Indicators from the Ecosystem Extent Account
Results and a proposal from South Africa

Virtual Expert Forum on Ecosystem Accounting

10 November 2020

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Outline

- Quick look at national terrestrial ecosystem extent account
  - Foundational spatial data layers
  - Key results – tables and maps

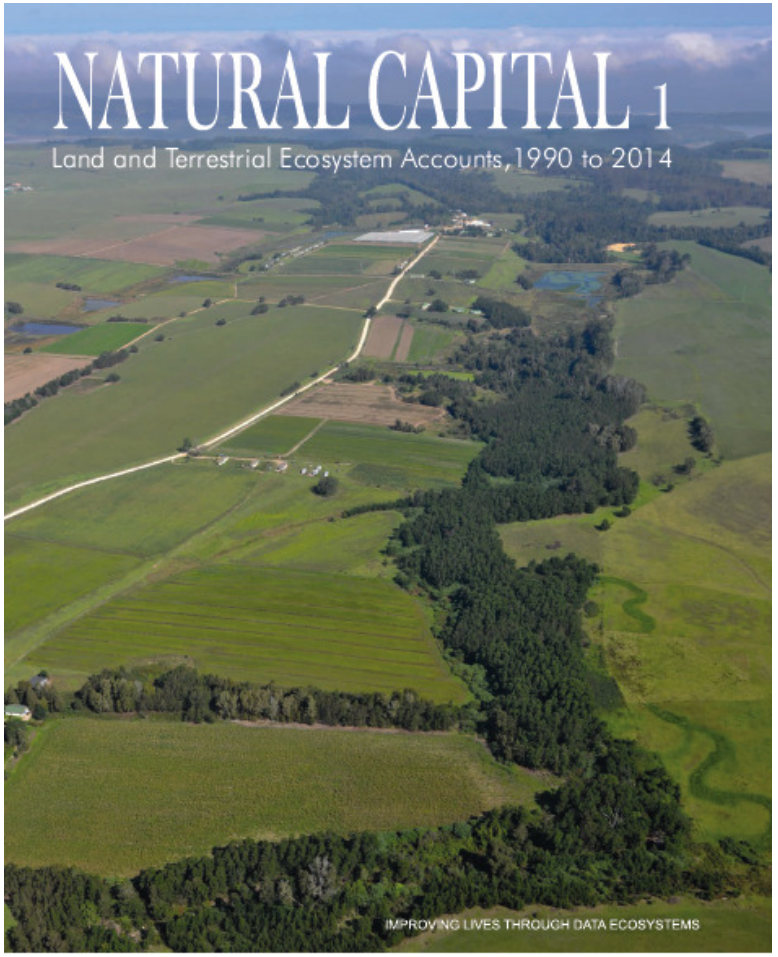
- Indicators drawn from the account
  - Proposed indicators in Chapter 14 – examples
  - Additional indicator: Ecosystem Extent Index

Key points

- Usefulness of including **reference extent** as well as opening and closing extent in the extent account
- Allows for an additional indicator – **Ecosystem Extent Index**
- Ecosystem Extent Index allows additional information to be drawn from the extent account, including about biodiversity

Quick look at South Africa's terrestrial ecosystem extent accounts

- Presented together with national land accounts
- To be published by Statistics South Africa in week of 23 November
- First publication in Stats SA's new *Natural Capital* series!



Foundational data layers

- National Vegetation Map
  - Provides **natural** biomes and ecosystem types

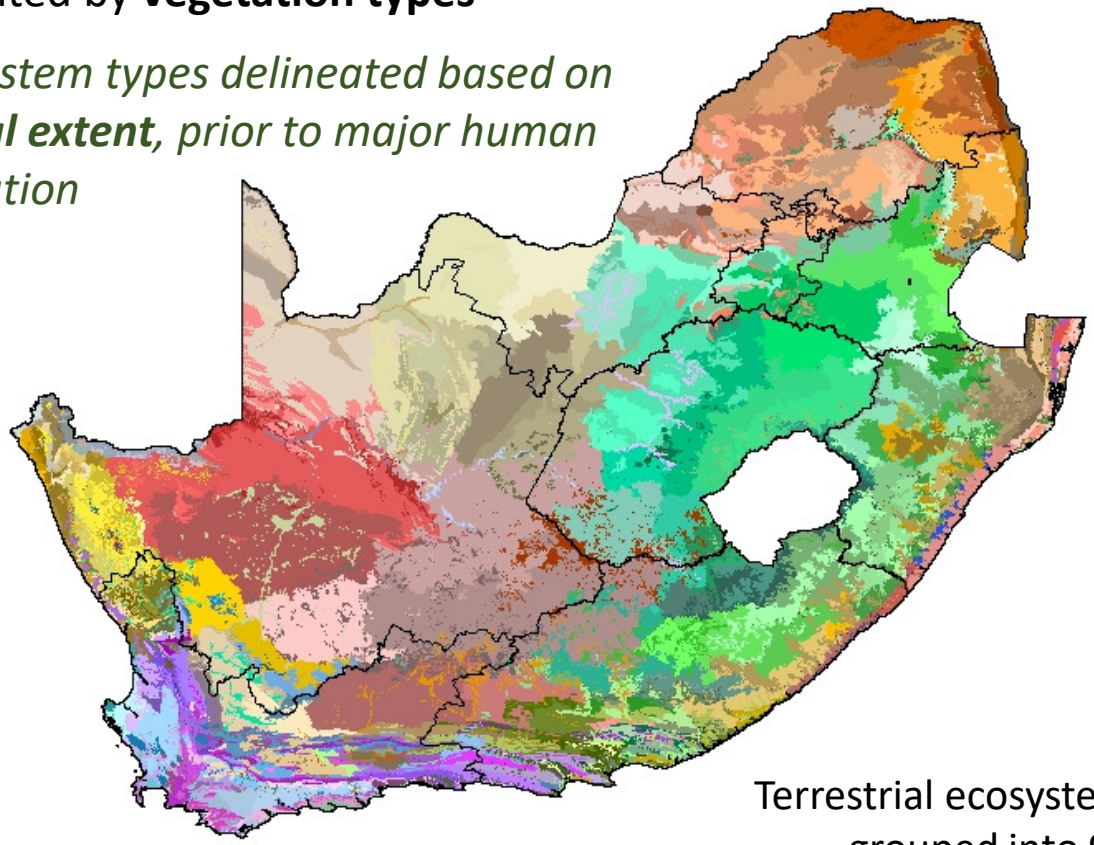
- National Land Cover
  - Provides **intensively modified** biomes and ecosystem types

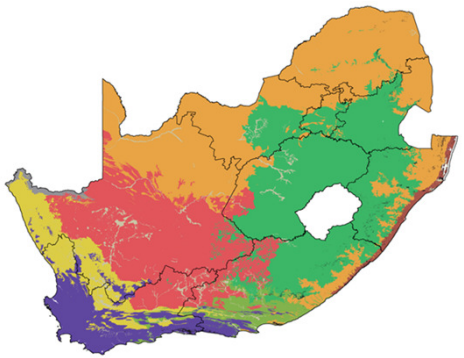
Foundational data layer: National Vegetation Map

Part of National Ecosystem Classification System

458 terrestrial ecosystem types,
represented by **vegetation types**

→ *Ecosystem types delineated based on* ***historical extent****, prior to major human modification*





Terrestrial ecosystem types are grouped into 9 **biomes** →

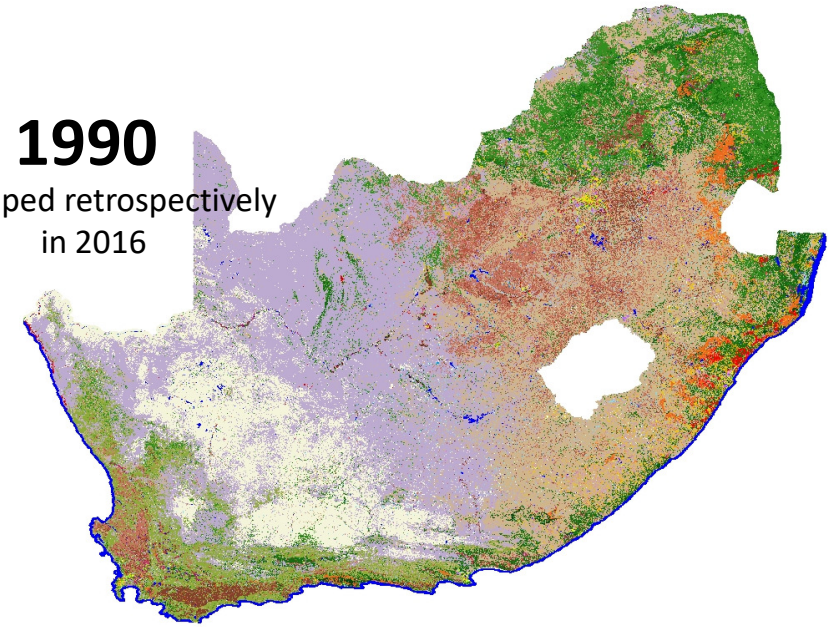
Biomes

- Albany Thicket
- Desert
- Forests
- Fynbos
- Grassland
- Indian Ocean Coastal Belt
- Nama-Karoo
- Savanna
- Succulent Karoo
- Azonal Vegetation
- Provincial boundary

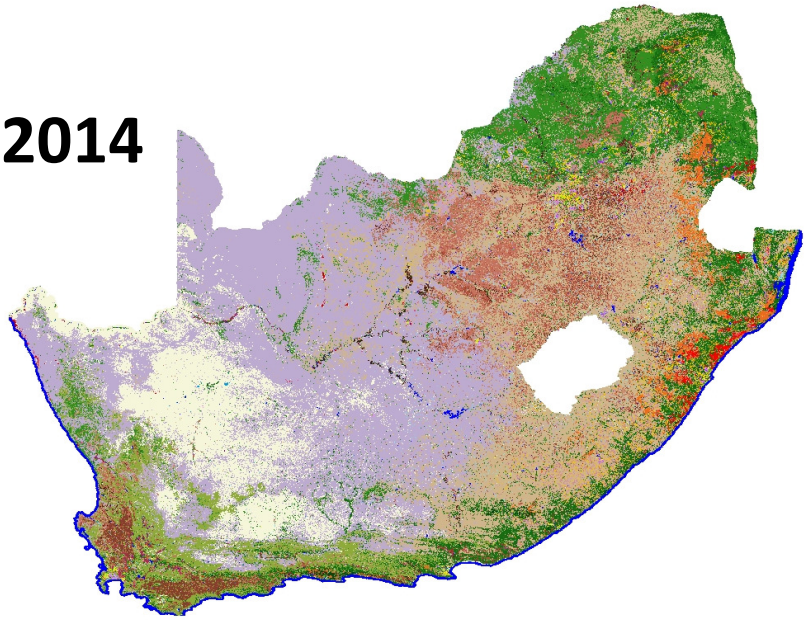
Foundational data layer: National Land Cover

1990

Developed retrospectively in 2016



2014



environmental affairs
Department:
Environmental Affairs
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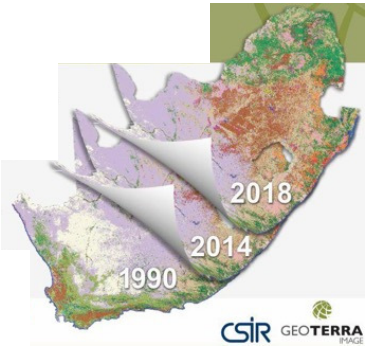
GEOTERRA IMAGE

Recently available for **2018**



Grouping of 72 National Land Cover classes into nested tiers

Broad land cover classes *Tier 1: 4 classes*	Main land cover classes *Tier 2: 8 classes*	Detailed land cover classes *Tier 3: 20 classes*	National Land Cover (NLC) classes *Tier 4: 72 classes*
Natural or semi-natural	Natural or semi-natural	Natural or semi-natural	8 land cover classes
Cultivated	Commercial crops	Cultivated commercial fields	4 land cover classes
		Cultivated commercial pivots	3 land cover classes
		Sugarcane	6 land cover classes
	Subsistence crops	Subsistence crops	3 land cover classes
	Orchards and vines	Orchards	3 land cover classes
		Vines	3 land cover classes
	Timber plantations	Timber plantations	3 land cover classes
Built-up	Urban	Urban parkland	4 land cover classes
		Urban industrial	1 land cover class
		Urban commercial	1 land cover class
		Urban built-up	4 land cover classes
		Urban residential	4 land cover classes
		Urban township	4 land cover classes
		Urban informal	4 land cover classes
		Urban smallholding	4 land cover classes
		Urban village	4 land cover classes
		Urban school and sports ground	1 land cover class
	Mines	Mines	5 land cover classes
Waterbodies	Waterbodies	Waterbodies	3 land cover classes

Natural or semi-natural classes grouped as a single class at Tier 1, 2 and 3

Intensively modified classes grouped into three tiers:

- align with **intensity of ecological impact**
- link to **socio-economic drivers** in the landscape as far as possible

Dual perspective on intensively modified areas

→ Seen as **land cover classes** in the **land account**

- **Tier 1 land cover classes**
  - Cultivated
  - Built-up

- **Tier 2 land cover classes**
  - Commercial crops
  - Subsistence crops
  - Orchards & vines
  - Timber plantations
  - Urban
  - Mines

→ Seen as **intensively modified ecosystem types** in the **ecosystem extent account**

- **Intensively modified "biomes"**
  - Cultivated
  - Built-up

- **Intensively modified "ecosystem functional groups"**
  - Commercial crops
  - Subsistence crops
  - Orchards & vines
  - Timber plantations
  - Urban
  - [Mines?]

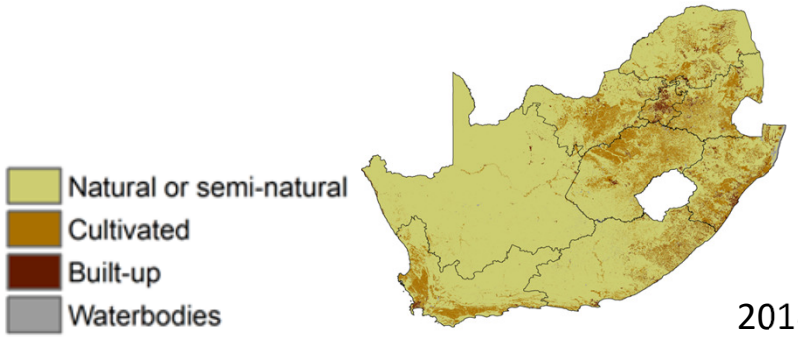
Land account for broad land cover classes (tier 1) at the national level, 1990–2014, in hectares

Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Opening stock 1990	**100 710 016**	**16 156 026**	**3 003 883**	**2 096 528**	**121 966 453**
Additions to stock	3 366 559	1 991 959	597 238	288 754	6 244 510
Reductions in stock	2 540 175	2 339 226	400 503	964 606	6 244 510
Net change in stock	826 384	(347 267)	196 735	(675 852)	
Net change as % of opening	**0.8%**	**-2.1%**	**6.5%**	**-32.2%**	
Unchanged (opening - reductions)	98 169 841	13 816 800	2 603 380	1 131 922	
Unchanged as % of opening	97.5%	85.5%	86.7%	54.0%	
Turnover (additions + reductions)	5 906 734	4 331 185	997 741	1 253 360	
Turnover as % of opening	5.9%	26.8%	33.2%	59.8%	
Closing stock 2014	**101 536 400**	**15 808 759**	**3 200 618**	**1 420 676**	**121 966 453**

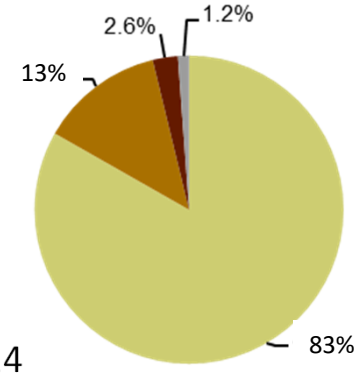
*The large net decrease in the extent of waterbodies reflects primarily that 1990 was a much wetter year than 2014.

By far the majority of South Africa's land area is **natural or semi-natural**

Not much change between 1990 and 2014 at the national level for tier 1 – BUT this hides a lot of sub-national variation and changes at tier 2 and 3



2014



Extent account for terrestrial ecosystem types summarised by biome

Natural biomes derived from National Vegetation Map

Intensively modified biomes derived from National Land Cover

Biomes	Albany Thicket	Desert	Forest	Fynbos	Grassland	IOCB	Nama-Karoo	Savanna	Succulent Karoo	Azonal vegetation	Cultivated*	Built-up*	Water-bodies**	TOTAL
Historical extent	**3 531 231**	**626 207**	**462 518**	**8 165 366**	**33 090 325**	**1 171 284**	**24 936 548**	**39 418 522**	**7 821 579**	**2 742 873**	-	-	-	**121 966 453**
Additions to extent	0	0	0	0	0	0	0	0	0	0	16 156 026	3 003 883	2 096 528	21 256 437
Reductions in extent	230 091	8 237	70 673	2 253 375	11 330 606	619 656	420 995	5 396 119	251 373	675 312	-	-	-	21 256 437
Net change in extent	(230 091)	(8 237)	(70 673)	(2 253 375)	(11 330 606)	(619 656)	(420 995)	(5 396 119)	(251 373)	(675 312)	-	-	-	
Net change as % of historical	**-6,5%**	**-1,3%**	**-15,3%**	**-27,6%**	**-34,2%**	**-52,9%**	**-1,7%**	**-13,7%**	**-3,2%**	**-24,6%**	-	-	-	
Closing extent 1990	**3 301 140**	**617 970**	**391 845**	**5 911 991**	**21 759 719**	**551 628**	**24 515 553**	**34 022 403**	**7 570 206**	**2 067 561**	**16 156 026**	**3 003 883**	**2 096 528**	**121 966 453**
Opening extent 1990	**3 301 140**	**617 970**	**391 845**	**5 911 991**	**21 759 719**	**551 628**	**24 515 553**	**34 022 403**	**7 570 206**	**2 067 561**	**16 156 026**	**3 003 883**	**2 096 528**	**121 966 453**
Additions to extent	44 432	1 142	24 900	241 184	1 444 446	75 114	146 910	1 160 055	38 422	189 954	1 991 959	597 238	288 754	6 244 510
Reductions in extent	36 008	1 260	7 689	196 035	1 180 183	63 783	78 038	885 303	33 631	58 021	2 339 226	400 503	964 606	6 244 286
Net change in extent	8 424	(118)	17 211	45 149	264 263	11 331	68 872	274 752	4 791	131 933	(347 267)	196 735	(675 852)	
Net change as % of opening	**0,3%**	**0,0%**	**4,4%**	**0,8%**	**1,2%**	**2,1%**	**0,3%**	**0,8%**	**0,1%**	**6,4%**	**-2,1%**	**6,5%**	**-32,2%**	
Net change in relation to historical extent	(221 667)	(8 355)	(53 462)	(2 208 226)	(11 066 343)	(608 325)	(352 123)	(5 121 367)	(246 582)	(543 379)	-	-	-	
Net change as % of historical	**-6,3%**	**-1,3%**	**-11,6%**	**-27,0%**	**-33,4%**	**-51,9%**	**-1,4%**	**-13,0%**	**-3,2%**	**-19,8%**	-	-	-	
Closing extent 2014	**3 309 564**	**617 852**	**409 056**	**5 957 140**	**22 023 982**	**562 959**	**24 584 425**	**34 297 155**	**7 574 997**	**2 199 270**	**15 808 759**	**3 200 618**	**1 420 676**	**121 966 453**

* Cultivated areas, built-up areas and waterbodies are treated as biomes for the purpose of the ecosystem extent account table. There is no reliable spatial information on the historical extent of waterbodies, subsistence cultivation or habitation.

** The large net decrease in the extent of waterbodies reflects primarily that 1990 was a much wetter year than 2014. Waterbodies include both natural and artificial water bodies (such as dams).

Indicators drawn from the extent account

Suggested in Chapter 14 (Table 14.1)

1. ✓Percentage EAA covered by specific ETs
2. ✓[Net] change in area covered by specific ETs [ha and %]
3. ✓Percentage of area unchanged
4. ✓Percentage of area changed [we've called this turnover]

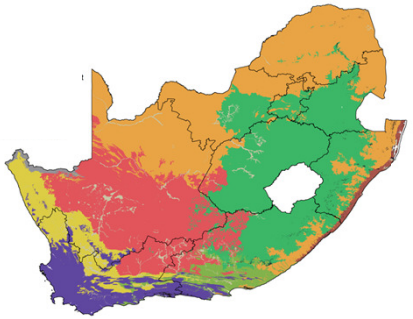
These are explicitly included in the land account table.
Not explicitly included in extent account table but could easily be.

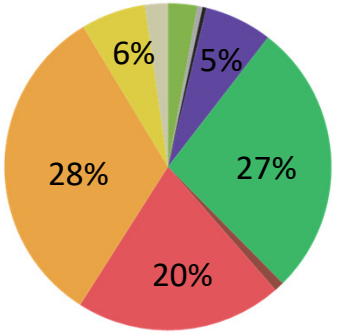
Not suggested in Chapter 14

- Ecosystem Extent Index

Examples of each indicator

① Proportion of EAA covered by specific ecosystem types



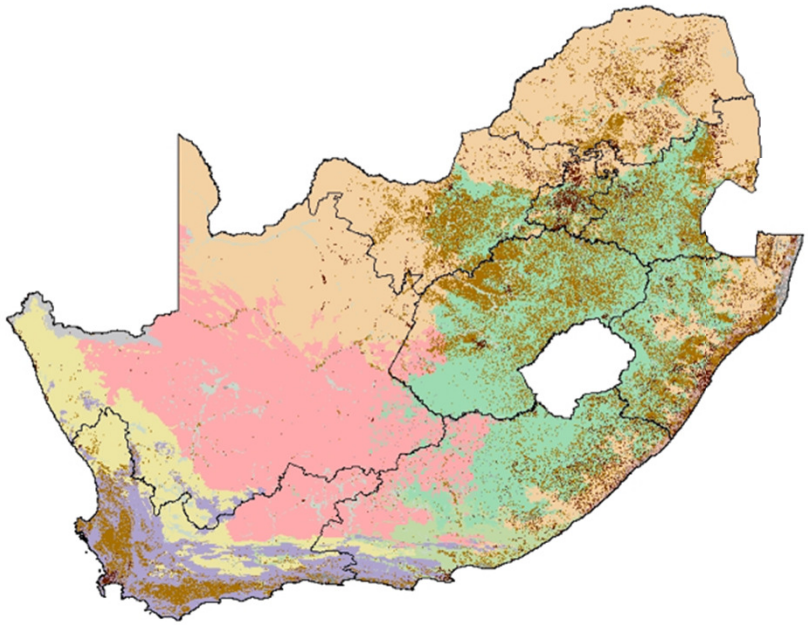


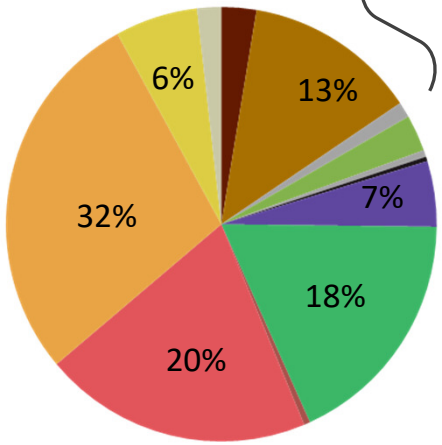
Historical reference

2014

Intensively modified "biomes"
- Built-up
- Cultivated
- Waterbodies

Natural or semi-natural biomes
- Albany Thicket
- Desert
- Forest
- Fynbos
- Grassland
- Indian Ocena Coastal Belt
- Nama-Karoo
- Savanna
- Succulent Karoo
- Azonal Vegetation
- Provincial boundary



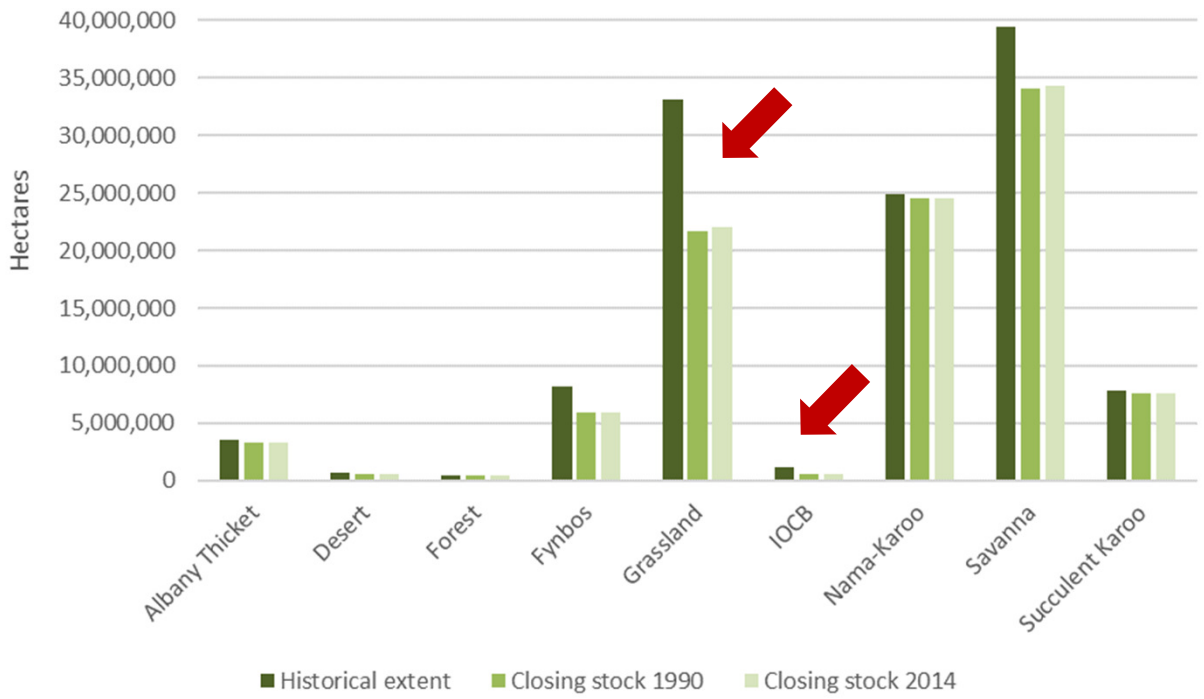


Intensively modified biomes have replaced portions of natural biomes

② Net change in area covered by specific ETs
(expressed in absolute or percentage terms)

Largest changes in natural biomes 1990 – 2014

- Largest *absolute decrease* in Grassland biome, from 33m ha to 22m ha
- Largest *percentage decrease* in Indian Ocean Coastal Belt, from 1.2m ha to 0.6m ha



③ Percentage of area unchanged

Definition

- (opening extent – reductions) / opening extent

- An indicator of **stability** in the landscape
- Proved a less useful indicator – not one we drew on in the results report

④ Percentage of area changed [we've called this percentage **turnover**]

Definition

- (additions + reductions) / opening extent

- Can indicate socio-economic changes in the landscape

Example

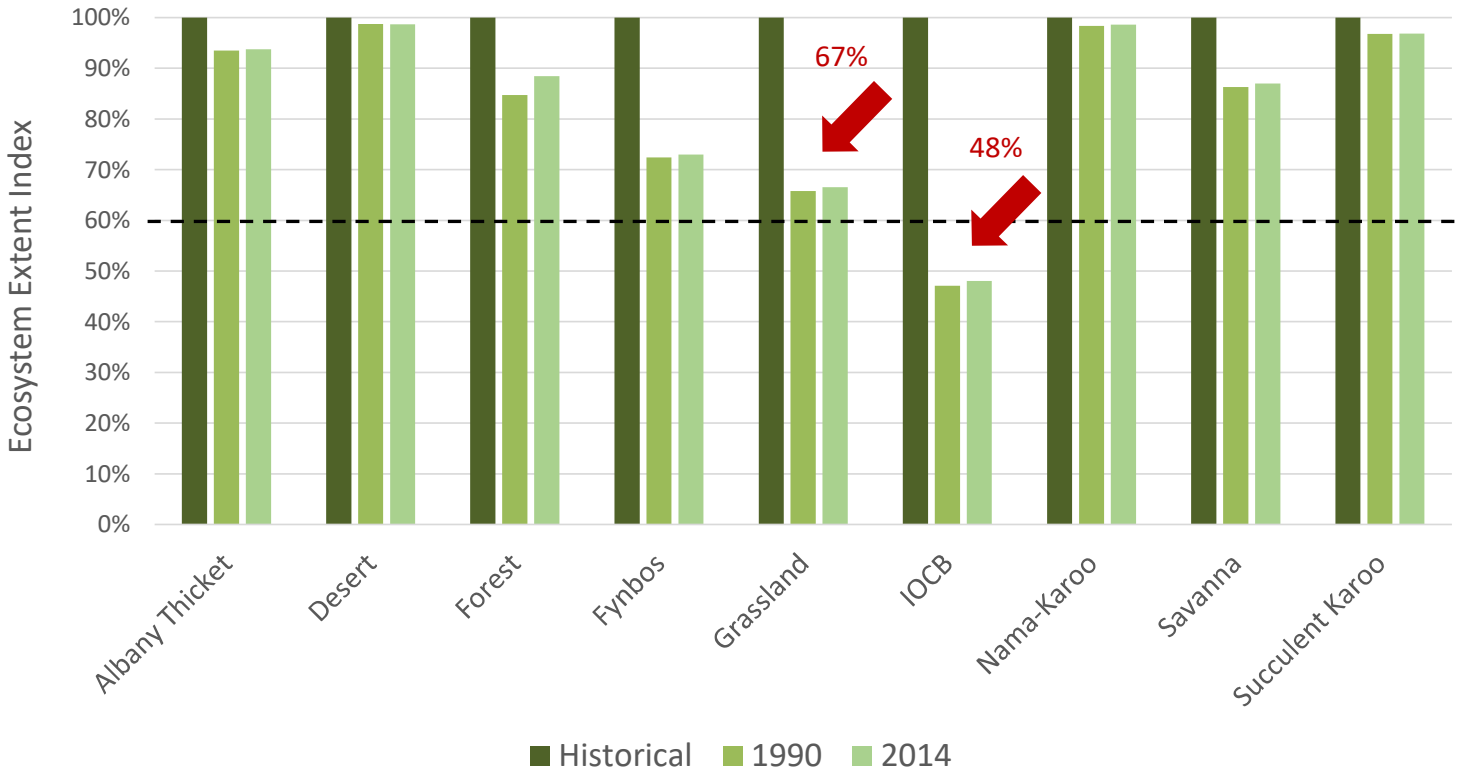
- **Net change** in subsistence crops of **only 1.1%**
  - from 1.95 million ha in 1990 to 1.97 million ha in 2014
- BUT **turnover was 46%** - indicating substantial changes in where cropping took place
  - Change matrix and maps can provide additional info to help interpret these shifts

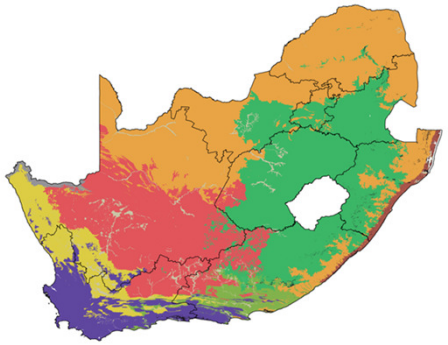
Additional indicator: Ecosystem Extent Index

Definition

- closing extent / historical extent
- i.e. extent at the end of the accounting period as a proportion of historical extent

Ecosystem Extent Index can be evaluated against thresholds, for example, a threshold for ecological functioning





Ecological function threshold

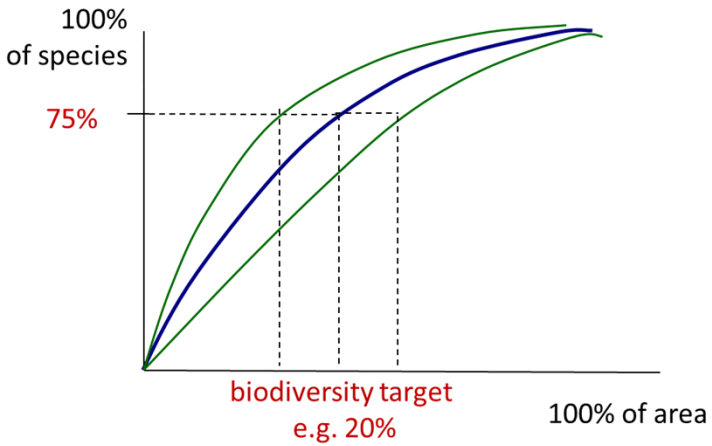
Biomes

- Albany Thicket
- Desert
- Forests
- Fynbos
- Grassland
- Indian Ocean Coastal Belt
- Nama-Karoo
- Savanna
- Succulent Karoo
- Azonal Vegetation
- Provincial boundary

Ecosystem Extent Index can provide information about biodiversity

Every ecosystem type in South Africa has a "biodiversity target"

Biodiversity target = minimum proportion of the historical extent of an ecosystem type that must remain in natural condition in order to conserve the majority of species associated with that ecosystem type



→ Higher for more species-rich ecosystem types

→ Ranges from 16% to 36% of historical extent for terrestrial ecosystem types

(In the absence of data to create species-area curves, a flat 20% or 30% target is perfectly workable)

Desmet, P. and R. Cowling. 2004. Using the species–area relationship to set baseline targets for conservation. Ecology and Society 9(2): 11. [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art11

E&S

Report

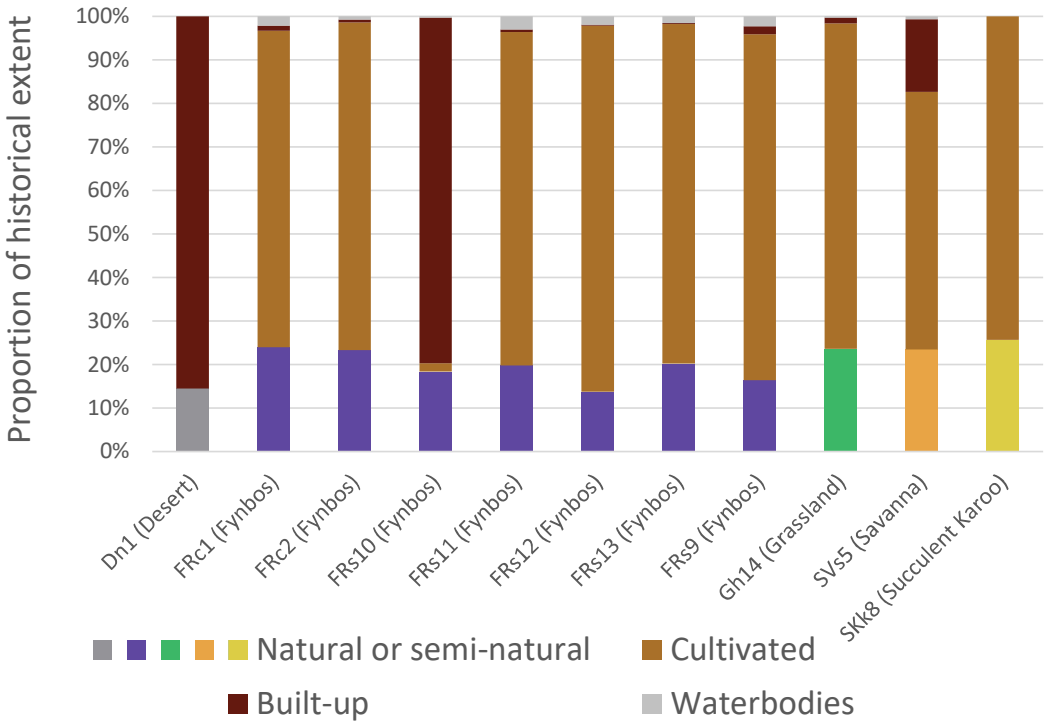
Using the Species–Area Relationship to Set Baseline Targets for Conservation

Philip Desmet[1] and *Richard Cowling*[2]

Desmet & Cowling 2004

Evaluating Ecosystem Extent Index against the biodiversity target

11 terrestrial ecosystem types in South Africa have an Ecosystem Extent Index that is less than their **biodiversity target**



Intensively modified ecosystem types have replaced large proportions of the historical extent of these ecosystem types

Remaining natural or semi-natural area

Ecosystem Extent Index requires a reference extent that remains constant across accounting periods

- Possible for natural ecosystem types in SA because they are mapped based on historical extent, which provides a stable reference extent
- In SA context, Ecosystem Extent Index cannot be meaningfully calculated for intensively modified ecosystem types, as their historical extent is zero

Generalised definition of Ecosystem Extent Index

- **closing extent / reference extent**

Important points

- Reference extent could be historical (e.g. pre-industrial) OR any other stable baseline
- A pre-industrial reference extent could include both natural and intensively modified ecosystem types in regions where humans have intensively modified the landscape for many hundreds or thousands of years

Key points

- Proposal to include **reference extent** as well as opening and closing extent in the extent account
- Allows for an additional indicator – **Ecosystem Extent Index**
- Ecosystem Extent Index can be **evaluated against thresholds** for ecosystem services and biodiversity
- (For another day: Ecosystem Extent Index **complements Ecosystem Condition Index** – ideally should be interpreted as a pair)

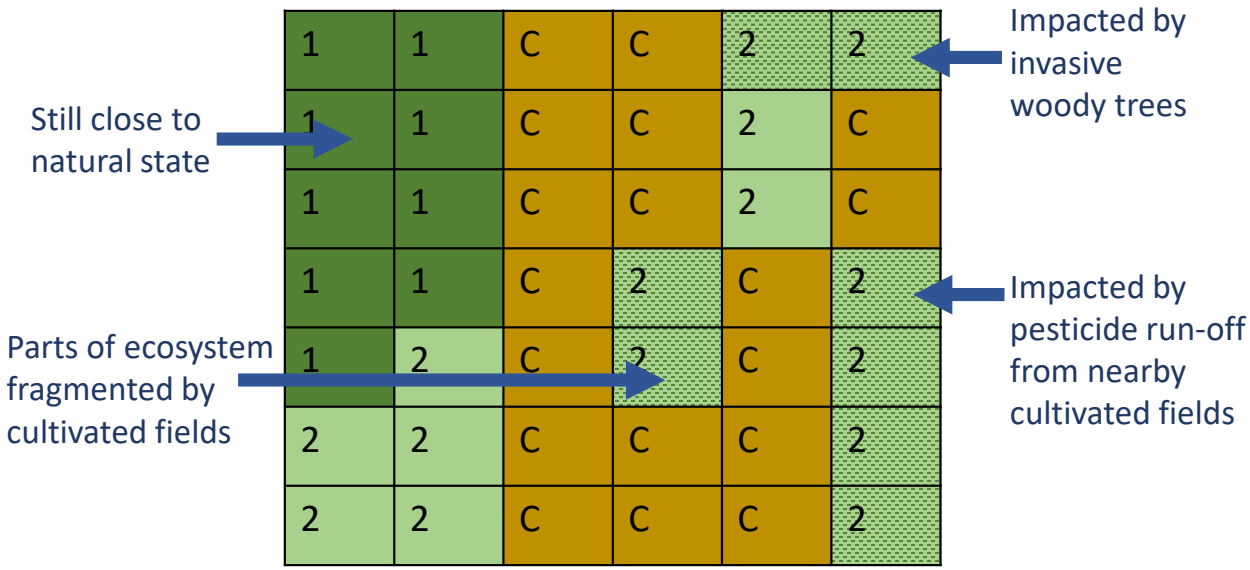
Relationship between ecosystem extent and ecosystem condition

Reference extent and condition

Ecosystem accounting area (EEA) = 42 ha

1	1	1	1	2	2
1	1	1	1	2	2
1	1	1	2	2	2
1	1	2	2	2	2
1	2	2	2	2	2
2	2	2	2	2	2
2	2	2	2	2	2

Closing extent and condition



1	1	C	C	2	2
1	1	C	C	2	C
1	1	C	C	2	C
1	1	C	2	C	2
1	2	C	2	C	2
2	2	C	C	C	2
2	2	C	C	C	2

Ecosystem types

- 1 Savannah (ET1)
- 2 Grassland (ET2)
- C Cultivated*

Reference extent:
ET1: Historical = 14 ha (EEI = 100%)
ET2: Historical = 28 ha (EEI = 100%)

Reference condition:
ET1: Natural (ECI = 100%)
ET2: Natural (ECI = 100%)

Closing extent:
ET1 = 9 ha
ET2 = 13 ha

Closing condition:
ET1: Still largely natural
ET2: Range of negative impacts

Ecosystem Extent Index (EEI):
ET1: EEI = 9/14 = 64%
ET2: EEI = 13/28 = 46%

Ecosystem Condition Index (ECI):
ET1: ECI = 86% (for example)
ET2: ECI = 50% (for example)

* This diagram doesn't deal with how an Ecosystem Extent Index and Ecosystem Condition index would be established for an anthropogenic ET such as cultivated land

Strengths of the Ecosystem Extent Index

- Computationally simple and easy to understand
- Versatile
  - Can be evaluated against a range of thresholds that are important for different purposes to identify those ecosystem types that are close to or beyond such thresholds, and can thus inform a range of difference planning and decision-making needs,
- Scalable
  - Can be calculated for individual ecosystem types at the local level or for ecosystem accounting areas at a range of spatial scales, up to the national level,
- Value-neutral
  - There is no inherently “correct” level for the index – a desired minimum Ecosystem Extent Index can be determined based on policy and management objectives, and might vary for different ecosystem types in different contexts
- Provides useful information from an ecosystem services perspective and a biodiversity perspective
- Complements the Ecosystem Condition Index proposed in Chapter 5
  - Can be paired with ECI to give a fuller picture of the state of an ecosystem type