Introducing indirect impacts of climate change on the adaptation agenda – responding to overseas climate change

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Abstract

In both research and policy, adaptation has so far mainly been framed as a domestic, territorial concern. For many countries, particularly the rich ones, it is however likely that the impact of climate change on their economy, policy making and international engagements will not manifest primarily as direct changes driven by climate and weather events within their territory, but as indirect impacts from (more severe) impacts elsewhere in the world. These impacts will together with global policy measures and changes in the global economy create changes in flows of goods, capital and people. They may also have severe conflict and security implications.

A recent comprehensive analysis by the UK government argues that consequences of climate change overseas could be as important as domestic climate change, which suggests that the dominant understanding of adaptation as a challenge primarily driven by local, place-based change may i) not adequately capture the real decision making situation on the ground, and ii) lead to sub-optimal policy responses, since not all relevant climate change impacts are accounted for. The implications of indirect impacts for decision-making and governance are poorly understood and conceptual frameworks are lacking.

Drawing on an empirical analysis of how indirect impacts of climate change are addressed in strategic documents analyzing the future global context for Swedish forestry, this paper provides some initial thoughts on how such effects could better be integrated in decision making and the repercussions they have for the research agenda, knowledge provision needs and efforts to financially support adaptation.

Introduction

It is likely that climate change may affect Europe, its economic sectors, policy making and international engagements, not only through direct impacts linked to changes in European climate and weather events, but also as indirect impacts from climate change effects elsewhere in the world. However, current adaptation policy, planning and implementation typically exclude considerations of indirect impacts.

Using the Swedish forestry sector as an example, this paper discusses the possible significance of indirect impacts of climate change, and their implications for the adaptation agenda. The purpose of the paper is to stimulate a discussion on the possible widening of the adaptation discourse to also explicitly include change processes outside a particular geographical location as important drivers for adaptation action within that location.

This is a scoping study, and the conclusions drawn from this work should be seen as tentative. The work presented is part of a larger program that during the coming years will explore issues related to

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the way in which indirect impact of climate change pose new or altered threats and opportunities; the approaches, tools or methods that could possibly be used to describe, quantify and analyze such impacts; and the opportunities for government and private sector decision making to better accommodate indirect impacts of climate change in decision making related to climate change.

The current framing of adaptation

In both research and policy, adaptation has so far mainly been framed as a domestic, territorial concern. Typically, vulnerability to climate change effects and impacts within a particular geographical location (region, nation state or sub-continent) has been taken as an argument for the need for adaptation within that particular area. For example, in their discussion on a terminology of climate impacts, Füssel and Klein (2006) take as a starting point a "climate-sensitive system" on which various levels of impacts act, the point being that the system should indeed be sensitive to "climate" and not to (say) changes in commodity prices (that may be affected by climate change).

The 2001 IPCC definition of adaptation (Smit et al., 2001) refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. Likewise, vulnerability (Yohe, 2000; O'Brien et al., 2004; Adger, 2006), is generally understood as a function of exposure, sensitivity and adaptive capacity (Schneider et al., 2001), while adaptive capacity has been defined as "the ability of a system to adjust to climate change … to moderate potential damage, take advantage of opportunities or to cope with the consequences" (IPCC, 2007:869). While these definitions in themselves do not specify any geographical boundaries, the implicit notion can be said to be that the climate change *effects* and the *needs to adapt* will occur in the same geographical locations, and that assessing the climate change impacts and/or associated vulnerabilities in a particular location will be sufficient to determine adaptation needs.[2]

The understanding of the adaptation challenge a primarily one of addressing effects of local/regional climate change is reflected also at the policy level. For example, the European Commission white paper on adaptation from 2009 is essentially void of any mention of climate change impacts outside the community's borders, apart from a mention that a failure to adapt on part of countries outside the EU could have security implications (European Commission, 2009). An assessment from the OECD in 2006 on the progress on adaptation to climate change in developed countries shares the notion that the adaptation process is by definition based on an appraisal of historical climate trends, climate change scenarios and impacts and risks assessments (Gagnon-Lebrun and Agrawala, 2006).

At the national level, the focus on local impacts of local climate change seems to dominating. In 2005 a Swedish Commission on Climate and vulnerability was tasked to examine "Swedish society's vulnerability to global climate change and the regional and local consequences of these changes" (Commission on climate and vulnerability, 2007:36). The resulting report provides a comprehensive

[2] This is of course a somewhat simplified argument. Many parts of the IPCC WGII report (as well as the supporting research) do indeed reflect the interconnectedness of various geographies, particularly through river basins that may stretch across multiple national borders, and for which changing precipitation patterns upstream may result in significant changes in flow regimes and water availability downstream.

analysis of the effects on Swedish society from climate change effects, but is strictly limited to the direct impacts from a changing climate *within* Sweden. Likewise, the Danish national adaptation strategy from 2008 is limited to the climate change effects in and on Denmark (Danish Government, 2008).

The Finnish national strategy from 2005 is essentially about dealing with climate change within national borders, but it also mentions the case of "adaptation to changes taking place in other parts of the world" (Ministry of Agriculture and Forestry of Finland, 2005). Just like the Swedish Commission's report it has a very brief account of possible impacts in other parts of the world that could potentially affect Finland.

In the Canadian national assessment of climate impacts and adaptation there is a separate section on Canadian climate change implications in an international context, and it is concluded that understanding the implications of climate change for Canada means having to account for the international dimensions (Bruce and Haites, 2007)

The aim here is not to provide a full account of the way in which national adaptation strategies frame the adaptation challenge, just to illustrate that the local effects focus has been dominating. The few times there is mention of climate change outside the geographical area in question, arguments are generally not based on analysis beyond expert opinion. This is part of a wider picture in which adaptation practice as it has played out on local-to-national scale has been focused on the local effects and the impacts they will generate. Given the way our world is connected through trade, migration and international investments, it seems however very likely that any individual country will be affected by the aggregate of climate change effects outside its borders. The question then becomes what role such considerations have in adaptation planning and implementation.

Indirect impacts of climate change

Using the distinction offered by the UK Foresight report on the international dimensions of climate change (The Government Office for Science, 2011:15), we here distinguish between climate change *effects* as long-term physical changes to the state of the climate, while climate change *impacts* are the resulting impacts on social and economic systems. The proposal here is that we by *indirect impacts* mean impacts experienced in a particular location ("A") resulting from climate change effects and impacts in another geographical location ("B"). Whether the impacts resulting from climate mitigation policy and action should be included in the analysis could be debated, but for the sake of the argument put forward here (about the extending the geographical boundaries for adaptation analysis beyond individual locations) it has less significance.

Indirect impacts can be placed on a spectrum with from high to low causality. In the causal end of the spectrum are effect-impact relations for which there are relatively few other factors, beyond climate change, that would affect the indirect impact. Hydrological relationships are probably the simplest such connection; i.e. the relation between an upstream and downstream part of a large river drainage basin, for which climate change effects upstream will have downstream impacts. For example, reduced or redistributed precipitation in the Ethiopian highlands will have severe implications for the flow of the Nile through Egypt, which means that adaptation in Egypt (e.g. addressing the future potential for using Nile water for irrigation), will have to take climate change in Ethiopia into account. These kinds of indirect impacts are clearly part of most of current adaptation planning and practice, even though hydrological regimes are generally very much dominated by

human intervention through dams, land use systems, water diversions for irrigation, and water harvesting efforts.

Less causal but still easy to see the principal argument for, are socio-economic indirect impacts, propagating between locations though flows of capital, goods (trade) and people (migration). As climate change effects hit individual regions and countries differently, and the adaptive response in those locations may vary in effectiveness, climate change will contribute to changing competitive relations across regions and countries. For example, deteriorating agricultural conditions in particular regions will result in an increased import needs or decreased export opportunities. Resulting changing employment opportunities in sectors affected by climate change may affect seasonal as well as permanent migration within and between countries.

On the largest, and causally weakest scale, examples of possible indirect impacts would be the melting Arctic ice cap changing the international security situation in the Arctic region; climate change resulting in declining long-term conditions for agriculture in southern Europe putting the common EU agricultural policy under pressure; or regions in poor countries put under environmental pressures (such as water shortages or land degradation) to a point where human security conditions make international interventions necessary.

In terms of exploring the implications of indirect climate change impacts there have been research efforts in a number of fields, exploring the international implications of climate change, without necessarily addressing linking them to adaptation as such. For example, efforts have been made to explore the international/human security dimensions, with a special focus on geopolitical and national security aspects (Barnett, J., 2003; Brown et al., 2007; Brown and McLeman, 2009; Mobjörk, M. et al., 2010). Interestingly, the term "adaptation" is rarely used in the environment and security literature, even though the conclusions drawn and actions suggested very often are characterized by the "adjustments … to reduce vulnerability … in response to observed or expected changes in climate and associated extreme weather events" suggested by the IPCC (2007:720) as characteristics of adaptation.

Studies have also addressed the health effects of climate change (e.g. Costello et al., 2009) and the impacts of climate change on global food security (e.g. Schmidhuber and Tubiello, 2007). A large amount of economic modelling at various scales has been carried out, primarily aimed at assessing the economic effects of various mitigation regimes. The interconnectedness within the earth's biophysical systems and the effects of climate change is a research field in itself (e.g. Smith et al., 2008), and in Integrated Assessment Models (IAM) the combined effects on ecosystems and the economy have been addressed.[3] Recent economic modeling research has started to look at whether rich countries may have an interest to finance adaptation in countries where the direct impact takes place, as a form of adaptation of its economy or reaping indirect adaptation benefits (Buob and Stephan, 2011).

Outside academia, there are a number of policy documents that have highlighted the possible implications of climate change for particular countries, typically addressing impacts arising from physical climate change as well as from climate policy. There is comprehensive analysis available for the UK (The Government Office for Science, 2011) and Canada (Bruce and Haites, 2007). The UK Foreign and Commonwealth Office Adaptation plan (FCO, 2007) argues that the indirect, socially

[3] For an overview of the modeling of impacts and adaptation in IAMs see Füssel (2010).

contingent, impacts of climate change will be as important in their potential effects on what the FCO is trying to achieve globally as the physical impacts themselves.

There are also sector-oriented analyses available for a number of sectors. Sedjo (2010) provides global estimates of the implications of climate change for industrial forestry, but excludes the potential future demand for energy sources from the analysis, while acknowledging that such demand could be "huge" and could "dramatically" alter the balance between wood production and demand. The US climate science program identifies climate driven indirect effects on the energy system such as energy security, prices, planning and technology R&D and preferences, concluding that "indirect effects could have a greater impact, positive or negative, on certain institutions and localities than direct effects [of climate change" (CCSP, 2007:49).

In conclusion, indirect impacts of climate change have been acknowledged in both research and policy as being an important factor contributing to the total implications of climate change in for particular locations or sectors. The significance of indirect impacts, as compared to direct effects and impacts, varies across geographical locations, and time scales. Quantitative analysis is lacking and there is very little reference made to ongoing adaptation research and practice.

In an attempt to enrich this picture and provide empirical support for arguments on how indirect impacts could be linked to adaptation at the national/sector level, the next sections of this paper explore in more detail how indirect impacts of climate change are currently addressed in strategic analysis related to the Swedish forestry sector.

Climate change impacts on forestry – the Swedish case

Approximately 60 percent of Sweden is covered by forests. Forests are one of Sweden's most important natural resources, and the forestry sector plays an important role in the Swedish economy. The Swedish Forestry Act has two objectives with equal importance: sustainable production of timber and wood, and biodiversity conservation. Globaly, attention has been drawn to the importance of forest management for climate change mitigation on one hand through the production of bio-fuels, and on the other through the role of forest soils, standing forests and forest products as carbon sinks. Sweden is one of the world's largest exporters of pulp, paper and sawn timber. The forest industry accounts for 10 to 12 percent of total employment, turnover and added value within Swedish industry, and it accounts for 11 percent of Sweden's exports of goods. In several counties the forest industry accounts for 20 percent or more of the industrial employment. The forestry sector accounts for 3 to 4 percent of Sweden's gross domestic product (GDP) and employs approximately 100 000 people. Although the Swedish forests are often seen as a common national resource, no less than 51 percent of the productive forest land is controlled by small-scale owners, typically families or individuals. In total there are more than 350 000 such owners. Remaining forest ownership is split evenly between the major forest companies and the state.

In a recent study by the UNECE, the authors conclude that international trends and major drivers of change for forest resources and wood use and projections of future developments in the use and supply of wood resources mean that demand is foreseen to vastly exceed the potential supply of woody biomass in Europe up to 2030, putting a very high pressure on the Swedish forest resource and likely forcing difficult trade-offs between forestry policy goals (Jonsson et al., 2011).

Worldwide, forests will be affected significantly by climate change. It is highly likely that changing temperature and precipitation pattern will produce a strong direct impact on both natural and modified forests (Kirilenko and Sedjo, 2007). Change will be driven by temperature and precipitation effects, possible carbon fertilization, disturbances and extreme events, and ecological responses and adaptation (Sedjo, 2010).

The most comprehensive assessment to date of the direct impacts on Swedish forestry concluded that

> *The consequences for Sweden's forests and forestry will be significant. Increased growth will result in greater timber production, although increased frequency and extent of damage primarily from insects, fungi and storms, as well as wetter forest land, can entail considerable costs.*
>
> (Commission on Climate and Vulnerability, 2007)

The Commission called for increased research, development and knowledge compilation in areas such as forest management, pest and pathogen ecology and climate indices, scenario interpretation and downscaling.

Method

In this scoping study, seven strategic documents analyzing or addressing the future context for Swedish forestry were identified. They represent a breadth of analysis and range from a strictly political statement of national level intentions for Swedish forestry (a Bill to parliament), to a forest product market review. The selection was made with the intention to provide a wide selection of sources as possible, enabling an understanding of the *nature* of analysis carried out and proposals put forward in these documents. The importance of the individual documents, in terms of affecting decision making, varies widely and was not evaluated. The content, purpose and scope of the seven analyzed documents are briefly summarized in Table 1.

Each document was analyzed assessing the extent to which climate change outside the geographical boundaries of the Sweden (or Europe, when applicable) were identified as a significant factor determining adaptation needs within the sector in the document in question. The significance was judged subjectively based on the language used and the data put forward by the authors.

For the documents that did address indirect impacts, the analysis went on to identifying the type of analytical approach employed (or the type of argumentation put forward) in valuing to what extent these impacts would be significant or not, and (if applicable) the key areas of further research and analysis that were identified by the document.

Table 1. Strategic documents relevant to the Swedish forestry sector analyzed in this research

Source		Content, purpose, scope
1	Swedish Forestry Bill 2007/08:108 *A forestry policy in line with the times*	Submitted to parliament in 2008, bill stresses the role of the forest for the climate, the need for increased growth in forests and improved nature conservation in forest management.
2	*Sweden facing climate change - threats and opportunities* (2007)	Final report from the Swedish Commission on Climate and Vulnerability, appointed by the Swedish Government in June 2005 to assess regional and local impacts of global climate change on the Swedish society including costs.
3	*A National Research Agenda – for the Swedish forest-based sector* (2006)	A common research agenda for key Swedish funding agencies supporting forestry and forest industry research
4	*Swedish Forest Sector Outlook Study* (2011)	Discussion paper in which international trends and major drivers of change for forest resources and wood use are reviewed and, together with wood supply wood-product market development projections, analyzed.
5	*European Forest Sector Outlook Study* II (2011)	Report using scenario analysis to address challenges such as climate change, protection of biodiversity, space for recreation and leisure, and energy and raw material needs. A reference scenario and four policy scenarios are prepared modeling trends in the European forest sector up to 2030, to illustrate the possible long-term consequences of policy choices.
6	EC Green Paper; *Preparing forests for climate change* (2010)	Describes the characteristics of EU forests and their functions; identifies the main challenges faced by EU forests in a changing climate and how they could compromise forest functions; and presents an overview of existing forest information systems and tools available to ensure forest protection.[4]
7	*Forest Products*, UNECE/FAO Annual Market review (2009-2010)	Provides general and statistical information on forest products markets in 2010 and early 2011 in the UN Economic Commission for Europe region (Europe, North America and Eastern Europe, Caucasus and Central Asia)

Results

The overall result of the analysis is that concerns for indirect impacts of climate change on forestry do not come through very clearly in the studied documents. The results of the analysis are summarized in Table 2. The Swedish and European outlook studies both include global climate change in the analysis, even though the climate change signal seems to be weak, compared to expected market changes in the near future. The Climate and Vulnerability Commission report has a very short section on “Changes in the world around us and their impact on Sweden”, but those expected changes do not appear as factors to consider in the section on adaptation needs and opportunities in Swedish forestry.

Beyond this overall assessment, a handful of more specific observations can be made.

[4] It should be noted though, that competence for forest policy lies primarily with the member states, under the subsidiarity principle.

First, the documents aimed at providing concrete advice or regulatory change related to adaptation (i.e. the government Bill, the Swedish Commission report and the EC Green paper (1,2,5)) are strictly limited to the activities in the forestry sector associated with forest management (i.e. planting, managing and harvesting trees, simply put). The three documents only briefly address the context in which forest management takes place; e.g. the market forces, traditions, or experience of individual forest owners that shape forestry decisions. It is thus maybe not surprising that the adaptation challenge that these documents describe is exclusively about how climate change effects will impact trees and forest ecosystems, either directly through e.g. increased risks for storm damage, or indirectly through pests and pathogens benefiting from a warmer climate.

The outlook and market analysis documents on the other hand (3,4,6) are exclusively driven by the global changing context. The two outlook studies both take climate change into account in the analysis, even though its relative importance is deemed small compared to other change, particularly in demand for wood products. Curiously, the UN/FAO Forest Products annual market review essentially lacks any forward-looking analysis (the text is exclusively focused on present-day conditions). Against this background it shouldn't come as a surprise that there is no analysis of market change as a response to future change, be it driven by climate or by other factors.

The national research strategy document is somewhat special case, as it is very much driven by an international competition logic (emphasizing global competition, sector transformation, and the need to provide high added value in the forest-based industry). It does not, however, provide a consolidated view on how global change processes (incl. climate change) may affect the Swedish forest sector. It should be noted though that the strategy is the result of a wide-ranging participative process involving sector representatives, and that global environmental change considerations may have shaped the considerations in the strategy without it showing particularly strongly in the final text.

Second, the analyses that *do* address indirect impacts of climate change do it based on data and modeling results, but in the end do not find those impacts to important. The Swedish outlook study (3) provides a short overview of possible changes in productivity, noting that the flow effects from increased global productivity caused by climate change could have "major" economic implications in the long term (Jonsson et al., 2011:32). The conclusions drawn in the report are, however, entirely focused on the market- and demand-driven change processes and their implications for land use and biodiversity.

Third, there is no common assessment approach applied when judging what indirect impacts to include in the analysis or not. Likewise, a common or dominating methodology for quantifying or comparing indirect impacts systematically does not appear. While this may not in itself be surprising, given that only two of seven studied documents include indirect impacts in the analysis, the lack of an systematic assessment approach points to the fact that it may not be very straightforward to include indirect impacts in adaptation even if the intention is there; how wide should be net be cast and how strong should causal links be for a particular impact to be subject to adaptation?

In summary there are two types of analysis put forward. First, there are the documents that explicitly talk about adaptation to climate change (the Bill, Commission report, Green paper). These analyses pay little (if any) attention to impacts from processes outside Swedish/European borders and focus the argument on the need to adjust forestry practices in response to changing weather conditions inside Swedish/European borders.

Second, there are the reports that are devoted to analyzing the impacts from processes outside those borders (the two outlook studies, and the market review). These reports only mention adaptation to climate change in passing and do not make any explicit link between the outside processes and adaptation per se.

Table 2. Summary of results

Source		**Indirect impacts on forestry *mentioned?***	**Indirect impacts on forestry *analyzed?***	**Indirect impacts *affecting conclusions, recommendations?***	**Comments**
1	Swedish Forestry Bill 2007/08:108 *A forestry policy in line with the times*	No	No	No	Emphasizing how market forces can "efficiently determine" what should be produced and how forestry is managed, downplaying the role of government intervention
2	*Sweden facing climate change - threats and opportunities* (2007)	Yes	No	No	Forest section of analysis exclusively focused on direct impacts on Swedish trees
3	*A National Research Agenda – for the Swedish forest-based sector* (2006)	No	No	No	Very conscious of globalization and Sweden competing on world markets. No consolidated global context analysis provided, but may have been part of strategy development process
4	*Swedish Forest Sector Outlook Study* (2011)	Yes	Yes, briefly	Yes	Market-based change dominating the picture; climate change predominantly affecting through mitigation policy and increasing demand for biofuels.
5	*European Forest Sector Outlook Study* II (2011)	Yes	Yes	Yes, but not explicitly	Climate change part of the reference scenarios, but the global outlook missing beyond market aspects
6	EC Green Paper; *Preparing forests for climate change* (2010)	No	No	No	Essentially separating forestry from the use and market dynamics of forest products.
7	*Forest Products*, UNECE/FAO Annual Market review (2009-2010)	No	No	No	No forward-looking analysis, no predictions or scenarios

Discussion

In current research and policy making, the dominant perspective is that adaptation is about understanding and responding to impacts of climate change inside the geographical boundaries of the particular location in which those climate change effects occur. Indirect impacts as they have been defined in this paper, are largely absent from the picture. The results from the review of strategic forestry documents support this view. A handful of insights from this preliminary study are important to highlight.

From a research point of view, there is clearly a need to better understand the relative importance of direct and indirect impacts of climate change in various contexts and at different time scales. The conclusions drawn in the Swedish sector outlook report (Jonsson et al., 2011) illustrate this point. It highlights the market- and demand-driven change processes and their implications for land use and biodiversity, based on wood resource use scenarios ranging to 2020 or 2030, while climate change (according to the sources used in the report) is only expected to affect global timber harvest marginally up until 2025, and by a mere six percent by 2050 (Sedjo, 2010)[5]. Meanwhile, total demand for wood for material and energy uses is expected to rise with as much as 60-70% by 2030, partly driven by efforts to increase the use of bio-fuels in the energy system (Mantau, 2010). Against this background, the relative importance of climate change impacts seems small.

In a parallel example, a recent account of global bio-energy potentials until 2050, exclude climate change altogether from the analysis as "the impact of climate change on crop yields is limited compared to increase in yields that are technically attainable, at least when looking at regional average numbers." (Smeets et al., 2007)[6].

Climate change (both in terms of direct and indirect impacts) and market/sector development currently seem to move on different timescales, which has been demonstrated in previous research at the local level (Keskitalo, 2008). Future adaptation research should explore the implications of such time scale differences, in order to better understand the conditions under which climate change is really the main reason for adaptation to occur.

On a similar note, a scale- or size-factor seems to be at play. It seems unreasonable that an individual forest owner in rural Sweden should factor in the effects of climate change in Brazil when making investments and management decisions related to her/his holdings. On the other hand one would expect a Swedish national forestry strategy to take such change into account, just like it should address the broader implications of global change, demographic and income futures, technology development and competition issues. Efforts to provide systematic and scientifically underpinned insights into the characteristics of the decision maker and the decision making situation that merit integration of indirect impacts of climate change would be very valuable.

In relation to forests, steps have been taken to extend the analysis of climate change impacts to also let the discussion cover factors like new markets, other land use change and political initiatives (e.g. Burgess et al., 2010; Meyfroidt et al., 2010; Lambin and Meyfroidt, 2011). However, more generic analytical frameworks capturing the whole range of potential indirect effects (both positive and

[5] Impacts on the standing stock (e.g. through pests, pathogens, forest fire, water shortage or storm damage) could however cause substantial losses to commercial forestry (Kirilenko and Sedjo, 2007)

[6] The authors do however point out that the climate change impacts for specific countries can be much larger than the regional average.

negative, and including effects that do not lend themselves to quantification) are to our knowledge missing, and certainly not available for decision-making at national scales and below. An initial step could be to map the existing efforts that have been made to assess the climate change implication for forestry, with an aim to identify major strands of thinking in terms of comparing the significance of drivers of change at different time scales, in different location and of vastly differing nature.

From a knowledge provision perspective, it seems reasonable to believe that there is a large number of decision making situations shaped by expectation of local or regional climate change impacts in which it would be beneficial (in terms of providing the "right" analysis) if a broader set of climate change impacts were integrated. Just like it makes sense for forward-looking irrigation policy and planning to factor in possible changes in river water availability as an effect of changing climatic conditions upstream, strategic planning and policy for Swedish and European forestry would probably benefit from a better understanding of climate change implications in countries providing wood products on the world market, even though the direct bio-physical link (through for example a river) is missing. Future research will have to demonstrate what types of value such better understanding would bring, and how it could be developed systematically. For adaptation to occur, there has to be an awareness of the problem (Füssel, 2007), and a recognition of indirect impacts raises the question of what the problem really is.

One important message from the 2007 IPCC assessment was that "adaptation measures are seldom undertaken in response to climate change alone" (Adger et al., 2007:719) and that planned adaptation activities frequently feature as part of larger sector initiatives. Moser and Ekstrom (2010:22026) suggest that adaptation is likely to occur in the context of "nonclimatic windows of opportunity" (e.g. infrastructure investment decisions or approval of new land use plans) and that decision making is likely to address more than climate change goals alone. A differentiation of the adaptation field thus seems warranted, recognizing the "spectrum" of decision making ranging from action primarily (or exclusively) warranted for local impact reasons (e.g. sea level rise) to ones in which local climate change is only one among many change factors to which actors and systems continuously respond. Future knowledge support will have to differ along this spectrum, both in terms of the content provided and the process in which it has been produced. For forestry, and for land use in general, adaptation knowledge provision as well as national strategy have to be harmonized with plans and strategies addressing climate, energy and biodiversity, bearing the international dimension in mind.

This research is also relevant for ongoing efforts to financially support adaptation. The purpose of this work has not been to investigate arguments or mechanisms for such financing – an issue addressed by a rich academic literature in itself. Yet, discussing implications of indirect impacts draws the attention to the question of *when* and *where* limited resources set aside for adaptation are best spent. There is a common understanding that adaptation benefits and costs predominantly occur at the local or regional level (e.g. Füssel, 2010). However, it is obvious that there is a number of situations in which successful adaptation measures taken in one location will benefit actors/systems well beyond the borders of that location. There are now claims that the indirect impacts of climate change may be of the same magnitude as the direct ones (e.g. (The Government Office for Science, 2011). In such situations there is (at least in theory) a case to be made for striking a balance between financing local adaptation, and financing efforts overseas to reduce the occurrence or magnitude of the indirect impacts. While this may currently be a difficult case to make in Swedish or European

politics, the international dimension of global environmental and climate change is such that the future undoubtedly will force to pay more attention to such questions whether we want it or not.

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