WATER POLLUTION

What does water pollution cost? Towards a holistic understanding

Wesley Evans from the Institute of Natural Resources unpacks the cost of water quality deterioration increasingly being faced by South African river systems.

Freshwater systems are one of the most threatened ecosystems on the planet. In almost every populated catchment on the planet, humans have to a greater or lesser degree increased the discharge of pollution, altered flow regimes, degraded catchments and/or modified the morphology of rivers (Vörösmarty ***et al***., 2010). Surface water quality (WQ) deterioration has become a serious concern worldwide primarily due to increased pollution.

It is estimated that, globally, over 80% of urban and industrial wastewater is released to freshwater systems without adequate treatment (IPBES 2019). The increasing pressure on freshwater ecosystems is threatening the use of water resources for human needs and has resulted in a loss of biodiversity and ecological functioning of these systems. At the time of writing, Vörösmarty ***et al***., (2010) estimated that 65% of global river discharge, and the aquatic habitats supported by river flows, were classified as moderately to highly threatened.

Effects of water pollution can be varied and widespread. It poses a risk to food and water security and the economy and it has the potential to impact human health, tourism, property values, commercial fishing, recreational businesses and many other sectors that depend on clean water. Water pollution also cultivates inequality as it disproportionately affects the poor, women and children. Given the wide-ranging risks associated with it, it is unsurprising that the pollution and degradation of freshwater systems incurs significant social and environmental costs.

Linking such costs (whether they are economic, ecological or social) to deteriorating water quality provides a clearer perspective on the value of water quality and pollution management for policymakers and the public. Among other stakeholders, the Department of Water and Sanitation (DWS) and Catchment Management Agencies (CMAs) specifically need to have a good understanding of the costs of deteriorating water quality as they are responsible for water pricing and protection. Theoretically, accurate costing of water should allow DWS and CMAs to recoup the true cost of water from its users.

While it is not possible to place a monetary value on all the impacts, and their significance to different people, of deteriorating water quality, the framework suggests methods that can be applied towards a better, more holistic understanding of the economics of water pollution management.

However, answering the question 'What does water pollution cost' is no simple task. Some costs are relatively obvious. As an example, consider the financial cost associated with treating water to a required standard. A study in the USA found that phosphorous and nitrogen pollution costs the US government and citizens at least US$4.3 billion annually, due to increased water treatment requirements (KSU, 2008).

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There are also many less obvious costs incurred by water users and broader society, such as impacts on ecosystem services. Freshwater ecosystems provide a variety of services, many of which are overlooked and undervalued. These services include water purification and food provision. Most financial estimates of ecosystem services focus on those with market value, rather than those with non-market value such as regulating services and cultural services. Therefore, costs related to the loss of the harder to measure regulating and cultural ecosystem services are often undocumented, such as the loss of the recreational amenity value associated with rivers. These undocumented costs are often unknowingly passed onto the public.

The costs of deteriorating water quality vary greatly based on spatial scales, geographies, intended use, quantity and nature of pollutants and the affected parties. The range and context specificity of the impacts of deteriorating water quality make it challenging to gain a holistic perspective of the full cost of WQ deterioration in different settings and at different scales.

As a first step towards characterising the costs of deteriorating

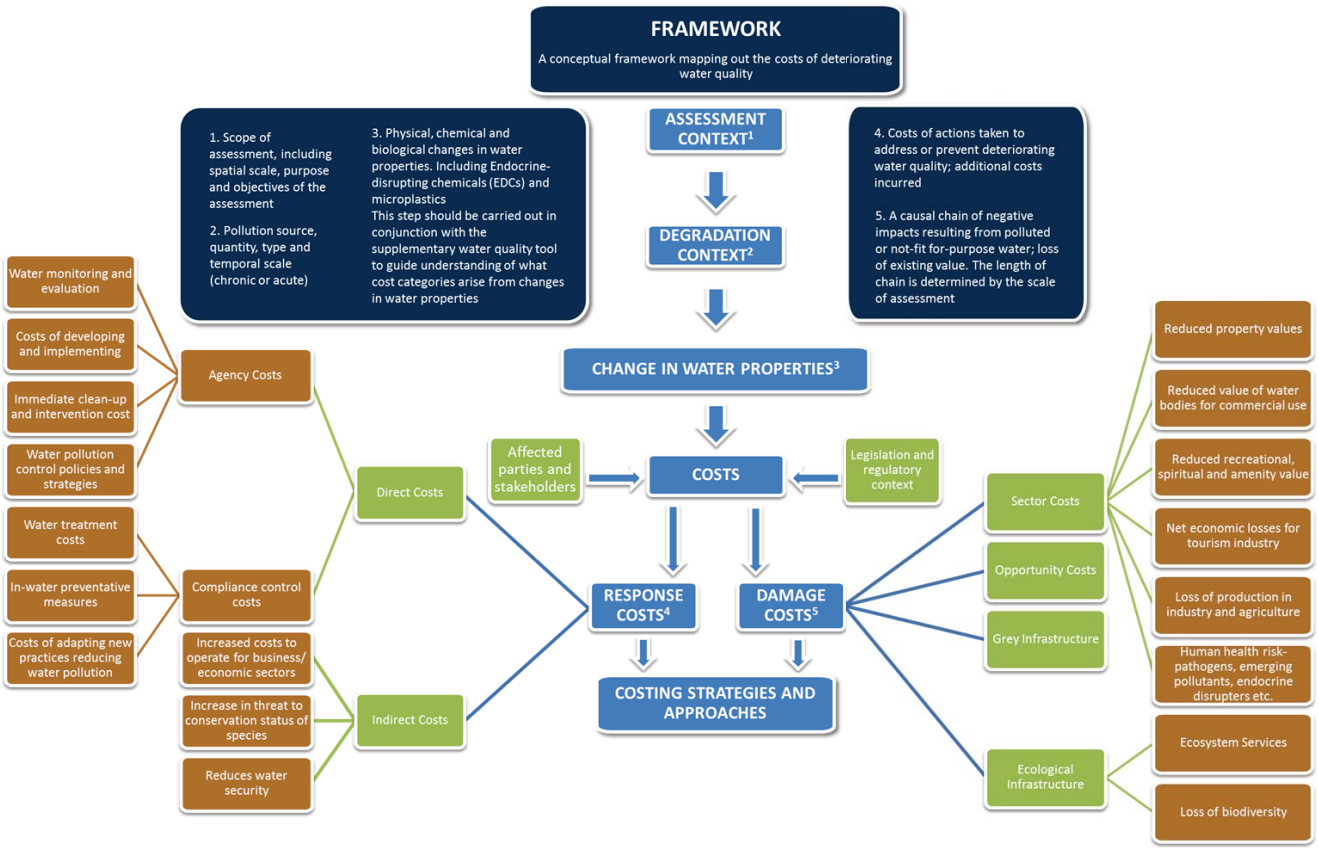

Figure 1: Conceptual framework for the costing of deteriorating water quality

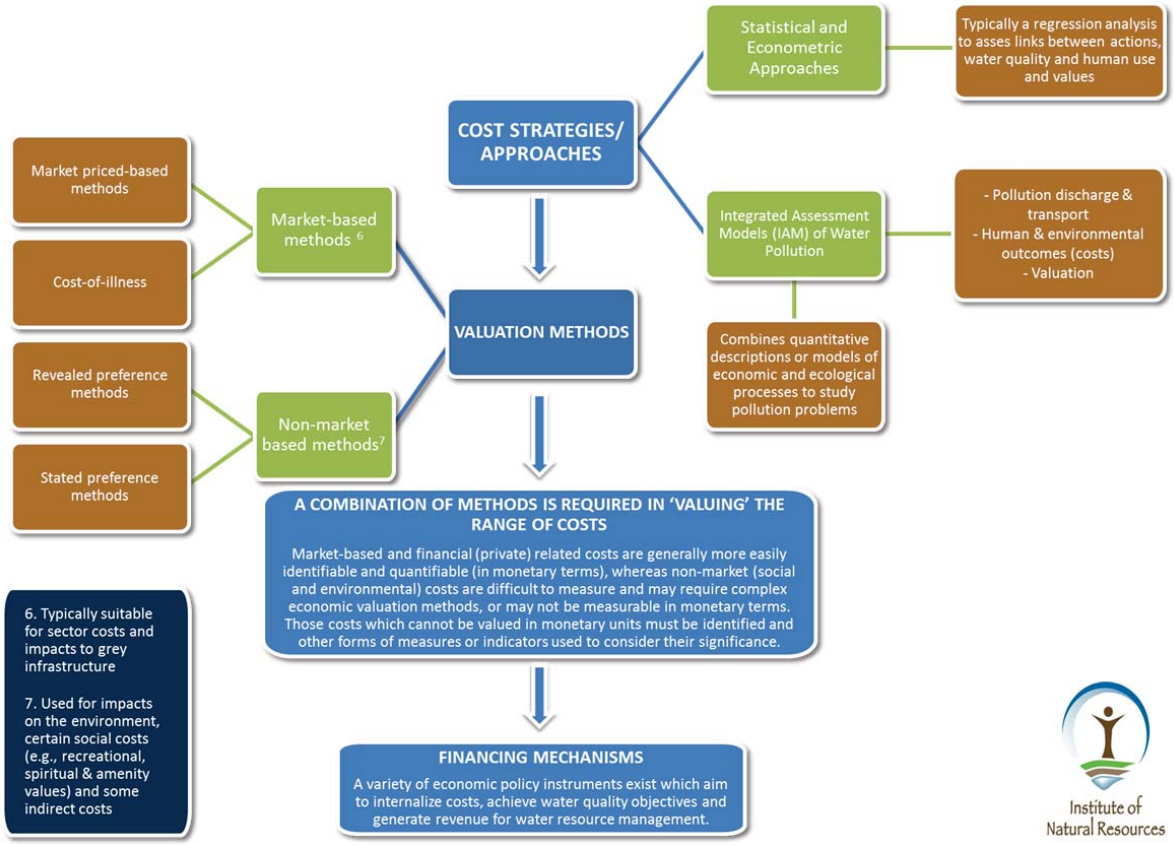

Figure 2: Conceptual framework for the costing of deteriorating water quality (continued)

water quality, a recent study (**Project no. K5/2948**) funded by the Water Research Commission under the research management of Dr Eunice Ubomba-Jaswa, and led by a team (Leo Quayle, Wesley Evans, Michelle Browne) from the Institute of Natural Resources NPC, aimed to develop a conceptual framework mapping out a range of potential costs associated with deteriorating water quality. Importantly, this conceptual framework did not attempt to quantify costs, but instead aimed to guide the user to consider a range of potential costs linked to deteriorating water quality.

The framework is not exhaustive, but highlights the range of potential cost categories and 'maps' these out in a structured manner. Expressing these costs in terms of their economic value can further contribute to identifying appropriate strategies and funding models for water quality management.

While it is not possible to place a monetary value on all the impacts, and their significance to different people, of deteriorating water quality, the framework suggests methods that can be applied towards a better, more holistic understanding of the economics of water pollution management. The framework is intended as a starting point towards implementation and further development into a comprehensive water quality costing model.

The conceptual framework was initially developed based on a thorough review of a variety of literature which provided a foundational understanding of water quality issues and related costs. In addition, a case study was used to inform the conceptual framework. In August 2019, several tons of caustic soda and vegetable oil were spilled into the Baynespruit and uMsunduzi Rivers in KwaZulu-Natal. The spill, which occurred at a Pietermaritzburg edible oil manufacturer, was the result of an accident on site. Interviews were carried out with several interested and affected parties to uncover some of the hidden social and economic costs.

The draft framework was then presented to a variety of water sector professionals, governance officials and researchers in a workshop setting where it was validated and amendments were made. A number of foundational principles were also developed out of the workshop to support the use of the conceptual framework, guiding the user towards a more holistic set of cost-categories for deteriorating water quality. The four key principles are:

a) In the context of this framework, 'water quality' describes the biological, chemical and physical characteristics of water as defined by the National Water Act.

b) Costs of deteriorating water quality are related to the intended use of the water; water 'use' includes human needs (water user requirements) and the protection of aquatic ecosystems.

c) Potential / projected climate change impacts on water supply, water quality and water uses / demands should be considered in identifying and assessing the costs of deteriorating water quality.

d) The condition of the water resource prior to the pollution

discharge must be considered. In assessing the costs associated with a point source discharge incident, the condition of the site prior to the incident is the point of reference (rather than the desired state). However, the desired state and cumulative impacts need to be borne in mind in considering the overall social costs of deteriorating water quality.

The conceptual framework, illustrated in Figure 1 and Figure 2, is to be used sequentially, starting with "Assessment Context", where the user considers the scope of assessment, including spatial scale, purpose and objectives of the assessment.

A water quality analysis / assessment tool was also developed to be used in conjunction with the conceptual framework. The tool links exceedances of established thresholds in water quality properties with potential consequences. The Microsoft Excel-based tool requires the input of water quality data which is compared to water quality guidelines outlined by the Department of Water and Sanitation. The user is then provided with potential consequences associated with the exceedance of the guideline levels. For more information on the project and the tool, go to the Water Quality Costing Framework Project page on the Ecosystems Theme page of INR website (https://www.inr.org.za/focus-areas/ecosystems-2).

References

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