FAOSTAT Domain Manure Management Metadata, release June 2020

Dataset Information:	
Title	**Manure Management**
Abstract	The FAOSTAT domain Manure Management contains estimates of methane (CH_4) and nitrous oxide (N_2O) emissions from aerobic and anaerobic processes of manure decomposition. Estimates are computed at Tier 1 following the 2006 Guidelines for National GHG Inventories of the Intergovernmental Panel on Climate Change (IPCC, 2006). Data are available by country, with global coverage and relative to the period 1961 – 2018, with annual updates, and projections for 2030 and 2050.
Supplemental	The FAOSTAT domain Manure management disseminates information by country, animal category and relevant aggregates on: CH_4, direct and indirect N_2O emissions, in units of Gg CH_4, Gg N_2O and Gg CO_2eq; implied emission factors; and activity data (i.e. animal stocks). Data are available for most countries and territories, for standard FAOSTAT regional aggregations, and for Annex I and non-Annex I groups. FAOSTAT data on Manure Management are FAO estimates. They may not coincide with data that are reported by countries to relevant international processes. This database is intended as a global knowledge product, with country-level information compiled transparently and in a comparable manner.
Creation Date	2012
Last Update	2020
Data Type	Climate Change - Greenhouse Gases
Category	Agriculture; Environment
Time Period	1961 – 2018; projections for 2030 and 2050
Periodicity	Annual
Geographical Coverage	World
Spatial Unit	In 2018, 191 countries and 25 other territorial entities
Language	Multilingual (EN, FR, ES)

Methodology and Quality Information:	
Methods and processing	The Manure Management domain of FAOSTAT GHG emissions database provides information on 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. 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. CH_4 emissions are estimated at country level, using the formula: *Emission = A * EF* where: *Emission* = GHG emissions in kg CH_4 yr^{-1}; *A* = Activity data, representing number of livestock in heads (1); *EF* = Tier 1, default IPCC emission factors, expressed in kg CH_4 $head^{-1}$ yr^{-1} (2). (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***.

For the period 1961-– 2018, activity data are derived directly from FAOSTAT domains Production/Live animals (http://www.fao.org/faostat/en/#data/QA) and Production/Livestock Primary (http://www.fao.org/faostat/en/#data/QL). Projections of activity data for 2030 and 2050 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 Production-Livestock domains include data for (total) Cattle (C) and for the subset dairy cattle (DC). Data on the number of heads of cattle are available in the FAOSTAT domain "Production/Live animals" as item "Cattle" and element "Stocks". Data on the number of heads for dairy cattle are available in the FAOSTAT domain "Production/Livestock Primary" as item "Milk, whole fresh cow" and element "Producing Animals/Slaughtered: Milk Animals".
In the FAOSTAT Emissions – Agriculture domains, cattle data are reported separately for "Cattle, dairy" (DC) and "Cattle, non-dairy" (NDC). The number of heads of non-dairy cattle is calculated as heads of cattle minus heads of dairy cattle (NDC = C – DC).
As the number of heads for cattle and for dairy cattle are obtained from two different FAOSTAT domains, their values may not be fully harmonized. For this reason, data for (total) Cattle (C) have been used as the main reference, and the following corrections and imputations have been applied to the data for dairy cattle (DC):

- If the number of heads for dairy cattle is higher than those for cattle (DC > C), the number for cattle is assigned to dairy cattle (and therefore DC = C).
- If there are missing data for dairy cattle only:
    - If no data are available for an entire time series, a regional average value for the share "S" of dairy cattle in cattle (S = DC/C) is applied. Therefore:
      $DC_i = S_R * C_i$ where "i" is a country and "R" a region or group of countries.
    - If one or more values are available in the time series, missing values between two available data are filled by linearly interpolating the share "S", and data points outside the time series of available data are filled by keeping constant the share value "S" of the closest available year.

**FAOSTAT Production-Livestock domains include data for (total) chicken (CH) and for the subset chicken layers (CHL). Data on the number of heads (in 1000 heads) for chicken are available in the FAOSTAT domain "Production/Live animals", as item "Chickens" and element "Stocks". Data on the number of heads (in 1000 heads) for chicken layers are available in the FAOSTAT domain "Production/Livestock Primary" as item "Eggs, hen, in shell" and element "Producing Animals/Slaughtered: Laying".
In the FAOSTAT Emissions-Agriculture domains, chicken data are reported separately for "Chickens, layers" (CHL) and "Chickens, broilers" (CHB). The number of heads of broilers is calculated as heads of (total) chickens minus heads of layers (CHB = CH – CHL).
As the number of heads for chickens and for layers are obtained from two different FAOSTAT domains, their values may not be fully harmonized. For this reason, data for (total) chickens (CH) have been used as the main reference, and the following corrections and imputations have been applied to the data for layers (CHL):

- If the number of heads for layers is higher than those for chickens (CHL > CH), the number for chickens is assigned to layers (and therefore CHL = CH).
- If there are missing data only for chicken layers:
    - If no data are available for an entire time series, a regional average value for the share "S" of layers in chickens (S = CHL/CH) is applied. Therefore:
      $CHL_i = S_R * CH_i$ where "i" is a country and "R" a region or group of countries.
    - If one or more values are available in the time series, missing values between two available data are filled by linearly interpolating the share "S", and data points

outside the time series of available data are filled by keeping constant the share value "S" of the closest available year.

***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 assigned to each country depend on the region and the country average annual temperature. The EF values applied were taken from IPCC (2006) table 10.14 (for cattle, buffaloes and pigs) and table 10.15 (for other animals), and the values for country average annual temperatures were taken from the FAO Global Agro-Ecological Zones (GAEZ) dataset (FAO/IIASA, 2011) "Mean annual temperature (baseline period 1961-1990)"
(see disclaimer at:
http://www.fao.org/fileadmin/user_upload/gaez/docs/User_Agreement_and_Disclaimer_EN.pdf).
For those territories with no specific values in the GAEZ dataset, other sources were used. These include mainly data from The World Bank Group (2016) Climate Change Knowledge Portal (see disclaimer at:
http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download).

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 category (*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 or poultry birds 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: Vol. 2, Ch.4 Tab. 4.7).

(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, in kg N yr^{-1};
EF = Tier 1, default IPCC emission factors, expressed in kg N_2O-N/kg N yr^{-1} (5).

(5) The fractions for volatilization by animal and MMS are taken from IPCC, 2006: Vol. 4, Ch. 10, Tab. 10.22. (6) All countries are assigned global default EF values for volatilization (IPCC, 2006: Vol. 4, Ch. 11, Tab. 11.3).

	Dimensionless conversion factors: 44/28, to convert the emissions from kg N_2O-N to kg N_2O gas; 10^{-6}, to convert kg to Gg; and Global Warming Potential (GWP): GWP-CH_4 = 21 (GWP 100-year time horizon) to convert Gg CH_4 to Gg CO_2eq ; and GWP-N_2O = 310 (GWP 100-year time horizon), to convert Gg N_2O to Gg CO_2eq (IPCC SAR, 1996: Technical Summary, Tab. 4 pg. 22). 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 IPCC guidelines (IPCC, 2006: Vol. 4, Ch. 10, Section 10.5.5). ***References*** IPCC SAR **1996**. Climate Change 1995. The Science of Climate Change. Houghton, J.T., Meira Filho, L.G., Callander, B.A., Harris, N., Kattenberg, A. and K. Maskell (eds.). Contribution of WGI to the Second Assessment Report (SAR) of the Intergovernmental Panel on Climate Change. Available from: http://www.ipcc.ch IPCC **1997**. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. OECD, Paris, France. Available from: http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html 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. Available from: http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html FAO/IIASA **2011**. Global Agro-ecological Zones (GAEZ v3.0). FAO, Rome, Italy and IIASA, Laxenburg, Austria. Available from: http://gaez.fao.org. Alexandratos, N. and Bruinsma J. **2012**. World agriculture towards 2030/2050: the 2012 revision. ESA Working paper No. 12-03. Rome, FAO. Available at: http://www.fao.org/docrep/016/ap106e/ap106e.pdf The World Bank Group **2016**. Climate Change Knowledge Portal – Downscaled data, Historical temperature data for period 1960 – 1990. Available from: http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download.
Data Collection Method	Computed
Completeness	100%
Useful links	http://www.fao.org/faostat/en/#data/QA http://www.fao.org/faostat/en/#data/QL http://www.fao.org/economic/ess/environment/en/ http://www.ipcc-nggip.iges.or.jp/public/

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