

Climate change adaptation in Swedish forestry: Driving forces, risks and opportunities



MISTRA SWECIA
CLIMATE, IMPACTS & ADAPTATION

The climate is changing because of human activities. Already the planet has warmed by about 1°C from pre-industrial times, and by the century's end, it could warm by another 1–3°C, depending on how sharply we reduce greenhouse gas emissions. Some climate change impacts will be unavoidable, with implications for our cities, farmland and forests.

In Sweden, the forestry sector, which accounts for about 2% of GDP,¹ is particularly exposed to climate change impacts. Though the impacts here are far less severe than in many other parts of the world, the forests are already being affected by warmer and more erratic temperatures, changes in precipitation, and extreme weather events. Large-scale losses from storms, droughts, fires and pest infestations are expected to become more common – but forest productivity is also increasing. Adaptation is crucial to minimize vulnerability to negative impacts and seize new opportunities.

This synthesis brief summarizes key insights from SEI's research on climate change adaptation in Swedish forestry as part of the 2008–2015 Mistra-SWECIA programme. By taking a broad perspective on climate risks, vulnerability and adaptation in a real-world context, we set out to better understand the social factors that determine the success of adaptation, and how to overcome barriers to enable stakeholders to adapt to the full extent of their capacity. In particular, we focused on the roughly 330,000 individual owners who manage about half of Sweden's forests, including about 11.5 million hectares of productive forest land.

SEI's work in Mistra-SWECIA also fostered science-based stakeholder dialogues to more directly address forest owners' questions and needs, and to enable knowledge-sharing and collaborative learning among forest owners and researchers. In addition, we examined the role of social networks for communicating different types of knowledge and information among actors, and how they underpin opportunities for – and barriers to – adaptation.

Working with two Mistra-SWECIA partners, Lund University and the Swedish Meteorological and Hydrological Institute, we designed and applied an interdisciplinary, participatory research approach combining climate science, climate impacts, and social science theories and methods.

A key aspect of our work was to speak directly with forestry stakeholders. We conducted focus group discussions, workshops and interviews with forest owners and forest officials in Kronoberg and Västerbotten counties in 2010–2011 and forest owners in Skåne, Jämtland, Västerbotten and Gävleborg in 2013–2014. Altogether, we spoke with 60 private forest owners and 13 forest officers representing forest companies, sawmill operators, forest owners' associations, and the Swedish Forestry Agency.

In 2014, we also distributed a survey to 6,000 forest owners and 1,100 forest advisers as well as 4,000 members of the general



A lumber business on Fårö, an island in the Baltic Sea.

public, asking about their perceptions and knowledge about climate change and adaptation, their experience with extreme weather events, attitudes towards climate risks, and risk-mitigating actions. The insights presented here draws on all this field research as well as the growing literature on adaptation and climate change communications.

A key finding from our work is that effective adaptation requires integrating climate concerns into forest operations. Forest owners do not address climate risks in isolation, but rather need to balance them with other concerns and priorities: from near-term costs and profits, to the social and recreational value of forests, to biodiversity and the long-term sustainability of the sector. Forest owners' perception of the climate risks involved, adaptation options available, and trade-offs will also shape their choices.

Climate change and Sweden's forests

Sweden's climate is already warming and becoming rainier, and climate scenarios indicate this trend is likely to continue. For the forests, this means a longer growing season, denser vegetation, and increased soil water retention – except in the south, where evaporation from warm summers is drying the soil. All across Sweden, winters are becoming milder, with less snow and more rain. The ground is freezing for shorter periods, and the depth of the frost is decreasing as well.

Climate change is also increasing the risk of pest infestations, forest fires and extreme weather events, including droughts, floods, and severe damage from storms. Forest management choices can directly affect the level of risk: large plantations of the same species are likelier to be ravaged by pests, and neat rows of trees of the same type and age are particularly vulnerable to heavy winds during storms.

How much more conditions change over time will depend on greenhouse gas emissions trends, but to reduce vulnerability, adaptation measures will be needed across the Swedish forestry sector. Many forest owners are already noticing shifts in the seasons and increased forest growth, and a third of Swedish forest owners

¹ All forest sector statistics cited here are from Swedish Forest Agency (2014). *Statistical Yearbook of Forestry*. Jönköping. <http://www.skogsstyrelsen.se/en/AUTHORITY/Statistics/Statistical-Yearbook-/Statistical-Yearbooks-of-Forestry/>.

and forestry advisors believe climate change will pose serious risks to the forest. Yet perceptions of the urgency of adaptation vary – “wait and see” is a common stance. At the same time, many forest owners believe that climate change can benefit the sector in the future; demand for Swedish forest products is already growing. Adaptation can help them seize new opportunities.

Adaptation in the Swedish forestry sector

Adaptation to climate change is a relatively new concern in Sweden. Discussions about climate risks, vulnerability and the need to adapt began to take hold in the early 2000s, motivated by growing scientific knowledge – especially the work of the Intergovernmental Panel on Climate Change (IPCC) – as well as economic concerns and extreme weather events such as torrential rains and floods. Still, in national climate policies, mitigation was the clear priority.

The storm Gudrun in January 2005 gave Sweden a new perspective. The storm devastated forests in southern Sweden, and the storm Per in 2007 brought another wave of destruction, in the central region. The Swedish Forest Agency (Skogsstyrelsen) had begun developing a climate policy as early as 2003, but had not offered clear recommendations for forest owners. In the aftermath of Gudrun and Per, new policies were adopted to reduce climate risks, at least in the near term. And across the forestry sector, awareness of climate change and the need for adaptation grew significantly.



Piles of forest debris cleared from the damage of the storm Gudrun in 2005 near Växjö, in southern Sweden.

The final report of the Swedish Commission on Climate and Vulnerability, in 2007, proposed a number of policy actions directly relevant to forestry, and also highlighted the need to protect biodiversity. The Climate and Energy Bill in 2009 assigned responsibility for climate change adaptation to the County Administrative Boards, which were given a coordinating role at the regional and local levels. The Swedish Forest Agency, in turn, was charged with developing a system to disseminate information about climate change and adaptation to forest owners and other operators in the sector. Funds were also provided to support further research on climate change impacts and to develop an early warning system for extreme weather events.

Forest owners’ awareness of climate risks – and of the need to adapt – has clearly increased since then, and some have implemented adaptation measures. Yet overall, the integration of adaptation issues in the forest sector has been slow and limited

in scope. At the national level, a recent shift that has helped to advance adaptation has been the recognition that mitigation and adaptation are not competing objectives, nor can one replace the other. This has gradually opened the door to broader discussions about how Swedish forestry practices should be modified to take advantage of new opportunities created by climate change while reducing climate-related risks. Swedish forestry researchers, advisory services, and forest owner associations are all paying increasing attention to adaptation issues.

Adapt or not? Perceptions, barriers and drivers

In Swedish forestry as in any setting, adaptation is not a one-off activity, but a learning process. Science provides crucial information about expected impacts and factors that affect vulnerability, but when it comes to choosing a path forward, stakeholders’ own knowledge, beliefs, values and priorities are at least as important. Effective adaptation planning will combine both scientific knowledge and practical experience, and consider adaptation options in the context of forest owners’ multiple objectives, such as preserving biodiversity, making a profit, and creating recreational opportunities.



A forwarder loads timber in a forest in Skellefteå, in the county of Västerbotten, in northern Sweden.

A key focus of our research was how different factors, including social and cultural aspects, shape Swedish forest owners’ perceptions of climate risks and resulting actions. In general, forest owners do not perceive climate change as an acute threat, and focus group discussions revealed that few are taking action directly in response to expected climate change impacts. However, attention to adaptation is growing, particularly among forest officials, who see a need to plan ahead and be prepared for future impacts. Forest owners, in turn, are increasingly considering the implications of climate change for their choice of tree species, clearing and thinning strategies, ditching and road maintenance.

Yet the perception of climate change as gradual, with the most severe impacts still far in the future, means forest owners are in no rush to adapt. Forestry involves fairly long lead times, and forest owners generally believe they can adapt over time. For example, as forest productivity increases, many expect to be able to shorten the production cycles and adjust planting and management practices as needed.

A similar attitude seems to prevail when it comes to biomass for energy. A study of over 800 forest owners in Sweden, Germany



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Rows of trees in Kronoskogen, a forest area between Ängelholm and Skålderviken in southern Sweden.

and Portugal² (not part of Mistra-SWECIA) found most forest owners expected sustained demand for forest products for energy, but they weren't ready to change what they grew just yet. The European Union has set a target of producing 20% of energy from renewable sources by 2020, and Member States have estimated that this will require a 45% increase in forest biomass production, yet clearly much stronger incentives will be needed to achieve this goal.

On the other hand, forest owners' long experience managing their forests – and tackling difficulties and finding innovative solutions – could facilitate adaptation. Many strategies that would build resilience to climate change impacts, such as diversifying forest species, are already used by forest owners to manage risks, even if they have not linked those strategies to the notion of “adaptation”. In general, forest owners are increasingly aware of risks to their operations and eager to manage them. They also recognize the need to keep adapting to changing conditions: not just the climate and weather, but technologies, economic trends, and the market for Swedish forest products.

More broadly, some forest owners are exploring how to optimize forest management to take advantage of more rapid growth, expanding markets and other factors. Climate change is only one of several factors in those discussions, highlighting the importance of looking at adaptation in a larger context. In fact, one of the challenges with adaptation is that it involves many decisions, actions, and activities that are beyond forest owners' direct control and decision-making power.

Yet adaptation is of growing concern as well. In Mistra-SWECIA's survey, a significant share of forest owners said they are considering their forest management options, and many said they believe adaptation is urgent. About a fifth believe that they will need to take first steps to adapt their forests to climate change in the near future, and almost half think they will need to take risk-reducing measures within the next five years.

The survey reveals a key barrier to adaptation: forest actors do not agree on the most effective measures to tackle climate change. The survey study shows, for example, that more than 40% of forest owners believe that alternative management methods, such as avoiding clear-cutting, is an effective way to manage effects of climate change. Only 17% of forest advisers agree. Opinions also vary with regard to thinning and intensive logging practices, among other topics.

² Blennow, K., Persson, E., Lindner, M., Faias, S. P. and Hanewinkel, M. (2014). Forest owner motivations and attitudes towards supplying biomass for energy in Europe. *Biomass and Bioenergy*, 67. 223–30. DOI:10.1016/j.biombioe.2014.05.002.



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SEL's Gregor Vulturius, left, and Olle Olsson during a field visit to the site of a forest fire in Västmanland, in central Sweden.

These differences reflect more than disagreements about adaptation strategies, but more broadly, different views on forestry goals. This could create obstacles to effective adaptation, particularly because many forest owners express doubts about their own abilities to implement and maintain effective adaptation strategies.

Another obstacle to adaptation that emerged in focus groups and interviews is lack of confidence in climate research and climate scientists. There seems to be some distrust of climate science that is rooted in individuals' beliefs and in past experiences of seeing scientific claims disproven, as during the acidification debate in the 1980s. Such distrust may be difficult to overcome through education. Moreover, the communication approaches typically used by scientists may not be optimal for supporting adaptation in the forestry sector. However, studies show that trust in climate



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A pine seedling on the site of the Västmanland fire, a first sign of forest regeneration.

research can be strengthened through extended interaction and relationship-building, and by engaging experts who are already trusted resources for forest owners.

We found that personal experience of extreme weather events increases awareness of climate risks and the willingness to implement adaptation measures. For extreme events to become a trigger for proactive adaptation, however, they need to be perceived by forest owners as a direct result of climate change – a tricky point given that, from a scientific perspective, direct attribution of any one event is not really possible. Still, our research fits with the findings of other studies that show climate science is likelier to be accepted when it fits with people’s own perceptions about weather and climate.

More broadly, the storms that Sweden has experienced in recent years have led forest owners to explore important questions about risks to their operations: Will storms and storm damage increase in the future? What does this mean for forestry? How should we relate to and manage storm risks? Some forest owners spoke about how they had fared well after a storm, but a neighbour had been hit hard – or vice versa. For some, escaping harm was a confirmation that they were doing the right things, while others felt greater uncertainty about how much forest owners could do to avoid impacts. Some wondered why forest owners who followed available guidelines and recommendations had still been hit hard.

In summary, it is clear that social and cultural factors play important roles in how Swedish forest owners perceive and respond to climate risks. Overall, climate change is not seen as an urgent threat, but more as a set of gradual changes that forest owners have time to adapt to. Many forest owners say that adaptation is already occurring as a result of a general increase in risk awareness. Still, disagreements between forest owners and advisors, and distrust of climate science, pose significant barriers to adaptation. The different actors’ personal beliefs and experiences – most notably, having lived through a major storm they see as caused by climate change – can greatly affect their willingness to take action.

The global playing field

Forestry and forest products combined contribute more to Sweden’s net exports than any other sector, valued at 127 billion SEK in 2011 (about 14 billion EUR). Swedish forestry is quite export-dependent, and is thus affected by global trends and markets, including with regard to land use, prices and demand for different products. This means that along with direct climate change impacts, the sector needs to be aware of – and prepare for – indirect impacts from climate change elsewhere that could affect markets.

That is not how most people are used to thinking about climate change. Although we understand that greenhouse gas emissions – and the resulting atmospheric concentrations – accumulate globally and have global effects, when talking about climate change impacts and adaptation, we tend to think locally. For example, as discussed above, Swedish forestry faces rising temperatures, precipitation changes, and increases in extreme weather events – and adaptation measures need to be tailored accordingly. But in an interconnected world, climate change impacts thousands of kilometres away may be felt in Sweden as well, as they reverberate through timber and forest product markets.

As part of Mistra-SWECIA, we analysed the different pathways by which climate change impacts elsewhere could affect Sweden: trade flows, biophysical flows, financial flows, and people.

Trade flows are an important risk pathway for Sweden because exports are crucial to the country’s economy and prosperity. Exports account for about 50% of Sweden’s GDP, one of the largest shares in the world, and much higher than the EU average of 40%. In the forestry and forest products sectors, export dependence is even greater: nearly 90% of pulp and paper and 70% of sawnwood are exported, while imports are small. Climate change may also alter global shipping conditions, which are important for the Swedish forest industry.

All of this means that Sweden has a lot at stake when it comes to climate change affecting export markets. Many Swedish exports are also quite dependent on imports, further increasing indirect climate change risks. A trend which works towards reducing vul-



A pile of timber ready for transport in Västmanland, in central Sweden.

nerability is that a growing share of Swedish exports consists of services. Our analysis of these issues is still preliminary, however; better statistics and more research will be needed.

The second indirect impact pathway is biophysical flows. Climate change affects habitats, and species may respond by trying to move with the climate zone they usually live in, even as it shifts northward. This could bring new species into Sweden, alter relationships among species, and create new competition for native species. Ticks are already spreading northwards, for example, and the forestry sector may face pests in the future that now live only in Continental Europe.

Global financial flows, the third impact pathway, already greatly exceed the value of material flows. Investors exploring where to invest their assets will increasingly assess companies' long-term strategies, to ensure that they are prepared for future climate change and other shifts. For countries such as Sweden, this may have implications both for capital inflows (foreign investors looking at Swedish companies' climate strategies) and outflows (for example, via Swedish pension funds' foreign investments). Currently very little Swedish foreign direct investment (FDI) goes to countries that are considered very vulnerable to direct climate change impacts, but a significant share goes to countries that are vulnerable to indirect impacts.

The fourth impact pathway involves people – most notably migration from climate-affected areas into areas that are safer and better off. The links between climate change and migration – best embodied by the term “climate refugees” – are hotly debated and the reasons why people migrate are very complex, and can seldom be reduced to a single factor.

Still, there is growing evidence that climate change can amplify or exacerbate existing problems, such as water and food scarcity, and thus affect migration patterns. For Sweden, a country that has long welcomed migrants and refugees from climate-vulnerable regions, this means the “people” impact pathway will be important to keep in mind and prepare for as climate change impacts become more severe around the world.

The “people” pathway is also highly relevant to Swedish tourism. Climate change is already affecting the desirability of different destinations in each season, and that trend is likely to increase over time. This could affect both the patterns of tourist travel into Sweden, and Swedes' own travel abroad.

The implications of indirect climate change impacts for Sweden's economy, society and public policies are clearly significant and warrant closer attention. Along with the specific sectors discussed above, indirect impacts could affect Swedish security, defence and foreign policy, and they are particularly relevant to Sweden's policies on development assistance. Sweden has already begun to integrate climate concerns in these policies, particularly in development assistance, but looking ahead, these issues are likely to require even more attention and consideration.

Indirect impacts and Swedish forestry

As noted earlier, Sweden's forestry and forest products sectors are export-intensive. This means that to the extent that climate change and climate policies affect key markets, those impacts are likely to be felt in Sweden as well. Currently most of Sweden's forest-related exports go to other European countries, but other markets are increasingly important, such as North Africa and the Middle East.

Climate change could affect conditions – and demand for Swedish products – in any of those markets.

Second, the general globalization of markets for forest products creates broader exposure to indirect climate change impacts. Swedish sawmills already exports sawnwood, for example, to Japan and China, which to some extent competes with suppliers from Canada and the United States. The North American forest industry, meanwhile, has been heavily affected by mountain pine beetle infestations linked to increasingly warm winters in western regions. That has made the timber supply from many sawmills less reliable and less competitive, creating opportunities for Swedish sawmills to step in.



A forest devastated by bark beetles in the western U.S.

A third consideration is that climate change impacts on other raw materials may benefit the forest products industry. One example is cotton, for which climate change is creating difficulties in regions that are already water-scarce. This could mean long-term competitive advantages for wood-based textiles, a product niche that is still fairly small but has great potential.

Finally, it is important to note again that the forest products industry can play an important role in reducing greenhouse gas emissions. Not only can it provide fuel for bio-based energy – already a significant factor in Sweden's efforts to decarbonize the energy sector – but it also provides raw materials and carbon storage in the forests. All of these benefits are likely to be valued even more highly over time, as the urgency of climate change mitigation is increasingly recognized.

Social networks and adaptation knowledge and action

Forest owners do not work in isolation. They have business partners, advisers, neighbours; they read trade magazines; many are part of forest owners' associations. They also have families and friends, read the news, watch TV. Research about adaptation suggests that all these relationships and information sources may influence what they know, think and feel about climate change, and what they do (or don't do) about it. Analysing forest owners' social networks can thus shed light both on where they get adaptation-related information, and how much they trust and act upon it.

We conducted a social network analysis covering more than 900 forest owners in Sweden, mapping who they are in contact with, how often they are in contact, and the perceived importance of the actors to the forestry-related decisions that are being made. According to the analysis, a large number of forest owners communicate frequently with their families and co-owners, neighbours

and other forest owners, but also with forest owners associations, forest companies and the Swedish Forest Agency. The latter offers various forms of advice towards forest owners and thus have a clear role in disseminating knowledge and information on adaptation, among other topics.

Yet forest owners rarely have contact with many actors in their networks; except with family and business partners, contacts are often just annual or even less frequent. Family and business partners were also perceived as being most important to the decisions taken in forestry. The actors with whom forest owners have only rare contact, such as forestry authorities and scientists, were perceived as less important, reflecting their different and more limited roles in actual forest operations.

Our focus group discussions with forest owners did identify several organizations that are trusted and relied upon, and may have good potential for facilitating the sharing of scientific information and knowledge about adaptation. For example, forest advisers are perceived as being important, particularly among forest owners who have no forestry training themselves. Many forest owners said they find it difficult to digest all the material, so the adviser plays an important role in synthesizing and communicating the most important information. However, other forest owners are more independent, particularly those who work full-time in forestry; they are glad to listen to others' input, they said, but they make their own decisions.

Many forest owners also talk with their peers in different contexts, and this helps them to form opinions about the merits of different forest management strategies. Neighbours, friends and relatives are seen as important mainly in terms of attitudes and values toward various management options. What others forest owners do in the vicinity can also stimulate changes in management practices by serving as good examples or role models.

Notably, there seems to be a disconnect between where forest owners get their information about forestry issues – the sources discussed above – and where they get most of their knowledge about climate change: the news media (print and broadcast).

Communicating science for adaptation

A key aspect of SEI's research in Mistra-SWECIA was to examine how scientists could better communicate with forestry stakeholders to encourage, facilitate and support adaptation. Science is crucial for adaptation, both to help forest owners understand the climate change impacts they need to prepare for, and to iden-



Building trust requires extended interaction – enough to develop friendly, comfortable relationships between scientists and forest owners.

tify effective adaptation strategies, which may involve insights and ideas from entirely different places or sectors. At the same time, in order for scientists to be able to provide relevant and actionable information, and gain forest owners' trust, they need to understand their perspectives and be ready to learn from local knowledge and experiences.

Along with our direct interactions with forest owners and other actors in focus group discussions, meetings and workshops, a key source of insights about effective climate change communication in the context of Swedish forestry came from our survey of 6,000 forest owners. The survey covered two distinct groups: 3,000 were randomly sampled from forest ownership records, and the other 3,000 had recently participated in a climate communications and adaptation capacity-building project run by the Swedish Forest Agency.³ As part of this project, forest owners received scientific information about climate change risks and adaptation measures through seminars, workshops, and individual consultations.

Overall, the survey showed that climate change science communication has measurable effects on people's perception of their own ability to adapt and can lead to adaptation. A comparison between the two groups showed that forest owners who had participated in the capacity-building project were indeed better positioned to address climate risks. More than 37% said they felt they had enough knowledge to implement adaptation measures in their forests, and 31% also said they would soon need to take steps to adapt. In contrast, only 23% of the forest owners who had not taken part in the project said they had enough knowledge to adapt, and 20% said they would soon need to start adapting.

Not all climate information is equally useful or likely to lead to adaptation, however. Through our work, and drawing on the adaptation literature, we identified three key criteria that scientific information needs to meet to promote climate adaptation: relevance, credibility and legitimacy.

Relevance means that the information is connected to stakeholders' objectives, practical needs and personal knowledge. For example, knowledge about global climate change projections is less relevant to Swedish forest owners than knowledge about projections for Sweden – or even better, their specific region. Similarly, projections to the year 2100 are less likely to be relevant than to 2030–2050, which is closer to the time-frame of decisions about what types of trees to plant, and in what configuration.

Credibility means that the scientific information presented needs to be accurate and reliable. This means that scientists should emphasize robust, peer-reviewed research. Where knowledge is still evolving or uncertain, they may still want to share it, but they should be clear and transparent about the nature of the information being shared.

Legitimacy implies that information and knowledge about climate change are developed in a transparent and participatory manner. For forestry stakeholders, this means that recommendations about forest management to reduce climate risks, for example, will be seen as more legitimate if they are developed in consultation with forest owners, advisers and officials, instead of simply being delivered “from the top down” by scientists or the government. Knowledge co-development and co-exploration can also be crucial for

³ The response rate for the random sample was 31%, or 932; for the project participants, the response rate was 46%, or 1,480.



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By mapping and exploring forestry stakeholders' social networks, we can better understand whom they trust and rely upon to inform their decision-making.

helping stakeholders overcome obstacles related to understanding of scientific uncertainty, complexity and credibility.

Our engagement with forestry stakeholders also highlighted the importance of communicating climate science in *clear, accessible language*. Scientific jargon tends to confuse and intimidate people, and can lead them to stop listening and just trust their own knowledge and opinions.

Language is also important when communicating uncertainty about future climate change risks and impacts. Scientists can be so cautious about the uncertainties in climate projections, for example, that they confuse stakeholders. Though it is important to communicate those uncertainties, the emphasis should be on the practical implications: Do forest owners need to adjust their management practices to prepare for two completely different possible scenarios? Or are trends going in a clear direction, but the question is how soon an impact might occur, or how severe it might be?

Another key insight is that communications about climate risks should avoid being alarmist. Climate change projections can be troubling, but emphasizing the worst possible outcomes can backfire in two important ways. Stakeholders may feel manipulated and lose trust in the information source, or they may be overwhelmed and feel powerless to make a difference. Recent research highlights the perils of the latter effect: two key factors in whether people are motivated to adapt are their belief in the efficacy of adaptation measures, and their belief that they can implement them effectively. Thus, the perception that climate risks are too great to manage can become a major barrier to action.

In closing, we want to emphasize the importance of building trust. Our eight years working on Mistra-SWECIA have shown that this cannot be accomplished through short, sporadic interactions. It requires a long-term commitment by scientists, public officials, and the stakeholders we interact with. Our extended engagement with the Swedish forestry sector gave us the opportunities we needed

to build trust and learn from one another. Going forward, strong, long-term relationships will be essential for effective adaptation in this and other sectors of Sweden's economy.

Further reading

- André, K., Simonsson, L., Gerger Swartling, Å. and Linnér, B.-O. (2012). Method development for identifying and analysing stakeholders in climate change adaptation processes. *Journal of Environmental Policy & Planning*, 14(3). 243–61. DOI:10.1080/1523908X.2012.702562.
- André, K. (2013). *Climate Change Adaptation Processes: Regional and Sectoral Stakeholder Perspectives*. PhD Thesis, Linköping Studies in Arts and Science 579. Linköping University, Linköping, Sweden.
- André, K. and Jonsson, C.A. (2015). Science-practice interactions linked to climate adaptation in two contexts: municipal planning and forestry in Sweden. *Journal of Environmental Planning and Management*, 58(2). 297–314. DOI:10.1080/09640568.2013.854717.
- André, K., Baird, J., Gerger Swartling, Å., Vulturius, G. and Plummer (forthcoming). The role of social networks in sharing knowledge on climate change adaptation: A case study of private forest owners in Sweden. In review, *Ambio*.
- André, K. and Simonsson, L. (forthcoming). Stakeholder perceptions of adaptation space: The relevance of direct experience and perceived ability to adapt to climate change in Sweden.
- Gerger Swartling, Å., Wallgren, O., Klein, R.J.T., Ulmanen, J. and Dahlin, M. (2015). Participation and learning for climate change adaptation: a case study of the Swedish forestry sector. In O'Brien, K. & Selboe, L. (eds.), *The Adaptive Challenge of Climate Change*. Cambridge University Press, Cambridge, UK, and New York, US.
- Jönsson, A. M. and Gerger Swartling, Å. (2014). Reflections on science-stakeholder interactions in climate change adaptation research within Swedish forestry. *Society & Natural Resources*, 27(11). 1130–44. DOI:10.1080/08941920.2014.906013.



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An autumn forest landscape in the area of Jönköping, in southern Sweden.

Ulmanen, J., Gerger Swartling, Å. and Wallgren, O. (2012). *Climate Change Adaptation in Swedish Forestry: A Historical Overview, 1990–2012*. SEI Project Report. Stockholm Environment Institute, Stockholm. <http://www.sei-international.org/publications?pid=2220>.

Ulmanen, J., Gerger Swartling, Å. and Wallgren, O. (2015). Climate adaptation in Swedish forestry: Exploring the debate and policy process, 1990–2012. *Forests*, 6(3). 708–33. DOI:10.3390/f6030708.

Vulturius, G. and Gerger Swartling, Å. (2013). *Transformative Learning and Engagement with Climate Change Adaptation: Experiences with Sweden's Forestry Sector*. SEI Working Paper No. 2013-12 and Mistra-SWECIA Working Paper No. 7. Stockholm Environment Institute, Stockholm. <http://www.sei-international.org/publications?pid=2461>.

Vulturius, G. and Gerger Swartling, Å. (2015). Overcoming social barriers to learning and engagement with climate change adaptation: experiences with Swedish forestry stakeholders. *Scandinavian Journal of Forest Research*, 30(3). 217–25. DOI:10.1080/02827581.2014.1002218.

Vulturius, G., André, K., Gerger Swartling, Å., Brown, C., Rounsevell, M., Jönsson, A.M. and Blanco, V. (forthcoming). Explaining engagement with climate change adaptation among forest owners in Sweden. In review, *Regional Environmental Change*.

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