the wetland restoration programme was prolonged until the end of 2006 and as a consequence of higher compensation to landowners, it was expected that only about 8000 ha would be restored.

Today approximately 7000 ha of land have been restored. Although the wetland restoration programme has been closed there are still projects which have received funding and are under construction. Thus, it is expected that yet 1000 - 2000 ha will be established as a result of the Second Action Plan. A monitoring programme for surveying the effects of the restoration of the wetlands has been set up. The programme includes basic data on land use and surveys of environmental effects and natural values.

Re-established shallow lakes cover 2985 ha, while a variety of different wetland projects ranging from areas irrigated with drainage water to restored river valleys including remeandered rivers cover 3844 ha. Based on different empirical equations and preceding small scale projects the mean nitrogen removal for all projects has been estimated to 259 kg N ha^{-1} $year^{-1}$.

Results from the monitoring programme revealed that wetlands remove between 39 and 372 kg N ha^{-1} $year^{-1}$, and areas with shallow lakes remove 40 – 254 kg N ha project area $year^{-1}$. As N-removal only was measured in the lakes and not in surrounding wetlands and meadows the latter figures are underestimated.

Retention of phosphorus has been surveyed in 8 lakes and 8 wetlands, and 2 lakes and 2 wetlands showed net release of phosphorus. Measured retention rates for lakes varies between -2.3 and 16.2 kg P ha $year^{-1}$ and between -0.5 and 12 kg P ha $year^{-1}$ for wetlands. Leaching of phosphorus is possibly due to construction works, senescence of terrestrial plants, and adaptation to changes in redox conditions. It is believed that all projects in the long-term will retain phosphorus

It can be concluded that in its initial phase, the wetland restoration programme suffered from unrealistically low compensations to landowners. Carrying out wetland restoration projects in practice is time-consuming because several rules and regulations have to interact, contact to landowners is labour-intensive, and planning and construction work also takes time. 8 – 10 years would be a more realistic time-schedule for such comprehensive restoration projects. Calculated nitrogen removal rates for both wetlands and shallow lakes vary around 260 kg N hectare year, and measured nitrogen removal rates seem to be in accordance with estimated rates although some

variation are seen. Variations in measured nitrogen removal are primarily a result of variation in climatic conditions (dry and wet years).