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# Cost-effective abatement of pollution from agricultural sources classified in risk classes†

## Introduction

In the light of widespread uncertainty related to water pollution from diffuse agricultural sources, a recent trend has been to classify these diffuse sources in 'risk classes', according to their pollution potential. Financial assistance that is earmarked for supporting abatement activities is then allocated by giving priority to sources classified in 'high risk' classes. This research provides answers to the following questions: Is this optimal? Is this cost-effective? Is there a better way?

## What does risk classification really mean?

Define a stochastic variable $\theta_i$ that represents the pollution flux (phosphorus in this case) from a diffuse source, *i*. Risk classification is simply expressing the uncertainty about the pollution flux θ*i* from a given diffuse source in discrete groups of expected realisations (the first moment of the probability density function of $\theta_i$):

If $k \leq E(\theta_i) \leq l$ then source *i* is classified as high risk,
if $l \leq E(\theta_i) \leq m$ then source *i* is classified as medium risk,
if $m \leq E(\theta_i) \leq n$ then source *i* is classified as low risk.

Given this classification, funds to support abatement are allocated with an emphasis on 'high risk' class. Doing this, does not in any way guarantee a cost-effective phosphorus pollution reduction. Cost-effectiveness means that allocation of funds should be done so that the greatest reduction of phosphorus pollution is achieved per dollar, or euro spent. This can be achieved if an economic optimisation is followed (described in the paper).

## Method and data

The cost-effectiveness of two allocation mechanisms—risk classification, and economic optimisation — was simulated using data provided by the Sydney Catchment Authority. The Authority faces serious water quality problems due to phosphorus pollution from diffuse agricultural sources. Annual budget was allocated in every year of the specified planning horizon, first according to risk classification mechanism, and then according to principles of economic optimisation by running a dynamic chance-constrained programming model.

## Simulated scenarios

| Scenario | Method of allocation | Budget ($) | Minimum expenditure in an area ($) |
|---|---|---|---|
| 1 | Optimisation | Unconstrained | 0 |
| 2 | Optimisation | Unconstrained | 1000 |
| 3 | Optimisation | 2 million | 1000 |
| 4 | Risk classification | 2 million | 1000 |
| 5 | Risk classification | 3 million | 1000 |

## Results and Conclusions

The results indicate that allocating a fixed budget by prioritising funding towards 'higher-risk' classes is less likely to meet the set pollution standard, and in the same time it is more costly in terms of discounted streams of expenditure on abatement measured as a net present value (NPV) over the planning horizon, in comparison to the optimisation scenarios.

| Optimisation Scenarios | P standard met (Yes / No) | Cost expended (NPV $) | Cost/kg P removed (NPV $) |
|---|---|---|---|
| 1 | Yes | 3,477,722 | 4,860 |
| 2 | Yes | 3,762,674 | 5,235 |
| 3 | Yes | 3,864,468 | 5,183 |
| **Risk classification scenarios** | | | |
| 4 | No | 7,248,632 | 11,012 |
| 5 | No | 10,872,948 | 14,347 |

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