Factsheet

UK Centre for Ecology & Hydrology

Ammonia

Key facts and figures

- Ammonia is released through decomposition of organic matter and is also manufactured
- UK ammonia emissions totalled 265,000 tonnes in 2021, with 88% coming from agriculture
- 64% of UK land is exposed to ammonia above critical level for lichens and mosses.
- The UK National Ammonia Network currently has 112 monitoring sites.

Q What is ammonia?

A

Ammonia (NH_3) is a colourless gas formed from nitrogen and hydrogen, and has a pungent smell. It is an important part of the nitrogen cycle and occurs naturally through the decomposition or burning of plant and animal organic matter such as animal and human excreta. For example, ammonia is released from livestock manure during grazing and in animal houses, and is subsequently stored and spread on fields.

Farmers apply manure, in solid form or liquid form (slurry), and synthetic ammonia fertilisers to fields because ammonia is a highly concentrated source of nitrogen, which is essential for plant growth including food crops and grass for animal feed. However, poor management of manure and the inefficient way that it and synthetic fertilisers are applied to fields produce excess ammonia, polluting air, land and water. Agriculture accounted

for 88% all UK ammonia emissions in 2021. Other sources include composting, anaerobic digestion, some industrial processes, poorly working vehicle catalytic converters, landfill and wastewater.

Ammonia pollution is a major threat to global biodiversity, air quality and human health. There is an urgent need to reduce and mitigate ammonia pollution and protect people and sensitive habitats. Climate change is expected to lead to higher emissions to the atmosphere because warmer conditions lead to a higher proportion of the nitrogen present in slurry and manure being emitted as ammonia to the air.

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Q How does ammonia reduce biodiversity?

A

High concentrations of ammonia and nitrogen oxides (NO_x) in air, or nitrogen in water affect organisms that have evolved to thrive under clean conditions and are sensitive to excess nutrients.

The UK Centre for Ecology & Hydrology (UKCEH) has led the revision of 'critical level' thresholds for ammonia concentrations in the air, agreed by the UN. When the critical level is exceeded, species of plants and other organisms, eg lichens and mosses, are at risk of damage and disappearing from an ecosystem. This has negative impacts on animals that rely on them for food or nesting material.

Ammonia and NOx landing on habitats (referred to as nitrogen deposition) act as fertiliser, increasing growth of tall plants such as nettles at the expense of short-growing wildflowers. This impacts upon the insects that feed on these.

Bogs, formed by mosses that are sensitive to atmospheric nitrogen, are

Healthy and damaged sphagnum moss.

major stores of carbon. By damaging or killing mosses, ammonia reduces bogs' ability to capture and retain carbon, increasing greenhouse gas emissions.

Regular monitoring and modelling by UKCEH for Defra estimates 64% of UK land area is exposed to ammonia concentrations above the critical level set to protect lichens and mosses.

Nitrogen can also enter water courses from agricultural run-off and leaching as well as sewage discharges, providing nutrients for the growth of algae which can outcompete other plants for both nutrients and sunlight. As the algae decay, oxygen is removed from the water, killing fish and other organisms.

Q What is the impact on air quality and human health?

A

Ammonia only poses a direct risk to human health at very high concentrations, such as inside poultry sheds, which are governed by UK Health and Safety regulations. However, ammonia contributes to poor air quality, including in urban areas, by reacting with products from other gases such as NO_x and sulphur dioxide to form fine particulate matter ($PM_{2.5}$). Fine particulate matter penetrates the lungs and bloodstream, which can aggravate respiratory and heart conditions, causing up to 36,000 premature deaths in the UK a year and 4.2 million globally.

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Q How is ammonia monitored in the UK?

A

UKCEH is a global leader in ammonia modelling and measurement, quantifying emissions and concentrations of ammonia, and monitoring how these change over distance and time.

Working with universities, government agencies, NGOs, farmers and businesses, UKCEH is improving our understanding of ammonia and atmospheric chemistry in agricultural areas and impacts in remote areas. We undertake experiments to learn more about its effects throughout the environment.

UKCEH coordinates the UK National Ammonia Monitoring Network for Defra and the UK's national environment agencies. This network has measured ammonia pollution for more than 25 years. There are currently 112 sites covering the length and breadth of the UK measuring concentrations of ammonia in the atmosphere. This long-term monitoring

UKCEH monitoring of impact of ammonia in Glencorse, near Edinburgh.

enables us to measure how changes in agricultural and environmental policies and practices affect ammonia concentrations across the UK. Our measurements, combined with our national-scale modelling, enable us to assess whether international emissions targets are being met.

UKCEH is also involved in shorter-term monitoring and research to better understand how ammonia gas moves across the landscape from sources to sensitive habitats, as well as assessing new options for mitigating air pollution.

Q What are the UK's total ammonia emissions?

A

While levels of other air pollutants such as sulphur dioxide and nitrogen oxides have declined substantially, ammonia emissions in the UK have been rising in the past decade. Data from the UK's National Atmospheric Emission Inventory suggest that emissions of ammonia fell to a low of 255,000 tonnes per year in the UK in 2013 but rose again to 265,0000 tonnes in 2021. The UK has to cut emissions to 235,000 tonnes by 2030 to meet its international commitment to reduce ammonia under the current National Emissions Ceilings Regulations.

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Q How is UKCEH research informing practices and policies?

A

UKCEH runs the Air Pollution Information System (APIS), a database with information on pollutants, including ammonia, and their impacts on habitats and species. Users include councils and farm consultants for planning issues.

Our scientists also lead international research into sustainable management of the nitrogen cycle, including ammonia, to reduce the amount wasted and lost to air, soils and water.

The proportion of nitrogen used by humans that is lost is estimated to be 80% globally. With the global tripling of fertiliser prices in 2022, this wasted resource is equivalent to 600bn US dollars. UKCEH scientists contributed to the drafting of the Colombo Declaration, agreed by UN Environment Programme member states, which has the ambition to halve nitrogen waste by 2030. In addition to benefits for farm incomes and industry, reducing nitrogen losses would bring substantial benefits for ecosystems, human health and climate.

UKCEH coordinates the International Nitrogen Management System (INMS) which brings together research organisations, companies and international agencies to provide evidence that supports the development of international policies.

UKCEH also heads a major research hub established under the UK Global Challenge Research Fund. The South Asian Nitrogen Hub (SANH) is investigating how to improve nitrogen management in agriculture, saving money on fertilisers and making better use of manure, urine and natural nitrogen fixation processes. It will also consider how nitrogen pollution could be turned back to fertiliser.

Prof Mark Sutton of UKCEH, who heads the Hub and INMS, led the production of the UNECE Guidance Document on integrated nitrogen management providing advice on efficient agricultural methods. It has been adopted by Parties to the UNECE Convention on Long-range Transboundary Air Pollution.

Members of the South Asian Nitrogen Hub

Q How can we reduce ammonia emissions?

A

The ways in which agricultural practice can be improved to cut emissions include:

- Targeted and efficient application of liquid manure to land, such as injecting it directly into soil or by trailing hoses rather the 'splash plate' method, which spreads slurry all over the field surface.
- Match animal diets to their protein needs, meaning less nitrogen is excreted and less ammonia produced.
- Improve the way that animal manure is stored and managed eg keeping floors of animal housing clean and covering stores of manure and slurry.
- Develop and use new types of fertilisers that lead to lower emissions.
- Develop technological and nature-based systems for removing ammonia from air close to emission sources.

Applying nutrients with low-emission techniques at the right time for crops and grass to make best use of them, and at the right amount, reduces emissions to the air, as well as run-off and leaching from fields

Applying fertiliser by a trailing hose.

Saving nitrogen within the farming system enables yields to be increased or fertiliser use to be reduced, thereby boosting farmers' incomes. Less fertiliser production and transportation reduces greenhouse gas emissions.

UKCEH carries out research into nature-based solutions to mitigating ammonia pollution, including planting trees to recapture some of the gas emitted by nearby animal housing. With Forest Research, we have developed an online calculator for farmers and tree planters, to maximise the benefits of planting tree shelterbelts for ammonia recapture as well as help mitigate climate change.

Q What action is being taken in the UK?

A

The four nations of the UK have their own plans to tackle air pollution. In 2019, Defra launched its Clean Air Strategy, which proposed a range of regulations and financial support mechanisms in England, recognising the risks posed by ammonia pollution.

The Scottish Government updated its Cleaner Air for Scotland Strategy in 2021. Wales has a Clean Air Plan and the Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland is developing its first Clean Air Strategy.

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