

Carbon Dioxide (CO ₂) Emissions {a} (in thousand metric tons of CO ₂)	Bhutan	Asia (excl. Middle East)	World
Total Emissions, 1998	386	7,360,942	24,215,376
Percent change since 1990	201%	38%	8%
Emissions as a percent of global CO ₂ production	0.0%	30.4%	
Emissions in 1998 from:			
solid fuels	180	4,020,885	8,654,368
liquid fuels	132	2,304,231	10,160,272
gaseous fuels	0	580,898	4,470,080
gas flaring	0	22,391	172,208
cement manufacturing	75	432,537	758,448

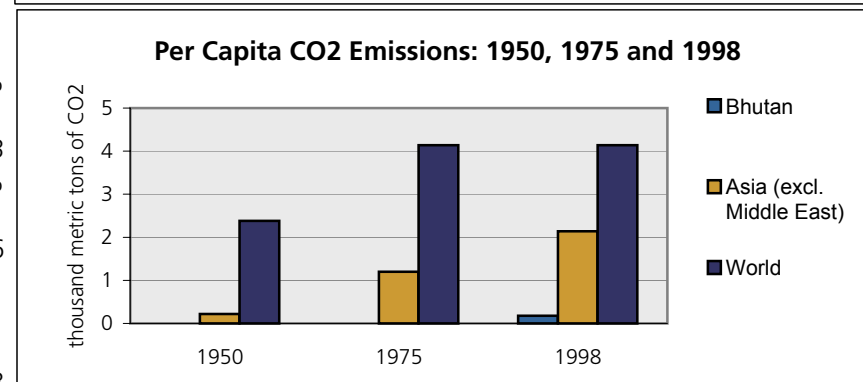
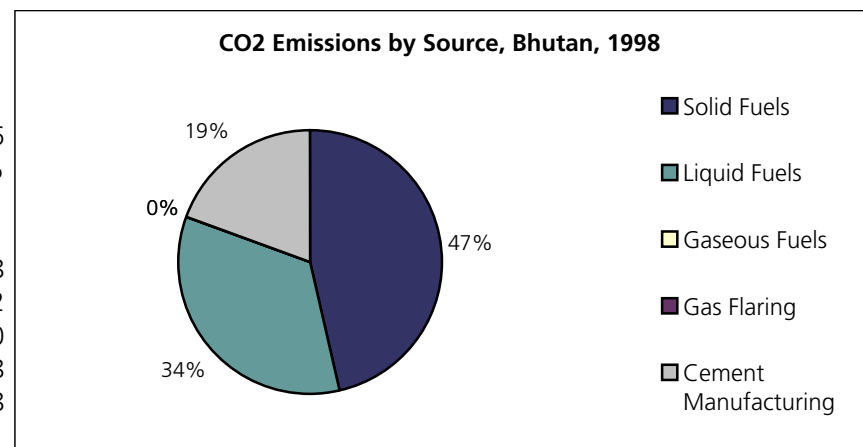
Per capita CO ₂ emissions, 1998 (thousand metric tons of CO ₂)	0.2	2.1	4.1
Percent change since 1990	157%	19%	-2%
CO ₂ emissions (in metric tons) per million dollars Gross Domestic Product {b}, 1998	1,032	X	773
Percent change since 1990	87%	X	-10%
Cumulative CO ₂ emissions, 1900-1999 (in billion metric tons)	2	161,972	933,686

CO₂ Emissions by Sector, 1999 {c} (in million metric tons of CO₂)

Public electricity, heat production, and autoproducers	X	2,697	8,693
Other Energy Industries	X	312	1,205
Manufacturing Industries and Construction	X	1,915	4,337
Transportation	X	943	5,505
Residential	X	471	1,802
Other Sectors {d}	X	580	5,640
Total Emissions All Sectors:	X	6,918	27,180

CO₂ Intensity, 1999

Emissions per total energy consumption (metric tons CO ₂ per terajoule energy)	X	56	56
Emissions per Gross Domestic Product {e} (metric tons of CO ₂ /million \$PPP)	X	540	582



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Atmosphere and Climate-- Bhutan

	Bhutan	Asia (excl. Middle East)	World
Non-CO2 Air Pollution, thousand metric tons			
Sulfur dioxide emissions, 1995	4	55,129	141,875
Nitrogen oxide emissions, 1995	6	28,962	99,271
Carbon monoxide emissions, 1995	181	258,325	852,415
Non-methane VOC emissions {f}, 1995	18	42,036	159,634

Multilateral Agreements Status as of September 2002

Data show the year each country ratified the agreement, unless labeled as "signed only".

Kyoto Protocol	2002
United Nations Framework Convention on Climate Change (UNFCCC)	1995
Vienna Convention	X

Other Resources:

Sustainable Development Country Profile of the
Food and Agriculture Organization of the United Nations:
<http://www.fao.org/countryprofiles/index.asp?subj=2&iso3=>

CO2 emissions: Relative Trends, Bhutan, 1960-1998

Footnotes:

Some footnotes are not incorporated here. Please refer to the Data Tables section of EarthTrends for a full listing.

- a. Source: Carbon Dioxide Information Analysis Center (CDIAC).
- b. Constant US dollars.
- c. Source: International Energy Agency (IEA).
- d. Includes the commercial sector, agriculture, the public service sector, and international bunkers
- e. GDP is in 1995 international dollars, adjusted for Purchasing Power Parity.
- f. VOC: Volatile Organic Compounds.

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Carbon Dioxide (CO₂) Emissions

Total CO₂ emissions represent the mass of CO₂ produced during the combustion of solid, liquid, and gaseous fuels, from gas flaring and the manufacture of cement. These estimates do not include bunker fuels used in international transportation due to the difficulty of apportioning these fuels among the countries benefiting from that transport. Carbon dioxide emissions are often calculated and reported in terms of their content of elemental carbon. For these data, their values were converted to the actual mass of CO₂ by multiplying the carbon mass by 3.664 (the ratio of the mass of CO₂ to that of carbon). The primary difference between Carbon Dioxide Information Analysis Center (CDIAC, reported here) and International Energy Agency (IEA) CO₂ emission estimates (also available from EarthTrends) is that the CDIAC data include emissions from sources other than fossil fuel combustion, primarily cement manufacture. Further differences in methodology are outlined on Web pages listed below..

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CO₂ emissions from solid fuels represent the mass of carbon dioxide emitted primarily, but not exclusively, from burning coal. View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=461&themeid=3

Carbon dioxide emissions from liquid fuels are primarily, but not exclusively, from burning of petroleum products. These estimates do not include bunker fuels used in international transportation due to the difficulty of apportioning these fuels among the countries benefiting from that transport. View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=462&themeid=3

Carbon dioxide emissions from gaseous fuels are primarily, but not exclusively, from burning of natural gas. View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=463&themeid=3

Carbon dioxide emissions from gas flaring result from the burning of gas released in the process of petroleum extraction. View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=464&themeid=3

CO₂ emissions from cement manufacturing are produced as cement is calcined to produce calcium oxide. Approximately 0.5 metric tons of carbon is released for each metric ton of cement production. View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=465&themeid=3

Per capita CO₂ emissions figures are obtained by dividing total emissions of carbon dioxide by the population for a particular country and year. Total CO₂ emissions represent the mass of CO₂ produced during the combustion of solid, liquid, and gaseous fuels, from gas flaring and the manufacture of cement. These estimates do not include bunker fuels used in international transportation due to the difficulty of apportioning these fuels among the countries benefiting from that transport. View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=466&themeid=3

CO₂ emissions per unit of GDP were calculated by WRI using CO₂ emissions data compiled by CDIAC and GDP data provided by the World Bank. Total CO₂ emissions represent the mass of CO₂ produced during the combustion of solid, liquid, and gaseous fuels, from gas flaring and the manufacture of cement. These estimates do not include bunker fuels used in international transportation due to the difficulty of apportioning these fuels among the countries benefiting from that transport. Gross Domestic Product (GDP) measures the total output of goods and services for final use occurring within the domestic territory of a given country, regardless of the allocation to domestic and foreign claims. To obtain comparable series of constant price data, the World Bank rescales GDP and value added by industrial origin to a common reference year, currently 1995. View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=468&themeid=3

Cumulative CO2 emissions levels are calculated by WRI based on CDIAC's CO2 emissions data through 1998, supplementing this data with the 1999 estimates from the Energy Information Administration. Total CO2 emissions figures consist of the sum of CO2 produced during the consumption of solid, liquid, and gaseous fuels, and from gas flaring and the manufacture of cement. These estimates do not include bunker fuels used in international transportation due to the difficulty of apportioning these fuels among the countries benefiting from that transport.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=779&themeid=3

Sources

Carbon Dioxide Information Analysis Center (CDIAC), Environmental Sciences Division, Oak Ridge National Laboratory: 2001. *Global, Regional, and National CO2 Emission Estimates from Fossil Fuel Burning, Cement Production, and Gas Flaring: 1751-1998*, NDP-030 (Available online at <http://cdiac.esd.ornl.gov/ftp/ndp030/>). CDIAC, Oak Ridge, Tennessee.

Energy Information Administration of the U.S. Department of Energy: 2001. *Carbon Dioxide Emissions from Use of Fossil Fuels*, International Energy Annual 1999. (Available on-line at <http://www.eia.doe.gov/iea/carbon.html>) Washington, DC: EIA.

CO2 Emissions by Sector

Carbon dioxide emissions from public electricity, heat production, and autoproducers include the sum of emissions from combustion of all fossil fuel types used for public electricity generation, public combined heat and power generation, and public heat plants. Public utilities are defined as those undertakings whose primary activity is to supply the public. Carbon dioxide emissions from unallocated autoproducers include the sum of emissions from combustion of all fossil fuel types used for generation of electricity and/or heat by autoproducers. Autoproducers generate electricity and/or heat wholly or partly for their own use to support their primary activity. Most of these emissions are attributed to the sector that the autoproducer falls within, but some autoproduction cannot be attributed to the end user and is represented here.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=478&themeid=3

Carbon dioxide emissions from other energy industries include the sum of emissions from combustion of all fossil fuel types used by energy industries. This includes fuel combusted in petroleum refineries, for the manufacture of solid fuels, coal mining, oil and gas exploration, and other energy-producing industries.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=480&themeid=3

Carbon dioxide emissions from manufacturing industries and construction include emissions from combustion of fossil fuels in all industries and construction.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=476&themeid=3

Carbon Dioxide emissions from all transportation include emissions from combustion of fossil fuels for road, rail, air, and other forms of transportation, and agricultural vehicles while they are on highways. The emissions include all sectors of the economy, but do not include international aviation or ship emissions, which are accounted for under bunker fuels. Emissions associated with international transport of people and goods are accounted for in the global total emissions and under bunker fuels.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=471&themeid=3

Carbon dioxide emissions from residential sources include emissions from combustion of all fossil fuel types in households.

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Carbon dioxide emissions from "other" sectors include the sum of emissions from combustion of all fossil fuel types used by Includes the commercial, agricultural, and public service sectors, as well as international bunkers.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=481&themeid=3

Sources

International Energy Agency (IEA), 2001. *CO2 Emissions from Fossil Fuel Combustion (2001 Edition)*. Eletronic database available online at <http://data.iea.org/ieastore/default.asp>. Paris: Organization for Economic Cooperation and Development (OECD).

CO2 Intensity, 1999

CO2 emissions per total energy consumption provides an indicator of how much carbon dioxide is emitted per amount of energy used in a country. This relationship is expressed in metric tons of CO2 per terajoule, and was calculated using the Reference Approach CO2 emissions and total primary energy supply (including biomass and other non-fossil forms of energy). A higher ratio indicates the use of more carbon-intensive fuels such as coal and oil and relative smaller usage of low-carbon fuels such as gas, and renewable energy.

Energy consumption is defined as the total amount of primary energy consumed as opposed to total final consumption. Primary energy includes losses through transportation, friction, heat loss and other inefficiencies. Specifically, consumption equals indigenous production plus imports minus exports plus stock changes minus international marine bunkers. IEA calls this category Total Primary Energy Supply (TPES).

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=605&themeid=3

CO2 emissions per GDP, PPP in 1995 \$ Intl indicates the amount of carbon dioxide emitted per amount of income generated by the country's economy. Carbon dioxide emissions represent total emissions for each country and are based on the reference approach, which include emissions from combustion of all fossil fuels.

Gross Domestic Product (GDP), PPP in constant 1995 international dollars is gross domestic product converted to international dollars using Purchasing Power Parity (PPP) rates, and rescaled to 1995 to give a common reference year. An international dollar has the same purchasing power in a given country as a United States Dollar in the United States. In other words, an international dollar buys an equivalent amount of goods or services in all countries.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=606&themeid=3

Sources

International Energy Agency (IEA), 2001. *CO2 Emissions from Fossil Fuel Combustion (2001 Edition)*. Eletronic database available online at <http://data.iea.org/ieastore/default.asp>. Paris: Organization for Economic Cooperation and Development (OECD).

Non-CO2 Air Pollution

Sulfur Dioxide, or SO₂, is a primary contributor to acid deposition, or acid rain. High concentrations of sulfur dioxide affect breathing and may aggravate existing respiratory and cardiovascular disease. Sulfur dioxide forms when fuel containing sulfur, such as coal and oil, is burned, when gasoline is extracted from oil, or metals are extracted from ore. Petroleum refineries, cement manufacturing, and metal processing facilities, as well as locomotives, large ships, and some nonroad diesel equipment burn high sulfur fuel and release SO₂ emissions to the air in large quantities.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=812&themeid=3

Nitrogen oxides, or NO_x, is the generic term for a group of highly reactive, acidifying gases, all of which contain nitrogen and oxygen in varying amounts. Nitrogen oxides are a precursor to ground-level ozone, which can trigger serious respiratory problems. NO_x also contributes to acid rain and global warming. It forms when fuel is burned at high temperatures, as in a combustion process. The primary sources of No_x are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=813&themeid=3

Carbon monoxide, or CO, is a precursor gas of ground-level ozone, which can trigger serious respiratory problems. When CO enters the bloodstream, it reduces the delivery of oxygen to the body's organs and tissues. Exposure to elevated CO levels can cause impairment of visual perception, manual dexterity,

learning ability and performance of complex tasks. CO is formed when carbon in fuel is not burned completely, and is a component of motor vehicle exhaust. Other sources of CO emissions include industrial processes (such as metals processing and chemical manufacturing), residential wood burning, stoves, and natural sources such as forest fires.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=814&themeid=3

Non-methane VOCs (Volatile Organic Compounds) are chemicals that vaporize at room temperature, like benzene, toluene, methylene chloride and methyl chloroform. Common sources that emit VOCs include housekeeping and maintenance products, and building and furnishing materials, such as solvents, paints, and glues. In sufficient quantities, VOCs can have adverse health effects on humans; some are suspected of causing, or are known to cause, cancer. VOCs are also precursors to ground-level ozone, which can trigger respiratory problems.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=815&themeid=3

Sources

National Institute for Public Health (RIVM) and Netherlands Organization for Applied Scientific Research (TNO). 2001. The Emission Database for Global Atmospheric Research (EDGAR) 3.2. Precursors:CO (Carbon Monoxide): Aggregated Emissions 1990/1995. Electronic database available online at: <http://arch.rivm.nl/env/int/coredata/edgar/>. The Netherlands: RIVM.

Multilateral Agreements, Status as of September 2002

The Kyoto Protocol to the United Nations Framework Convention on Climate Change strengthens the international response to climate change, and promotes the Convention's ultimate objective of preventing "dangerous anthropogenic [human-made] interference with the climate system". The Kyoto Protocol, which was adopted by consensus at the third session of the Conference of the Parties (COP-3) in December 1997, contains emission targets for Annex I (developed) countries for the post-2000 period.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=428&themeid=3

The United Nations Framework Convention on Climate Change (UNFCCC) refers to the international agreement that targets industrial and other emissions of greenhouse gases such as carbon dioxide. The UNFCCC is the centerpiece of global efforts to combat global warming. Initially adopted in 1992 at the Rio de Janeiro "Earth Summit" (<http://www.un.org/geninfo/bp/enviro.html>), the Convention entered into force on March 21, 1994. The ultimate objective of the UNFCCC is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-made) interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=620&themeid=3

The Vienna Convention refers to the United Nations Environment Program's (UNEP) Convention on the Protection of the Ozone Layer, adopted by the governments of the world in 1985. Through the Vienna Convention on the Protection of the Ozone Layer, governments committed themselves to protect the ozone layer, to cooperate in scientific research, and to improve the understanding of atmospheric processes

Under the Convention, nations agree to take "appropriate measures...to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the Ozone Layer." The measures are unspecified. There is no mention of any substances that might harm the ozone; CFCs appear towards the end of the annex to the treaty, where they are mentioned as chemicals that should be monitored.

View full technical notes on-line at http://earthtrends.wri.org/searchable_db/variablenotes_static.cfm?varid=622&themeid=3

Sources

United Nations Framework Convention on Climate Change (UNFCCC). 2002. *Kyoto Protocol Status of Ratification*. Bonn: UNFCCC. Available on-line at <http://www.unfccc.int/resource/kpstats.pdf>.

United Nations Framework Convention on Climate Change (UNFCCC). 2001. *UNFCCC Status of Ratification*. Bonn: UNFCCC. Available on-line at <http://unfccc.int/resource/conv/ratlist.pdf>.

Secretariat for the Vienna Convention and the Montreal Protocol . 2002. *Status of Ratification/Accession/Acceptance/Approval of the agreements on the protection of the stratospheric ozone layer*. Nairobi: United Nations Environment Program. Available online at: <http://www.unep.ch/ozone/ratif.shtml>.