WFD and the disproportionality principle
A national scale assessment for diffuse pollution mitigation in Scottish lochs

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Introduction

The European Water Framework Directive (WFD) aims to deliver good ecological status (GES), as defined by local regulators, to Europe’s waters. It calls for the use of economic tools and principles. It prescribes Programmes of Measures (PoMs) to fulfill pre-determined environmental objectives using the most cost-effective combination of measures. Cost-Effectiveness Analysis (CEA) is hence proposed as the general framework for prioritising mitigation measures. Importantly, however, the WFD allows ecological objectives to be derogated on the basis of disproportionality of costs of implementation relative to the social benefits that GES provides. This suggests the use of Cost-Benefit Analysis (CBA). These two decision making frameworks (CEA and CBA) have been widely accepted and adopted by most national guidelines across Europe. However, the way they should be joined up in the specific context of the WFD remains unresolved. This research explores a novel approach to linking CEA to proportionality analysis to serve the purposes of the WFD in practice at a national scale.

Methods

National scale benefit estimation
Marginal benefits of mitigation were derived from the choice experiment (CE) of Glenk et al. (2011). SEPA’s national water environment characterisation data for Scotland (SEPA, 2005a,b) were used to estimate improvements in the ecological status classification in WFD from baseline conditions by 2015. Respondents to a representative national scale survey (n=432) were asked to repeatedly choose from options that reflected future improvements in WFD ecological status category at a given cost (included to enable estimation of Willingness-to-Pay (WTP)), and a “no change/no cost” option. The baseline condition was 25% of Scottish loch area at GES, the maximum improvement level was 81%. Marginal benefit estimates were derived from choice model parameters, representing the additional benefits derived from a unit (1%) increase in national loch surface area under GES by 2015.

Cost-effectiveness analysis and marginal mitigation cost curve
Estimated P loads to lochs as a function of land use were based on a national scale database (‘screening tool’, SNIFER, 2007). Three marginal abatement cost curves were developed (arable, improved grassland, rough grazing) using information from Haygarth (2003). A fixed proportion of the land cover in each land use area was assumed to be affected by each measure in each catchment. Costs and effectiveness for mitigation of P export from sewage treatment works and septic tanks were based on Overarup (2005). We also added an optional “mop-up” term, enabling sufficient mitigation of P load to achieve GES on all lochs (£200/kg P/y using chemical treatment of Lochs to remove soluble P). The most cost-effective combination of measures in each catchment was estimated by solving for an objective function minimising costs to derive a target reduction in P load. To enable comparison with national scale marginal benefit estimates, the marginal cost curve was derived by sorting for cost-effective mitigation in relation to the respective contribution of the loch surface area in a catchment to the national total (in %).

Results

A simple definition of disproportionate costs can be derived from basic economic theory: resources should be deployed such that the marginal costs of pollution abatement for a catchment equate to marginal benefits of improvement. Abatement costs beyond this point can be considered as disproportionate. Figure 1 illustrates the principle for the case of national scale diffuse pollution (P) mitigation in Scottish lochs.

![Disproportionate Abatement](image)

Figure 1 Marginal costs and benefits of achieving loch-P mitigation: estimates at national scale. Any costs to the right of the point where the marginal cost curve cuts the marginal benefit curve, are not proportionate.

In the absence of “mop-up” mitigation (figure not shown), the marginal benefit line crossed the marginal cost curve at £1500/y/ha loch. At this point, 61.8% of loch area is mitigated, at a (proportionate) cost of £1.6 m/y. A further 0.2% of loch area could be mitigated, at a (disproportionate) cost of £0.5 m/y. Apart from other sources of uncertainty (upland P export coefficients, benefits of GES for individual lochs as opposed to national scale average, cost estimates for mitigation), the fraction of total loch area mitigated proportionally and the proportionate costs expended on this fraction are therefore sensitive to assumptions about “mop-up” costs and to the precision of marginal WTP estimates for improvements in the fraction of lochs at GES.

Conclusions

- The CEA/CBA framework described gives a basis for estimating proportionate costs for mitigation of P pollution of Scottish Lochs
- Using national scale benefit information, expenditure on the mitigation of P pollution in vulnerable loch catchments is found to be proportionate at least up to SEPA’s target compliance level of 67% of loch area under GES by 2015
- Further work on local P export coefficients and local valuation/benefits transfer in the context of WFD would be helpful to confirm this conclusion