EVALUATING THE IMPACTS OF COW FARM EMISSIONS ON AIR QUALITY, IN THE VILLAGE GARBOVA, ALBA COUNTY

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Abstract. *The atmospheric dispersion of pollutants characterizes the evolution in time and space of an ensemble of particles (aerosols, gases, dust) emitted into the atmosphere. This report explores the impact of cow farm on the atmosphere and aims to provide practical suggestions which could be easily monitored on how to reduce or eliminate any identified negative environmental effects. The study attempts to assess the emissions of pollutants (CH_4 and NH_3) in the atmosphere at cow farm, located in the village Garbova, the Alba county, and their atmospheric dispersion modeling using AERMOD program, developed by the American Meteorological Society in collaboration with the Environmental Protection Agency the United States. The study has shown that the volume of gases emitted have no significant impact on nearby communities . The results, measured in terms of average concentration of the pollutants at ground level show that such concentrations are below the limits established by current Romanian legislation. It can be concluded that AERMOD program can provide useful information to identify high pollution impact areas. Therefore, air dispersion model is an easy way used for simulation and assessment of directions and concentrations of air pollutants exposure to the environment.*

Key words: *AERMOD, atmospheric dispersion, pollutants, air pollution*

INTRODUCTION

The main problem faced by the agricultural sector is the need to produce more to ensure the population's growing needs, but also to produce a low impact on the environment. These result in problems of direct point source pollution, diffuse pollution and pressure on marginal habitats and landscape features.

The main impact of cow farm occurs on air quality, because a large portion of the exhaust gases is discharged into the atmosphere as greenhouse gases, responsible for producing climatechange.

Recent estimates of global Green House Gas (GHG) emissions from different sources by the Intergovernmental Panel on Climate Change (IPCC), the United Nations Framework Convention on Climate Change (UNFCCC) and the "Stern Review", show that land use changes consequent on deforestation contribute 18.3 percent to total GHG emissions whilst agriculture accounts for 13.5 percent (of which agricultural soils is 6 percent, livestock and manure 5.1 percent) and the transportation sector 13.5 percent (of which road transport is 10 percent). HG emissions arise from feed production (e.g. Chemical fertilizer production, deforestation for pasture and feed crops, cultivation of feed crops, feed transport and soil organic matter losses in pastures and feed crops), animal production (e.g. Enteric fermentation and methane and nitrous oxide emissions from manure) and as a result of the transportation of animal products. It can thus be shown that livestock contribute about 9 percent of total anthropogenic carbon-dioxide emissions, but 37 percent of methane and 65 percent of nitrous oxideemissions. [3]

Methane is a potent greenhouse gas (GHG) associated with dairy farm operations. It comes from two primary sources – enteric methane from cow belching and flatulence (passing gas), and from manure. Because most high-production conventional farms use freestall barns to house animals, they depend on liquid-based systems to flush manure from alleyways and holding pens. This sort of system typically relies on some sort of liquid/slurry storage system to hold flush water. Lagoon-based systems, a common liquid/slurry storage option, lose 40-times or more methane than the systems used on most organic farms. [1]

The impact of dairying on the atmosphere arises from de-nitrification, the production of, methane, ammonia volatilisation and carbon dioxide. Whilst methane generation per animal tends to be higher in low input systems than in the more intensively managed systems that use feed supplements, ammonia emissions are higher for intensively managed systems. [2]

Air dispersion modeling is the mathematical estimation of pollutant impacts from emissions sources within a study area. Several factors impact the fate and transport of pollutants in the atmosphere, including meteorological conditions, site configuration, emission release characteristics, and surrounding terrain, amongst others. [4]

MATERIAL AND METHODS

For modeling the dispersion of pollutants in the atmosphere was used AERMOD program, developed by the American Meteorological Society in collaboration with the Environmental Protection Agency of the United States.

AERMOD View is a complete and powerful air dispersion modeling package that seamlessly incorporates the popular U.S. EPA models, ISCST3, ISC-PRIME and AERMOD, into one interface without any modifications to the models. These models are used extensively to assess pollution concentration and deposition from a wide variety of sources. The AMS/EPA Regulatory Model (AERMOD) is the next generation air dispersion model based on planetary boundary layer theory. AERMOD utilizes a similar input and output structure to ISCST3 and shares many of the same features, as well as offer additional features. AERMOD fully incorporates the PRIME building downwash algorithms, advanced deposition parameters, local terrain effects, and advanced meteorological turbulence calculations [5].

AERMOD is a steady-state plume model. For the purpose of calculating concentrations, the plume is assumed to travel in a straight line without significant changes in stability as the plume travels from the source to a receptor. At distances on the order of tens of kilometers downwind, changes in stability and wind are likely to cause the accuracy to deteriorate. For this reason, AERMOD should not be used for modeling at receptors beyond 50 kilometers. AERMOD may also be inappropriate for some near-field modeling in cases where the wind field is very complex due to terrain or a nearby shoreline [4]

For uses plume air dispersion model AERMOD View was necessary to analyse air emissions from cow farm, specifying the emission surfaces.

The gas emissions were estimated by calculating utilized CORINAIR emission factors. According to this methodology the emission of methane (CH_4) from dairy cows are estimated at 81 kg / cow / year and emissions of ammonia (NH3) cow's milk from liquid waste collection system are estimated at 39, 3 kg / cow / year.

AERMOD also, require information on the meteorological conditions and the terrain of the considered sane. It was necessary to calculate the emission rate from all stacks. We use the meteorological data from the Romanian National Administration of Meteorology, from the nearest weather station from the study area, located in Sebes city.

RESULTS AND DISCUSSIONS

Cow farm is located in the village Garbova, the Alba county, in the northeast part of the town, and is situated at about 900 m from the northern limit of the built - up area.

The most frequent winds are from the southeast and northwest part. The annual average of temperature is 8.9°C, the coldest month is January (with an average of 3°C) and the warmest is June (with a yearly average of + 19.6°C).

Cattle farm has a capacity of 2,000 cows, with four cowsheds with a capacity of 500 cows each, a hall of milking and breeding, a storehouse for threshed grain, a large room for repairing machinery and farm tools, sanitary filter, administrative pavilion, and a lagoon of manure storage. The manure lagoon, with a capacity of 15,000 cubic meters, is made in the form of clay vats on a compacted fill layer of ballast and gravel, with walls inclined at 45% protected by a sheet resistance rising. The halls are connected to the cows manure storage lagoon through underground channels.

The entry in the farm is done by a concrete platform that allows the transportation of equipment. The entry and exit from the enclosure is performed through conveyor for heavy transport,also, is provided a entrance for personnel, health auto filter - tank at ground level.

The beneficiary produces grain in their own farm, then uses it as raw material for cattle feed to improve the weight gain. The area of 1819 ha of arable land being leased or owned by the beneficiary provide a large amount of forage production, the rest being provided by the market.

Although, considered by many a waste, the manure generated by dairy cows, is in reality a good quality of raw material resulting from livestock technology used with good results for fertilizing farmland. Theoretically, organic materials derived from animals (manure) must be applied, usually on arable land, because they are a rich source of nutrients for crops and also constitutes a protection against soil degradation.

According to the Order of the Minister of Environment and Water Management no.1182 / 22.11.2005 regarding the Code of Good Agricultural Practice for the protection of waters against pollution caused by nitrates from agricultural sources, is recommended a manure storage period of 5 months (23-24 weeks) when assessing the risk of pollution during landspreading of manure, due to increased surface flow or seepage due to rapid internal drainage.

In general, the pollutant emissions are low in the process of increasing the milk cows and doesn't affect the atmosphere , only by specific odors emanate.

The key aspect of the growth of dairy cows is influenced by natural processes because the cows metabolize food and excrete all the nutrients in the manure. The quality and composition of manure, as well as storage is influenced by several factors related both to the nature of emitted pollutants and their physical properties. The most important emissions are ammonia, odors and dust coming from shelters.

The smell is a local problem but becomes an important issue as the intensive livestock grow and increase the number of residential buildings in farm areas. Neighbor farms are expected to accord big attention to odor as an environmental issue. The odor may be emitted by stationary sources such as manure storage and during the spreading on the ground, depending on the technique applied. Its impact increases with farm size. The dust from farms contribute to odor. Emissions of odor are given by many different compounds such as mercaptans, H2S, ammonia etc. The odor emissions derived from the activities described in the previous section contribute as individual sources to the total odor emission from livestock farms and also depend on factors such as the maintenance and organization of farm, the manure composition and the techniques used for handling storage of manure.

Dust is harmful to animals and humans, but is also an element of spreading the odors. It has been found that the dust from work is not a problem for surrounding environment, but can cause disturbance when the wind blows. Dust generated by undertaken activities in the cow farm are quickly deposited without significant environmental effects.

Generation of gaseous substances in shelters affect air quality and can affect animal health. Inside the halls, aeration will be done properly through ventilation system that ensures the elimination of gases inside the halls. Temperature , humidity, dust levels, air flow and gas concentrations must be in low harmful levels.

Polluting gases analyzed in this study were ammonia and methane.

The frequently phenomenon in livestock farms is nitrification - biochemical process whereby ammoniacal nitrogen is released from organic nitrogen compounds.

Ammonia emissions are considered important factors in soil and water acidification. The ammonia gas (NH_3) has a sharp and pungent odor and in high concentrations can irritate the eyes, throat and mucous membranes of humans and animals. This gas arises from manure and spreads through the building and is removed through the ventilation system. The ammonia gas released can reduce the fertilizing quality of manure distribution process. Ammonia is delivered from shelters, from manure storage during their fermentation process, and during spreading of manure on farmland. Factors such as temperature, ventilation, humidity, percentage of storage and the food composition can also affect the level of ammonia.

Methane is a colorless, odorless, flammable,and if is combined in some proportions with air can make an explosive mixture. Methane is a greenhouse gas that comes from natural sources in a proportion of about 50%, the rest coming from agriculture and the production of fossilfuels.

Air emissions level is determined by several factors and their influence may be due to the construction of halls, wastewater collection system and manure, ventilation system and quantity and quality of manure that depend on feeding strategy, watering system and the numberofcattle.

For using AERMOD program it was necessary a range of values of the input parameters to simulate the dispersion of pollutant emission in atmospheres and how they affect the surrounding areas in different situations: during mediation, wind direction and frequency, ambient temperature, meteorological parameters, height exhaust emission rate.

The height of the exhaust emissions have been taken into account was h = 0 m emissions from the lagoon and 9 m emission from shelters.

Emission sources were considered:

-laguna semi-liquid manure storage;

-animal shelters;

For calculating the emission rate were used Corinair emission factors correlated with a maximum population of the farm. According to this methodology, emissions of methane (CH_4) from dairy cows are estimated at 81 kg / cow / year and emissions of ammonia (NH_3) from dairy cow derived from liquid waste collection system are estimated at 39,3 kg / cow / year.

On the farm there are four shelters for cows with a total capacity of 2,000 cows, which indicates that annual emissions, according to CORINAIR (calculation for 365 days / year)are:

$$CH_4: 81 \text{ kg x } 2000 = 162000 \text{ kg / year} \sim 16,2 \text{ tons / year} \sim 5,12 \text{ g/s}$$

NH_3: 39,3 kg x 1000 = 78600 kg / year ~ 78,6 tons / year~ 2,5 g/s

Following the mathematical modeling of pollutant dispersion in the atmosphere, using Gaussian model AERMOD View v.7.4., were obtained following pollutant dispersion charts presented in Figures 1 and 2.

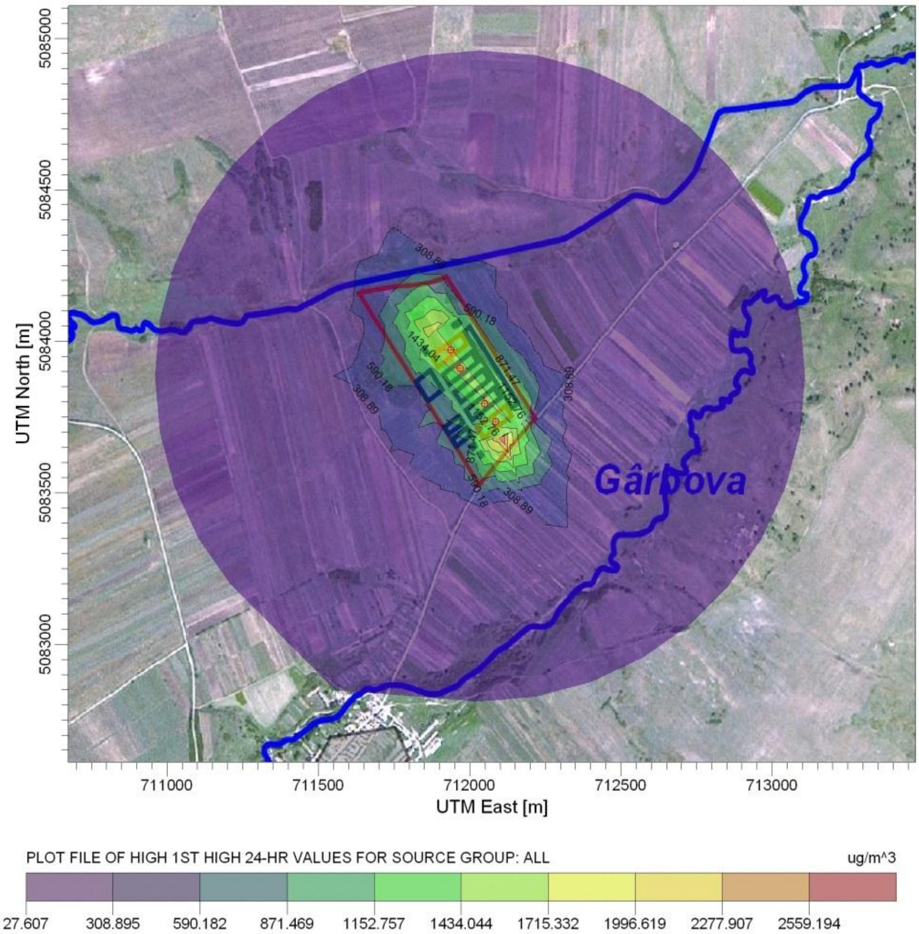

Fig.1 Methane dispersion CH_4

After modeling the dispersion of pollutants in the atmosphere, it can be seen that the highest value of methane is registered in the farm relative 2559.194 89 μg/mc, this concentration decreased to 308.89 μg/mc to several hundred meters around the farm, and at level of the first houses in the town Garbova value recorded is 27,607 89 μg/mc.

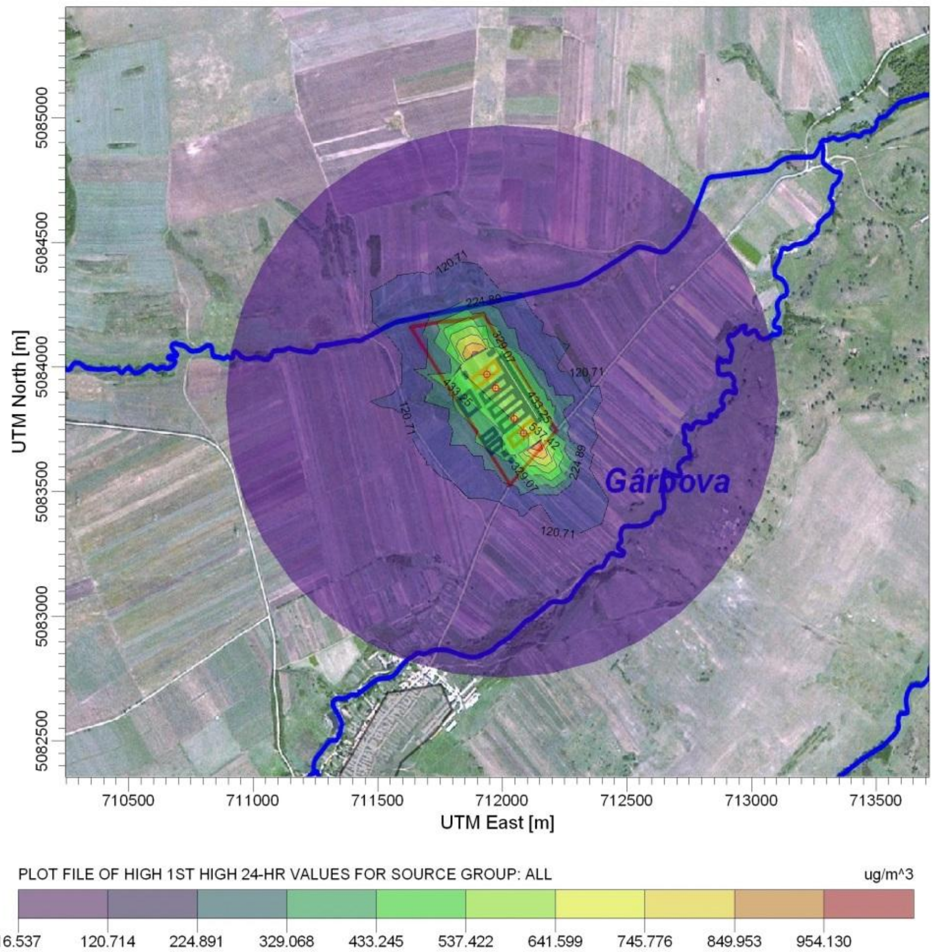

Fig.2 Ammonia dispersion NH_3

After modeling the dispersion of pollutants in the atmosphere, it can be noticed that the highest value of ammonia is registered in the farm with 954.13 mg / m³, this concentration decreased to 120.71 mg / m³ to several hundred meters around the farm, and at level of the first houses in the town Garbova value recorded is 16,537 mg / m³.

From the calculated data and representations above results that the provisions STAS12574/87 - Air in protected areas. The quality conditions respect for their activity in emission of CH_4 and NH_3 in the most adverse weather conditions and at a maximum number of cows.

CONCLUSIONS

The values obtained by modeling the dispersion of pollutants in the atmosphere allow us to conclude that manure stocking levels and potential gases emissions are low. In conformity with the Code of Good Agricultural Practice concerning to the minimum period of storage of manure for fermentation, and adequate management of manure collected on arable land, the parameters of air quality in the area will be kept within the limits established by current law. This study provided that emissions of methane and ammonia from cow farm have no significant impact on dairy farming from Garbova, and does not affect the air quality. These gases are emitted into the atmosphere in large enough quantities and they contribute to the greenhouse effect globally. This problem can be solved only partially.

The main ways to reduce the amount of methane and ammonia emitted by the farm are: modification of the management system of manure (building a biogas installation) and by adoption strategies for feeding animals.

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