

Carbon Dioxide Emissions by Source 2005

Source: Carbon Dioxide Information Analysis Center (CDIAC),
World Resources Institute (WRI)

EarthTrends
Data Tables:
Climate and
Atmosphere



	Carbon Dioxide (CO2) Emissions by Source (thousand metric tons)											
	Solid Fuels		Liquid Fuels		Gaseous Fuels		Gas Flaring		Cement Manufacturing		Land-Use Change	
	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000
WORLD	8,712,992	8,112,096	9,313,888	10,636,592	3,718,960	4,744,880	161,216	113,584	575,248	824,400	7,918,083	7,618,621
ASIA (EXCL. MIDDLE EAST)	3,149,532	3,706,081	1,638,621	2,339,314	274,397	669,984	20,809	13,691	234,696	480,704	3,593,308	3,957,108
Armenia	..	..	..	839	..	2,565	..	..	..	109	..	..
Azerbaijan	..	..	..	17,521	..	11,421	..	..	..	100	..	..
Banladesh	1,066	1,249	6,548	9,574	7,577	16,646	..	..	168	1,784	-7,745	-9,251
Bhutan	48	176	81	143	..	..	..	..	..	75	..	..
Cambodia	..	..	451	531	..	..	..	..	..	..	46,979	56,115
China	1,930,510	1,827,083	334,406	601,493	29,301	64,387	..	..	104,644	297,487	223,881	-47,322
Georgia	..	59	..	4,012	..	1,924	..	..	..	173	..	..
India	476,463	782,180	145,314	192,950	19,122	45,045	9,948	3,344	24,417	47,339	-33,745	-40,307
Indonesia	7,845	52,490	81,436	158,153	61,812	41,271	7,733	3,803	6,877	13,847	2,145,806	2,563,074
Japan	304,632	388,117	624,943	607,667	99,031	148,322	..	..	42,057	40,397	12,042	4,357
Kazakhstan	..	80,648	..	18,925	..	21,119	..	..	..	586	..	..
Korea, Dem People's Rep	223,196	173,897	13,469	11,974	..	..	..	..	7,973	2,990	1,846	931
Korea, Rep	93,421	162,608	124,789	200,795	6,225	38,073	..	..	16,743	25,541	2,634	1,216
Kyrgyzstan	..	1,759	..	1,323	..	1,308	..	..	..	249	..	..
Lao People's Dem Rep	4	4	227	366	..	..	..	..	..	46	19,777	23,623
Malaysia	5,412	9,977	37,039	66,274	6,837	56,539	3,062	5,916	2,930	5,703	585,151	698,938
Mongolia	7,306	6,134	2,455	1,315	..	..	..	..	220	46	276	498
Myanmar	158	671	2,037	5,503	1,740	2,741	7	37	206	196	356,146	425,401
Nepal	33	1,154	542	2,099	..	..	..	..	53	149	103,363	123,462
Pakistan	8,530	8,189	32,646	55,663	23,116	36,017	..	..	3,732	4,933	33,575	33,008
Philippines	5,727	22,105	35,013	49,449	..	18	..	..	3,169	5,959	79,423	94,868
Singapore	77	..	44,067	54,718	..	2,708	..	..	922	1,619	73	39
Sri Lanka	4	4	3,558	9,677	..	..	..	..	199	502	24,733	29,543
Tajikistan	..	194	..	2,312	..	1,436	..	..	..	25	..	..
Thailand	13,590	40,531	62,006	109,968	11,120	35,446	..	..	9,019	12,706	39,875	47,629
Turkmenistan	..	..	..	9,416	..	24,948	..	..	..	224	..	..
Uzbekistan	..	2,711	..	19,566	..	94,593	..	..	..	1,755	..	..
Viet Nam	11,058	21,167	9,116	27,040	7	2,601	..	..	1,246	6,651	-40,783	-48,713
EUROPE	..	1,816,860	..	1,987,973	..	1,832,033	..	17,071	..	139,808	16,289	32,567
Albania	2,777	40	3,653	2,730	465	33	..	..	374	55	782	782
Austria	16,272	13,663	28,004	30,001	10,985	15,301	..	..	2,442	1,881	-772	-772
Belarus	..	3,499	..	22,101	..	32,632	..	..	..	920	..	5,642
Belgium	41,018	31,811	37,376	36,277	18,694	30,594	..	..	3,453	3,563	..	..
Bosnia and Herzegovina	..	15,990	..	2,583	..	531	..	..	..	149	..	..
Bulgaria	35,299	24,673	26,582	9,856	11,113	6,709	..	..	2,347	1,101	-2,046	-2,046
Croatia	..	1,806	..	11,300	..	5,056	..	..	..	1,421	..	-201
Czech Rep	..	82,418	..	17,148	..	17,162	..	..	..	2,039	..	-50
Denmark	23,468	14,989	21,379	19,786	3,847	8,405	241	421	827	1,001	-100	-100
Estonia	..	12,066	..	2,257	..	1,513	..	..	..	164	..	2,198
Finland	20,284	19,540	24,934	25,348	5,174	7,830	..	..	832	709	-802	-802
France	..	..	..	..	..	..	..	..	..	..	-6,178	-6,178
Germany	..	311,795	..	291,977	..	163,444	..	991	..	17,305	0	0
Greece	31,723	36,145	33,408	42,316	315	3,898	5	2	6,777	7,240	-3,009	-3,009
Hungary	18,778	13,597	20,346	16,865	18,357	22,028	..	..	1,958	1,670	-722	-722
Iceland	227	370	1,737	1,718	..	..	..	..	57	72	..	..
Ireland	13,165	11,201	12,311	21,867	4,335	7,863	..	..	812	1,305	-1,705	-1,705
Italy	51,230	48,189	227,659	227,989	90,805	132,593	..	..	19,932	19,396	-2,959	-2,959
Latvia	..	436	..	3,052	..	2,499	..	..	..	..	..	3,891
Lithuania	..	414	..	6,445	..	4,727	..	..	..	284	..	3,115
Macedonia, FYR	..	8,610	..	2,162	..	125	..	..	..	292	..	..
Moldova, Rep	..	366	..	1,253	..	4,836	..	..	..	111	..	..
Netherlands	40,520	29,601	26,612	27,213	70,525	80,135	183	198	1,859	1,719	-100	-100
Norway	3,272	4,074	25,850	22,816	29,741	20,702	1,124	1,398	628	922	-3,109	-3,109
Poland	288,280	220,906	34,661	50,164	18,419	22,779	..	..	6,229	7,498	-1,755	-1,755
Portugal	10,999	14,751	27,700	35,277	..	4,653	..	..	3,628	5,154	-5,717	-5,717
Romania	47,856	26,864	43,305	25,091	59,185	31,305	..	..	4,719	3,019	-1,474	-1,474
Russian Federation	..	363,311	..	325,546	..	721,427	..	8,627	..	16,145	..	54,218
Serbia and Montenegro	..	29,154	..	7,907	..	3,649	..	..	..	1,055	..	140
Slovakia	..	15,118	..	5,551	..	13,220	..	..	..	1,517	..	3,009
Slovenia	..	5,254	..	6,716	..	1,986	..	..	..	648	..	1,095
Spain	75,460	81,169	110,558	147,432	11,369	35,332	126	5	14,002	18,993	-8,626	-8,626
Sweden	10,519	9,680	36,490	34,343	1,213	1,598	..	..	1,236	1,321	-60	-60
Switzerland	1,422	465	34,940	31,148	3,734	5,569	..	..	2,596	1,879	-431	-431
Ukraine	..	166,313	..	31,316	..	142,500	..	..	..	2,647	..	..
United Kingdom	240,230	139,866	208,075	218,829	113,665	197,515	..	5,429	7,325	6,205	-1,705	-1,705
MIDDLE EAST & N. AFRICA	88,094	143,354	531,756	941,597	253,058	459,979	69,039	52,511	52,843	79,576	51,594	191,119
Afghanistan	278	4	1,850	630	403	224	26	22	56	25	7,491	8,812
Algeria	3,023	1,729	26,656	35,193	38,908	35,277	8,694	13,080	3,159	4,136	2,764	2,786
Egypt	3,360	2,642	52,032	87,229	13,015	40,326	..	..	7,026	12,030	3,090	2,984
Iran, Islamic Rep	4,518	5,723	140,397	146,622	43,506	121,916	21,821	24,141	6,478	11,900	9,166	8,101
Iraq	4	..	34,819	66,340	1,477	7,174	7,978	1,827	4,983	997	191	175
Israel	10,142	28,070	23,321	31,723	55	18	..	..	1,430	3,289	145	123
Jordan	..	..	9,277	13,791	..	443	..	..	907	1,315	13	13
Kuwait	..	..	27,641	28,315	13,971	17,617	1,346	962	448	997	0	0
Lebanon	..	315	8,643	13,447	..	..	..	..	448	1,399	557	569
Libyan Arab Jamahiriya	15	15	19,679	43,576	9,523	10,021	7,213	2,020	1,345	1,495	823	708
Morocco	4,683	10,688	16,602	21,728	110	95	..	..	2,093	4,036	2,469	2,570
Oman	..	..	4,584	8,094	5,086	8,951	1,372	1,874	498	855	0	0
Saudi Arabia	..	..	44,188	268,612	58,760	95,612	14,493	1,096	5,980	9,023	0	0
Syrian Arab Rep	..	11	26,897	36,988	3,133	10,618	4,070	4,166	1,744	2,407	69	59
Tunisia	264	282	8,849	10,677	2,499	4,356	5	259	1,644	2,819	4,151	3,931
Turkey	61,522	93,736	63,556	81,095	6,533	28,872	..	..	12,208	17,852	20,163	20,894
United Arab Emirates	14,770	21,196	36,728	31,613	2,020	3,066	1,625	3,040
Yemen	7,738	698	415	351

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	Solid Fuels		Liquid Fuels		Gaseous Fuels		Gas Flaring		Cement Manufacturing		Land-Use Change	
	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000
SUB-SAHARAN AFRICA	238,977	284,293	149,488	157,208	12,454	22,651	5,314	1,987	9,696	12,004	1,060,343	1,398,779
Angola	..	..	1,748	3,397	1,011	1,085	1,759	1,745	130	174	13,500	17,809
Benin	..	..	568	1,495	..	..	..	..	149	125	27,450	36,211
Botswana	2,169	2,561	..	1,290	..	..	..	..	..	..	14,918	19,680
Burkina Faso	..	..	993	1,004	..	..	..	..	..	25	488	643
Burundi	15	18	180	224	..	..	..	..	..	..	5,523	7,286
Cameroon	4	4	3,397	6,097	..	..	..	..	311	443	58,446	77,100
Central African Rep	..	..	198	271	..	..	..	..	..	..	6,796	8,965
Chad	..	..	143	125	..	..	..	..	..	..	2,646	3,491
Congo	..	..	1,788	1,319	4	238	168	240	45	10	7,489	9,880
Congo, Dem Rep	766	839	2,975	1,843	..	..	..	..	230	48	240,532	317,305
Côte d'Ivoire	..	..	5,144	7,251	..	2,898	..	..	249	324	69,090	91,142
Equatorial Guinea	..	..	117	205	..	..	..	..	..	..	3,366	4,441
Eritrea (a)	..	..	..	586	..	..	..	..	..	22	..	..
Ethiopia (a)	..	..	2,796	5,137	..	..	..	..	169	439	6,397	8,438
Gabon	..	..	2,045	1,839	506	1,557	3,386	..	58	105	2,781	3,669
Gambia	..	..	191	271	..	..	..	..	..	..	-198	-262
Ghana	7	7	3,382	4,917	..	..	..	..	336	972	21,153	27,905
Guinea	..	..	1,011	1,143	..	..	..	..	..	149	7,927	10,457
Guinea-Bissau	..	..	209	264	..	..	..	..	..	..	864	1,140
Kenya	403	264	4,664	8,519	..	..	..	..	753	571	9,035	11,919
Lesotho	..	..	..	..	..	..	..	..	..	..	0	0
Liberia	..	..	443	392	..	..	..	..	25	7	29,853	39,381
Madagascar	33	26	876	2,213	..	..	..	..	30	25	45,662	60,236
Malawi	48	44	502	641	..	..	..	..	49	78	20,256	26,722
Mali	..	..	410	542	..	..	..	..	10	15	6,085	8,027
Mauritania	15	15	2,568	3,001	..	..	..	..	52	55	..	..
Mozambique	154	..	802	1,026	..	..	..	..	39	155	7,039	9,286
Namibia	..	7	7	1,740	..	..	..	..	..	75	1,724	2,275
Niger	458	465	583	696	..	..	..	..	10	20	528	697
Nigeria	128	172	35,991	21,057	7,478	13,674	..	..	1,744	1,246	147,647	194,773
Rwanda	..	..	498	535	..	..	2	2	30	36	5,645	7,447
Senegal	..	..	2,884	3,679	11	..	..	..	234	498	2,725	3,595
Sierra Leone	..	..	333	517	..	..	..	..	..	50	10,089	13,310
Somalia	..	..	..	..	..	..	..	..	20	..	..	..
South Africa	218,744	267,303	59,401	52,296	3,444	3,199	..	..	3,892	4,480	1,297	1,711
Sudan	..	..	2,931	5,148	..	..	..	..	83	73	23,120	30,499
Tanzania, United Rep	11	209	2,052	3,682	..	..	..	..	269	415	11,025	14,544
Togo	..	..	553	1,444	..	..	..	..	199	349	6,527	8,611
Uganda	..	..	802	1,341	..	..	..	..	14	183	29,809	39,323
Zambia	832	286	1,396	1,348	..	..	..	..	218	189	178,485	235,454
Zimbabwe	14,568	11,018	1,726	3,290	..	..	..	..	349	498	35,962	47,440
NORTH AMERICA	1,879,504	2,188,745	2,215,555	2,395,904	1,085,878	1,393,364	12,428	10,369	40,664	50,059	-319,416	-338,304
Canada	91,003	107,963	176,220	170,035	137,902	146,084	4,363	5,491	5,830	6,284	83,418	64,531
United States	1,788,501	2,080,782	2,038,100	2,224,795	947,976	1,247,281	8,065	4,878	34,834	43,774	-402,834	-402,834
C. AMERICA & CARIBBEAN	10,582	22,552	374,893	445,575	83,931	101,782	5,048	5,311	18,041	23,137	432,184	303,227
Belize	..	..	311	780	..	..	..	..	..	..	30,440	21,357
Costa Rica	..	..	2,609	4,851	..	..	..	..	309	573	14,076	9,876
Cuba	396	40	30,089	28,960	70	1,103	..	..	1,495	814	-12,795	-8,977
Dominican Rep	26	513	9,010	23,622	..	..	..	..	528	997	0	0
El Salvador	..	..	2,297	5,419	..	..	..	..	320	1,248	5,893	4,135
Guatemala	..	..	4,232	9,068	18	22	..	..	837	797	80,683	56,608
Haiti	33	..	861	1,422	..	..	..	..	100	..	2,865	2,010
Honduras	..	..	2,264	4,239	..	..	..	..	325	548	25,077	17,594
Jamaica	139	191	7,599	10,329	..	..	..	..	220	260	3,742	2,625
Mexico	9,134	20,511	278,013	303,724	73,756	80,454	2,559	3,501	11,860	15,785	137,976	96,806
Nicaragua	..	..	2,045	3,558	..	..	..	..	598	180	76,536	53,699
Panama	92	187	2,777	5,654	110	117	..	..	149	379	67,691	47,493
Trinidad and Tobago	..	..	4,294	4,170	9,922	20,013	2,489	1,810	218	370	..	..
SOUTH AMERICA	65,219	80,432	359,724	484,439	106,608	179,668	19,066	18,123	24,360	38,510	2,927,452	2,053,944
Argentina	3,070	1,656	56,396	63,193	43,213	69,777	5,253	..	1,799	3,563	78,553	55,114
Bolivia	..	..	3,517	6,423	927	3,048	774	1,060	279	534	119,455	83,811
Brazil	35,728	51,215	144,358	213,652	7,420	18,009	2,250	5,107	12,856	19,538	1,955,614	1,372,088
Chile	10,776	14,246	19,767	31,580	3,345	11,633	385	299	1,056	1,740	22,044	15,466
Colombia	13,883	10,776	30,594	29,400	7,541	12,487	807	937	3,114	4,858	151,289	106,147
Ecuador	..	..	13,267	21,189	509	1,356	1,669	1,509	1,121	1,395	83,944	58,896
Guyana	..	..	1,132	1,598	..	..	..	..	..	..	49,752	34,907
Paraguay	..	..	2,099	3,312	..	..	..	..	162	349	29,405	20,631
Peru	542	1,806	18,335	24,494	1,308	1,396	382	..	1,091	1,844	266,841	187,219
Suriname	..	..	1,784	2,088	..	..	..	..	25	30	0	0
Uruguay	4	4	3,657	5,056	..	..	..	..	249	349	-34,782	-24,403
Venezuela	1,216	729	64,014	81,561	42,345	61,962	7,546	9,212	2,606	4,285	205,339	144,069
OCEANIA	150,561	207,972	100,841	119,538	42,836	55,722	..	..	3,968	4,258	135,674	153,761
Australia	145,794	203,330	82,850	93,527	33,848	44,166	..	..	3,523	3,737	8,173	4,256
Fiji	62	48	711	630	..	..	..	..	39	47	125	112
New Zealand	4,265	4,166	10,083	16,034	8,841	11,395	..	..	374	473	4,877	3,194
Papua New Guinea	4	4	2,279	2,264	147	161	..	..	..	..	122,229	145,998
Solomon Islands	..	..	161	165	..	..	..	..	..	..	190	163
DEVELOPED	4,374,065	4,985,462	4,598,551	5,280,066	1,921,918	3,624,443	15,470	27,440	215,291	246,385	-276,595	-286,455
DEVELOPING	3,019,389	3,468,328	2,355,879	3,613,415	628,065	1,123,371	119,276	91,624	292,328	582,590	8,174,023	7,905,339

a. Starting in 1993, Eritrea and Ethiopia, formerly Ethiopia PDR, are shown separately.

VARIABLE DEFINITIONS AND METHODOLOGY

Carbon Dioxide (CO₂) Emissions by Source refers to the amount of CO₂ emissions due to a specified cause. All data are converted to their actual mass of CO₂ by using a multiplier of 3.664, the ratio of the mass of CO₂ to that of Carbon (C). Moreover, data do not include bunker fuels used in international transportation due to the difficulty of apportioning these fuels among the countries benefiting from that transport.

CO₂ emission estimates from 1950 to the present are derived primarily from energy statistics published by the United Nations in its Energy Statistics Yearbook 2001. The statistics are compiled by the U.N. from annual questionnaires filled out by countries and supplemented by official national statistics. Some official sources are "supplemented by [the U.N. through] other means and estimates, where these have been subjected to professional scrutiny and debate and are consistent with other independent sources." However, the process of verifying and supplementing national data is not as extensive as that undertaken by the International Energy Agency.

The Carbon Dioxide Information Analysis Center (CDIAC) calculates CO₂ emissions for gas flaring, cement manufacturing, and solid, liquid, and gaseous fuels. The data is derived from statistics on fuel production, trade, and net apparent consumption by applying emissions factors for each fuel and its use. The basic equation used is $CO_2 \text{ emissions} = P * FO * C$, where P = production or consumption of a fuel, FO = the emissions factor, and C = the carbon content of the fuel in tons of C per ton of fuel. The FO of crude oil, for example, is 0.918 + 3%, while C is 0.85 per ton of fuel + 1%.

Solid Fuels refer to the mass of CO₂ emitted primarily, but not exclusively, from burning coal.

Liquid Fuels refer to CO₂ emissions primarily, but not exclusively, from burning petroleum products.

Gaseous Fuels refer to CO₂ emissions primarily, but not exclusively, from burning natural gas.

Gas Flaring refers to CO₂ emissions that result from the burning of gas released in the process of petroleum extraction. U.N. gas flaring estimates are supplemented with data from the U.S. Energy Information Administration, data provided by G. Marland at CDIAC, and a 1974 paper, "First Estimates of Global Flaring of Natural Gas" by R.M. Rotty.

Cement Manufacturing refers to CO₂ emissions produced as cement is calcined to form calcium oxide. Based on data from the United States Geologic Survey (USGS), it is estimated that approximately 0.5 metric tons of carbon is released for each metric ton of cement production.

For further information on the data, methodology, and sources used for gas flaring, cement manufacturing, and solid, liquid, and gaseous fuels, please consult following web page maintained by CDIAC: http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm. A complete record of the formulas and assumptions used to calculate CO₂ emissions is available on-line at <http://cdiac.esd.ornl.gov/trends/emis/factors.htm>.

CO₂ Emissions from Land-Use Change measures the total mass of carbon dioxide absorbed or emitted into the atmosphere as a result of man-made land use changes (e.g. deforestation, shifting cultivation, vegetation re-growth on abandoned croplands and pastures). Positive values indicate a positive net flux ("source") of CO₂; for these countries, carbon dioxide has been released into the atmosphere as a result of land-use change. Negative values indicate a negative net flux ("sink") of CO₂; in these countries, carbon has been absorbed as a result of the re-growth of previously removed vegetation.

Data include emissions from both living and dead vegetation disturbed at the time of clearing or harvest, emissions from wood products (including fuelwood), and emissions from the oxidation of soil organic matter in the years following initial cultivation. Those ecosystems that are not directly affected by human activities such as agriculture and forestry are not included in these estimated sources and sinks.

The net flux of CO₂ was calculated on a global and regional level by R.A. Houghton. Regional fluxes (changes in above- and below-ground carbon) were modeled based on annual rates of wood harvest and changes in agricultural area.

Once regional fluxes were calculated, they were divided among countries. For tropical regions, each flux was distributed among countries in proportion to the product of change in forest area (1990-2000) and average forest biomass as reported by the Food and Agricultural Organization (FAO)'s Forest Resources Assessment 2000 (see <http://www.fao.org/docrep/004/y1997e/y1997e00.htm>). For regions outside the tropics, the flux was divided among countries in proportion to annual rates of wood production (harvest) as reported by FAOSTAT (see <http://apps.fao.org>). The only exception to this method was for European countries between 1975 and 2000. For this interval, the regional sink was distributed among countries by the 1990-2000 change in forest area (similar to the approach for tropical regions). Three of the "regions" (Canada, the United States, and China) provided national estimates directly.

FREQUENCY OF UPDATE BY DATA PROVIDERS

Solid Fuels, Liquid Fuels, Gaseous Fuels, Gas Flaring, and Cement Manufacturing

As of January 2005, data were available on-line through 2000 at http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm. CDIAC updates the data annually in July or August.

Land Use Change

Annual country-level data are provided by R.A. Houghton at the Woods Hole Research Center in Woods Hole, MA. While a number of regional and global estimates have been calculated for carbon flux from land-use change, this is the first global data set with country-level data.

DATA RELIABILITY AND CAUTIONARY NOTES

Solid Fuels, Liquid Fuels, Gaseous Fuels, Gas Flaring, and Cement Manufacturing

Although CDIAC's estimates of world emissions are probably within 10 percent of actual emissions, individual country estimates may depart more severely from reality. The trends demonstrated in a consistent, uniform time series are usually more accurate than individual values in the time series.

CDIAC annually recalculates the entire time series from 1950 to the present, incorporating its most recent understanding and the latest corrections to the database. The carbon emissions estimates have therefore become more consistent, and probably more accurate, each year.

The sum of individual country totals listed does not equal the global totals because emissions from fuels used in international trade (i.e., bunker fuels) are not included in national totals. In addition, global totals include the oxidation of fuels used for non-energy purposes, but do not include annual changes in national fuel stocks, and statistical differences exist between the sum of exports for all exporters and the sum of imports by all importers.

Land Use Change

These data provide a very rough picture of the level of carbon entering the atmosphere from land-use change and should be treated as order-of-magnitude estimates. Houghton states that yearly flux estimates are uncertain on the order of $\pm 150\%$ for large fluxes, and ± 50 million metric tons of carbon per year for estimates near zero.

The estimates do not explicitly include changes in carbon stocks that may result from various forms of management such as agricultural intensification, fertilization, no-till agriculture, thinning of forests, changes in species or varieties, and other silvicultural practices. Furthermore, the analysis ignores fluxes of carbon to or from ecosystems not directly affected by land-use change.

SOURCES

Solid Fuels, Liquid Fuels, Gaseous Fuels, Gas Flaring, and Cement Manufacturing

Data are compiled by G. Marland and T.A. Boden of CDIAC and R.J. Andres of the University of North Dakota. Carbon Dioxide Information Analysis Center (CDIAC), Environmental Sciences Division, Oak Ridge National Laboratory: 2005. Global, Regional, and National CO₂ Emission Estimates from Fossil Fuel Burning, Cement Production, and Gas Flaring: 1751-2000, NDP-030 (Available online at http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm). CDIAC, Oak Ridge, Tennessee.

Land Use Change

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