CHAPTER 17

Land-use Change and Forestry

Emissions

An estimated 18 percent of global GHG emissions (and 24 percent of CO_2 emissions) are attributable to land use change and forestry (LUCF)[179] (Figure 17.1). This contribution is the largest for any single sector, with the exception of electricity and heat. Estimates reflect the CO_2 flux (emissions and sink absorptions) from the following activities: land clearing for permanent croplands (cultivation) or pastures (no cultivation), abandonment of croplands and pastures (with subsequent regrowth), shifting cultivation,[180] and wood harvest (industrial and fuelwood).[181] The largest source is deforestation driven by the conversion of forest to agricultural lands, primarily in developing countries (Figure 17.2).

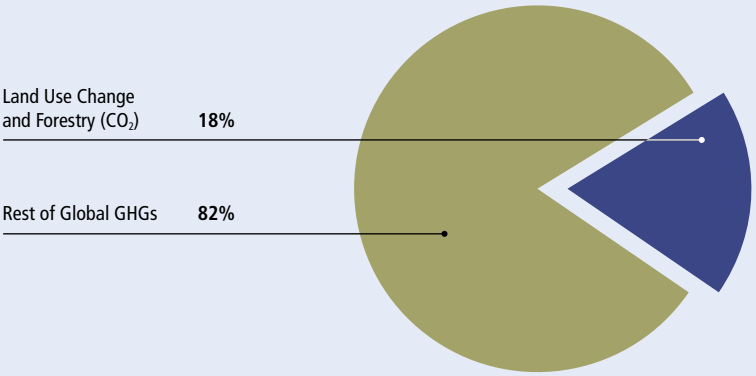
Emissions and absorptions from LUCF have several unique characteristics. First, the pattern of emissions and absorptions across countries is unlike any other sector (see Figure 17.3). Most countries have very small fluxes, either slightly positive or slightly negative (that is, sequestering more CO_2 than they emit in this sector). A majority of LUCF emissions come from tropical countries;[182] estimates by Houghton (2003a) suggest that the largest sources are Indonesia and Brazil, with 34 percent and 18 percent, respectively, of the global total. Some countries that are not among the largest overall GHG emitters account for significant shares of the global total from land-use change and forestry. They include Malaysia, Myanmar, and the Democratic Republic of Congo. For developing countries collectively, CO_2 from LUCF constitutes an estimated one-third of total emissions (see Chapter 2).

Industrialized countries, on the other hand, are presently believed to be net *absorbers* of CO_2. This is due to land clearing in North America and Europe prior to the 20th century. During these periods, deforestation emitted significant quantities of CO_2, while today's forests are absorbing CO_2 through natural regrowth. Thus, the profile of emissions across countries has changed significantly over time. Estimates for 1875 show North America, Europe, and the former Soviet Union contributing more than two-thirds of global LUCF emissions during that time period.[183]

Second, a unique characteristic of the sector is that emissions and absorptions of CO_2 in the terrestrial biosphere depend on complex interactions between the carbon cycle, nutrient cycles, and the hydrological cycle.[184] Each of these can be influenced by human activities, though it can be difficult to discern what effects are said to be "human induced."

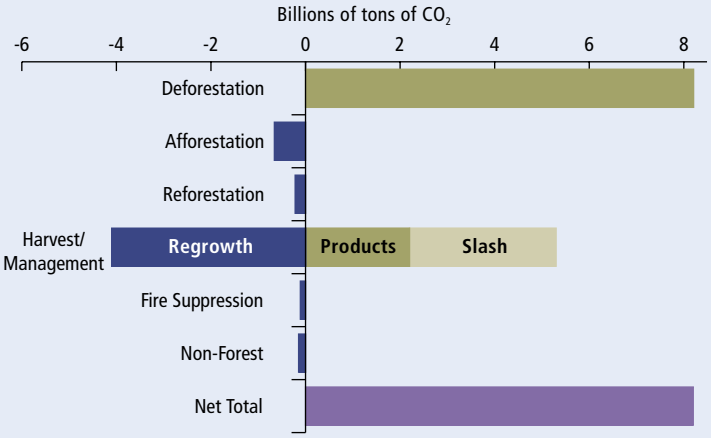
Third, and related, emissions data from the land-use change and forestry sector are subject to extraordinary uncertainties.[185] The IPCC estimates that, during the 1990s, global LUCF emissions aver-

Figure 17.1. CO_2 from LUCF



Sources & Notes: CAIT, based on Houghton, 2003a. See Appendix 2 for sector definitions and data sources. Absolute emissions in this sector, estimated here for 2000, are 7,619 $MtCO_2$.

Figure 17.2. Annual Emissions and Absorptions from Land-Use Change Activities, *Global estimates for the 1990s*



Sources & Notes: Houghton, 2003b. Deforestation and reforestation in tropical countries include only the net effect of shifting cultivation. For afforestation, areas of plantation forests are not generally reported in developed countries (this estimate includes only China's plantations). Fire suppression is probably an underestimate, as it includes the U.S. only (similar values may apply elsewhere). Non-Forests include CO_2 from agricultural soils, but only resulting from cultivation of new lands.

aged 1.6 gigatons (GtC) per year ±0.8 GtC.[186] The 1.6 GtC figure amounts to 20 percent of global CO_2 emissions.[187] Taking uncertainties into account, CO_2 from LUCF may be as little as 0.8 GtC (12 percent of world emissions) or as high as 2.4 GtC (28 percent), a difference of a factor of three. Estimates used here, based on Houghton and Hackler (2002) and Houghton (2003b), amount to 2.2 GtC per year (26 percent of CO_2 in the 1990s), which is in the upper range of IPCC estimates. This sector also includes emissions and removals of CH_4 and N_2O, although there are no reliable global estimates of the influence of these gases on the LUCF sector.[188]

Uncertainties increase further for national-level figures, where estimates are uncertain on the order of ±150 percent for large fluxes, and ±180 $MtCO_2$ per year for estimates near zero.[189] A comparison of the data presented here with the official data submitted by governments to the UNFCCC helps illustrate the uncertainties (Figure 17.4). In some cases, the two sources are close in their estimate (for example, Mexico and some small countries). However, for large emitters and absorbers, the estimates are significantly different, most notably in Indonesia, Brazil, and the United States. In some cases, such as China, India, and Argentina, the data submitted by governments show a negative source (that is, a net sink) of CO_2, whereas other sources report a positive emissions source.

A final characteristic of LUCF is that absorptions, by definition, are reversible. If a forest absorbs CO_2 during a given year, those absorptions may be returned to the atmosphere in any subsequent year. This reversal may be due to human drivers, such as deforestation, or natural causes such as fires or forest die off. The non-permanence of claimed emission reductions in this sector poses technical and legal challenges within policy-making contexts.

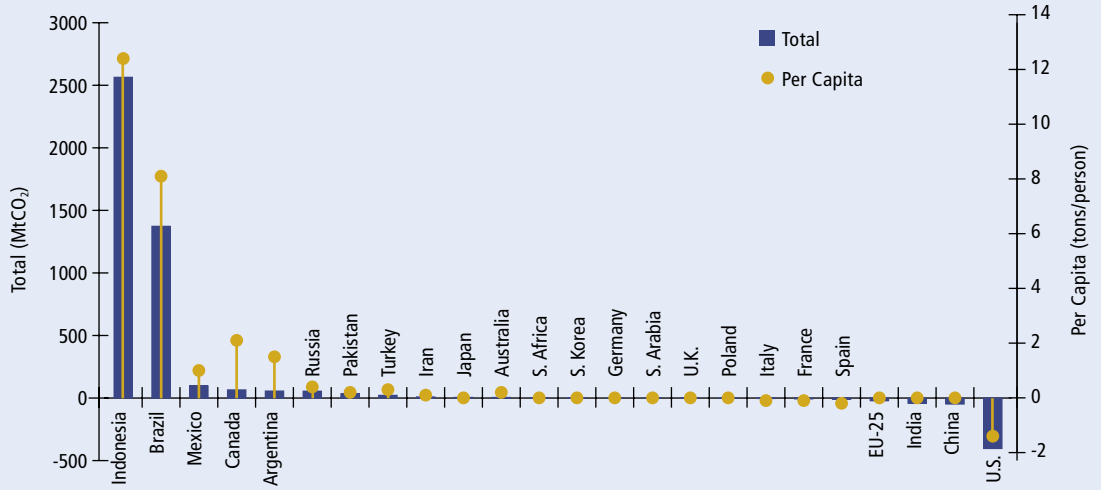
Sector Context

The land-use change and forestry sector, more than others, is difficult to characterize at the global level. The circumstances in tropical countries, for instance, have little in common with those in industrialized countries other than some ecosystem characteristics.

In the developing world, this sector is closely connected with poverty and human development, including through agriculture and energy use (biomass). The practice of converting forest land to agricultural land, noted above, is widespread. Likewise, wood energy—usually in the form of fuelwood or charcoal—is the most important source of energy for 2 billion people, mostly the poor that lack access to modern energy services.[190] In numerous other ways, forests directly influence livelihoods in developing countries, notably through eco-tourism and harvesting of forest products—such as timber, rubber, coconuts, bamboo, and palm oil—for both local use and export.

The degree to which different forces, such as those described above, are driving worldwide CO_2 emissions in this sector is not well known, in part because of measurement uncertainties noted previously. However, the available evidence suggests that there are a diffuse set of processes, products, and actors that contribute to forest degradation and consequent CO_2 emissions, though as noted above emissions seem to be concentrated in relatively few countries.

Figure 17.3. CO_2 from Land-Use Change, Total and Per Capita, 2000
Top 25 GHG emitters



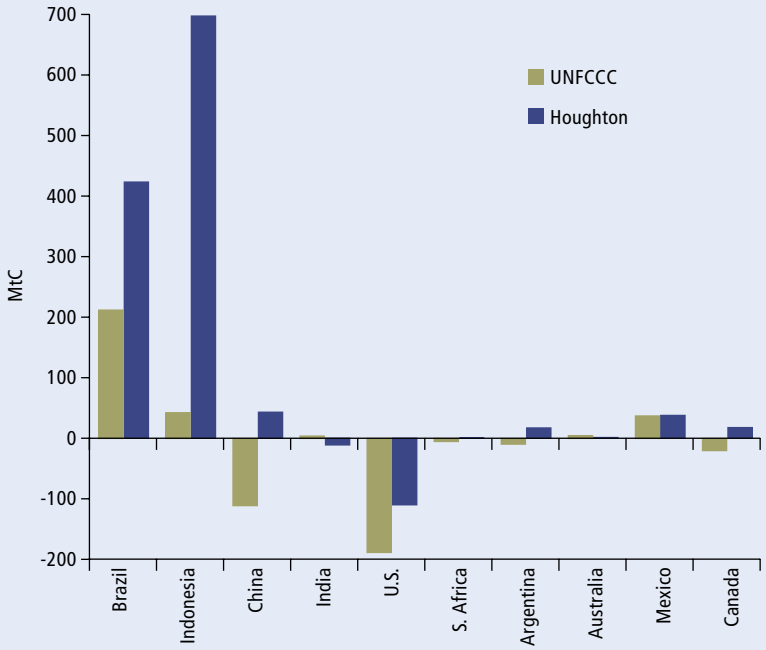
Source: WRI, CAIT (based on Houghton, 2003a).

Government intervention in the forest sector is high. Generally, forests are viewed as a sector to be managed by governments, and in many cases the government itself owns most forested lands.[191] Since the 1990s, however, more governments in both the developed and developing worlds are privatizing forest resources as a means of improving economic performance and raising revenue.[192] Privatization takes many forms, including transferring land ownership, concessions and leases, volume permits or standing timber sales, outsourcing, and community-based approaches.[193] One consequence of this trend is increased ownership and administration of forests by local communities. As characterized by the FAO, "[i]n general, policy and regulatory functions remain with central governments, while the private sector and civil society are taking charge of operations."[194] However, it should be noted that regulatory effectiveness may be weak, as illegal logging and noncompliance with forestry law is not uncommon, particularly in certain tropical countries.

The forestry sector, like agriculture, is both local in nature but also subject to international trade. This primarily takes the form of international demand for forest products[195]—including roundwood, sawnwood, pulp, and paper—although it is not clear to what degree this demand is the primary driver of CO_2 emissions in this sector (compared to say, forest clearing for agriculture). Forest products are estimated to contribute to about 1.2 percent of world GDP, and 3 percent of international merchandise trade.[196] Trade volumes are expanding, with the largest importers for these products being Europe, the U.S., and China.[197]

The relationship between international trade and sustainable forest management has led to a variety of responses, such as certification of forest management, product labeling, and a range of trade-related measures.[198]

Figure 17.4 Comparisons of LUCF Estimates



Sources & Notes: Houghton, 2003a; CAIT-UNFCCC. UNFCCC data is taken from national communications (developing countries) and national inventories (industrialized countries). Estimates from U.S., Canada, and Australia are for 2000; Mexico is from 1990, and others are from 1994.