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Identifying national freshwater ecosystem priority areas

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INTRODUCTION

- In this project, we identified which rivers and wetlands in South Africa are most important to be maintained in, or restored to, a good ecological condition.
- The resulting maps feed seamlessly into both land and water resource planning, providing an opportunity for bridging gaps between these often separated sectors.

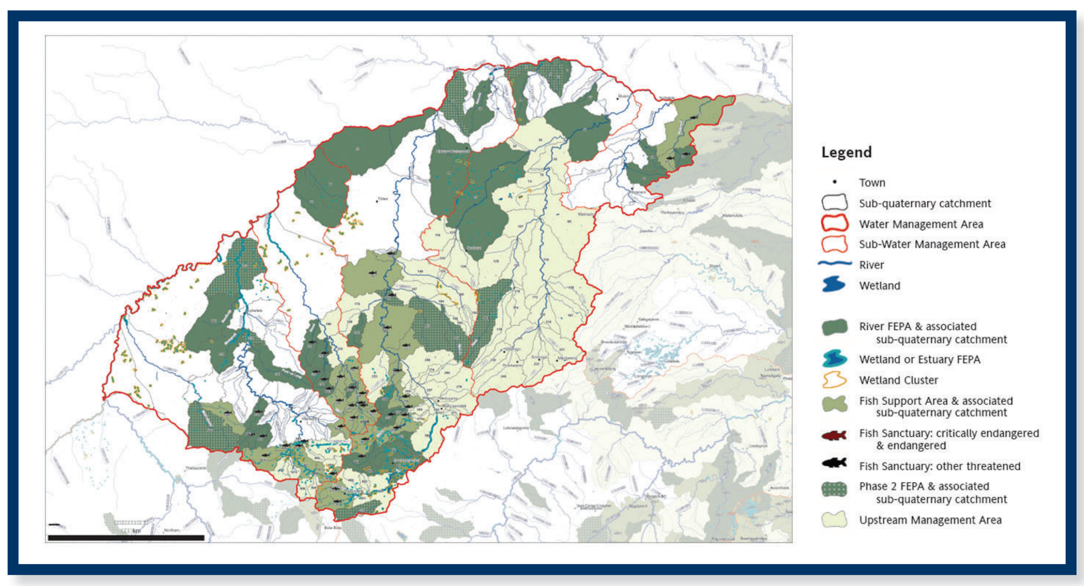

Figure 1: An example of a map of Freshwater Ecosystem Priority Areas. A map for each of South Africa's 19 Water Management Areas was developed for use in catchment management plans and integrated development plans. The categories on the map and associated management guidelines are explained in Nel et al. (2011) and Driver et al. (2011)

A SYSTEMATIC CONSERVATION PLANNING APPROACH FOR FRESHWATERS

- Explicit criteria for identifying priority areas were developed with stakeholders (**Table 1**).
- GIS data for each criterion were collated and used within a systematic conservation planning framework to identify priority rivers and wetlands (**Figure 2**).
- The Marxan conservation planning software (Possingham et al., 2000) was adapted to take into account longitudinal connectivity (Nel et al., 2009; Linke et al., 2011). Modelled hydrologically-linked catchments accounted for lateral connectivity.

Table 1: Criteria used for identifying priority areas

Objective	*Rationale*
1. Representation of river, wetland and estuarine ecosystem types	Ecosystem types share similar physical features (such as climate, flow, water chemistry and geomorphology) and, under natural conditions, are expected to share similar biological response potential and biogeographic differences. They can therefore be used as coarse-filter biodiversity surrogates, advancing freshwater conservation beyond species, to also conserve habitats and ecosystems on a systematic basis.
2. Representation of threatened freshwater species	Species serve as fine-filter biodiversity surrogates for conserving representative examples of freshwater biodiversity in South Africa. Threatened species should be particularly targeted, since limited options remain for their conservation. Data were only available for freshwater fish species, although it would be preferable to consider other freshwater taxa.
3. Representation of wetland clusters	These are clusters of wetlands embedded in a relatively natural landscape matrix through which dispersal between wetlands can occur (e.g. of frogs and invertebrates). The occurrence of threatened wetland-dependent frogs, insects and birds also guided selection of wetland clusters where choices existed.
4. Representation free-flowing rivers	Conserves representative coarse-scale processes such as natural flow regimes, erosion and sediment transport. There are very few free-flowing rivers left in South Africa, and several flagship free-flowing rivers have been identified as representative of free-flowing rivers remaining across the country.
5. High water yield areas per region	These are our 'water factories' for each primary catchment. Degradation of water supply areas can have exponentially negative impacts on ecological, social and economic well-being of the region.
6. Preferentially select rivers connected to priority estuaries	Incorporates persistence of estuaries in the long term.
7. Preferentially select ecosystem types from intact river systems	These systems are the ones that are most likely to support biodiversity features that persist in the long term. They also serve as reference sites.
8. Incorporate longitudinal, lateral and vertical connectivity into planning	The persistence of all but the most isolated priority areas depends fundamentally on management of connected systems.

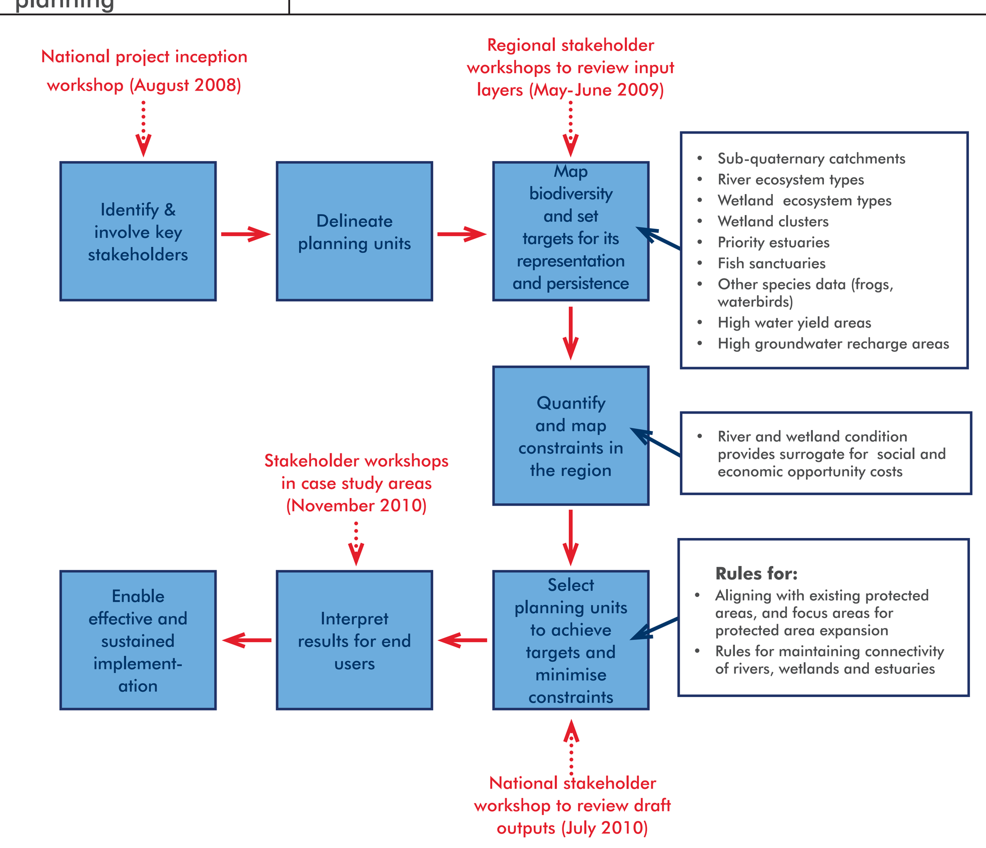

Figure 2: The conservation planning framework (blue boxes) that guided the approach, including data (white boxes) that were used and stakeholder workshops held

INPUT GIS LAYERS

- Input GIS layers were developed and reviewed by 250 regional experts (**Figure 2**).
- Key GIS layers included:
  - *Landforms* used to classify wetlands (**Figure 3**)
  - *Wetland and river ecosystem types* classified using hydrogeomorphological approaches (**Figures 4** and **5** respectively)
  - *River and wetland ecological condition* which combined observed data and condition indices modelled from natural land cover
  - *Free-flowing rivers* or rivers without dams that are still in a good ecological condition
  - *Wetland clusters* or wetlands embedded in a relatively natural landscape mosaic
  - *Strategic water supply areas* with high mean annual runoff (**Figure 6**).

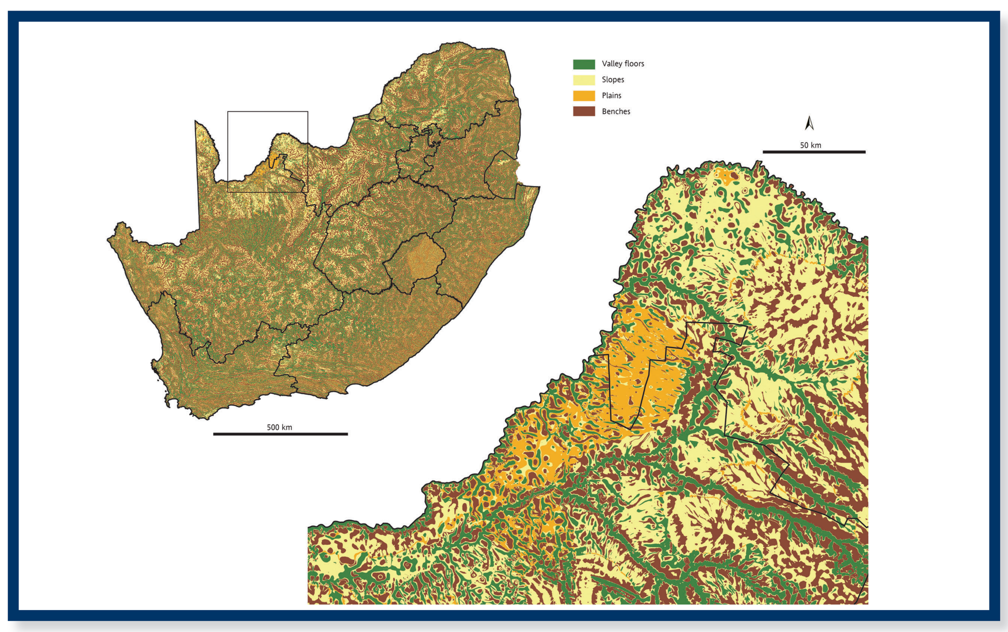

Figure 3: The ArcGIS 9.3 Landform Tool (Jenness, 2006) was used to identify landform classes, which describe the topography of a land surface in the context within which it occurs. The Landform Tool calculated standard deviation from the average elevation using a small GIS neighbourhood to consider local context within which the landform occurs, and a large one to reflect the regional context

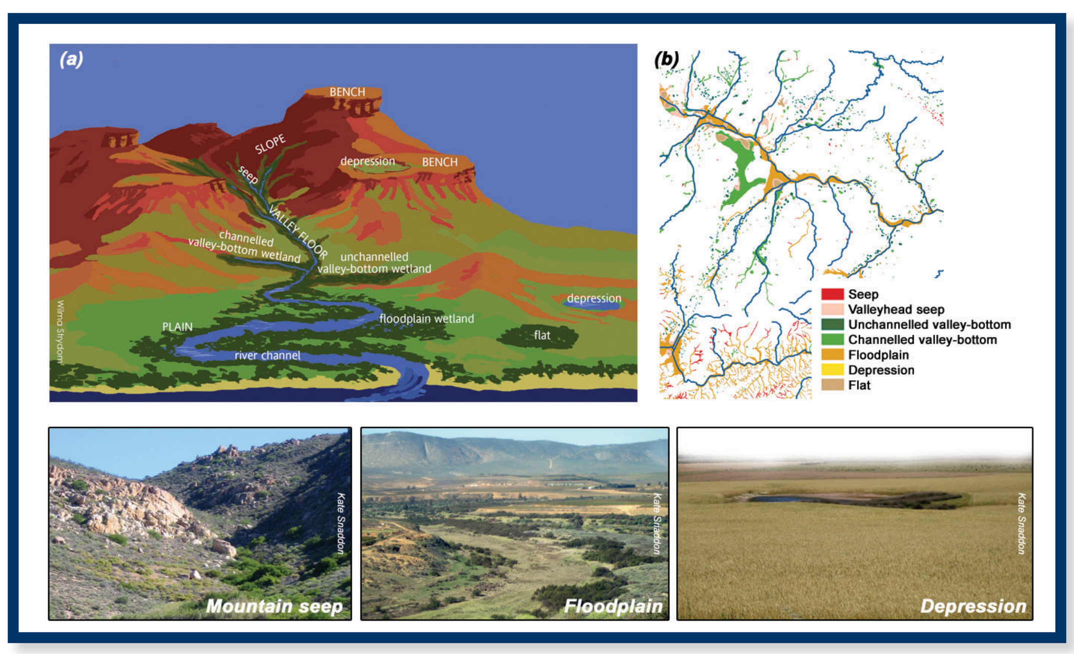

Figure 4: Landforms are shown schematically in (a) uppercase text, and informed the classification of wetlands into hydrogeomorphic types shown in lowercase text. A mapped example of wetland hydrogeomorphic types is shown in (b), which was combined with the vegetation type to produce 791 distinct combinations of wetland ecosystem types. Some examples are shown in the bottom panel

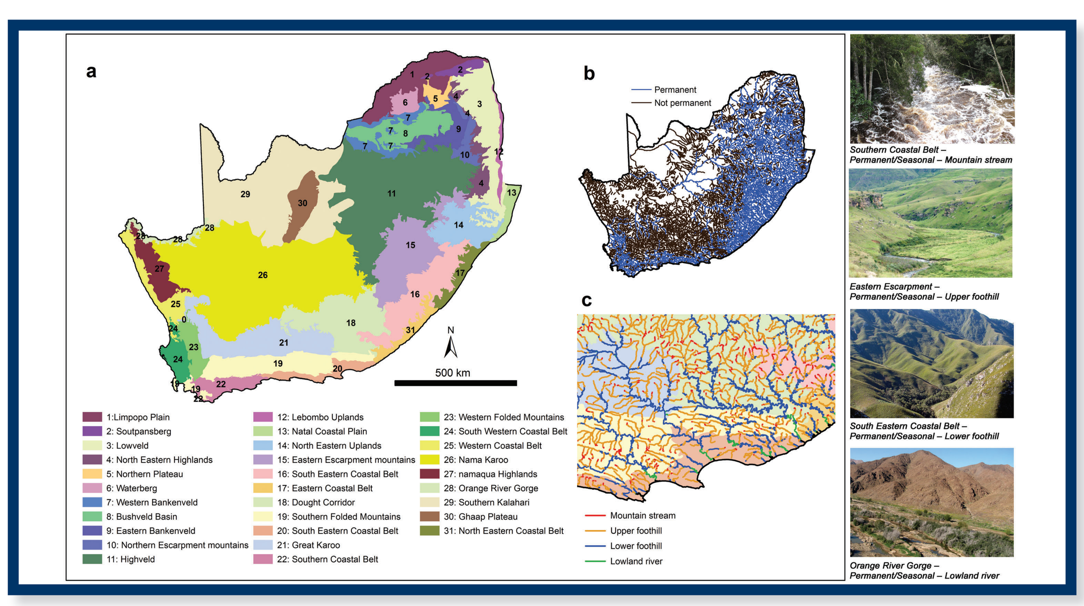

Figure 5: Three GIS layers were combined for river ecosystem types. (a) Level 1 ecoregions (Kleynhans et al. 2005), (b) flow variability (DLA-CDSM 2005-7), and (c) longitudinal river zones (Rowntree and Wadeson, 1999). This produced 223 distinct combinations of river ecosystem types. Some examples are shown in the right hand panel

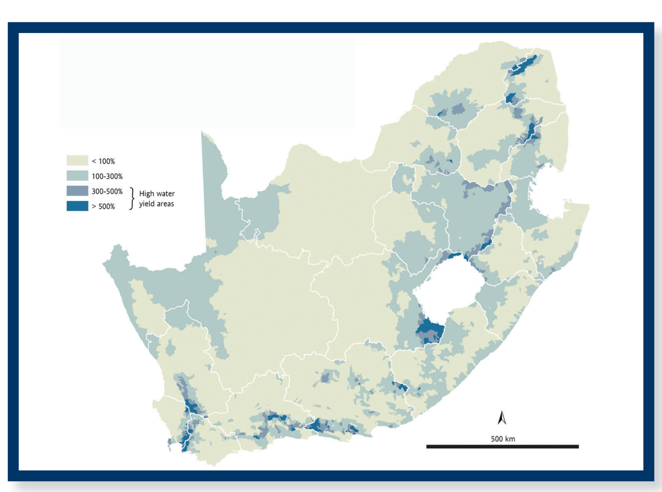

Figure 6: South Africa's strategic water supply areas, calculated as those sub-catchments where mean annual runoff is at least three times more than the average for the related river basin. These areas contribute significantly to overall water supply of the country

Use of systematic conservation planning to identify priority areas for managing the health of freshwater ecosystems and their associated biodiversity and ecosystem services.

CONCLUSIONS

- This systematic conservation planning exercise resulted in the most comprehensive freshwater conservation plan for South Africa to date, identifying FEPAs comprising 22% of South Africa's river length, 38% of wetland area and 41% of estuaries (Nel and Driver, 2011b).
- Key findings included:
  - Tributaries are in a better condition than main rivers
  - River and wetland ecosystems are highly threatened – respectively 57% and 75% are threatened
  - Only 22% of South Africa's river length has been prioritised, making conservation of these systems very feasible
  - There are only 62 large free-flowing rivers, representing just 4% of South Africa's river length
  - Only 18 % of strategic water supply areas are formally protected
  - By protecting only 15% of the country's river length, we can protect all fish species on the brink of extinction.
- An implementation manual that provides relatively detailed guidance on how to effect the implementation of these priority areas in different policy contexts was also developed (Driver et al., 2011).

FURTHER INFORMATION

The following documentation was produced:

- A technical report – targets a scientific audience
- An Atlas and accompanying data DVD – targets implementers and communicates map products
- An implementation manual – targets implementers and sets out how to use map products in different policy and management contexts

All information and supporting GIS layes are available from the Water Research Commission, South Africa (http://www.wrc.org.za/), or can be downloaded from the SANBI biodiversity GIS website (http://bgis.sanbi.org/nfepa/project.asp).

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