COST action FP0703 – ECHOES

Expected Climate Change and Options for European Silviculture

COUNTRY REPORT

SWEDEN

Joint report for *COST ACTION FP 0703 Echoes: Expected Climate cHange and Options for European Silviculture* and the Swedish *Future Forests* programme.[1]

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[1] Parts of the report may be published in an upcoming book chapter by E. Carina H. Keskitalo, Christer Nordlund and Jenny Eklöf, (in prep.) "Climate Change Mitigation and Adaptation in Sweden's Forest Sector: Fuelling Biofuel Development".

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Introduction

While Sweden has traditionally been a leader with regard to mitigation in terms of emission reduction, the last few years have seen also the emergence of an adaptation paradigm through especially the Swedish Commission on Climate and Vulnerability (2007). This report utilizes in particular the Commission report, supplemented with literature such as the 2007 Forest Bill as well as personal communication regarding adaptation and mitigation measures in forest industry. The report focuses in particular on forestry, excluding other forest uses; however, given a tradition of large community forest use for hunting, berry picking and the like, as well as indigenous reindeer husbandry practices in boreal forest and mountain areas, any more complete report would need to include among other things concurrent adaptation and land use practices. Translations from Swedish have been made by the author.

Forest structure

Sweden's total area of productive forest is about 23 Mill. Ha. Of this some 50% is owned by small, non-industrial, private owners (some 350 000 in total) and 40% by large forest companies including the state. The total export value of forestry and forest products makes up about 10% of all exported products from Sweden and about 4% of Sweden's GNP (Swedish Forest Agency, 2008). Pine (39%) and spruce (425) are the most important species for forestry and the forest industry, and production centers on paper, cardboard and to some extent biofuels and wood production (Swedish Commission on Climate and Vulnerability, 2007).

I. Impacts and vulnerability of forestry

I.1. Observed impacts

Observed impacts of climate change can be seen in some unusually warm years during the last 15 years, such as 2006 and 2008. In addition, "the rise in temperatures and precipitation over the past 15 years has been unusually large, from a 100-year perspective" (Swedish Commission on Climate and Vulnerability, 2007). There have also been large storm events, such as Gudrun in January 2005 and Per in January 2007. Storm Gudrun caused storm-felled timber in much of southern Sweden, in total 75 million m3 (twice that of the storms of 1969), equivalent to a whole year of felling for the country as a whole or to ten years of felling in some districts. Gudrun also caused major infrastructural damage and disruptions in electronic, railways and road communications, totaling an estimated cost of SEK 21 billion (of which SEK 11-12 billion to forestry) for the storm. Gudrun can be linked to mild weather with a lack of ground frost which made the storm felling particularly severe. In addition, the structure of the forest, with a composition focused on spruce that to a large extent was felled in the storm, may have effected the severity of impact. Storm Per caused storm fellings of about 16 million m3 in southern Sweden (Swedish Commission on Climate and Vulnerability, 2007). Rot in spruce trees is already considered to cost SEK 500−1,000 million annually through decreasing the timber value, and pine weevil damage as well as elk grazing pressure are also current impacts on forest, resulting in that spruce is chosen on grounds where pine would otherwise have been more beneficial (Swedish Commission on Climate and Vulnerability, 2007).

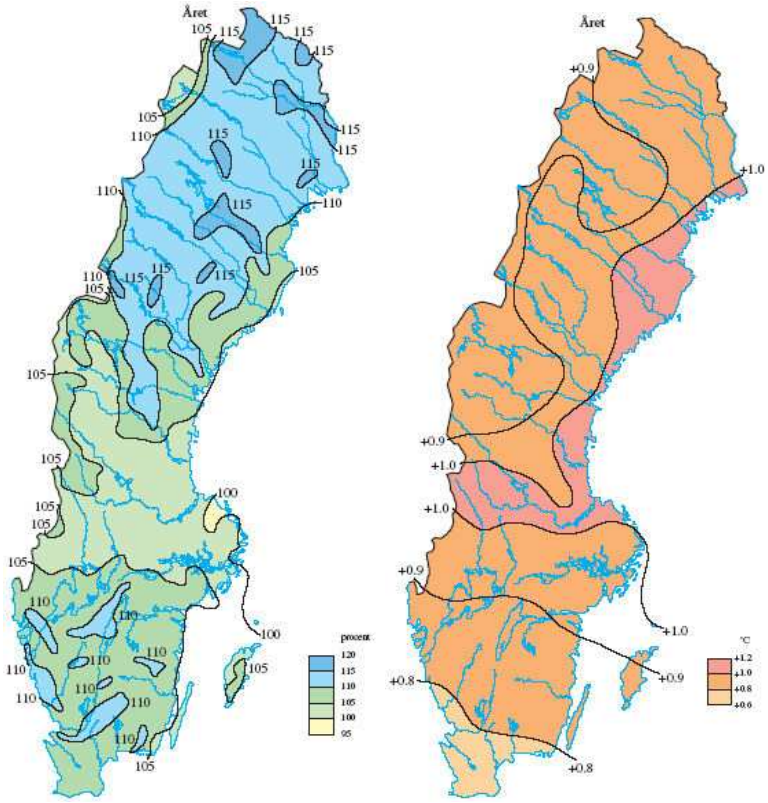

Figure 1: The figures indicate, respectively, the relationship between annual precipitation and annual temperature 1991-2005 to a comparison period 1961-1990 for Sweden. Source: Reproduced from SMHI, 2009.

Forest industry representatives have also noted that wetter winter grounds may result in larger risks for windfall, and that shorter winters may potentially result in higher survival of game (increasing grazing damages) (pers. comm., KSLA Conference 2009). Previous studies of stakeholders' perceptions of weather and climate change describe that some persons who have been working in forestry for a long time (20-30 years) note differences between present conditions and those when they started working. In a study in southern Norrbotten county in northern Sweden, stakeholders noted among other things warmer temperatures, sometimes less snow in the area as wind patterns have changed, and that there are shifts in seasons. For instance, while Easter have in the area traditionally been seen as the time to leave winter roads due to thawing, thawing incidents have during the last few years from about year 2000 occurred during winter and sometimes resulted in that already logged wood cannot be accessed for transport out of the area. Similar changes were noticed in the autumn, with lower reliability as to the dates when winter roads and softer grounds are frozen sufficiently to be accessed for logging (Keskitalo, 2008a).

I.2. Expected impacts

Expected impacts of climate change include both positive impacts (increased growth) but also potential disruptions and negative impacts. In generally do projections indicate warmer climate and increased occurrence of extreme events, precipitation increase in winter, a longer vegetation season, new tree species and northwards expansion of existing broadleaf (oak and beech), and disruptions through storms and pests. Warmer climate and longer vegetation season as well as new tree species will increase growth. Pine, spruce and birch growth rates may by 2100 be 20-40% higher than today. The highest growth rate increase is expected in northern Sweden, whereas drier summers may negatively impact spruce growth in southern

Sweden. “Spruce and birch will become more competitive compared to pine in Norrland, while the reverse is true in Svealand and Götaland. In the south, drier summers will mean that an increase in growth as regards spruce will change to a decrease during the latter part of the century” (Swedish Commission on Climate and Vulnerability, 2007). The increased growth will result in increased earnings in forestry and forest industry, and could be added to by rotation periods being shortened and by potential cultivation of species for which the climate is currently restricting the northern limit, such as oak, beach, and hybrid aspen and poplar for biofuel. To impede grazing by cloven hoofed game, which is expected to increase and thereby increase grazing pressure in a further climate, fencing may need to be increased to some cost. Conditions for non-native conifers such as hybrid larch, Sitka spruce and Douglas fir that are already cultivated may improve. With increased growth, conifer wood density will, however, decrease, resulting in potentially poorer quality although larger dimensions if logging cycles are maintained. In southern Sweden (Götaland and Svealand), reduced summer precipitation is expected to disadvantage especially drought-sensitive species such as spruce and birch while advantaging pine and oak.

The Swedish Commission on Climate and Vulnerability notes that: “Damage to forests is primarily caused by insects, fungi, grazing animals, storm winds and heavy wet snow” (Swedish Commission on Climate and Vulnerability, 2007). The increasing growth rate and taller trees may increase storm felling even in the absence of increased storm rates. Spruce and then pine are the most storm sensitive species. The potential for increased extreme weather events and storms in particular in southern Sweden, decreases in ground frost and wetter winters will also increase storm risks and make logging more difficult, both by impeding logging by decreasing access on winter roads and on softer grounds as well as impeding transport. Heavy and wet snow may also become more common in northern Sweden, increasing snow breakage. Warmer and wetter conditions will also increase fungal and insect pressure. Root rot on spruce due to the bracket fungus may also increase and spread throughout much of the country with warmer temperatures, and require increased forest management actions in particular during thinning. Pine weevil attacks (currently estimated that it would cost SEK 0.5–1.0 billion annually untreated, with countermeasures on plants costing some SEK 100 million annually) and spruce bark beetle may increase, in particular as the spruce bark beetle may be able to swarm several times per year. The pine processionary moth and pine wood nematode currently not existing in Sweden could also potentially spread to Sweden in a warmer climate. Costs for combating forest fires, which in Sweden have only averaged some SEK 7-8 million annually, may also increase to as much as SEK 200-300 million annually in southern Sweden (Swedish Commission on Climate and Vulnerability, 2007).

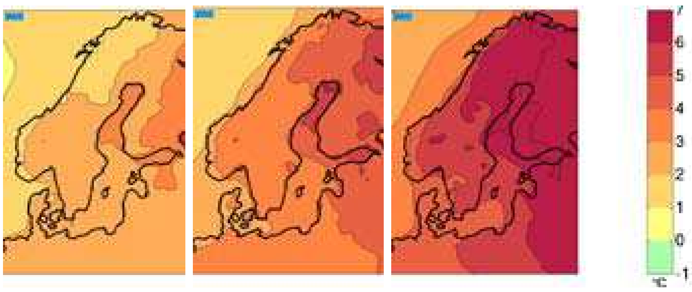

Figure 2: Changes in average temperature in January, in 2020, 2050 and 2080, respectively (RCA3-EA2). Source: Reproduced from Swedish Commission on Climate and Vulnerability, 2007, p. 161.

These sorts of impacts have been noted also by Swedish forestry representatives who to a large extent described corresponding risks (pers. comm., KSLA Conference 2009), and who especially described concerns about windfall especially as wetter winter grounds result in larger windfall risk, and about shorter winters potentially resulting in higher survival of game (increasing grazing damages).

I.3. Impact monitoring

The Swedish Commission on Climate and Vulnerability notes that a number of monitoring measures are needed. In particular does climate change issues need to be included in forest-related training and in education and communication with individual forest owners by the Swedish Forest Agency's regional organisation and forest sector organizations (the investigation noting in particular the need for separate resources to the Swedish Forest Agency for an information campaign). "The deregulated forestry policy means that, to a large extent, it is the forest owners' own decisions now and over the next few decades that will govern the state of the forest this century, which is extremely important for one of our most important business sectors as well as for other social functions" (Swedish Commission on Climate and Vulnerability, 2007).

The investigation also notes the need for increased knowledge about local variations in climate, methods for spreading risk including mapping the suitability for different tree species over geographical areas, adaptation measures for practical forestry, broadleaf tree management, mixed stands and new species, dynamics determining wind damage and tools for minimizing such damage, forest fire, and population dynamics and adaptations in regard to pests and game increase. In addition are technical developments needed to minimize logging damage on unfrozen ground, and to assure that adaptation measures in forestry do not have negative impacts on biodiversity (ibid.).

I.4. Impact management

The Commission on Climate and Vulnerability proposes several measures beyond existing state financing of fire and airborne monitoring of damage. These include that:

- The instruction for the Swedish Forest Agency should be amended to responsibility for adaptation to a changed climate (reinforced in the Climate Bill; see Swedish Government, 2009).
- The Swedish Forest Agency should be commissioned to lead a review of the Forestry Act and the Agency's associated directives and general advice with respect to climate change, and assess whether the environmental objective Healthy Forests is affected by climate change parameters
- The Swedish Forest Agency should in consultation with the Swedish University of Agricultural Sciences develop a system for monitoring and evaluating damage and costs of climate-related parameters such as game, storms and insects, and establish trial areas for tree species selection and management
- The Swedish Forest Agency should undertake an information campaign to forest owners on climate change (for this being attributed SEK 10 million over three years

II. Adaptation

II.1. General adaptation strategy or policy

Swedish adaptation to climate change with relevance for forestry is treated mainly in the Commission on Climate and Vulnerability (2007) and its sub-reports. In addition, the Climate Commission (2008) and the climate bill (Swedish Government, 2009) are important sources. Sweden's climate policy has traditionally focused on mitigation, which is described in a number of sources, including Swedish Ministry of Sustainable Development (2005) and Swedish Government (2005, 2001). The Swedish perspective on adaptation has also to a larger extent focused on developing countries, as evident in the establishment of a Commission on Climate and Development (Swedish Ministry of the Environment, 2008).

The main commission including work on adaptation is thus the Commission on Climate and Vulnerability, appointed in June 2005 following government acceptance of the the proposition National climate policy in global cooperation (prop. 2005/06:172). The commission finalized its report in October 2007: Commission on Climate and Vulnerability (2007). The report as a whole to a large extent focuses on climate change as an additional security threat, and mentions for instance propositions in 2005 on coordination in a crisis situation and the planned development of a coordinated agency on crisis management from 2008 onwards (Commission on Climate and Vulnerability, 2007). Previous to this, the Commission on Climate and Vulnerability notes that there have existed a commission and a proposition on security and awareness (both in 2001); climate change is, however, not explicitly mentioned in these. Funding for climate change adaptation should be developed for larger-scale investments with the aim to decrease vulnerability to extreme weather events and long-term change (Commission on Climate and Vulnerability, 2007). Other roles are also attributed: the state meteorological institute SMHI is made responsible for knowledge development regarding climate change, the Swedish Environmental Protection Agency provides responsibility for following and reporting climate change adaptation, and all sector agencies (for instance, with forestry as one example) are appointed responsibility for adaptation to climate change in their own issue area (Commission on Climate and Vulnerability, 2007; see also the Climate Bill under Swedish Government, 2009).

The investigation report suggests that adaptation to climate change in Sweden needs to start explicitly given the risks for flooding and erosion in many areas. The report suggests that the County Administrative Boards should have a central role in climate adaptation. A specific climate adaptation delegation should be appointed at each County Administrative Board to provide support especially to municipalities; undertake regional analyses of climate change impacts and summarise information; follow up sectoral and private adaptation work; and to initate the development of catchment level groups (Commission on Climate and Vulnerability, 2007).

II.2. Forest adaptation measures

The Commission on Climate and Vulnerability notes a number of potential adaptation measures. In particular is spruce, the species with the highest production value on some forest land, seen as especially threatened by increased storm and pest damage as well as by drought. Shortening the rotation periods, thinning early and hard and adapting logging planning to avoid edges that are very exposed to wind, together with combating spruce bark beetles through removal of dead spruce wood and setting of traps, could serve as adaptions in relation to spruce. Increased focus on pine, mixed stands and oak in southern Sweden could be used to counter drought risk, and to increase variation and spreading of risk. Existing insurances against fire and wind damage are also seen as needing evaluation, as they seldom give full compensation or compensate damage to smaller areas. The Commission on Climate and Vulnerability notes:

> *There is considerable uncertainty surrounding exactly how the climate will change and future demand for different tree species. Land owners must however be prepared for the fact that the risks will increase over time, particularly in traditional forestry targeted at maximum production. For many, the increased production will make up for the damage, although individual land owners may be seriously affected* (Commission on Climate and Vulnerability, 2007).

As a result, means of increasing variation and spreading risk are targeted. These could include, for instance, mixed stands with conifers and birch, pine and oak on drier lands, or the planting of fast-growing tree species in some stands, as well as increased variation in thinning and felling regimes, including continuity forestry on some areas. "There is insufficient knowledge about optimum management of mixed stands and species other than spruce and pine, however, and this needs to be developed in order to achieve good-quality, wider ranging advice" (Commission on Climate and Vulnerability, 2007). Consequently, the investigation notes that there is:

> *a need for an overhaul of the rules and recommendations as regards the choice of tree species, provenance choice, clearing, thinning and final felling, as well as for fertilising, the use of non-native tree species, rotation periods and rules aimed at minimising pests. This overhaul should be targeted at strengthening the potential to achieve the forest policy's two objectives of a good yield and the protection of biodiversity in sustainable forestry in a changed climate* (Commission on Climate and Vulnerability, 2007).

Game, for instance elk, management would also need to be adjusted, for instance by increased hunting, and protection for seedlings and young forest increased, for instance through greater access to grazing of broad-leaf forest resulting in less damage to young trees.

In addition is stump treatment during logging to prevent root rot relevant to extend under conditions of climate change; counter-measures to pine weevil need to be investigated. Preventative measures to forest fires need to be extended, both for monitoring, communicating fire restirictions and learning from examples in southern Europe. Monitoring for damage (storms, insects, fungi, grazing and logging and transport) also needs to be extended. Increased costs due to accessability problems on grounds and roads, such as using technical aids (for which rules would also need to be developed), clearing ditches or developing new forest roads (for which a test procedure may need to be developed to avoid conflicting with environmental objectives on streams and wetlands), could to some extent be countered through increasing stocks in the forest compared with present levels.

The investigation also notes that the Swedish Road Administration needs to consider climate change when planning maintenance. "Improving 70 percent of the forest roads to a higher standard that permits transport during the majority of the year, and equipping an equally large proportion of the lorries with variable air pressure, would cost around SEK 2 and SEK 1.5 per cubic metre (solid volume excluding bark) respectively" (Commission on Climate and Vulnerability, 2007).

Swedish forestry representatives at a conference held in February 2009 (pers. comm., KSLA Conference 2009) to a large extent described that measures such as these are considered and to some extent already under implementation. Among ongoing adaptations among forest companies were the following:

- Development and tests of new plant material such as exotic species
- Adjustment of silvicultural and management programmes to a shorter harvesting cycle and storm risk
- Improvement of forest roads to deal with warmer winters and limited access to winter roads
- Development of forestry machines able to operate on non-frozen, waterlogged grounds

So far, however, there was limited adjustment to larger forest fire risk. Many of the representatives also considered potential strategies for risk spreading and variation. These included

- Discussions of mixed stands and substitution of spruce: some participants also requested changed recommendations for use of different tree species.
- Consideration of more active forest management with increased thinning, using tree species with shorter rotation times, and increasing preparedness to insect attacks. Also this point was seen as potentially resulting in needs for changes in advice and action programmes for certain insects

With regard to the potential environmental impacts of certain measures discussed above (such as higher density of forest stands and planting of exotic species), participants also noted that environmental consideration could be increased or emphasised through maintenance of buffer zones, control of invasive species and potentially increased environmental consideration in certain areas. This would potentially require including migration paths for different species in the regulative framework for biodiversity, modifications to hunting and game management, changes in the regulative framework for exotic species in order to support mixed species stands with such inclusion in order to spread risks (and potentially also over time changes in the limits for difficult to regenerate areas). One person also noted that the impacts of climate change on forestry would lead to "generally increased importance of planning … logistics, risk analyses, fire and other crisis management, monitoring and adaptive management". As a result, raising the awareness and management among forest owners may become more crucial in the future. Some participants also noted that the point that adaptation to climate change supports production would need to be highlighted, as well as that regulation frameworks on several levels would need to be adapted. In addition, with these multiple demands on forestry, it may also be necessary to improve or increase actions to decrease conflicts between forest use sectors (pers. comm., KSLA Conference, 2009).

The Forest Bill 2007/08:108 (Swedish Ministry of Agriculture, 2007) also provides suggestions with relevance for adaptation to climate change along the parameters discussed above. The bill reports that there is room for increased wood production within the framework provided by present regulation and legislation. The bill notes among other things that long-term sustainable increases in the outtake of wood, among other things through forestry increasing their investments, is needed to meet increased demands for forest produce including biofuel, and to avoid negative consequences on the competitiveness of Swedish industry. Noting that this may result in increased conflicts between sectors, the bill notes that forestry and other sectors need to work together to realize Swedish forest policy. The bill notes that the Swedish Forest Agency should be responsible for evaluations of the definition of exotic species, which is presently seen as unclear in legislation. In addition, the Swedish Forest Agency should evaluate the limitations for Contorta pine, given among other things the larger resistance of Contorta pine in comparison with pine to certain pests.

II.4. Research studies on forest adaptation: examples

The Swedish University of Agricultural Sciences is responsible for monitoring of forest for the state, and has among other things developed forest decision support systems such as Heureka and forest databases. With regard to adaptation, much of Swedish studies on adaptation have taken place under the framework of the Commission on Climate and Vulnerability (2007) and its sub-reports, which to some extent summarises existing Swedish-based work on adaptation to climate change in forestry. There also exists research studies in particular with regard to storms (e.g. Blennow and Olofsson, 2008) as well as with regard to forestry and forest industry stakeholders perceptions of adaptation and adaptation needs (Keskitalo 2008a, 2008b). These latter note for instance the risks perceived from pests, changes in temperature and precipitation and seasonal shifts, as well as impacts of increased tree growth and potential shifts in benefitted tree species. Adaptations on the regional and local level in selected cases (interviews made 2003-2005) in particular highlighted adaptations to limitations in site accessibility due to thawing and decreased reliance on winter roads, i.e. to effects that have a direct impact. Adaptations to more long-term changes such as changes in forest growth rate and associated changes in quality or in benefitted species were seen in the context of a market framework, where potentially lower prices for lower qualities would potentially be compensated by higher production (Keskitalo 2008a, 2008b).

III. Mitigation

III.1. Carbon accounts

The Swedish Climate Commission report (2008) describes that mitigation of GHG would need to take place with 50% until 2050 and be ceased altogether until 2100 in order to stabilise the GHG level in the atmosphere to not increase global mean temperature above 2°C. The report notes that Sweden should take its part of global responsibility through setting ambitious targets through an environmental objective on limited climate impact on temperature on the global level (to limit increases in global mean temperature to 2°C compared to pre-industrial levels), concentration of GHG on the global level (of 400 PPM CO2-equivalents, in order to reach temperature objectives), and Swedish aims on short, medium and long term. The report describes Sweden's aim in the EU to set targets for decreasing GHG for year 2020 (in comparison with 1990 levels) to 30%, without compensation for Swedish carbon sinks. The corresponding Swedish aim to reach this target would be a decrease in GHG emissions by about 35%, while implementing the suggestions in the report as a whole would lead to about 3% further in emissions reductions. The government shall annually in a report to the parliament report the Swedish GHG emissions in total and per sector in order to assess the possibility of reaching the 2020 aim, as well as if needed propose actions to do so; an extended report shall be provided every fourth year. The aim for 2050 would be a reduction on Sweden's part with 75-90% less than in year 1990. Aims for the period 2008-2012 remain at the previously set level of at least 4% below emissions in 1990, without compensation for carbon sinks or flexible mechanisms. It is suggested that the aims should be reconsidered in line with changes in the world at large that may impact formulation of aims, calculations and future results.

Sweden's action plan to reach the proposed targets include international cooperation as well as domestic successive and continuous responses to revise energy policy, planning and infrastructure. Among these are improved cross-sectoral actions and economic means of steering, lowering the emissions allowed under the EU system for CO2 allowances and reducing emissions in sectors not within the EU system for CO2 allowances. Given that some 50% of Sweden's area is forest covered (productive and non-productive forest), CO2 is to a large extent bound in carbon sinks in growing forest and ground vegetation, whereas CO2 is emitted from agricultural soils, for instance dried-up lake floors and peat soils. CO2 is also bound in wood and paper products (in total 70 million tones CO2 annually in 2006). In the short term, bio fuel use causes release of CO2 until forest biomass has grown to replace the emitted CO2 (the report noting that this is of importance especially for stabilizing CO2 levels in the crucial coming decades). Carbon sinks are, however, difficult to assess and requires knowledge and assessments of carbon flows to and from forest land, future logging levels, the dynamics of peat soils (where peat is currently defined in the EU as a fossil fuel and thus not included in carbon sink dynamics) and the impact of storms or pests that may affect carbon sinks in forests. Actions to support carbon sinks can also impact biological diversity positively or negatively depending on how they are developed (Climate Commission, 2008).

The UNFCCC climate convention notes that carbon sinks should be promoted and that countries under the Kyoto protocol can include CO2 storage in carbon sinks under certain rules. The net uptake of CO2 emissions in newly planted forest (and increases in growth related to improved management and potentially to increased fertilisation) and the retaining of CO2 in standing forest (for instance through increases in land for nature reserves) may be seen relative the emission of CO2 through deforestation for instance through logging. The report notes that since Sweden has relatively low GHG emissions but large carbon sinks and a large forest industry the development of carbon sink regulations will have an especially large role for Sweden. Increased ground fertilization may, while benefitting carbon storage, also have negative impacts on biodiversity or other environmental objectives beyond that of a limited climate impact. Some pilot projects on increasing carbon storage and growth up to 50% through increased thinning and fertilization are currently ongoing. The report notes that changes in forest management to optimize carbon storage may benefit from changes in the forest law and related directives, or by including carbon sinks under the EU carbon trade system (which would in turn require measures to calculate these sinks), and that potential actions on national level to support carbon storage should be investigated (Swedish Climate Commission, 2008).

Among forest companies (pers. comm., KSLA Conference, 2009), mitigation was mainly seen as centered on companies' own possibilities to develop more effective energy use. Measures that were discussed as part of mitigation efforts included effectivisation and rationalisation of energy use, development of renewable energy (wind power), and revision of transport systems (for instance switching road to railway transports).

The Forest Bill (Swedish Ministry of Agriculture, 2007) in addition notes that the Swedish Forest Agency should develop a basis for forest management advice in order to support the role of forestry as a bioenergy producer and to limit the GHG emissions from forest land and improve its function as a carbon sink. The Swedish Forest Agency and the Swedish EPA has also emphasized that bioenergy production should not be at the cost of other environmental considerations. The Swedish Forest Agency and KSLA, among others, also note that the focus on developing knowledge on biofuel production should be extended to developing knowledge on increased wood production overall (Swedish Ministry of Agriculture, 2007).

III.2. Forestry as a source of bioenergy[2]

Ethanol has recently become more important in Sweden as a source of limiting oil dependency and supporting climate change mitigation. The portion of biofuels (wood fuels, forestry residues, pulp and paper by-products, energy crops, fuelwood, peat, animal waste, and sewage) make up some 20% of Sweden's total energy supply. Given a large increase in the "green car" segment of the market, Sweden's share of renewable transport sector fuels is 4% (2007), and Sweden and Germany were the only European countries to reach EU's 2005 targets for biofuel share of transport fuels (2%). While most ethanol has so far been imported, a number of governmental commissions (including a Commission on Oil Independence presenting its report in 2006) have recommended higher domestic biofuel development. Some media attention has also been placed on the competition of imported biofuel crops with food production, while the forest industry has noted that high-refined forest products should be a priority before domestic biofuel production.

Conclusion

Sweden has during the last few decades developed a large focus on emissions reduction and mitigation (supported by among other things relatively large access to water and nuclear power). The use of Swedish forest for carbon sinks and biofuels has recently come under discussion. At the same time has an adaptation focus in Swedish forestry started developing, to a large extent as a result of the 2005 Gudrun storm and its large storm-felling of wood. So far, there exists few studies of to what extent adaptation measures have started to be implemented among Sweden's numerous small-scale forest holders, as well as to what extent adaptation may be becoming mainstreamed in forest industry practice. Mitigation and well as adaptation purposes in Swedish forestry in these respects may be best characterised as under development.

[2] This report part summarises contributions by Christer Nordlund and Jenny Eklöf In a preliminary book chapter (in prep.) "Climate Change Mitigation and Adaptation in Sweden's Forest Sector: Fuelling Biofuel Development".

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