Climate and boreal forests

Stating the facts

PROTECT THE FOREST

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Protect the Forest. November 2009

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Intensified forestry – is it as climate smart and environmentally friendly as the forest industry claims? Or will the growing pressure on the world's forest ecosystems have devastating consequences?

During the current Swedish EU presidency, attention has been drawn to two of our greatest global challenges – the climate and biodiversity. Soon, the UN Climate Change Conference will be held in Copenhagen, where a successor to the Kyoto Protocol will be negotiated.

What are the future solutions and models to counter negative climate impacts?

The Swedish government and the Swedish forest industry argue strongly that "forestry saves the climate", and claim that increased and active forest production would mitigate climate change. The Swedish forestry model, which includes clear-cutting methods and plantation forestry, is now being heavily promoted internationally, with the pretext to solve the global climate problem.

Sweden is considered to be a good actor when it comes to sustainable forestry. This is starkly contrasted by the fact that Sweden has never had as little natural old-growth forests as today. Only a few percent of the productive forests below the mountain region (sub-alpine forests) are old-growth forests. Although, Sweden holds a considerable proportion of the remaining old-growth forests in Western Europe.

Old, natural forests are and have been clear-cut and replaced by plantations and industrial forests with low biodiversity values. Sweden is far from fulfilling its commitments under the Convention on Biological Diversity.

More than 1,800 animal and plant species in the Swedish forests are near-threatened or endangered, mostly because of the forestry.[1] There is a consensus among Sweden's leading biology scientists that the Swedish forest policy is threatening biological diversity in the forests. Read more in the debate article *Forest policy threatens biological diversity*, written by 14 leading Swedish scientists (April 2008):
http://protecttheforest.se/en/skogen-i-media/40-vad-saeger-forskarna/432-dn-skogspolitiken-hotar-biologiska-mangfalden

The Swedish organization Protect the Forest proposes and recommends that necessary measures to mitigate climate change and the loss of biodiversity be investigated and analyzed by independent scientists, environmental, technical and engineering experts, rather than by industries which have vested interests and adjust their rhetorics to the current climate debate. We are deeply concerned that our decision makers will be misled by the forest industry's increasingly loud campaign, which claims that forestry will save the climate.

Introduction

The climate issue is frequently used by politicians and companies at the expense of other important environmental issues, which often are directly or indirectly linked to the climate. So far, nature conservation and living boreal forest landscapes have been forgotten in the international debate. Sure, it may be tempting to drop the ethical and ecological aspects when seemingly simple solutions are presented by the forest industry on how the climate objective can be achieved.

However, it is obvious that many financially driven companies want to take advantage of the climate issue to enforce solutions that benefit their economic growth. Sweden's largest woodpulp producer, Södra, claims that if half the world's forests were run like Sweden's, the entire greenhouse effect could be eliminated.[2]

The Swedish forest industry is, at the moment, investing in a campaign, both nationally and internationally, for increased forest production and consumption of wood products. The Swedish government has already been deceived. These so called climate efforts could, however, hamper rather than help the climate. These mock solutions are both irresponsible and shortsighted, and will have devastating consequences if fully implemented.

By using clear scientific examples in this report, we would like to show that the relationship between the forest and the climate is much more complex than is declared by the Swedish government and the forest industry.

Hereby you will be informed about the current and up-to-date research about the forest and the climate.

To start with, what is a boreal forest?

The boreal forest is the coniferous forest belt in the Northern hemisphere that stretches from Alaska and Canada to Scandinavia, Russia, Mongolia, China and northern Japan. The remaining old boreal forests in this hemisphere serve as important carbon sinks, and mitigate climate change.

Natural Forests preserve Biodiversity, Ecosystem services and Non-timber forest products

All over the world, scientists, social movements and environmental organizations have raised concerns about the negative effects on the climate, local people and biodiversity, as natural forests are being clear-cut and replaced with plantations, and as intensified forestry is being practiced.

As forests decline, nature stops providing services which are essential for life. Ecosystem services include, among other things, food, freshwater, air quality regulation, climate regulation, water regulation, erosion regulation, water purification, waste treatment, disease regulation, pharmaceuticals, pollination and natural hazard regulation. In other words, the forest ecosystem is central to life.

The global economy is annually losing more money from the loss of biodiversity than through the current banking crisis, according to the study The Economics of Ecosystems and Biodiversity (TEEB), initiated by the German Federal Ministry for the Environment and the European Commission.[3] The study puts the annual cost of forest loss at between $2 trillion and $5 trillion. The figures come from adding the value of the various services that forests perform, such as providing clean water and absorbing carbon dioxide.

Read the study (*TEEB Climate Issues Update*, September 2009) here:
http://www.teebweb.org/LinkClick.aspx?fileticket=L6XLPaoaZv8%3d&tabid=1052&language=en-US

Climate change

New studies consider the safe level of atmospheric carbon dioxide no more than 350 ppm (parts per million), and it may be less.[4] The present carbon dioxide amount is already at 388 ppm and rising by about 2 ppm per year.[5] To avoid a global disaster, the goal is to keep global warming less than two degrees Celsius.[6] In other words, we do not have many years to curb the negative trend.

A study in the scientific journal Nature has tried to identify the Earth-system processes and thresholds which, if crossed, could generate unacceptable environmental change. Three of them are already considered to be exceeded; rate of biodiversity loss, climate change and human interference with the nitrogen cycle.[7]

Forest degradation contributes significantly to global warming

The Intergovernmental Panel on Climate Change (IPCC) estimates that deforestation contributes to about 20 per cent of global carbon dioxide emissions, which is more than the emissions from the whole world's transportation sector (cars, trucks, and airplanes combined).[8] FAO estimated in 2005 that deforestation accounts for 25 percent of all man-made emissions of carbon dioxide.[9]

In other words, there is an immediate need to make significant progress in reducing deforestation, forest degradation, and associated emissions of greenhouse gases.

REDD

The United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD Programme) is a collaboration between FAO, UNDP and UNEP. The programme aims to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development.[10]

Carbon stocks in boreal and tropical forests

It is important to bear in mind that greenhouse gases are released from both boreal and tropical forests when disturbed and logged. Boreal forests store about twice as much carbon in the soil as tropical forests, indicating that much of this carbon will be released as carbon dioxide when logged. Tropical forests, on the other hand, store more carbon in the biomass than boreal forests do.[11]

Boreal old-growth forests are large global carbon sinks

Until recently, there has been a common understanding that old-growth forests are "carbon dioxide neutral"; their uptake and release of carbon dioxide have been thought to counterbalance at a certain age. However, new research has shown that boreal forests continue to sequester carbon dioxide and accumulate carbon, even when the forests are several hundred years old.

A study in the scientific journal Science in 2006 showed that the top 20-centimeter soil layer in preserved old-growth forests in southern China accumulated atmospheric carbon at an unexpectedly high average rate.[12]

According to a study in the scientific journal Nature, boreal and temperate old-growth forests are global carbon sinks, in need of protection. The study is based on a literature search where data has been analyzed from 519 plot studies dealing with forests between 15 and 800 years old. Old-growth forests accumulate carbon for centuries and contain large quantities of it. However, much of the carbon, including the soil carbon, is expected to move back to the atmosphere if these forests are disturbed. The authors of the study point out that there are no international treaties to protect old-growth forests [13]

According to a study in the scientific journal Biology Letters, undisturbed boreal old-growth forests maximize the long-term carbon storage. Old undisturbed forests can store much more carbon than younger ones because of the large increase in carbon stored in the soil. Conservation of undisturbed old-growth forests and its biodiversity may have real potential for sequestering carbon, especially when they store much more carbon in long-term soil pools and involve much less loss of organic matter than, for example, intensively managed forests.[14]

The Swedish Environmental Protection Agency reveals in its National Inventory Report 2009, submitted under the United Nations Framework Convention on Climate Change, that the net carbon sink has decreased since 1990, especially during the last few years, due to increased forest felling and a severe storm called Gudrun in 2005 that brought down large quantities of forest.[15]

Worldwatch Institute emphasizes the importance of protecting forest areas. These areas store carbon and major releases in greenhouse gas emissions are avoided.[16]

Links, reports, news

1. Swedish University of Agricultural Studies (17.09.2009). News: *Undisturbed old-growth forests maximize carbon storage*, http://www.slu.se/?id=675&Nyheter_ID=11158&FunktionID=20
2. Worldwatch Institute (2009). Report: *Farming and Land Use to Cool the Planet* (Chapter 3), http://www.worldwatch.org/files/pdf/SOW09_chap3.pdf
3. Swedish Environmental Protection Agency (2009). Report: *National Inventory Report 2009*, http://www.naturvardsverket.se/upload/05_klimat_i_forandring/statistik/2008/NIR2009_sweden.pdf
4. Carlson, M, Wells, J. & Roberts, D. (2009). Report: *The Carbon the World Forgot*. Canadian Boreal Initiative & Boreal Songbird Initiative, http://www.borealbirds.org/resources/carbon/report-full.pdf

A warmer climate does not necessarily favor production

It is often emphasized that tree growth is expected to benefit from a warmer climate, but the opposite might actually be the case. Growth is likely to increase as temperatures increase moderately, but the growth will be inhibited when it reaches a certain threshold.[17] Respiration will then increase, while the uptake of carbon dioxide is expected to decrease.[18]

A study in the journal Nature found that both photosynthesis and respiration increase during autumn warming, but the increase in respiration is greater. In contrast, warming increases photosynthesis more than respiration in spring. Simulations and observations indicate that northern terrestrial ecosystems currently may lose carbon dioxide in response to autumn warming, offsetting 90 percent of the increased carbon dioxide uptake during spring. If future autumn warming occurs at a faster rate than in spring, the ability of northern ecosystems to sequester carbon may be diminished sooner than previously suggested.[19]

A temperature increase will likely increase decomposition and carbon losses from the soil.[20] An increased mean soil temperature will lead to faster decay, enhancing carbon dioxide release from decomposers, and thus upsetting the balance.[21] Water shortages during summers in combination with increased evaporation can lead to reduced tree growth.[22]

Nature conservation mitigates negative climate effects

Climate change undeniably implies increased stress and vulnerability to the forests and the species that live there. Intact forest landscapes and natural forests resist and recover better from fires, storms, insect outbreaks and other types of climate impacts, compared to fragmented areas and plantations. These areas give the trees, plants and animals better possibilities to migrate, adapt and survive in a climate that is changing.[23,24,25]

Links, reports, news:
Society for Conservation Biology (2007). News: *Nature conservation helps fight climate change*,
http://www.european-desertnet.eu/docs/PressreleaseSCB-ES_Uppsala_Feb07.pdf

Forests buffer microclimate

The boreal forest has its own microclimate, a complex system which involves a number of climatic and environmental variables, such as temperature, moisture availability and evapotranspiration (the transport of water into the atmosphere through evaporation from surfaces, soil and through transpiration from vegetation). This microclimate affects the local surrounding climate, which is disturbed when the forest is clear-cut.

Stable local climates shield trees, plants, and animals from the rapid changes in the aftermaths of climate change. Intact boreal forests maintain more stable temperatures throughout the year, reducing temperature stress and freeze-thaw damage in both spring and fall. Intact forests store more water when it is in excess and release water when it is in shortage. Clear-cut and bare-ground areas lose water rapidly – something which may delay the recovery of disturbed and logged forests.[26]

The levels of mercury are alarmingly high in fish from lakes in Sweden. Forestry operations result in significant increases in run-off export of mercury and methyl mercury from boreal forests to watercourses, rivers and lakes.[27] According to an article in the Swedish paper SkogsEko (no. 3/2009), the Swedish forestry is the cause of 25 percent of the mercury concentrations in fish. The run-off continues several years after the logging has been conducted.[28]

Links, reports, news
Royal Swedish Academy of Agriculture and Forestry (2009). Report: *Does forestry contribute to mercury in Swedish fish?* (no. 1/2009),
http://www.ksla.se/sv/retrieve_file.asp?n=1905

Forests form clouds

Boreal forests emit biogenic volatile organic compounds, called terpenes, into the atmosphere. These terpenes react with water vapor and form aerosols, which build up clouds. Terpenes emitted by boreal forests increase the formation of clouds, which reflect back the incoming sunlight. This has a cooling effect on Earth. When boreal forests are logged, the cloud formation is reduced, which will likely lead to increased atmospheric warming.[29]

Here large quantities of greenhouse gases are being released. The stately owned forest company Sveaskog has clear-cut the forest and conducted stump extraction (2009).

Clear-cuts release large quantities of greenhouse gases

When a forest is clear-cut, large amounts of carbon dioxide are released into the atmosphere. After logging, the soil respiration increases and large quantities of carbon dioxide is released into the atmosphere. This increase is due to the soil being exposed to solar radiation, which is associated with an increase in temperature. Soil scarification, when the soil is turned over, releases the carbon that is stored in the soil. The older the forest is, the more carbon is stored in the soil and the more carbon dioxide is released.[30] In many cases it takes over 100 years for the carbon stocks in logged forests to return to pre-logging levels.[31]

A Norwegian publication indicates that it might be more important to retain the carbon stocks in the forest than to try to achieve a fast re-uptake of carbon after forest loggings. The carbon storage in Norwegian forests is estimated to be 400-500 times as big as the yearly uptake.[32]

The forest also ceases to function as a carbon sink when the trees that sequester carbon are removed. The sparse vegetation in a clear-cut area cannot compensate for the carbon dioxide that has been released. The first 15 years after a clear-cut felling, the forest loses more carbon than it sequesters. After another 15 years (which makes it 30 years all together), the forest has compensated the initial losses and starts to accumulate carbon.[33]

Forestry methods are important

To safeguard biodiversity and mitigate climate change, old-growth forests should be excluded from forestry. However, it is of great importance that forestry in commercial forests is conducted with the least damaging effect. Each manipulation of the forest ecosystems (logging, etc.) leads to a release of large amounts of carbon dioxide. The so called clear-cut forestry of today should be avoided in order to minimize carbon dioxide emissions. Thinning and selective felling are better forestry methods from a climate perspective, since many trees are left on the felled area and the soil is not turned over to the same extent.[34,35] According to Anders Lindroth, Professor in Physical Geography at Lund University, Sweden, a modified forestry is necessary to avoid initial carbon losses. By avoiding the clear-cut phase and instead conducting continuous-cover forestry, the net up-take of carbon dioxide in Swedish forests could increase considerably.[36] Clear-cut areas should mainly be regenerated naturally, with a greater proportion of deciduous trees or coniferous/deciduous forests.[37,38] The deciduous trees' initial growth, and thus the rate at which carbon is reabsorbed from the atmosphere, is often faster compared to coniferous trees.[39]

Storm effects

In Sweden, Gudrun was a major storm in 2005 causing widespread wind-throw. The effect of wind-throw on carbon exchange is a reduction in absorption capacity of carbon dioxide and an increase in respiration from coarse woody debris decomposition (whereas carbon dioxide is released). The effective wind-thrown area after the storm Gudrun was estimated at 272 000 hectares. The soil, including the root systems, was significantly disturbed. Heavy disturbance was thereafter caused by machinery due to all trees lying in disorder on the surface after the storm. In addition, the normal rotation length of the forest was shortened.[40]

Since Gudrun in 2005, approximately 20 tons of carbon dioxide have been lost on average per hectare each year. The loss was larger the first years after the storm, but significant amounts of carbon dioxide are still being lost.[41] Storm damage and intensified felling have decreased the net carbon sink in Sweden.[42]

Links, reports, news (also see links under the reference notes)

1. Greenpeace (2008). Report: *Turning up the heat*, http://www.greenpeace.org/raw/content/canada/en/campaigns/boreal/resources/documents/turningupttheheat.pdf
2. Swedish University of Agricultural Studies (2009). News: *Thinned forest maintains the carbon sink*, http://www2.slu.se/forskning/2009/pdf/ShapingtheFuture.pdf
3. International Boreal Conservation Campaign. News: *Canada's Boreal Forest – Part of the global climate change solution*, http://www.interboreal.org/globalwarming/ibcc-borealandclimate.pdf
4. The Christian Science Monitor (10.03.2009). News: *Canada's carbon sink has sprung a leak*, http://features.csmonitor.com/environment/2009/03/10/canada%E2%80%99s-carbon-sink-has-sprung-a-leak/

Weblinks

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2. International Boreal Conservation Campaign, *Boreal Forest Protection Critical in world's fight against global warming*, http://www.interboreal.org/globalwarming/

Forest drainage leads to increased emissions of greenhouse gases

The Swedish government wants to increase the drainage of forest land. Many of the forest wetlands are already drained by ditches. Additional drainage will have a heavy impact on the ecosystem, damaging sensitive environments and its biodiversity. Drainage increases the emissions of nitrous oxide (N_2O) from forest areas.[43] Nitrous oxide is a greenhouse gas that is 298 times more powerful than carbon dioxide (per molecule basis, based on a time scale of 100 years).[44] Already, large quantities of the Swedish emissions of nitrous oxide derive from drained forest lands.[45]

The role of peatlands

Peat is comprised of accumulated decayed vegetation matter from mosses, grasses, shrubs, and trees, in permanently waterlogged conditions. When peatlands are drained by ditches, carbon dioxide and nitrous oxide is released. When the water level rises, the greenhouse gas methane (CH_4) is formed under oxygen deficient conditions.[46] Methane is a greenhouse gas that is about 25 times more powerful than carbon dioxide (per molecule basis, based on a time scale of 100 years). [47]

Disadvantages of forest fertilization

Nitrogen fertilization is used by the forestry to increase forest production and carbon sequestration in the soil. However, there are also increased risks with acidification, eutrophication and loss of biological diversity. Also, nitrous gas is emitted when the forest is fertilized. The risk is larger during winter when the plants' up-take of nitrogen is low in Sweden. The nitrogen surplus leads to an increased run-off of nitrogen.[48]

Scientists warn that fertilizers can disturb the forest's natural nitrogen fixation process, particularly in older, coniferous forests. The forest's natural nitrogen fixation process is carried out by cyanobacteria, which live on the shoots of feather mosses and convert nitrogen from the atmosphere to a form that can be used by other living organisms. By doing this, large quantities of nitrogen enter the forest ecosystem. The scientists have come to the conclusion that elevated nitrogen deposition from pollution and fertilizers reduce the bacteria's nitrogen fixation rates, which ultimately eliminates the natural nitrogen fixation in old forests.[49]

Links, reports, news

1. Swedish University of Agricultural Sciences (30.05.2008). News: *Forest canopies help determine natural fertilization rates – Scientists clarify controls on boreal nitrogen resource that dictates long-term forest productivity*, http://www.slu.se/?id=675&Nyheter_ID=8664&FunktionID=20

Forest products are negligible as carbon storages

The forest industry's products only sequester small amounts of carbon dioxide. This was stated by the Swedish Forest Agency during a seminar in October 2008 at Royal Swedish Academy of Agriculture and Forestry.

"It would be nice to say that it represents a large amount in the calculations, but it does not. The increased storage is negligible in furniture and paper. According to one calculation, the proportion of carbon in wooden houses is less than 0.4 million tons per year. This can be compared to up to the 10 megatons which are sequestered in protected forests. Emissions in Sweden correspond to 65 megatons," says Hillevi Eriksson at the Swedish Forest Agency. (this text is freely translated from the Swedish forest magazine SKOGEN).

Eriksson states that there are risks when too much emphasis is put on the changes in carbon stocks in international climate negotiations. However, the forest products are of significant importance for emissions, since they replace dirtier materials. When building a single-family wooden house, a lot less carbon dioxide is released compared to when concrete houses are built.[50]

The Swedish Forest Agency writes in its statement to the Government and Ministry of the Environment regarding the Swedish government advisory Climate Committee's report *Swedish Climate Policy* (SOU 2008:24):[51]

"It is written regarding the carbon balance of the forest: 'If the trees become wood or paper products, the release is delayed'. In this context, it is worth mentioning that there is no significant increased storage in wood and paper products in the Swedish society. We throw away and tear down at the same rate as we buy and build new. It should also be mentioned that the entire storage of such products is so small that any increase would be a relatively unimportant measure in this context. It is important in order to understand that, currently, we have a 'carbon sink' in the increasing growing forest stock only." (this text is freely translated into English)

Most of the carbon is stored in short-lived products such as paper, or is lost during logging, transport and processing.[52] According to Living Tree Paper Company, the pulp and paper industry is the fifth largest consumer of energy in the world, and it uses more water to produce a ton of products than any other industry.[53] Only a small fraction ends up in longer-term products such as timber.[54]

Biofuels are not always climate smart

Forest fuels affect the climate. Not even biofuels from the forest are climate neutral, since they all result in net emissions of greenhouse gases. Apart from the forest machines releasing carbon dioxide, many more links in the chain contribute to the global warming, e.g. the carbon storage in the soil decreases. Elforsk and IVL Swedish Environmental Research Institute have compiled and considered many aspects. Their study also includes a comparison between imported and domestic solid biofuels. Invaluable forest ecosystems are being exploited because of irresponsible production of biofuels all over the world (e.g. palm oil).[55]

The general view is that emissions of carbon dioxide from forest fuels are balanced by new vegetation, which sequesters carbon dioxide. If wood residues would be left in the forest, it would be decomposed over time, and carbon dioxide would be emitted. However, the losses of carbon dioxide from forest wood residues continue from a few years up to hundred years or more, depending on the type of biomass. Carbon dioxide emissions from the burning of biomass occur immediately.[56] It is important to bear in mind that the atmosphere does not tell the difference between carbon dioxide from biomass and carbon dioxide from fossil fuels. The burning of biomass contributes to the global warming just as much as the burning of fossil fuels. The difference is that the biomass is renewable, unlike fossil fuels.

Other things to keep in mind are that the amount of dead wood, which is important for several animal and plant species, decreases when forest biomass is removed from the forest. There is also an increased risk of acidification, since the nutrients in the wood residues are removed and do not enter the forest ecosystem.[57]

Increased production of biomass for energy has the potential to offset substantial use of fossil fuels, but it also has the potential to threaten conservation areas, pollute water resources and compromise food security. Deployed at a larger scale, biomass energy could exacerbate climate change. It is estimated that it will take 50 years to reach the break-even point for carbon balance, when replacing a forest with biomass energy agriculture. Because of the long time span needed for the re-absorption of carbon dioxide, the conversion of forests to biomass energy production is not recommended.[58]

A new study in the journal Science (2009) indicates that a global biofuels program will lead to intense pressure on land supply and can increase greenhouse gas emissions from land-use changes.[59] Other new studies show the same tendency.[60, 61] Fertilizer use is predicted to increase, which will make nitrous oxide emissions more important, in terms of warming potential, than carbon losses. A global greenhouse gas emissions policy that protects forests and encourages best practices for nitrogen fertilizer is suggested to dramatically reduce emissions associated with biofuels production.[62]

Links, reports, news

EurekAlert! (23.10.2009). News: *Biofuels - why we should proceed with care*, http://chinese.eurekalert.org/en/pub_releases/2009-10/aaft-b-w101909.php
Greenpeace (2008). Report: *How Unilever Palm Oil Suppliers are Burning Up Borneo*, http://www.greenpeace.org.uk/media/reports/burning-up-borneo
Greenpeace (2007). Report: *Cooking the Climate*, http://www.greenpeace.org/raw/content/international/press/reports/cooking-the-climate-full.pdf
Food and Agriculture Organization of the United Nations (FAO) (2005). Report: *Livestock's Long Shadow*, http://www.fao.org/docrep/010/a0701e/a0701e00.HTM

Missed goals in Sweden - ten scientists on forest-related challenges

Much more comprehensive measures are necessary to safeguard the forest diversity than what is the case with current forestry. This is the conclusion in the WWF Sweden report *Missed Goals* (*Missade mål* – only available in Swedish), where ten Swedish forestry and environmental scientists share their point of view. Investments in more intensive forest management, including increased ditch cleaning, stump extraction and usage of exotic species, are likely to threaten biodiversity. The report also highlights how climate change can be handled in the forest landscape.

Striving for goals

In 2007, over 1,500 scientists from 51 countries around the world called for the protection of half of Canada's Boreal Forest, while the rest of the forests should be managed sustainably.[63] This was in accordance with the Boreal Forest Conservation Framework, a plan already endorsed by Canadian conservation groups, Canadian First Nations (indigenous people), and industries.[64]

The governments of Ontario and Quebec have identified terrestrial carbon conservation as part of the basis for commitments to protect half of their northern boreal forest, an area accounting for over 725,000 km^2.[65]

Links, reports, news

WWF (2008). Report: *Living Planet Report 2008*, http://assets.panda.org/downloads/living_planet_report_2008.pdf

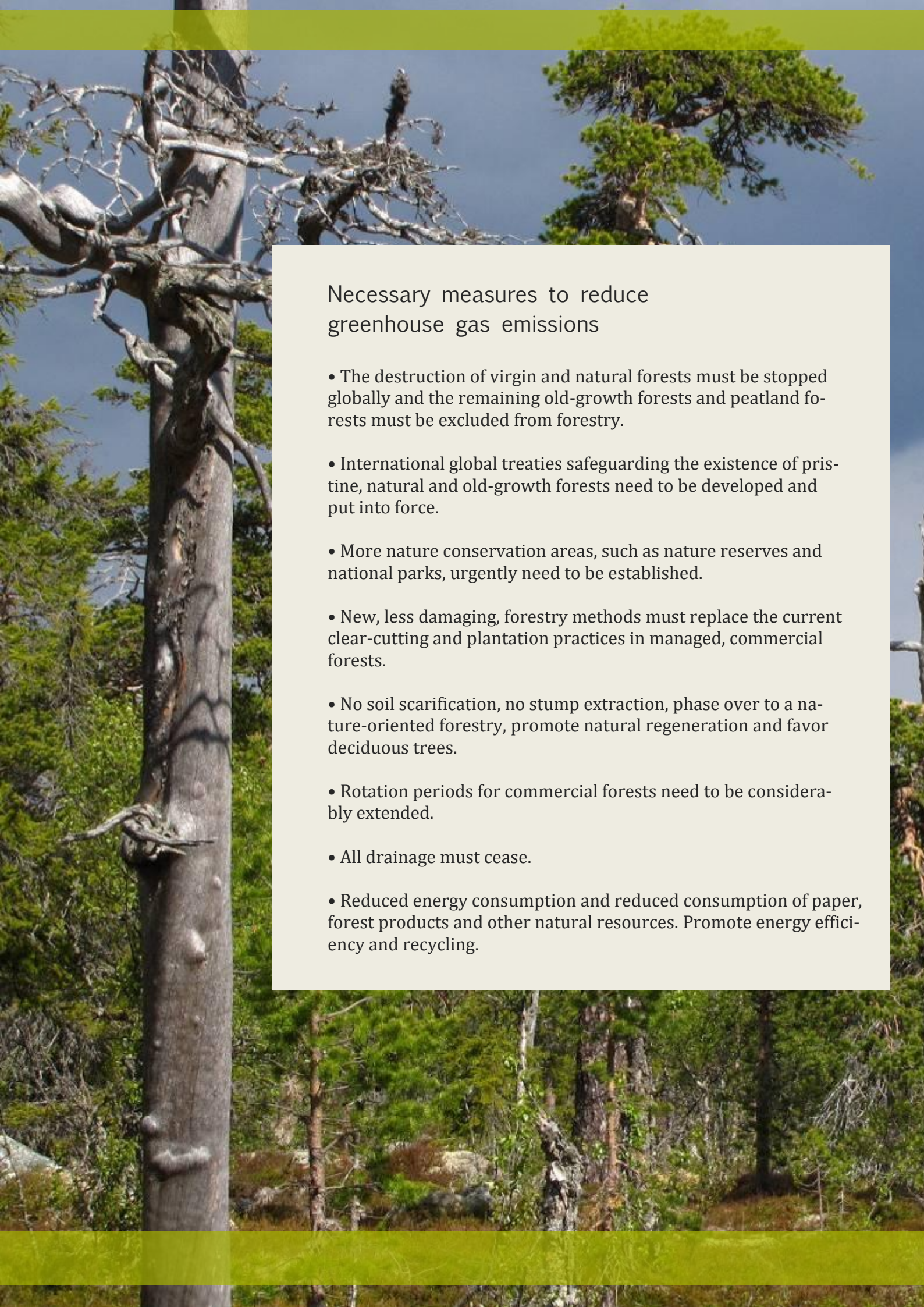
Rockström, J. et al. (2009). Report: *A safe operating space for humanity*. Nature 461, 472-475 (24 September 2009), http://www.nature.com/nature/journal/v461/n7263/full/461472a.html

WWF Sweden (2008). Report: *Missade mål* (*Missed Goals*), http://www.wwf.se/source.php/1192603/Missade%20m%E5l%20Skogsrapport%202008.pdf (Only in Swedish)

WWF Sweden (21.04.2008). News: *Sverige missar miljömålet i skogen* (*Sweden misses environmental goal in the forest*), http://www.wwf.se/press/1171034-sverige-missar-miljomalet-i-skogen (Only in Swedish)

Goldenberg, S. (29.10.2009). News: *Canada sets aside its boreal forest as giant carbon vault*. Guardian.co.uk, http://www.guardian.co.uk/environment/2009/oct/29/canada-boreal-forest-carbon-vault

Check, E. (17.05.2007). News: *Canadian government pushed to protect land*. Nature 447, 241, http://www.borealbirds.org/news_pages/news_detail.php?a_id=559



Necessary measures to reduce greenhouse gas emissions

• The destruction of virgin and natural forests must be stopped globally and the remaining old-growth forests and peatland forests must be excluded from forestry.

• International global treaties safeguarding the existence of pristine, natural and old-growth forests need to be developed and put into force.

• More nature conservation areas, such as nature reserves and national parks, urgently need to be established.

• New, less damaging, forestry methods must replace the current clear-cutting and plantation practices in managed, commercial forests.

• No soil scarification, no stump extraction, phase over to a nature-oriented forestry, promote natural regeneration and favor deciduous trees.

• Rotation periods for commercial forests need to be considerably extended.

• All drainage must cease.

• Reduced energy consumption and reduced consumption of paper, forest products and other natural resources. Promote energy efficiency and recycling.

Conclusions

What we need is climate-smart solutions to solve the climate issue. However, the solutions must be long-term and not formed according to the industry's growth demands. Global consumption exceeds the Earth's production capacity to regenerate by 30 percent - the rich countries have the largest ecological footprint. The development of many ecosystems and species continue to point downwards. Three out of four countries are ecological debtors. By the early 2030s, two planets will be needed to maintain our lifestyles, according to Living Planet Report 2008 (WWF).

Merely replacing fossil fuels with biofuels from devastated forests, while maintaining the current consumption and growth patterns, will exacerbate the situation. There is a significant risk that the increasing population and global consumption growth pattern will neutralize the positive effects of biofuels and more efficient technology used in light bulbs and cars, etc. We rapidly need to phase out fossil fuels and get rid of hazardous energy sources, in order to safeguard the environment of generations to come. The energy alternatives must be carefully analyzed by Environmental Impact and Life Cycle Assessments. The primary sustainable long-term solution to the climate change problem is a factual reduction in consumption of natural resources. We need a more fair distribution globally, we need to support and encourage local production and smarter energy, transportation and technology solutions. Last but not least, a focus on biodiversity and the protection of old-growth forests is a step in the right direction towards a more climate-smart society.

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