Putting an economic value on nitrogen pollution in Europe: can we improve the unit N cost method using results of the Eurobarometer?

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Abstract
The unit N cost method was applied for the European Nitrogen Assessment (ENA) to monetize the social cost of impacts of N pollution on human health, ecosystems and climate stability for the European Union. Unit costs are based on Willingness To Pay (WTP) of people to prevent these impacts by reducing N pollution. Underlying cost-impact data for various impacts came from diverse sources, apply to different periods and sometimes regions. Incompatibility of data sources may have created artefacts, like an apparent five time higher unit N cost to prevent impacts of N on aquatic ecosystems than on terrestrial ecosystems. This paper explores if we can validate and improve the unit N cost method using the Eurobarometer surveys by the European Commission. This survey polls societal concerns in the European Union including those for environment. A preliminary estimate of the social cost of N pollution in 2013-2014 for the European Union based on the Eurobarometer is more than three times lower than the value for 2008 as derived in ENA and differences in this cost between low and high GDP countries are larger than reported in ENA.

Key Words: WTP Willingness To Pay, cost benefit analysis

Introduction

Cost-benefit analysis can be used to provide guidance for emerging policy priorities in reducing nitrogen (N) pollution. The unit cost method is a simple method to estimate the social cost of N pollution based on the Willingness To Pay (WTP) to prevent the specified and quantified impacts. For the EU27 in 2008, the total social cost thus was estimated between 75-485 billion € per year (Grinsven et al., 2013). The used approach recognizes considerable uncertainties and conceptual challenges in such a monetized valuation of non-commensurable issues. Unit N costs for the various impacts vary considerably (Table 1) and in part may be artefacts from incompatibilities in underlying data, use of no-effect levels and interaction between WTP for prevention of different impacts of N pollution.

Table 1. Marginal costs between 1995 and 2005 of different Nr -threats in EU (Grinsven et al., 2013)

Effect	Emitted nitrogen form	Emission/ loss to	Estimated cost € per kg N_r emitted,
Human health (PM, NO_2 and O_3)	NO_x	Air	10 – 30
Ecosystems (eutrophication, biodiversity)	N_r runoff , deposition	Surface Water	5 – 20
Human health (particulate matter)	NH_3	Air	2 – 20
Climate (greenhouse gas balance)	N_2O	Air	4 – 17
Climate**	NOx	Air	-9 - 2
Climate**	NH_3,	Air	-3 – 0
Ecosystems (eutrophication, biodiversity)	NH_3 and NO_x	Air	2 – 10
Human health (drinking water)	N_r (nitrate)	Groundwater	0 – 4
Human health (increased ultraviolet radiation from ozone depletion)	N_2O	Air	1 – 3
Crop damage (ozone)	NO_x	Air	1 – 2

* Cooling effects

Methods

The Eurobarometer measures the relative concern of European citizens for the most important current societal issues (28,000 respondents in 2014). This relative concern was assumed to be a proxy for the priorities for public policy and public spending of individual member states and the European Commission. However, we acknowledge that the relation between public concern and WTP is complex. WTP requires a

notion of responsibility to solve the problem and cost efficiencies for measures to reduce social problems considerably vary between issues. For our alternative approach to estimate costs of N pollution, priorities are monetized by assuming that the total available public budget in the EU is a proxy for the collective WTP to prevent or solve public issues. As a proxy for the total available public budget we take total paid tax (average 40% of GDP, ranging between 20 and 50% for individual member states).

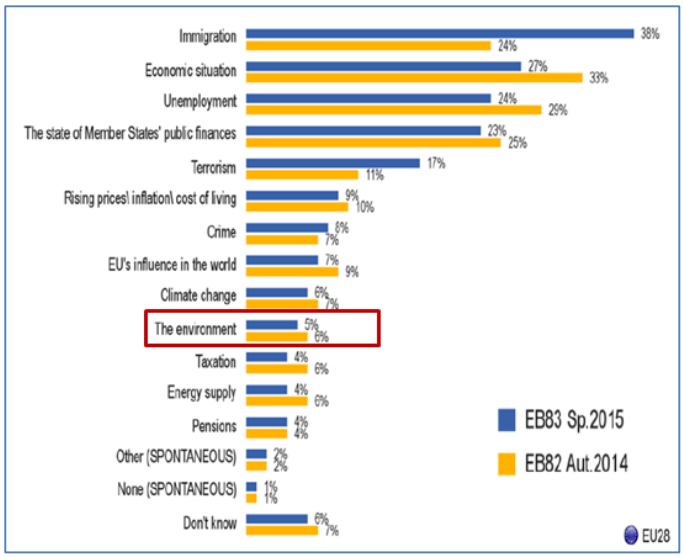

Figure 1. Relative concern of Europeans for social issues in autumn 2014 and spring 2015 (European Commission, 2015)

The Eurobarometer addresses concerns about environment and climate change, which for 5% of the European citizens are one of their three major concerns (Figure 1). The relative share of these concerns range between 0.1% and 2% in southern and eastern EU, and between 2-12% in EU member states in the northwest (Figure 2).

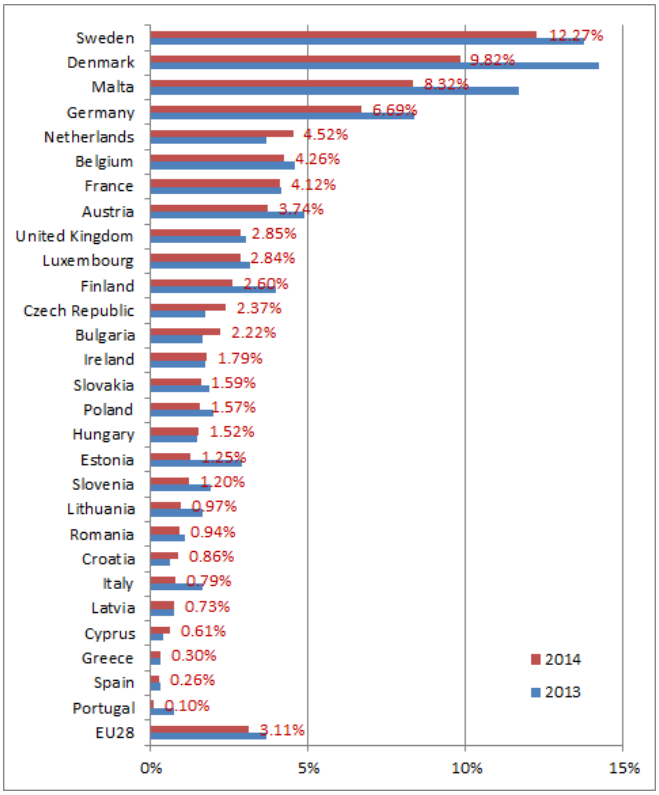

Figure 2. Relative concern of Europeans for environment and climate in 2013 and 2014

Surveys for environment concerns address various issues. Water and air pollution are the most important concerns and both have a strong link to nitrogen pollution, which is also the case for agricultural pollution

(Figure 3). Also loss or extinction of species and habitats and climate change are, albeit to a lesser extent, related to N pollution. Concern for the first three issues with a strong link to N pollution represents 33% of the concern for all surveyed environmental issues (Figure 3) in the EU and this share varies between 28% and 38% for individual countries.

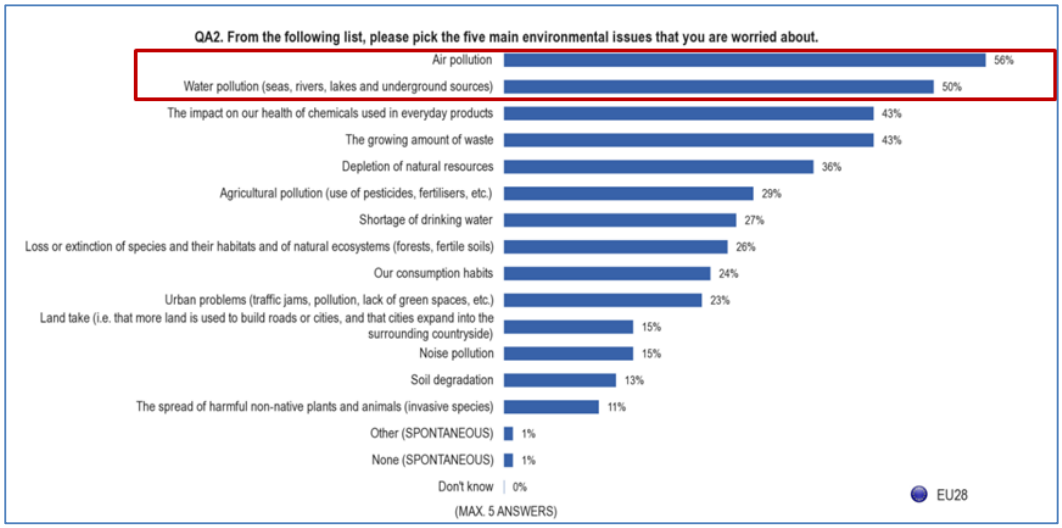

Figure 3. Relative concern of Europeans for environmental issues in 2014 (European Commission, 2014)

If we assume public concern to be equivalent to WTP, and a uniform effectivity of every euro of tax to reduce public concerns, this infers a first estimate of collective WTP to prevent/reduce N pollution in the EU based on the Eurobarometer of about1.5% (5%*0.3) of total tax receipt (5300 billion € in 2012). However, by this we do not take into account other pollutants than nitrogen contributing to water and air pollution.

Results

The alternative estimate of the mean WTP to prevent N pollution for 2013 and 2014 in the EU was 73 billion € (current prices) and 67 billion € for Purchase Power Parity corrected GDP. The level of concern for environment and climate varies strongly between countries and years (Figure 2). The WTP to prevent N pollution based on the Eurobarometer (Figure 4) shows more contrast between countries than reported in ENA (Brink et al., 2011).

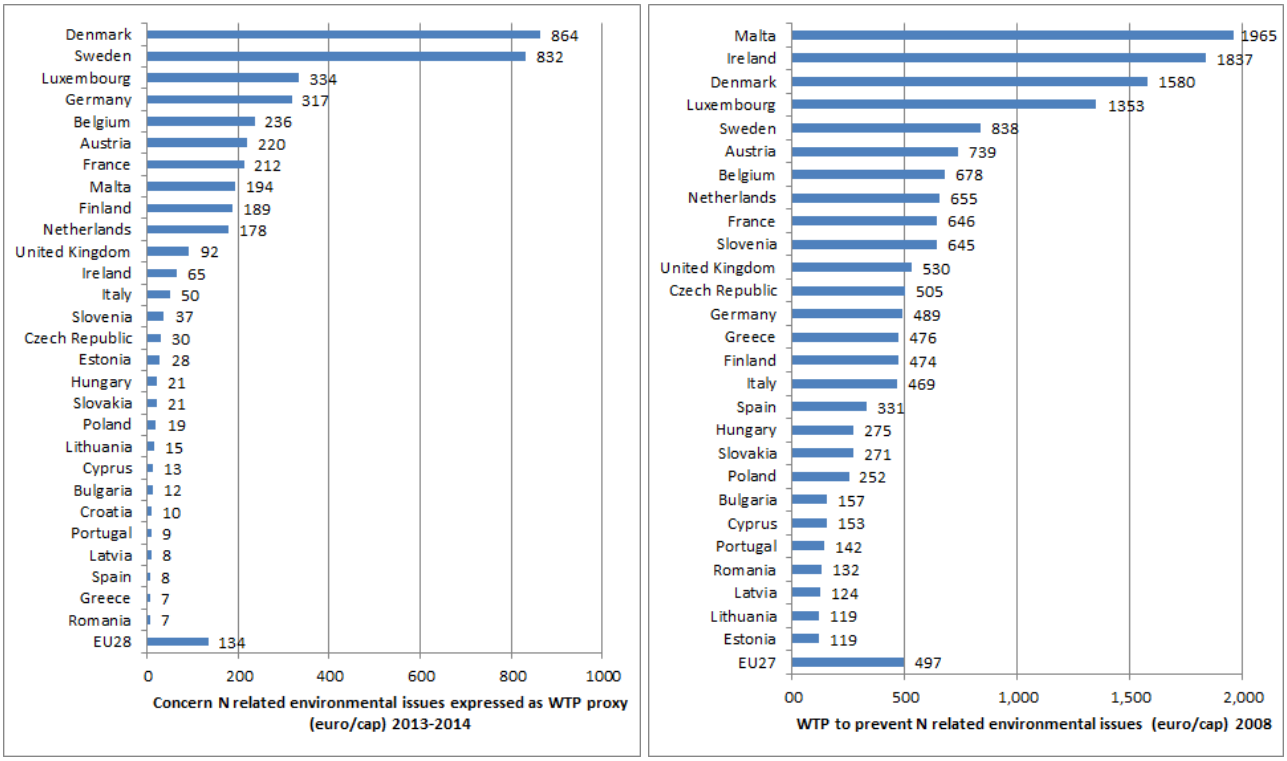

Figure 4. Average monetized WTP of Europeans to prevent or reduce nitrogen pollution in 2013 and 2014 based on the Eurobarometer and for 2008 as in the European Nitrogen Assessment based on single impact studies.

Different WTP values in countries both reflect differences in concern and GDP, as tax rates in the EU vary less than GDP. The absolute national WTP values (Figure 4) are lower than reported in ENA, almost by a factor of four. Correlation between both approaches is weak (R^2 *0.27*), but improves slightly when correcting national GDP for Purchase Power Parity (R^2 *0.33)*.

WTP in ENA may have been overestimated because of different contextual storylines of the various surveys underlying ENA. Further, WTP in ENA (Brink et al., 2011) was based on adding WTP values derived from single issue studies (eg. eutrophication of the Baltic; Athiainen et al., 2014) or single values (monetary value for of human life year (VOLY); 40,000 €). WTP based on the Eurobarometer puts public environmental concern in a broader social context . Included social issues are the current economic crisis in Europe, the refugee problem and unemployment (Figure 1). These issues particularly hit southern and eastern Europe and may compete with concerns for environment. Another reason for higher WTP in ENA is that they in part are stated rather than revealed WTP. Further, the new approach caps total WTP at the total tax receipt. A minor explanation for the lower N cost in 2013/2014 is the decrease of N emissions since 2008.

Conclusion

The perceived cost of damage from Nr externalities, based on the Eurobarometer survey, reflects a (revealed) preference to prevent or reduce the external damage associated with Nr through the use of tax revenues. This perceived cost in the EU27 in 2013-2014 is estimated at 73 billion €, which is more than three times lower than the ENA estimate of 245 billion € for 2008. This alternative estimate just outside the uncertainty range of the 2008 estimates of €75-485 billion per year. An advantage of the alternative approach is that it puts abatement of Nr pollution in a broader context of public concerns and bounds the potential WTP to a proportion of the total budget for public expenditure. However, assuming relative public concern to be equivalent to willingness to spend tax revenues to solve public issues can be questioned as the cost for solution of widely divergent issues, from immigration tot water and air quality, can be very different. Moreover, concerns for some issues can change very fast due to changed perceptions (Figure 1). So we need to critically review the theoretical relation between public concern, WTP and spending of tax revenues. Further, the alternative method proposed here does not allow derivation of WTP values to prevent specific impacts of N pollution on human health, ecosystems and climate stability. A possible next steps will be to integrate both approaches and use Eurobarometer results for interpolating and extrapolating WTP for specific impacts. Also, the alternative method can be used to extrapolate the social cost of Nr externalities to regions where Nr fluxes are available but which lack dedicated WTP surveys for Nr impacts on water and air quality.

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