Delineation of river types for rivers of Mpumalanga, South Africa: establishing a spatial framework for selection of reference sites

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Executive Summary

The implementation design phase of the National Aquatic Ecosystem Biomonitoring Programme (NAEBP) was initiated in August 1997. This programme, subsequently renamed the River Health Programme (RHP), consists of four portfolios each focusing on different aspects of river health such as communication (including stakeholder and grassroots communication); capacity building; research, development and funding; and training. In addition to these general portfolios, each province of South Africa is represented by a regional "champion" who is responsible for the initiation of biomonitoring within their province. The overall objective of the RHP is to develop the procedures and infrastructures for implementation and ongoing maintenance of biomonitoring on a national scale.

Within the research and development component, attention has focused on establishing a method for the derivation of ecological reference conditions. The need for such a reference condition or established benchmark with which monitoring information can be compared, has been expressed on several occasions by organisations involved in biomonitoring. Reference conditions enable the degree of degradation or deviation from natural conditions to be ascertained. South Africa has a varied climate (and hence hydrological type), geology (and hence water chemistry) and geomorphology (and hence channel type, substratum composition, erosion potential). Variation in these factors, both among and within rivers, together with natural biogeographic differences in the distribution of riverine biota, may potentially lead to biotic differences. Such differences need to be taken into account when implementing a national biomonitoring programme and deriving ecological reference conditions. The establishment of a spatial framework facilitates the identification of ecologically-similar river types, for which ecological reference conditions can be derived.

This report is the first in a series of reports that focuses on the establishment of such reference conditions. Specifically, this report outlines the development and application of a spatial framework, and consists of a series of Geographical Information System (GIS) maps designed to assist with the identification of river types and the selection of reference sites. The focus is on the rivers of Mpumalanga, or rather DWAF primary catchments B and X, hereafter referred to as Mpumalanga region. Although reference conditions are being derived for Mpumalanga rivers, the methodologies developed may subsequently be transferred to other provinces.

A three-tiered hierarchical spatial framework has been applied, wherein level 1 is represented by ecoregions, level 2 by sub-regions or geomorphological zones and level 3 by river types. Ecoregions (Kleynhans *et al*. 1998a) for the Mpumalanga region are a refinement of the bioregions identified at a spatial framework workshop held in January 1996 (Brown *et al.* 1996). A top-down approach was followed, in which physical variables such as physiography, climate, geology, soils and potential natural vegetation were used to classify rivers into ecoregions. The assumption in an ecoregion approach is that instream features such as the distribution of the biota or water chemistry are intimately linked to these variables in the order in which they

were placed in the classification hierarchy (Eekhout *et al.* 1997). Verification of the level 1 ecoregions will need to be undertaken once more detailed information has been collected. It will most likely be an iterative process, with ecoregions becoming more refined over time. This is, however, outside the scope of the current project, although information collected during this project will contribute to verification of the ecoregions.

Level 2 in the hierarchy is that of longitudinal sub-regional division or geomorphological zonation. The zonation of the main rivers and tributaries of Mpumalanga region has enabled the identification of the geomorphological zones present in each of the represented ecoregions, and some indication has been attained as to the proportional representation of each zone within each ecoregion. Extrapolation from zoned rivers to ones for which geomorphological zonation is not yet known may be possible using the terrain morphology cover of the ENPAT97 series (Van Riet *et al*. 1997). This has not been done at this stage as it was beyond the scope of the report. However, complications are likely to arise where smaller rivers are concerned.

Level 3 in the hierarchy is the identification of river types, which is performed using factors such as river size, hydrological type (ephemeral, seasonal or perennial), geomorphological characteristics (channel type, substratum composition) and other chemical and biological factors. Initially the level 3 analysis was planned as a desktop exercise using available literature and local knowledge. The exercise, however, proved to be problematic because of limited responses from local experts and scant information. The type of information needed for this level of the hierarchy, such as river size, geomorphological and biological characteristics, is best collected in the field. It is therefore suggested that river types be identified as part of subsequent ground-truthing or field verification phases. Components incorporated in the ecoregions such as terrain morphology, vegetation and geology may also prove useful contributors to the identification of river types.

The Mpumalanga region has been graphically characterised in terms of bioregions (Brown *et al.* 1996), ecoregions (Kleynhans *et al*. 1998a), terrain morphology (Van Riet *et al*. 1997), potential natural vegetation (Low and Rebelo 1996) and geology (Vegter 1995). Subsequently, each DWAF secondary catchment has been graphically characterised in terms of ecoregions, geomorphological zones or sub-regions (main rivers and tributaries only), terrain morphology, vegetation and geology. This information, together with tabulated summary information of all named rivers at 1:250 000 or 1:500 000 scale provides details related to each river's "parent" river, level 1 ecoregion, vegetation type, geological or lithostratigraphic type and hydrological type.

Ecoregions, which incorporate physiography, climate, geology, soils and potential natural vegetation, therefore, facilitate the grouping of rivers at level 1 of the hierarchy. Geomorphological zones divided rivers at level 2 of the hierarchy. GIS maps of terrain morphology, potential natural vegetation and geology, together with information of hydrological type, contribute to identification of level 3 river types. Finalised river typing will, however, need to be done later at the field verification stage. It is within this framework

that potential reference sites will be selected and used to derive the ecological reference conditions for identified river types in Mpumalanga.

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