Where developing countries are making economic progress, they risk repeating the mistakes of the past by putting growth before the environment—because growth can be a two-edged sword. Although economic growth raises living standards and gives people the means to enjoy their environment, it is often accompanied by urbanization, more motor vehicles, and increased energy consumption. And because unbridled growth can lead to congestion, overloaded infrastructure, and dangerous declines in air and water quality, growth at the expense of the environment is likely to be unsustainable.

Economic and social change is putting increasing pressure on the world's environmental resources. Much of the world's biological diversity is in developing nations and it is estimated to be disappearing at 50 to 100 times natural rates. Wetlands and forests are being lost at 0.3 to 1 percent a year. Greenhouse gas emissions are growing strongly with increasing economic activity. Reversing these trends will require actions by both developed and developing countries.

Many governments are adopting policies for sustainable development—that is, development that preserves the opportunities for well-being of both current and future generations. Economic growth and better environmental management can be complementary, because growth provides the resources to improve the environment. Striking a better balance between the costs and benefits of economic development will require reliable information to guide policy design and track progress toward sustainable development.

Measuring the environment

Understanding the environment and its links to economic activity requires a sound base of data and indicators. Some indicators deal with environmental "goods" such as protected areas or biodiversity (table 3.4). Others measure "bads" (deforestation, soil loss, air and water pollution). Still others monitor the effects of environmental degradation—waterborne disease, species loss, and numbers of threatened species. Such indicators are important because the links between the environment and the economy are often direct and immediate.

Many relevant indicators are not available because of weaknesses in country coverage and concerns about the quality and comparability of data. Moreover, some environmental indicators are not meaningful at a national level.

Although the world is divided into nation-states, air and water pollution do not respect national boundaries, and many other environmental problems are highly localized and location-specific. Thus a comprehensive set of environmental indicators must embrace local, national, regional, and global aspects of environmental problems.

The main indicators presented here cover important themes for which national information is available: land use, deforestation, biodiversity, protected areas, freshwater and water pollution, energy production and use, energy efficiency and net trade, sources of electricity generation, carbon dioxide emissions, urbanization, traffic and congestion, air pollution, and government commitment. There are important innovations in environmental indicators, however, for cases where limitations in data and coverage do not permit comprehensive national-level tabulations. Three such indicators are highlighted here.

"Green GNP" is one indicator gaining currency. There is widespread concern that standard national accounts indicators do not reflect environmental depletion and degradation and so may send false policy signals for nations aiming for environmentally sustainable development. While a greener measure of gross national product would have some policy uses, a related measure, genuine saving (described below), gets directly to the question of whether a country is on a sustainable path.

Trade and the environment is another issue high on the international agenda, particularly since the formation of the World Trade Organization in 1995. Whether trade liberalization is good or bad for the environment is hotly debated, and questions of environmental protection and competitiveness are of great concern to developing countries. A significant issue is whether polluting industries and firms will move to countries where environmental legislation is poor or weakly enforced. Indicators comparing exports to imports of pollution-intensive sectors can speak to these questions.

Finally, while many aspects of growth are beneficial to the environment (rising income means increased willingness and ability to pay for environmental protection), certain concomitants of growth are harmful. Indicators relating growth in incomes to the demand for polluting transport fuels provide an important link between growth and the environment.

Genuine saving

Achieving sustainable development is a process of creating and maintaining wealth. For this to be a satisfactory definition, however, it is essential that wealth be broadly conceived to include human capital, natural resources, and the natural environment. The rate at which this expanded notion of wealth is being created (or destroyed) is measured by an indicator of *genuine saving*. This is a comprehensive measure of a country's rate of saving after accounting for investments in human capital, depreciation of produced assets, and depletion and degradation of the environment.

Genuine saving departs from standard national accounting conventions in several ways, notably by expanding the range of assets being valued. Natural resource extraction (which includes the economic rent associated with the scarcity of the resource being exploited) is explicitly treated in genuine saving by deducting the value of depletion of the underlying resource. (Where forests, water resources, and other renewable assets are sustainably managed, there is no net depletion). Deducting pollution damages, including lost welfare in the form of human sickness and death, is also necessary if it is assumed that society is aiming to maximize welfare. Finally, genuine saving estimates consider current education spending (on books, teacher salaries, and the like) as a component of saving (rather than consumption, as in the traditional national accounts), since education spending is an investment in human capital.

Table 3a provides genuine saving estimates for selected countries in Latin America and the Caribbean. *Extended domestic investment* is measured as gross domestic investment plus current education spending. While this adjustment does not have a large effect for some countries (Bolivia), it more than doubles the rate of domestic investment for others (Haiti). The next step in the accounting is to deduct net foreign borrowing,

Environmental indicators for the 21st century

A recent OECD–United Nations–World Bank conference identified six environmental indicators to be monitored by the development community as part of a new international development strategy. (The table numbers in parentheses show where these indicators appear in the *World Development Indicators*.)

Government and institutional commitment
- Countries with a national strategy for sustainable development (table 3.13)

Water resources
- Population with access to safe water (tables 2.14 and 3.5)
- Intensity of freshwater use: percentage of annual available resources used (table 3.5)

Biodiversity
- Nationally protected area as a percentage of total land (table 3.4)

Energy use
- GDP per unit of energy use (table 3.8)
- Total and per capita carbon dioxide emissions (table 3.8)

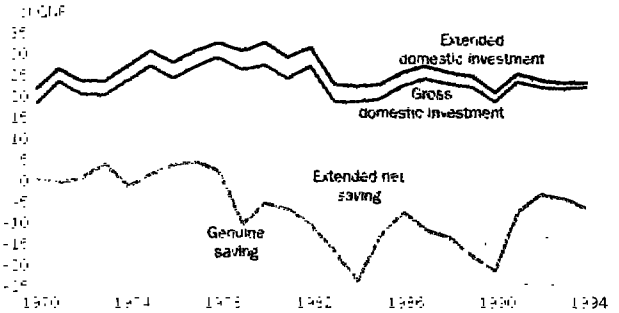
Three other topics were identified as important for obtaining a more complete picture of the state of the world's environment—air quality, land use, and the marine environment.

add net official transfers, and subtract depreciation of produced assets to arrive at an extended measure of net saving.

Next the value of resource depletion is deducted from extended net saving to arrive at *genuine saving I*. The natural resources included are bauxite, copper, gold, iron ore, lead, nickel, silver, tin, coal, crude oil, natural gas, phosphate rock, and timber. (Several assets—including water, fish, and soil—are not included because of difficulties in valuation.) The depletion of metals and minerals is measured as the difference between extraction values at world prices and the total cost of production (including depreciation of fixed assets and return on capital). (For technical reasons this approach probably overstates depletion. More detailed estimates could embody rising scarcity rents and account for the reserve life by applying a discount rate.) The difference between the rental value of roundwood harvest and the corresponding value of natural growth both in forests and plantations gives the measure of timber depletion. *Genuine saving II* equals genuine saving I less pollution damage. Because much pollution damage is localized (and difficult to estimate without location-specific data), table 3a includes only global damage from carbon dioxide emissions.

Figure 3a

Adjusting for environmental costs lowers Ecuador's savings and investment rates



Source: [illegible]

Table 3a

Genuine savings rates in selected countries in Latin America and the Caribbean

	Average 1970s	Genuine saving II Average 1980s	Average 1990–94	Gross domestic investment 1994	Extended domestic investment 1994	Extended net saving 1994	Genuine saving I 1994	Genuine saving II 1994
Antigua and Barbuda[a]			11.5	26.7	29.8	13.4	13.4	11.9
[illegible]	17.0	3.8	5.0	20.2	20.7	6.7	6.4	6.1
Barbados[a]	7.8	12.2	11.4	14.0	14.6	12.6	12.7	11.9
Belize		18.4	17.9	26.1	30.9	14.5	14.6	14.2
Bolivia	-4.8	-25.6	-14.0	19.2	16.5	-5.0	-9.4	-9.9
Brazil	12.1	3.4	11.3	21.3	18.4	14.1	12.9	12.7
Chile	-1.8	-3.4	10.2	27.4	30.3	20.3	13.2	12.9
Colombia	6.7	4.2	6.2	20.3	21.7	9.4	6.0	4.3
Costa Rica	13.0	12.2		28.6	31.1			
Dominican Republic	13.2	9.7	7.2	20.9	21.9	11.4	11.0	10.6
Ecuador	0.7	-12.6	-8.5	22.3	23.4	4.5	-6.9	-8.4
El Salvador	11.4	1.5	3.1	18.7	19.7	6.9	7.1	6.9
Grenada[a]		22.0	14.6	30.7	32.7	10.4	10.2	9.9
Guatemala	7.2	-0.1	0.1	13.8	16.8	3.9	1.7	1.5
Haiti	0.3	-2.0	-11.6	1.7	9.8	-1.4	-15.8	-16.0
Honduras	-0.8	-3.4	0.3	23.6	28.3	12.1	6.5	6.0
Mexico	9.1	-3.0	2.3	24.2	25.6	6.9	3.5	2.5
Paraguay	14.9	11.2	3.7	21.2	24.6	-0.1	-0.1	-0.3
Peru	5.6	-0.8	6.7	24.1	27.3	9.7	8.2	7.9
Trinidad and Tobago	-8.3	-20.6	-11.0	15.0	21.2	13.7	-1.4	-1.6
Uruguay	13.2	4.1	4.0	13.3	16.6	3.3	3.4	3.2
Venezuela	1.4	-17.6	-17.3	12.7	19.9	1.0.0	-11.1	-11.3

Note: [illegible]

a. Data are for [illegible]

Source: [illegible]

Figure 3a shows genuine saving in Ecuador from 1970 to 1994 and carries some important messages. First, Ecuador's genuine saving rate was near zero or negative for much of the period of oil exploitation. Second, investment in human capital as a share of GNP shrank for the last decade. Finally, negative genuine saving implies that total wealth is in decline. Policies resulting in persistently negative genuine saving lead to unsustainability.

As well as serving as an indicator of sustainability, genuine saving has other advantages as a policy indicator. It presents resource and environmental issues within a framework that finance and development planning ministries can understand. It reinforces the need to boost domestic saving, and hence the need for sound macroeconomic policies. It highlights the fiscal aspects of environment and resource management, since collecting resource royalties and charging pollution taxes both raise development finance and ensure efficient use of the environment. Measuring genuine saving also makes the growth-environment tradeoff more explicit, because countries planning to grow today and protect the environment tomorrow will have depressed rates of genuine saving.

Trade and the environment

Are developing countries net exporters and developed countries net importers of pollution-intensive goods? The export-import ratio for polluting goods can shed some light on this issue.

The export-import ratio compares the total value of exports to the total value of imports of the products of each country's six most polluting industrial sectors. These sectors

Table 3b

Export-import ratios for selected countries, 1986 and 1995

	1986	1995		1986	1995
Algeria	1.01	0.95	Malaysia	0.39	0.36
Argentina	0.60	0.58	Mexico	0.82	0.71
Australia	1.00	1.11	Morocco	0.82	0.66
Austria	1.29	1.21	Netherlands	1.91	1.33
Belgium[a]	1.62	1.04	New Zealand	0.46	0.80
Bolivia	1.24	0.51	Norway	1.26	1.19
Brazil	1.57	1.02	Oman	0.11	0.27
Canada	1.91	2.05	Pakistan	0.06	0.02
Chile	1.75	1.52	Panama	0.04	0.07
Colombia	0.35	0.34	Peru	0.92	1.01
Egypt, Arab Rep.	0.20	0.35	Philippines	0.44	0.20
El Salvador	0.19	0.20	Poland	0.95	0.98
Finland	1.42	2.81	Portugal	0.69	0.60
Germany	1.14	1.18	Senegal	0.92	1.16
Greece	0.37	0.48	Singapore	1.63	0.65
Guatemala	0.09	0.15	Spain	1.00	0.77
Honduras	0.02	0.03	Sweden	1.60	1.65
India	0.13	0.37	Switzerland[b]	0.82	1.01
Indonesia	0.45	0.43	Thailand	0.16	0.17
Ireland	0.69	1.08	Tunisia	0.80	0.67
Israel	0.61	0.57	Turkey	0.55	0.41
Italy	0.77	0.71	United Kingdom	0.89	0.85
Jamaica	0.66	1.05	Uruguay	0.22	0.24
Japan	1.26	1.19	United States	0.51	0.89
Jordan	0.32	0.41	Venezuela	2.61	0.95
Korea, Rep.	0.65	0.68	Zimbabwe	0.89	0.56
Madagascar	0.06	0.05			

a. Includes Luxembourg. b. Includes Liechtenstein.

Source: World Bank staff estimates.

were identified, first, by ranking pollution control spending per unit of output for industries in the United States and other OECD economies, and then by ranking emission intensities (in terms of air pollutants, water pollutants, and heavy metals) for U.S. industries. The six most polluting sectors are iron and steel, nonferrous metals, industrial chemicals, petroleum refineries, nonmetallic mineral products, and pulp and paper products. (Some highly polluting sectors such as low-technology coal-fired thermal power stations that are basically domestic in orientation are not included.).

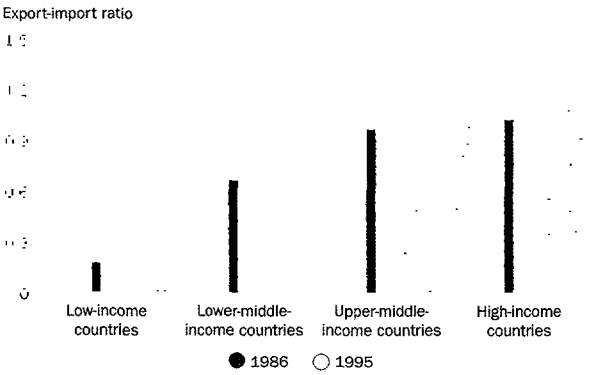
Table 3b shows the calculated export-import ratio for selected countries in 1986 and 1995. A ratio greater than one indicates that the country is a net exporter of polluting products. Contrary to a common perception, the results show that with few exceptions developing countries tend not to specialize in heavily polluting industries—instead, exports are lower than imports for the polluting sectors and the export-import ratio is less than one. Figure 3b shows that lower-income countries tend to have lower export-import ratios. Most high-income countries have ratios near or greater than one. These countries, particularly those with large resource sectors, appear to be the source of polluting goods.

Has trade liberalization in 1986–95 influenced this pattern? Whereas the average export-import ratio for middle-income countries has fallen, those for high- and low-income countries increased (see figure 3b). For high-income countries the ratio increased by 29 percent, to 1.32. For the United States the increase was 75 percent. For low-income countries the increase was 71 percent, possibly the result of the rapid export growth typical of the early stages of industrialization. Mexico, which has swiftly lowered trade barriers, had a lower export-import ratio in 1995 (0.71) than in 1986 (0.82), signaling a shift away from pollution-intensive goods. But Sub-Saharan Africa and Asia tended to increase their ratios during this period (figure 3c).

There may be several explanations for these results. Environmental protection costs may be lower than wage and capital costs, so that specialization is driven largely by entrenched technologies and by an economy's relative abundance of labor and physical capital. Thus countries with a large labor supply tend to specialize in relatively "clean" labor-intensive sectors, whereas physical- and human capital–intensive countries specialize in more polluting sectors. (World Bank research finds that the five most pollution-intensive sectors are about three times as energy intensive, twice as physical capital intensive, and 2.5 times less labor intensive than the five cleanest sectors; Mani and Wheeler 1997.) The tendency of countries to specialize in sectors in which they are relatively well endowed with factor inputs is reinforced by lower trade barriers. Given that the most capital-intensive economies are in the OECD, this implies that pollution-intensive production increasingly takes place in countries with relatively stringent regulation. As environmental regulations become more strict, however, comparative advantage may shift. Moreover, some of these industries tend to be relatively immobile, given their heavy dependence on a natural resource as a main factor of production. This cannot explain changes in the export-import ratio over time, however. And some resource-dependent sectors, such as petroleum refineries, tend to be close to the market rather than to the source of the input.

Figure 3b

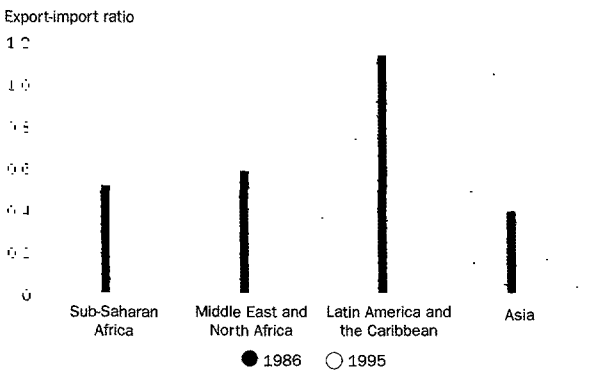
High-income countries generate more exports from the six most polluting industries



Source: World Bank staff estimates.

Figure 3c

Trade of the six most polluting industries by region



Note: Sample includes 5 countries for Sub-Saharan Africa, 5 countries for the Middle East and North Africa, 20 countries for Latin America and the Caribbean, and 7 countries for Asia.

Source: World Bank staff estimates.

Growth and the environment

Many of the indicators in this section relate to energy production and use and to the emissions of carbon dioxide associated with fossil fuel combustion. This is because energy use is both pervasive in economic activities and pollution-intensive. While global pollutants such as carbon dioxide are emphasized in the following indicator tables, energy production and use is also a major source of local pollutants such as acid rain and particulates suspended in air. Excess mortality and morbidity are strongly linked to high concentrations of particulates.

Table 3c

Income elasticity of demand for motive fuels in selected Asian economies, 1973–90

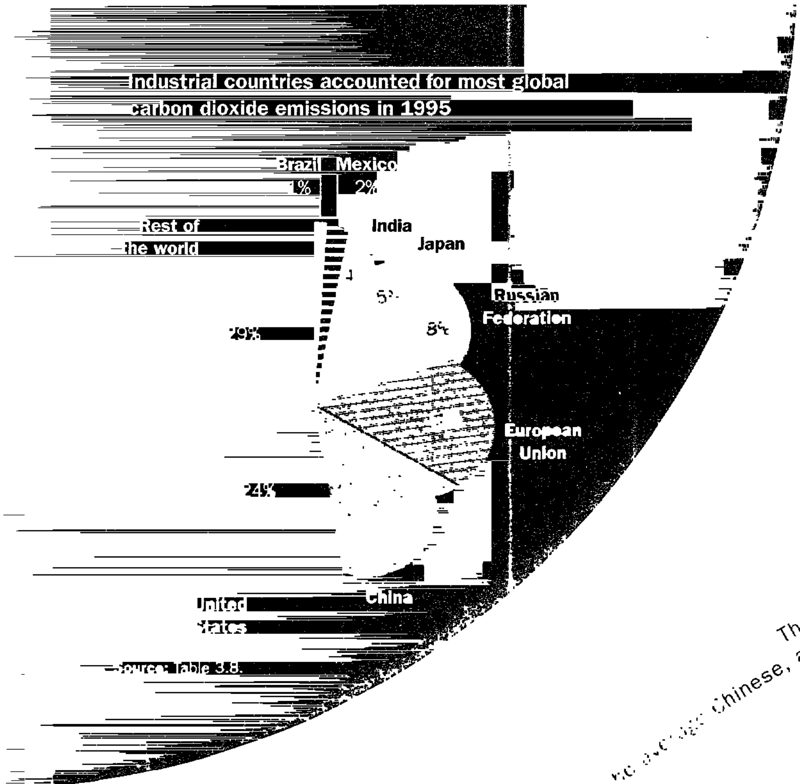
	Gasoline	Diesel
[illegible]	[illegible]	[illegible]
Hong Kong, China	0.89	0.56
[illegible]	[illegible]	[illegible]
Indonesia	1.63	1.59
[illegible]	[illegible]	
Malaysia	1.62	1.53
[illegible]	[illegible]	[illegible]
Philippines	..	3.16
[illegible]	[illegible]	[illegible]

Source: World Bank staff estimates.

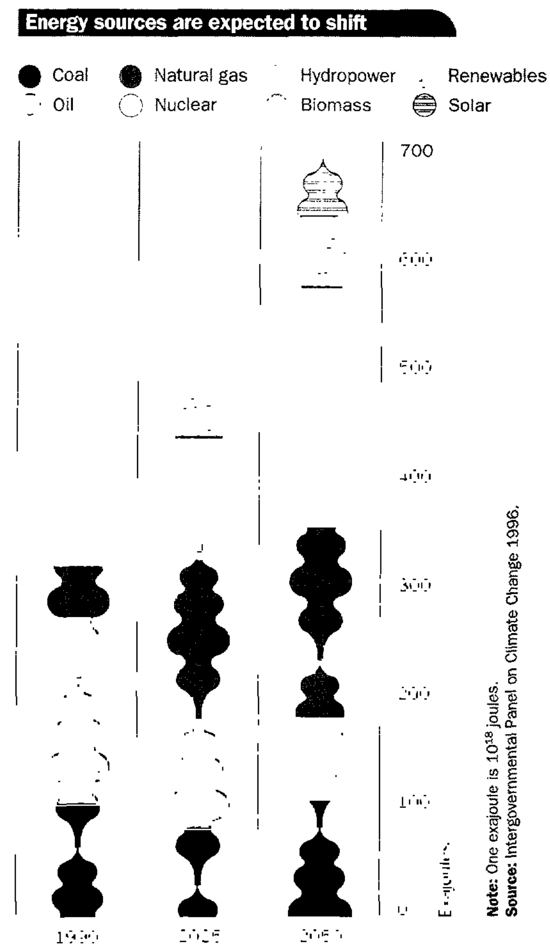
Consumption of motive fuel (diesel and gasoline) is particularly important in the urban environment because pollutants are emitted at ground level, where there is the greatest exposure to humans. Historical data on energy production and consumption tell much about pressures on the environment, but the rate of growth of energy demand can help indicate the likely *future* state of the environment. Extrapolating past growth rates is one method of analysis, but greater insight is gained by estimating one of the key determinants of energy use—the income elasticity of demand for motive fuels. This is economists' jargon for a simple ratio: the percentage change in demand for gasoline (for example) divided by the percentage change in income. Does demand for motive fuels rise proportionately at a greater or lesser rate than income? The answer to this question has profound implications for the relationship between growth and the environment (table 3c).

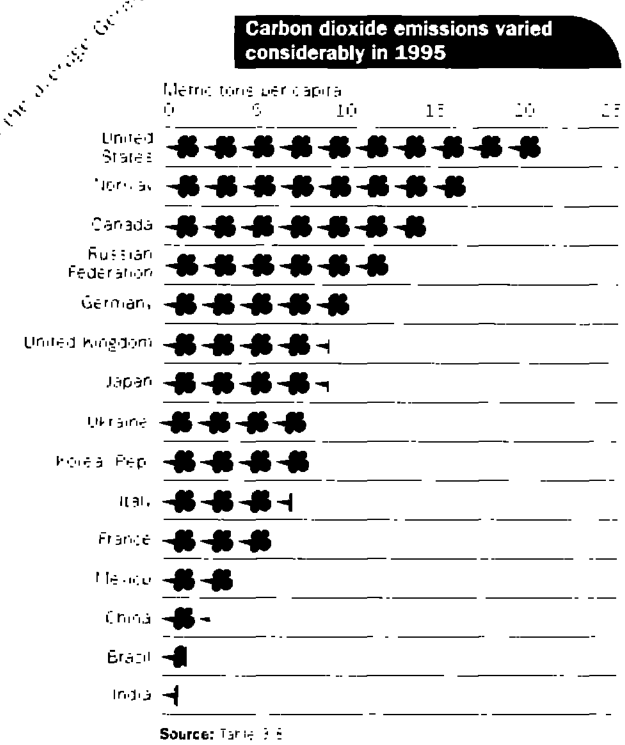
The pattern is clear. Except for Hong Kong and (for gasoline) Thailand and Bangladesh, income elasticities for motive fuels are greater than one and in many cases sharply greater. Hong Kong may be an outlier because of its limited land area, high vehicle taxes, and well-developed public transit system. Setting aside the outliers, a 1 percent increase in income leads to a 1.2–1.9 percent increase in demand for gasoline and a 1.3–3.2 percent increase in demand for diesel. Although only income elasticities are shown, the underlying analysis embodies a more complete specification of demand, including the effects of own-price and cross-price change (that is, how an increase in the diesel price would affect the demand for gasoline).

Past behavior may or may not be a good guide to the future, but the pressures that growth in incomes could place on the urban environment in developing countries are evident. If economic growth rates of 6–8 percent a year are typical of countries that have made the transition to industrialization and urbanization, growth rates in motive fuel demand of 10–15 percent a year are possible. Without policies to curb pollution emissions, especially of particulates, serious health consequences could follow.

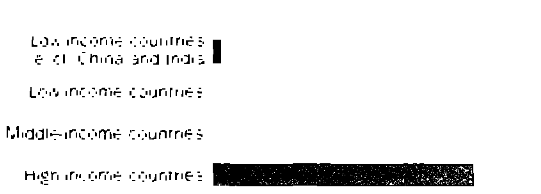


The average American produces 21 metric tons of carbon dioxide a year, twice as much as the average German—and the average Chinese, about 3 metric tons a year, three times as much as the average Indian

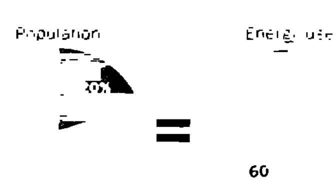




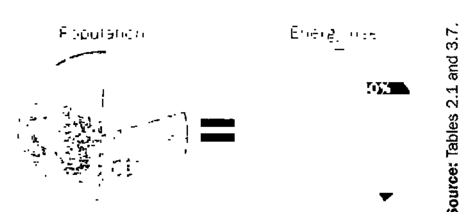
Wealthy countries consume a disproportionate share of the world's energy



20% of the world's population uses about 60% of its commercial energy



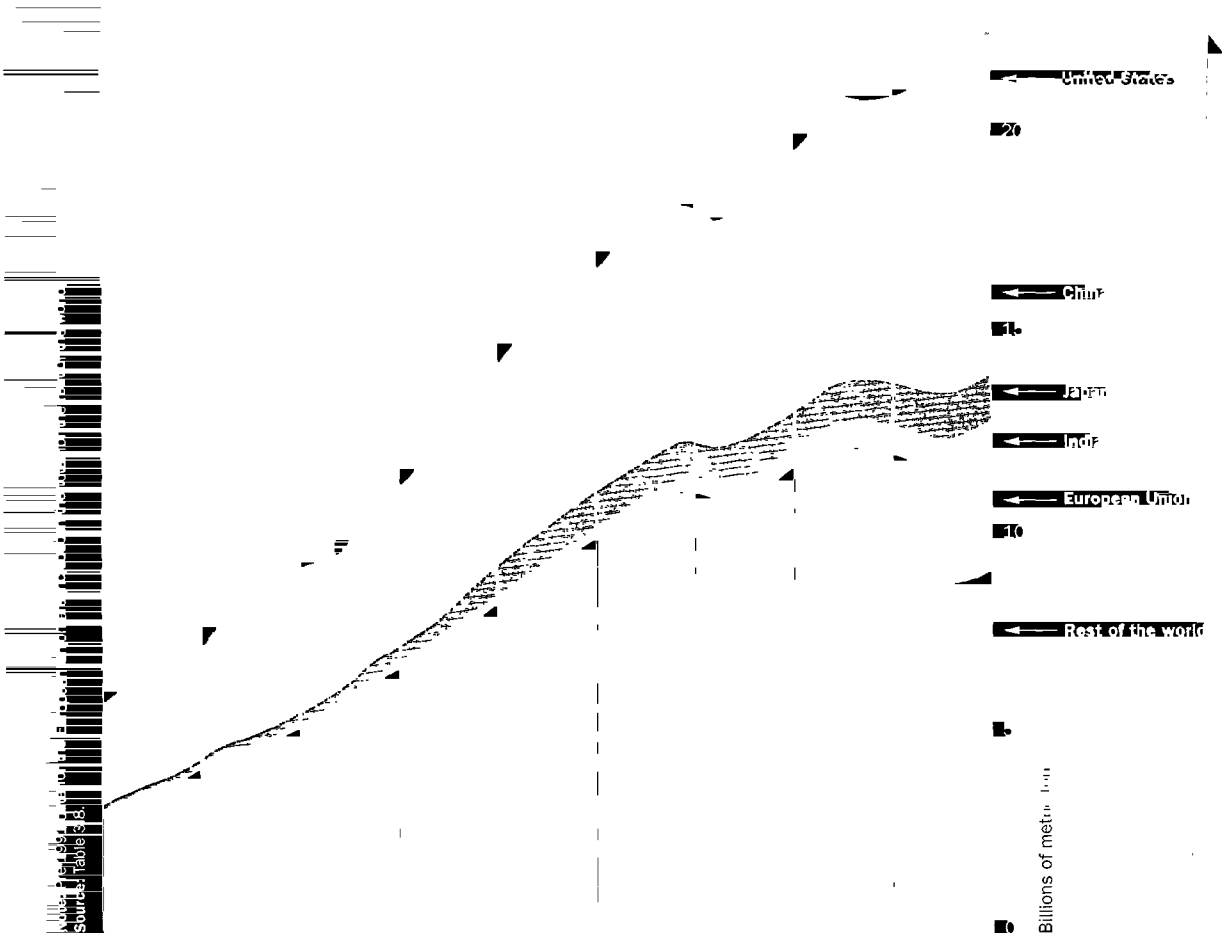
while 50% of the world's population uses about 4% of its energy



The United States, European Union, and Japan contain 13 percent of the world's people—but account for 42 percent of global carbon dioxide emissions

Carbon dioxide emissions have more than tripled since 1950—to 23 billion metric tons a year

Carbon dioxide emissions have been rising steadily



Source: Table 3.8.