The development of water quality methods within ecological Reserve assessments, and links to environmental flows

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Abstract

In the South African National Water Act (NWA, No 36 of 1998), the ecological Reserve is defined as the quality and quantity of water required to ensure appropriate protection of water resources, so as to secure ecologically sustainable development and use. Aquatic ecosystems are recognised as the core location of water resources, and although considerable progress has been made in developing methods for quantifying environmental flow requirements, this paper describes and discusses the first agreed method for quantifying environmental water quality requirements in an ecological Reserve assessment. Integration of flow and water quality is emphasised, and is based on the philosophy that environmental flows should be motivated to provide ecologically important flow-related habitat, or geomorphological function, but should not be motivated to solve water quality problems by dilution. Water quality is multivariate, and not all variables can be considered in an ecological Reserve assessment, but core water quality variables include: system variables (salts, dissolved oxygen, turbidity, temperature), nutrients (phosphate, nitrite, nitrate) and toxic substances (those listed in the South African Water Quality Guidelines for Aquatic Ecosystems, including toxic metal ions, toxic organic substances, and/or substances from a chemical inventory of an effluent or discharge). In addition, biological indicator data (e.g. SASS data), chlorophyll-*a* (e.g. phytoplankton and periphyton data) and toxicity test data may be used. For each variable, a concentration range or response is linked to a class within a water resource classification system, where classes range from minimally to severely modified. There are five main stages in the environmental water quality method:

- Initiate study and determine scope of assessment.
- Delineate water quality sub-units.
- Select sites and collect data and information.
- Determine benchmarks, including generic boundary values (literature-based concentrations related to classes); the unimpacted, natural or reference condition; the present ecological state; and the contribution of water quality to the overall ecosystem importance and sensitivity.
- Provide quantified and qualitative water quality objectives for each ecosystem health class, and each variable in each resource unit. These steps are integrated with environmental flow assessment procedures. After environmental flows have been recommended to achieve a selected level of protection (class), flow-concentration relationships are modelled, and the likely water quality consequences of modified flows are provided to resource managers, who then decide on whether to allocate water for dilution and/or to address the pollution problem directly using source controls.

Keywords: environmental water quality, environmental flow requirements, ecological Reserve, water resource management

Introduction

The ecological Reserve

The two founding principles of the South African National Water Act (No. 36 of 1998) (NWA) are "sustainability" and "equity" (NWA, 1(1)(xviii)(b)). These principles are supported by acknowledging that the water cycle is an integrated process and should be managed as such. Particular attention should be paid to integration between water quality and quantity; ground- and surface water; and between rivers, impoundments, wetlands and estuaries. In the NWA there are only two rights to water:

- Water for drinking, cooking and hygiene
- Water for sustainable ecosystems.

All other water (for industry, agriculture, domestic use and waste disposal) is allocated to water resource users by licence or general authorisation. The two water rights are provided for by the *Reserve,* comprising the basic human needs Reserve and the ecological Reserve, and this paper deals only with the latter.

Environmental goods, services and classification

In any developing country, the optimal use of natural resources for sustainable economic activity is essential (Howarth and Farber, 2002). It is therefore necessary to provide people with choices, and information about the goods and services offered by aquatic ecosystems (Palmer et al., 2002; 2004). The NWA provides for a water resource classification system, and a preliminary classification is being used in ecological Reserve determinations (Jooste and Rossouw, 2002; DWAF, 2004; Hughes, 2004). The classification system aims to optimise sustainable water resource use, by providing an organised basis for identifying and selecting "ecological health", and for setting descriptive and quantified resource quality objectives. Each class can be

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