

## SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

**Action number: CA15206 Payments for Ecosystem Services (Forests for Water)**

**STSM title: Woodlands for water PES schemes review in Denmark**

**STSM start and end date: 22/08/2019 to 04/09/2019**

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**Host: Prof. Mette Termansen, Department of Food and Resource Economics, University of Copenhagen, Denmark**

### PURPOSE OF THE STSM:

The aim of the STSM was to identify woodlands for water payments for ecosystem services (PES) schemes in Denmark. There was also carried out the analysis of the public policy and current situation of the PES in Denmark, reviewed the information collected on public-private and public-public PES schemes related to woodlands and water in Denmark and the cost effectiveness analysis for the nitrate and pesticide reducing measures of afforestation in an area in the vicinity of Aalborg Municipality in northern Denmark. The following combination of scientific methods and approaches such as consultations and interviews with host scientists, literature reviews and analysis of collected data were used in order to achieve the aim.

### DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

The STSM at the Department of Food and Resource Economics (Institut for Fødevarer- og Ressourceøkonomi), Copenhagen University, Denmark lasted for two weeks. During the first week detailed PESFOR-W's literature reviews and analysis of existing W-for-W PES case studies in Denmark as well as the review of the cost effectiveness analysis for the nitrate and pesticide reducing measures of afforestation in an area in the vicinity of Aalborg Municipality in northern Denmark were done. The second part of STSM was dedicated to (i) collection of key data, including the area of afforestation, afforestation costs, subsidies (including private, public and from the EU), data of nitrate reduction from afforestation and other financial and socio-economic information on W-for-W PES schemes in Denmark; and (ii) preparation of the scientific report.

### DESCRIPTION OF THE MAIN RESULTS OBTAINED

The main environmental problem related to groundwater resources in Denmark is the threat of groundwater pollution stemming from pesticides and fertilizers used in agriculture<sup>1</sup>. While this problem has already existed for several decades, some improvements have been achieved in the near past

<sup>1</sup> Danish Ministry of the Environment, at <http://www.geus.dk/publications/grundvandsovervaagning/grundvandsovervaagning-uk.html>.

through the implementation and enforcement of several policy and legal instruments to address in particular the pollution through pesticides and nutrients, such as nitrates and phosphorus.

In view of the impacts of agricultural and urban ecosystems on groundwater bodies, the importance of forests for the quality of groundwater resources has been better understood over the years. It has been recognized that forest cover is beneficial for water protection as the quality of forest waters is generally good. Nevertheless, air pollution and some land management practices may still have negative effects on the groundwater resources. Watershed management must therefore focus more on integrating water and biodiversity concerns.

In Denmark a few public and public-private woodlands for water PES schemes were identified. The first case study is the site with the longest history developed in the municipality of Aalborg to mitigate nitrate pollution in the drinking water resource. The parties involved in the scheme are the municipality and Aalborg Water Ltd. and a groundwater protection cooperation Aalborg. A large number of groundwater production wells have been closed mainly due to high levels of nitrate. In the entire municipality 1500 ha of land has been involved in different forms of water protection measures. The main aim is to stop agricultural land use on specific areas - close to water extraction points and areas with the largest potential for improving the groundwater quality (protect the water catchment area). In some areas contracts for permanent grassland (with no use of fertilizers/pesticides etc.) are established; in other areas (e.g. the Drastrup area) afforestation is used as a permanent land use change (areas where the co-benefits of afforestation are large e.g. close to urban areas, regions with little forest etc.). In areas where afforestation has been selected, the afforestation has also been subsidized by the state, and the area has in some regions been bought by the municipality. This varies between areas. In the areas converted to permanent grassland the farmer maintains the ownership, in areas where a larger afforestation project is established, the municipality ends up owning the land, but private afforestation could also take place. The starting point for implementation of the schemes has been attempts to negotiate voluntary contract with the farmers, however, if this has not been achieved, the municipality has had the authority to enforce a ban on the use of fertilizers/pesticides on areas of particular importance for groundwater resources. The Aalborg case study is ongoing over several years e.g. Drastrup Forest was established in 2002 as one of the early forests for water protection. The public water company Aalborg Water Ltd has paid approximately 13 000 EUR/ha for these measures.

Another example of a PES scheme is based on the state policy to double the country's forest area within a sixty to hundred years' time period. In this case, public water companies have entered into a contract with public land owners (the Danish state and local municipalities) who change their forest management practices, or are engaged in large scale afforestation projects in watershed areas so that they preserve water quality. One such afforestation project has been initiated, for example, in 2001 near Odense, Denmark's third largest city. The Danish Forest and Nature Agency has cooperated with Odense municipality and the local waterworks to establish more than 2000 ha of new forest close to Odense. This new forest shall strengthen the recreational possibilities as well as protect the important drinking water resources located in this area. The time frame of these agreements between the state, the municipalities and the waterworks is 30 years with a periodic review every 5 years. In the scheme between the waterworks company and the state about 2 million EUR/year is paid to buy agricultural land and start afforestation. The farm land can be bought at around 10 000-15 000 EUR/ha and afforestation costs may be another 5 000 EUR. For changing the diversity of existing forests, up to 100 EUR/ha has been paid to forest owners, depending on the particular contract (Greiber et al, 2009). In order to fund these activities, based on the Water Supply Act a levy on the water price is charged to the water consumers. The money raised is and invested in afforestation projects with the state and municipalities implementing them in public forests. This PES scheme regarding public forests can be characterized as a public PES. The main stakeholders here are the private water consumers who pay a levy and thus buy the environmental service of water purification, the Danish state and the local municipalities which provide this service through their public forests, and the water supply companies or waterworks corporations who again play the role as an intermediary working together with the state and the local municipalities in order to develop and implement afforestation plans.

Another public PES scheme is groundwater protection area of Bolbro and Eksercermarken Wellefield that was established in 2001 and has been expanded over the years. Partnership between VandCenterSyd Denmark, Odense Municipality and the Nature Agency. Joint financing of municipal and state funded afforestation. Approximately 380 ha acquired for afforestation through land consolidation. Voluntary participation of landowners. In total the project of Elmelund forest costs 15.8 mill. EUR out of which the public water company (VandCenterSyd) paid 9.3 mill. EUR, the municipality of Odense - 1.2 mill. EUR and the Nature Agency under the Ministry of Environment - 5.3 mill. EUR. The large task of the land consolidation process and the practical agreements, negotiations etc. with farmers have been carried out (financially) by the public water company.

From the other hand, public-private agreements started after 2000. For example, Copenhagen Energy Corporation delivers drinking water to around one million consumers in and around the municipality of Copenhagen. During the last twenty years Copenhagen Energy has lost about 14 million m<sup>3</sup> of groundwater per year. One of the largest groundwater bodies used by Copenhagen Energy is the Vigersted well field from which also ca. 5 million m<sup>3</sup>/year are abstracted. This is equal to the consumption of 100 000 Copenhageners per year. It has therefore been very important for Copenhagen Energy to protect this groundwater body through afforestation measures and the designation of wellhead protection zones where no pesticides are used. A privately owned forest is located just next to the Vigersted well field used by Copenhagen Energy. In order to secure the quality of the groundwater resources found in this area, an agreement has been made between Copenhagen Energy and the owner of the forest. Through this voluntary agreement the private forest owner is now obliged to set aside 95 ha of his forest where in the future no pesticides may be used. In addition, Copenhagen Energy was able to buy 530 ha of farm land on which broadleaf trees were planted. Afforestation activities were implemented and managed by the state and local municipalities. In the case of Copenhagen Energy, a fund has been set up by the water company itself in order to finance the provision of the environmental services. The average consumer pays about 10 EUR/year to the fund. Copenhagen Energy has calculated to pay ca. 1.5 million EUR in total (Greiber et al, 2009) for setting aside 95 ha of private forest. The forest owner will be paid on a yearly basis for reducing the use of pesticides. In case of non-compliance with his contract obligations, the forest owner will be fined. This PES scheme can be characterized as a public-private PES scheme. In this case, the environmental service of improved groundwater quality is provided by a private forest owner who eliminates pesticides in his forest, as well as private farmers who sell their land so that it can be afforested. These private persons are compensated by other private persons, namely the customers of Copenhagen Energy who consume the supplied water, and are the ones who contribute to Copenhagen Energy's fund. Copenhagen Energy again plays only the role of an intermediary in this scheme that collects the money from the clients, and afterwards invests the funds as an incentive for private land owners to change their forest management behaviors or sell their agricultural land.

Another public-private PES scheme is an afforestation partnership in Denmark between a water utility and a private partner called Brylle forest for water (Brylle vandskov) was established in 2017 by the Ministry of Food and Environment in Denmark and it is utilizing the state's subsidy scheme for afforestation on private land. VandCenterSyd and the large company Hedeselskabet have established a partnership with the aim of protecting water catchment areas close to the city of Odense, Denmark, in order to secure clean groundwater for drinking purposes in the future and carry out an afforestation project which under the Danish legislation means that the area has to remain forest land in perpetuity. Hedeselskabet is the owner and manager of the afforestation and land in the future. Acquisition of farmland has been carried out through land consolidation over time. The project has been established through voluntary participation of land owners. VandCenterSyd Denmark contributes with 60 % of the acquisition costs. Hedeselskabet are responsible for afforestation, operation and maintenance. The forest is established with both water protection, recreation, amenity values and timber production in mind. The public water company VandCenterSyd has paid approximately 19 000 EUR/ha (and they estimate that the process has made up 30% of these costs). The total area is 132 ha and the area of afforestation created by the case study – 112.6 ha. Private forest management company Hedeselskabet is getting EU subsidies – approx. 250 EUR/ha/year, other subsidies for private afforestation – 4 250 EUR/ha.

So, voluntary public-private and public arrangements have been established which are mainly funded by the private water consumers who pay more on their water bills. With these funds, water companies invest in afforestation and sustainable forest management by buying land or by paying private forest owners to ensure the required practices on a voluntary basis.

In welfare economic analysis the EU subsidies should also be taken into account. However, the Rural Development Programme has just changed the possibilities of receiving afforestation subsidies. Today it is only possible for private owners of agricultural land to receive subsidies. It is no longer possible for public authorities – in this case the Municipality of Aalborg – to receive subsidies<sup>2</sup>. So, in 2007-2013 total subsidies for first afforestation of agricultural land were 39.9 million EUR, of which paid by European Agricultural Fund for Rural Development – 14.32 million EUR (Ministry of Food, Agriculture and Fisheries, 2012).

According to the Danish Rural Development Programme 2007-2013 afforestation in Denmark absorbs approx. 10 tons/ha of CO<sub>2</sub> yearly and the loss of N emission from agriculture will be reduced by approx. 50 kg N/ha. In the paper (Konrad, M. et al, 2017) the level of climate change regulation has been estimated at a CO<sub>2</sub> price of 50 EUR/ton and in other research the level of water quality

<sup>2</sup> Danish Forest and Nature Agency (2007): Privat Skovrejsning Tilskud, Vejledning, 2007 [www.skovognatur.dk/Service/Tilskud/PrivatSkovdrift/Skovrejsning](http://www.skovognatur.dk/Service/Tilskud/PrivatSkovdrift/Skovrejsning).

could be estimated as the average cost-effect ratio of the cost minimization solution - 7.3 EUR/kg N (Konrad et al, 2014).

It is possible to estimate the recreational value of afforestation by the hedonic price method. This means that the recreational value of the forest is highly dependent of the house prices and the number of houses. The recreational value of Drastrup is 19 592 EUR/ha (Hasler et al, 2002). However, the hedonic method does not capture the recreational value from persons who do not live close to the forest. The contingent valuation method has been used to estimate the total value of forest visits 22 EUR or 0.7 EUR per visit (Watercost, 2008). Also the predicted recreational values per site based on fixed parameter model and mixed logit model (Termansen et al, 2013) vary between about 2 thousand and 2 million EUR/year. On a per hectare basis for forest sites utilized for timber production (larger than 100 ha), the predicted recreational values vary between less than 20 to more than 7500 EUR/ha/year. This illustrates that for some sites the recreational values contribute significantly to the overall generation of economic benefits.

Besides the previous benefits getting from afforestation on agricultural lands, quantifying costs of land use change include, in addition to the gross margin, establishment costs as well as an expected future income from forestry. These costs and income differ across the country and are combined in the net present value. The annualized net present value of forestry ranges between 134 and 179 EUR/ha/year, dependent on forest region (Konrad et al, 2017).

### Conclusions

On the basis of the review of Woodlands for water PES schemes in Denmark the following conclusions have been drawn:

In Denmark there exist special supporting policies that strengthen afforestation efforts and sustainable forest management for the protection of groundwater. However, these are mainly focused on publicly owned forests while the majority of forest land in the country is privately owned. In addition, voluntary public-private and public arrangements have been established which are mainly funded by the private water consumers who pay more on their water bills. With these funds, water companies invest in afforestation and sustainable forest management by buying land or by paying private forest owners to ensure the required practices on a voluntary basis.

In welfare economic analysis the EU subsidies should also be taken into account. However, the Rural Development Programme has just changed the possibilities of receiving afforestation subsidies. Today only private owners of agricultural land can receive subsidies while public authorities are no longer subsidized.

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