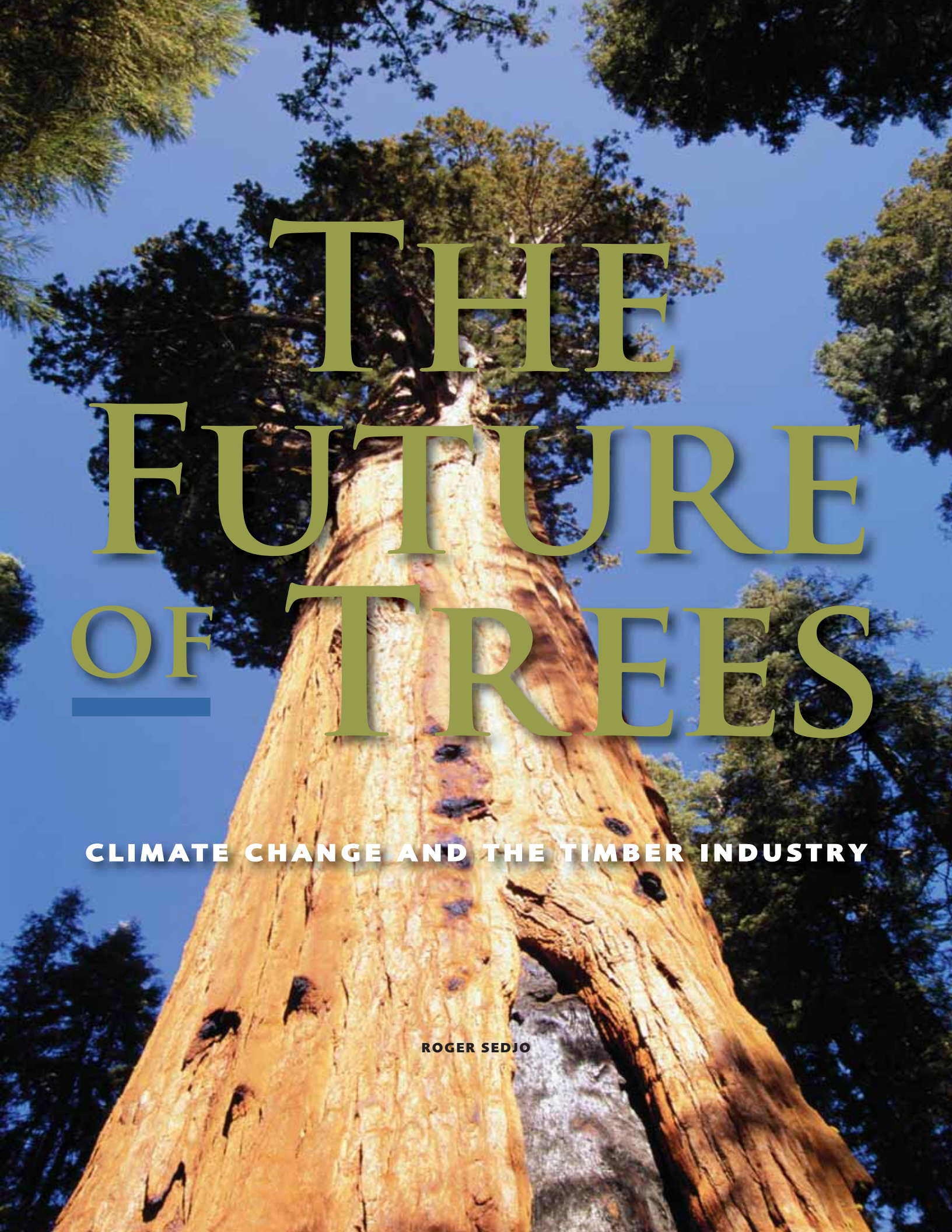

THE FUTURE OF TREES

CLIMATE CHANGE AND THE TIMBER INDUSTRY

ROGER SEDJO

Not all the news on global climate change is gloomy. Global production of industrial timber should increase, even in the face of some regional losses.

In a warming world, global forest area could increase by 5 to 6 percent by 2050. Forest productivity—essentially, the rate at which the trees in the forest grow—is expected to rise. Timber harvests could be 6 percent greater in 2050 than they might have been without warming. In either scenario, forests would colonize unforested regions, and there would be large-scale conversions from some forest types to others. The equatorial region may not change much, but I predict there will be a significant expansion of forests in the high latitudes.

These estimates are based on a report that I recently submitted to the World Bank looking at how the world's forests can be expected to change in a slightly warmer world. My aim was to predict the fate of the worldwide timber industry to the year 2050 if levels of carbon dioxide (CO_2) were to double from those of the late 1990s. To accomplish this, I reviewed the substantial body of climate change literature and used studies that paired two commonly used climate change models (the Hamburg T-106 model and the UIUC model) and an ecosystem model (BIOME$_3$) to provide a starting place for my economic analysis. Although my focus was on global impacts, I also examined some regional cases and suggested steps that the global community might undertake to compensate developing countries for their losses and minimize any future ones they may experience.

Not every forest will thrive, however, and some forests will die back. The fate of individual forests will depend upon the interaction of several variables, including temperature; moisture; and changes in natural disturbances, such as fires and infestations. Some tree species will persist in a region while others will decline.

How Climate Change May Affect Forests

Forecasters predict that the most dramatic increases in temperature will occur in high latitudes. Forests can adapt to undesirable changes in temperature by "migrating" to a more favorable climate. Boreal forests, which prevail in northern latitudes, eventually could possibly replace up to 50 percent of what is now frozen tundra. The temperate forests of the middle latitudes may also expand into lands formerly dominated by boreal forests. These relocated forests will not look exactly like their predecessors, because only some species will thrive and less adaptable species will die off. Temperatures in the equatorial regions should not increase dramatically, so tropical forests will not likely change much if at all.

Migrating forests require more than just an agreeable temperature. They need suitable soil, sufficient moisture, and adequate daily sunlight. They also need time. If temperatures rise too fast or if trees cannot meet their other cultural requirements, some trees, and perhaps entire forests, may die before they can migrate. Some of this dieback is expected at the southern boundary of the boreal forests.

A Quick Botany Lesson

Trees require CO_2 to grow, so the increased levels of CO_2 that are contributing to climate change are a boon to them. This *carbon fertilization effect* may be significant, particularly during the prime growth years. In one study, trees grew 23 percent faster in a high CO_2 environment. Although it will take more research to determine the limits to this beneficial effect, one thing is not in doubt: both CO_2 and forest growth rates have been increasing since the middle of the 20th century.

Changes in precipitation and moisture may have the greatest impact on forests. Climate models are limited in their ability to predict precipitation changes, but they tend to agree that continental interiors will become drier. This could be problematic for some forests; some midlatitude regions may convert to grassland because they are too dry for the forests that live there. We know little about the adaptability of tropical forest species; if they are not resilient, a drier environment may overwhelm them.

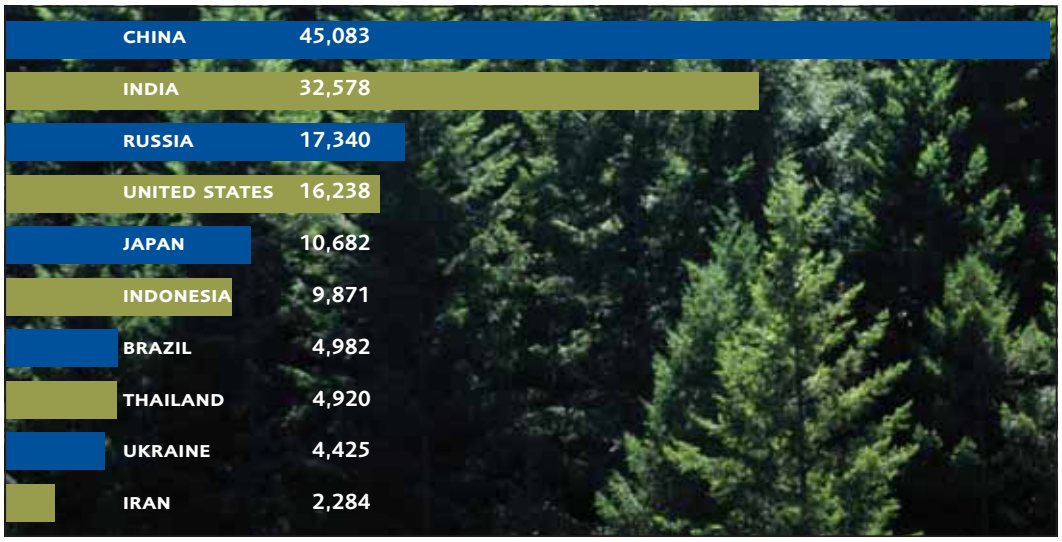

Figure 1.

Forest Plantation Development Area (1,000/hectares)

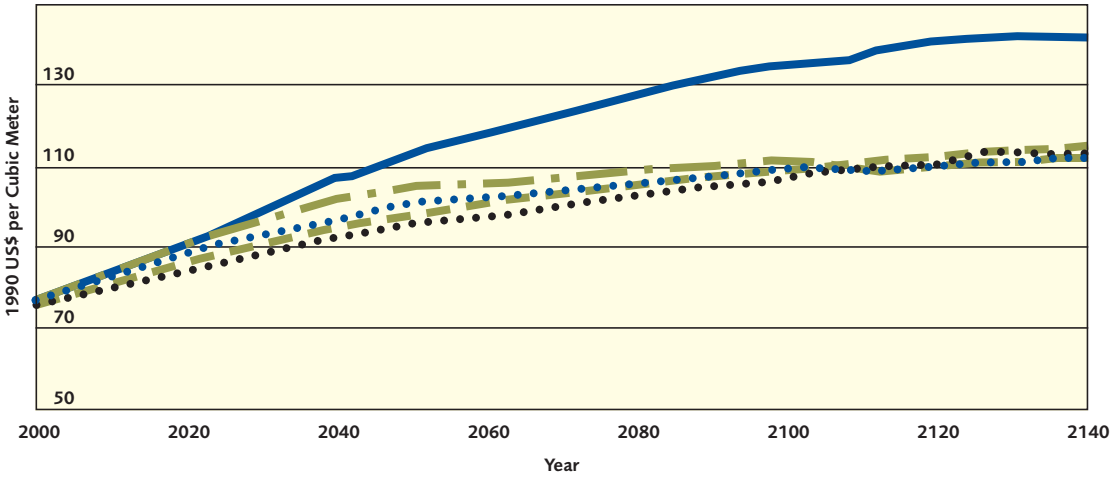

Figure 2.

Global Timber Prices Over Time

Baseline Case
Hamburg Regeneration
Hamburg Dieback
UIUC Regeneration
UIUC Dieback

Source: Sohngen et al. 2001.

Northern and coastal regions may become wetter. Trees tend to thrive in moist environments, so forests in these areas may succeed, even in the face of higher temperatures.

Healthy forests can tolerate many natural disturbances, such as wildfires, disease, pests, and wind. As trees are stressed by changes in temperature and precipitation, they may be less able to withstand natural disturbances. Climate change is expected to increase the frequency and severity of some disturbances, such as wildfires and pest infestations. Forests that adapt poorly are likely to suffer, and this process may be occurring already. Devastating infestations of beetles have recently threatened forests in western Canada, and many scientists believe it is because warmer winters have allowed the insect population to flourish.

Changes Ahead for the Timber Industry

Historically, wood for industrial use came from the vast natural forests of the temperate regions—North America, Russia, and northern Europe. Gradually, the natural forests of Southeast Asia and the South American and African equatorial regions became major sources of timber. Today, natural stands are being eclipsed by planted forests, which are expected to provide more than half of the world's industrial wood by midcentury. Global change could hasten this transition, as some natural forests die back and are replaced by planted forests in suitable species.

Many of these planted forests reside in regions, such as Asia and Latin America, that did not play a big role in the timber industry before. Figure 1 shows the amount of land devoted to planted forests in various countries. Some of this was planted to restore and conserve forests, but much of it is destined for harvest.

When a resource is abundant, prices fall. Figure 2 presents five scenarios of wood price projections until 2140. The baseline case assumes no climate change. There are two scenarios for each climate model, one anticipating that lost forests will regenerate and one predicting they will not. The striking conclusion is that in either global change scenario, timber will be significantly more abundant than it would be in the absence of climate change.

According to the Hamburg model, near-term losses will be greatest in the middle- and high-latitude regions of North America, the former Soviet Union, China, Oceania, and Europe—regions that currently supply 77 percent of the world's industrial wood. Meanwhile, forests in the lower-latitude regions of South America, India, Asia-Pacific, and Africa will thrive, because temperature changes will be minimal but CO_2 levels will increase. The northern regions will become more productive once valuable species have again taken hold and matured. The UIUC model foretells less dramatic changes in the middle and high latitudes, but greater temperature increases in the tropics, which would mean less dramatic productivity gains in that region.

The Future of Forestry

Although we cannot know what will become of individual forests in the coming decades, managers can prepare for and minimize the effects of climate change. In most areas, little or no adaptation will be necessary. Those who manage natural forests may consider converting some vulnerable natural acreage to planted forests with either current species that have short rotations or new, more sustainable species by providing for the distribution of new seed sources. This could substantially reduce losses that might occur if natural systems adapted on their own.

Where adaptation measures are required, the cost may be high. Any increase in natural disturbances may require higher training and containment costs, at least while trees are adjusting to new environmental conditions. Pest infestations may require managers to replant with different species or to use genetic engineering to create pest-resistant strains of a species already in place. Fires may be more prevalent and require expensive control activities. Forestry may no longer be profitable in some areas, so resource managers may have to plan for alternative land uses. Plantation managers may have to replant other species or relocate, but increased productivity may offset these costs. ■

Further Reading

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THREE CASE STUDIES

Brazil, South Africa, and China have invested heavily in planted forests. Currently, China is the world's leader in the establishment of planted forests, while Brazil ranks seventh. South Africa's contribution is much more modest, but the country is a player in the international pulp and paper industry. I studied the potential effect that climate change could have on the timber industry in each of these countries. In a warming world, they face very different futures.

China

China's forests have made a remarkable recovery in the last 30 years, largely because the government established large areas of planted forest that have increased from 28 million hectares in 1986 to 48 million hectares in 2001. Total forested land area in China has increased from 107.2 million hectares to 158.5 million hectares between 1986 and 2005 and plans to continue expanding its forest area.

China faces only modest challenges to its wood industry from climate change. The main threat appears to be infestations, which have plagued some of the noncommercial poplar forests in the country's interior. China is responding to this threat with pest-resistant genetically engineered poplar trees. If pests begin to attack timber trees, the country could face significant adaptation costs. Overall, however, the outlook for China is positive, particularly because of the country's active policies to establish, manage, and protect its forests.

Brazil

Forest plantations comprise only 1 percent of Brazil's land area, yet they are the core of the country's forest industry. Approximately 50 percent of the total industrial wood now produced by Brazil comes from the 6 million hectares of planted forests and the country plans to plant an additional 500,000 hectares of land annually. The focus is on fast-growing industrially important species that will expand the country's market share by 0.8 percent per year over the next 50 years.

The plantation areas of southern and southeastern Brazil are likely to warm, which would open up new frost-free territory for commercial production of eucalyptus. Pine, another major industrial species, can continue to thrive, although it may be necessary to replace loblolly pine with the more tolerant slash pine or tropical pines if temperatures rise substantially. Pine and eucalyptus are resilient and easily relocated, if necessary. Some forested land may convert to grassland as a result of decreasing rainfall, in which case it would become too costly to try to maintain a forest industry in those areas. Overall, however, climate change should generate more benefits than damages for Brazil's wood-producing industry, at minimal cost.

South Africa

Most of South Africa is arid or semi-arid, with forest plantations concentrated in a swath of relatively moist, frost-free upland. Even today, there are occasional droughts. Compared to other timber-producing countries, South Africa's investment has been small and erratic. In recent years, South Africa has planted an average of 11,000 hectares per year. It had been difficult for the country to locate suitable land in politically stable areas.

Climate change could spell the end of South Africa's timber industry. If the winters become drier, forests may yield to grassland. Irrigation is not economically feasible, and the other regions of the country are already too dry for forests. A small amount of grassland may become wet enough to support forests. Otherwise, the country would need to consider how best to salvage the timber it has before converting the land to grazing or other uses.