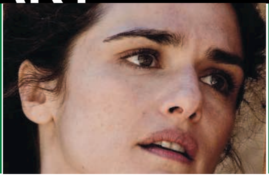

LETTERS

edited by Jennifer Sills

Forests and Climate: A Warming Paradox

E. ROTENBERG AND D. YAKIR ("CONTRIBUTION OF SEMI-ARID FORESTS TO THE CLIMATE SYSTEM," Reports, 22 January, p. 451) showed that forestation may not be an effective tool for climate change mitigation. They found that in a semi-arid landscape, the warming potential of a forest due to changes in the surface albedo and the longwave radiation emission far outweighs the cooling effect due to carbon sequestration. However, their analysis did not address the fact that the radiation balance of the surface is not the same as the radiation balance of the climate system. The atmosphere retains a significant portion of the longwave radiation emitted and the shortwave radiation reflected by the surface. Globally, only 10% of the surface longwave radiation escapes the atmosphere to the outer space (*1*). The escape fraction over Rotenberg and Yakir's site is probably higher due to low cloud cover, but not by much: The outgoing longwave radiation for a clear sky at the top of the atmosphere suggests a maximum of 20% (*2*). Similarly, because of atmospheric absorption and cloud reflection, the local albedo at the top of the atmosphere is lower than the surface value. By not taking into account this energy redistribution, Rotenberg and Yakir may have substantially overestimated the warming effect of forestation (and the cooling effect of desertification).

A deeper issue, also related to energy redistribution, is whether it is accurate to combine the CO_2 radiative forcing and the surface radiation change for the purpose of analysis. To help policy discussions, the greenhouse effects are often expressed as climate sensitivity (*3*), estimated at ~0.8°C increase in the surface temperature per W m^{-2} increase in the radiative forcing (*4*). The surface exchange process does not work that way. Rotenberg and Yakir's paradoxical result—that the forest, being an efficient convector, is much cooler despite more radiation loading than the shrubland—provides a powerful argument against combining the two quantities. In humid climates, forests also cool the surface by removing its latent heat, which is released above the atmospheric boundary layer by cloud condensation.

XUHUI LEE

School of Forestry and Environmental Studies, Yale University, New Haven, CT 06511, USA. E-mail: xuhui.lee@yale.edu

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Yatir forest. In their Report, Rotenberg and Yakir studied the semi-arid Yatir forest in Israel.

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Forests and Climate: The Search for Specifics

E. ROTENBERG AND D. YAKIR ("CONTRIBUTION of semi-arid forests to the climate system," Reports, 22 January, p. 451) demonstrate that dryland afforestation amplifies global warming and that desertification has resulted in net global cooling. However, the climatic impact of desertification warrants a more detailed analysis.

First, Rotenberg and Yakir's results from Yatir forest [located at the arid/semi-arid transition zone (*1*)] cannot be extrapolated to all areas undergoing desertification. Modeling the climatic effects of land-use change must account for diverse climate sensitivities dependent on various combinations of plant communities and climate (*2*).

Second, the spectral properties of infrared radiation reflected from green vegetation are fundamentally different from those of exposed soil (*3*). Unlike the radiation generated by soil, vegetation-derived shortwave infrared radiation (700 to 2000 nm) hardly interacts with the major absorption bands of CO_2, H_2O, and methane and dissipates substantial amounts of energy to space that are not accounted for by conventional analysis of albedo effects.

Third, common dryland ecosystems (open woodlands, savannas, and grasslands) differ from the pine forest analyzed by Rotenberg and Yakir. Such ecosystems have higher albedo than pine forest and produce an average 7 tons of biomass per hectare and year (*4*). Drylands support high biodiversity and provide livestock fodder, woody biomass, or high-value agricultural products (*5*, *6*). Desertification may have benefits in terms of increasing albedo, but those come at a cost: fossil fuel use, progressive further land degradation, and a shift to intensive irrigation agriculture that will result in high additional energy costs and greenhouse gas emissions.

We must address these questions before rendering final judgment on the climate sensitivity of desertification processes.

STEFAN LEU