Archives of Environmental Protection
Vol. 45 no. 4 pp. 114–121

PL ISSN 2083-4772
DOI 10.24425/aep.2019.130247

Ammonia emission from livestock production in Poland and its regional diversity, in the years 2005–2017

Paulina Mielcarek-Bocheńska[1], Wojciech Rzeźnik[2]*

[1]Institute of Technology and Life Sciences, Poland
[2]Poznan University of Technology, Poland

*Corresponding author's e-mail: wojciech.rzeznik@put.poznan.pl

Keywords: mitigation, livestock production, ammonia emission.

Abstract: Agriculture is a significant source of gaseous pollutants such as ammonia, methane, nitrous oxide and volatile organic compounds. Ammonia is particularly important due to the high emission and local, as well as global impact on the environment. The release of NH_3 is one of the main ways of nitrogen emission to the atmosphere and it contributes to its subsequent deposition. The aim of the study was to analyze ammonia emissions from animal production in Poland in 2005–2017, its regional diversity and possibilities of its reduction in agriculture. The ammonia emission was calculated for the animal production groups according to the NFR classification. The values of ammonia emission were calculated based on ammonia emission factors used by KOBIZE, in accordance with the EMEP/EEA methods. In 2017, the NH_3 emission from Polish agriculture amounted 288 Gg and it accounted for 96% of the emission in 2005. Ammonia emission from livestock production, in 2005–2017, on average accounted for 79.8% of agricultural emissions. The largest share had the cattle (51%) and swine (30%) production. The NH_3 emissions differed strongly between provinces. The emission density (kg $NH_3 \cdot km^{-2} \cdot year^{-1}$) in provinces with intensive livestock production was about 5.5 times higher than in regions, where livestock production was the lowest. The mitigation strategies should be implemented primarily in provinces where reduction potential is the largest. The assessment of the reduction potential should take into account the NH_3 emission per 1 km^2 and the low NH_3 emission technologies, which are already applied in the regions.

Introduction

The intensification and concentration of agricultural production has been observed for years. On the one hand, it allows to deliver a large amount of relatively cheap food to the market, on the other, it increases the risk of negative impact of agricultural production on the environment. Agriculture, especially animal production, is a significant source of gaseous pollutants such as ammonia (NH_3), methane (CH_4), nitrous oxide (N_2O) and volatile organic compounds (VOC) (Adamowicz 2018, Rzeźnik and Mielcarek 2016, Viguria et al. 2015).

Ammonia is particularly important due to the high emission and local, as well as global impact on the environment. The release of NH_3 is one of the main sources of reactive nitrogen emission to the atmosphere and it contributes to its subsequent deposition. Ammonia emission into the atmosphere is part of the cycle of chemical changes, which may cause also negative effects in both soil and water (Pinder et al. 2006, Yunnen et al. 2016). The main result is soil acidification due to nitrification processes of ammonium ions from the atmosphere and eutrophication related to the supply of biogenic compounds to waters, including NH_3 from agricultural sources (Tarkowska--Kukuryk 2013, Werner et al. 2017). Soil acidification caused a decrease in the content of humus in the soil, an increase in solubility and the possibility of movement of some toxic substances, including aluminum and heavy metals, and a reduction in the biodiversity (Čakmak et al. 2014, Tian and Niu 2015). The enrichment of water with biogenic compounds accelerates the growth of algae and other higher forms of plants, which leads to undesirable disturbance of biological water relations. The effect of the eutrophication process is the limitation of the possibility of using water to supply people's needs, and also for economic activity and recreation (Adamczyk and Jachimowski 2013, Withers et al. 2014). Ammonia is also highly reactive in the formation of aerosols (PM2.5) moving to large distances of over regional range (Mensink and Deutsch 2008).

The long-term goal of the European Union's (EU) environmental policy is to achieve the air quality levels that do not cause negative effects or risks for human health and the environment. Over the last 20 years, many activities have been taken in the EU concerning anthropogenic emissions and air quality. The main element of these actions was the Directive 2001/81/EC of the European Parliament and Council establishing the limits of the total annual NH_3 emissions for EU Member States till 2010 (EC 2001). As a result, in the EU in 1990–2010, the NH_3 emissions were reduced by 28% (EC 2016). Nevertheless, there are still significant negative effects and risks for human health and the environment (COM 2013). The new, from 2020 to 2030, reduction targets of ammonia emissions for the EU member countries are defined in the Directive of the European Parliament and Council (EU) 2016/2284 from 14 December 2016 (the so-called NEC Directive). According to this directive, Poland is obliged to reduce NH_3 emissions by 1% in each year from 2020 and by 17% from 2030, compared to the 2005 emissions (EC 2016). As part of the implementation of the NEC Directive in Poland, the national air pollution control program and national advisory code of good agricultural practice to control ammonia emissions, taking into account the UNECE Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions of 2014, should be established. Methods and strategies for the reduction of NH_3 emissions from agriculture included in the national program and the implementation by farmers of the principles contained in the national advisory code are to be the main tools for effective reduction of ammonia emissions.

The annual inventory of NH_3 emissions in Poland is carried out by the National Center for Emissions Management (KOBIZE), mainly for reporting to the UN Convention on Long-Range Transboundary Air Pollution (LRTAP). The NH_3 emission from agriculture was approximately 94% of the Polish ammonia emission in 2017. The main source is manure management – 78%, and 22% of emission comes from the use of nitrogen mineral fertilizers (Bebkiewicz et al. 2019).

Ammonia is emitted as a gas with local effects on ecosystems. A high proportion is redeposited close to its source before it transforms into ammonium particulate matter (Gilliland et al. 2006). Therefore, to implement effective reduction methods of the NH_3 emission from agriculture, it is necessary to know its regional diversity. It is important to locate the main emission areas, emission sources and determine the reduction potential.

The aim of the study was to analyze ammonia emissions from animal production in Poland in 2005–2017, its regional diversity and possibilities of its reduction in agriculture.

Material and methods

The analysis was made for the years 2005 to 2017. The ammonia emission was calculated for the animal production groups according to the NFR (New Format for Reporting) classification: dairy cattle, non-dairy cattle, sheep, goats, horses, swine (sows, fattening pigs), laying hens, broilers and other poultry. The values of ammonia emission ($E_{livestock}$) were calculated for Poland and for each province (voivodship), based on ammonia emission factors used by KOBIZE, in accordance with the Tier 2 method described in the "EMEP/EEA Air Pollutant Emission Inventory Guidebook", using national data on animal manure management systems (AMMS) (Bebkiewicz et al. 2019). This Tier 2 approach is composed of 15 steps based on a mass balance, which considers the pathways for emission of N-compounds, by which emissions from manure management systems (E_{AMMS}) and excreta deposited on pasture ($E_{grazing}$) are estimated (Eq. 1):

$$E_{livestock} = E_{AMMS} + E_{grazing} = (E_{AMMS_{yard}} + E_{AMMS_{building}}) + E_{grazing} \quad (1)$$

In general, emissions from AMMS occurred from manure managed in livestock buildings ($AMMS_{building}$) and outdoor yard areas ($AMMS_{yard}$). These two components of AMMS have three main contributors arising from (Eq. 2): NH_3N losses from the livestock building and yards (E_{losses}), storage ($E_{storage}$) and land spreading of manure ($E_{application}$):

$$E_{MMS} = E_{losses} + E_{storage} + E_{application} \quad (2)$$

Equations (1), (2) summarize the main aspects of the 15-step Tier 2 approach. More details are explained in the EMEP/EEA (2016).

The numbers of animals are published by Statistics Poland (GUS) a few times a year, but only those from June concerned all livestock production groups. Moreover, summer populations of animals are usually the highest in each year, hence the use of other statistical data may lead to underestimation of emissions. Due to these reasons, the values recorded by GUS in June of each analyzed year were used for calculations (Bebkiewicz et al. 2019, EMEP/EEA 2009, EMEP/EEA 2016, GUS 2018). To show the share of livestock production in agricultural NH_3 emissions, calculations of NH_3 emissions were also made for the use of nitrogen mineral fertilizers. The data on the consumption of nitrogen mineral fertilizers used in the calculations also came from the Statistics Poland (GUS 2018).

In ammonia emission calculations from mineral fertilizers the country specific emission factor was used. It was established on the basis of method published in "EMEP/EEA Air Pollutant Emission Inventory Guidebook" using domestic structure of nitrogen fertilizers application by Pietrzak (2006). The weighted mean NH_3 emission factor for Poland amounts to 0.0538 kg $NH_3 \cdot kg^{-1}$ N and it has been applied to all calculated years. The structure of mineral fertilizers for calculation of weighted mean NH_3 emission factor was: ammonium sulphate – 1%, urea – 25%, ammonium nitrate – 45%, calcium ammonium nitrate – 16%, nitrogen solutions – 4%, ammonium phosphate – 1%, other NK and NPK – 8% (Bebkiewicz et al. 2019, EMEP/EEA 2009).

Because of the small share in Polish NH_3 emission the following emission sources have been excluded in calculations: other animals (fur animals) and sewage sludge used in the fields.

Results and discussion

In the years 2005–2017, ammonia emission from Polish agriculture varied from 266 to 309 Gg, and the average annual emission was 286 Gg. According to the calculations for 2017, NH_3 emission from Polish agriculture amounted 288 Gg and it accounted for almost 96% of the emission value for 2005.

The shares of animal buildings and manure storages, animal manure applied to soils and urine and dung deposited by grazing animals in NH_3 emission from livestock production, changed slightly. During the studied period, they were from 47.9 to 49.4%, from 47.8 to 49.3% and from 2.8 to 3.1%, respectively. In 2017, they were as follows: animal buildings and manure storages 47.9%, animal manure applied to soils 49.3%, urine and dung deposited by grazing animals 2.8% (Bebkiewicz et al. 2019).

In the studied period, livestock production was the dominant source of NH_3 emissions from agriculture. Its share in total ammonia emissions from Polish agriculture varied from 76.8 to 84.0%, on average 79.8% (Fig. 1).

The studied time may be divided into two periods. The first, from 2005 to 2012, when the ammonia emissions from animal production decreased, the average annual rate of change was about 2.3%. This trend may be related to Poland's accession to the European Union and the adaptation of agriculture to the conditions set by the EU. The production in many small family farms became cost-ineffective, what caused their progressive liquidation. In these years, a 25% decrease in the number of the smallest farms (up to 5 ha) was observed, while the total number of farms decreased by 22.4% (Herbut and Walczak 2015). In the second period, from 2013 to 2017, the total ammonia emission from livestock production in Poland grew slightly year by year. The average annual rate of change at this time was 1.0% (Fig. 2). The key factor influencing the Polish agriculture and rural areas in this period is the EU Common Agricultural Policy aiming at improvement of productivity through introducing technical progress and stabilization of agricultural market.

The NH_3 emission in the analyzed period in each province is presented in Figure 3.

The mean annual NH_3 emission from livestock production differed among provinces, and average value was 14.2±11.5 Gg. The largest emissions were recorded in Greater Poland (45.8 Gg) and Masovia (34.6 Gg), and the lowest in the Lubusz (4.6 Gg), West Pomerania (5.1 Gg) and Lower Silesia (5.4 Gg). Almost half (45.8%) of the Polish NH_3 emission is released from three provinces: Greater Poland, Masovian and Podlaskie provinces. The differences among provinces concern not only the amount of released NH_3, but also time trends. In provinces with the largest ammonia emission in 2015–2017, the NH_3 emission increased. The annual rate of change in these years was 2.7% for Greater Poland, 2.8% for Masovia and 2.2% for Podlaskie. While, in regions with low emissions of NH_3 (Lower Silesia, Upper Silesia, Opole) its minor fluctuations with a downward

Fig. 1. The share of livestock and crop production in NH_3 emission from Polish agriculture for 2005–2017

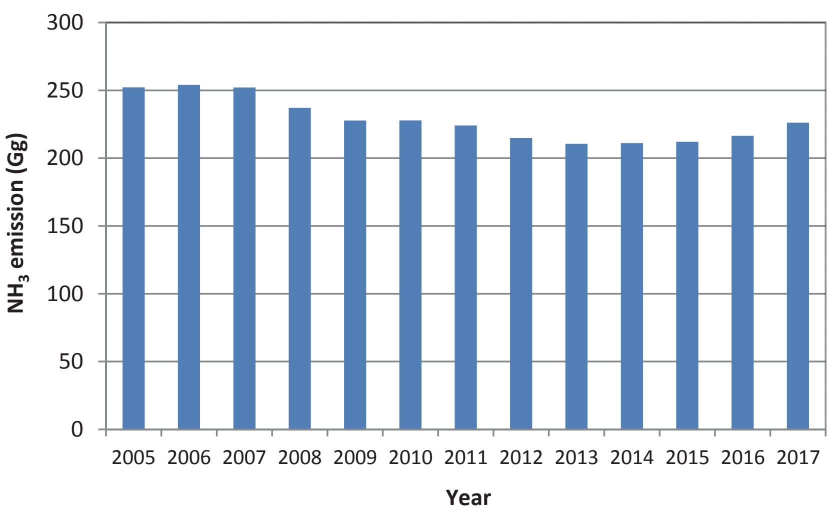

Fig. 2. Ammonia emission from livestock production in Poland for 2005–2017

trend in recent years was observed. This may result from the directions of development of individual provinces. In typical agricultural regions, there is an increase in livestock production, while in the provinces where agricultural production is small, the liquidation of animal farms is observed.

The environmental impact assessment of animal production should be done based on emissions referenced to the unit of area, number of animals, number of farms, etc. In the case of NH_3, the most appropriate is conversion per 1 km² of area (Fig. 4) and per 1 ha of agricultural land – AL (Fig. 5).

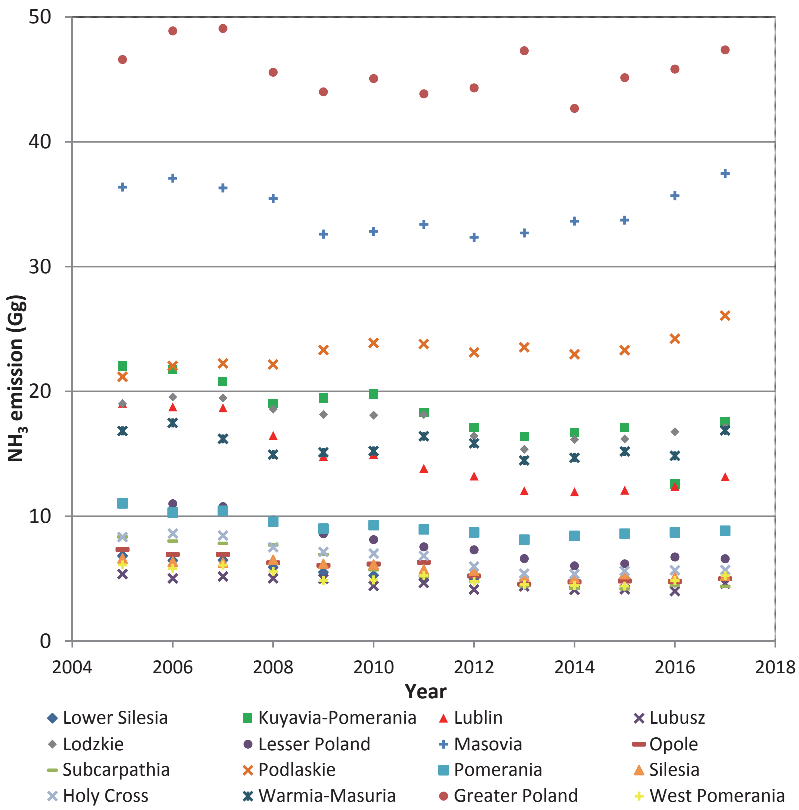

Fig. 3. Ammonia emission from livestock production in each province for 2005–2017

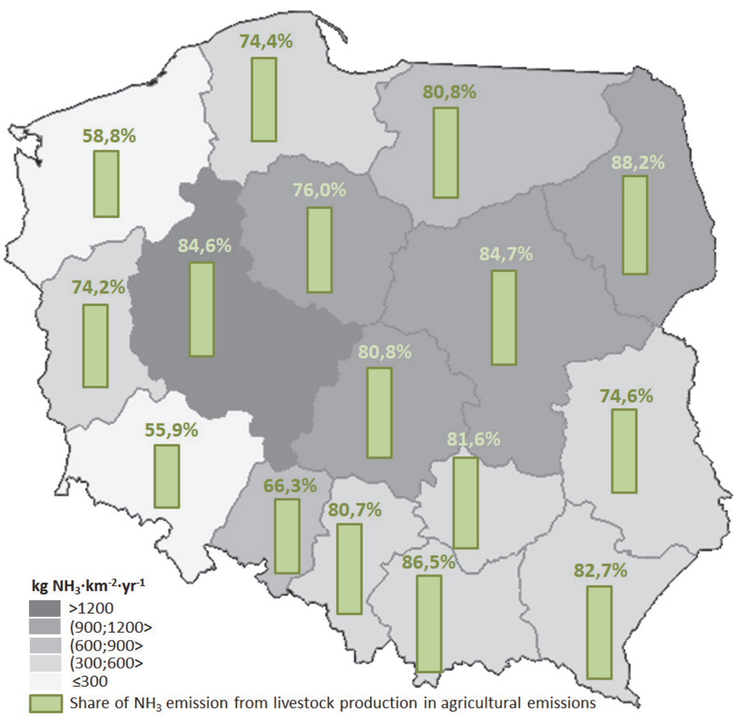

Fig. 4. The NH_3 emission per 1 km², from livestock production (mean for 2005–2017)

In 2005–2017, the mean NH_3 emission from livestock production per 1 km^2 in Poland was 671 $kg \cdot km^{-2}$, and its variation depending on the province was high (coefficient of variation = 52.4%). The highest emission of NH_3 was noted in Greater Poland (1536 $kg \cdot km^{-2}$). This value was on average 42% higher than in the next two provinces: Podlaskie (1150 $kg \cdot km^{-2}$) and Kuyavia-Pomerania (1022 $kg \cdot km^{-2}$). On the other hand, the lowest NH_3 emissions were observed in Lower Silesia (271 $kg \cdot km^{-2}$) and West Pomerania (225 $kg \cdot km^{-2}$).

In 2005–2017, the mean NH_3 emission from livestock production per 1 ha of AL in Poland was 13±5 $kg \cdot ha\ AL^{-1}$. The highest NH_3 emission was observed also in Greater Poland (25.7 $kg \cdot ha\ AL^{-1}$), and the lowest in Lower Silesia (5.7 $kg \cdot ha\ AL^{-1}$), West Pomerania (5.7 $kg \cdot ha\ AL^{-1}$), Subcarpathia (8.7 $kg \cdot ha\ AL^{-1}$) and Lublin (9.9 $kg \cdot ha\ AL^{-1}$). Comparing these data with NH_3 emission from livestock production per 1 km^2, it was observed that some of the provinces have been assigned to other emission classes. This is due to the number of animals per 1 ha of agricultural lands.

The share of NH_3 emissions from livestock production in Polish emissions of this gas from agriculture is also regionally different. The largest was in Podlaskie (88.2%) and Lesser Poland (86.5%), and the lowest in West Pomerania (58.8%) and Lower Silesia (55.9%). Comparing with the results of Bieńkowski (2010), who made the analysis of NH_3 emissions from agriculture for 2005–2007 years, the regional distribution of NH_3 emission per 1 km^2 is slightly different.

Figure 6 shows the share of NH_3 emission in Poland for groups of animals: cattle (dairy cattle, non-dairy cattle), swine (sows, fattening pigs), poultry (laying hens, broilers, other poultry) and other (sheep, horses, goats). For the years 2005–2017, the largest NH_3 emission from animal production

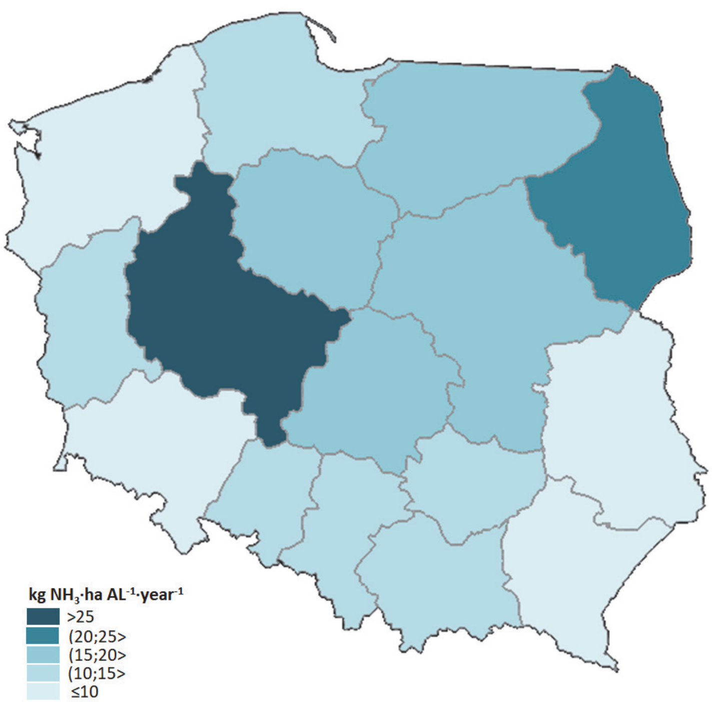

Fig. 5. The NH_3 emission per 1 ha of agricultural land (AL), from livestock production (mean for 2005–2017)

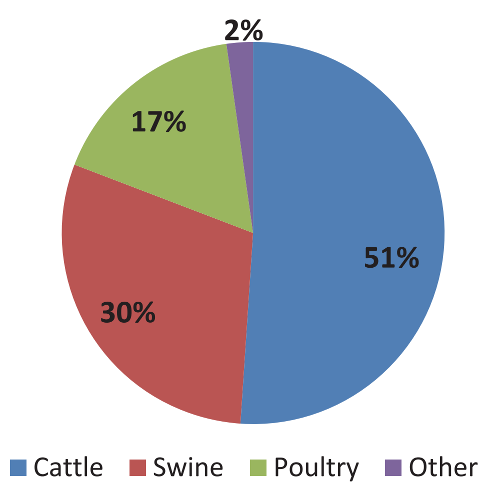

Fig. 6. The share of groups of animals in NH_3 emission in Poland (mean for 2005–2017)

was related to the production of cattle. The annual mean for this group of animals was 116.5 Gg·year^{-1} and was greater by approximately 68% than for swine – 67.9 Gg·year^{-1}.

Analyzing the share of animal groups in Polish NH_3 emission for 2005–2017 years, the increase of non-dairy cattle share (the annual rate of changes 3.1%) was observed, what may be due to the popularization of beef cattle production. For dairy cows at this time there was a slight decrease of NH_3 emissions with a tendency to stabilize in the last few years. The largest decreases of NH_3 emissions were noted for sows, on average by 5.9% per year. For fattening pigs, this emission basically decreased for the years 2007–2013, on average, by 8.6% per year. Later, the stabilization occurred and some small fluctuations of NH_3 emissions resulted from the situation on the market. For poultry, the increase of NH_3 emissions was observed for broilers. The average annual rate of changes was 3.6% for the whole of the analyzed period. For other groups of animals (sheep, goats and horses) NH_3 emissions decreased, on average by 4.0% per year (Fig. 7).

The share of animal groups in the total ammonia emission from animal production differed among provinces (Fig. 8). It was observed that in the eastern part of Poland the dominant group of animals was cattle. In seven provinces (Lublin, Holy Cross, Lesser Poland, Warmia-Masuria, Masovia, Podlaskie, Lodzkie), the share of cattle in the total NH_3 emission from livestock production was over 50%. It reached more than 81% of ammonia emission in the Podlaskie province. In contrast, in the western part of Poland, ammonia was emitted mainly from swine and poultry production. In three provinces: Greater Poland, Opole and Pomerania, the share of pigs in the total NH_3 emission amounted to nearly 50%. Only in Lubusz province the dominant source of NH_3 was poultry production (49% of total NH_3 emission).

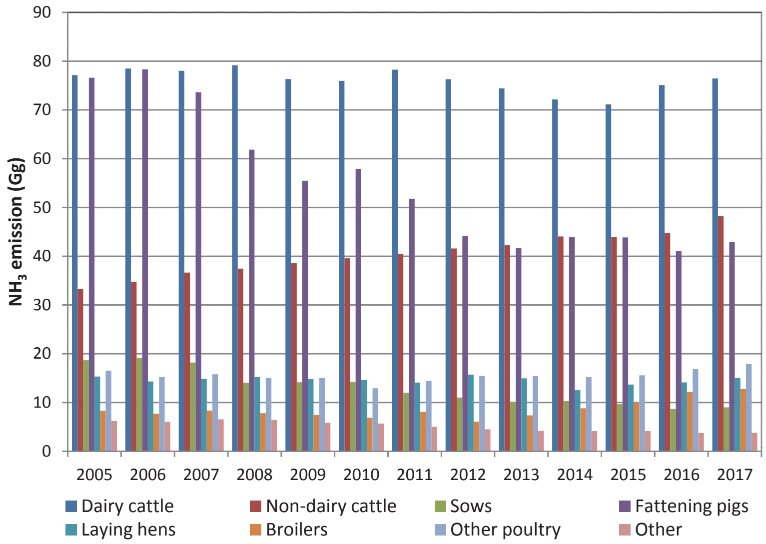

Fig. 7. The share of groups of animals in NH_3 emission in Poland for years 2005–2017

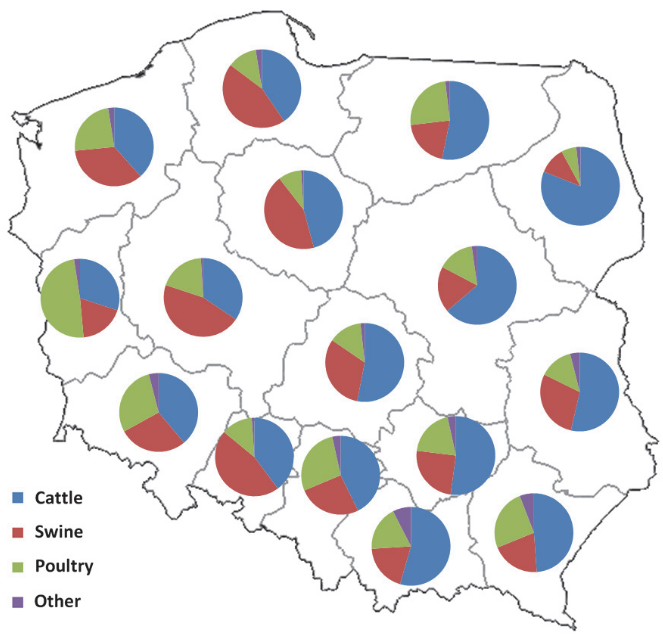

Fig. 8. The share of animal groups in NH_3 emission from livestock production (mean for 2005–2017)

Conclusions

The implementation of the European policy of improving air quality and mitigating the emission of harmful gases, requires further reduction of NH_3 emissions from all sectors of the economy, mainly agriculture. The increasing demand for food will result in greater NH_3 emission, so the mitigation initiatives must be highly effective. To change this trend the nitrogen management practices, also for ammonia, need to be adapted. Mitigation strategies for NH_3 emission from livestock production have been extensively studied and they have great potential. For example, the feeding management, the use of cover, acidifiers and additives for manure, the microclimate and ventilation control in livestock buildings. The natural fertilizers application is also part of NH_3 emission from livestock production. The studies show that low-emission manure application practices may result in 4 to 10.6% of NH_3 emission reduction in Poland (Jarosz and Faber 2018).

The achievement of EU reduction targets by Poland will require changes in livestock and crop production. However, effective application of mitigation strategies needs detailed knowledge about the share structure of NH_3 emission sources in Poland. Meeting the EU reduction targets for the whole country does not necessarily mean improving the environmental situation in all regions. The conducted analysis showed that the regions with the highest NH_3 emission density are mostly associated with the livestock production. This is mainly due to the optimization of production costs, but it leads to its concentration and intensification. This adversely affects the environment and human health in the near area, despite the positive effect achieved in the country.

The mitigation strategies should be implemented primarily in provinces where reduction potential is the largest. The assessment of the reduction potential should take into account the NH_3 emission density and the low NH_3 emission technologies, which are already applied in regions. Practices limiting emissions should be implemented both in new and existing buildings. In addition to the introduction of new technologies, it is also very important to change the habits of agricultural producers, which involves the need to raise environmental consciousness among farmers. Before implementing the mitigation strategies, their environmental effects should be analyzed in relation to the costs. It allows to reach the optimum between environmental effects and the costs of implementation of reduction strategies.

Acknowledgements

The work co-financed by the Ministry of Agriculture and Rural Development and carried under the Multiannual Program for the years 2016–2020 "Technological and environmental projects for innovative, effective and low-emission economy in rural areas".

References

Adamczyk, W. & Jachimowski, A. (2013). Impact of biogenic components on quality and eutrophication of flowing surface waters constituting the source of drinking water for the city of Kraków, *Żywność. Nauka. Technologia. Jakość*, 6, 91, pp. 175–190. (in Polish)

Adamowicz, K. (2018). Assessment of the average rate of changes in atmospheric CO emissions in OECD countries, *Archives of Environmental Protection*, 44, 1, pp. 97–102, DOI: 10.24425/118186.

Bebkiewicz, K., Dębski, B., Chłopek, Z., Kanafa, M., Kargulewicz, I., Olecka, A., Rutkowski, J., Skoskiewicz, J., Waśniewska, S., Zasina, D., Zimakowska-Laskowska, M. & Żaczek, M. (2019). *Poland's Informative Inventory Report 2019*, KOBIZE, IOŚ-PIB, Warszawa 2019.

Bieńkowski, J. (2010). Regional differentiation of ammonia emission in Polish agriculture in the years 2005–2007, *Fragmenta Agronomica*, 27, 1, pp. 21–31. (in Polish)

COM (2013). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Clean Air Programme for Europe, European Commission, Brussels, 18.12.2013, COM(2013) 918 final.

Čakmak, D., Beloica, J., Perović, V., Kadović, R., Mrvić, V., Knežević, J. & Belanović, S. (2014). Atmospheric deposition effects on agricultural soil acidification state – key study: Krupanj Municipality, *Archives of Environmental Protection*, 40, 2, pp. 137–148, DOI: 10.2478/aep-2014-0022.

EC (2001). Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, Official Journal of the European Communities.

EC (2016). Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC, Official Journal of the European Union.

EMEP/EEA (2009). EMEP/EEA air pollutant emission inventory guidebook. EEA Technical report, 9/2009, European Environment Agency, Copenhagen 2009.

EMEP/EEA (2016). EMEP/EEA air pollutant emission inventory guidebook. EEA Technical report, 21/2016, European Environment Agency, Copenhagen 2016.

Gilliland, A.B., Appel, K.W., Pinder, R.W. & Dennis, R.L. (2006). Seasonal NH_3 emissions for the continental united states: Inverse model estimation and evaluation, *Atmospheric Environment*, 40, pp. 4986–4998, DOI: 10.1029/2008GL033732.

GUS (2018). Local Data Bank. Central Statistical Office, (https://bdl.stat.gov.pl/BDL (25.01.2018)).

Herbut, E. & Walczak, J. (2015). Animal production in Poland and the common agricultural policy, *Wiadomości Zootechniczne*, 4, pp. 109–120. (in Polish)

Jarosz, Z. & Faber, A. (2018). Possibilities of reduction of ammonia emissions from manure management, *Roczniki naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu*, 20, 4, pp. 60–66, DOI: 10.5604/01.3001.0013.2071. (in Polish)

Mensink, C. & Deutsch, F. (2008). On the role of ammonia in the formation of PM2.5, in: *Air Pollution Modeling and Its Application XIX. NATO Science for Peace and Security Series, Series C: Environmental Security*, Borrego, C. & Miranda, A.I. (Eds.). Springer, Dordrecht, pp. 548–556, DOI: 10.1007/978-90-481-3812-8.

Pietrzak, S. (2006). Inventory method for ammonia emissions from agricultural sources in Poland and its practical application, *Woda-Środowisko-Obszary Wiejskie*, 16, 1, pp. 319–334. (in Polish)

Pinder, R.W., Adams, P.J., Pandis, S.N. & Gilliland, A.B. (2006). Temporally resolved ammonia emission inventories: current estimates, evaluation tools, and measurement needs, *Journal of Geophysical Research*, 111, pp. 1–14, DOI: 10.1029/2005JD006603.

Rzeźnik, W. & Mielcarek, P. (2016). Greenhouse gases and ammonia emission factors from livestock buildings for pigs and dairy cows, *Polish Journal of Environmental Studies*, 25, 5, pp. 1813–1821, DOI: 10.15244/pjoes/62489.

Tarkowska-Kukuryk, M. (2013). Effect of phosphorous loadings on macrophytes structure and trophic state of dam reservoir on a small lowland river (Eastern Poland), *Archives of Environmental Protection*, 39, 3, pp. 33–46, DOI: 10.2478/aep-2013-0029.
Tian, D. & Niu, S. (2015). A global analysis of soil acidification caused by nitrogen addition, *Environmental Research Letters*, 10, pp. 1–10, DOI: 10.1088/1748-9326/10/2/024019.
Viguria, M., Sanz-Cobeña, A., López, M.D., Arriaga, H. & Merino, M.P. (2015). Ammonia and greenhouse gases emission from impermeable covered storage and land application of cattle slurry to bare soil, *Agriculture, Ecosystems & Environment*, 199, pp. 261–271, DOI: 10.1016/j.agee.2014.09.016.
Werner, M., Kryza, M., Geels, C., Ellermann, T. & Skjøth, C.A. (2017). Ammonia concentrations over Europe – application of the WRF-Chem model supported with dynamic emission, *Polish Journal of Environmental Studies*, 26, 3, pp. 1323–1341, DOI: 10.15244/pjoes/67340.
Withers, P.J.A., Neal, C., Jarvie, H.P. & Doody, D.G. (2014). Review agriculture and eutrophication: where do we go from here? *Sustainability*, 6, pp. 5853–5875, DOI: 10.3390/su6095853.
Yunnen, C., Changshi, X. & Jinxia, N. (2016). Removal of ammonia nitrogen from wastewater using modified activated sludge, *Polish Journal of Environmental Studies*, 25, 1, pp. 419–425, DOI: 10.1007/s11270-017-3643-7.

Emisja amoniaku z produkcji zwierzęcej w Polsce i jej regionalne zróżnicowanie, w latach 2005–2017

Streszczenie: Rolnictwo jest znaczącym źródłem zanieczyszczeń gazowych między innymi: amoniaku, metanu, podtlenku azotu i lotnych związków organicznych. Amoniak jest szczególnie istotny ze względu na znaczną emisję i lokalne oraz globalne oddziaływanie na środowisko. Uwalnianie NH_3 jest jednym z głównych źródeł emisji azotu do atmosfery i przyczynia się do jego późniejszej depozycji. Celem pracy była analiza emisji amoniaku z produkcji zwierzęcej w Polsce w latach 2005–2017, jej regionalnego zróżnicowania oraz możliwości jej ograniczania z rolnictwa. Emisję amoniaku obliczono dla grup zwierząt zgodnych z klasyfikacją NFR. Do tego celu wykorzystano wartości współczynników emisji amoniaku stosowanych przez KOBIZE, zgodnie z metodami EMEP/EEA. W 2017 r. emisja NH_3 z polskiego rolnictwa wyniosła 288 Gg i stanowiła 96% tej emisji z 2005 r. Emisja amoniaku z produkcji zwierzęcej, w latach 2005–2017, stanowiła średnio 79,8% emisji z rolnictwa. Największy udział w tej emisji miała produkcja bydła (51%) i trzody chlewnej (30%). Emisje NH_3 różniły się znacznie między województwami. Gęstość emisji ($kgNH_3 \cdot km^{-2} \cdot rok^{-1}$) w województwach o intensywnej produkcji zwierzęcej była około 5,5 razy większa niż w województwach, w których produkcja zwierzęca była najmniejsza. Osiągnięcie unijnych poziomów redukcji emisji NH_3 wyznaczonych dla Polski, będzie wymagało zmian w produkcji zwierzęcej i roślinnej. Strategie ograniczania powinny być wprowadzane w pierwszej kolejności w regionach, w których występuje duży potencjał redukcji, czyli w województwach o wysokiej gęstości emisji NH_3.