THE ROYAL SOCIETY

14 August 2018

Royal Society submission to the Department of Environment, Food and Rural Affairs Clean Air Strategy Consultation.

The Royal Society is the National Academy of Science for the UK and the Commonwealth. It is a self-governing Fellowship of many of the world's most distinguished scientists working across a broad range of disciplines in academia and industry. The Society draws on the expertise of its Fellows and Foreign Members to provide independent and authoritative scientific advice to UK, European and international decision makers. The Society provides authoritative, accessible and independent scientific evidence to policymakers on areas including climate science and low carbon energy to inform decisions.

The Royal Society, working with RAND Europe recently completed an evidence synthesis on *The Impact of Ammonia Emissions on Biodiversity*. The Royal Society therefore welcomes this opportunity to submit this synthesis in response to Defra's Clean Air Strategy Consultation and an embargoed copy of the report is attached – embargo date, 17 September 2018.

This evidence has been drawn from published academic literature and supplemented by interviews with the UK's leading scientists. As levels of other air pollutants have declined, ammonia emissions in the UK have been rising since 2013, with significant implications for the environment and human health. Ammonia is one of the main sources of nitrogen pollution and the agricultural sector is responsible for 82 per cent of all UK ammonia emissions. In terms of costs, the implications of ammonia emissions if not addressed are significant. Bringing together existing estimates of the impact on human health and biodiversity, we find that if no action is taken to reduce ammonia emissions, the negative impacts to the UK in 2020 could be valued at over £700 million per year[1].

The findings of the report are particularly applicable to Chapter 7 'Actions to Reduce Emissions from Agriculture' and Chapter 3 'Protecting the Environment' of the draft Clean Air Strategy. Therefore this evidence can be used to inform questions 5, 6, 16, 17 and 18.

Our report presents the impact of ammonia emissions on biodiversity, options for intervention and the economic costs of action and inaction. The first section outlines the value of biodiversity, presents a series of case studies which demonstrate the impact of ammonia emissions on different species and habitats, and estimates the costs of biodiversity loss. The second section presents evidence on the effectiveness and feasibility of different methods for reducing ammonia emissions from agriculture, many of which are identified in section 7.3 of the Clean Air Strategy document. The final section presents reflections, conclusions and considerations for policy implementation.

Our findings highlight the potentially serious impacts of ammonia on biodiversity, particularly on sensitive species and habitats such as lichen, mosses, peatlands, heathlands and forests. The Centre for Ecology and Hydrology experimental site at Whim Bog in the Scottish borders provides strong evidence of the impact of long term ammonia emissions, even at low concentrations, on sensitive ecosystems. The published literature provides many examples of how rarer and less nitrogen tolerant plant species are replaced by nitrogen loving plant species in areas with ammonia pollution. This can

[1] See report section 2.5 for the full data and caveats. The £700m figure comes with a range between £580 million and £16.5 billion (based on variation within the published literature and exact methodology used). £700m was calculated by combining an estimate of £2 per kg for health impacts (*based on the Watkiss (2008) and Dickens et al. (2013) estimates which are most relevant to the UK context, use the UK standard values for a value of life years lost (VOLY) and do not include additional costs e.g. related to crop damage*) with an estimate of £0.42 for impacts on biodiversity (*based on the most comprehensive and recent analysis in the UK context, by Jones et al. (2018)*) to arrive at a conservative estimate of the total costs from both health and biodiversity impacts of £2.50 per kg of NH_3.[1] Combining this with projected emission data,[1] we can provide an indicative estimate of overall cost equivalents to the UK of ammonia emissions. If no action is taken to reduce emissions, the costs are estimated to be over £700m per year.

result in changes in bee and butterfly, and potentially even bird, populations, although in general, evidence relating to the impact of ammonia on whole ecosystems and animals is weaker and this is discussed.

Regarding potential options for intervention, our synthesis strongly suggests that there is no silver bullet. A range of interventions and methods will be required to reduce ammonia emissions from the UK agriculture sector. Figure 13 presents a summary of the cost effectiveness, acceptability and strength of evidence for the different methods assessed – noting that most interventions are cost effective taking into account our costings of the potential damage from ammonia emissions.

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