SNAP CODE: **110701**
110702
110703

SOURCE ACTIVITY TITLE: **OTHER SOURCES AND SINKS: ANIMALS**
Termites
Mammals
Other Animals

NOSE CODE: **301.07.01**
301.07.02
301.07.03

NFR CODE: **N/A**

1 ACTIVITIES INCLUDED

This section covers the emissions from wild-living animals. Both the emissions from the intestines and from excreta are included. Not covered are emissions from animal husbandry (chapter 10.4: Enteric fermentation) or from pets, which are partly similar, but may be considered influenced by human behavior in many respects. Still included here however are emissions from humans (breath, sweat, etc.; excreta are dealt with in chapter 9.1.7, latrines, or 9.10.2, waste water treatment), as they do not appear anywhere else and should be perceived differently to other anthropogenic emissions.

2 CONTRIBUTIONS TO TOTAL EMISSIONS

The information available is very sparse. With respect to the global situation, animal methane emissions have been attributed to termites, which are hardly relevant for Europe. The relatively high emissions of ammonia given for humans in some publications include emissions from pets, and thus need to be considered with caution for the purpose of this chapter. Nevertheless the figures presented may give some guidance which levels of emissions are to be expected.

For the UK [1], ammonia emissions from humans (without pets) have been estimated at 0.7 % of total ammonia emissions, and wild animals (deer and birds) at 0.2 %. Global emissions of ammonia were estimated at 4.8 % for humans, and at 0.2 % for wild animals [2]. The estimate for humans here however includes emissions from pets (which in [1] are estimated to total three times the amount of human emissions) and from latrines. Estimates for methane are not available for Europe, but using global estimates [3] or the emission factors provided below the contribution of emissions appears to be smaller than 1% of the total.

3 GENERAL

3.1 Description

Metabolic processes especially in the intestines of animals, but also processes in their excretions are responsible for gas formation. One important pathway leading primarily to methane formation is the anaerobic degradation of plant cellulose by symbiotic microflora (methanogenic bacteria, but also acetogenic bacteria) in the intestines. Major kinds of animals that are known to emit methane are mammals (primarily ruminants and rodents) and termites. A completely different pathway of emissions is the decay of urea or uric acid to ammonia in animal manure (mammals or birds). This pathway may also lead to N_2O formation. Emissions however are much more pronounced for domestic animals, where manure is actually collected and kept liquid for longer periods of time, or other sites where animals live in a very dense population (point emissions from bird breeding colonies on small islands, e.g. in the North Sea). Other relevant emissions are volatile organic compounds like isoprene, however no specific information could be obtained as this source is probably negligible.

It is very important to discuss the difference and the reasons of the difference between domestic and wild animals. Domestic animals are generally kept more densely, such that manure management is needed and the manure has to be stored for a longer period of time. Chemical processes in the manure (decay of urea to ammonia) are completely different and much less relevant for natural animals. Also, the diet is quite different between natural and domestic animals, influencing the feed nitrogen content, which is important for ammonia formation. The diet also affects the methane yield, the proportion of food energy content emitted in the form of methane. Nevertheless emissions need to be considered comparable to some extent, especially due to the absence of any better data (see section 8).

For a gas which deposits quite efficiently as ammonia, also a canopy effect may be taken into account. Gases released effectively from the animals may well be absorbed immediately in the forest canopy or in the grass before ever actually escaping to the lowest layers of the atmosphere. These emissions will never have any apparent effect on the atmosphere.

3.2 Definitions

Wild-living animals: Animals which are not severely affected in their feeding behavior or their mobility by anthropogenic influences, and are not controlled by humans.

3.3 Controls

Not applicable.

3.4 Emissions

Emissions are mainly methane and ammonia. Some NMVOC emissions are also possible, but probably small. Considering similar processes as for domestic animals, also nitrous acid emissions should be expected. For instance, formic acid emissions have been attributed to formicine ants [4]. These emissions have never been actually quantified and may not be relevant anywhere outside the tropical rain forests.

3.5 Controls

There is no controls to natural emissions by definition.

4 SIMPLER METHODOLOGY

Apply emission factors given in section 8.

5 DETAILED METHODOLOGY

For detailed emission assessment, emission factors as given in section 8 should be adapted towards national particularities. Such an approach has been used in [5]. Animal weights may vary within a species as much as a factor of 2, leading to considerably different emission scaling factors, depending on which variety of a species is dominant in a certain country. Also, the feeding habits should be taken into account, both in terms of energy content in order to assess methane emissions [3], and in nitrogen content for scaling ammonia emissions [2].

6 RELEVANT ACTIVITY STATISTICS

Information from wildlife specialists, hunting statistics etc. on number and kind of animals present. For big game species, hunting accounts for about 20-30% of the winter population (which resembles the annual population minimum).

7 POINT SOURCE CRITERIA

There are no point sources.

8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

As measuring emission factors for wild living animals is almost by definition very difficult, the data quality is poor (D-E). Most information is taken from similarities and analogies between domestic and wild animals. The choice of emission factors for ammonia has been discussed in detail [1]. Ammonia emission rates have been given for red deer (0.9 kg/individual and year, [1]) and for reindeer (1 kg N per individual and year, [2]). The emission factors seem to be similar enough to be combined for Table 1. Not considered here however was possible redeposition of ammonia in forests at plant surfaces before emissions actually can reach the atmosphere (canopy effect), as discussed in [2].

For methane, data presented in this guidebook for enteric fermentation were used [6]. Large uncertainty is associated with deriving deer emissions from cattle emission factors. Scaling of these emissions for moose and for red deer was performed using estimated excretion of nitrogen [2] as an indicator of their metabolic activity. These emission factors are about 50 % larger than those suggested previously [3]. However as methane emissions from animal droppings are not included in either of the data given (an additional 25 % according to[6]), the emission factors proposed here still should not be considered upper limits. Methane emissions from humans, mainly in human breath, have been assessed from measured values [3]. The resulting emission factor of 0.07 kg/person and year is notably lower to that of pigs, which may have a comparable metabolism. Considering the food uptake of humans, which is about one third of that of pigs, an emission factor of 0.5 kg/person would be expected. Much of this discrepancy may be due to a different diet but no full explanation is possible. We thus propose to apply an emission factor of 0.1 kg/person and year.

As weights for different game species vary considerably, we recommend to further scale the emissions by the life weight in a linear fashion. A more complex scaling proportional to the ¾ power of weight has been suggested [3], which may describe the food demand more closely, but other parameters also contribute to methane emissions such that it does not seem justified to perform an increase in complexity. The average weights of species have been simplified from much more detailed literature data [7]. Thus the average weight of red deer and reindeer is taken at 100 kg, fallow deer and white-tailed deer 90 kg, roe deer 15 kg, chamois 35 kg, ibex 70 kg and mufflon 25 kg. Moose emissions were assumed to be twice those of reindeer, according to estimates of nitrogen excretion [2]. The resulting methane emission factors are consistent with estimations by the Swiss Federal Office of Environment [8]. Ammonia emission factors agree in part with data from the Czech Republic [5]. There are discrepancies of almost a factor of 3 for red deer however, as the dominant variety is the unusually heavy Carpathian deer (170 kg).

Table 8.1: Emission factors for wild animals' emissions (in kg per animal/person and year)

	Assumed life weight [kg]	CH_4	NH_3	Literature
deer (red deer, reindeer)	100	25	1.1	derived from [6],[1]
moose	350	50	2.2	derived according to [2]
Roe deer	15	4	0.2	scaled from red deer*
boar		1.5	1	[6], derived from [1]
birds	0.8	--	0.12	[1]
Large birds	2.4	--	0.36	[1]
humans		0.1	0.05	derived from [3], [1]

* Use animal weights to similarly scale emissions for other species

No information at all was available for rodents. Here also linear scaling by weight should be performed. While this probably underestimates the metabolic activity of small animals somewhat, the methane yield, given in [3] as the fraction of food energy content that is emitted as methane, has been assumed to be clearly smaller for any species other than ruminants. A Czech study [5], taking into account the nitrogen content of feed, assumes ammonia emissions from hares to be about 8 times of what should be expected from weight scaling. On the other hand, for smaller animals living close to or under the ground, the canopy effect should be expected very large. All of this is to be considered part of overall uncertainty. Not included were termite emissions, which are currently assumed negligible for the European continent, even if termites have become established in Southern Europe, or emissions from other invertebrates.

9 SPECIES PROFILES

No profiles are needed for methane or ammonia emissions. Information on NMVOC is missing.

10 UNCERTAINTY ESTIMATES

Uncertainty is to be considered very high (data quality D, for methane emissions from deer E).

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

Emission rates are primarily inferred from domestic animals.

12 SPATIAL DISSAGGREGATION CRITERIA FOR AREA SOURCES

Forest area or grassland area, depending on animal species considered.

13 TEMPORAL DISSAGGREGATION CRITERIA

Source is too small such that no detailed temporal disaggregation is needed.

14 ADDITIONAL COMMENTS

Wild living animals are generally to be considered as causing natural emissions, even if their number is to a large extent dependent of human interest (in both directions: animals in competition to domestic animals, but also animal feeding in winter because of hunting interests). The reason is that anthropogenic influence should not be considered overwhelming in this respect.

More problematic is the question of human emissions. The human metabolism clearly is associated with anthropogenic activities, and the number of humans on earth (or in Europe) clearly is out of its natural boundary. Nevertheless it seems ethically not correct to submit this type of emissions to those which are effectively controllable by man. Human control in that respect, i.e. regulation of the number of people on earth for the sake of limiting emissions to the atmosphere, can not be acceptable. Therefore also these emissions should be considered "natural".

15 SUPPLEMENTARY DOCUMENTS

16 VERIFICATION PROCEDURES

17 REFERENCES

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18 BIBLIOGRAPHY

19 RELEASE VERSION, DATE AND SOURCE

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20 POINT OF ENQUIRY

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