Ecosystem Asset Accounts for Rivers* in South Africa

Forum of Experts in SEEA Experimental Ecosystem Accounting

19 June 2018

Natural Capital Accounting & Valuation of Ecosystem Services

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environmental affairs
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Environmental Affairs
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United Nations

UN environment

System of Environmental Economic Accounting

* River ecosystems are not the same as water resources

Initial ecosystem accounts in SA piloted through

Advancing Natural Capital Accounting (ANCA), 2014-2015

United Nations Statistics Division

UNEP

Convention on Biological Diversity

NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

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→ **National River Ecosystem Accounts** – extent and condition

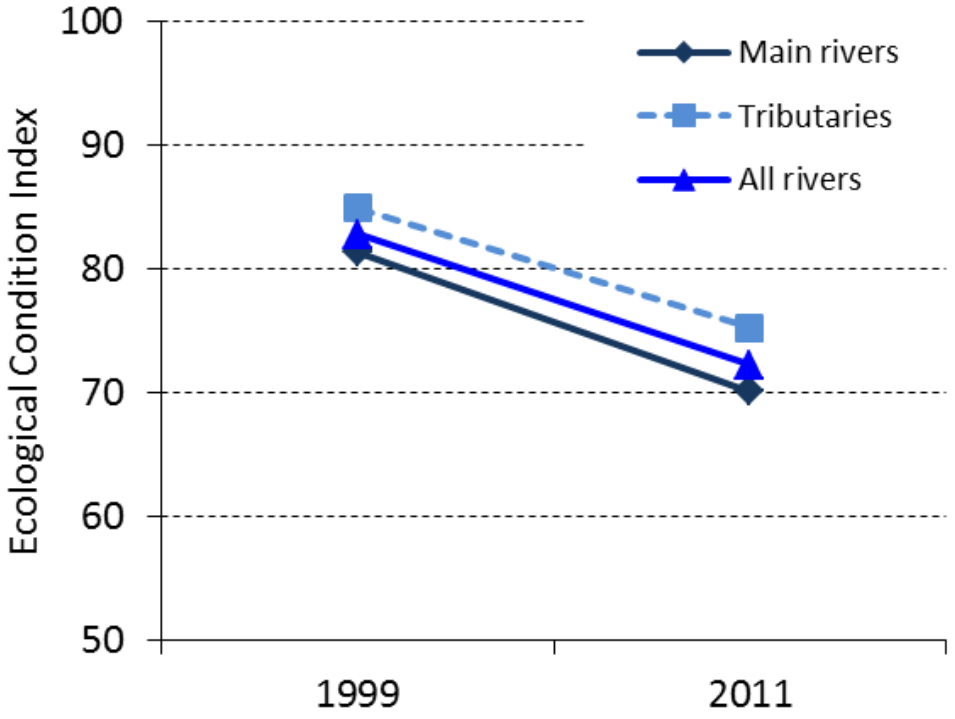
→ Land and Ecosystem Accounts for KwaZulu-Natal

Context for river accounts

- South Africa is a water scarce country
  - Droughts, frequently followed by floods

→ Rivers are hard-working ecosystems
  - Water quantity and quality throughout the year, especially dry season
  - Flood mitigation

Ecological Condition Index



Headline finding from river ecosystem account:

Overall
10% decline
in ecological
condition of rivers
1999 - 2011

	Main rivers	Tributaries	All rivers
1999	81.3	84.9	82.8
2011	70.1	75.2	72.2
Change between 1999 and 2011	-11.2	-9.7	-10.6

A more detailed look

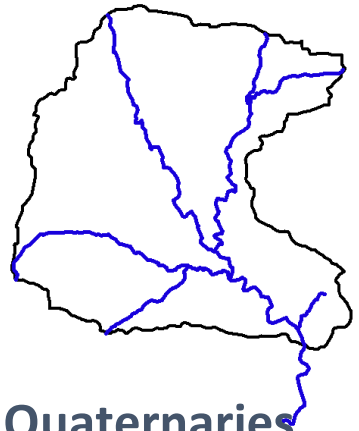
- Mapping and classifying river ecosystems
- Assessing condition of river ecosystems
  - Indicators of condition
  - Condition categories
  - Ecological condition index
- Putting this into an accounting framework

- Quick mention of wetlands if time

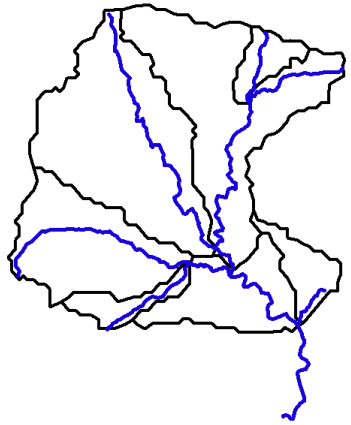
Mapping rivers

- At what scale?
  - From large rivers to small streams…
- Linear features, not well captured in land cover

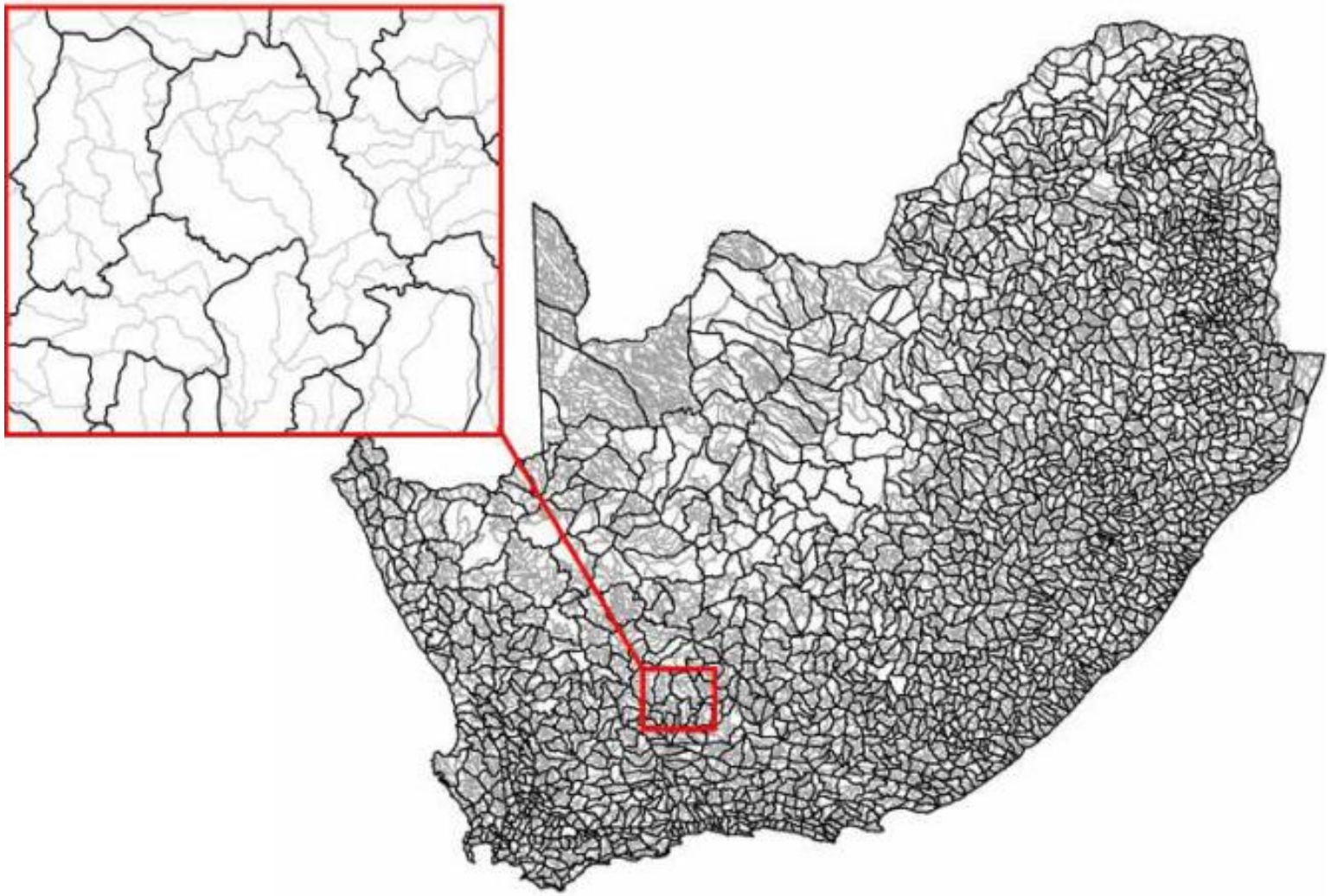
Rivers are nested in **catchments / river basins**
In South Africa: system of primary through to sub-quaternary catchments



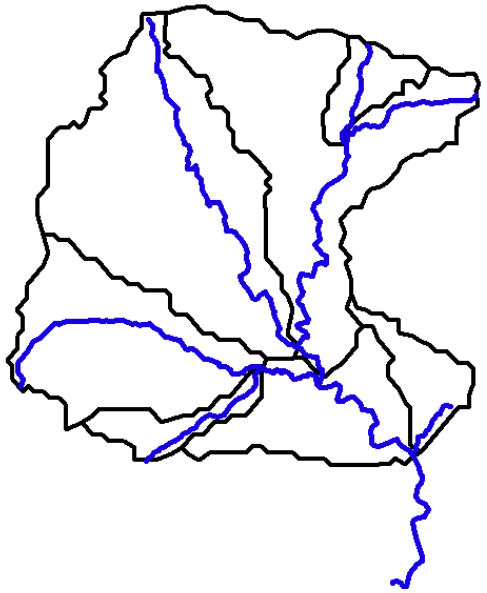
- **Quaternaries**
  Average size ~650 km^2



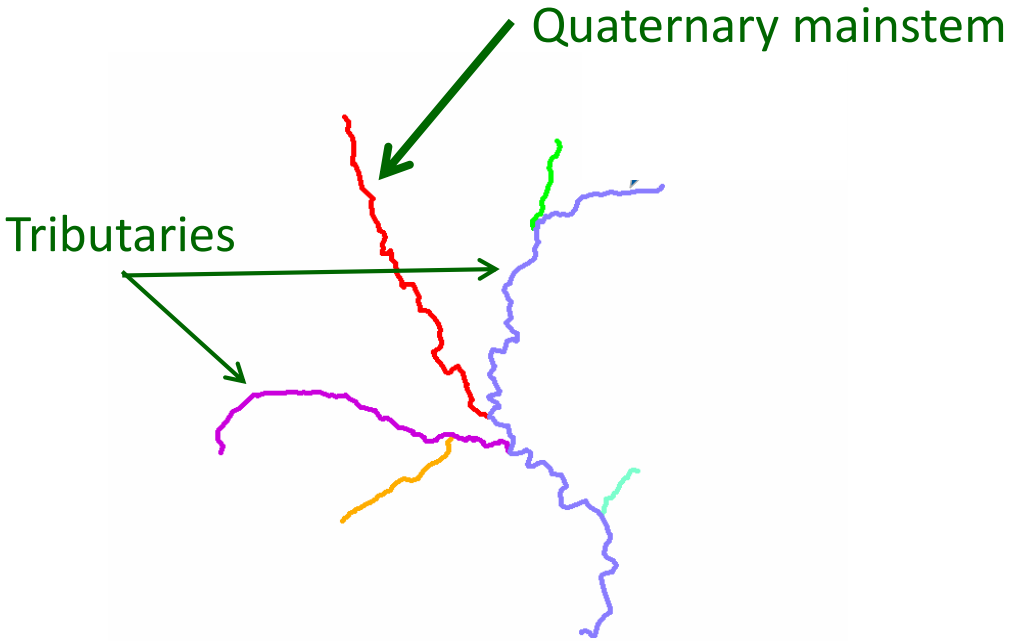
- **Sub-quaternaries** 8547
  Average size ~170 km^2



River reaches within catchments



Quaternary catchment divided into sub-quaternaries



River network topology

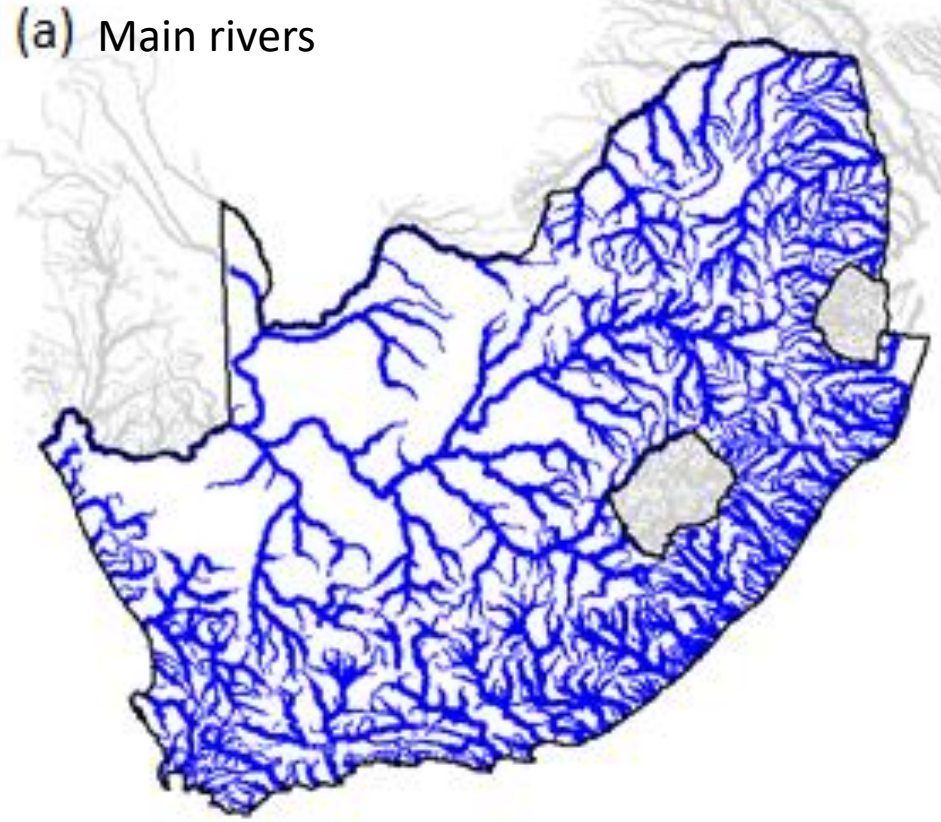
For the accounts

Main rivers
- Span more than one quaternary catchment

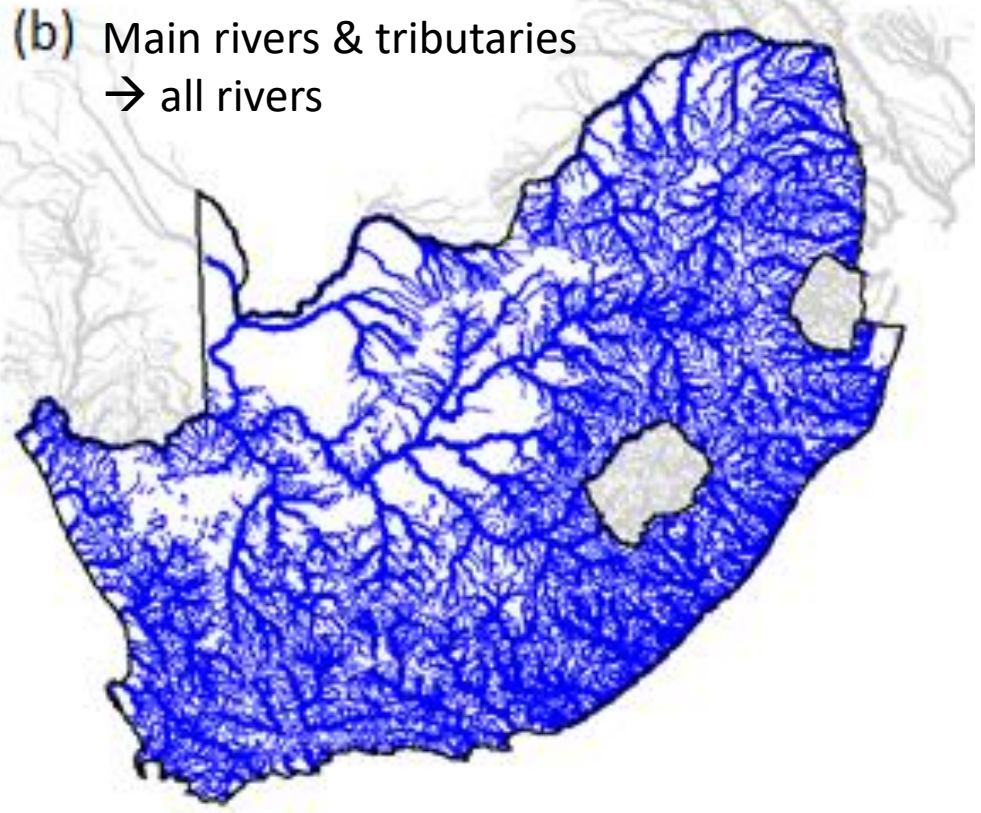
Tributaries
- Contained within a single quaternary
- Feed into main rivers

All rivers

(a) Main rivers



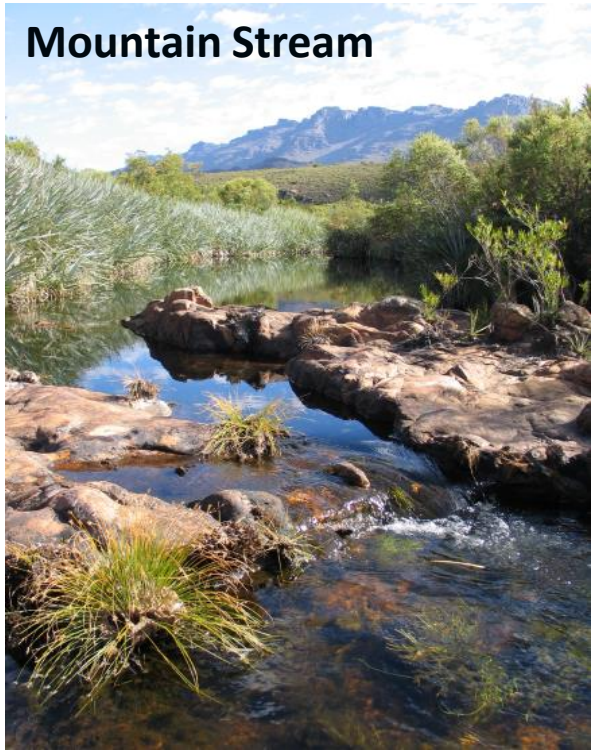
(b) Main rivers & tributaries
→ all rivers

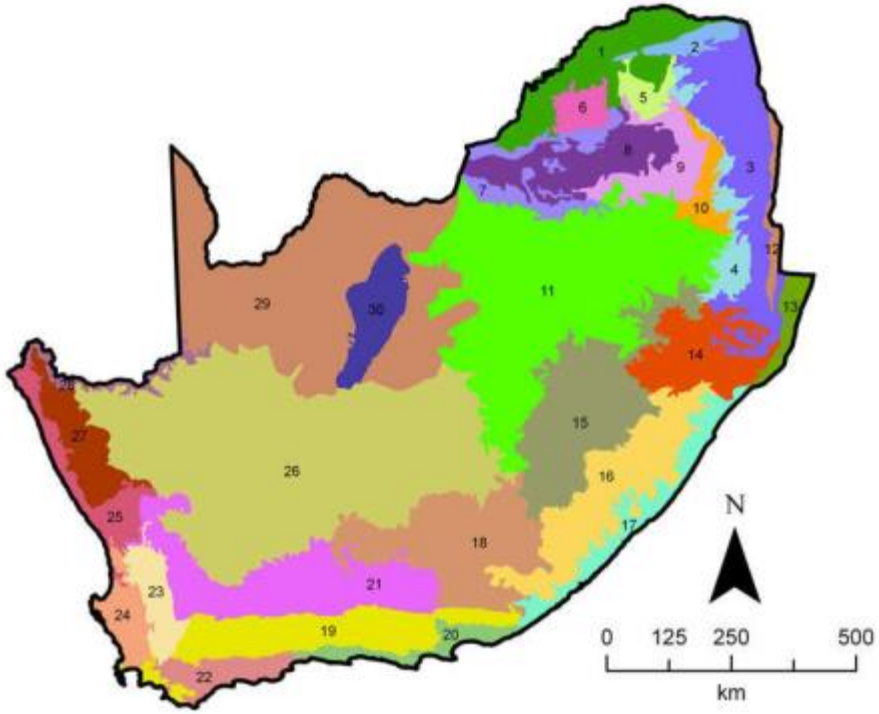


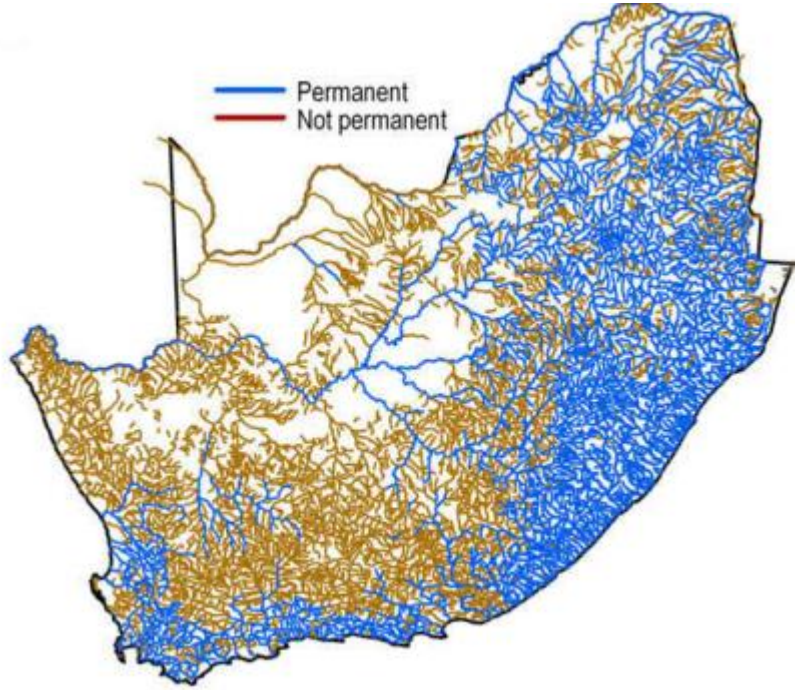
Classifying river ecosystem types

- South Africa is a diverse country – geologically, geomorphologically and climatically
- Large diversity of river ecosystems across the country

Not all rivers are alike!



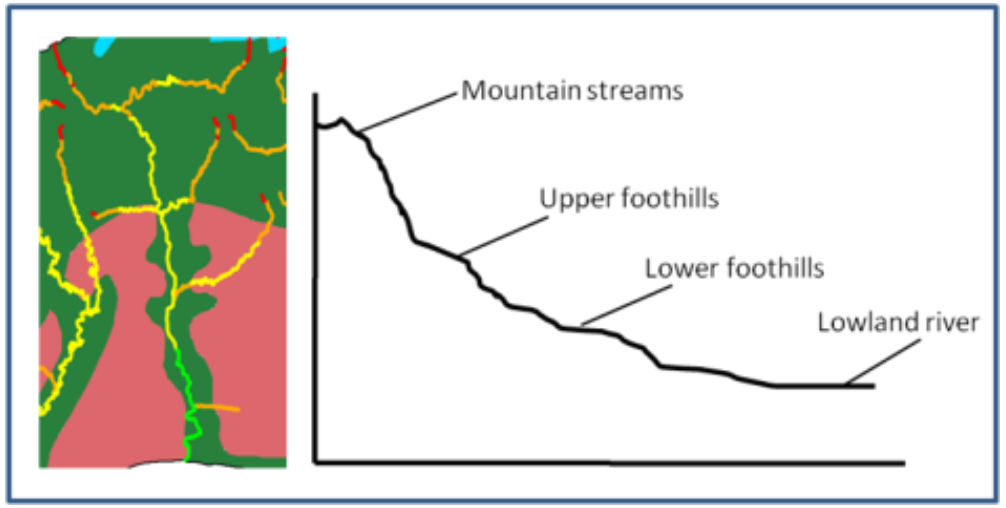




223 national river ecosystem types

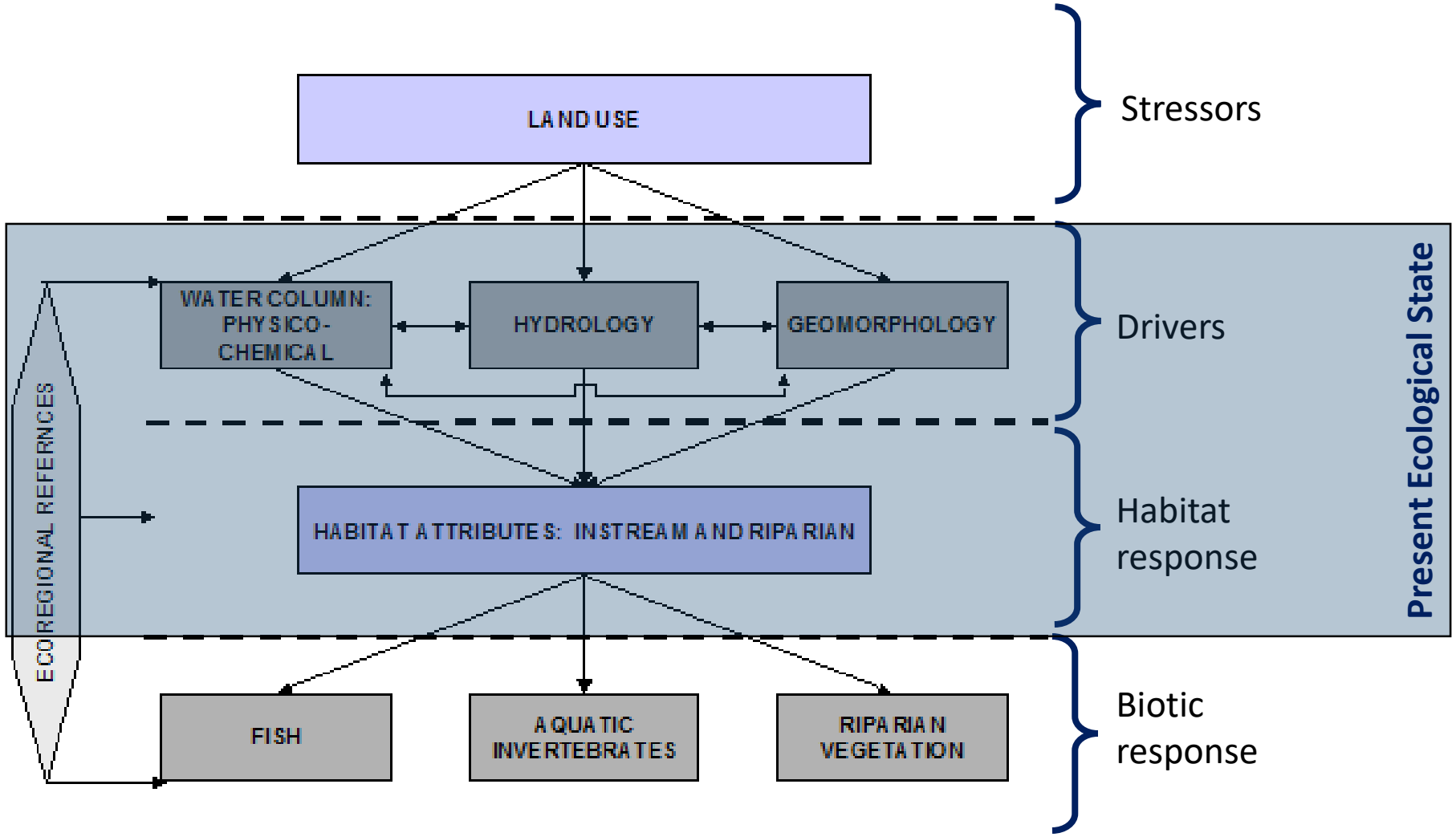
Based on:

- Landscape classification – 31 freshwater ecoregions
- Flow variability – 2 flow regime categories
- Slope – 4 longitudinal zones



Assessing condition of river ecosystems

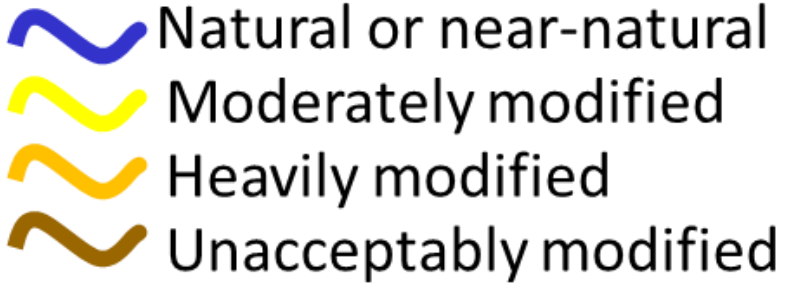
Conceptual framework for assessing ecological condition of rivers



Categories of river ecological condition – used by Department of Water & Sanitation

- 6 categories; grouped to 4 for accounts

Ecological category	Description	
A	Unmodified, natural	Unmodified
B	Largely natural, few modifications	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged
C	Moderately-modified	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged
D	Largely-modified	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred
E	Seriously-modified	Loss of natural habitat, biota and basic ecosystem functions is extensive
F	Critically/Extremely-modified	System has been modified completely with an almost complete loss of natural habitat and biota.



Based on degree of modification from a reference condition of "natural"

Not all rivers need to be natural – hard-working rivers are often in a D condition (heavily modified), and can be sustainably used in that condition

Two comprehensive national assessments of Present Ecological State

Based on **four indicators** of ecological condition:

- Flow
- Water quality
- Instream habitat
- Riparian habitat

Assessed for **each river reach**

water & sanitation

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Water and Sanitation
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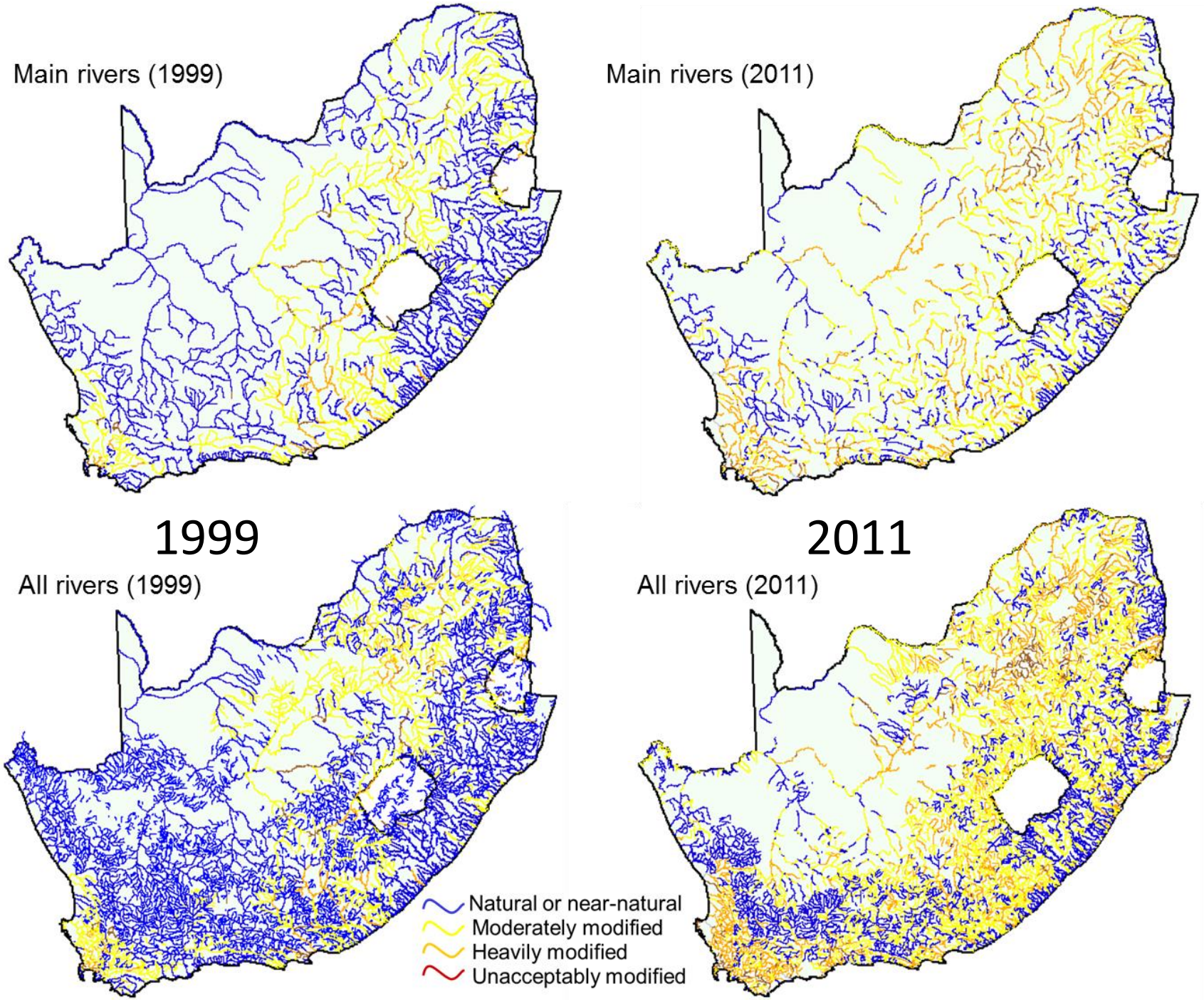


Putting this into an accounting framework

Ecosystem extent accounts for rivers

- Options for measuring extent of rivers
  - **Length – based on linear river network data – scale dependent**
  - Area – requires river channels to be mapped
  - Volume – naturalised flow volumes

km	Main rivers	Tributaries	All rivers
Opening stock 1999	76 310	87 223	163 533
Opening stock as % of total river length	47	53	100
Additions/reductions	0	0	0
Additions/reductions as a % opening stock	0	0	0
Opening stock 2011	76 310	87 223	163 533
Opening stock as % of total river length	47	53	100

River extent account by Water Management Area

km	Main rivers	Tributaries	All rivers	% total river length
Berg-Olifants	4 166	6 078	10 243	6
Breede-Gouritz	5 313	7 129	12 441	8
Inkomati-Usuthu	3 808	2 289	6 097	4
Limpopo	6 117	5 625	11 742	7
Mzimvubu-Tsitsikamma	16 000	17 317	33 317	20
Olifants	6 242	4 722	10 964	7
Orange	13 104	23 580	36 684	22
Pongola-Mzimkulu	10 613	7 272	17 884	11
Vaal	10 948	13 212	24 160	15
Total	**76 310**	**87 223**	**163 533**	**100**

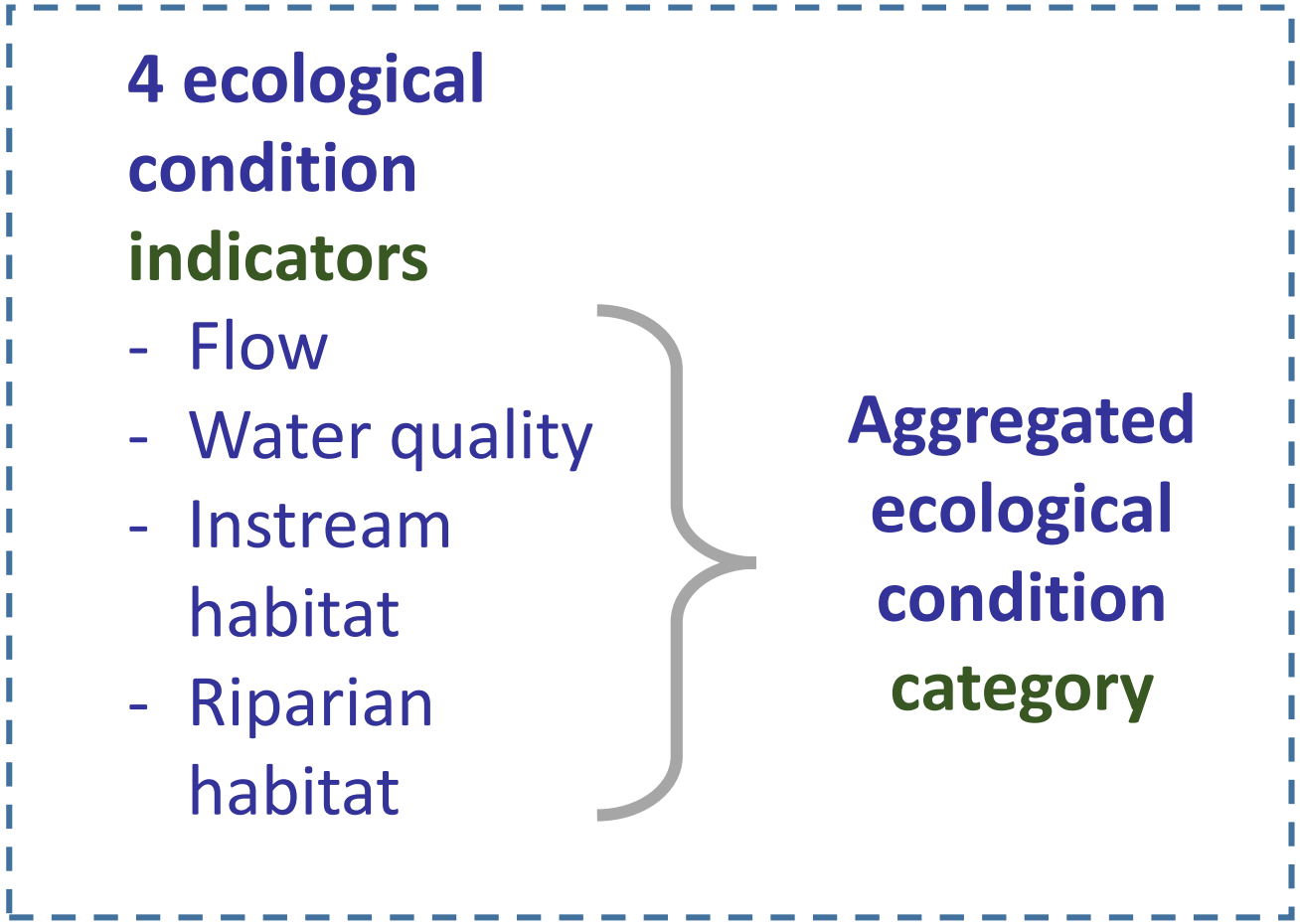
River extent account by longitudinal zone

km	Main rivers	Tributaries	All rivers	% total river length*
Mountain stream	1 609	5 145	6 754	4
Upper foothill stream	21 566	52 592	74 158	45
Lower foothill stream	38 893	27 553	66 445	41
Lowland river	14 243	1 008	15 251	9
No Data	0	926	926	1
Total	76 310	87 223	163 533	100

Surprise finding: lowland rivers make up only 9% of total river length


Lowland rivers often heavily impacted – fertile flood plains

Three options for ecosystem condition account

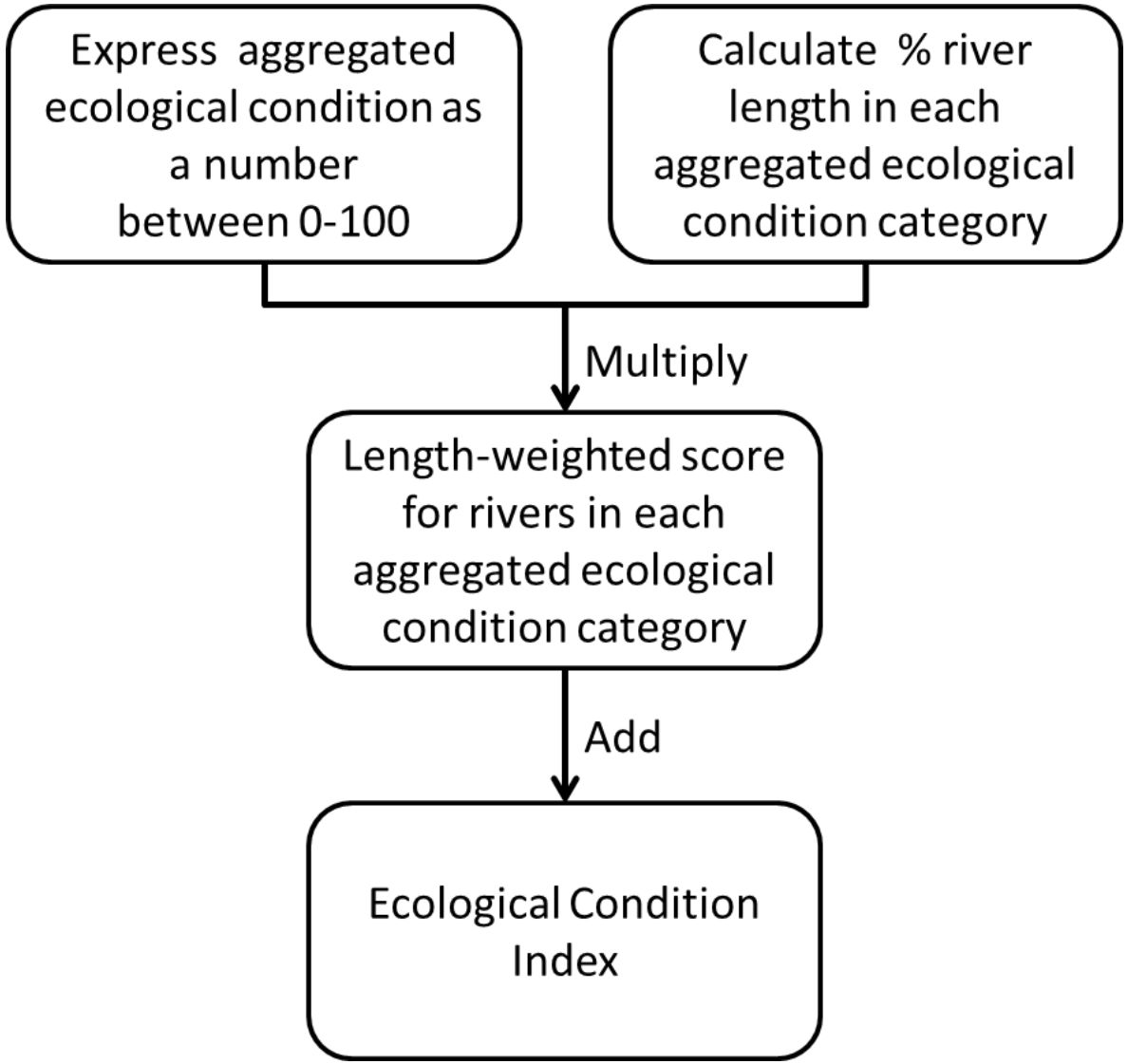


Directly from DWS Present Ecological State assessment

Ecological Condition Index

Developed for the account based on Present Ecological State data

From aggregated ecological condition category to **Ecological Condition Index**



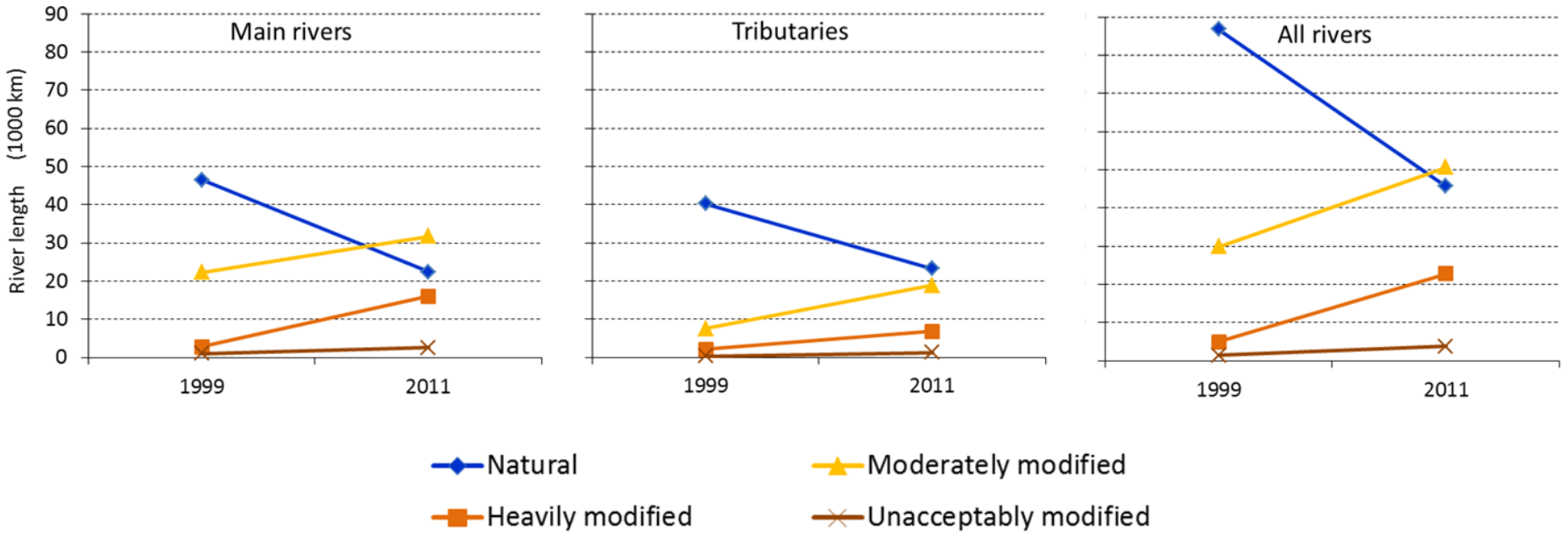
- A single integrated index to indicate ecological condition in a simple but ecologically meaningful way
- Scaleable
  - can do for any particular area from river reach to whole country

Ecosystem condition account based on **aggregated ecological condition category**

All rivers (km)	Natural	Moderately modified	Heavily modified	Unacceptably modified	No Data	Total
Opening stock 1999	**86 835**	**29 784**	**4 875**	**1 354**	**40 684**	163 533
Opening stock as % total river length	53	18	3	1	25	100
Increases/decreases	-41 163	20 806	17 935	2 422	0	
Increases/decreases as % opening	-47	70	368	179	0	
Opening stock 2011	**45 673**	**50 591**	**22 810**	**3 776**	**40 684**	**163 533**
Opening stock as % total river length	28	31	14	2	25	100

- **Big decrease in extent of river length in natural category**
- Large increase in extent of river length in heavily modified category
- Unacceptably modified rivers – small proportion of total river length (< 5% in 2011), but large percentage increase

Changes in aggregated ecological condition category 1999-2011



Ecosystem condition account based on

4 ecological condition indicators

For each indicator:
How much river length in each condition category (km, %)

Flow

	Degree of modification from natural					
Flow (km)	None/ small	Moderate	Large	Serious/ Critical	No Data	Total
Opening stock 1999	**34 084**	**22 814**	**10 328**	**5 447**	**3 637**	**76 310**
Opening stock as a % total river length	45	30	14	7	5	100
Increase/decreases	-10 546	-2 316	6 017	5 129	1 715	
Increases/decreases as % opening stock	-31	-10	58	94	47	
Opening stock 2011	**23 538**	**20 499**	**16 345**	**10 576**	**5 352**	**76 310**
Opening stock as a % total river length	31	27	21	14	7	100

Water quality

	Degree of modification from natural					
Water quality (km)	None/ small	Moderate	Large	Serious/ Critical	No Data	Total
Opening stock 1999	**40 579**	**24 634**	**5 518**	**1 943**	**3 637**	**76 310**
Opening stock as a % total river length	53	32	7	3	5	100
Increase/decreases	-5 769	-3 591	6 149	1 496	1 715	
Increases/decreases as % opening stock	-14	-15	111	77	47	
Opening stock 2011	**34 810**	**21 043**	**11 667**	**3 439**	**5 352**	**76 310**
Opening stock as a % total river length	46	28	15	5	7	100

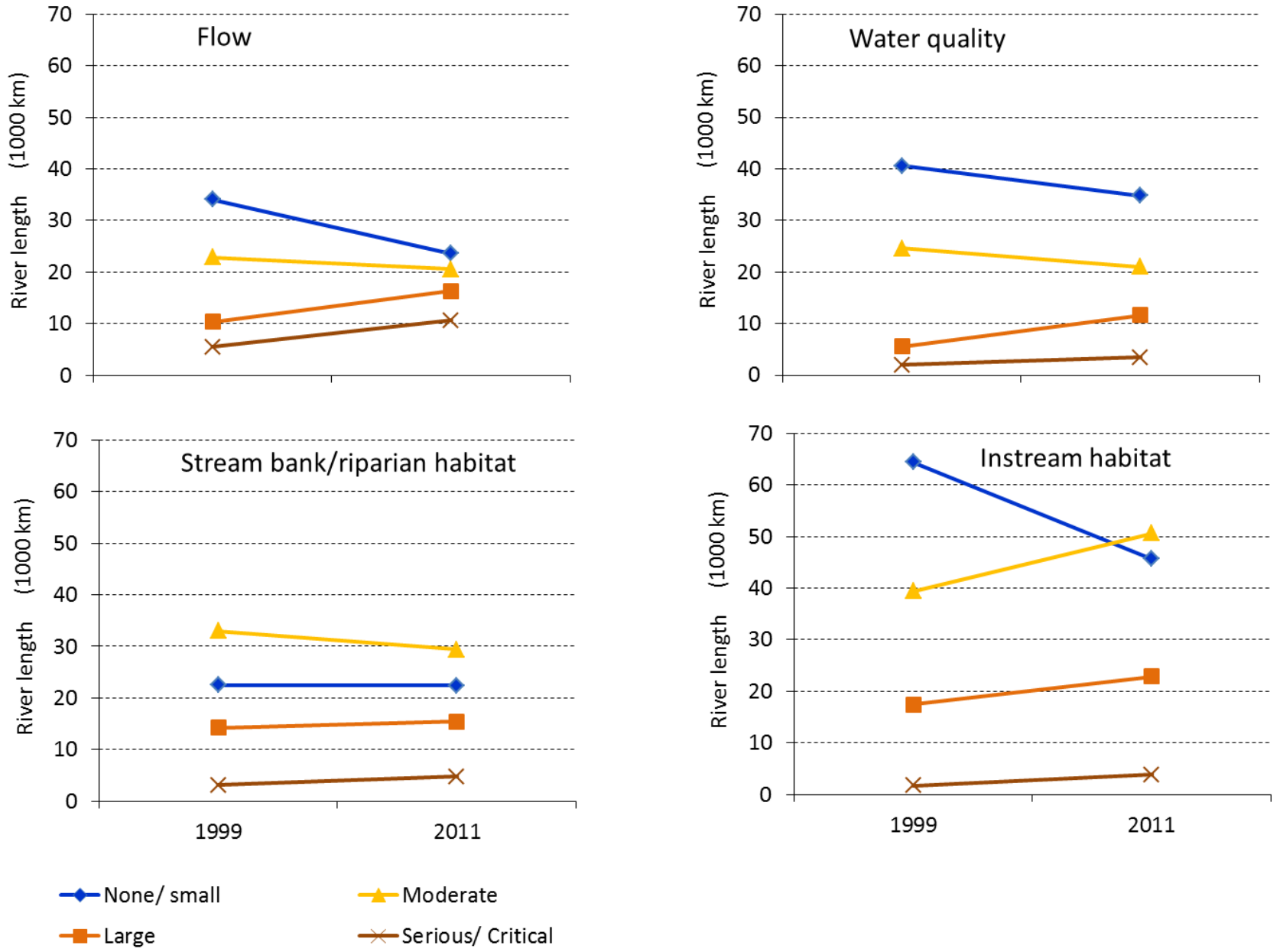
Riparian habitat

	Degree of modification from natural					
Stream bank/riparian habitat (km)	None/ small	Moderate	Large	Serious/ Critical	No Data	Total
Opening stock 1999	**22 469**	**32 951**	**14 164**	**3 088**	**3 639**	**76 310**
Opening stock as a % total river length	29	43	19	4	5	100
Increase/decreases	-50	-3 612	1 255	1 667	740	
Increases/decreases as % opening stock	0	-11	9	54	20	
Opening stock 2011	**22 418**	**29 339**	**15 420**	**4 755**	**4 379**	**76 310**
Opening stock as a % total river length	29	38	20	6	6	100

Instream habitat

	Degree of modification from natural					
Instream habitat (km)	None/ small	Moderate	Large	Serious/ Critical	No Data	Total
Opening stock 1999	**39 736**	**26 188**	**5 446**	**1 301**	**3 639**	**76 310**
Opening stock as a % total river length	52	34	7	2	5	100
Increase/decreases	-11 245	426	8 180	1 898	740	0
Increases/decreases as % opening stock	-28	2	150	146	6 840	
Opening stock 2011	**28 491**	**26 615**	**13 626**	**3 200**	**4 379**	**76 310**
Opening stock as a % total river length	37	35	18	4	6	100

Changes in 4 ecological condition indicators 1999-2011



Ecological Condition Index

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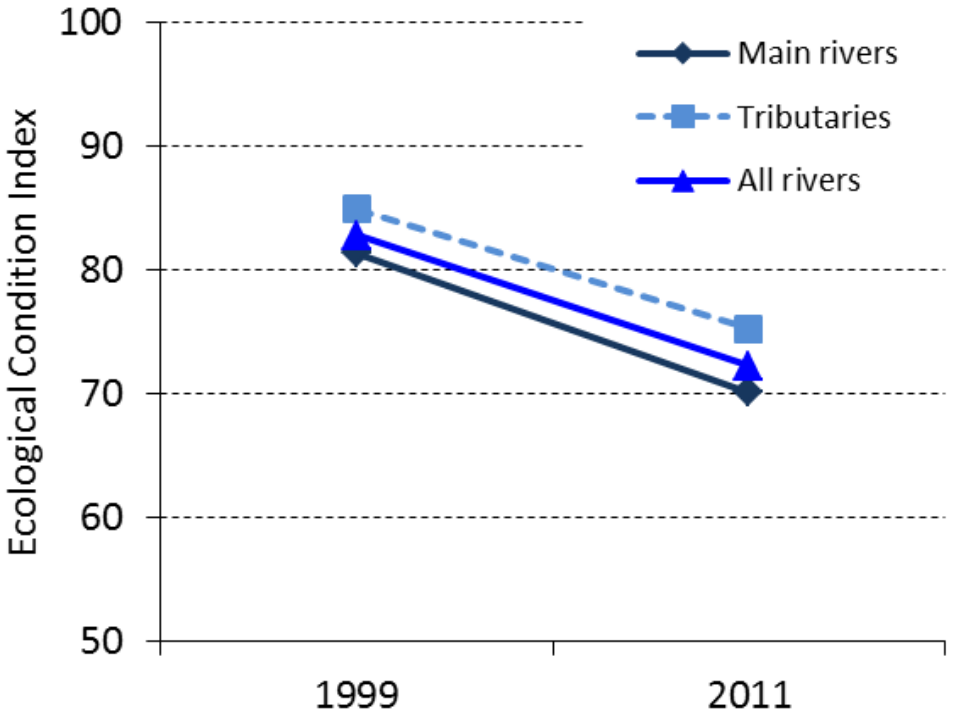
Change between 1999 and 2011	-11.2	-9.7	-10.6

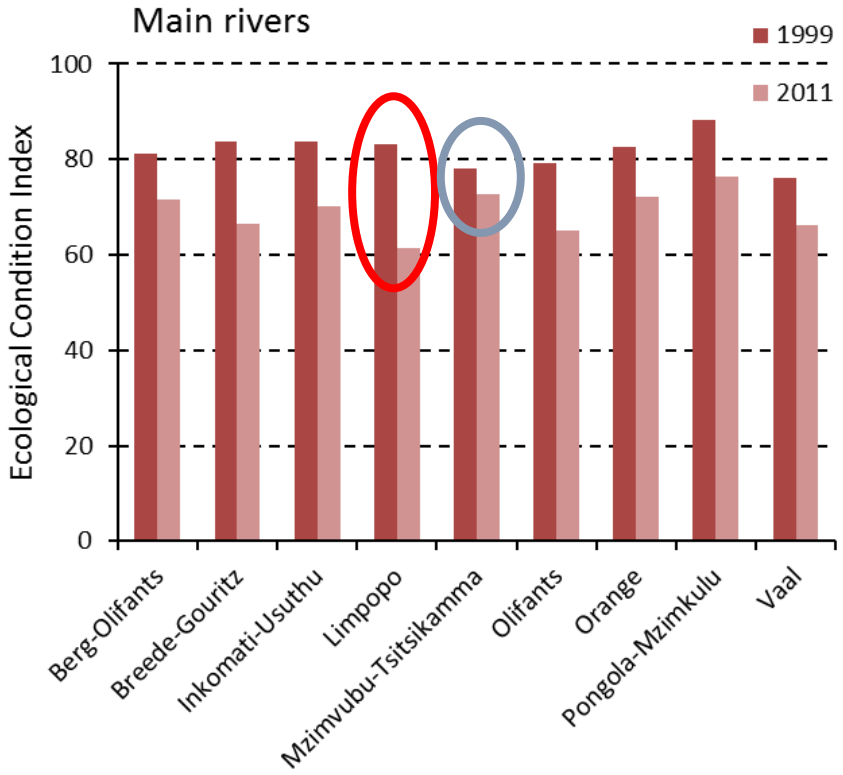


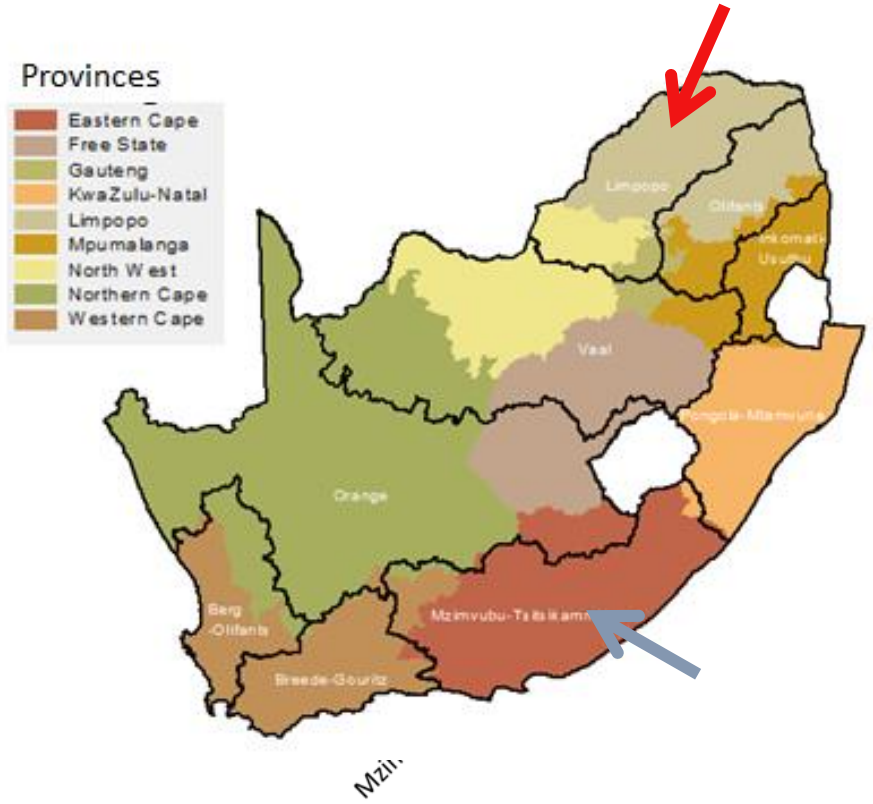
Overall
10% decline in
ecological condition
of rivers
1999 - 2011

Ecological Condition Index can be disaggregated for a range of reporting units, for example:

- Water Management Area
- Municipality
- River ecoregion
- Longitudinal zone (mountain stream through to lowland river)

Change in Ecological Condition Index by Water Management Area





- Biggest decline – Limpopo, esp for main rivers (>20%)
- Smallest decline – Mzimvubu-Tsitsikamma

Important message

- Don’t necessarily need to choose between:
  - Multiple indicators of condition
  - Overall condition category
  - Index of condition
- These are not mutually exclusive options

- Using all three gives flexibility in reporting
  - Could report on individual indicators for small accounting units…
    → useful for informing particular management decisions at the local level
  - …through to single ecological condition index for whole country
    → useful for high level political messages

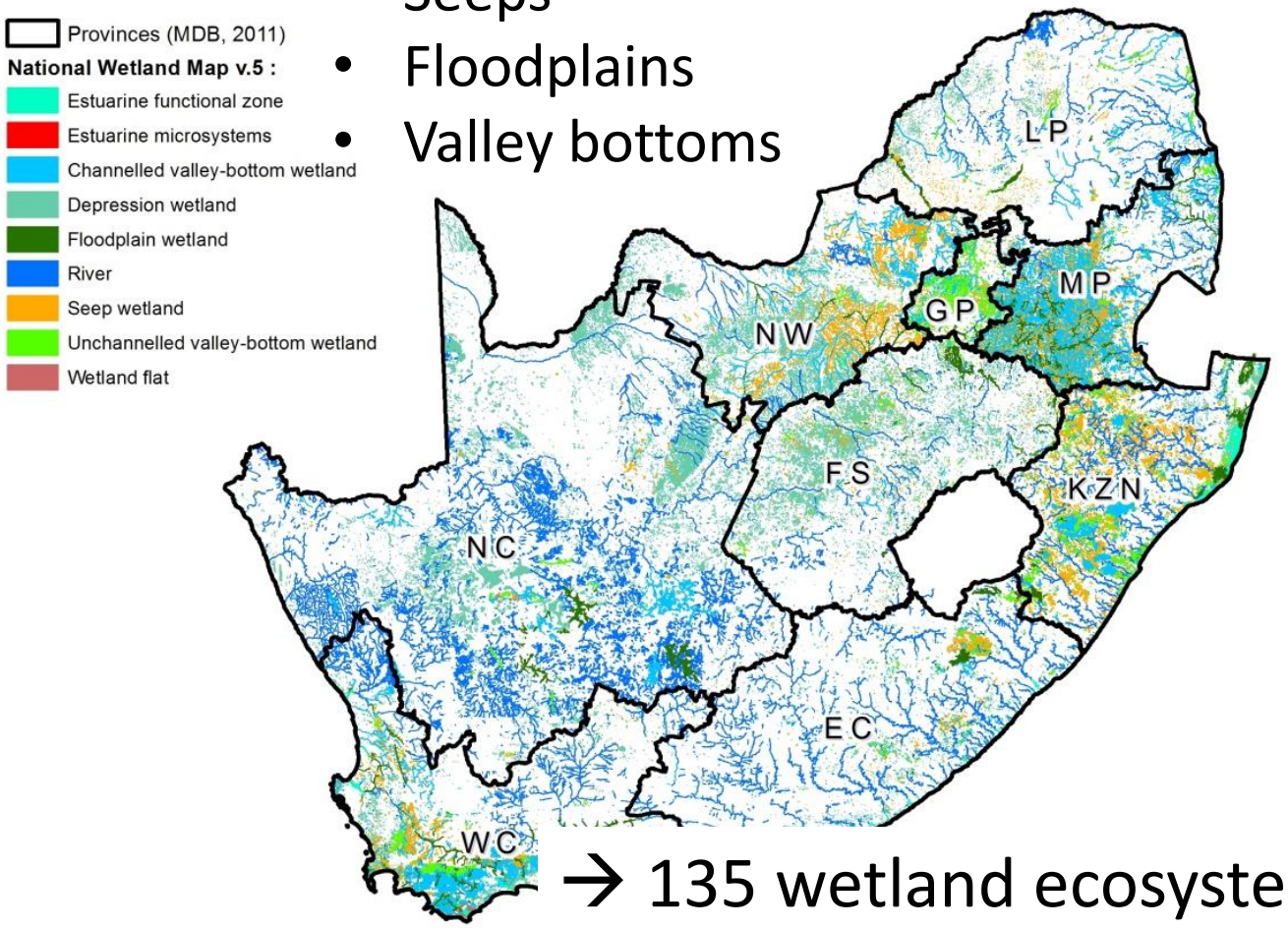
A word on wetlands

- Mapping:
  - combination of modelling and groundtruthing
  - keep artificial and natural wetlands separate
- Classification:
  - HGM types + bioregions
- Condition:
  - Modelled based on:
    - Distance to dams or weirs (artificial wetlands), waste water treatment works, aquaculture and roads
    - Proportion of natural land cover within 50m, 100m and 500m buffer of each wetland

Wetland ecosystem types

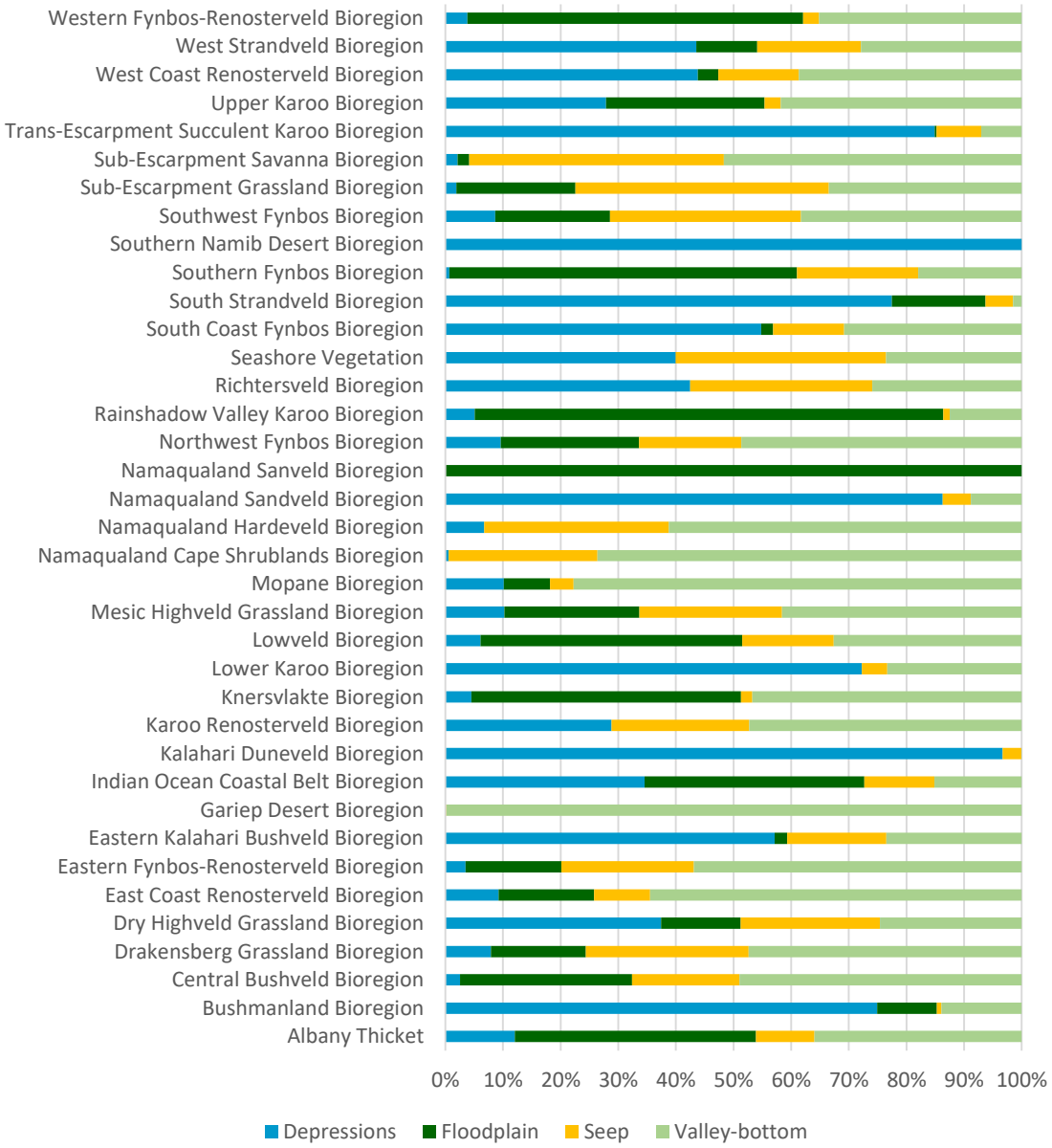
4 hydro-geomorphic types:

- Depressions
- Seeps
- Floodplains
- Valley bottoms

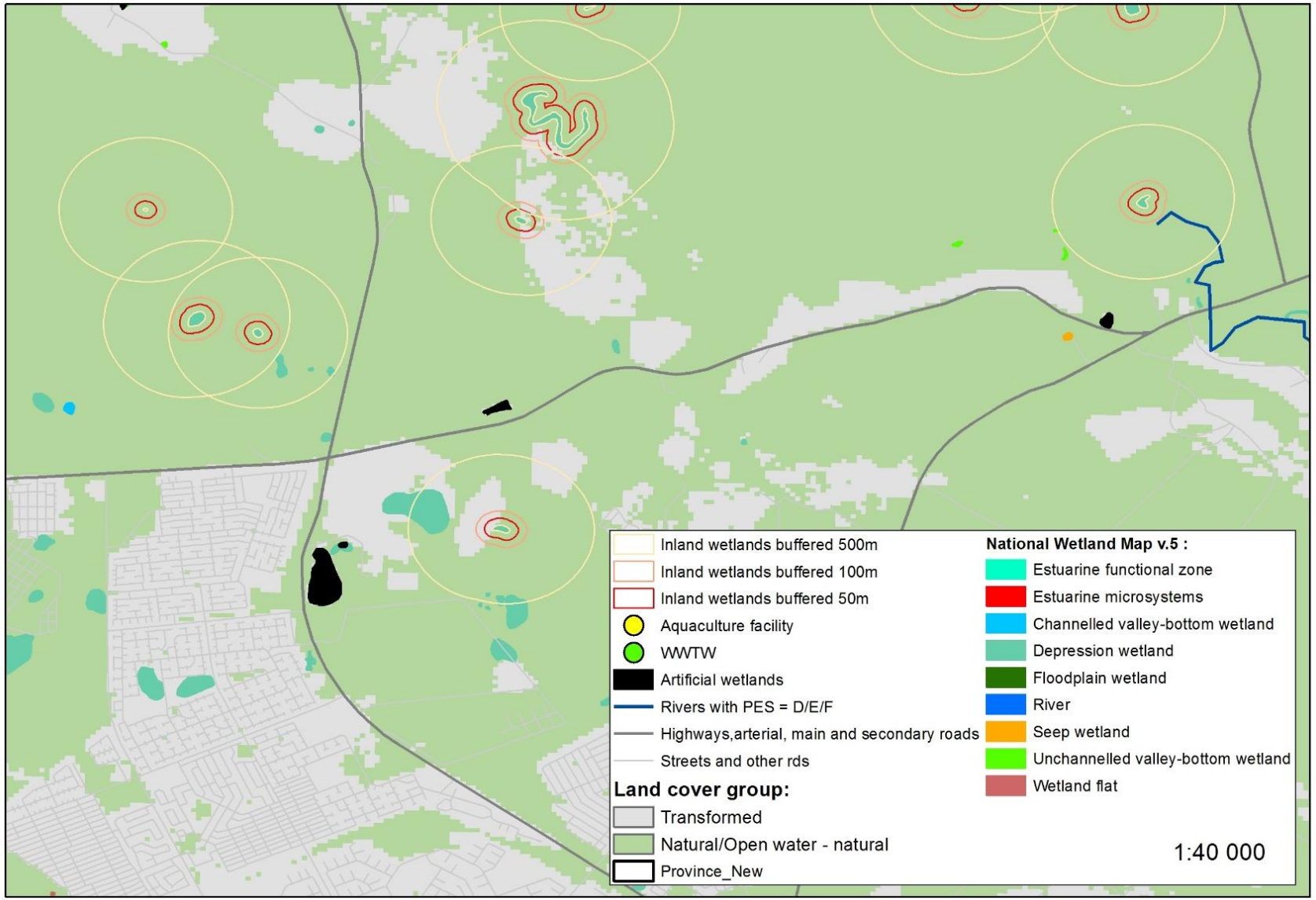


→ 135 wetland ecosystem types

37 bioregions based on vegetation



Modelling wetland condition



South Africa's initial pilot ecosystem accounts:

- Land and Ecosystem Accounts for KZN
- National River Ecosystem Accounts

Reports available at

http://biodiversityadvisor.sanbi.org

(under "Planning and Assessment" section)