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# WILL AFFORESTATION IN TEMPERATE ZONES WARM THE EARTH?

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For decades, forest researchers have known that afforestation can lower the surface albedo and that landscapes with low albedo will absorb more solar radiation than more reflective surfaces. As a result, afforestation will typically darken the surface of the Earth (when compared to grasslands or deserts). This darkening of the landscape can be measured and the local warming effect can be quantified.

In spite of this knowledge, many believe that afforestation will have a cooling effect on the Earth's atmosphere since wood is composed of carbon molecules. As a result, there are two schools of thought when it comes to claiming how afforestation will affect the climate. The "CO<sub>2</sub> school" believes that afforestation will have a cooling effect, regardless of the location of the plantation. In contrast, the "holistic school" believes the climate is a complex system that is affected by numerous variables, including clouds and the surface albedo. Many from this school say that afforestation in boreal zones could have a warming effect on the Earth.

Some say that afforestation in temperate zones will cool the Earth (Montenegro and others 2009) while others suggest it might warm the Earth (Feddema and others 2005, Barnes and Roy 2008, South 2008). Others say the effect is not clear (Bonan 2008, South and others 2011) or that the effect is not statistically different from zero (Arora and Montenegro 2010, Fall and others 2010). Some say the result would depend on both growth rate of the plantations and the amount of change in the albedo of the Earth's surface. Afforestation with slow growing conifers in high altitude zones (e.g. the Pyrenees) may not sequester much carbon by 2050 but it would have a relatively large effect on the albedo. In contrast, afforestation with exotic conifers in New Zealand would sequester more carbon and would have less of a change in surface albedo (Kirschbaum and others 2011). In some arid zones, it may take 5 to 8 decades before the "carbon sequestration" effect will equal the warming effect from darkening the Earth's surface (Rotenberg and Yakir 2010).

The climate is not a simple system and therefore, there is no simple answer to the question "will afforestation in temperate zones warm the Earth?" The answer will vary depending on the model used and if the answer is related

to "global effects" or just "local effects." Some modelers have suggested that afforestation in the Tropics would cool the Earth while Boreal afforestation would warm the Earth. We claim we do not know if afforestation in temperate zones will have any statistically significant effect on the global temperature. To date, the climate models used in the modeling have not been verified and this makes speculations about "global" effects questionable. We have a low level of confidence that the predictions from these models are accurate down to the second decimal place (ie. 0.01°C). In the absence of data, we doubt that afforestation in temperate zones is an effective practice for the mitigation of climate change.

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**Table 1—Estimated temperature effects from afforestation and deforestation. Estimated costs are not associated with deforestation since short-term profits are typically obtained with the sale of wood products**

| Region               | change (ha)   | Cost          | Temperature effect              | Reference                 |
|----------------------|---------------|---------------|---------------------------------|---------------------------|
| <b>AFFORESTATION</b> |               |               |                                 |                           |
| Arctic               | +0.3 billion  | \$300 billion | Arctic warmed $\approx +1$ C    | Swann and others 2010     |
| Arctic               | +0.1 billion  | \$100 billion | Globe cooled $\approx -0.015$ C | Arora and Montenegro 2011 |
| Temperate            | +1 billion*   | \$1 trillion  | ?????                           | House and others 2002     |
| Temperate            | +0.1 billion  | \$100 billion | Globe cooled $\approx -0.017$ C | Arora and Montenegro 2011 |
| Tropical             | +0.1 billion  | \$100 billion | Globe cooled $\approx -0.07$ C  | Arora and Montenegro 2011 |
| <b>DEFORESTATION</b> |               |               |                                 |                           |
| Arctic               | -1.37 billion | --            | Arctic cooled $-3.3$ C          | Bala and others 2007      |
| Temperate            | -1.04 billion | --            | Land in NH cooled $-0.7$ C      | Bala and others 2007      |
| Temperate            | -1.04 billion | --            | Globe cooled $-0.04$ C          | Bala and others 2007      |
| Tropical             | -1.76 billion | --            | Globe warmed $+0.7$ C           | Bala and others 2007      |

\*Assumes temperate forests can sequester 200 tonnes C/ha