Cumulative Emissions

The preceding chapters focused largely on current and future GHG emissions. However, climate change results from the cumulative buildup of GHGs in the atmosphere over time, not emissions in any particular year. Accordingly, the cumulative sum of a country's historical emissions is one indicator that tries to capture the contribution a country has made to the climate change problem.

Country-level estimates of CO_2 emissions from fossil fuels go back as far as 1850.[39] Based on that record, the United States ranks first and the EU second in cumulative emissions. Together, the 25 major emitters today account for 83 percent of current global emissions and 90 percent of cumulative global emissions. Figure 6.1 shows the cumulative emissions for the major emitting countries. All but five of the top 25 current emitters also rank among the top 25 historic emitters.

In most cases, a country's historic share of global emissions differs from its current share. For most industrialized countries, the historic share is higher, in many cases significantly so. The EU, with 16 percent of current fossil fuel emissions, accounts for nearly 27 percent of cumulative emissions. For the United Kingdom, an early industrializer, the difference is even more pronounced: its historic share is nearly three times its current share. Conversely, the historic share for many developing countries is sharply below their current share of global emissions. China and India's cumulative shares (7.6 percent and 2.2 percent, respectively, since 1850) are only half their current shares. Overall, developing countries, which generate 41 percent of current fossil fuel emissions, have contributed only 24 percent of cumulative emissions.

Historic contribution can be assessed in different ways, including the following:

- The *cumulative emissions* approach weighs all historic emissions equally, regardless of when they occurred. A ton of CO_2 emitted in 1850 has the same "value" as a ton of CO_2 emitted in 2005.
- An alternative approach assesses a country's contribution to increased atmospheric CO_2 *concentrations*. By taking into account the decay of GHGs over time, this approach estimates a country's share of emissions presently in the atmosphere.
- A third approach attempts to measure a country's contribution to the increase in global average *temperature* (approximately 0.6° C, globally, above pre-industrial levels).[40]

Figure 6.1. Cumulative CO_2 Emissions, 1850–2002

Country	% of World	(Rank)
United States	29.3	(1)
EU-25	26.5	(2)
Russia	8.1	(3)
China	7.6	(4)
Germany	7.3	(5)
United Kingdom	6.3	(6)
Japan	4.1	(7)
France	2.9	(8)
India	2.2	(9)
Ukraine	2.2	(10)
Canada	2.1	(11)
Poland	2.1	(12)
Italy	1.6	(13)
South Africa	1.2	(14)
Australia	1.1	(15)
Mexico	1.0	(16)
Spain	0.9	(20)
Brazil	0.8	(22)
South Korea	0.8	(23)
Iran	0.6	(24)
Indonesia	0.5	(27)
Saudi Arabia	0.5	(28)
Argentina	0.5	(29)
Turkey	0.4	(31)
Pakistan	0.2	(48)
Developed	**76**	
Developing	**24**	

Source: WRI, CAIT.

While the scientific certainty underlying these alternative methodologies varies significantly,[41] the relative results they yield are quite similar for most countries (Table 4). For several countries, the calculated share of historic contribution is nearly identical in all three approaches.

When CO_2 from land-use change is also taken into account, the picture changes considerably. Looking at data for all emissions since 1950 (earlier country-level estimates for land use-related emissions are not available[42]), the historic share for most industrialized (and some developing) countries drops sharply (Figure 6.2 and Table 5). The United States' cumulative contribution, for instance, drops from 26.6 percent to 16.7 percent. The most dramatic increases in historic share are for tropical countries with large forest sectors. Brazil and Indonesia, with 0.9 percent and 0.6 percent of cumulative fossil fuel emissions, respectively, jump to 6.1 percent and 7.2 percent, respectively, with the inclusion of CO_2 from land-use change. Overall, the developing country share of cumulative emissions since 1950 rises from 29 to 49 percent. As discussed in Chapter 17, however, this is in part due to the fact that periods of rapid deforestation in (present-day) developed countries pre-dates 1950, and thus is not reflected in the available data.

A second major factor influencing the calculation of historic contribution is the time period chosen. Going back only to 1990, the baseline year for emission targets in the UNFCCC and the Kyoto Protocol, yields very different results than going back a century-and-a-half (Figure 6.3 and Table 6). The historic share for developed countries drops from 76 percent to 61 percent, while the share for developing countries rises by a commensurate amount.

Implications for International Climate Cooperation

Data constraints will likely prevent international climate agreements based on cumulative emissions or "responsibility." The relevance of historical responsibility for climate change is noted in the Climate Convention and generally acknowledged to be an important factor in shaping response strategies that are widely acceptable. This concept has also become noteworthy since, in the run-up to the 1997 Kyoto Protocol negotiations, the Government of Brazil advanced a specific proposal that would have apportioned GHG emissions targets according to each (Annex I) country's historical responsibility for the global temperature increase.[43] Although this proposal did not prevail, the topic has continued to be studied under the UNFCCC.[44]

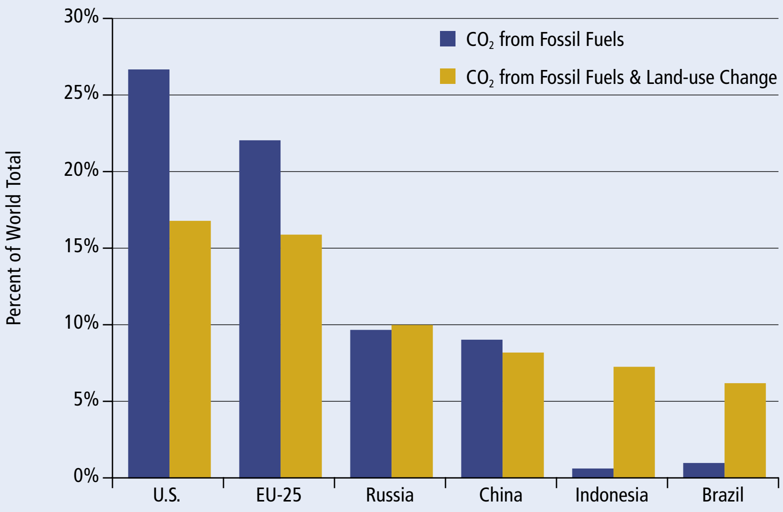
Proposals that rely on historical emissions prior to 1990, however, are unlikely to garner widespread support, in part due to data constraints. As shown above, the country-level contributions to climate change are extremely sensitive to two factors: (1) the time period chosen and (2) inclusion of LUCF (and non-CO_2)

emissions. Even if countries could agree on which time period to adopt, no official country-level data exists prior to 1990. Unofficial data for CO_2 from fossil fuels extends back to the 1800s.[45] However, the certainty of data covering such distant time periods is likely to be disputed. Historical data is also geographically biased, as earlier data is more likely to be available for European countries. Equally significant is the absence of virtually any country-level data for non-CO_2 gases and LUCF prior to 1990. The one country-level dataset that is available for LUCF covers only 1950 to 2000, and it is understood to be highly uncertain (see Chapter 17). The lack of LUCF data in historical responsibility calculations will have highly varying effects at the country level.

This is not to suggest that the concept of historical responsibility is irrelevant, only that it is unlikely that this concept can form the core of an agreement, or could be assessed in a manner reliable enough to be the basis for legal obligations. It should also be noted that other factors, unrelated to data issues, have also led to political objections pertaining to proposals to base the international climate change regime on historical emissions, including concerns over equity and the potential lack of required action by some Parties.

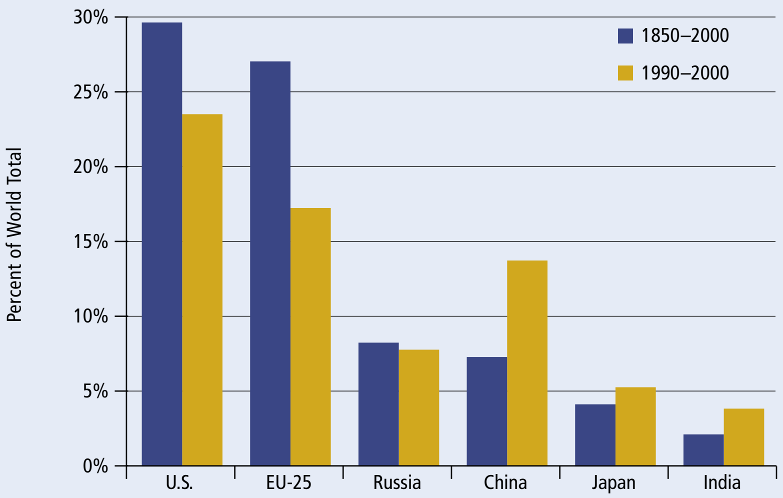
Two major factors may influence assessments of a country's contribution to climate change: the time period analyzed and the gases and sources included.

Figure 6.2. Cumulative CO_2 Emissions, 1950–2000
With and without land-use change & forestry



Sources & Notes: WRI, CAIT. CO_2 from fossil fuels includes CO_2 from cement manufacture.

Figure 6.3. Cumulative CO_2 Emissions, Comparison of Different Time Periods



Sources & Notes: WRI, CAIT. CO_2 includes emissions from fossil fuels and cement manufacture.