

## 10. Recalculations and Improvements

Each year, emission and sink estimates are recalculated and revised for all years in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, and attempts to improve both the analyses themselves, through the use of better methods or data, and the overall usefulness of the report. In this effort, the United States follows the IPCC Good Practice Guidance, which states, regarding recalculations of the time series, “It is good practice to recalculate historic emissions when methods are changed or refined, when new source categories are included in the national inventory, or when errors in the estimates are identified and corrected (IPCC 2000).”

The results of all methodology changes and historical data updates are presented in this section; detailed descriptions of each recalculation are contained within the source descriptions contained elsewhere in this report. Table 10-1 summarizes the quantitative effect of these changes on U.S. greenhouse gas emissions and Table 10-2 summarizes the quantitative effect on U.S. sinks, both relative to the previously published U.S. Inventory (i.e., 1990-2001 report). These tables present the magnitude of these changes in units of teragrams of carbon dioxide (CO<sub>2</sub>) equivalent (Tg CO<sub>2</sub> Eq.). In addition to the changes summarized by the tables below, three new sources—CO<sub>2</sub> emissions from phosphoric acid production and CH<sub>4</sub> emissions from abandoned coal mines and iron and steel production—have been added to the current Inventory.

The Recalculations Discussion section of each source presents the details of each recalculation. In general, when methodological changes have been implemented, the entire time series (i.e., 1990 through 2001) has been recalculated to reflect the change. Changes in historical data are generally the result of changes in statistical data supplied by other agencies. References for the data are provided for additional information.

The following emission sources, which are listed in descending order of absolute average annual change in emissions from 1990 through 2001, underwent some of the most important methodological and historical data changes. A brief summary of the recalculation and/or improvement undertaken is provided for each emission source.

- *Land-Use Change and Forestry.* The most influential of the changes in the calculation of CO<sub>2</sub> sequestration from land-use change and forestry was a switch in basing the estimates of non-soil forest carbon stocks and fluxes in other pools on state-based assessment rather than regionally-based assessment. Overall, this change, along with several other alterations, resulted in an average annual decrease in the net CO<sub>2</sub> sequestration of 126.8 Tg CO<sub>2</sub> Eq. (13.2 percent) for the period 1990 through 2001.
- *CO<sub>2</sub> from Fossil Fuel Combustion.* The emissions calculation was revised to incorporate a new carbon content coefficient for LPG, industrial coal emissions that now account for carbon exported as CO<sub>2</sub> to Canada, an annually variable (rather than static) feedstock storage factor, and updated energy consumption data for all years. Overall, these changes and revisions to “Carbon Stored in Products from Non-Energy Uses of Fossil Fuels” and “International Bunker Fuels” (which affect emissions from this source) resulted in an average annual decrease in CO<sub>2</sub> emissions from fossil fuel combustion of 12.3 Tg CO<sub>2</sub> Eq. (0.2 percent) for the period 1990 through 2001.
- *Substitution of Ozone Depleting Substances.* The calculation of emissions was adjusted to incorporate the use of both a new Vintaging Model and a set of updated assumptions for the model. Overall, changes resulted in an average annual increase in HFC, PFC, and SF<sub>6</sub> emissions from the substitution of ozone depleting substances of 6.7 Tg CO<sub>2</sub> Eq. (9.1 percent) for the period 1990 through 2001.
- *Coal Mining.* The major change in the calculation of emissions was the incorporation of new in-situ gas content values. Overall, changes resulted in an average annual decrease in CH<sub>4</sub> emissions from coal mining of 5.0 Tg CO<sub>2</sub> Eq. (7.1 percent) for the period 1990 through 2001.
- *Agricultural Soil Management.* The emissions calculation changed to incorporate a corrected percent residue applied for rice in the year 2001, an additional significant digit in the conversion between short tons and metric tons, and a number of methodological and historical data revisions in the calculations of nitrogen from livestock that is applied to soils. Overall, changes resulted in an average annual decrease in N<sub>2</sub>O emissions from agricultural soil management of 4.9 Tg CO<sub>2</sub> Eq. (1.7 percent) for the period 1990 through 2001.

- *Waste Combustion.* The calculation of emissions has been revised to incorporate a new emission factor, a new method for filling in a time series where data are unavailable, and updated data for several sub-categories within the municipal solid waste combustion sector. Overall, changes resulted in an average annual decrease in CO<sub>2</sub> emissions from waste combustion of 4.4 Tg CO<sub>2</sub> Eq. (21.8 percent) for the period 1990 through 2001.
- *Landfills.* Revisions to the emissions calculation incorporated an improvement in the estimation of emissions avoided by landfill gas to energy projects for which flares could not be identified in the flare database, additional data on flares that were installed from 1994 to 2002, changes to the landfill gas to energy database, and revisions to the procedure used to estimate emissions avoided by landfill gas to energy projects that generate electricity. Overall, changes resulted in an average annual decrease in CH<sub>4</sub> emissions from landfills of 4.0 Tg CO<sub>2</sub> Eq. (1.9 percent) for the period 1990 through 2001.
- *Petroleum Systems.* The calculation of emissions was revised to incorporate a modified activity factor for methane emissions from oil tanks in the production sector, a new data source for fuel gas systems in the refinery sector, and a revision of the emission factors for high and low bleed pneumatic devices. Overall, changes resulted in an average annual increase in CH<sub>4</sub> emissions from petroleum of 1.7 Tg CO<sub>2</sub> Eq. (7.4 percent) for the period 1990 through 2001.
- *Natural Gas Systems.* The emissions calculation was revised to incorporate new Gas STAR emissions reduction data and new sources of water production activity factors for coalbed methane emissions. Overall, changes resulted in an average annual increase in CH<sub>4</sub> emissions from natural gas systems of 1.1 Tg CO<sub>2</sub> Eq. (0.9 percent) for the period 1990 through 2001.
- *Semiconductor Manufacture.* The emissions calculation was changed to incorporate an updated version of EPA's PEVM model with more current reference data, updated historical data for several participants in the PFC Reduction/Climate Partnership for the Semiconductor Industry, and an alteration in the methodology for estimating the distribution of historical emissions by gas type. Overall, changes resulted in an average annual decrease in HFC, PFC, and SF<sub>6</sub> emissions from semiconductor manufacture of 0.3 Tg CO<sub>2</sub> Eq. (4.3 percent) for the period 1990 through 2001.
- *Natural Gas Flaring.* The methodology for estimating emissions, which had previously focused solely on on-shore natural gas flaring, was revised to include emissions from offshore flaring. Overall, changes resulted in an average annual increase in CO<sub>2</sub> emissions from natural gas flaring of 0.3 Tg CO<sub>2</sub> Eq. (4.3 percent) for the period 1990 through 2001.
- *Carbon Dioxide Consumption.* The methodology used to calculate emissions was revised to adjust an outdated underlying assumption that 20 percent of the CO<sub>2</sub> produced for domestic consumption was from "natural sources." Overall, changes resulted in an average annual decrease in CO<sub>2</sub> emissions from CO<sub>2</sub> consumption of 0.2 Tg CO<sub>2</sub> Eq. (19.2 percent) for the period 1990 through 2001.

Table 10-1: Revisions to U.S. Greenhouse Gas Emissions (Tg CO<sub>2</sub> Eq.)

| Gas/Source                                 | 1990         | 1996          | 1997          | 1998          | 1999         | 2000          | 2001          |
|--|--------------|---------------|---------------|---------------|--------------|---------------|---------------|
| <b>CO<sub>2</sub></b>                      | <b>(1.4)</b> | <b>(16.3)</b> | <b>(17.7)</b> | <b>(11.7)</b> | <b>(4.4)</b> | <b>(24.1)</b> | <b>(63.0)</b> |
| Fossil Fuel Combustion                     | (0.1)        | (15.7)        | (16.0)        | (8.1)         | +            | (18.6)        | (56.1)        |
| Natural Gas Flaring                        | 0.3          | 0.3           | 0.3           | 0.3           | 0.3          | 0.2           | 0.2           |
| Cement Manufacture                         | NC           | NC            | NC            | NC            | NC           | NC            | NC            |
| Lime Manufacture                           | NC           | NC            | NC            | NC            | NC           | NC            | +             |
| Limestone and Dolomite Use                 | 0.1          | 0.2           | 0.2           | 0.1           | 0.4          | 0.2           | 0.5           |
| Soda Ash Manufacture and Consumption       | NC           | NC            | NC            | NC            | NC           | NC            | NC            |
| Carbon Dioxide Consumption                 | +            | (0.4)         | (0.3)         | (0.2)         | (0.3)        | (0.2)         | (0.4)         |
| Waste Combustion                           | (3.1)        | (2.2)         | (3.4)         | (5.4)         | (6.3)        | (7.4)         | (8.1)         |
| Titanium Dioxide Production                | NC           | NC            | NC            | NC            | NC           | NC            | NC            |
| Aluminum Production                        | NC           | NC            | NC            | NC            | NC           | 0.3           | +             |
| Iron and Steel Production                  | NC           | NC            | NC            | NC            | NC           | (0.1)         | +             |
| Ferroalloys                                | NC           | NC            | NC            | NC            | NC           | NC            | NC            |
| Ammonia Manufacture & Urea Application     | NC           | NC            | NC            | NC            | NC           | NC            | (0.3)         |
| Phosphoric Acid Production <sup>a</sup>    | 1.5          | 1.6           | 1.5           | 1.6           | 1.5          | 1.4           | 1.3           |
| <i>Land-Use Change and Forestry (Sink)</i> | 114.9        | 5.8           | 19.7          | 124.7         | 165.3        | 144.5         | 148.4         |

|  |               |               |               |               |              |               |               |
|--|---------------|---------------|---------------|---------------|--------------|---------------|---------------|
| <i>International Bunker Fuels</i>                | +             | +             | +             | 2.2           | +            | 2.1           | 0.5           |
| <i>Biomass Combustion</i>                        | 216.7         | 244.3         | 233.2         | 217.2         | 222.3        | 226.8         | 204.4         |
| <b>CH<sub>4</sub></b>                            | <b>(1.3)</b>  | <b>0.2</b>    | <b>(0.7)</b>  | <b>(2.6)</b>  | <b>(2.5)</b> | <b>1.1</b>    | <b>(0.8)</b>  |
| Stationary Sources                               | 0.1           | 0.1           | 0.2           | 0.1           | 0.1          | 0.1           | (0.2)         |
| Mobile Sources                                   | +             | +             | +             | +             | +            | +             | +             |
| Coal Mining                                      | (5.2)         | (5.2)         | (5.5)         | (5.2)         | (4.8)        | (4.7)         | (5.1)         |
| Abandoned Coal Mines <sup>a</sup>                | 3.4           | 6.0           | 5.6           | 4.8           | 4.4          | 4.4           | 4.2           |
| Natural Gas Systems                              | +             | (0.1)         | 0.1           | 0.5           | 0.6          | 4.5           | 7.5           |
| Petroleum Systems                                | 1.4           | 1.7           | 1.9           | 2.1           | 2.1          | 2.3           | 2.2           |
| Petrochemical Production                         | +             | +             | +             | +             | +            | +             | (0.1)         |
| Silicon Carbide Production                       | NC            | NC            | NC            | NC            | NC           | NC            | NC            |
| Iron and Steel Production <sup>a</sup>           | 1.3           | 1.3           | 1.3           | 1.2           | 1.2          | 1.2           | 1.1           |
| Enteric Fermentation                             | +             | +             | NC            | +             | +            | +             | (0.5)         |
| Manure Management                                | (0.2)         | (0.3)         | (0.3)         | (0.3)         | (0.2)        | (0.3)         | +             |
| Rice Cultivation                                 | +             | +             | +             | +             | +            | NC            | +             |
| Field Burning of Agricultural Residues           | +             | +             | +             | +             | +            | +             | +             |
| Landfills  | (2.1)         | (3.3)         | (4.1)         | (5.9)         | (5.9)        | (6.5)         | (9.7)         |
| Wastewater Treatment                             | +             | 0.1           | 0.1           | +             | 0.1          | +             | (0.2)         |
| <i>International Bunker Fuels</i>                | +             | +             | +             | +             | +            | +             | +             |
| <b>N<sub>2</sub>O</b>                            | <b>(4.4)</b>  | <b>(4.9)</b>  | <b>(4.6)</b>  | <b>(4.7)</b>  | <b>(4.6)</b> | <b>(4.1)</b>  | <b>(7.3)</b>  |
| Stationary Sources                               | 0.1           | 0.1           | 0.3           | 0.1           | 0.2          | 0.2           | (0.3)         |
| Mobile Sources                                   | +             | +             | +             | (0.1)         | (0.1)        | (0.1)         | 0.3           |
| Adipic Acid                                      | NC            | NC            | NC            | NC            | NC           | NC            | NC            |
| Nitric Acid                                      | NC            | +             | +             | +             | +            | 0.5           | (1.7)         |
| Manure Management                                | +             | +             | +             | +             | +            | (0.1)         | +             |
| Agricultural Soil Management                     | (4.7)         | (5.1)         | (5.0)         | (4.9)         | (4.9)        | (4.8)         | (5.7)         |
| Field Burning of Agricultural Residues           | +             | +             | +             | +             | +            | +             | +             |
| Human Sewage                                     | 0.1           | +             | +             | 0.1           | 0.1          | 0.2           | 0.1           |
| N <sub>2</sub> O Product Usage                   | NC            | NC            | +             | +             | +            | +             | +             |
| Waste Combustion                                 | 0.1           | 0.1           | 0.1           | 0.1           | 0.1          | 0.1           | 0.1           |
| <i>International Bunker Fuels</i>                | +             | +             | +             | +             | +            | +             | +             |
| <b>HFCs, PFCs, and SF<sub>6</sub></b>            | <b>(3.4)</b>  | <b>1.2</b>    | <b>4.8</b>    | <b>8.1</b>    | <b>14.5</b>  | <b>18.1</b>   | <b>18.8</b>   |
| Substitution of Ozone Depleting Substances       | (0.6)         | 4.6           | 8.7           | 12.0          | 15.0         | 17.8          | 19.7          |
| Aluminum Production                              | +             | NC            | NC            | NC            | NC           | 1.0           | (0.2)         |
| HCFC-22 Production                               | NC            | NC            | NC            | NC            | NC           | NC            | NC            |
| Semiconductor Manufacture                        | +             | 0.1           | (0.2)         | (0.1)         | (0.5)        | (1.1)         | (1.0)         |
| Electrical Transmission and Distribution         | (2.9)         | (3.4)         | (3.6)         | (3.8)         | +            | 0.4           | 0.3           |
| Magnesium Production and Processing              | NC            | NC            | NC            | NC            | NC           | +             | +             |
| <b>Net Change in Total Emissions<sup>b</sup></b> | <b>(10.5)</b> | <b>(19.7)</b> | <b>(18.2)</b> | <b>(10.9)</b> | <b>3.0</b>   | <b>(9.0)</b>  | <b>(52.3)</b> |
| <b>Percent Change</b>                            | <b>(0.2%)</b> | <b>(0.3%)</b> | <b>(0.3%)</b> | <b>(0.2%)</b> | <b>+</b>     | <b>(0.1%)</b> | <b>(0.8%)</b> |

+ Absolute value does not exceed 0.05 Tg CO<sub>2</sub> Eq or 0.05 percent.

<sup>a</sup> New source category relative to previous inventory.

<sup>b</sup> Excludes emissions from land-use change and forestry, international bunker fuels, and biomass combustion.

NC: (No Change)

Note: Totals may not sum due to independent rounding.

Table 10-2: Revisions to Net CO<sub>2</sub> Sequestration from Land-Use Change and Forestry (Tg CO<sub>2</sub> Eq.)

| Component                       | 1990         | 1996        | 1997        | 1998         | 1999         | 2000         | 2001         |
|---------------------------------|--------------|-------------|-------------|--------------|--------------|--------------|--------------|
| Forests                         | 136.0        | 14.9        | 28.9        | 133.9        | 174.2        | 153.0        | 158.8        |
| Urban Trees                     | NC           | NC          | NC          | NC           | NC           | NC           | NC           |
| Agricultural Soils              | (13.3)       | (5.4)       | (5.4)       | (5.4)        | (5.4)        | (5.3)        | (5.6)        |
| Landfilled Yard Trimmings       | (7.8)        | (3.7)       | (3.8)       | (3.8)        | (3.5)        | (3.3)        | (4.9)        |
| <b>Net Change in Total Flux</b> | <b>114.9</b> | <b>5.8</b>  | <b>19.7</b> | <b>124.7</b> | <b>165.3</b> | <b>144.5</b> | <b>148.4</b> |
| <b>Percent Change</b>           | <b>10.7%</b> | <b>0.5%</b> | <b>2.3%</b> | <b>15.0%</b> | <b>19.7%</b> | <b>17.3%</b> | <b>17.7%</b> |

NC: (No Change)

Note: Numbers in parentheses indicate an *increase* in estimated net sequestration, or a decrease in net flux of CO<sub>2</sub> to the atmosphere. In the “percent change” row, negative numbers indicate that the sequestration estimate has decreased, and positive numbers indicate that the sequestration estimate has increased. Totals may not sum due to independent rounding.