## Dataset Information:

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| **Title** | **Manure Management** |
| **Abstract** | Greenhouse gas (GHG) emissions from manure management consist of methane and nitrous oxide gases from aerobic and anaerobic manure decomposition processes. Computed at Tier 1 following the 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2006); available by country, with global coverage and relative to the period 1961 to present, with annual updates, and projections for 2030 and 2050. |
| **Supplemental** | This domain contains data on GHG emissions, associated emission factors and underlying activity data.<br>The FAOSTAT Emissions data are estimates by FAO and do not coincide with GHG data reported by member countries to UNFCCC. The database is intended primarily as a service to help member countries assess and report their emissions, as well as a useful international benchmark. The FAOSTAT Emissions data are disseminated publicly to facilitate continuous feedback from member countries. |
| **Creation Date** | 2012 |
| **Last Update** | 2013 |
| **Data Type** | Climate Change - Greenhouse Gases |
| **Category** | Environment |
| **Time Period** | 1961-present; projections for 2030 and 2050 |
| **Periodicity** | Annual |
| **Geographical Coverage** | World |
| **Spatial Unit** | Country |
| **Language** | Multilingual (EN, FR, ES) |

## Methodology and Quality Information:

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| **Methods and processing** | GHG emissions from manure management consist of methane and nitrous oxide gases from aerobic and anaerobic decomposition processes. The FAOSTAT emission data are computed at Tier 1 following IPCC, 2006, Vol. 4, Ch. 10 and 11.<br><br>The term manure includes both urine and dung (i.e., both liquid and solid material) produced by livestock. More specifically, $CH_4$ gas is produced by anaerobic decomposition of manure stored or treated, while $N_2O$ is produced directly by nitrification and de-nitrification processes in the manure, and indirectly by nitrogen (N) volatilization and re-deposition processes, as well as from leaching of manure N.<br><br>$CH_4$ emissions are estimated at country level, using the formula:<br><br>*Emission = A * EF*<br><br>where:<br>*Emission* = GHG emissions in kg $CH_4$ $yr^{-1}$;<br>*A* = Activity data, representing number of livestock in heads (1);<br>*EF* = Tier 1, default IPCC emission factors, expressed in kg $CH_4$ $head^{-1}$ $yr^{-1}$ (2).<br><br>(1) Activity data cover the following animal categories: buffalo, sheep, goats, camels, llamas, horses, mules, asses, ducks, turkeys, dairy and non-dairy cattle*, chickens layers and broilers** and market and breeding swine***.<br><br>For the period 1961-present, activity data are taken directly from FAOSTAT (domain: Production/Live animals). Projections of activity data for 2030 and 2050 for the following categories: dairy and non-dairy cattle, buffaloes, sheep, goats, pigs and poultry, are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO |

perspective studies (Alexandratos and Bruinsma, 2012). Activity data for animal categories for which FAO projections were not available were set to the most recent available FAOSTAT value. The FAO projections used cover some 140 countries. Projections of activity data for countries not included assume the same growth rate of neighboring countries.

*FAOSTAT livestock data include the items cattle and dairy cattle. Dairy cattle data are expressed as heads of cows producing milk, and can be found under the domain Production/Livestock Primary by selecting the item cow milk, whole fresh and the element producing animals. Non-dairy cattle is derived from FAOSTAT categories, specifically as cattle minus dairy cattle;

**FAOSTAT livestock data include the items chicken and chicken layers. Chicken layers are expressed in 1000 heads of hens which have laid eggs in the reference period, and can be found under the domain Production/Livestock Primary by selecting the item hen eggs, in shell and the element producing animals. chickens broilers is derived from FAOSTAT categories, specifically as chickens minus chickens layers;

***FAOSTAT livestock data include the item pigs. Market and breeding swine are calculated respectively as 90% and 10% of item pigs (IPCC, 2006, Vol.4, Ch.10, Tab.10.19).
(2) The EF values are assigned to each country (IPCC, 2006: Tab. 10.14 for cattle, buffaloes and pigs and Tab. 10.15 for all other animals), as a function of country-level average annual temperature ($^{o}$C). Average annual temperatures by country are taken from the FAO Global Agro-Ecological Zones (GAEZ) dataset (IIASA/FAO, 2012), relative to the baseline period 1961-1990.

Direct $N_2O$ emissions are estimated at country level, using the formula:

*Emission = A * EF*

where:
*Emission* = GHG emissions in kg $N_2O$-N $yr^{-1}$;
*A* = Activity data, representing the total amount of N in manure treated in manure management systems (MMS) in kg N $yr^{-1}$ (3);
*EF* = Tier 1, default IPCC emission factors, expressed in kg $N_2O$-N/kg N $yr^{-1}$ (4).

(3) It is the total amount of N excreted (i) for each livestock categories (ii) treated in MMS (iii).
(i) Following IPCC, 2006: Vol. 4, Ch. 10 Eq. 10.30, the total amount of N excreted by each livestock category is calculated multiplying the number of livestock heads by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (Nex). Both parameters vary according to geographic region. TAM values are obtained from IPCC, 2006: Vol.4, Ch. 10, Annex 10A.2, Tabs. 10A-4 to 10A-9; Nex values are derived from IPCC, 2006: Vol.4, Ch. 10, Tab. 10.19.

(ii) see (1) for the livestock categories.

(iii) Default IPCC percentages of total N treated in different MMS, by region and livestock category, are taken from IPCC, 2006: Vol.4, Ch. 10, Annex 10A.2 Tabs. 10A-4 to 10A-9 (for poultry: IPCC, 1997: Ch.4 Tab. 4.21).

(4) The EF values depend on the specific MMS, as per IPCC 2006, Vol.4, Ch. 10, Tab. 10.21.

Indirect $N_2O$ emissions are estimated at country level, using the formula:

*Emission = A * EF*

where:
*Emission* = GHG emissions in kg $N_2O$-N $yr^{-1}$;
*A* = Activity data, representing the fraction of total amount of nitrogen (N) in manure treated in MMS that volatizes as $NH_3$ and $NO_x$ and is lost through runoff and leaching, in

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| | kg N $yr^{-1}$ (5);<br>*EF* = Tier 1, default IPCC emission factors, expressed in kg $N_2O$-N/kg N $yr^{-1}$ (6).<br><br>(5) The fractions for volatilization by animal and MMS are taken from IPCC, 2006: Vol. 4, Ch. 10, Tab. 10.22. A mean fraction value of 10% for all countries is used for leaching (IPCC, 2006: Vol. 4, Ch. 10, note to Eq. 10.28).<br><br>(6) All countries are assigned global default EF values for volatilization and leaching (IPCC, 2006: Vol. 4, Ch. 11, Tab. 11.3).<br><br>Dimensionless conversion factors used are:<br>44/28, to convert the emissions from kg $N_2O$-N to kg $N_2O$ gas;<br>$10^{-6}$, to convert kg to Gg; and<br>GWP-$CH_4$ = 21 and GWP-$N_2O$ = 310 (100-year time horizon global warming potential), to convert Gg $CH_4$ or Gg $N_2O$ to Gg $CO_2$eq. (IPCC, 1996: Technical Summary, Tab. 4 pg. 22).<br><br>The manure management domain contains the following data categories available for download: country-level GHG emissions, provided as total, direct and indirect amounts in Gg CH4, Gg N2O and Gg CO2eq, by livestock species and by species aggregates, as well as their total; implied emission factors; and activity data. Data are available for all countries and territories, as well as for standard FAOSTAT regional aggregations, plus Annex I and non-Annex I groups. The data period is 1961 to present, with annual updates, and projections for 2030 and 2050.<br><br>Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors and activity data. They may be related to, inter alia, natural variability, partitioning fractions, lack of spatial or temporal coverage, spatial aggregation. In the case of manure management, more detailed information is available in the guidelines (IPCC, 2006: Vol. 4, Ch. 10, Section 10.5.5).<br><br>*References*<br><br>Alexandratos, N. and J. Bruinsma. 2012. World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03. Rome, FAO.<br><br>IIASA/FAO. 2012. Global Agro Ecological Zones (GAEZ v3.0), IIASA, Laxenburg, Austria, and FAO, Rome. www.fao.org/nr/gaez<br><br>IPCC. 1996. Climate Change 1995 - The Science of Climate Change: Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge.<br><br>IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (Eds), IGES, Hayama, Japan. |
| **Data Collection Method** | Computed |
| **Completeness** | 100% |
| **Links** | www.fao.org/climatechange/micca/ghg/<br>www.ipcc-nggip.iges.or.jp/public/ |

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