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## On the climate impacts of boreal forests

The climate benefit of utilizing biomass from Norwegian forests is currently being discussed controversially. The public debate focuses primarily on the carbon balance of different forest management practices, which is only one factor affecting climate. The following summary highlights important research findings from international peer-reviewed journal literature which are highly relevant for the development of policies and strategies for the forestry and bio energy sectors.

### ***1. There are other factors than the CO<sub>2</sub> emission balance that influence the climate impact of forests***

- It is well known that changes in forest management practice to accommodate increased outtake of biomass for bioenergy purposes *may* cause a period of higher GHG emission (carbon debt) compared to a reference case with unchanged management and use of fossil fuels (Marland and Schlamadinger 1995; Schlamadinger and Marland 1996).
- There are, however, other factors than GHG emissions that are important for the climate impacts of forests. These can alter temperatures much more than the CO<sub>2</sub> balance of the forest does, and often in a conflicting way (Pielke Sr., Marland et al. 2002; Bonan 2008; Jackson, Randerson et al. 2008).
- These factors, stemming from changes in the physical properties of Earth's surface, can affect the surface solar reflectivity (albedo), the fluxes of sensible and latent heat to the atmosphere, and the overall distribution of energy within the climate system (Pielke Sr., Marland et al. 2002; Marland, Pielke et al. 2003).
- Failure to account for these may have consequences that are potentially at odds with the aims of climate change mitigation (Betts 2007).

## ***2. The reflection of sunlight from snow cover is significant for the overall climate impacts of boreal forests.***

- A growing body of literature describes the importance of snow cover reflection for the overall climate impacts of forests in boreal and other snow-covered regions, where darker trees absorb more heat and radiation than snow does. (Bonan and Pollard 1992; Betts 2000; McGuire, Chapin et al. 2006; Randerson, Liu et al. 2006; Bala, Caldeira et al. 2007; Thompson, Adams et al. 2009).
- “Biogeophysical processes influence climate more immediately than does the carbon cycle. Slow rates of carbon accumulation in boreal forests may in the short-term be offset by more rapid albedo changes” (Bonan 2008).

## ***3. Several studies have shown that afforestation in boreal regions may be counterproductive to climate mitigation.***

- Afforestation in boreal systems may actually contribute to global warming rather than cooling because of the importance of the snow-cover albedo feedback (Bonan and Pollard 1992; Betts 2000; McGuire, Chapin et al. 2006; Randerson, Liu et al. 2006; Bala, Caldeira et al. 2007).
- Forest projects in boreal forest systems should be preceded by thorough analyses of the true cooling potential before being included in climate policies (Jackson, Randerson et al. 2008).
- A “carbon-only” accounting approach that ignores albedo impacts can significantly overestimate the climate benefit of forestation in some regions, warranting the need for more location-specific assessments (Thompson, Adams et al. 2009) which are inclusive of the relevant climate impact mechanisms and metrics (Pielke Sr., Marland et al. 2002).

## ***4. Boreal forest fires may even have a net climatic cooling effect.***

- An article in *Science* has shown that a forest fire in Alaska resulted in net climatic cooling. The cooling due to increased snow cover albedo was shown to outweigh the warming from increased CO<sub>2</sub> in the atmosphere during the succeeding regrowth period (Randerson, Liu et al. 2006).

***5. The authors recommend that substantial revisions to the Norwegian Government's policies on forest and bio energy should await the establishment of a broad international scientific consensus.***

- There is an increasing volume of international peer reviewed literature highlighting the complexity and challenges of addressing the climate impacts of boreal forests and bio energy systems.
- More research is needed to understand the best management practices for boreal forests with respect to climate mitigation. This must include assessments that go beyond CO<sub>2</sub> balances.
- We discourage the design of Norwegian climate policies based on any single individual research contribution. Due to the intricacy and breadth of the issue, it is strongly advised to build policies on a strong international scientific consensus which respects the peer-review process.
- The upcoming 5<sup>th</sup> Assessment Report of the IPCC will summarize the international peer-reviewed research, assess the degree of consensus, and evaluate the mitigation potential associated with different strategies.
- ***Any policy-oriented recommendations prescribed today should be interpreted with great caution.***

Several Norwegian institutions have ongoing research projects that will directly or indirectly contribute to a better understanding of the total climate implications of alternative forest management regimes in Norway which are inclusive of land ecosystem-atmosphere interactions (like albedo change) in metrics that extend beyond emission-based accounting.

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