CRC for
Water Sensitive Cities

Cost-effective Strategies to Reduce Nitrogen and Phosphorus Emissions in an Urban River Catchment

Industry Note
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Emissions of nitrogen (N) and phosphorus (P) from various sources into urban waterways cause algal blooms and generally degrade delicate aquatic ecosystems. Perth's Canning River is a prime example, and yet protecting it from these emissions has been a policy challenge for the last 50 years. A mix of incentives and regulation is needed to improve the cost effectiveness of abatement actions.

Introduction

The quality of surface and groundwater in many urban and rural catchments is reduced due to elevated levels of nutrients coming from non-point source pollution (NPSP) sources including farms, gardens and turf grass, as well as from point sources such as septic tanks. The challenge to reduce emissions is managing multiple agents such as farms, local governments, and households. This research proposes the combination of tools such as; behaviour change, new technologies, regulatory instruments. This study investigated abatement actions for the Canning Catchment with an approach that can be widely applied to other catchments and can be adapted as new technologies for nutrient abatement become available.

Study area

The Canning Catchment, a sub-catchment of the Swan Canning Catchment and a source of pollutants flowing into the lower Swan Canning Estuary (Figure 1). It was selected as a case study to explore the cost-effectiveness of options for managing nutrient emissions in a mixed peri-urban and urban catchment. The catchment comprises upstream sub-catchments where the dominant land use is native vegetation, the middle reach sub-catchments around the rapidly urbanizing suburb of Armadale, and the lower reach sub-catchments characterised by high rates of urbanisation and established urban land-use patterns.

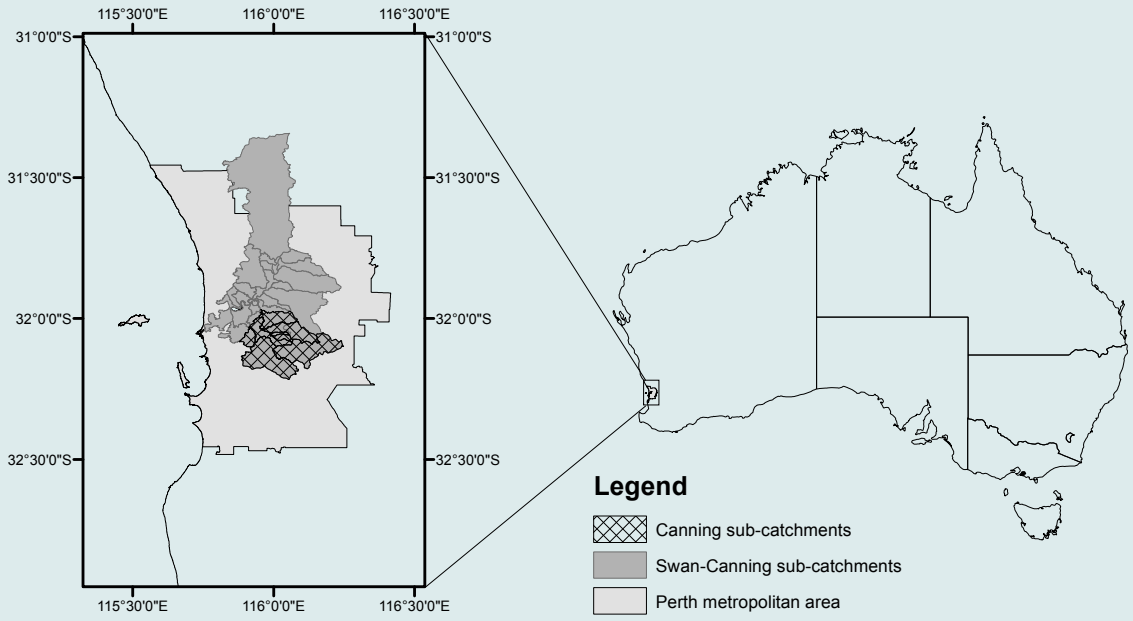

Figure 1: Swan and Canning estuaries

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Modelling Emissions Reduction

The economic analysis in this study applies a catchment wide approach to nutrient pollution in the Canning River and Estuary. A cost-effectiveness analysis assumes a single regulator who aims to minimize the cost of achieving a given level of nutrient reduction. The analysis is across sub-catchments and for a long term planning horizon. The actions considered, by sub-catchments and over time are a feasible set of actions that have either already been applied (education of households, soil amendment, removal of septic tanks and investment in constructed wetlands) or could be considered if legislation was introduced (banning standard fertilizers) further to the restrictions introduced in 2010 on the phosphorus content of domestic fertilizers.

What is the Cost Effective Set of Emission Abatement Measures?

The results indicate that it is more difficult to achieve the targeted reduction of N than it is P. In fact even with the maximum abatement capacities of the set of options currently applied, it was not possible to reach the targeted reduction in N emissions. If an additional policy of banning standard fertiliser was introduced only then the achieved reduction for N would be close to target (Figure 2). Infill of septic tanks and constructed wetlands were policies that were applied at most levels of abatement targets. The cost-effectiveness of constructed wetlands was partly due to an assumption that their net-cost was reduced by a significant amenity value captured by local residents. The total net cost of reducing emissions to the target level of P and achievable level of N in perpetuity was a present value of $616 million (at a 5% discount rate). Estimates from a non-market valuation of ecological values for the Swan-Canning imply that this expenditure spread over a 20 year period could be justified. Figure 2 shows abatement cost curves over a long time horizon for nitrogen under three scenarios. Scenarios 1 and 2 adjust costs downwards by the amenity benefits of constructed wetlands while Scenario 3 just gives the costs to the government and community. Scenario 2 is the least cost at all abatements levels and shows how budget costs can be reduced when a fertilizer product is banned by legislation.

How to Make Emission Abatement Work?

The challenge is to find a policy design and legislative framework that minimizes the cost of achieving the abatement targets. Currently what is lacking is a clear system of incentives for economic agents to abate nutrients to a level that gives long term protection to the Canning River, at least cost. Alternative approaches that push more costs onto polluters might be considered. It is noted that current policies provide weak or no incentives for economic agents (households, farms, sports clubs and LGAs) to take additional abatement actions. If incentive based schemes, such as subsidies for replacing grass verges with native plants, were introduced along with tighter regulation on the use of standard fertilizers then the government cost of achieving abatement targets could be reduced substantially making the long term management of the Canning less dependent on public funds and therefore more ambitious abatement targets could be achievable within current budgets.

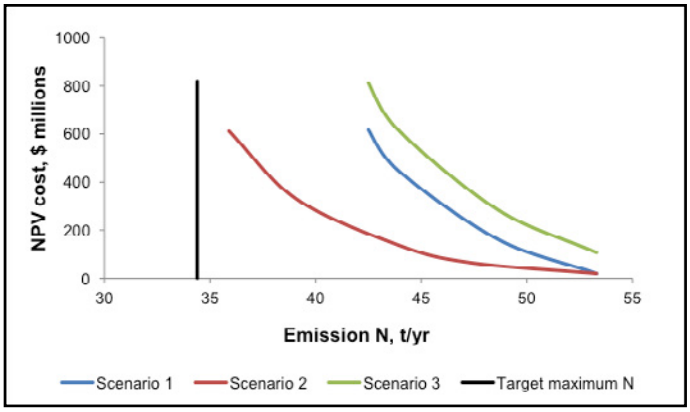

Figure 2: Nitrogen abatement cost curves under three modelling scenarios. The curves show the cost of achieving certain emission targets. The vertical line is nitrogen emission target. Scenario 1 is the base case, Scenario 2 assumes banning standard fertilisers, and Scenario 3 assumes that costs are not offset by amenity value of constructed wetlands.

About the research & further reading

Polyakov, M, White, B. and Fan Zhang (2017) Cost-effective Strategies to Reduce Nitrogen and Phosphorus Emissions in an Urban River Catchment. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities. https://watersensitivecities.org.au/content/cost-effective-strategies-reduce-nitrogen-phosphorus-emissions-urban-river-catchment/

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