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Forest Research for the 21st Century

LAST MONTH THE UNITED NATIONS (UN) CONCLUDED A BIODIVERSITY CONFERENCE IN Bonn, Germany, where delegates from 191 countries negotiated "access to and sharing of the benefits of the rich genetic resources of the world." Many of these resources reside in forests, which cover 4 billion hectares or 30% of Earth's land. Forests are decreasing at a rate of 7 million hectares annually, mostly in the tropics. How can research encompassing the ecological, social, economic, and political dimensions of forest conservation contribute to reducing forest destruction and maintaining biodiversity, climatic stability, and the livelihoods of the poor, 40 to 50% of whose resources come from forests?

We continue to learn about how rainforests support so many species in so little space. We also better understand how the social drivers of change, including subsistence needs, global market forces, and political governance, result in the degradation and fragmentation of forests. But much less has been achieved in addressing how to attain forest sustainability in all its dimensions.

Monitoring the global status of forests and changes in their attributes, as is being done by the Food and Agriculture Organization of the UN (with government data), must continue, in combination with satellite-based remote sensing, to know where the most rapid changes are taking place, as shown for Amazonia, Africa, and southeast Asia. Also, computer modeling of vegetation has used climatic data from general circulation models to simulate shifts in global biome boundaries under changing climate, and empirical-statistical "bioclimate envelope" models have done likewise for plant species distributions. These analyses provide a broad understanding of the spatial direction of potential shifts in biomes and species but need refinement for use in regional adaptation strategies for forest conservation.

We need to know more about forest structure and function: plant physiological ecology (photosynthesis, respiration, and nutrient and water use); phenology (leaf flush and senescence, flowering and pollination, fruiting and dispersal, and seed germination and regeneration); community competitive interactions; and population dynamics. This knowledge may help in predicting how trees will respond to changes in temperature, precipitation, and other climatic variables projected for this century—information needed to take measures to minimize species extinction.

Forests have been promoted for their role in carbon sequestration and climate mitigation, but the strength and duration of the terrestrial carbon sink are unclear, especially for tropical forests. Vulnerability to invasive species, pests, diseases, and fires has to be factored into these studies as well as the complex carbon and nutrient dynamics of forest soils.

As for the sustainable management of forests, there are two major components: the harvest of roundwood valued at U.S. $64 billion annually and of non-wood products with a reported value of U.S. $4.7 billion annually. Sustainable harvest of industrial roundwood from temperate forests has considerable scientific backing (such as in Sweden), but this is not the case with tropical forests. Although hundreds of millions of people across the tropics depend directly on fuelwood and non-wood products, we still need to develop sustainable harvest practices. This complex task requires research on all aspects of plant species' biology, and the ability to separate the influences of natural factors versus human use in their dynamics. Socioeconomic changes have to be factored into research on future demand and supply of non-wood forest products. In Malaysia, there are now attempts to sustainably manage rainforest logging, although large-scale conversion of forests to oil palms for biofuel production has already occurred.

China is increasing its forest area of 200 million hectares by planting 4 million hectares annually. Brazil is aiming at carbon credits for reducing deforestation, presently 3 million hectares per year. India has made similar demands for forest conservation and afforestation. Research should help integrate such efforts with the broader goals of carbon sequestration, biodiversity conservation, and reversing forest fragmentation.

Given environmental variability and the long-lived nature of trees, long-term studies with comprehensive mandates extending from basic to applied research are likely to be the most useful in providing the scientific basis for sustainable forest management. **– Raman Sukumar**

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