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TECHNICAL BRIEF

Catchment Management

Unpacking the water quality use allocation challenge

Water Quality Use Allocation

The challenge of water quality use allocation

Water allocation principles and plans are prime components of catchment management strategies, as required by the National Water Act (NWA). Allocation of water for use does not only apply to water quantity. As innovatively defined in the NWA, **'water use'** includes, among others, the use of the water resource to dispose of waste.

Because disposal of waste reduces water quality, this practice may be considered an example of **'water quality use'**, as opposed to water quantity use. However, like water quantity use, water quality use must be taken into consideration when developing water allocation principles and plans.

What makes water quality use allocation an enormously challenging task is that it has to take account of both point and non-point sources of constituents that impact on water quality. These sources, in conjunction with complex processes of constituent transport, determine the constituent loads in a catchment.

In quantifying these, one has to contend with relatively poor databases relating to water quality as well as the need to take into consideration various policies and regulations that have a bearing on water quality use allocation in South Africa. Because of this complexity, a focused research effort has been necessary to unpack and fully understand the conceptual and technical components of the water quality use allocation challenge.

The research effort included seeking guidance from the international literature on best practices relating to water quality use allocation. It further followed a 'learning-by-doing' approach, in developing and applying a conceptual framework for water quality use allocation practice in a stressed catchment having water quality concerns – the Berg River catchment being a good example.

In opting to work there, it was possible also to take advantage of, and considerably improve on, a pre-existing water quality information system (WQIS) developed for the catchment during the course of earlier research.

International guidance

Common elements emerging from the international best-practice review included:

- Water quality standards or water quality management objectives generally serve as the departure point for allocating constituent loads.
- The identification of impaired rivers commonly acts as the catalyst for specific actions, with the level of impairment dictating the level of effort and resources needed to restore the impaired water bodies.
- Water quality targets are often set as end-of-catchment targets, with total load allocations then being determined to meet those targets without necessarily apportioning the loads to specific contributors.
- In setting end-of-catchment targets, upstream/downstream dependencies come into play, since meeting downstream targets often calls for restriction of certain upstream activities.
- Target-setting requires models of differing complexity: coarse-scale models for end-of-catchment targets; and finer-scale, more detailed models for exploring results of within-catchment management actions.

Conceptual framework

The conceptual framework for water quality use allocation comprises the policies and regulations that govern water quality management in South Africa as well as the technical guidelines and tools that have been developed to support the practice of water quality use allocation.

The regulatory and policy environment for water quality use allocation

Decisions about water allocation, including allocation for the purpose of discharging waste, are rooted in the process of water resources management prescribed in the NWA and various policies and regulations that give effect to this process. Statutory water resources management starts with the development of a catchment management strategy which includes a water quality component. This component dictates the goals for water quality management in a catchment.

Key elements are the classification of each significant resource and, in accordance with the class assigned to the resource, the setting of resource quality objectives (RQOs) from which ***resource water quality objectives*** (RWQOs) are derived, taking into account the requirements of users and use of the resource to dispose of water containing waste. The RWQSs form the foundation for determining ***source management objectives*** (SMOs) and for deciding how waste sources will be managed across a water management area. Formulation of a water quality use allocation plan is a major component of this process.

Technical guidelines and support for water quality use allocation

The guidelines developed address the following aspects:

Water quality variables: Water quality use allocation and the tools designed to support the process should focus on the water quality variables of concern.

Technical support tools: The degree of technical support for water quality use allocation is dependent on the degree of water quality stress in the catchment, namely:

- *Water-quality unstressed:* Simple tools can be used to support the water quality use allocation process. These could include an inventory of the sources and their loads, as well as simple mass balance models with conservative assumptions for allocating loads to individual sources in support of the meeting of source management and resource water-quality objectives.

- *Potentially water-quality stressed:* Technical support required would be more complex, with the need to consider upstream/downstream dependencies and impacts. The appropriate modelling scales are spatial scales that are coarse, no smaller than quaternary catchment scale, and temporal scales that are equivalent to those of water resource planning models commonly used in South Africa. Loads from point as well as non-point sources need to be accommodated and models should be calibrated against observed water quality data.

- *Water-quality stressed:* Two tiers of support are required:
  - *First-tier support*: a simple coarse-scale catchment water quality model, such as that described above.
  - *Second-tier support:* a finer-scale model, set up for complex and problematic sub-catchments or river reaches wherever disaggregation of loads to individual users, or site-specific estimates of the water quality impacts, are required. The ACRU ***salinity*** model was the model of choice for the research undertaken in the Berg River catchment.

Link to water resource planning tools: The coarser scale models should be compatible with water resource planning models, in terms of both spatial and temporal scales.

Modelling practices: Modelling and data preparation procedures should be consistent with good modelling practices. A considerable amount of research effort was expended in configuring and adapting the ACRU ***salinity*** model for use in the Berg River catchment, after which it was calibrated to adequately simulate the patterns of salinity production and mobilisation observed in the highly saline catchments of the Berg River basin.

Scenario development and evaluation: The water quality allocation support tools should facilitate the rapid development and evaluation of waste load allocation scenarios.

Model outputs & stakeholder communication: While recognising the technical complexity of tools needed to support water quality use allocation, tools should nevertheless be selected according to their ability to produce user-friendly output that the water quality modeller can interpret and that can also be used in interacting with institutional stakeholders.

Recommendations

- Testing the application of the conceptual framework for water quality use allocation has yet to be completed and should proceed across the full range of anticipated scenarios.
- There is a need for a simple, catchment-scale model that can simulate both conservative and non-conservative constituents (nutrients and microbes included) and be used for the first tier of water quality use allocations.
- A more mechanistic module for salinity generation and mobilisation should be incorporated into the ACRU s***alinity*** model to facilitate use of measurable salinity-related parameters specific to the natural geology and land-use, thereby reducing dependence on parameter calibration.
- There is a need to investigate which of a wide range of possible methods for allocating constituent loads to individual dischargers is appropriate in South Africa, given the primary objectives of equity and sustainability embedded in the National Water Act.
- Uncertainty analysis should be incorporated into the water use allocation process, given the current inadequacies in available data and the errors inherent in model computations.

Further reading:

- *Improvements to the ACRU Salinity Model and Upgrading of the Berg River Water Quality Information System* (Report No: 1301/1/07)
- *Technical Instruments to Support Water Quality Use Allocation* (Report No: 1301/2/07)

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