

Setting the Thresholds of Potential Concern for river Geomorphological diversity, Terrestrialization and Sedimentation

Rationale

Rivers form an important and integral feature of any ecosystem and fulfil an even more important role in semi-arid and arid regions. These life-supporting drainage lines are inseparable from their terrestrial surroundings; indeed, they are closely interconnected with and part of their catchment areas. The flow regimes of rivers traversing the Kruger National Park (KNP) are expected to change in response to catchment developments outside and upstream of conservation areas (MacKenzie *et al.* 2003). The status of some rivers has already changed from perennial to seasonal. These changes can have serious consequences for both heterogeneity and diversity within riparian zones. It is partly changes outside river systems that affects and changes the latter, eg. poor land-use practices resulting in increased sediment loads of the rivers. In addition to this, changed flows with lowered sediment carrying capacity cause all of the KNP rivers to undergo dramatic geomorphological changes. Riparian zones in semi-arid areas are particularly sensitive to water level changes while declines in groundwater levels can alter the composition and structure of the riparian vegetation (Stromberg *et al.* 1996). Another factor that contributes to the sensitivity of riparian zones is the edge effect between aquatic and terrestrial habitats (Gregory *et al.* 1991; Naiman & Décamps 1997). In fact, one of the processes affecting this transitional zone is called terrestrialization whereby terrestrial elements invade the former zone as a result of desiccation.

While past research contributed to improved and clearer understanding of aquatic and terrestrial ecosystems, longer term information is required before one can create an even clearer picture of river dynamics. The importance of medium to long-term monitoring is emphasized by the 2000 flood which has caused considerable changes to the pre-flood river template. Understanding the effect of such large infrequent disturbances on river geomorphology and associated biota will have to be included in monitoring programmes if better understanding of the functional role of river systems is to be achieved. This will provide many answers to the questions currently raised under the Water in the Landscape Objective, of which the Awareness Objective forms an important part. This latter objective will have to receive serious attention if the crises in which our rivers find themselves are to be resolved before it is too late.

At this stage, three different approaches to monitoring river changes are considered. These include a physical approach in terms of geomorphological diversity, and two biological approaches, namely the Breonadia and Terrestrialization Model. Considering that changes in geomorphological parameters are

regarded as slow responders, the need arose to search for a quick responder which could act as an early indicator for system changes. For this purpose, the Breonadia Model was developed, followed later by the Terrestrialization Model. Thus, both models focus on the biotic component as a measure of change. These three different monitoring programmes should not be seen in isolation but rather as complementing each other in assessing geomorphological and flow changes.

References:

Gregory, S.V. Swanson, F.J., McKee, W.A. & Cummins, K.W. 1991. An ecosystem perspective of riparian zones. *BioScience* **41**: 540-551.

MacKenzie, J.A., Jacoby, D.L. & Rogers, K.H. 2003. Modelling of terrestrialization and technology transfer to enable management of Kruger National Park Rivers. WRC Report No. 1063/1/03, Pretoria.

Naiman, R.J. & Décamps, H. 1997. The ecology of interfaces: riparian zones. *Annual Review of Ecological Systematics* **28**: 621-658.

Stromberg, J.C., Tiller, R. & Richter, B.D. 1996. Effects of groundwater decline on riparian vegetation of semiarid regions: the San Pedro, Arizona. *Ecological Applications* **6**: 113-131.

TPC
<p>Geomorphological diversity¹</p> <ul style="list-style-type: none"> • In anastomosing reaches (channel types): <ul style="list-style-type: none"> – bedrock core bars must cover 50% or more of total area; – other 3 units (anastomosing bar, bedrock pavement and bedrock pool) must cover 2-10% of total area. • In pool-rapid channel types: <ul style="list-style-type: none"> – lateral and point bars must not cover > 20% of total area. – pools must cover 15% and more of total area. <p>Terrestrialization Model²</p> <ul style="list-style-type: none"> • T:R ratio of 0.2 for active feature • T:R ratio of 1 for seasonal feature • T:R ratio of 6 for ephemeral feature <p>Breonadia Model³</p> <ul style="list-style-type: none"> • $r^2 = 0.926$ (if < 0.926) (degree of fit/shape of curve). • x-coefficient = - 0.68 (if > -0.68) (steepness/slope of curve; relative densities of smaller size classes). • constant = 4.04 (if < 4.04) (average densities of all size classes).

¹ The percentage cover of key units within different channel types is used as a measure to monitor geomorphological changes.

² The ratio in the number of key terrestrial (2 species) versus riparian woody species (2 species) in three different geomorphic units (features) is used as a measure to indicate terrestrialization or the change from riparian to terrestrial species; an equal number of individuals of both categories would result in a T:R ratio of 1.

³ The TPC for loss of bedrock influence is described by a negative J-shaped population structure for all non-germinant established individuals of *Breonadia salicina*. Reduced establishment of smaller size class individuals would be indicated by a change in shape of the curve and or change of slope from steep to moderate; overall loss in population density will result in a shift of the whole curve downwards (lowering of interception point with Y-axis).