Interreg Baltic Sea Region

Baltic Slurry Acidification

Status for air quality in the Baltic Sea Region with respect to ammonia

by

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Ammonia emissions stems 94% from farming and contributes to the entire air pollution. The negative effects of ammonia emissions are multiple as it affects the level of particles and ozone, and contributes to acid rain and eutrophication of waters through atmospheric depositions. Ammonia emissions deteriorate human health, nature and environment. International policies related to ammonia emission and air quality in general is organised by United Nations Economic Commission for Europe (UNECE) on basis of the Convention on long-range transboundary air pollution (LRTAP) from 1979. The Convention is supported by HELCOM and EU, who since the Gothenburg Protocol from 1999 has integrated the LRTAP Convention and amendments into EU law. HELCOM connect atmospheric and waterborne nutrient loads to the Baltic Sea, and has set country-wise targets for its total reduction, including for RU and BY, and only Denmark has so far achieved to meet nitrogen ceilings to all HELCOM sub-basins. While the ammonia emissions dropped by 33% from 1990 to 2005, we have unfortunately since then seen a negative development. Provisional data from 2014 indicates that all countries in the Baltic Sea Region increased their ammonia emissions in 2014 with averagely more than 10% from the previous year. All eight EU member states in the Baltic Sea Region have 2030 targets below current emission levels. The hazard of ammonia emissions depends on contribution to air pollution from other sectors, such as transport and energy, and the situation is especially alarming in Germany, Poland and Denmark, for whom the European Science Foundation has estimated societal health costs of ammonia emissions to be 22, 12 and 10 € per kg ammonia emission, respectively. In the light of this, slurry acidification deserves a more widespread use as a win-win technology with high effect on ammonia emissions, and the ongoing Baltic Slurry Acidification project is working for its disseminated use in the Baltic Sea region countries.

European Environment Agency report on air quality

The quality of the air we breathe is slowly getting better. A just published European Environment Agency (EEA) report shows that the level of sulphur oxides (SOx) emissions has been reduced with no less than 70% in the period from 2000 to 2014. Ammonia is another very important polluter of the air, with strong impacts on e.g. human health and eutrophication of waters, but ammonia emissions has only been reduced with 7% in that period, according EEA's report.

Ammonia and SOx emission sources and costs

Sulphuric oxides, especially sulphur dioxide (SO2), stems mainly from combustion and the major sources includes heat and power plants. SOx is unwanted because it in moist air contribute to the formation of sulfuric acid, which falls down with the precipitation and represents a thread against biotopes for flora and fauna. While SOx is a polluter of the air, its main constituent, sulphur (S) is in the same time one of the five most important crop nutrients. The current much reduced SOx emissions has made fertilising of crops with sulphur essential for the harvest yields, crop productivity and economic returns of crop farming, compared to the situation 30-40 years ago, where even crops with a high S need received sufficient amounts of S through atmospheric deposition. S fertilisers costs typically around 1 € per kg pure nutrient.

Similarly, ammonia is a strong and unwanted polluter while in the same time its main constituent, nitrogen (N), is the most important macronutrient for crops. NH3 contributes to acid deposition and eutrophication. The subsequent impacts of acid deposition can be significant, including adverse effects on aquatic ecosystems in rivers and lakes, and damage to forests, crops and other vegetation. Eutrophication can lead to severe reductions in water quality with subsequent impacts including decreased biodiversity, changes in species composition and dominance, and toxicity effects. NH3 also contributes to the formation of secondary particulate aerosols, an important air pollutant due to its adverse impacts on human health. It has been estimated (European Science Foundation, 2011) that the social health costs of ammonia emissions are 2-22 € per kg N for the countries in the Baltic Sea region, highest for Germany with 22 €/kg and lowest for Estonia with 2 €/kg. Similarly, EEA (2016) has estimated premature deaths associated with the 2013 levels of air pollution with PM2.5 (particulate matter with a diameter of 2.5 micrometres (μm)), NO2 and O3, which for instance in Poland's case is 51,030 premature deaths.

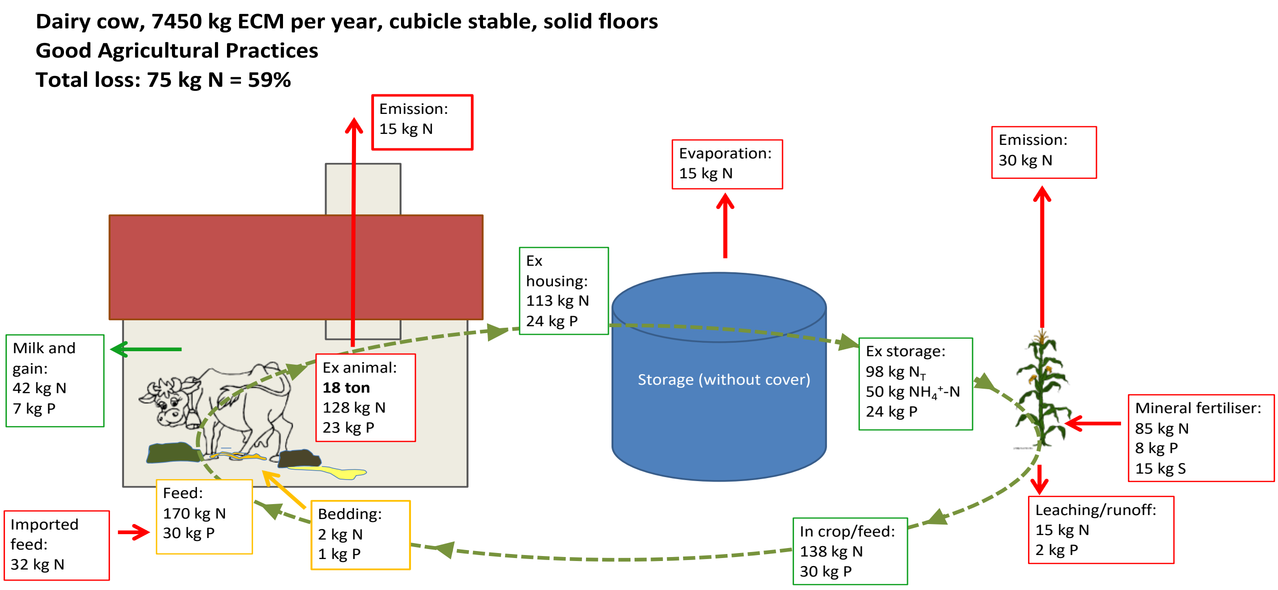

Figure 1: Manure handling at livestock farms is one of the main sources of ammonia emissions, and it can be divided into emissions from stables, manure storages and field spreading. Farms that respects good agricultural practices will normally loose about half of the nitrogen – in this example 75 of 128 kg N per cow, mainly due to ammonia emissions. This is far from circular economy, and it represents a big economic loss and a high environmental burden.

Political initiatives

Having recognised the harmful effects of air pollution and acid rain, 32 countries in the Pan-European region, signed the "1979 Convention on long-range transboundary air pollution" (LRTAP), which entered into force in 1983. All eight EU Member States in the Baltic Sea Region are now parties to the Convention after it has being ratified by the Baltic countries, latest Estonia in 2000. The effect of national commitments to the LRTAP led to a 17.9% ammonia emission reduction in EU-28 in the years 1990-95.

The 1999 Gothenburg Protocol to the LRTAP was ratified by the European Union on behalf of its Member States, who in 2001 issued the National Emission Ceilings Directive (NEC Directive), which strengthened the importance of the issue due to more direct possibilities for enforcement of the politically decided targets. Following this, the ammonia emission reduction targets for EU Member States has since 1999 been coordinated under the LRTAP Convention. Table 1 shows the 2010, 2020 and 2030 targets for ammonia emissions for the EU member states in the Baltic Sea region, as well as the actual, reported emissions for selected years.

Table 1: Figures on actual ammonia emissions in the years 1990, 2005, 2013 and 2014, and policy targets for the years 2010, 2020 and 2030 for the eight EU Member States in the Baltic Sea Region. The table also shows the 2030 targets, re-calculated into kg ammonia emission per ha Utilised Agricultural Area. (Various sources.)

Country	1990	2005	2010	2013	2014*	2020		2030		Utilised Agricultural Area (UAA)	2030
	Actual emissions		Target	Actual emissions		Reduction commitments (% reduction compared to 2005) and targets (kiloton)					Target
	Kiloton					%	Kiloton	%	Kiloton	1,000 ha	Kg per ha UAA
DA	124	83	69	71	73	-24	63	-24	63	2.646,9	23,83
DE	761	573	550	633	740	-5	544	-29	407	16.704,0	24,36
EE	25	10	-	11	13	-1	10	-1	10	940,9	10,31
FI	35	39	31	34	37	-20	31	-20	31	2.291,0	13,62
LV	38	16	-	11	17	-1	16	-1	16	1.796,3	8,82
LT	97	39	-	38	41	-10	35	-10	35	2.742,6	12,80
PL	490	270	-	259	263	-1	267	-17	224	14.447,3	15,51
SE	49	55	57	45	54	-15	47	-17	46	3.066,3	14,89
Total, Kt	1,619	1,085	707	1,101	1,227	-	1,013	-	832	-	-
Total, %	100	67	-	68	76	-	63	-	51	-	-

** Provisional*

It is seen form the table that actual ammonia emissions in 2014 for DK, DE and FI exceeds their defined NEC Directive and LRTAP Gothenburg Protocol targets for 2010. For DE, the excess is 35%! Ammonia emissions were for all eight Baltic Sea Region countries reduced with 24% from 1990 to 2014. It is worrying that the development on ammonia emissions are going in the wrong direction, evaluated on basis of the latest available, provisional data from 2014, which shows higher ammonia emissions for all eight countries, compared to 2013.

LRTAP decided on its thirtieth session in 2012 to adopt historic amendments to the Convention's 1999 Gothenburg Protocol and include national emission reduction commitments for 2020, which are seen in Table 1.

The latest development is that EU has issued a new Directive on the reduction of national emissions of certain atmospheric pollutants (2016/2284/EC), which came into force by 31 December 2016. The directive will replace the NEC Directive, which is repealed by 1 July 2018. The new Directive holds EU Member State commitments for ammonia emission by 2030 - see Table 1. Only three Baltic Sea Region countries, namely PL, DE and SE has committed themselves to higher 2030 targets than those that are valid for 2020.

It is clear from Table 1 that Germany has the most ambitious 2030 targets, while in the same time is being the country that currently is most behind its target for ammonia emission reduction.

Table 1 is also holding columns that shows the 2030 ammonia emission reduction targets in terms of kg ammonia per ha Utilised Agricultural Area. The calculated targets per ha UAA shows that while DE and DK percent-wise has committed themselves to the largest ammonia emission reductions, the emissions would anyway be substantially higher than for most of the other countries. It is natural that countries have different targets for ammonia emissions, because the severity of adverse impacts are dependent on factor like climatic conditions.

However, the situation is that only one country, namely Poland already has reached its 2020 target for ammonia emission, while all eight EU member states in the Baltic Sea Region have 2030 targets below current emission levels.

The role and efforts of HELCOM

Aiming to have a Baltic Sea unaffected by eutrophication, HELCOM Contracting Parties – Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden, agreed in 2007 within the Baltic Sea Action Plan on applying a Nutrient Reduction Scheme. HELCOM Nutrient Reduction Scheme is a regional approach to sharing the burden of nutrient reductions to achieve good environmental status the of the Baltic Sea. It was estimated in 2007 that for achieving this goal, the maximum allowable annual nutrient pollution inputs (MAI) into the Baltic Sea would be 21,000 tonnes of phosphorus and about 600,000 tonnes of nitrogen. Annual reductions of some 15,000 tonnes of phosphorus and 135,000 tonnes of nitrogen would be required to achieve the plan's crucial "clear water" objective. In 2013, the HELCOM Copenhagen Ministerial Meeting adopted the revised HELCOM nutrient reduction scheme.

One of the main components of the nutrient reduction scheme is the Country-Allocated Reduction Targets (CART), indicating the target for HELCOM countries' reduction of atmospheric and waterborne nutrient inputs of total nitrogen and phosphorous, compared to a reference period from 1997 to 2003. The 2013 HELCOM Ministerial Meeting also stressed that the achievement of good environmental status for the Baltic Sea also relies on additional reduction efforts by non-Contracting Parties.

Table 2: 2007 and 2013 CARTs on nitrogen for HELCOM and non-HELCOM countries, as well as progress towards CARTs for 2012.

Country	2007	2013	2012	
	Country-Allocated Reduction Targets, Kt/a		Extra reduction (total input) compared to targets for Baltic Sea basins since 1997-2003, Kt/a	Missing reduction (total input) to fulfil targets for Baltic Sea basins since 1997-2003, Kt/a
DA	17.21	2.89	16.86	0
DE	5.6	7.17 +0.5*	6.18	2.66
EE	0.9	1.8	0.2	2.42
FI	1.2	2.43 +0.6*	0.29	7.66
LV	2.56	1.67	0.001	9.83
LT	11.7	8.97	0.02	15.66
PL	62.4	43.61**	1.24	23.78
SE	20.78	9.24	9.64	2.77
RU	6.97	10.380*	0	14.86
Transboundary Common pool* (including BY)	3.78	3.32 1.98	0 0	2.65 1.85

** Reduction requirements stemming from*
- German contribution to the river Odra inputs, based on ongoing modelling approaches with MONERIS;
- Finnish contribution to inputs from river Neva catchment (via Vuoksi river);
- these figures include Russian contribution to inputs through Daugava, Nemunas and Pregol

*** At this point in time Poland accepts the Polish Country Allocated Reduction Targets as indicative due to the ongoing national consultations, and confirms their efforts to finalize these consultations as soon as possible*

The updated CART (2013) are calculated for waterborne and airborne inputs of nitrogen and for countries and specific sub-basins. That is why it might be extra reduction for one basin which cannot be directly accounted within progress for the whole country due to missing reduction to another basin. Moreover, there are no strict amount which should be reduced via air or via water, and the country can decide how to reduce the total load.

Per the latest results of HELCOM assessments (Table 2) the following conclusions can be made:

- Denmark fulfilled nitrogen ceilings to all HELCOM sub-basins
- Germany and Sweden met their nitrogen CART's to all HELCOM basins except to the Baltic Proper
- Russia and Belarus exceeded their maximum allowable inputs to all sub-basins
- Finland increased its nitrogen inputs to Bothnian Bay.

Measures to implement the policies

It is a national decision, how the political commitments to ammonia emission reductions shall be reached. However, it is given that national legislation to implement the Industrial Emissions Directive (2010/75/EU) has a large role concerning limitation of ammonia emissions from farming. The Directive explicitly requires EU Member States to take measures to reduce ammonia emissions on livestock holdings that have at least 40,000 places for poultry, 2,000 places for production of pigs (over 30 kg) or 750 places for sows. Joint Research Centre is coordinating the identification and description of Best Available Techniques for reduction of the ammonia emissions. Also, the Nitrates Directive (91/676/EEC) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices.

Slurry acidification

For reach of policy goals, a priority is always to employ cost-effective measures without trade-offs, i.e. that do not have negative side effects elsewhere, but on the contrary, are sustainable from an entire value chain perspective and as well accepted by the industry. Slurry acidification is among such instruments. By bringing pH a bit down in the slurry, from a typical level above pH 7.0 to about 6.4 via slurry acidification, it is secured that almost all ammonia is on ammonium salt form that does not evaporate. By doing the acidification with sulphuric acid is achieved that the ammonia nitrogen content in the manure is avoided from slipping away as ammonia emissions while the slurry in the same time is enriched with sulphur, generally making it a better and more valuable fertiliser for the crops.

Picture 1: Slurry acidification technologies comprise in-field, in-house, and in-storage technologies.

Slurry acidification techniques (SATs) comprise in-house, in-storage and in-field slurry acidification. It is especially used in Denmark, where it is officially recognised to reduce the ammonia emissions from slurry with 40-70%. Slurry acidification gives benefits to farms via the higher content of nitrogen and sulphur in the treated slurry and is in that way different from most agro-environmental technologies that alone means extra costs for the farms.

Baltic Slurry Acidification is a large project with a multiple governance partnership, representing 17 organisations, farms, authorities and businesses from all EU Member States in the Region, as well as partners from Belarus and Russia, which has joined the project in 2017. The project is co-funded by Interreg Baltic, and has due to its role in relation to the EU Strategy for the Baltic Sea Region (EUSBSR) achieved Flagship project status. The project aims to promote the implementation of slurry acidification techniques throughout the Baltic Sea Region.

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