

# Session 5: Ecosystem condition

## Country example from South Africa: National River Ecosystem Accounts

Mandy Driver

with acknowledgements to Jeanne Nel

Regional Training Workshop on SEEA EEA for African Countries

28-31 October 2019

Sheraton Hotel, Pretoria



**stats sa**

Department:  
Statistics South Africa  
REPUBLIC OF SOUTH AFRICA



**environmental affairs**

Department:  
Environmental Affairs  
REPUBLIC OF SOUTH AFRICA

**SANBI**

Biodiversity for Life

South African National Biodiversity Institute



United Nations

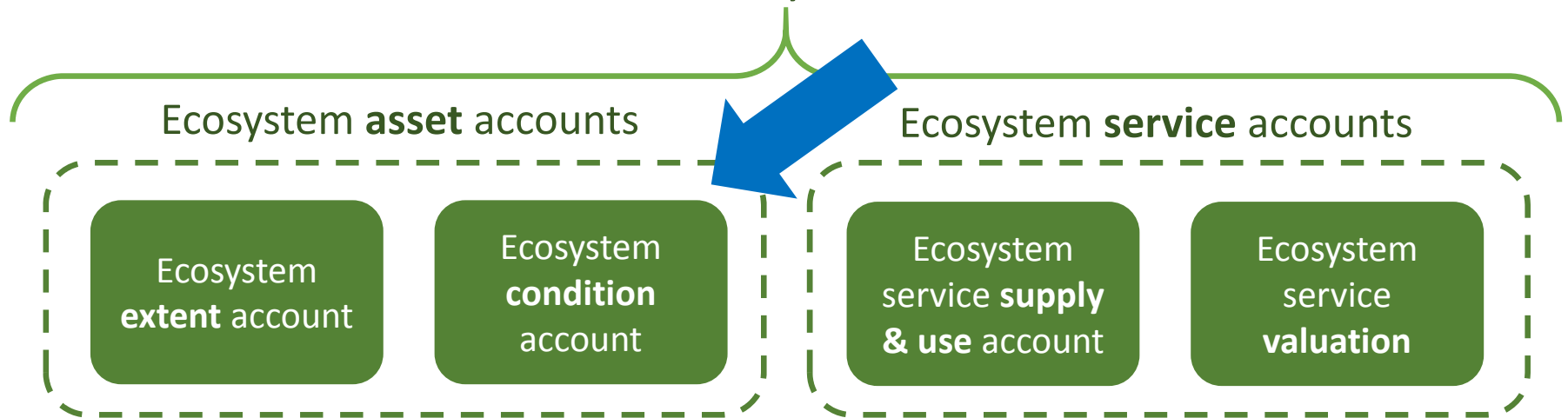


System of  
Environmental  
Economic  
Accounting



# Overview of ecosystem accounts

## Core set of ecosystem accounts



	Eco type 1		Eco type 2		....	
	ha	cond	ha	cond	ha	cond
Opening balance						
Increases						
Decreases						
Reappraisals						
Closing balance						

# National River Ecosystem Accounts done as part of Advancing Natural Capital Accounting (ANCA) project, 2014-2015



## Seven pilot countries:

Bhutan, Chile, Indonesia, Mauritius, Mexico, **South Africa**, Vietnam

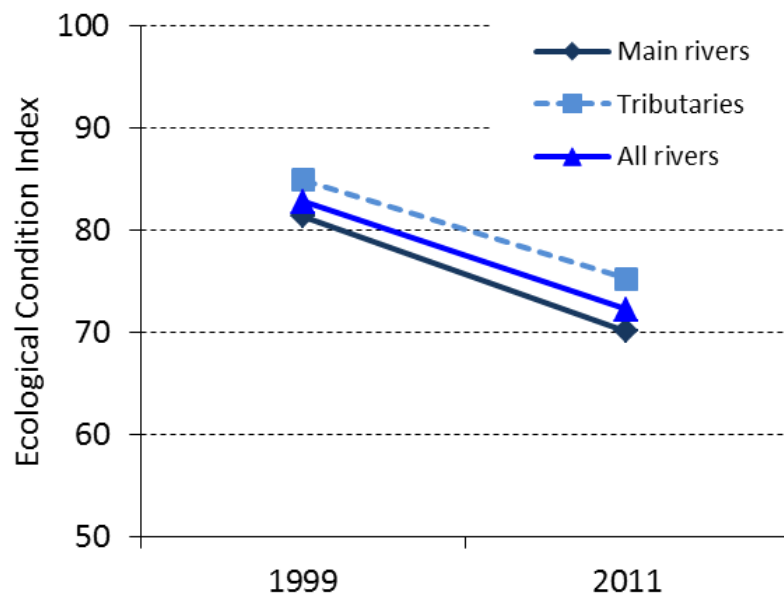
# Context for river accounts

- South Africa is a water scarce country
  - Droughts, frequently followed by floods
- Rivers are hard-working ecosystems
  - Providing water quantity and quality throughout the year, especially dry season

The Drakensberg mountain range includes several Strategic Water Source Areas, where high-altitude grasslands play a critical role in supplying water to the dams downstream. (Injisuthi River with Monks Cowl in background). © Simon van Noort.



# Ecological Condition Index



	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

Headline finding from river ecosystem account:

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

Information for national policies, such as **National Water & Sanitation Master Plan**

# A more detailed look

- Classifying and mapping river ecosystem types
- Assessing condition of river ecosystems
  - Indicators of condition
  - Condition categories
  - Ecological condition index
- Putting this into an accounting framework
- Displaying the results
- Quick mention of other realms (terrestrial, marine) if time



# Classifying river ecosystem types

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

Upper foothills – Highveld



Not all rivers are alike!

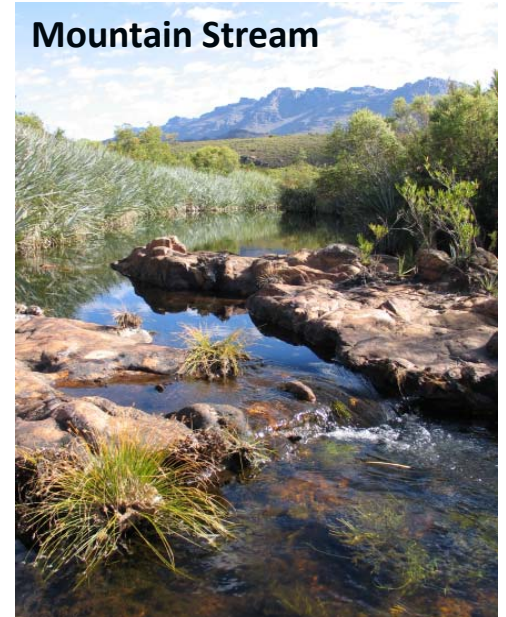
Upper foothills  
– Western Cape



Lower foothills – Highveld

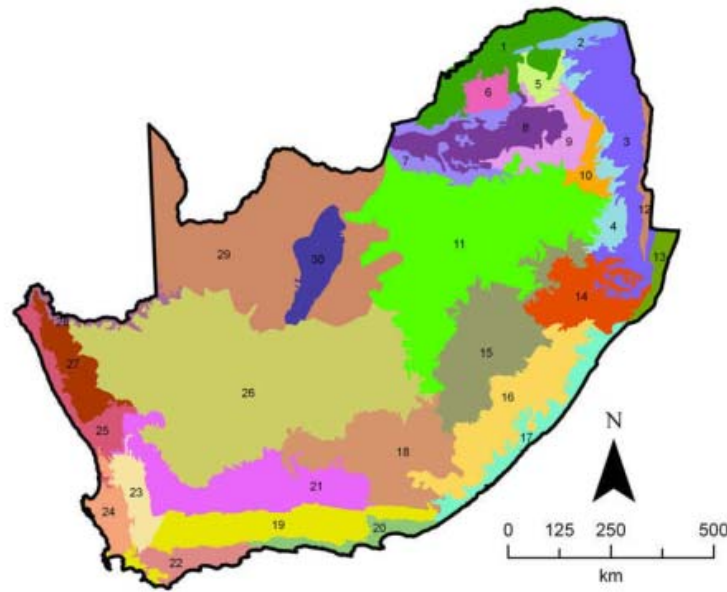


Mountain Stream



Lowland Stream

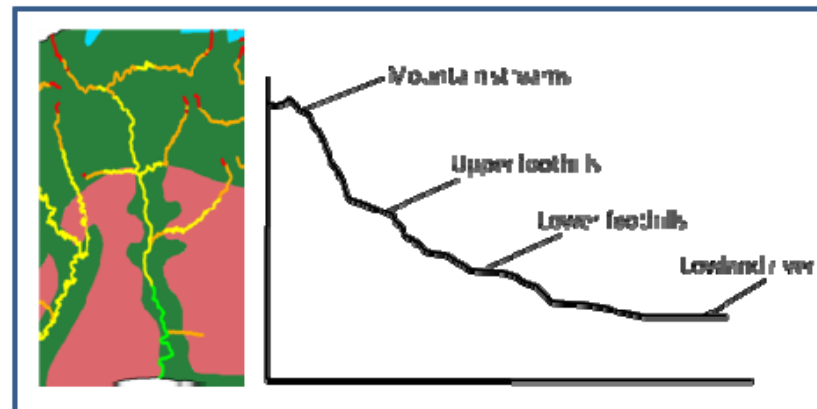
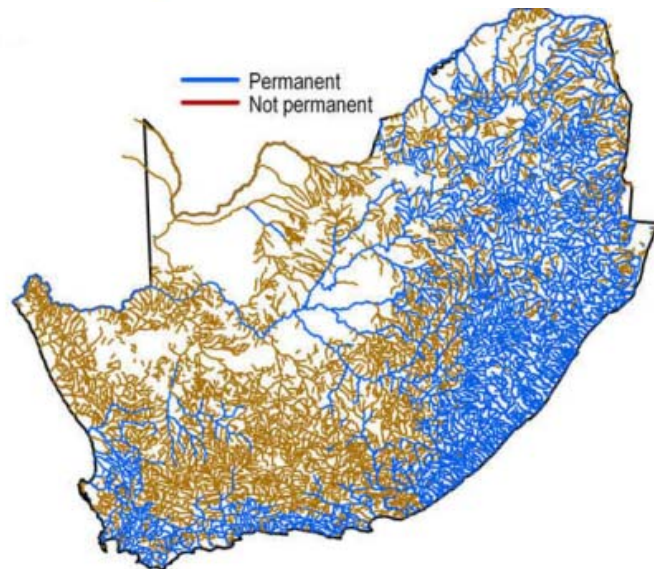




## 223 national river ecosystem types

Based on:

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

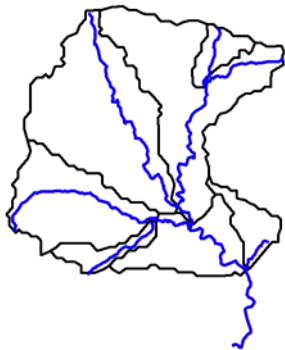




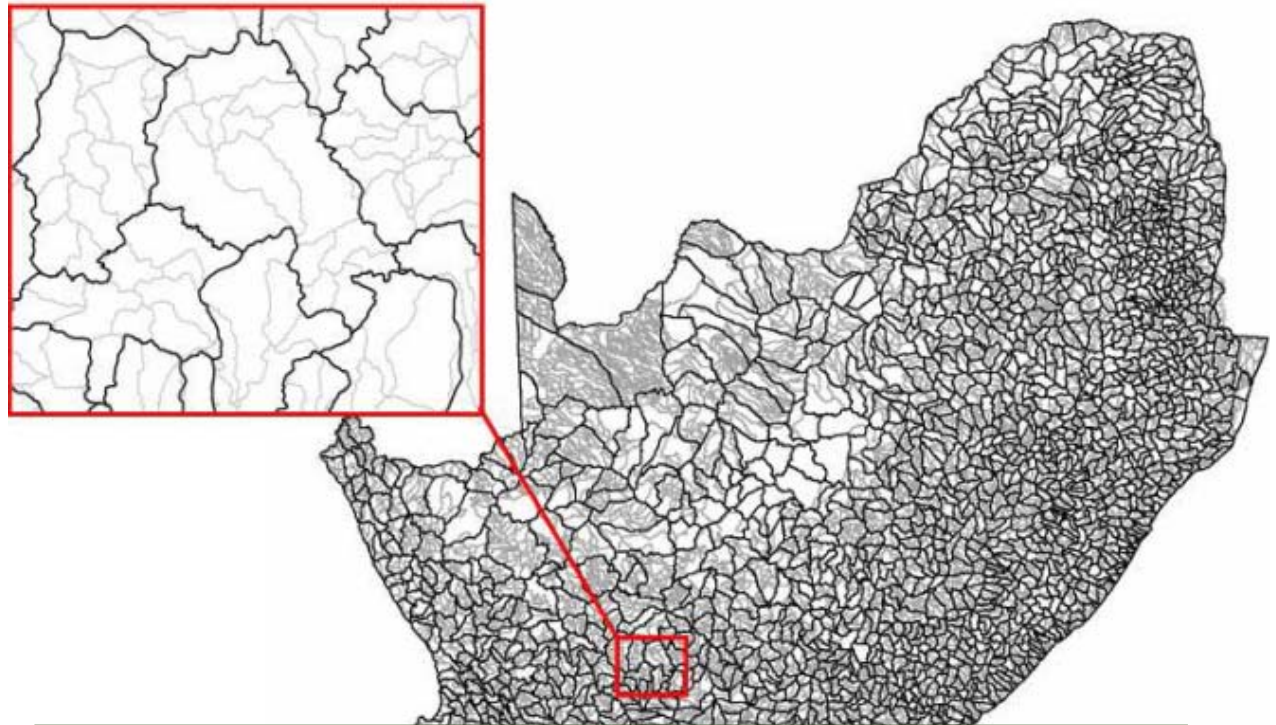
Rivers are nested in **catchments / river basins**  
System of primary through to sub-quaternary catchments



- **Quaternaries**  
Average size ~650 km<sup>2</sup>



- **Sub-quaternaries** 8547  
Average size ~170 km<sup>2</sup>



Spatial units for river accounts:  
**river reaches** within quaternary catchments

# Assessing condition of river ecosystems



**water & sanitation**

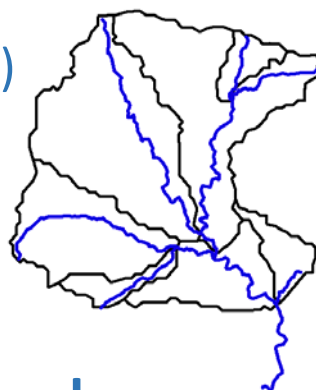
Department:  
Water and Sanitation  
REPUBLIC OF SOUTH AFRICA

## Two comprehensive national assessments of river condition, in 1999 and 2011

Based on **four indicators**:

- Flow (quantity, timing, velocity)
- Water quality
- Instream habitat
- Riparian habitat

→ assessed for **each river reach**  
at quaternary catchment scale



### **How?**

Combination of  
gathering available data  
and then applying  
expert knowledge

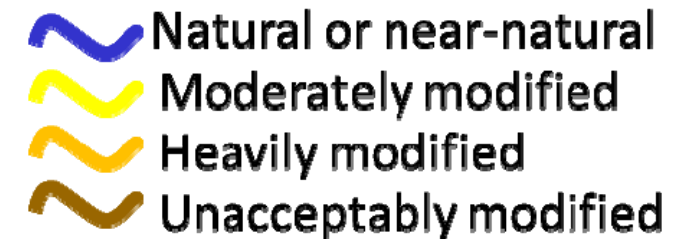
Indicators then aggregated to an **ecological condition category**  
for each river reach

# Ecological condition categories for rivers

– used by Department of Water & Sanitation

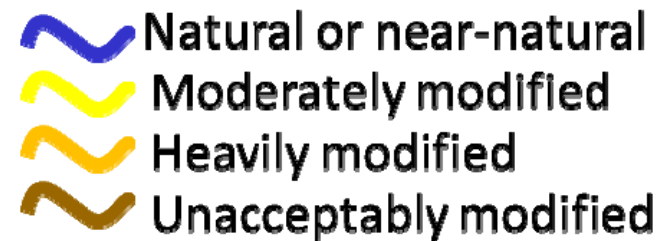
- 6 categories, grouped to 4 for accounts

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.



# Reference condition

Assessment of condition is based on **degree of modification** from a **reference condition of “natural”**



**NB: This does NOT mean that all rivers must be natural**

For example, hard-working rivers are often heavily modified, and can be sustainably used in that condition

**Important not to confuse reference condition with desired or ideal condition**



Putting this into an accounting framework

# Ecosystem extent accounts for rivers

- Options for measuring extent of rivers
  - **Length** – 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

<b>km</b>	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
<b>Total</b>	<b>76 310</b>	<b>87 223</b>	<b>163 533</b>	<b>100</b>

## River extent account by longitudinal zone

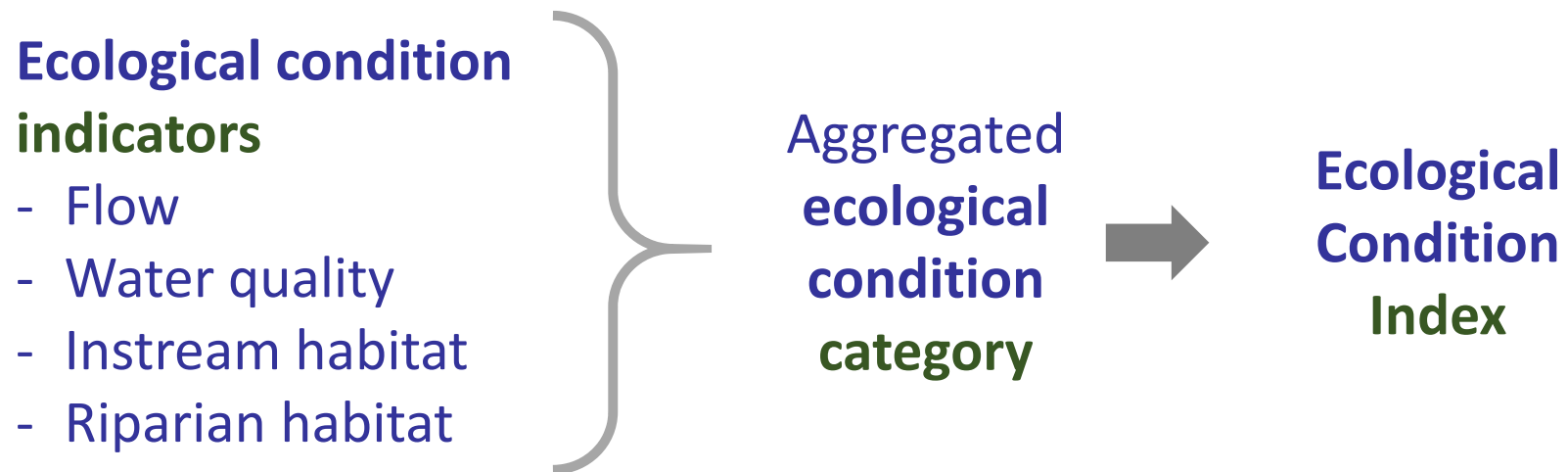
<b>km</b>	Main rivers	Tributaries	All rivers	% total river length*
Mountain stream	1 609	5 145	6 754	4
Upper foothill stream	21 566	52 592	74 158	45
Lower foothill stream	38 893	27 553	66 445	41
Lowland river	14 243	1 008	15 251	9
No Data	0	926	926	1
<b>Total</b>	<b>76 310</b>	<b>87 223</b>	<b>163 533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

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

Lowland rivers often heavily impacted – fertile flood plains



## Three options for ecosystem condition account





## 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				No Data	Total
	None/ small	Moderate	Large	Serious/ Critical		
<b>Flow (km)</b>						
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	
<b>Opening stock 2011</b>	<b>23 538</b>	<b>20 499</b>	<b>16 345</b>	<b>10 576</b>	<b>5 352</b>	<b>76 310</b>
Opening stock as a % total river length	31	27	21	14	7	100

### Water quality

	Degree of modification from natural				No Data	Total
	None/ small	Moderate	Large	Serious/ Critical		
<b>Water quality (km)</b>						
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	
<b>Opening stock 2011</b>	<b>34 810</b>	<b>21 043</b>	<b>11 667</b>	<b>3 439</b>	<b>5 352</b>	<b>76 310</b>
Opening stock as a % total river length	46	28	15	5	7	100

Ecosystem condition account based on  
**4 ecological condition indicators**

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

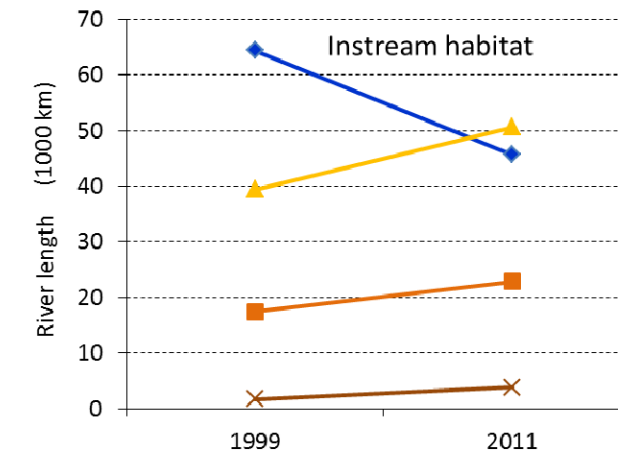
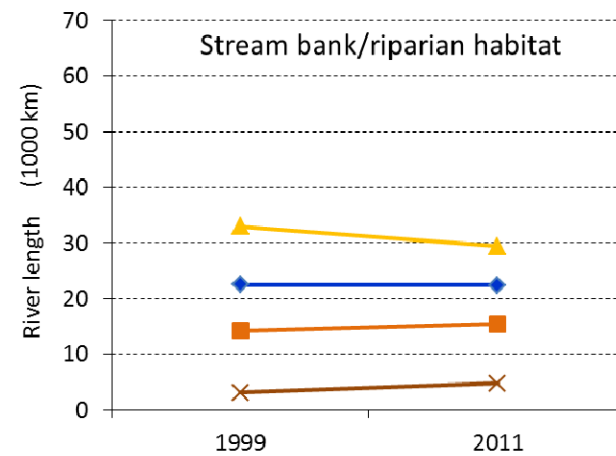
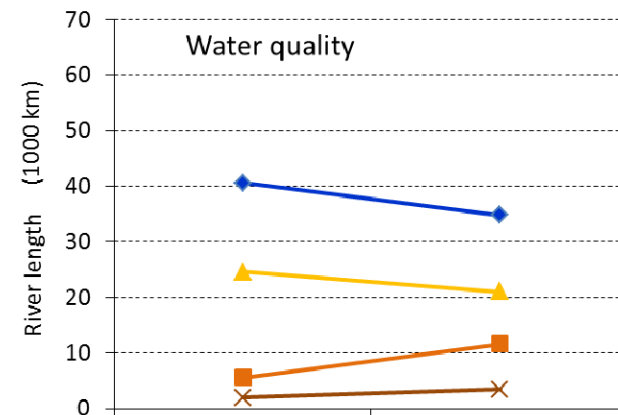
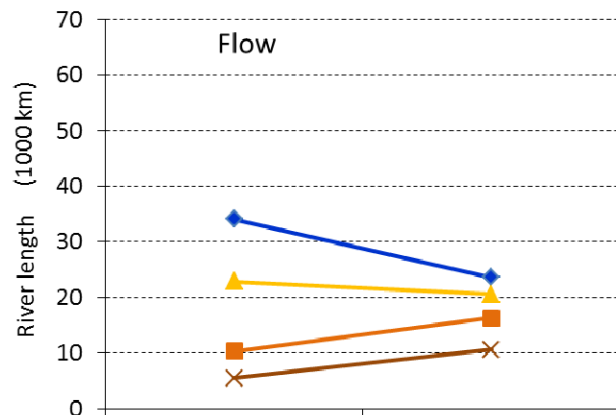
Riparian  
habitat

	Degree of modification from natural				No Data	Total
	None/ small	Moderate	Large	Serious/ Critical		
<b>Stream bank/riparian habitat (km)</b>						
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	
<b>Opening stock 2011</b>	<b>22 418</b>	<b>29 339</b>	<b>15 420</b>	<b>4 755</b>	<b>4 379</b>	<b>76 310</b>
Opening stock as a % total river length	29	38	20	6	6	100

Instream  
habitat

	Degree of modification from natural				No Data	Total
	None/ small	Moderate	Large	Serious/ Critical		
<b>Instream habitat (km)</b>						
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	
<b>Opening stock 2011</b>	<b>28 491</b>	<b>26 615</b>	<b>13 626</b>	<b>3 200</b>	<b>4 379</b>	<b>76 310</b>
Opening stock as a % total river length	37	35	18	4	6	100

## Changes in 4 ecological condition indicators 1999-2011



—◆— None/ small      —▲— Moderate  
—■— Large      —×— Serious/ Critical

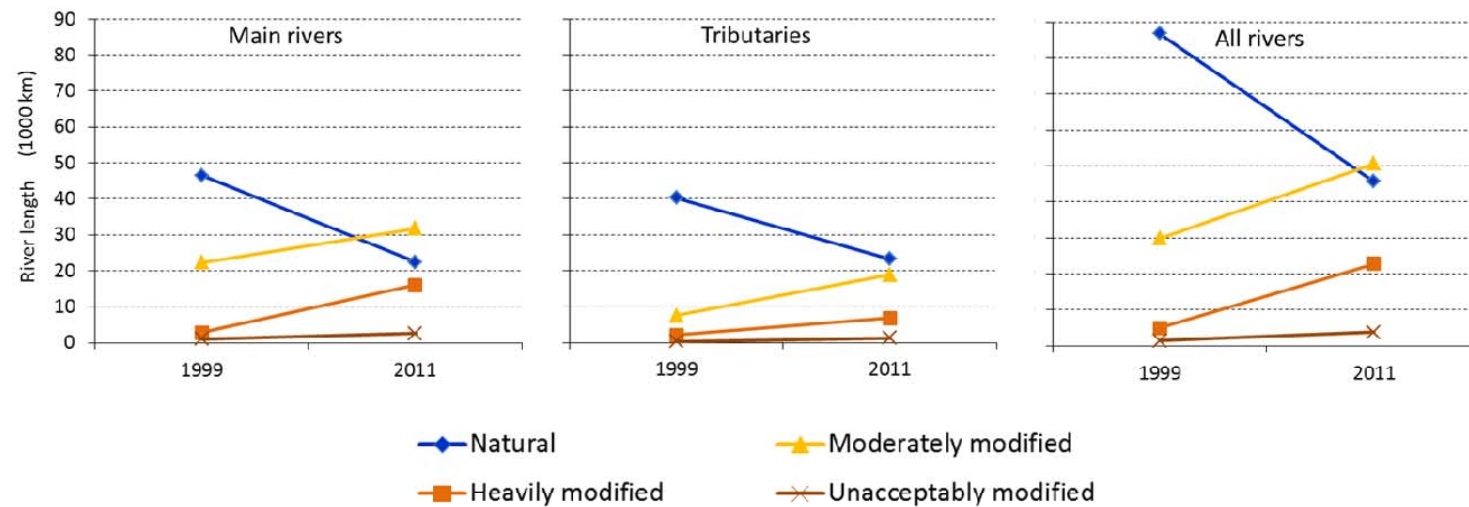
## Ecosystem condition account based on aggregated **ecological condition category**

Changes reported in absolute (km) and percentage terms

<b>All rivers (km)</b>	Natural	Moderately modified	Heavily modified	Unacceptably modified	No Data	Total
<b>Opening stock 1999</b>	<b>86 835</b>	<b>29 784</b>	<b>4 875</b>	<b>1 354</b>	<b>40 684</b>	<b>163 533</b>
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	
<b>Opening stock 2011</b>	<b>45 673</b>	<b>50 591</b>	<b>22 810</b>	<b>3 776</b>	<b>40 684</b>	<b>163 533</b>
Opening stock as % total river length	28	31	14	2	25	100

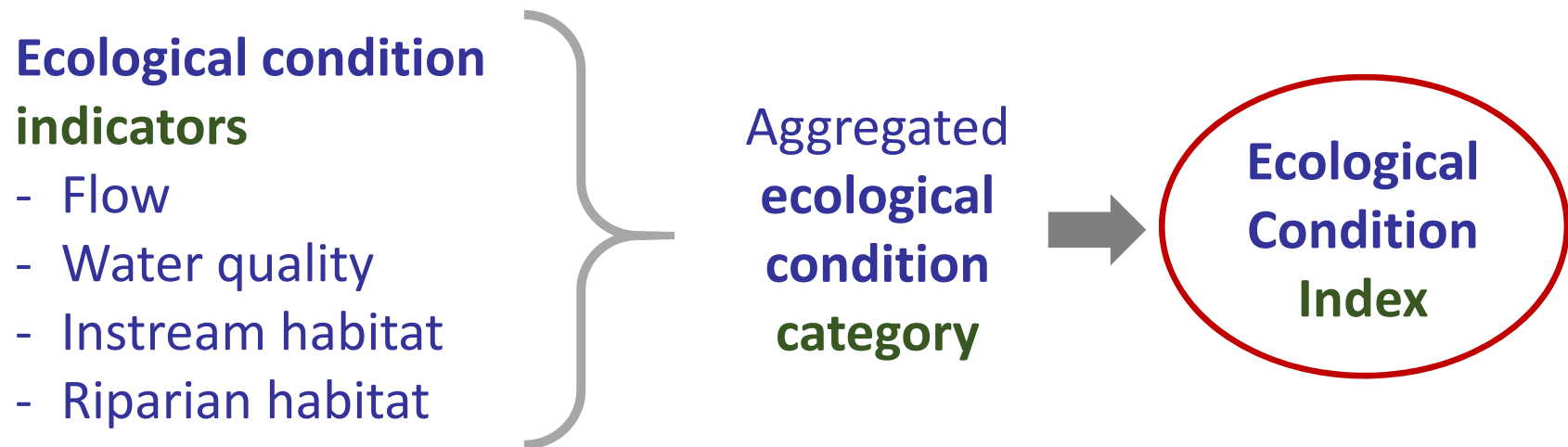
- **Big decrease in extent of river length in natural category**
- Large increase in extent of river length in heavily modified category
- Unacceptably modified rivers – small proportion of total river length (< 5% in 2011), but large percentage increase

## Changes in aggregated **ecological condition category** 1999-2011





## Three options for ecosystem condition account

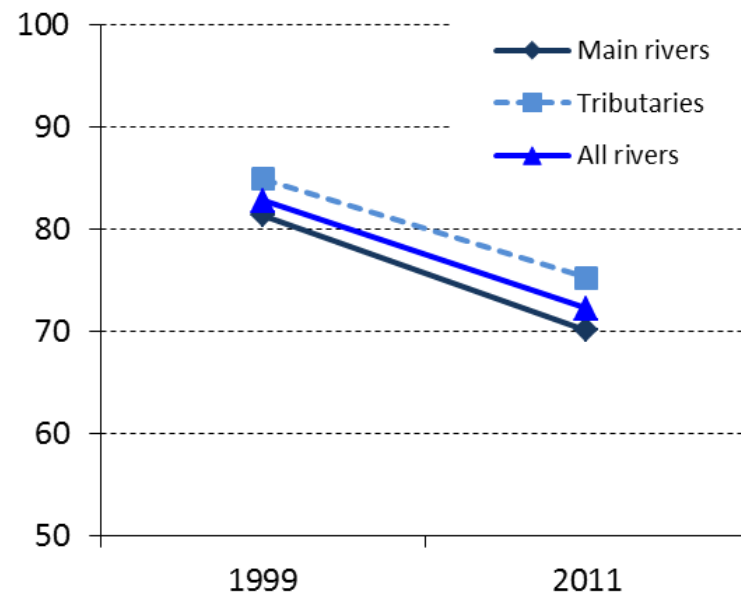


## Advantages of an **Ecological Condition Index**

- A single integrated index to show ecological condition in a simple but ecologically meaningful way
- Weighted by length of river reach
- Scalable
  - can do for any particular area from river reach to whole country

# Ecological Condition Index

	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

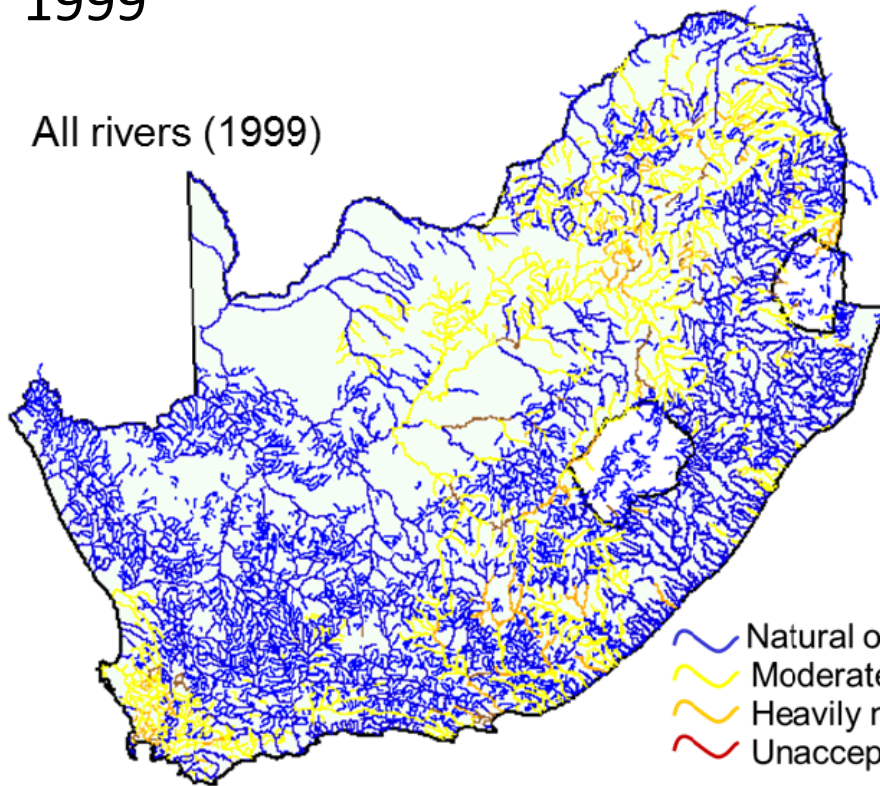


Overall  
**10% decline** in  
ecological condition  
of rivers  
1999 - 2011

Results of the account can be mapped – **ecological condition category**  
very useful for displaying results spatially

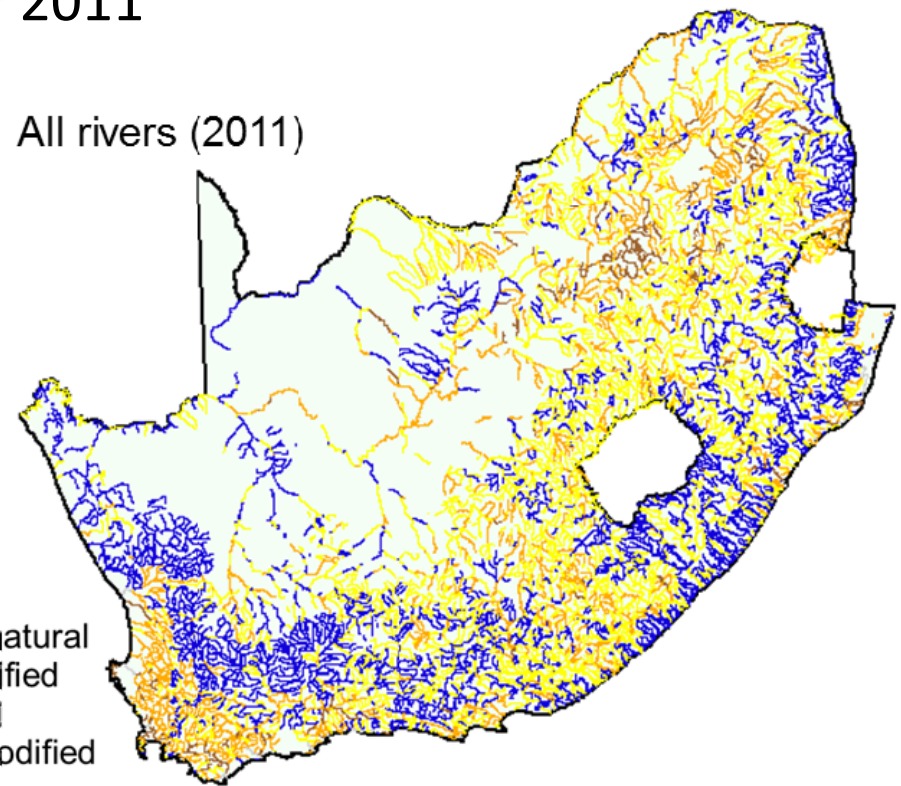
1999

All rivers (1999)



2011

All rivers (2011)

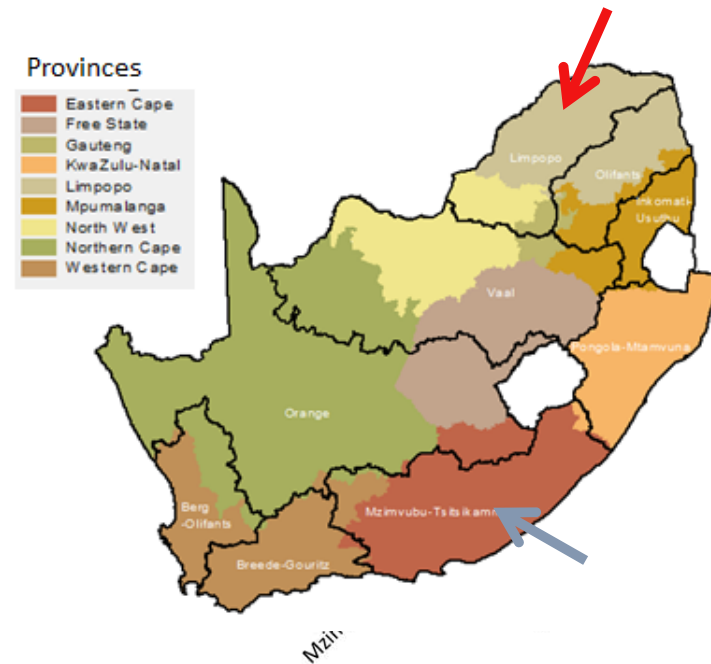
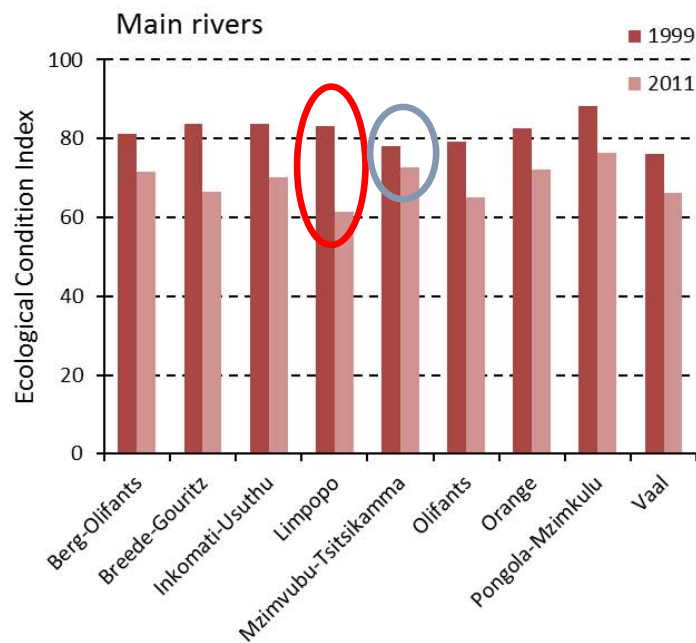


- ~ Natural or **near-natural**
- ~ **Moderately modified**
- ~ **Heavily modified**
- ~ **Unacceptably modified**

**Ecological Condition Index** can be spatially 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 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



Now building on this with  
Natural Capital Accounting & Valuation of Ecosystem Services  
(NCA&VES) project

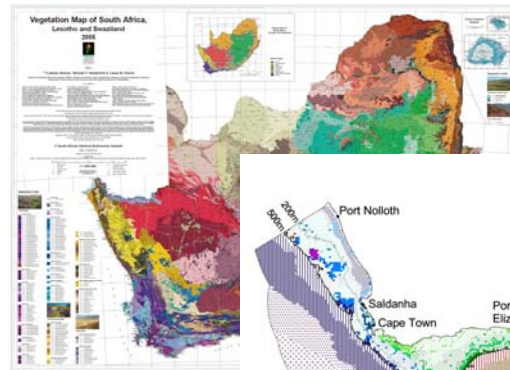


**Five pilot countries:** Brazil, China, India, Mexico, **South Africa**

# Accounts to be produced in NCA&VES Project in South Africa

National

National  
**ecosystem  
asset**  
accounts –  
terrestrial &  
marine,  
extent &  
condition



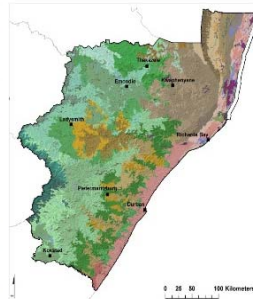
Species accounts –  
rhino, cycads



Protected  
**area**  
accounts –  
terrestrial &  
marine



Sub-national



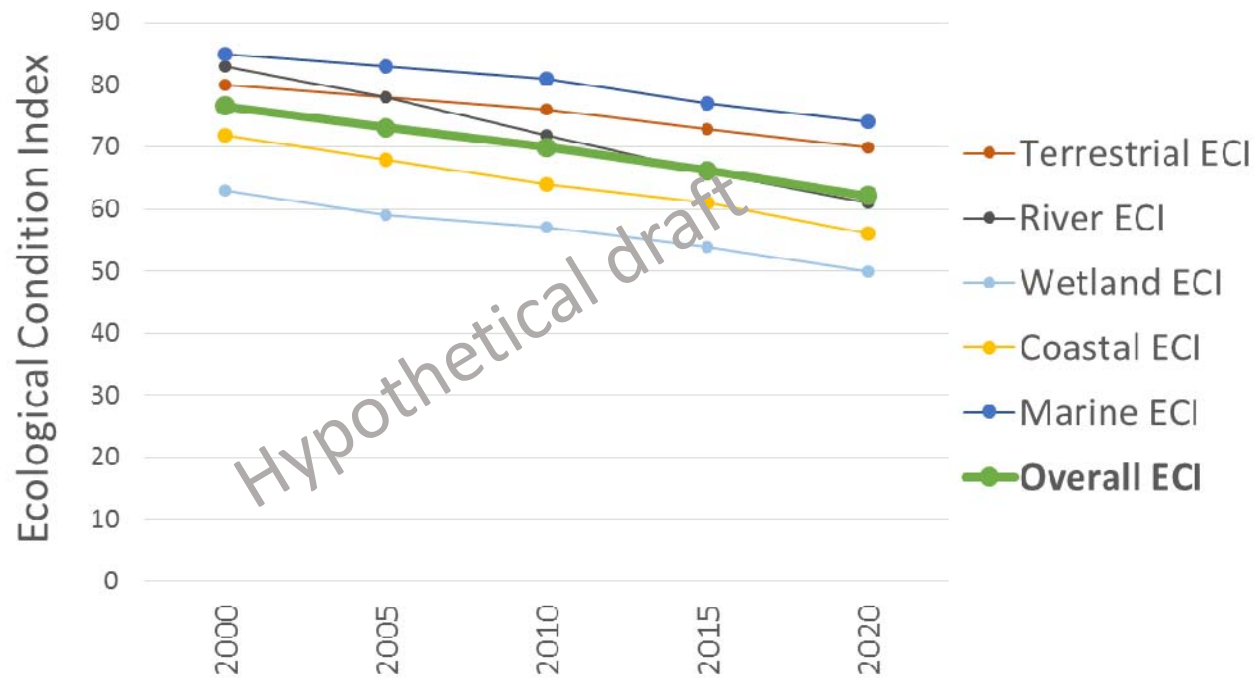
KZN: Full suite of  
**ecosystem asset**  
**and ecosystem**  
**service** accounts

**City-regions:** land and  
ecosystem accounts for  
selected metros



# Working towards an **Ecological Condition Index** for all realms, from terrestrial through to offshore marine

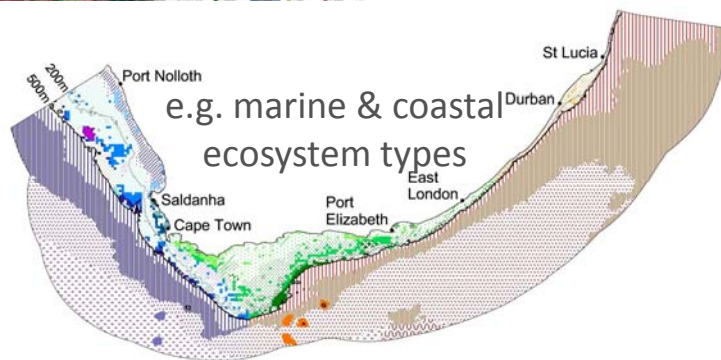
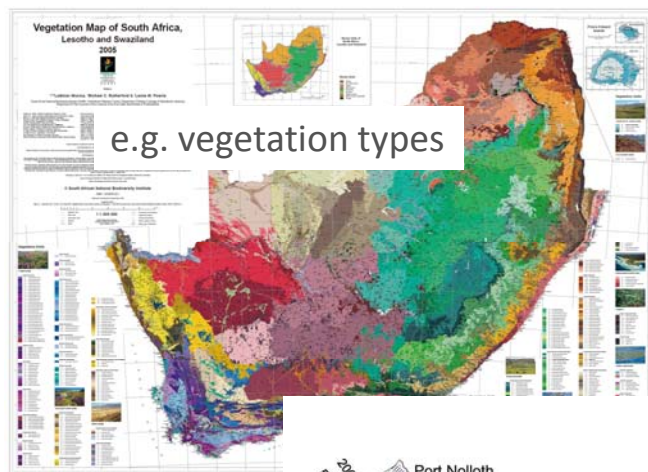
## Hypothetical Ecological Condition Index for South Africa



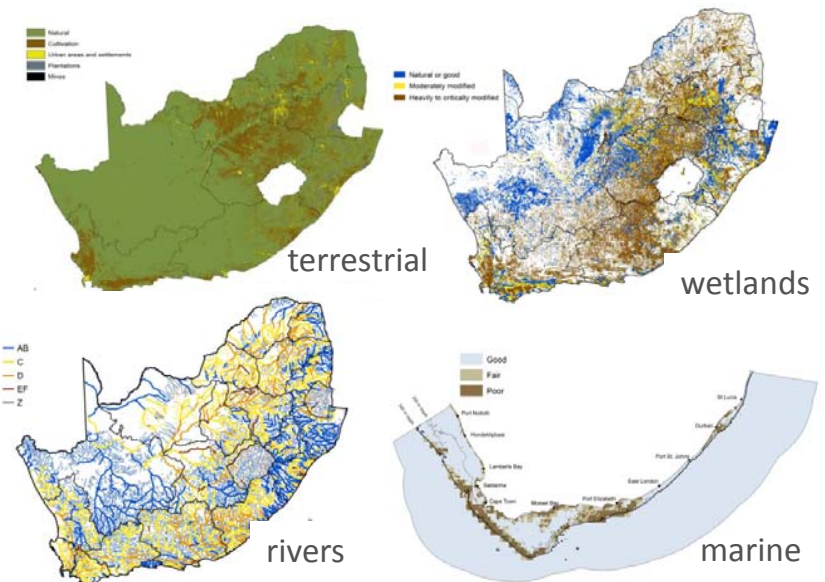
ECI could be compared  
against  
**critical thresholds** for  
**ecological functioning** and  
**persistence of species**,  
and could be used to  
set targets

# National Biodiversity Assessment provides science foundations / building blocks for ecosystem asset accounts

→ Classification & mapping of ecosystem types



→ Maps of ecological condition

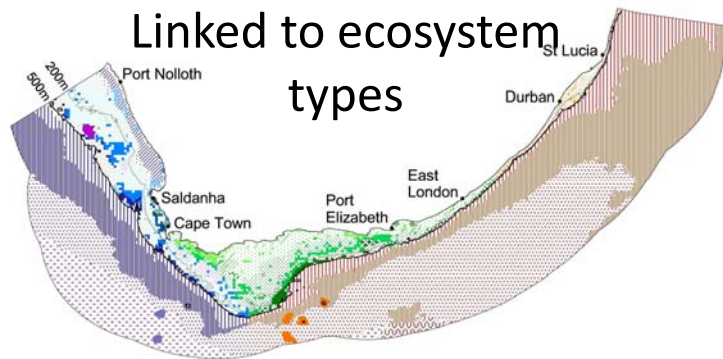
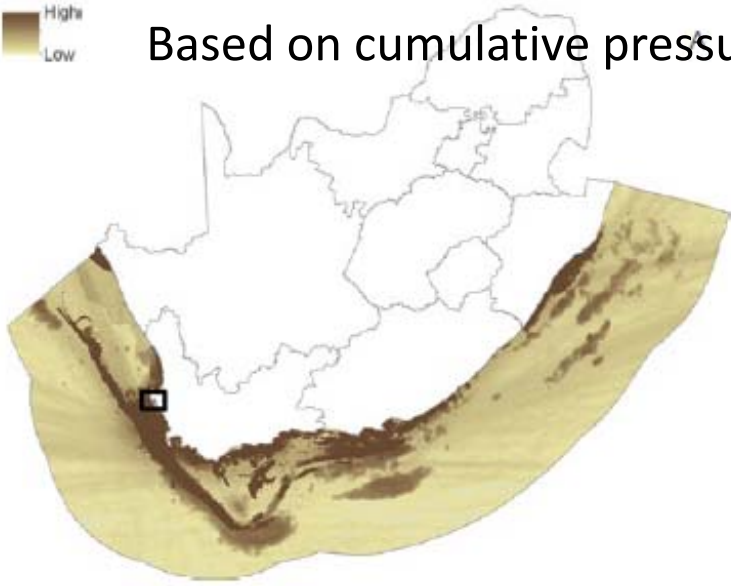




# Condition assessment in the marine realm

High  
Low

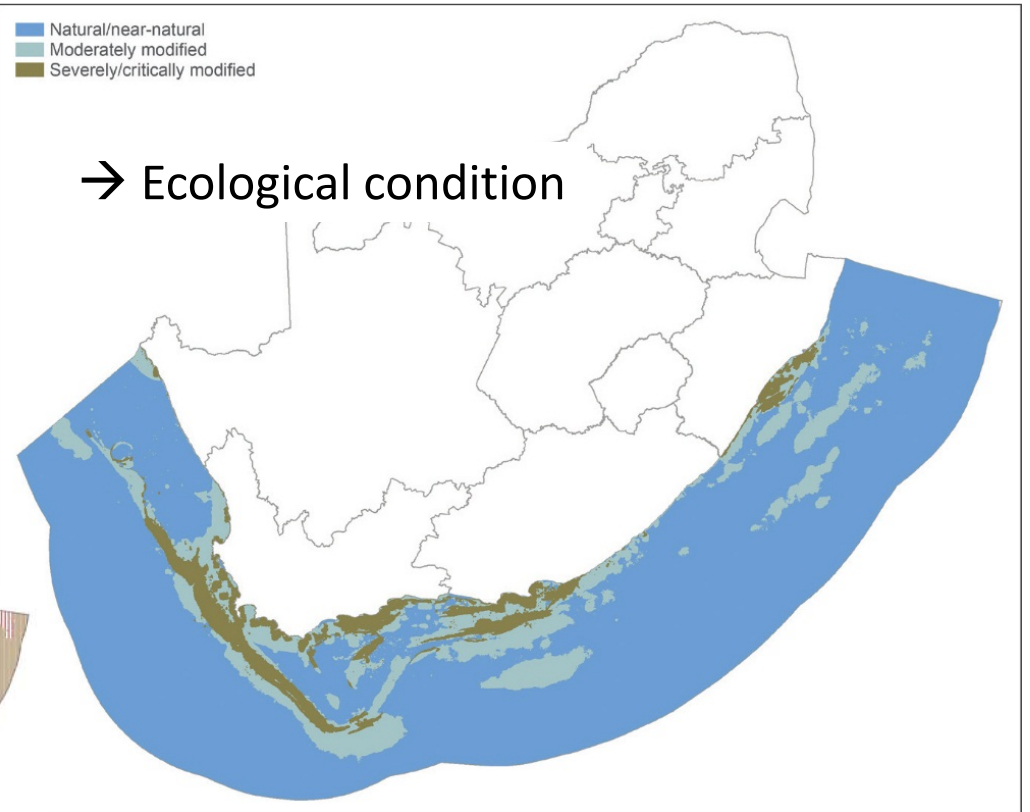
Based on cumulative pressures



Linked to ecosystem  
types

Natural/near-natural  
Moderately modified  
Severely/critically modified

→ Ecological condition



Condition assessment in the terrestrial realm: based strongly on **land cover data**, which shows areas where natural ecosystems have been severely or critically modified

