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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Eutrophication

Managing eutrophication in South African dams

The Water Research Commission (WRC) has completed an evaluation of the total maximum daily (pollutant) load (TMDL) approach for managing eutrophication in South African dams.

Background

TMDLs are, firstly, a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and, secondly, an allocation of that amount to the pollutant's individual sources.

The TMDL protocol was developed in the USA, and can be applied to any pollutant as well as in both lentic and lotic waters.

TMDLs are intended to be a binding, legal tool to control the discharge of pollutants by source. They are set at various temporal frequencies that depend both on the nature of the impact they cause, through weekly, monthly or seasonally, to annually.

Roodeplaat Dam, Gauteng, in November 2014, illustrating the need for pollutant control in South Africa.

The setting of the TMDL is linked to a specific threshold or impact response in the receiving waterbody, ideally linked to a biological criterion. The threshold or impact is defined by the loss of beneficial or designated use that the pollutant(s) impart when specified levels are exceeded.

Annual TMDLs for phosphorous loadings to certain South African dams have been provisionally estimated. This latest WRC project undertook a feasibility evaluation of the protocol in order to determine:

a) Those aspects thereof that can be used and supported by existing skills and information in South Africa, and
b) The immediate skills and information needs that require development in order to effectively use the protocol or a variant thereof.

The project focused centrally on the question: Can a TMDL be formulated in South Africa using only existing data and tools?

Main results

The approach adopted in this project indicates that the answer to the above question is a resounding but qualified 'yes' and that the formulation of a Rapid TMDL, disaggregated over a range of temporal scales, is achievable using existing data, data processing tools and information.

The approach followed has supported the determination and cross-checking of loads via three pathways. Central to this process is the use of the FLUX32 software, a readily obtainable, easy-to-use and versatile tool for the conversion of flow and concentration data into parameter loads.

The generation of loads, both point and non-point, was characterised as highly seasonal, with as much as 80% of

the total annual load generated during the wet season from April to September. Depending on the degree of resolution of the catchment audit, other point- and non-point sources can be added to the loading profile with ease.

For more complex TMDLs, additional hydrological, hydraulic and other information will be needed. The formulation of such TMDLs will likely be more costly as they will require input from, for example, hydrologist engineers.

A general limitation in the Department of Water and Sanitation (DWS) database is that water quality data are based at best on 14-day intervals. Accordingly, relatively long chronological sets of data are required in order for a program such as FLUX32 to accurately infill missing data – especially where the pollutant in question is not strictly correlated with flow. Analysis of several datasets from different systems is required to elucidate the strength of the relationships between flow and concentration.

The need for the development of South Africa-specific runoff coefficients for nutrients should be predicated on the findings of more TMDLs developed using the simple methodology employed in this project. It may well be the case that generic coefficients, already developed for various landuse types in other countries, may suffice.

The examination of a larger suite of case studies, in which wastewater effluents play a varying role in the total loading, should indicate the amplitude of non-point source runoff from, for example, areas of urban development.

This project assessed two scenarios, the first in which wastewater (point source) loading was profoundly dominant, and the second in which background loading was the primary nutrient source but with wastewater effluents already at the limit beyond which the receiving waterbody might be more seriously impacted. In both cases, the simple expedient of imposing the South African 1 mg/ℓ Special Phosphate Standard would obviate the need for the imposition of a TMDL and provide both relief from extant pollution excesses and time to more closely examine and audit non-point pollution sources.

Rapid TMDLs can be applied to the determination of a variety of problems, ranging from salinity and suspended solids, the maintenance of dissolved oxygen levels and other physic-chemical issues through to impacts of specific toxicants.

Conclusions

While a suite of various TMDL-related models and tools were identified during this project, it was apparent that, without exception, the use of these in a South African context would require further development, preparation of supportive databases, benchmarking and relatively-wide spatial testing across a variety of catchments in order to dovetail these tools with locally-relevant information.

It is anticipated that, should and when the need for higher confidence TMDLs become a reality in South Africa, such supportive instruments would be developed on a catchment specific basis, for example, for sections of the Vaal or Crocodile Rivers.

A more immediate and readily achievable goal would be to compare loads at gauged points with the upstream landuse characteristics, for example, downstream of mining activities, large urban conurbations as well as for sections of largely undeveloped catchments. In this manner, the validity of export coefficients can be determined using already existing data and information in a rapid and semi-automated spatial analysis process.

Further reading:
To order the report, ***A feasibility evaluation of the total maximum daily (pollutant) load (TMDL) approach for managing eutrophication in South African dams*** (**Report No. 2245/1/15**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.