National Freshwater Ecosystem Priority Areas Project (NFEPA)
Freshwater ecosystems are in a shocking state

(Driver et al. 2005; Nel et al. 2007)

- Present ecological status 1999
  - Only 30% intact (Class A or B)
- River Health Programme
  - Ongoing deterioration over a 12 year period
- National Spatial Biodiversity Assessment
  - 84% threatened, 50% critically

HOW DO WE MANAGE OUR WATER RESOURCES MORE SUSTAINABLY?

![Map of South Africa showing river health statuses](image)

![Bar chart showing number of river signatures by conservation status](chart)
Sustainability: Balancing protection and utilization

- Protection & utilization work hand-in-hand
- Catchments can be designed for multiple levels of use
- Natural rivers support sustainability of hard working rivers
- Which rivers, and how many, are needed in a natural state?

This concept is firmly embedded in SA water policy
SYSTEMATIC BIODIVERSITY PLANNING

also known as

“Systematic Conservation Planning”
What is systematic biodiversity planning?

**Biodiversity planning identifies strategic**

*spatial* **priority areas for conservation action**

*Strategic*
- Strives for efficiency
- Proactive use of limited resources (money, capacity)

*Systematic*
- Strives for representation of the full variety of freshwater ecosystems in a planning region

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Margules & Pressey 2000 Nature
Systematic biodiversity planning

- Pioneered in terrestrial ecosystems

- Ad hoc approaches until 1970s
- Scoring approaches 1980s
- Planning for representation 1990s
- Planning for persistence 1990s
- Planning for implementation 2000s
- Planning for climate change adaptation 2000s

Systematic biodiversity planning:
representation + targets + persistence + policy
Principles of systematic biodiversity planning

- **Representation** (Margules & Pressey 2000)
  - Requires and operational means of mapping biodiversity
  - Use “biodiversity surrogates”
  - Scale-dependent (global, regional, national, local)

- **Setting of quantitative biodiversity targets** (Desmet & Cowling 2004)
  - How much of each biodiversity surrogate is enough
  - Should be based in strong science
  - Failing that, agreed-upon policy targets can be very powerful

- **Persistence** (Rouget et al. 2006; Nel et al. 2011)
  - We need to make sure that the processes that maintain the biodiversity are still functional
  - Especially the landscape ones that operate over the large spatial areas
“Implementation principles”

Systematic conservation planning identifies priority areas for conservation action across landscapes

**FUNDAMENTAL PRINCIPLES**

- **Representation**
  Conserve a representative sample of all biodiversity

- **Persistence**
  Conserve the processes that sustain biodiversity

- **Quantitative target setting**
  Don’t need to conserve everything, but what are the minimum requirements?

**IMPLEMENTATION PRINCIPLES**

- **Efficiency**
  Areas should complement, not duplicate each other

- **Flexibility**
  Map options to assess trade-offs in the interest of equity

- **Transparency**
  Explicit step-wise framework, stakeholder participation & quantitative targets
Increased applicability of systematic biodiversity planning to freshwaters

• Focus on entire landscape, NOT JUST PROTECTED AREAS
  • Can design a catchment for different levels of use
  • Includes people rather than fencing off and locking resources away
• Focus shifting from ‘representation’ to ‘representation + persistence’
  • Increased attention connectivity over large areas
  • Ability to incorporate this into conservation planning algorithms
**Freshwater biodiversity planning**

**Sub-catchment delineation with river-tree networks**
- HydroSHEDs
- ArcHydro

**Freshwater biodiversity surrogates**
- Turak et al. 2007 Hydrobiologia
- Ausseil et al. 2010 Freshwater Biol.

**Decision support tools for longitudinal connectivity**
- Linke et al. 2007 Freshwater Biol.
- Moilanen et al. 2008 Freshwater Biol.
- Linke et al. marxan

**Reviews & case studies**
- Thieme et al. 2007 Biol. Cons.
- Sowa et al. 2007 Ecological Monographs
- Nel et al. 2009 Aquatic Conservation
- Linke et al. 2010 Freshwater Biol.
- Freshwater Biol. Special Issue 2011

**Policy frameworks showing relevance within Integrated Water Resources Management**

**Conservation targets?**
- Rivers-Moore 2010 WRC Report
HISTORY OF FRESHWATER BIODIVERSITY PLANNING IN SOUTH AFRICA
Freshwater conservation planning in SA

Noble 1959
- 30 aquatic biotopes
- Descriptive (not spatially explicit)
- Final sites well-known by experts; not systematic
- Limited to 30 sites

Skelton 1995
- Systematic
- Based on fish species only
- Fish are not good biodiversity surrogates for invertebrates

O’Keeffe 1986
- Based on areas experts know well
- “Until we can classify our rivers zones in detail, management of different priorities will at best be haphazard”
- Not systematic

Freshwater Ecosystem Priority Areas
- Systematic and most comprehensive at this scale in the world
- Ecosystems and fish, water birds and frogs
- Broader species data not included
- Concerted effort for improving ecosystem condition needed
Studies forming the foundation for NFEPA

• Science
  • Ecoregions (Kleynhans et al. 2005)
  • Geomorphic zones (Rowntree & Wadeson 1999)
  • Fish database & IUCN assessment (SAIAB and Albany Museum; Darwall et al. 2009)
  • National land cover (van den Berg 2008)
  • Wetland classification (typing) framework (SANBI 2009)
  • Case studies

• Policy
  • Integrated environmental flow assessment (King & Brown 2010; Brown & King 2010)
  • Water Resource Classification system (Dollar et al. 2010)
  • National Spatial Biodiversity Assessment (Driver et al. 2005; Nel et al. 2007)
  • Cross sector policy process for conserving freshwater ecosystems (Roux et al. 2006)
National Freshwater Ecosystem Priority Areas Project (NFEPA)
NFEPA Aims

1. To identify **National Freshwater Ecosystem Priority Areas**

2. To develop an institutional basis to enable effective implementation
   - National component - aligning water & environment sector policy mechanisms
   - Sub-national component - building capacity to use products at catchment levels
Co-production of knowledge
Collective experience of almost 1000 years!
NFEPA project outputs

1. *Atlas and NFEPA DVD*: packages map products and data

2. *Implementation manual*: how to use FEPA maps in existing planning and decision-making processes, along with freshwater ecosystem management guidelines


4. *GIS data and associated metadata*: in shapefile format
Criteria to ID FEPAs

• Represent river, wetland and estuary ecosystem types
• Represent threatened fish
• Represent free-flowing rivers
• Represent NB migration routes
  • Fish corridors
  • Wetland clusters
• Maintain water supply areas
  • High water yield areas
  • High groundwater recharge areas
• Represent estuary species
• Identify connected systems
Integrating criteria into a systematic biodiversity planning framework

National Project Inception Workshop (August 2008)
- Identify and involve key stakeholders

Regional Stakeholder Workshops to review input layers (May-June 2009)
- Delineate planning units
- Map biodiversity & set targets for its representation & persistence

Stakeholder workshops in case study areas (November 2010)
- Quantify and map constraints in the region

Enable effective & sustained implementation
- Interpret results for end users

Select planning units to achieve targets & minimize constraints

National Stakeholder Workshop to review draft outputs (July 2010)

- Sub-quaternary planning units
- River types
- Wetland types
- Wetland clusters
- Estuary types
- Fish sanctuaries
- Other species data (frogs, Important Bird Areas)
- High water yield areas
- High groundwater recharge areas

MARXAN rules for:
- Aligning with existing protected areas, and focus areas for expansion
- Rules for connectivity (river, wetlands & estuaries)
Input data

Sub-quaternaries

River types

Wetland delineations

Wetland clusters

Fish sanctuaries

Free-flowing rivers

Estuaries

Landforms

Wetland types

River condition

Groundwater recharge

Wetland condition

Water yield (MAR)
Planning units: nested sub-quaternary catchments

- Quaternaries
  Average size ~650 km²

- Sub-quaternaries 9,417
  Average size ~135 km²

WARNING: There a few ugly ones
- Flat sub-catchments
- Coastal/estuarine sub-catchments
River types

- 31 Level 1 Ecoregions
- 4 longitudinal zones
- 2 flow regime categories
River condition

COMBINED:

• DWA Present Ecological State data (1999)
• DWA PES updates in certain regions
• River Health Programme data
• Reserve data
• Modelled land cover data
• Expert opinion
Wetland types

National Wetland Classification System, LEVEL 4
(Ollis et al., 2009)

1. Seep
2. Valley-head seep
3. Channelled valley-bottom
4. Unchannelled valley-bottom
5. Floodplain
6. Depression
7. Flat
Landforms for South Africa

Van Deventer et al., in prep

- **Small neighbourhood**
  - average valley-width for Partridge et al. (2010) geomorphic province (plus 1 km)

- **Large neighbourhood**
  - Maximum width of tertiary catchment (plus 1 km)
Wetland types

• Combine 7 HGM types with 133 vegetation type groupings ("wetveg types")
  • Azonal/Forest lumped into neighbouring vegetation
• Each wetland unit assigned its majority "wetveg type"
• 792 wetland types
Wetland condition

- Used to rank the relative importance of a wetland

**CONDITION OF NON-RIVERINE WETLANDS**
- Based on the minimum % natural land cover in and around the wetland:
  - Wetland
  - 50 m area around a wetland
  - 100 m area around wetland
  - 500 m area around wetland

**CONDITION OF RIVERINE WETLANDS**
- The condition of the river is also considered
  - If river condition is D, E or F
    - wetland condition is D, E or F
  - If river condition is A, B, C or unknown
    - wetland condition is based on minimum % natural landcover in and around the wetland
Wetland condition

- AB – intact wetland
- C – riverine wetland with associated C river
- DEF – riverine wetland with associated D, E or F river
- Z1 – not intact and based on % natural land cover
- Z2 – majority of wetland unit “Artificial”
- Z3 - “Artificial” from CDSM
<table>
<thead>
<tr>
<th>CRITERION</th>
<th>RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetlands that intersect with a <a href="https://www.ramsar.org">Ramsar</a> site</td>
<td>1</td>
</tr>
<tr>
<td>Wetlands within 500 m of a <a href="https://www.iucn.org">IUCN</a> threatened <a href="https://www.iucn.org">frog</a> point locality</td>
<td>2</td>
</tr>
<tr>
<td>Wetlands within 500 m of a threatened <a href="https://www.iucn.org">waterbird</a> point locality</td>
<td>2</td>
</tr>
<tr>
<td>Wetlands (excluding dams) with the majority of its area within a sub-quaternary catchment that has sightings or breeding areas for threatened <strong>Wattled Cranes</strong>, <strong>Grey Crowned Cranes</strong> and <strong>Blue Cranes</strong></td>
<td>2</td>
</tr>
<tr>
<td>Wetlands (excluding dams) within a sub-quaternary catchment <strong>identified by experts</strong> at the regional review workshops as containing wetlands of exceptional biodiversity importance, with <strong>valid reasons documented</strong></td>
<td>2</td>
</tr>
<tr>
<td>Wetlands (excluding dams) within a sub-quaternary catchment <strong>identified by experts</strong> at the regional review workshops as containing wetlands that are good, intact examples from which to choose</td>
<td>2</td>
</tr>
<tr>
<td>Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of biodiversity importance, but with <strong>no valid reasons documented</strong></td>
<td>3</td>
</tr>
<tr>
<td>Wetlands (excluding dams) in A or B condition <strong>AND</strong> associated with more than three other wetlands (both riverine or non-riverine wetlands were assessed for this criterion)</td>
<td>4</td>
</tr>
<tr>
<td>Wetlands in C condition <strong>AND</strong> associated with more than three other wetlands (both riverine or non-riverine wetlands were assessed for this criterion)</td>
<td>4</td>
</tr>
<tr>
<td>Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing impacted Working for Wetland sites</td>
<td>5</td>
</tr>
<tr>
<td>Any other wetland (excluding dams)</td>
<td>6</td>
</tr>
</tbody>
</table>
Wetland clusters

Clustering of wetlands embedded in a relatively natural landscape matrix through which dispersal between wetlands can occur.

- Clusters are a biodiversity feature IN ADDITION to representing wetland types.
- More than 3 non-riverine wetlands within 1 km of each other where:
  - > 50% of the wetland systems are natural,
  - the landscape matrix is ≥ 25% natural.
  - Preferential selection first from ones with ≥ 50% natural.
- Strive for representation across wetland vegetation groups.
Fish sanctuaries

- To support the fish sanctuaries, we have identified:
  - Upstream Management Zones
  - Fish Migration Corridors
  - Translocation Zones
  - Restoration Zones
Biodiversity targets

- River ecosystem types – 20% of total length per type
- Wetland ecosystem types – 20% of total area per type
- Threatened freshwater fish species – 100% of all confirmed Critically Endangered or Endangered populations; at least 10 populations of all other threatened
- Wetland clusters – 20% of total area per “wetveg type”
- Free-flowing rivers – 20% of total length per ecoregion group
- Estuary ecosystem & habitat types – 20% of total area per type
- Estuary-dependent species – 50% of the population of threatened species; 40% of the population of exploited species; 30% of the population of all other species
- Non-threatened freshwater fish species
  - No a priori target
  - where there are less than 10 populations after other FEPAs selected, additional areas will be chosen
Planning protocol

Rivers

1. Load data into MARXAN
   • Allows planning for connectivity
2. Select all fish sanctuaries
   • Irrespective of river condition
   • But only allow A or B rivers to contribute to river type targets
3. Discount sub-catchments containing focus areas for protected area expansion
4. Set boundary cost to favour longitudinal connectivity
5. Run MARXAN to achieve remaining targets for:
   • River types, Free-flowing rivers
6. Add in Freshwater Ecosystem Support Areas

Wetlands

7. Discount sub-catchments containing focus areas for protected area expansion AND river FEPAs
8. Set boundary cost to favour longitudinal connectivity
9. Run MARXAN to achieve remaining targets for:
   • Wetland types, wetland clusters
   • Preferential selection in top wetland ranks
10. Select wetland units within sub-catchments selected by MARXAN
    • Exclude dams & wetland rank = 6
    • Cut wetland units using sub-catchment boundary
11. Add in Freshwater Ecosystem Support Areas
    • Sub-catchments containing FEPAs get selected as FESAs
NFEPA map products

WMA level
1. FEPA map (Freshwater Ecosystem Priority Areas)

National level
2. Density of FEPAs by Water Management Area
3. Density of FEPAs by sub-Water Management Area
4. Free-flowing rivers
5. Fish sanctuary areas
6. Water supply areas
MAP 1: FEPA map (one for each WMA)

• Incorporating a conservation vision into Catchment Management Strategies

• Biodiversity sector input into scenario planning in water resource classification

• Planning by national & provincial conservation agencies
Biodiversity planning outputs underpinning map products

River FEPAs

Wetland FEPAs
MAP 2: Density of FEPAs per WMA

- Biodiversity responsibility not equal across country
- What mechanisms support implementation of biodiversity goals
MAP 3: Density of FEPAs per sub-WMA

- Biodiversity responsibility not equal within a WMA
- What mechanisms support implementation of biodiversity goals in the WMA
MAP 4: Free-flowing rivers

- 63 rivers
- Only 4% of our river length
- Only 25 ≥ 100 km
- FLAGSHIPS

- Acknowledge need for some development
<table>
<thead>
<tr>
<th>NORTHERN CAPE</th>
<th>EASTERN CAPE</th>
<th>KWAZULU-NATAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Sak, Klein- Sak &amp; tributaries*</td>
<td>Riet</td>
<td>Mzimkhulu*</td>
</tr>
<tr>
<td>Kap</td>
<td>Mzumbe</td>
<td></td>
</tr>
<tr>
<td>WESTERN CAPE</td>
<td>Mpekweni</td>
<td>Mpambanyoni*</td>
</tr>
<tr>
<td>Doring &amp; tributaries*</td>
<td>Mgwalana</td>
<td>aMahlongwa</td>
</tr>
<tr>
<td>Klaas Jaagers</td>
<td>Kobonqaba</td>
<td>aMahlongwana</td>
</tr>
<tr>
<td>Rooiels</td>
<td>iNxaxo</td>
<td>Mkomazi &amp; tributaries*</td>
</tr>
<tr>
<td>Touws</td>
<td>Qhorha &amp; tributaries*</td>
<td>Mkuze &amp; tributaries*</td>
</tr>
<tr>
<td>Karatara-Hoekraal</td>
<td>Shixini</td>
<td>Nsuze* tributary of Thukela</td>
</tr>
<tr>
<td>Homtini</td>
<td>Nqabarha*</td>
<td>Matigulu &amp; tributaries*</td>
</tr>
<tr>
<td>Knysna</td>
<td>Ntlyonyane</td>
<td>Black Mfolozi &amp; tributaries*</td>
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<tr>
<td>Bietou-Palmiet</td>
<td>Xora*</td>
<td>Nsonge</td>
</tr>
<tr>
<td>Groot</td>
<td>Mncwasa</td>
<td>Nondweni</td>
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<tr>
<td>Bloukrans</td>
<td>Mdumbi</td>
<td>Ngogo</td>
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<tr>
<td></td>
<td>Mtkatyhe*</td>
<td>Mfule*</td>
</tr>
<tr>
<td>LIMPOPO</td>
<td>Mnenu</td>
<td>Nyalazi*</td>
</tr>
<tr>
<td>Mutale-Luvuvhu*</td>
<td>Sinangwana</td>
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<tr>
<td>Mohlapitse</td>
<td>Mngazana</td>
<td>MPUMALANGA</td>
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<tr>
<td></td>
<td>Mntafufu</td>
<td>Ntombé tributary of Phongolo</td>
</tr>
<tr>
<td>NORTHWEST</td>
<td>Mzintlava</td>
<td>Hlelo*</td>
</tr>
<tr>
<td>Upper Groot-Marico</td>
<td>Mkozi</td>
<td>Upper Vaal*</td>
</tr>
<tr>
<td></td>
<td>Msikaba*</td>
<td>Elands*</td>
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<tr>
<td></td>
<td>Mtentu*</td>
<td>Mbyamiti</td>
</tr>
<tr>
<td></td>
<td>Sikombe</td>
<td>Nwanedzi-Sweni*</td>
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<td></td>
<td>Mpahlane</td>
<td></td>
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<tr>
<td></td>
<td>Mzamba*</td>
<td></td>
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<tr>
<td></td>
<td>Mtamvuna &amp; tributaries*</td>
<td></td>
</tr>
</tbody>
</table>
MAP 5: Water Supply Areas

• High water yield areas

• High groundwater recharge areas

3 x higher than average for catchment
MAP 6: Fish Sanctuary Areas

- Number threatened species per sub-quaternary
Key findings

- Tributaries are in a better condition than main rivers
- Rivers, wetlands and estuaries are highly threatened
  - Respectively 57%, 65% and 82% are threatened
- Freshwater Ecosystem Priority Areas (FEPAs) comprise only 22% of South Africa’s 1:500 000
- There are only 62 large free-flowing rivers, representing only 4% of our river length
- Only 18% of our water supply areas are formally protected
- By protecting only 15% of our river length we protect all our fish on the brink of extinction
Key messages

1. Freshwater Ecosystem Priority Areas are a valuable national asset
2. Freshwater inputs are critical to estuarine and marine environments
3. Free-flowing rivers are part of our natural heritage
4. Healthy tributaries and wetlands support the sustainability of hard-working rivers
5. Healthy buffers of natural vegetation mitigate the impact of land-based activities
6. Groundwater sustains river flows particularly in dry seasons
7. Mountain catchment areas play a critical role in securing our water supplies
8. Healthy freshwater ecosystems support resilience and adaptation to climate change
Key recommendations

• Employ aquatic ecologists in provinces, Catchment Management Agencies and municipalities
• Set up mechanisms to support uptake of FEPA maps, especially by provincial conservation authorities and Catchment Management Agencies.
• Use FEPA maps in assessing EIA applications, in water resource development processes, and in applications for mining and prospecting
• Pilot formal mechanisms for the management and protection of FEPAs
• Revive the Mountain Catchment Areas Act,
• Review general authorisations of the National Water Act in relation to their impact on FEPAs.
• Strengthen and expand the scope of the River Health Programme to include wetlands and actively target FEPAs as new monitoring sites.
• Strengthen collaboration of DWA and DEA around managing and conserving freshwater ecosystems.
POLICY CONTEXT
Policy context:
The shared mandate for freshwater biodiversity

- FEPAs are the biodiversity sector’s input into DWA-led water resource planning and management
- Talks to both the Water and Biodiversity Act
- Provides a strategic framework for DWA and DEA engagement around managing & conserving freshwater ecosystems
BIODIVERSITY POLICY CONTEXT

(Protected Areas Act & Biodiversity Act)
BIODIVERSITY GOALS

- Representation
- Persistence

**STRATEGY 1**
Expand and consolidate protected area network

**STRATEGY 2**
Conservation of ecosystems in priority areas outside the PA network

**Range of new tools**, including…

- Listing threatened ecosystems
- Listing threatened species
- Bioregional plans
- Biodiversity management plans
- IAS regs
Listing threatened ecosystems

Rivers

Wetlands
Bioregional plans

Systematic Biodiversity Plan (usually provincial)

Map of Critical Biodiversity Areas (CBAs)

IDPs

SDFs

EMFs

SEAs

EIAs

WRCS

CMSs

New ones in future?

NFEPA feeds into provincial biodiversity plans and CBA maps

Multi-sectoral planning tools, frameworks, assessments etc
WATER POLICY CONTEXT

(National Water Act)
NFEPA provides biodiversity sector input on:

- **How many** rivers, wetlands and estuaries should be designated for high protection?
- **Which** are best suited for conservation purposes?

(E.g. hard-working Vaal River needs healthy tributaries to sustain the ecosystem services it provides – how many and which ones?)
Integrated Water Resources Management in SA (National Water Act)
Water Resource Classification

- Sets a ‘Class’ for every significant water resource through consultation
- The class defines management objectives for the water
  - Describes the desired condition of the resource & extent to which it can be utilised
- Three classes
  - CLASS I: minimally used
  - CLASS II: moderately used
  - CLASS III: heavily used
- There are guidelines on the required configuration of ecological categories within a catchment for achieving the assigned class

<table>
<thead>
<tr>
<th>IUA class</th>
<th>Percentage category representation at units represented by biophysical nodes in an IUA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥A/B</td>
</tr>
<tr>
<td>Class 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥40</td>
</tr>
<tr>
<td>Class 2</td>
<td></td>
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<tr>
<td>Class 3</td>
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<td>Either</td>
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<td>Or</td>
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