COST-Action ECHOES

Expected Climate Change and Options for European Silviculture

COUNTRY REPORT FOR THE NETHERLANDS

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Introduction

The Netherlands has a small forest area (360 000 ha). This however, makes its resources very precious. The growing stock is increasing while the harvest is approximately stable. The total forest area increases marginally. Around 1/3 of the forests are state-owned, 1/3 is private and 1/3 is owned by municipalities and nature conservation agencies (each 50%). Nearly all forests are open to the public and Dutch forest visitors are involved in forest management. This requires good communication about forest management to the public.

Forest management is financially supported through detailed target oriented systems that require intense monitoring. Still, forestry is clearly not a very attractive activity in economic terms. The Dutch forests are rich in cultural historical perspective, but are loosing biodiversity values because of pressures from outside the forests. It is unknown yet if forests are fit to adapt to climate change. Generally the forest management is in a state of transition to a closer to nature forestry. This is executed in a system where limited investments in the forests are being.

Wood harvesting has a negative image, and the public does not see the forest as a natural resource. Also due to the limited forest area the national harvest fulfils a clear minority of the consumption. The ownership is fragmented and is often not business oriented. Forest owners rely more and more on natural regeneration of forests. There is limited insight in the future wood quality of this naturally regenerated forests. The small forest area and the reliance on resources elsewhere, requires attention to European and tropical issues.

In the Netherlands, being a delta of several major rivers, changes in peak discharge of water, and changes in water regimes are the presumed impacts of climate change that receive largest attention. Impacts on forests has received little attention. Forestry in the Netherlands focuses on 4 themes: nature conservation, historic landscape conservation, recreation and production. The dominant species in Dutch forests is Scots Pine (*Pinus sylvestris*), covering approximately 40% of the forest area. Other important species include Oak (*Quercus rober* and *Q. rubra*), Beech (*Fagus sylvatica*), and Birch (*Betula pendula*). An important invasive species is the Black cherry (*Prunus serotina)*.

I. Impacts

I.1. Observed impacts
Flooding and drought are among the two major impacts that are currently observed in the Netherlands. Although they seem contradicting impacts, they are related. Peak discharges by the rivers are the major cause for flooding, but because of less continuous water flow, droughts can occur during the summer. Also in agricultural areas, efficient draining for agriculture conflicts with the nature objectives of many forest managing organisations.

I.2. Expected impacts

Although projections for future climate are uncertain, the expectation is that winter rainfall will increase while summer rainfall will become less certain. In combination with efficient drainage for agricultural purposes, droughts in summer can become more likely. apart from water availability, storm damage is an issue that becomes more important in Dutch forestry.

In 2008 a study was conducted to the potential impacts of climate change on Dutch forests (Verkaik et al. 2009). To deal with the uncertainty of the future climate, the effects of the four, so called KNMI'06 climate scenarios (Van den Hurk et al. 2006) were studied. These four scenarios combine two different levels of mean global temperature rise (+1ºC or +2ºC abbreviated with G and W) with two anticipated atmospheric circulation regime changes; a strong and a weak change of circulation. A main difference between the four scenarios is the precipitation which is expected in summer. In the two scenarios without a changing atmospheric circulation pattern (G and W scenarios), the potential evaporation in summer is expected to increase with a few percent, but so is the amount of precipitation. In the two scenarios with a change in the atmospheric circulation pattern, the potential evaporation is expected to increase with 8 to 15% in summer while the amount of precipitation is expected to decrease with 10% (G+) or even 19% (W+) in summer (Van den Hurk et al. 2006). In this impact study, the following aspects of climate change were taken into account: decreased water availability during the growing season in case of increased drought, increased soil water levels in case of increased summer precipitation, the incidence of forest fires, salinization and insect infestations. A literature review was conducted to evaluate the sensitivity of Dutch tree species to these aspects of climate change and the information from literature was combined with information on the composition of the Dutch forests and with information on the exposure of these forests to the different aspects of climate change.

The results of this impact study indicated that if drought events occur more regularly in future, this would have a negative impact on the growth of a large proportion of the Dutch forests. The potential impact of the aspects forest fire, rise of the groundwater level and salinization were smaller. Insect pests were expected to become more abundant under climate change. The potential impact of climate change appeared to be largest on elevated sandy soils in the Netherlands, since the aspects drought, forest fire and a rise of the water table all might have an impact in these areas. On the clay and peat soils in the western and north-western parts of the Netherlands, increased salinization during droughts might have a negative impact on trees (see Figure 1). The potential impact of the different aspects was expected to be especially large under the climate scenario W+ (Verkaik et al. 2009).

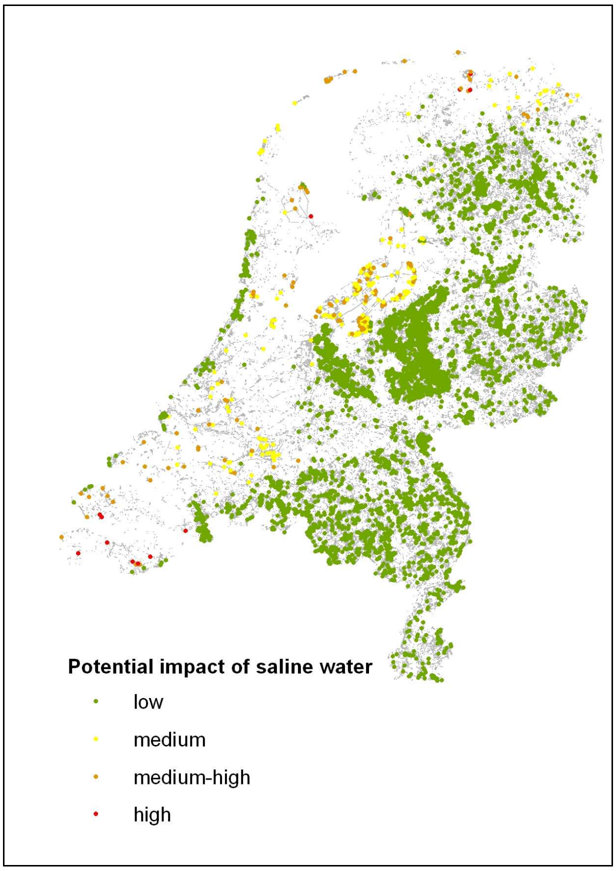
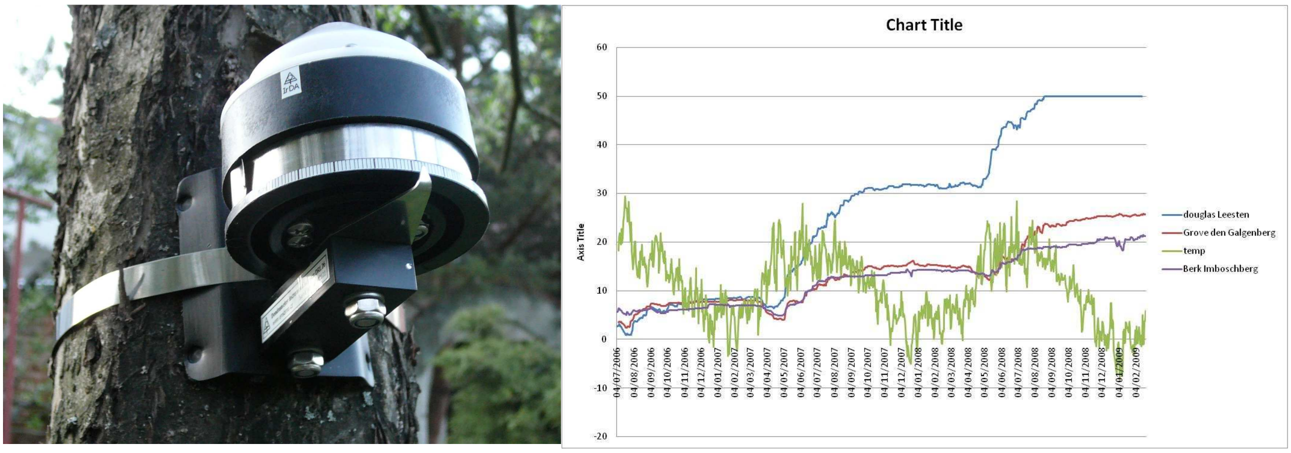


Figure 1. The potential impact of saline seepage water to trees in the Dutch forest inventory plots (from Verkaik et al. 2009).

I.3. Impact monitoring

No integrated research programmes on impacts have been carried out so far. Instead several ad hoc studies have been done, such as on phenology monitoring (www.natuurkalender.nl) , or simulation studies of forest dynamics under climate change. Furthermore, several eddy flux sites provide insight in daily behaviour of some forest sites. With sap flow measurements, Van der Werf looked into drought vulnerability and acclimation by beech and oak.

Forest responses to drought and other extremes are monitored since 2007 with automated dendrometer increment sensors. These are placed at 22 sites on 110 trees in total; see Figure 2). These devices measure the tree circumference every hour, providing insight in growth of trees. Both short term responses to extremes will become visible as well as long term trends in growth. Preliminary results show interesting responses of trees to temperature and rainfall (see Figure 2).



A B

Figure 2 **A) Dendrometer, and B) results of three years of measuring on three trees.**

I.4. Impact management

Forest managing organizations as well as the Dutch government focus on water storing capacities of forests to create buffers for peak discharges by rivers in the spring season. This involves scaling up of nature areas, connecting existing nature fragments, and assigning overflow areas that can store excess water when needed. Most of these overflow areas will have a nature function, resulting in interesting riparian vegetation structures with their own adaptations to flooding, although some agricultural areas are also assigned as overflow area.

An important target in Dutch nature conservation is to increase natural areas with 75.000 ha in 2020, in line with a natural network. The idea is to connect nature areas. Given the new problems with river peak discharges, connecting nature along existing water systems is an interesting option receiving much attention. Nature area increase is achieved by land acquisition by both the state forestry and the NGO's, like natuurmonumenten (the biggest landowner after the state forestry).

Damage as a result of storm is sometimes seen as an opportunity. Storms create structural diversity in forests and give opportunities to pioneer plant species and insects and other organisms tat associate with these species. Also, the debris wood is left in the forests after a storm, giving opportunities to species that are living of dead wood, including many fungi and insects. Modelling studies reveal which management may cause the least risk of storm damage, however, implementation in practice is not happening. The fire risk is very small at the moment. Even though with increased summer droughts this will increase, the damage will probably stay small because the forests are very accessible to fire fighters.

II. Adaptation

II.1. Vulnerability of forests and forestry

Forests in the Netherlands will mainly be vulnerable to effects of summer drought, because many sites consist of poor sandy soils where the water table can drop deep during a summer drought.

II.2. General adaptation strategy or policy

For flooding problems, overflow buffer areas are assigned, and synergy is sought to do this in cooperation with the goal to increase the natural areas with 75.000 ha. Apart from flooding, water table management is applied to prevent severe drought effects on natural areas. No specific policy for adaptation of forest and other nature areas exist.

II.3. Forest adaptation measures

Specific adaptation measures for the Dutch forestry sector mainly focus on drought and/or resistance to drought of tree species. For regeneration, research advocates to be more restrictive in planting Douglas fir (Pseudotsuga menziesii) and Norway spruce (*Picea abies*) because of their susceptibility to drought, while under warmer climates the possibilities for growing for linden (*Tilia*) and ash (*Fraxinus*) may increase. There are opportunities for Hornbeam (Carpinus) on sites with stagnating groundwater. Finally, the forestry sector aims more at flexibility in forest management to adapt timely to changing conditions. However, so far no studies have been carried out in this field. It is mostly expert knowledge that is being used.

II.4. Research studies on forest adaptation

At the Forest Ecology and Forest Management group of Wageningen University, research is being conducted to study combined effects of flooding and summer drought on pedunculate oak (Quercus robur). Pedunculate oak is frequently growing in both riverine forest and man-made water-retention areas. Flooding of pedunculate oak during spring can result in a drastic reduction in earlywood-vessel area, in those parts which are actually flooded (Sass-Klaassen et al., in prep). Up to now, no studies are available on possible consequences of these local reductions in vessel area, on tree physiology and drought tolerance.

To fill this gap a joint project in co-operation with the Dendro Sciences group (WSL, Switzerland) and the Wageningen NMR centre (WUR, Netherlands) has been established. The main goal of the project is to investigate the effect of spring flooding and summer drought on young potted trees, using a joint approach where wood anatomical research is combined with non-invasive Nuclear Magnetic Resonance (NMR) imaging, stomata, and photosynthesis measurements.

III. Mitigation

III.1. Carbon accounts

For GHG reporting of the LULUCF sector, the Netherlands has developed and improved an overall approach within the National System since 2003. This LULUCF part of the National System has been deployed for the National Inventory Reports (NIR’s) since 2005, covering the period since 2003. It was also used for a full recalculation of the period 1990 – 2003. This LULUCF part of the Dutch National System has been documented in several publications. See e.g. Nabuurs et al. (2003, 2005), De Groot et al (2005) and Kuikman et al. (2003; 2005).. In the first years after development, several improvements and updates were implemented as described in Van den Wyngaert et al. (2007)

The system has gone through a series of reviews since then (see Van den Wyngaert et al., 2007). In 2007, an in country review was held by the UNFCCC (see also chapter 3). Both reviews indicated limited transparency for some parts and a need for further updating and improvement.

The system was based on the establishment of a land use and land use change matrix for the period 1990-2000 based on topographical maps (chapter 4; see also de Groot et al. 2005 for motivation of topographical maps as basis for land use calculations).

The maps for 1990 and 2000 were gridded in a harmonised way and an overlay produced all land use transitions within this period (Nabuurs et al., 2005).

The carbon balance for forests remaining forests was based on National Forest Inventory (NFI) data, as were the emission factors for emissions through changes in forest area (Nabuurs et al., 2005). NFI plot data were available from two National Forest Inventories: the HOSP dataset (1988-1992; 3448 plots) and the first two recording years of the MFV dataset (2001-2002; 1811 plots out of 3622 plots in total). For other components, more simple assumptions were made, e.g. with emissions factors for deforestation, and build up of carbon in the litter layer.

Table 1. Part of the table 5 as submitted to UNFCCC

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**Net CO_2 emissions/removals[(1), (2)]**
	(Gg)
Total Land-Use Categories	**2,537.23**
A. Forest Land	**-2,741.91**
1. Forest Land remaining Forest Land	-2,167.08
2. Land converted to Forest Land	-574.83
B. Cropland	**47.69**
1. Cropland remaining Cropland	NA,NE
2. Land converted to Cropland	47.69
C. Grassland	**4,788.24**
1. Grassland remaining Grassland	4,246.00
2. Land converted to Grassland	542.24
D. Wetlands	**55.38**
1. Wetlands remaining Wetlands [(3)]	NE
2. Land converted to Wetlands	55.38
E. Settlements	**291.85**
1. Settlements remaining Settlements [(3)]	NE
2. Land converted to Settlements	291.85
F. Other Land	**24.91**
1. Other Land remaining Other Land [(4)]	
2. Land converted to Other Land	24.91
G. Other *(please specify)*[(5)]	**71.08**
Harvested Wood Products[(6)]	NE
Lime application in all land use categories	71.08
Information items[(7)]	

Forest Land converted to other Land-Use Categories	962.05
Grassland converted to other Land-Use Categories	-312.23

III.2. Forestry as a source of bioenergy

The two currently operational major bio-energy plants of The Netherlands (Cuijk and Lelystad) require some 280.000 ton (ca. 150.000 m3) of wood per year. Currently they mainly obtain their resources from recycled wood, waste wood and pruning material from urban green areas. The share that originates from forests is unclear, although it is known that the National Forest Service supplies around 50.000 m^3

Additional there are several small scale green-energy production sites where sawmill residues, some wood from forest-thinning and top- and branches wood from non forest origin are used. Co-firing of waste wood in coal-fuelled electricity plants is practised and gasification has been tried out on plant scale. Developers and suppliers of dedicated equipment to chip large size wood and combustion units for a wide range of sizes are available for the national and European market.

Several studies looked into available biomass for bioenergy (e.g. Tolkamp et al, 2006 , De Jong et al. 2007). The Jong et al conclude that some 360 000 tonnes of biomass may be available for bioenergy from forests and forest landscape elements.

III.3. Processes, instruments and strategies

The Dutch government has initiated a fund for afforestation, to stimulate carbon sequestration. Otherwise no policies are in place to adapt to climate change, or to mitigate

III.4. Research studies on mitigation

Mainly modelling studies have been carried out. The Dutch groups have been active as well in European scale studies with the EFISCEN model.

IV. Case studies and references

At this moment we do not elaborate on case studies, but provide a list of references for further perusal.

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