European Commission

Science for Environment Policy

Monetising the biodiversity benefit of reducing nitrogen pollution in the air

Nitrogen deposited from the atmosphere is in decline in Western Europe due to targeted policies on emissions, with emissions 25% lower than their peak in 1990. Policy measures to lower nitrogen air pollution — which damages plant diversity, buildings and human health — have made an impact and are forecast to continue to lower nitrogen levels in the future, offering an opportunity to evaluate their impact. This study uses the UK as a case study to answer the policy question: what is the economic impact on biodiversity of forecast reductions in nitrogen pollution?

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Source: Jones, L., Milne, A., Hall, J., Mills, G., Provins, A. and Christie, M. (2018). Valuing Improvements in Biodiversity Due to Controls on Atmospheric Nitrogen Pollution. *Ecological Economics*, 152: 358-366.

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Policy measures tackling nitrogen levels in the atmosphere have lowered these levels drastically since the mid 1990s, with policies addressing agricultural sources of ammonia (NH_3) and combustible sources of nitrogen oxide (NO_x), (nitric oxide (NO) and nitrogen dioxide (NO_2), known together as oxides of nitrogen (N). Attempts to evaluate the financial impact of this reduction have found it to have both negative and positive impacts on ecosystem services, as there is a cost associated with lowering the amount of free fertiliser in the air; since nitrogen leaves the air and falls in rain on to agricultural land.

The benefits of lowered nitrogen in the air include improved water quality, reduction in greenhouse gases, and increasing biodiversity (particularly plant species diversity) and therefore provide many important benefits for society. However, it is easier to monetise the cost, which comes from a loss of free fertiliser to farmers, than it is to monetise the environmental benefits, such as increasing biodiversity. It is difficult to evaluate economic values of biodiversity conservation — for example, the joy we have from looking at biodiversity in an outdoor location — but a total economic value (TEV) that fails to include this impact would inaccurately assess the net benefit of reducing nitrogen in the air.

The researchers used an impact-pathway approach[1] to assess how atmospheric nitrogen pollution impacts on biodiversity[2] — an analysis that models the full sequence of impacts from its source through to final benefit or cost. Species richness of plants was measured and used as an indicator for the wider impacts on biodiversity; the researchers evaluated the species richness of four habitat types across the UK — heathland, grassland, dunes and bogs — using a grid-cell scale of five by five kilometres.

The study compared a projected decline in nitrogen from 2007 to 2020 — based on the UEP43 Energy Scenario 3 for 2020 from the UK Department of Energy and Climate Change — with a contrasting scenario that assumed nitrogen emissions will stay at 2007 levels. Using these two scenarios means this study is looking to answer the following question: 'what is the expected impact on ecosystem service values under forecast reductions in nitrogen deposition?'. The UEP43 scenario estimates a projected 43% decline in oxidised nitrogen emissions, and a 6% decline in forms of nitrogen from agriculture.

A value-transfer procedure was applied to the study data. This is a way of estimating the value of ecosystem services based on existing valuation studies. The value-transfer made use of a study relating to species richness of so called 'non-charismatic species' — in this case, plants. Data were taken from Christie and Rayment's 2012 choice experiments[3] to provide an estimate of how much money households were willing to pay (WTP) in order to avoid species richness changes in each habitat. This value was scaled to give a pound sterling (£) per hectare value for the change of species richness in each grid cell. This figure was then multiplied by the area of each of the four chosen habitat types — as listed on the Centre for Ecology and Hydrology (CEH) Land Cover Map 2007 to work out a total value for the UK.

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1. Friedrich, R. and Bickel, P., 2001. Estimation of external costs using the impact-pathway-approach. *TA Datenbank-Nachrichten*, Nr 3, 10 Jg, 3: 74–82.

2. An earlier study by the researchers showed that the impacts on the benefits from biodiversity were greater than any other ecosystem service: Jones, L *et al* (2014). A review and application of the evidence for nitrogen impacts on ecosystem services. *Ecosystem Services* 7, 76–88. http://dx.doi.org/10.1016/j.ecoser.2013.09.001

3. Christie, M. and Rayment, M. (2012). An economic assessment of the ecosystem service benefits derived from the SSSI biodiversity conservation policy in England and Wales. *Ecosystem Services*, 1(1): 70–84.

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The annual benefits from nitrogen reduction amount to £32.7 million (approx €37.2 million), with acid grassland and heathland receiving the greatest benefit (due to their large areas). The unit damage costs to the environment of NO_2 and NH_3 are £103 (€114.77) and £414 (€461.32) per tonne, respectively. These economic benefits relate to the modelled changes in species richness due to the decline in nitrogen deposition: there was a 20% increase in species richness in some heathland areas, with the pattern of percentage increase reflecting the change in nitrogen deposition in that area. Dune grasslands also showed increases of up to 20% in species richness, and bogs showed an increase of up to 10%.

This methodology to quantify N impacts on biodiversity, coupled with the value transfer to calculate the willingness to pay (WTP) value of changes in N deposition, could be applied to other airborne pollutants to enable policymakers to monetise the positive and negative impacts of regulations, and, in particular, the benefits which are usually not valued. This enables better appraisal of the impacts of policy changes when sufficient data is available. The values calculated in this study — i.e. £414 (€461.32) per tonne of NH3 saved — are lower than the value of £1972 (€2197.40) (2010) prices recommended for UK policy appraisal of $PM_{2.5}$ aerosol component of ammonia, but illustrate a previously unquantified aspect of air pollution's impact on the environment by quantifying the benefits for society that are usually not valued in monetary terms.

WTP is one of several valuation methods that can be used to estimate the value of biodiversity or ecosystem services. This study focuses on WTP as it is an often overlooked aspect of biodiversity — the non-use value of conservation of species and maintaining species abundance via WTP. The study calculates the value associated with a decline in nitrogen pollution and its subsequent impacts on the general public's appreciation of biodiversity. The monetary losses due to effects of nitrogen pollution on biodiversity overall are of a much greater magnitude — with the total economic value (TEV) of reducing nitrogen amounting to approximately €37.2 million. TEV comprises direct- and indirect-use values, i.e. crops versus climate regulation, as well as non-use values — including wanting others to benefit from access to ecosystems and maintaining biodiversity for future generations. WTP can contribute to the non-use factors in valuing the overall monetary benefit of nitrogen reduction policy on ecosystem services.