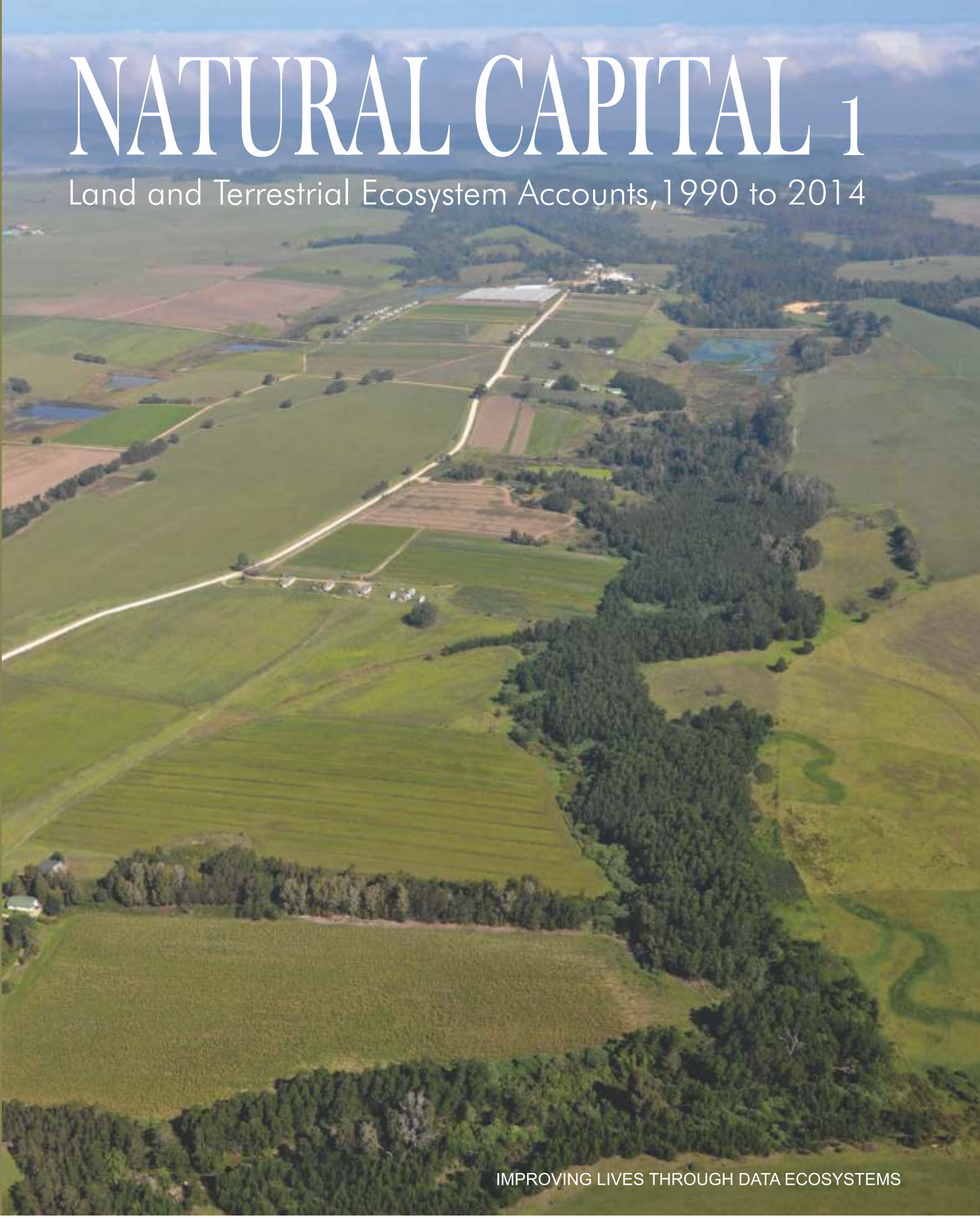
NATURAL CAPITAL 1

Land and Terrestrial Ecosystem Accounts, 1990 to 2014



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Natural Capital 1

Land and Terrestrial Ecosystem Accounts, 1990 to 2014

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PREFACE

South Africa is at the forefront of a global movement on Natural Capital Accounting (NCA). NCA is a growing field of work globally and in South Africa. It includes accounting for environmental assets such as water, minerals and energy, with an international standard, the System of Environmental-Economic Accounting (SEEA), in place for these accounts. A more recent aspect of NCA is ecosystem accounting, which focuses on accounting for ecosystem assets and ecosystem services. This discussion document forms part of Statistics South Africa's (Stats SA) Natural Capital series, and presents South Africa's first land and terrestrial ecosystem accounts as one of a series of natural capital accounts that will be published.

These accounts are a first of their kind for South Africa and have been produced as part of the *Natural Capital Accounting and Valuation of Ecosystem Services (NCAVES)* project, which was launched in 2017 by the United Nations Statistics Division (UNSD) and United Nations Environment Programme (UN Environment) with funding from the European Union (EU). South Africa is one of five countries (along with Brazil, China, India and Mexico) participating in this international project, which aims to advance the global knowledge agenda and initiate testing of SEEA Experimental Ecosystem Accounting (SEEA EEA), which focuses specifically on accounting for ecosystems. In South Africa, the NCAVES project was led jointly by Stats SA and the South African National Biodiversity Institute (SANBI).

Stats SA is proud to have been involved in the development of the SEEA and several sets of SEEA accounts since the late 1990s through, amongst other things, its role on the UN Statistical Commission, the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) and the SEEA Technical Committee. Stats SA has developed natural capital accounts in the form of environmental economic accounts, which included water, fisheries, mineral and energy accounts, since the early 2000s.

Stats SA is also proud to be collaborating with SANBI and the Department of Environment, Forestry and Fisheries (DEFF), in consultation with a range of national and sub-national stakeholders, on piloting SEEA EEA. The standardised approach being developed in the SEEA EEA will allow for the international comparison of ecosystem-related statistics across different countries as more countries adopt this approach. It also links to Stats SA's objective in the development of statistics with the goal of producing timely, accurate, and official statistics in order to advance economic growth, development, and democracy.

This report is published as a discussion document in the Natural Capital series to contribute to advancing the knowledge on NCA through application in a developing country context, including using information from NCA to monitor progress against achieving the goals of the National Development Plan (NDP) and the global Sustainable Development Goals (SDGs). Using the best available data in South Africa (which includes linking natural capital to Population Census data) and applying robust, globally endorsed methodologies, NCA can help public and private sector actors to understand more about the interactions between the economy, society and the environment.

ACKNOWLEDGEMENTS

The EU is acknowledged for funding the NCAVES project and the Delegation of the European Union to South Africa for supporting its implementation in South Africa. The UNSD and UN Environment are acknowledged for leading the NCAVES project globally and supporting its management and implementation in South Africa. The contents of the report are the sole responsibility of Stats SA and do not necessarily reflect the views of the EU or the United Nations (UN).

Members of the NCAVES Project Reference Group are acknowledged for their strategic guidance, including representatives of the Delegation of the European Union to South Africa, DEFF, UN Environment, UN Environment Country Office, and UNSD.

SANBI is acknowledged as co-lead with Stats SA in the NCAVES project in South Africa. Gerhardt Bouwer (Stats SA) and Amanda Driver (SANBI) are acknowledged for their leadership of the project. SANBI commissioned Anchor Environmental Consultants (Pty) Ltd, in partnership with GEOTERRAIMAGE (Pty) Ltd (GTI), to assist Stats SA and SANBI with the compilation of the land and terrestrial ecosystem accounts. Specific acknowledgements are given to Amanda Driver (SANBI), Jane Turpie (Anchor), and Aimee Ginsburg (SANBI) as the principal leads in the development, writing and finalisation of these accounts. Joshua Weiss (Anchor), Nokuthula Mahlangu (SANBI), Rob Anderson (Stats SA), Brenda Mphakane (Stats SA), Mark Thompson (GTI) and Katherine Forsythe (Anchor) are acknowledged for their considerable work in undertaking the spatial analysis and production of accounting tables. Gerhardt Bouwer (Stats SA) and Jeanne Nel (Wageningen Environmental Research) are acknowledged for their expert advice. Mark Eigenraam (Institute for Development of Environmental-Economic Accounting – IDEEA Group) is acknowledged for his technical support and advice on the production of the accounts. Robert Parry and Riaan Grobler (Stats SA) are acknowledged for their editorial support and guidance.

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The photograph on the front cover showing the various types of land cover was provided courtesy of Andrew Brown.

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ABBREVIATIONS

BSU	Basic Spatial Unit
CBA	Critical Biodiversity Area
DC	District Code
DEFF	Department of Environment, Forestry and Fisheries
ECI	Ecosystem Condition Index
EEI	Ecosystem Extent Index
EEZ	Exclusive Economic Zone
ESA	Ecological Support Area
ET	Ecosystem type
EU	European Union
GTI	GEOTERRAIMAGE
ha	Hectare
IDEEA	Institute for Development of Environmental-Economic Accounting
IOCB	Indian Ocean Coastal Belt
IUCN	International Union for Conservation of Nature
NBA	National Biodiversity Assessment
NCA	Natural Capital Accounting
NCAVES	Natural Capital Accounting and Valuation of Ecosystem Services
NDP	National Development Plan
NLC	National Land Cover
SAIIAE	South African Inventory of Inland Aquatic Ecosystems
SANBI	South African National Biodiversity Institute
SA-NECS	South African National Ecosystem Classification System
SDGs	Sustainable Development Goals
SEEA	System of Environmental-Economic Accounting
SEEA CF	SEEA Central Framework
SEEA EEA	SEEA Experimental Ecosystem Accounting
SNA	System of National Accounting
Stats SA	Statistics South Africa
UN	United Nations
UNCEEA	UN Committee of Experts on Environmental-Economic Accounting
UN Environment	United Nations Environment Programme
UNSD	United Nations Statistics Division

1 INTRODUCTION

This report presents the results of South Africa's first set of land and terrestrial ecosystem accounts. Land and terrestrial ecosystem accounts form part of Natural Capital Accounting (NCA). In future, the intention is to expand natural capital accounts to encompass marine, estuarine and inland water (river[1] and wetland) ecosystems, as well as ecosystem services, in order to produce a comprehensive set of national ecosystem accounts for South Africa.

Given that this is the first time land and terrestrial ecosystem accounts have been produced, this section provides background on NCA, what land accounts and ecosystem accounts are, South Africa's approach to land and terrestrial ecosystem accounts, the scope, purpose and potential uses of these accounts, as well as key indicators that can be drawn from the accounts.

1.1 Natural Capital Accounting

NCA refers to the use of an accounting framework to provide a systematic way to measure and report on stocks and flows of natural capital, analogous to accounts for other forms of capital. It is a broad term that includes accounting for individual environmental assets or resources, both biotic and abiotic (such as water, minerals, energy, timber, fish), as well as accounting for ecosystem assets and ecosystem services. NCA provides a common framework for measuring and tracking over time the contribution of ecosystems and natural resources to social and economic goals, such as water security, food security and job creation, and provides a wealth of information that can improve planning and decision-making related to the management of natural resources.

Using an accounting framework provides well-accepted, broadly based and globally consistent information on the nature of humanity's connection to the environment and how this is changing over time. Regular production of natural capital accounts can therefore provide standardised statistical information (comparable between countries, or between administrative units within a country, and over time) for tracking and reporting on progress towards sustainable development, including goals and targets set out in policies, frameworks and plans at international, continental, national, provincial or local levels. NCA can therefore provide dynamic information to inform economic policy and decision-making for sustainable development.

To this end, the **System of Environmental-Economic Accounting (SEEA)** has been developed to organise and present statistics on the environment and its relationship with the economy. It is a statistical system that brings together economic and environmental information into a common framework. The SEEA contains an internationally agreed set of standard concepts, definitions, classifications, accounting rules and tables to produce internationally comparable statistics and indicators for policymaking, analysis and research. The **SEEA Central Framework (SEEA CF)**[2] describes methods to account for changes in land cover, pollution and waste, as well as to account for stocks and use of natural resources (water, minerals, energy, timber, fish, soil). To complement this, the **SEEA Experimental Ecosystem Accounting (EEA)**[3] describes methods to account for ecosystems and their services, using a spatial approach. In South Africa, some preliminary work has already been done on land and ecosystem accounting in KwaZulu-Natal (Driver et al., 2015; Turpie et al., 2020) towards the finalisation of the approach at the national and international level.

[1] South Africa already has a set of national river ecosystem accounts that were piloted as part of an earlier project on ecosystem accounting and published by SANBI (Nel & Driver 2015). These river accounts will be updated and published as part of the *Natural Capital Series* in future.
[2] https://seea.un.org/content/seea-central-framework
[3] https://seea.un.org/ecosystem-accounting

1.2 What are land and ecosystem accounts?

Land accounts, which fall under the SEEA CF, use land cover and land use data to provide an assessment of the changing shares of different types of land cover and land use within a country (SEEA, 2016). They can also include information about land ownership.

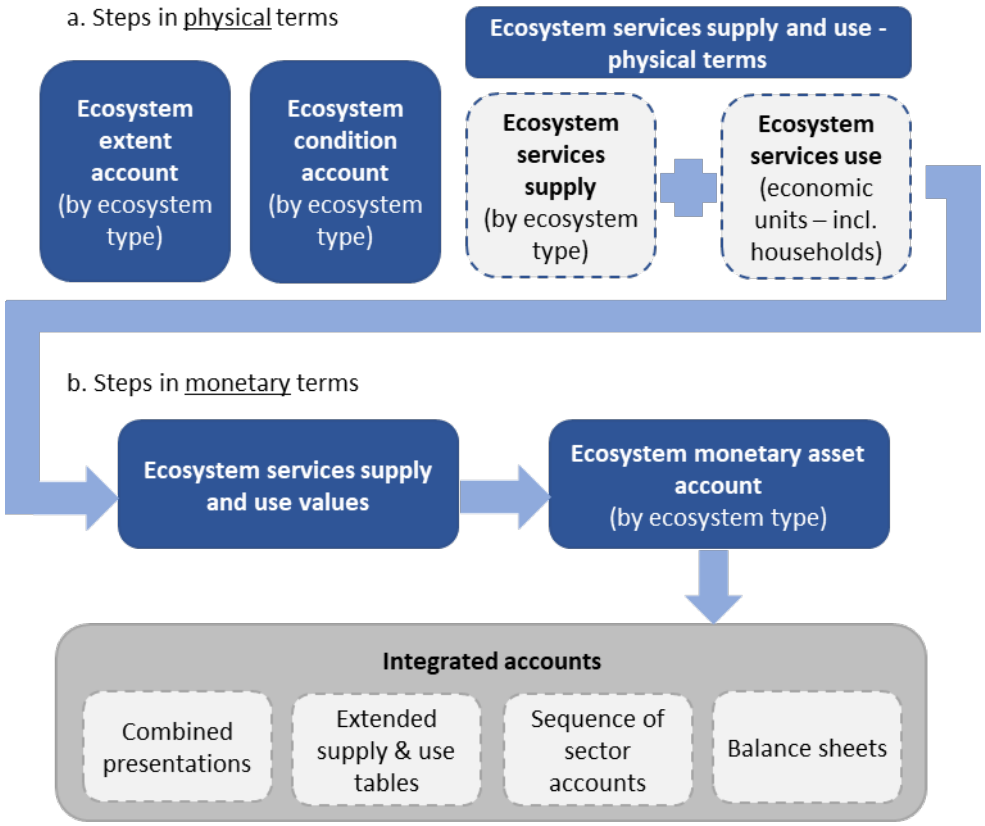
Land accounts rely heavily on land cover data. Land cover data are spatial data describing the different types of physical and biological cover found on Earth's surface, including both vegetated and abiotic (non-living) cover. Land cover includes natural or semi-natural land cover, intensively modified cover (such as cultivation, urban settlements and mines) and inland waterbodies (such as dams and some wetlands). The different types of land cover are organised into *land cover classes* as far as can be discerned from satellite imagery (see Section 2.1 for more detail about how land cover maps have been compiled for South Africa). Land cover data allow for the monitoring of rates of change in land cover from one type to another, and can capture, for example, rates of change in urban extent, intensive agriculture, timber plantations and mining.

Ecosystem accounts fall under SEEA EEA, which provides a framework for systematic measurement of ecosystem assets, ecosystem services, and the benefits generated from ecosystem services for people and the economy. There are five core ecosystem accounts – the ecosystem extent account, the ecosystem condition account, ecosystem services supply and use accounts in physical terms, ecosystem supply and use accounts in monetary terms, and the ecosystem monetary asset account (Figure 1).

Ecosystem asset accounts quantify the extent and condition of ecosystems in biophysical terms (such as hectares or biophysical measures of ecological condition). Ecosystem service accounts provide an assessment of the flow of services from ecosystem assets to people and the economy, and can be quantified in both physical and monetary terms. Monetary flows can then be used to estimate the monetary value of ecosystem assets in terms of their net present value. Note that the first three of the five core accounts quantify ecosystem assets and ecosystem services in *physical* terms. Ecosystem accounts in physical terms are important and versatile in themselves. They are also an essential basis for any monetary ecosystem accounts that may follow, although monetary accounts need not be developed where they are not necessary or appropriate.

Ecosystem assets are delineated as spatial areas containing a combination of biotic and abiotic components and other characteristics that function together and provide ecosystem services. Ecosystem extent accounts measure changes in the spatial extent of different ecosystem types over time, while ecosystem condition accounts measure changes in their condition. Section 2.2 describes how ecosystem types are defined and delineated in South Africa.

Figure 1. Five core ecosystem accounts – the ecosystem extent account, the ecosystem condition account, the ecosystem services supply and use accounts in physical and monetary terms, and the ecosystem monetary asset account



Source: Adapted from UN, 2017

1.3 South Africa's approach to land and terrestrial ecosystem accounts

In several countries that have produced experimental ecosystem accounts, land cover classes and land-based ecosystem types have been dealt with using a single classification, with land cover classes used as a proxy for terrestrial ecosystem types and some inland water ecosystem types. South Africa has a South African National Ecosystem Classification System (SA-NECS) that represents the best available data for classifying and mapping ecosystem types (see Section 2.2). Therefore, South Africa has chosen to treat land accounts and terrestrial ecosystem asset accounts as two distinct sets of accounts, although closely related and hence presented in the same document.

The land accounts presented here focus primarily on measuring changes in the spatial extent of intensively modified land cover classes, such as cultivated, urban and mined areas, defined based on the National Land Cover (NLC) (see Section 2.1).

The terrestrial ecosystem accounts presented here focus primarily on measuring changes in the spatial extent of terrestrial ecosystem types defined in the SA-NECS. Terrestrial ecosystem types take the form of vegetation types that are mapped based not on current land cover classes but based rather on a range of abiotic and biotic factors that reflect their historical extent (prior to major human modification of the landscape). This means that although terrestrial ecosystem types align spatially with land cover classes in some instances, they are conceptually distinct.

The land cover account and the terrestrial ecosystem extent account together enable an analysis of which intensively modified land cover classes have replaced natural or semi-natural land cover in which terrestrial ecosystem types. Section 2.1 provides an overview of both land cover classes and terrestrial

ecosystem types used in these accounts. This is a powerful approach because different intensively modified land cover classes have widely varying ecological impacts and can often be linked to socio-economic drivers in the landscape, while natural or semi-natural terrestrial ecosystem types can be linked to some (although not all) ecosystem services based on their ecological characteristics.

A dual perspective is taken on intensively modified areas, which include cultivated areas and built-up areas. For the purpose of the land account they are seen as land cover classes, while for the purpose of the ecosystem extent account they are seen as "ecosystem types" that have a historical extent of zero. This is explained further in Section 4.1.

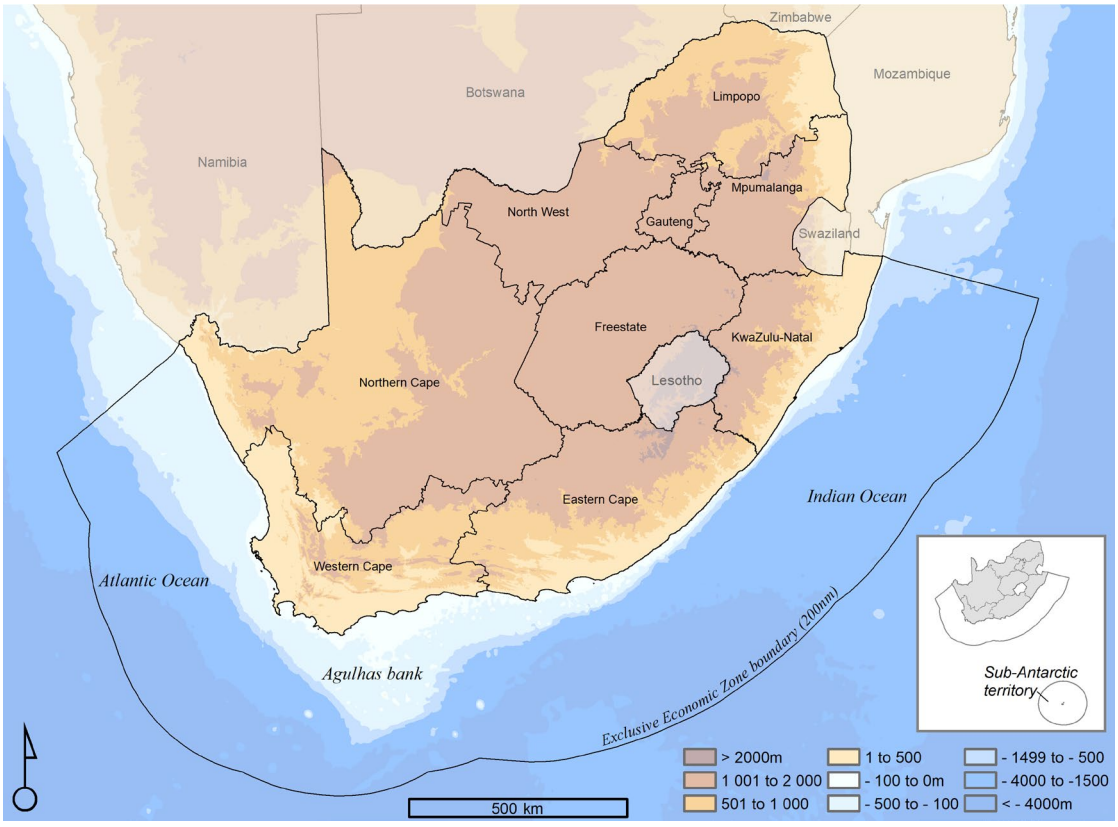
This approach does *not* preclude measurement of ecosystem service flows based on current land cover within natural or semi-natural areas, including from natural or semi-natural land cover classes that do not align neatly with ecosystem types defined based of vegetation types.

1.4 Scope of these accounts

The accounts presented here cover South Africa's mainland territory with its nine provinces, depicted in Figure 2. The provincial boundaries were delineated in 1995, following South Africa's transition to democracy in 1994.

The accounts describe landscape-level changes in land cover and terrestrial ecosystem extent that have occurred over nearly a quarter of a century from 1990 to 2014 in South Africa. During this period, South Africa experienced significant social, demographic and economic shifts as a result of national political processes, including the transition from the apartheid regime to democratic governance, combined with changes in the global economy.

Figure 2. The geography of South Africa showing the elevation range of the mainland and bathymetric (depth) profile of the territorial waters and Exclusive Economic Zone (EEZ), as well as provincial boundaries. The location of South Africa's sub-Antarctic territory, namely Prince Edward and Marion Islands, 1 700 km from the mainland, is shown in the inset



Source: SANBI, 2019

The **land account** describes changes in land cover at a national, provincial and district municipality scale. For the purposes of simplifying the analysis as well as presentation of results, the land cover classes are aggregated into groups across four tiers, as explained in Section 2.1 and detailed in Appendix 1. Additions and reductions to land cover classes as well as net changes (summarised by tier) are reported in terms of area (hectares) and in terms of percentage change from the baseline (1990). In addition, the area of each land cover class (summarised by tier) that remained unchanged over the accounting period is reported in both hectares and percentage terms, and the area of each land cover class that changed to another land cover class (summarised by tier) is reported in both hectares and percentage terms. This provides several key indicators of land cover change (see Section 1.5). Key trends are then explored and discussed in relation to relevant socio-economic statistics.

Not included at this stage is information about land ownership. This may be included in future land accounts.

The **terrestrial ecosystem account** describes the historical extent of different terrestrial ecosystem types and quantifies the change in extent by 1990 and then 2014. In almost all cases, the extent of terrestrial ecosystem types has declined relative to their historical extent as natural or semi-natural areas have been converted to intensive land uses such as cultivation, mining and urban development. The ecosystem extent account together with the land account allows analysis of which intensive land cover classes have resulted in the decline in the extent of which ecosystem types. The ecosystem extent account is used to derive an Ecosystem Extent Index (EEI), which can be evaluated in relation to ecological thresholds to identify ecosystem types that are under pressure and in need of management or conservation interventions. For the purposes of simplifying the results, terrestrial ecosystem types are grouped into biomes, as explained in Section 2.2.

Not included at this stage is information about the condition of terrestrial ecosystems. Assessing the condition of ecosystem assets is not straightforward, and considerable further work is required to reliably determine the condition of terrestrial ecosystems. An ecosystem condition account will be included at a future stage, preferably including a retrospective assessment for 1990 and 2014 to match the extent account presented here, and will provide an Ecosystem Condition Index (ECI) to complement the EEI derived from the ecosystem extent account.

The suite of ecosystem accounts will also be expanded in future to include not only ecosystem asset accounts but also ecosystem service accounts (see Figure 1).

1.5 Purpose and potential uses of these accounts, and key indicators

The purpose of the land and terrestrial ecosystem accounts for 1990 to 2014 is to provide detailed data and insights into changes in the extent of different land cover classes and terrestrial ecosystem types within South Africa over this period. The accounts provide detailed information that captures the changing dynamics of land cover and terrestrial ecosystems, to provide information for assessing how these changes may impact on people and the economy.

There are a wide range of potential uses and applications of the information presented in these accounts as well as the underlying data. The accounts provide consistent, comparable information over time, suitable for trend analysis, footprint analysis, integrated planning and assessment, and forecasting. This information can be used to improve policy, spatial planning and decision-making related to land use, natural assets and natural resources across a range of sectors. Furthermore, the sub-national data and indicators can be used for strategic and spatial planning at provincial, district and local level, and thematic breakdowns will be of use to particular sectors (such as agriculture). NCA can be applied to monitor progress against achieving the goals of the National Development Plan (NDP) and the global Sustainable Development Goals (SDGs). It provides a source of statistical information that adds to the richness of evidence available to policy and decision-makers.

The accounts presented here provide data for several indicators that can be extracted from accounting tables at a range of spatial scales, from national to local. These indicators include:

- **Percentage change per land cover class**, which reflects and points to a range of social and economic dynamics;
- **Percentage turnover in land cover**, which reflects the degree of "churn" in the landscape, highlighting areas where it is likely that rapid socio-economic changes are taking place;
- **EEI**, which tracks the percentage change in extent of each ecosystem type relative to its historical extent, highlighting ecosystem types that are approaching critical thresholds that may impact on their functioning.

This report summarises the key results and trends of interest extracted from the full set of accounting tables, with some interpretation of the information provided, including in the form of maps and graphs.

1.6 Structure of this report

The report is structured in five sections as follows:

- **Section 1 (this section)** – clarifies the concepts of NCA, the SEEA, and land and terrestrial ecosystem accounts; highlights the purpose and potential uses of this work; and frames the scope of this work.

- **Section 2: Foundations for the accounts** – outlines the foundational data layers and key components associated with national land accounts and terrestrial ecosystem accounts, including the hierarchical classification systems used to summarise results.

- **Sections 3 and 4: Key findings** – present the results for the land account at the national level, then disaggregated to the provincial and district municipality levels. It further disaggregates the accounts by the thematic areas of cultivation, urban development and mining, and explores these in relation to socio-economic data. Finally, it presents the results for the terrestrial ecosystem extent account.

- **Section 5: Recommendations** – makes recommendations for future ecosystem accounting work.

The discussion document is accompanied by a supplementary Excel workbook containing tables and matrices that can be downloaded from the Stats SA website (http://www.statssa.gov.za/). A Sources and Methods Report, which gives details on the data sources used and the methodology, is available from Stats SA on request.

2 ESSENTIAL FOUNDATIONS FOR LAND AND TERRESTRIAL ECOSYSTEM ACCOUNTS

Land accounts and ecosystem accounts are inherently spatial, in other words geographical. This means that producing the accounts requires the use of geospatial information. This section describes two of the fundamental spatial datasets used in the creation of these accounts:

- The **National Land Cover** (**NLC)** dataset, which is essential for land accounts;
- The **National Vegetation Map**, which represents terrestrial ecosystem types and is essential for terrestrial ecosystem accounts.

To produce the accounts these datasets are intersected with the national **Basic Spatial Unit** (BSU) layer, a grid of 1 hectare (ha) (100 x 100 m) cells which provides a consistent spatial framework for integrating data on land and ecosystems as well as demographic and economic data. Information about the BSU is available in a separate BSU report as well as in the Sources and Methods Report that accompanies this account, which are available from Stats SA on request.

The foundational data layers of South Africa's land and terrestrial ecosystem accounts are spatially very detailed. So although the results from the accounting tables in this report are aggregated into broad groupings to simplify presentation and interpretation, deeper investigation of changes is possible for those who wish to access the detailed accounting tables and even the accompanying spatial layers.

2.1 Land cover data

Land cover data are spatial data concerning different types of physical and biological cover found on Earth's surface. These can be natural, semi-natural or intensively modified and are generally organised into land cover classes.

South Africa's NLC dataset is derived, as is typical, from remotely sensed imagery. NLC datasets have been produced for the years 1990 (GTI, 2016) and 2014 (GTI, 2015) using equivalent methods to allow for comparability between the two datasets. Both are derived from multi-seasonal Landsat 8 imagery, using operationally proven, semi-automated modelling procedures developed specifically for the generation of these datasets, based on repeatable and standardised modelling routines (GTI, 2015). The NLC is produced in a raster format with a spatial resolution of 30 x 30 m covering the whole of South Africa's mainland. The NLC 1990 and 2014 have been purchased with an open licence by the Department of Environment, Forestry and Fisheries (DEFF) and both are thus freely available as open access datasets.[4] DEFF has committed to continued funding for future updates of the NLC, to provide a time series going forward.

The NLC dataset contains 72 land cover classes[5] covering a wide range of natural and human-modified landscape characteristics, with each 30 x 30 m cell assigned a single code representing the dominant land cover class (determined from analysis of multiple images). The reliability of land-cover change statistics is influenced by the accuracy of the input data against which change is determined. The accuracy of the NLC has been assessed using a method described in detail in the metadata reports (GTI, 2015; GTI, 2016). The overall map accuracy is 81,3%, with a mean land cover class accuracy of 91,2%. The accuracy levels for many of the intensively modified land cover classes are higher than the average map accuracy (for example, 100,0% for cultivated sugarcane pivots and >96,0% for urban township, village, residential, informal, and schools and sports fields).

[4] South Africa's NLC datasets and metadata reports are available from the Department of Environment, Forestry and Fisheries at https://www.environment.gov.za/projectsprogrammes/egis_landcover_datasets

[5] GTI (2015) highlights that the term "land cover" is used "loosely to incorporate both land-cover and land-use information in the context of the GTI 2013-14 South African National Land-Cover dataset". This also applies to the 1990 NLC dataset. For simplicity the term "land cover classes" is used throughout these accounts, rather than referring each time to "land cover/land use classes".

Whilst there have been multiple attempts to standardise a land cover classification system, there is no single internationally agreed land cover classification system, although most follow a similar hierarchical classification. The land cover classes used in South Africa are aligned with the South African NLC Classification Standard[6] in terms of class definitions and hierarchical format. The complete list of classes that have been mapped and the associated class descriptions are supplied in Appendix 1.

For the purposes of simplifying the analysis as well as presentation of results from the land accounts, the 72 NLC classes are aggregated into groups across four hierarchical tiers as illustrated in Table 1. The aggregation of land cover classes was done in such a way that the classes in tiers 1, 2 and 3 are aligned with likely intensity of ecological impact and also linked to socio-economic drivers in the landscape as far as possible. This is important for linking land accounts to ecosystem extent and condition accounts as well as enabling analysis of demographic and economic information in relation to land cover change. Maps of broad land cover classes (tier 1) and main land cover classes (tier 2) appear in Section 3, as well as brief descriptions of the tier 3 classes.

Table 1. Grouping of National Land Cover classes into four tiers

Broad land cover classes	Main land cover classes	Detailed land cover classes	National Land Cover classes
Tier 1: 4 classes	*Tier 2: 8 classes*	*Tier 3: 20 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 (other)	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

It is important to note that natural or semi-natural land cover, while consisting of eight NLC classes, is not disaggregated at tier 1, 2 or 3 into categories based on structural forms identifiable from satellite imagery (such as “indigenous forest”, “woodland/open bush” and “low shrubland”). Terrestrial ecosystem types based on the National Vegetation Map (see Section 2.2) describe and delineate the type of ecosystem more meaningfully and accurately than these eight NLC classes, which are thus grouped here as “natural or semi-natural”. This broad natural or semi-natural land cover class is used to determine how much of each terrestrial ecosystem type remains in a natural or semi-natural state, as explained further in Section 4.

The term “natural” is used to describe areas in which species composition, vegetation structure and ecological processes are largely intact, reflecting a more or less natural state prior to substantial human modification. The term “natural” is used with full recognition that in the current context of the Anthropocene there are no ecosystems that are untouched by human influence, so it does not imply a pristine or wilderness state and includes areas that are near-natural rather than strictly natural. The term semi-natural is used to describe areas in which species composition no longer reflects a natural

[6] SANS 1877: SA Bureau of Standards designated national land-cover classification standard for South Africa.

state and vegetation structure has also changed, but in which ecological processes remain largely intact or have been largely restored. Examples of semi-natural areas include areas invaded by invasive alien plant species, rangelands that have been heavily grazed, and previously cultivated areas that have lain fallow for several years or more (also called secondary natural areas). Intensively modified areas include urban areas, mined areas and cultivated areas.

Natural and semi-natural areas exist on a continuum, so drawing a definitive line between natural, near-natural and semi-natural is challenging (mapping accuracy for these classes is also lowest between 54,0%-85,0%). Notwithstanding this continuum from natural through to semi-natural, it may be possible to take a pragmatic approach to drawing a line between natural areas and semi-natural areas, in the same way that it is possible to take a pragmatic approach to delineating boundaries between different ecosystem types when in fact there is usually a transition zone between them. Such a pragmatic approach would be the preference for terrestrial ecosystem accounts in the South African context; however, at this stage it is not possible to reliably distinguish natural areas from semi-natural areas based on remotely sensed imagery. A distinction between natural or semi-natural areas on the one hand, and intensively modified areas (such as cultivated fields and urban areas) on the other, is much easier to identify based on remotely sensed imagery, making it possible to delineate intensively modified areas reliably in these accounts. In future terrestrial ecosystem accounts it would be ideal to distinguish spatially between natural areas and semi-natural areas, which will likely require non-satellite derived data to be incorporated. Such spatial information would not be used directly in the ecosystem extent account but would feed into the development of an ecosystem condition account and ECI for terrestrial ecosystems.

The NLC includes three detailed (tier 4) land cover classes that relate to water surfaces, namely wetlands, water seasonal and water permanent. Although these classes have been retained in the accounting tables under the collective “waterbodies” class, they are not disaggregated in this report and are not displayed in graphs. Land cover data are not well suited to mapping inland water ecosystems, which requires non-satellite derived data. South Africa has more comprehensive and accurate sources of data for inland water ecosystems, including rivers and wetlands, and for artificial waterbodies such as dams, that will be used to develop accounts for freshwater ecosystems in the future.

2.2 Terrestrial ecosystem types

South Africa has the SA-NECS includes classification systems and maps of all ecosystem types in the country, across the terrestrial, inland water (river and wetland), estuarine and marine realms, with around one thousand distinct ecosystem types recognised altogether.[7]

The SA-NECS aligns well with the Global Ecosystem Typology developed and recently released by the International Union for Conservation of Nature (IUCN),[8] which will be used as the global reference classification for ecosystem types in the SEEA going forward.

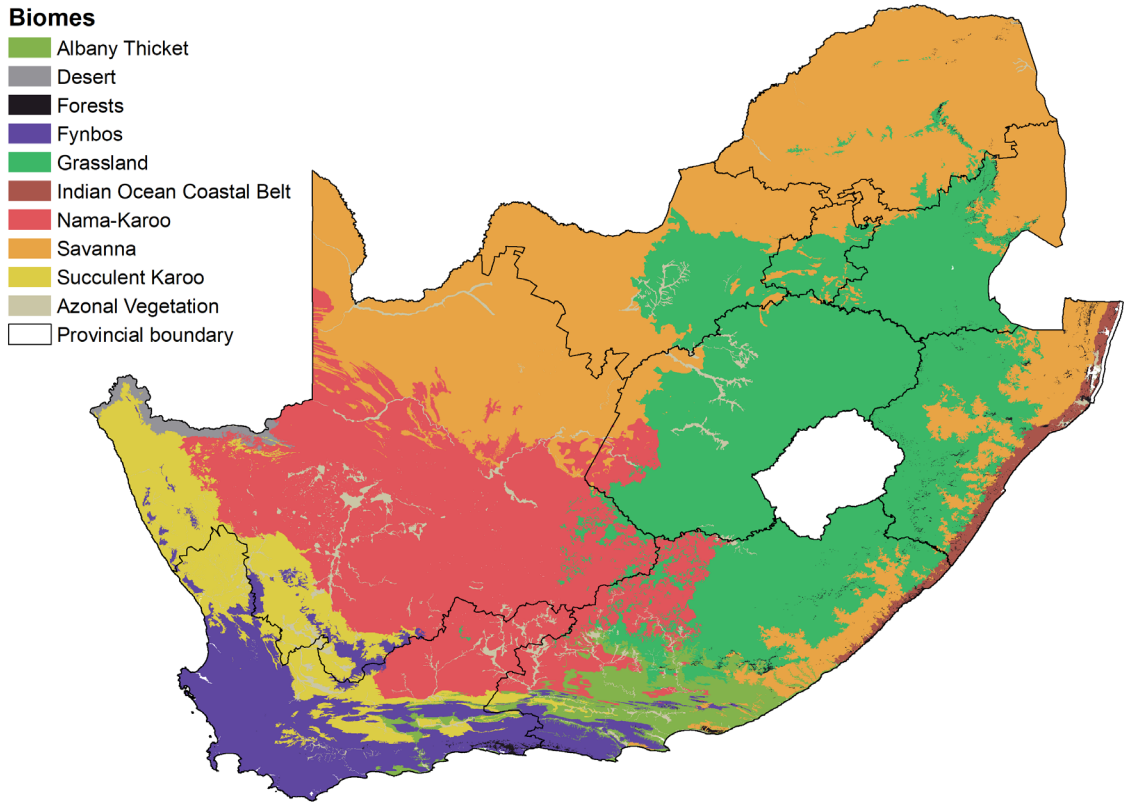
Terrestrial ecosystem types are represented by vegetation types identified in the South African portion of the Vegetation Map of South Africa, Lesotho and Swaziland (SANBI, 2018) (referred to as the National Vegetation Map). Vegetation types are relatively homogenous units in the landscape, identified based on their biophysical characteristics such as species distribution, community composition, underlying geology and soil types, altitude, and rainfall gradients. Vegetation types are delineated based on their historical or potential extent, prior to major human modification. They are therefore regarded as a stable set of ecosystem units based on ecological characteristics, against which changes in ecosystem extent over time can be assessed. Vegetation types also provide useful spatial units for ecosystem accounts because they link directly with functional aspects of ecosystems, which in turn links to the supply of some ecosystem services.

[7] SANBI is the custodian of the SA-NECS, as part of its mandate under the National Environmental Management: Biodiversity Act (Act 10 of 2004). A National Ecosystem Classification Committee, with a sub-committee for each realm, is convened by SANBI to oversee the development and refinement of the classification and accompanying maps of ecosystem types. Spatial data and other information from the SA-NECS is freely available on SANBI’s Biodiversity GIS website (http://bgis.sanbi.org).
[8] https://iucnrle.org/about-rle/ongoing-initiatives/global-ecosystem-typology/

The National Vegetation Map comprises 458 vegetation types in South Africa (see Figure 16 in Section 4) that are grouped into nine biomes based on similar characteristics (Figure 3).[9] Appendix 2 provides a brief description of each biome based on its characteristic physiognomy and climatic conditions. The National Vegetation Map also includes some wetlands, reflected as "azonal vegetation" (i.e. not belonging to a particular biome), but wetlands were not mapped systematically across the country as part of the development of the National Vegetation Map. The South African Inventory of Inland Aquatic Ecosystems (SAIIAE) provides a much more comprehensive map and classification of wetlands, and will be used to produce wetland ecosystem accounts in the future. Rivers are currently mapped separately as linear features (with their extent measured as length rather than area), and have not been integrated into the vegetation map. Spatial data on rivers together with the national classification of river ecosystem types formed the basis for earlier river ecosystem accounts (Nel & Driver, 2015), which will be updated in future.

National vegetation types have been used as surrogates for terrestrial ecosystem types in a range of applications related to national assessment, planning and policy (e.g. DEA, 2011; DEA, 2016; Driver et al., 2012; SANBI, 2019).

Figure 3. Terrestrial biomes of South Africa



Source: SANBI, 2018

[9] South Africa's national vegetation types correspond more or less with the most detailed level (level 6) of the Global Ecosystem Typology, referred to as "local ecosystem types", while South Africa's biomes correspond more or less with level 2 of the Global Ecosystem Typology, also referred to as biomes. Level 3 of the Global Ecosystem Typology is referred to as ecosystem functional groups, which nest within biomes. South Africa's vegetation types have yet to be grouped into an agreed set of functional vegetation groups, equivalent to level 3 of the Global Ecosystem Typology, but work is under way to do this.

3 LAND ACCOUNTS: KEY FINDINGS

This section presents key findings from the land accounts at national, provincial and district municipal level, for the broad, main and detailed land cover classes outlined in Section 2.1. A selection of findings is presented to illustrate the types of information that can be extracted from the accounts and presented in graphs or maps. A wide range of further findings and analyses are possible based on the underlying accounting tables.

The accounting tables present the opening stock, additions, reductions and net changes to stock and closing stock for each land cover class over the accounting period (1990 to 2014).[10] These are used to derive three indicators:

- **Percentage change per land cover class**, which reflects and points to a range of social and economic dynamics;
- **Percentage land cover unchanged**, which reflects how "stable" or unchanged each land cover class has been, by calculating the number of hectares that have not changed relative to the opening stock for that class;
- **Percentage turnover in land cover**, which reflects the degree of "churn" in the landscape from one land cover class to another, calculated as the sum of both the additions and reductions in each class relative to its opening stock. This highlights areas where it is likely that rapid socio-economic changes are taking place.

In addition, land cover change matrices show which land cover classes changed to which over the accounting period, as explained in more detail below.

3.1 National-level land accounts

Land accounts aggregated to the national level are presented below for broad (tier 1), main (tier 2) and detailed (tier 3) land cover classes, to show overall national trends in land cover change.

3.1.1 Broad land cover classes (tier 1) at the national level

South Africa's land account is summarised in its most aggregated form in Table 2. The table shows the opening stock of each broad land cover class (natural or semi-natural, cultivated, built-up and waterbodies) in 1990 and the closing stock in 2014 for the country as a whole, together with the additions, reductions and net changes in each class. The extent of South Africa's mainland is nearly 122 million ha, which has not changed over the accounting period.

The net change in stock (shown in the highlighted row) is calculated as the area that was added to any one land cover class (additions to stock) minus the area that was converted to something else (reductions in stock) over that time period. The net change in hectares for a land cover class can also be expressed as a percentage, which gives an indication of degree of change in that land cover class. The absolute and percentage changes are best read together. For example, the change in stock of natural or semi-natural land cover is less than 1,0% but amounts to over 826 000 ha in absolute terms, while the net change of 6,5% in built-up land cover amounts to a much smaller area in absolute terms of less than 200 000 ha.

At this aggregated level, the majority of South Africa's land area is natural or semi-natural. However, the proportion of natural or semi-natural land is much lower in some parts of the country than others, as will be explored in Sections 3.2 and 3.3. At the national level, natural or semi-natural land cover

[10] Future accounting tables will ideally include further disaggregation of additions (into managed expansion, natural expansion and upward reappraisals) and reductions (into managed regression, natural regression and downward reappraisals). This breakdown has not been included in these accounts as the difference between natural and managed change is not always obvious to distinguish. Doing so consistently would require additional consideration and possibly additional data.

remained largely unchanged over the accounting period (97,5% unchanged) and turnover was relatively low (5,9%).

Cultivated land cover showed a net decrease during this period of nearly 350 000 ha, with additions to stock of nearly 2 million ha and reductions of more than 2,3 million ha. Eighty-five percent of the land area that was cultivated in 1990 remained cultivated in 2014.

The stock of waterbodies decreased by just over 30,0% during this accounting period and only 54,0% of the area that was waterbodies in 1990 remained in 2014. This reflects primarily that 2014 was a drier year than 1990. Also, as discussed in Section 2.1, land cover data are not well suited to mapping inland water ecosystems, so it is not possible to draw more detailed conclusions from this finding.

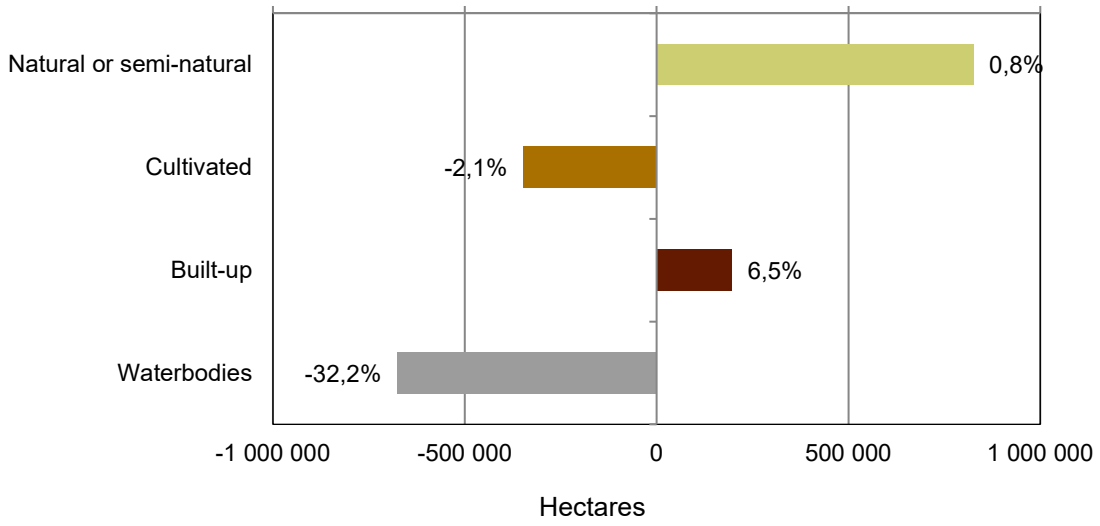
Table 2. Land account for broad land cover classes (tier 1) at the national level, 1990–2014, in hectares

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**

*Changes in the extent of waterbodies reflect primarily that 1990 was a wetter year than 2014.

The net change across the broad land cover classes can be depicted graphically. Figure 4 illustrates the net increase in natural or semi-natural and built-up land cover and net decrease in cultivated land cover and waterbodies between 1990 and 2014.

Figure 4. Net change in broad land cover classes (tier 1) at the national level, 1990–2014, in hectares (net percentage change shown at the end of each bar)



The accounts allow one to see not only the change in different land cover classes from one time period (opening stock) to another (closing stock), but also to see which land cover changed to which. This is

presented in a change matrix that shows conversions between land cover classes, shown in Table 3. For instance, reading along the row for cultivated land cover, one can see that just under 2,2 million ha of cultivated land reverted to natural or semi-natural, 13,8 million ha remained unchanged, and approximately 110 000 ha was converted to built-up land cover. Reading down the column for cultivated land cover, one can see that the bulk of additions to cultivated land came from conversion of natural or semi-natural areas to cultivation.

Table 3. Land cover change matrix for broad land cover classes (tier 1) at the national level, 1990–2014, in hectares. Reductions in land cover classes are read in rows, additions are read in columns, and shaded cells show the extent that remained unchanged

Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Total reductions
Natural or semi-natural	98 169 841	1 835 126	481 052	223 997	2 540 175
Cultivated	2 171 575	13 816 800	109 773	57 878	2 339 226
Built-up	321 605	72 019	2 603 380	6 879	400 503
Waterbodies*	873 379	84 814	6 413	1 131 922	964 606
Total additions	3 366 559	1 991 959	597 238	288 754	

*Changes in the extent of waterbodies reflect primarily that 1990 was a wetter year than 2014.

The spatial distribution of broad land cover classes can be displayed on a map, as shown in Figure 5 (1990) and Figure 6 (2014). Depicted on a map or in a pie chart as a proportion of the whole country, the changes over the period 1990 to 2014 appear to be relatively small. However, this national picture does not reflect the substantial changes that have taken place at the sub-national level and between land cover classes at more detailed tiers of land cover classification, explored in the sections that follow.

Figure 5. Broad land cover classes (tier 1) in 1990 with associated proportion of total mainland area

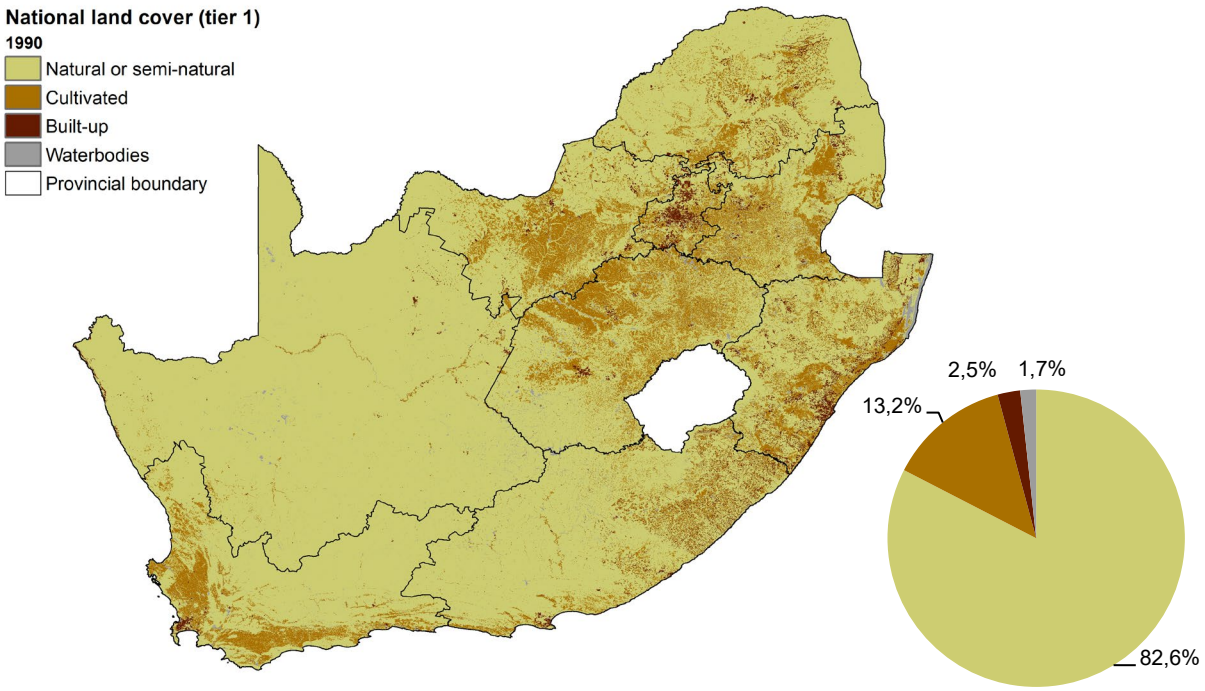
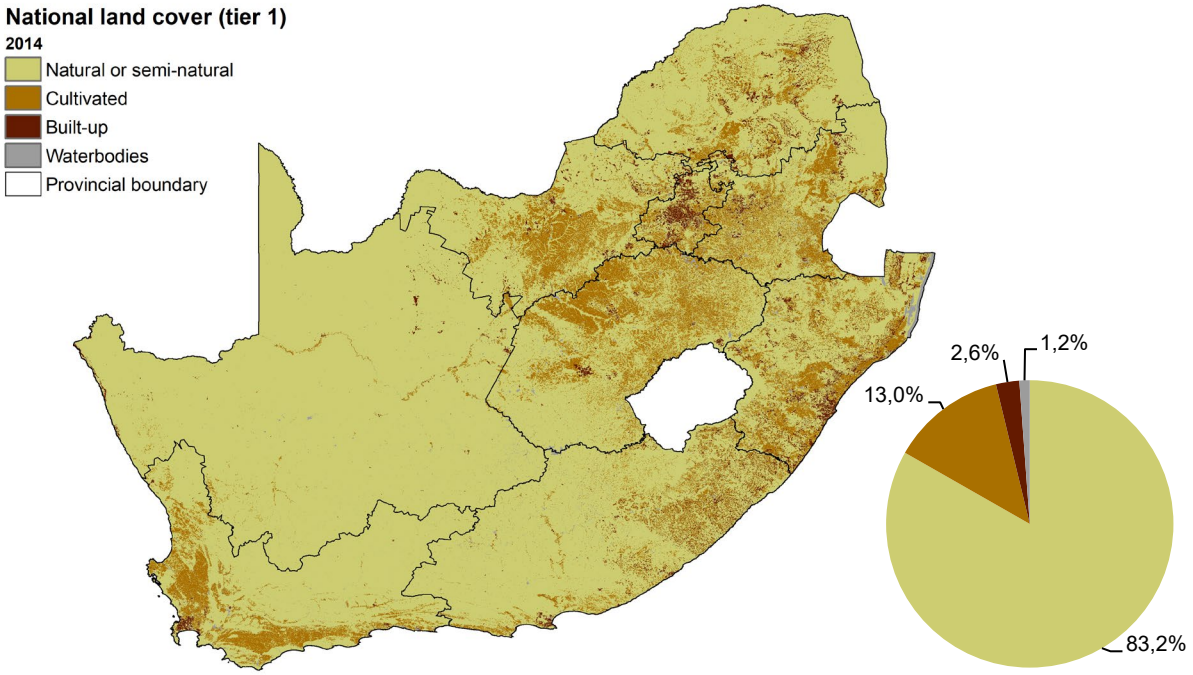


Figure 6. Broad land cover classes (tier 1) in 2014 with associated proportion of total mainland area



3.1.2 Main land cover classes (tier 2) at the national level

Table 4 presents the land account for main land cover classes (tier 2), which disaggregate the broad land cover classes for cultivated and built-up land cover. The broad land cover class “Cultivated” is disaggregated at tier 2 into commercial crops, subsistence crops, orchards and vines, and timber plantations. South Africa’s largest commercial crops include maize, wheat, sugarcane and sunflower seeds. Subsistence crops include maize, sorghum and millet. The broad land cover class “Built-up” is disaggregated into urban areas and mines at tier 2. Urban areas include residential suburbs, townships, informal settlements, commercial and industrial areas, as well as villages in rural settings. (See Table 6 and Table 7 in the next section as well as Appendix 1 for more detailed descriptions.) These disaggregations are intended to reflect different socio-economic drivers of change in the landscape. For example, trends and spatial patterns in commercial crops are likely to be driven by different factors from trends in subsistence crops, and changes in urban informal settlements may reflect different factors from changes in residential suburbs.

As discussed in Section 3.1.1, cultivated land cover showed an overall decrease in extent between 1990 and 2014. Exploring this change at a greater level of detail, Table 4 shows that this is principally the result of net decreases in commercial crops and secondly timber plantations, which together decreased by over 440 000 ha (3,5% and 1,9% of their opening stock, respectively). There were net increases in the extent of orchards and vines (>78 000 ha or 17,4% of opening stock) and subsistence crops (>21 000 ha or 1,1% of opening stock), but these additions were far smaller than the reductions in commercial crops and timber plantations in this accounting period.

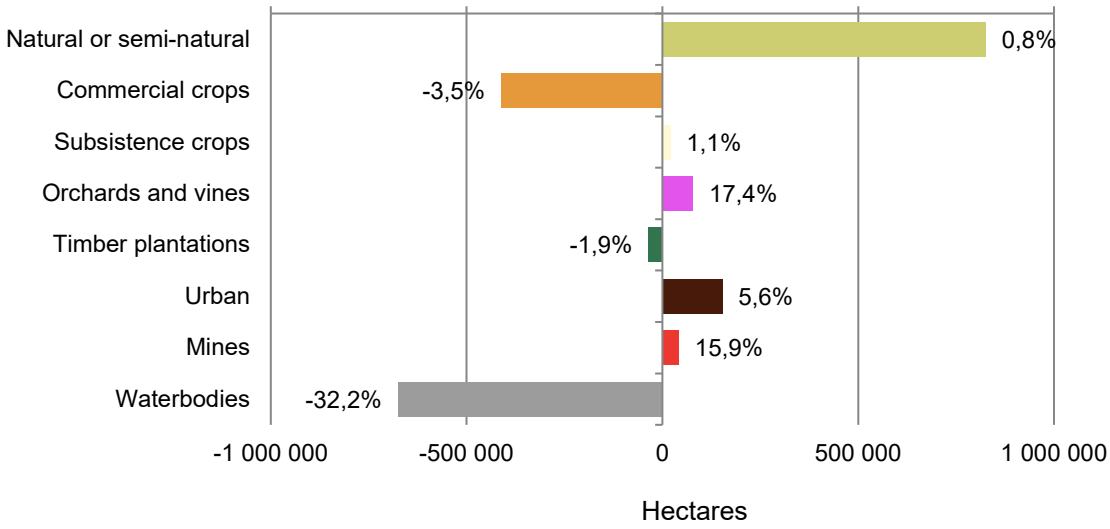
Within the built-up land cover class, both urban and mining land cover increased, by approximately 154 000 and 43 000 ha, respectively. In percentage terms, the area under mines increased by 15,9%, while urban areas increased by 5,6% between 1990 and 2014.

Table 4 shows that commercial crops, orchards and vines and urban land cover were relatively stable between 1990 and 2014, all with over 80,0% of their area remaining unchanged. Mining land cover had the highest percentage turnover at 80,2%, indicating that the spatial distribution of mining land cover may have changed. At a finer scale, experts and policymakers may want to explore specific geographic

areas and link the turnover to fragmentation of certain land cover types and certain ecosystem types. Going forward it will also be important to assess rates of turnover across different time periods and understand the drivers of these.

The net change in land cover across the main land cover classes is depicted as a graph in Figure 7, highlighting the land cover classes that increased or decreased most between 1990 and 2014. For the intensively modified land cover classes, the largest change in absolute terms was the net decrease in commercial crops, while the largest changes in percentage terms were the net increases in orchards and vines (17,4%) and mines (15,9%).

Figure 7. Net change in main land cover classes (tier 2) at the national level, 1990–2014, in hectares (net percentage change shown at the end of each bar)



The change matrix for main land cover classes (tier 2) in Table 5 shows conversions between the different main land cover classes over the period 1990 to 2014. Reading along the row for any land cover class, one can see the area that has been converted to each of the other land cover classes. Portions of all the intensively modified main land cover classes (commercial crops, subsistence crops, orchards and vines, timber plantations, urban, mines) have converted to the natural or semi-natural class. Intensively modified land cover classes that revert to a more natural state are often referred to as “secondary natural” areas and are considered semi-natural rather than natural. They may regain some of the functional and structural characteristics of natural areas but are highly unlikely to regain the species composition that would have been associated with the area prior to intensive modification. For almost all ecosystem types in South Africa it is not possible to restore them to their natural condition once they have been intensively modified, even with substantial and costly intervention. However, rehabilitation to a semi-natural state can usually be achieved, which will restore a degree of ecological functioning and associated ecosystem services. This is achieved either by allowing natural ecological succession processes of regeneration (although this often takes many years, even decades in arid ecosystems) or by intervening actively to rehabilitate.

Reading down the column for a land cover class, one can see additions to that land cover class and from which other land cover classes those additions were drawn. The total addition to natural or semi-natural land cover was nearly 3,4 million ha over the accounting period. Of this, over 1,4 million ha came from commercial crops, over 370 000 ha from subsistence crops, and over 320 000 ha from timber plantations. These results suggest shifting production patterns across the country, with certain areas seeing a decrease in cultivation and timber production. Other possible causes of the additions to natural or semi-natural land cover are mine rehabilitation and the autogenic (self-generated) succession of abandoned agricultural areas or settlements to natural vegetation. As discussed above, these areas would be considered semi-natural rather than natural, and they may be in poor ecological condition. For example, abandoned lands could have been overtaken by weeds or invasive species.

Table 4. Land account for main land cover classes (tier 2) at the national level, 1990–2014, in hectares

Broad land cover classes (tier 1) / Main land cover classes (tier 2)	Natural or semi-natural	Cultivated				Built-up		Waterbodies*	Total
		Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines		
Opening stock 1990	**100 710 016**	**11 873 834**	**1 945 395**	**454 245**	**1 882 552**	**2 733 549**	**270 334**	**2 096 528**	**121 966 453**
Additions to stock	3 366 559	1 227 069	461 357	140 516	368 391	470 002	129 867	288 754	6 452 515
Reductions in stock	2 540 175	1 638 765	440 334	61 581	403 920	316 248	86 886	964 606	6 452 515
Net change in stock	826 384	-411 696	21 023	78 935	-35 529	153 754	42 981	-675 852	
Net change as % of opening	*0,8%*	*-3,5%*	*1,1%*	*17,4%*	*-1,9%*	*5,6%*	*15,9%*	*-32,2%*	
Unchanged (opening - reductions)	98 169 841	10 235 069	1 505 061	392 664	1 478 632	2 417 301	183 448	1 131 922	
Unchanged as % of opening	*97,5%*	*86,2%*	*77,4%*	*86,4%*	*78,5%*	*88,4%*	*67,9%*	*54,0%*	
Turnover (additions + reductions)	5 906 734	2 865 834	901 691	202 097	772 311	786 250	216 753	1 253 360	
Turnover as % of opening	*5,9%*	*24,1%*	*46,4%*	*44,5%*	*41,0%*	*28,8%*	*80,2%*	*59,8%*	
Closing stock 2014	**101 536 400**	**11 462 138**	**1 966 418**	**533 180**	**1 847 023**	**2 887 303**	**313 315**	**1 420 676**	**121 966 453**

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

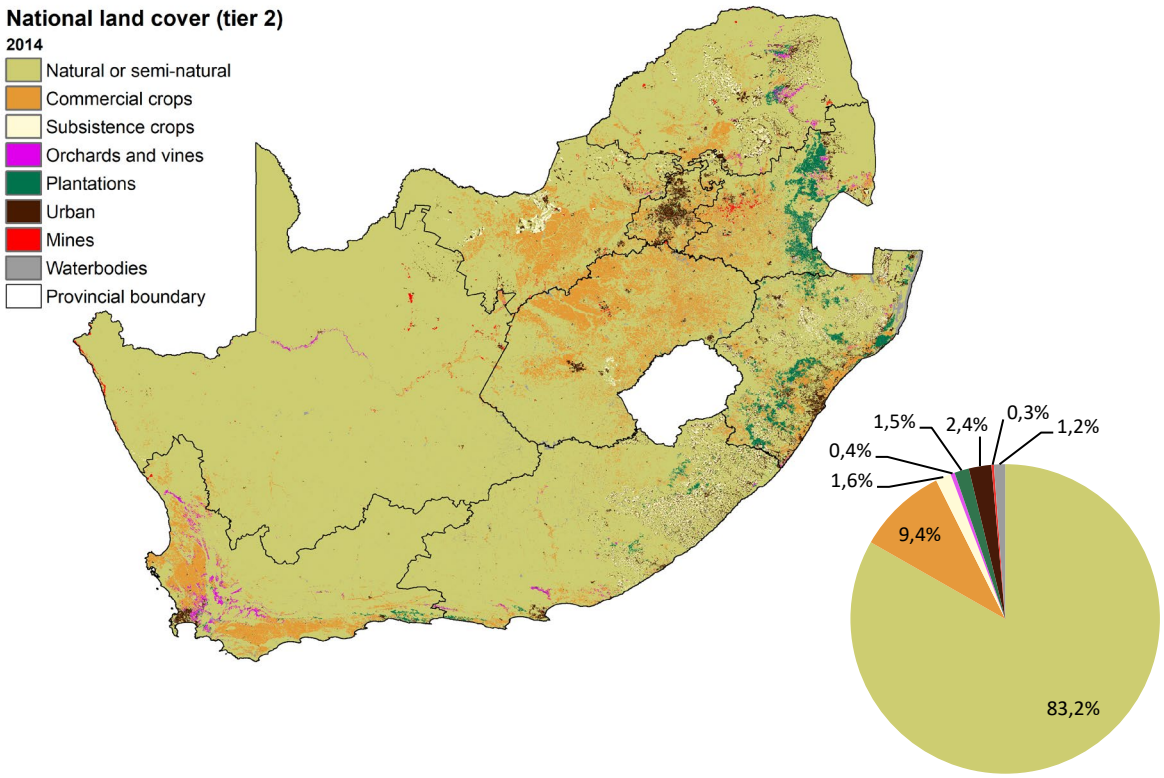
Table 5. Land cover change matrix for main land cover classes (tier 2) at the national level, 1990–2014, in hectares. Reductions are read in rows, additions are read in columns, and shaded cells show the extent that remained unchanged

Main land cover classes (tier 2)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total reductions
Natural or semi-natural	98 169 841	1 055 094	387 160	74 633	318 239	397 588	83 464	223 997	2 540 175
Commercial crops	1 437 998	10 235 069	19 364	49 377	27 971	28 190	37 705	38 160	1 638 765
Subsistence crops	374 685	47 880	1 505 061	2 893	1 595	9 574	1 441	2 266	440 334
Orchards and vines	34 616	20 887	2 115	392 664	950	1 495	47	1 471	61 581
Timber plantations	324 276	22 919	2 288	7 135	1 478 632	27 675	3 646	15 981	403 920
Urban	239 919	22 266	34 610	1 314	11 697	2 417 301	1 476	4 966	316 248
Mines	81 686	1 019	344	10	759	1 155	183 448	1 913	86 886
Waterbodies*	873 379	57 004	15 476	5 154	7 180	4 325	2 088	1 131 922	964 606
Total additions	3 366 559	1 227 069	461 357	140 516	368 391	470 002	129 867	288 754	

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

Figure 8 shows the spatial distribution of main land cover classes (tier 2) for South Africa in 2014. Distinct patterns in distribution are evident. For example, timber plantations occur predominantly in KwaZulu-Natal and Mpumalanga, while orchards and vines are concentrated in Western Cape with smaller pockets in some other provinces. Land cover changes by province are explored in Section 3.2.

Figure 8. Main land cover classes (tier 2) in 2014 with associated proportion of total mainland area



3.1.3 Detailed land cover classes (tier 3) at the national level

Changes in land cover that are not evident when land cover classes are grouped at tier 1 or tier 2 become clearer when exploring the more detailed classes at tier 3. The tier 2 class cultivated land cover is disaggregated into seven detailed classes at tier 3 (see Table 6) and built-up land cover into 11 detailed classes (see Table 7). The accounting tables and associated change matrices at tier 3 are too large to be included in this report.[11] Instead, the indicator of net change is summarised graphically, first for the cultivated land cover classes and then for the urban land cover classes.

Table 6. Descriptions of detailed land cover classes (tier 3) within the broad land cover class "Cultivated"

Main land cover class (tier 2)	Detailed land cover class (tier 3)	Short description (see Appendix 1 for more detail)
Commercial crops	Cultivated commercial fields	Cultivated lands used primarily for the production of rain-fed, annual crops for commercial markets. Typically represented by large field units, often in dense local or regional clusters. Includes non-pivot irrigated areas, which are difficult to distinguish from rain-fed areas. Major annual crops in South Africa include maize, wheat and sunflowers.
	Cultivated commercial pivots	Cultivated lands used primarily for the production of centre pivot irrigated, annual crops. For example, potatoes.
	Sugarcane	Commercial and semi-commercial non-pivot sugarcane fields (rain-fed and irrigated) as well as commercial pivot irrigated sugarcane fields. Sugarcane is an important agricultural export crop from South Africa.
Subsistence crops	Subsistence crops	Cultivated lands used primarily for the production of rain-fed, annual crops for local markets and/or home use. Typically represented by small field units, often in dense local or regional clusters. Typical subsistence crops in South Africa include maize, sorghum and millet.
Orchards and vines	Orchards	Cultivated lands used primarily for the production of both rain-fed and irrigated permanent crops for commercial markets. Includes tree and shrub crops. Examples include citrus, deciduous fruit, pineapples, nuts.
	Vines	Cultivated lands used primarily for the production of both rain-fed and irrigated permanent crops for commercial markets. Primarily grapes.
Timber plantations	Timber plantations	Planted forestry plantations for growing commercial timber tree species. Commercial forestry in South Africa is based on exotic (non-indigenous) species such as pine and eucalyptus.

[11] They are available in a supplementary spreadsheet of tables and matrices that can be downloaded from the Stats SA website (http://www.statssa.gov.za/).

Table 7. Descriptions of detailed land cover classes (tier 3) within the broad land cover class "Built-up".

Main land cover class (tier 2)	Detailed land cover class (tier 3)	Short description (see Appendix 1 for more detailed description)
Urban	Urban parklands*	Recreational green open space in urban areas. Non-natural vegetated areas containing a low density mix of buildings and other built-up structures associated with recreation. Includes residential golf estates and non-residential golf courses.
	Urban industrial	Areas containing buildings and other built-up structures associated with industrial and manufacturing activities, including power stations.
	Urban commercial	Areas containing high density buildings and other built-up structures associated with commercial, administrative, health, religious or transport (e.g. train station) activities.
	Urban built-up (other)*	Areas not clearly identifiable as one of the other built-up classes. Includes a wide range, e.g. runways, major infrastructure development sites, holiday chalets, roads, car parks, cemeteries.
	Urban residential*	Areas containing variable density buildings and other built-up structures typically associated with formal, regulated, residential housing. Includes established suburbs, townhouses, hostel complexes, flats.
	Urban township*	Areas containing high density building and other built-up structures typically associated with formal residential housing, including government subsidised housing, in low income areas.
	Urban informal*	Areas containing high density building and other built-up structures typically associated with informal, often non-regulated, residential housing. May include new formal developments with limited infrastructure developments.
	Urban smallholding*	Areas containing a low density mix of buildings, other built-up structures within open areas (which may or may not be cultivated), typically located on the periphery of urban areas.
	Urban village*	Areas containing variable density structures typically associated with rural villages, including both traditional and modern building formats. Includes dense rural settlements.
	Urban school and sports ground	Areas containing buildings, other built-up structures and open sports areas typically associated with schools and school sports grounds.
Mines	Mines	Includes mine buildings, surface infrastructure associated with mining, mining activity footprint (including extraction pits, tailings, waste dumps) and waterbodies within mining areas.

* Each of these detailed urban land cover classes includes areas with dense trees or bushes, open trees or bushes, low vegetation or grass, and bare areas, which are distinguished in the 72 NLC classes.

The overall decrease in commercial crops (tier 2) discussed in the previous section (see Figure 7) is disaggregated in Figure 9. The detailed land cover classes reveal that the decrease in commercial crops was largely due to a decrease in cultivated commercial fields (either rain-fed or non-pivot irrigated), which decreased by over a million hectares or 9,2% of their opening stock. The change matrix[12] shows that this area has been replaced to some degree by pivot-irrigated commercial cultivation, which increased by nearly 530 000 ha or 221,4% since 1990. So while there was a net decrease of 3,5% in the extent of commercial cultivation as a whole (Table 4), pivot irrigated fields increased in extent by more than 200,0%. This appears to signal a shift from rain-fed cultivation to pivot irrigation systems. Only those farmers who have the financial resources to invest in the required infrastructure, and who have access to suitable water sources (either ground or surface water), would be in a position to make this transition. The ecological implications of this shift are likely to be significant and long lasting.

[12] Available separately in a supplementary spreadsheet that can be downloaded from the Stats SA website (http://www.statssa.gov.za/).

Sugarcane crops (including rain-fed, non-pivot irrigated and pivot-irrigated sugarcane) are found only in KwaZulu-Natal and Mpumalanga and increased in extent by over 24,0%. This was largely a result of the conversion of 58 000 ha of natural or semi-natural land cover, 26 000 ha of subsistence crops, 9 000 ha of commercial fields (primarily rain-fed, annual crops produced for commercial markets) and nearly 7 000 ha of timber plantations into sugarcane crops.

Orchards expanded by nearly 18,0% of their 1990 area, and vines (which occur only in Western Cape and Northern Cape – see Table 12 in Section 3.2.3) expanded by nearly 17,0% of their 1990 area. Orchards largely replaced natural or semi-natural areas or cultivated commercial crops, but also replaced timber plantations and vines.

At the national level, there was little overall change in the area of subsistence crops, but this disguises some substantial changes at the provincial level, discussed in the next section.

Figure 9. Net change in detailed cultivated land cover classes (tier 3) at the national level, 1990–2014, in hectares (net percentage change shown at the end of each bar)

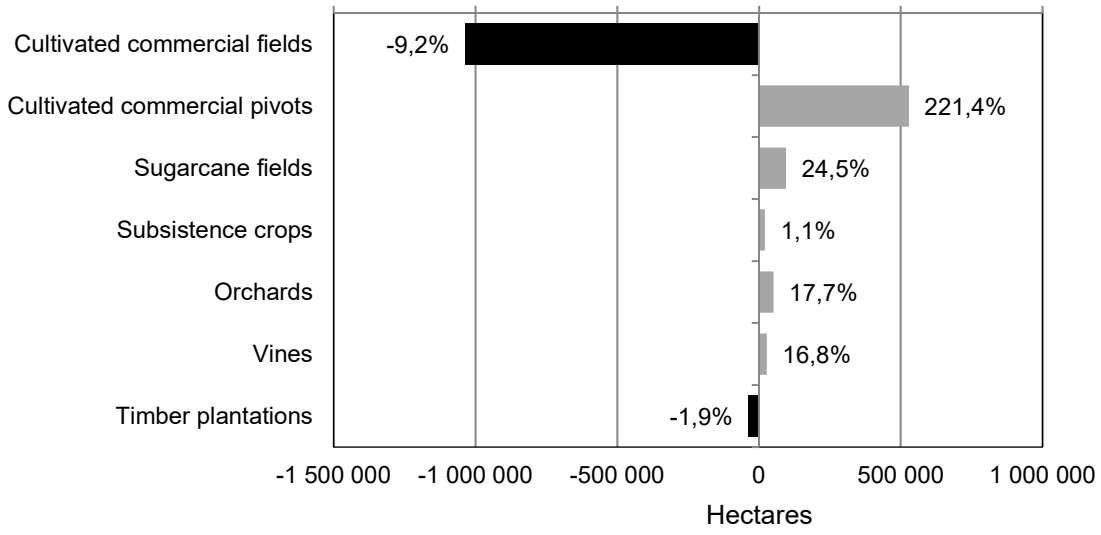


Figure 10 shows the disaggregation of the built-up land cover class (tier 2) into detailed land cover classes (tier 3). With the exception of urban smallholdings and urban industrial areas, all urban land cover classes at tier 3 increased in extent over the period 1990 to 2014.

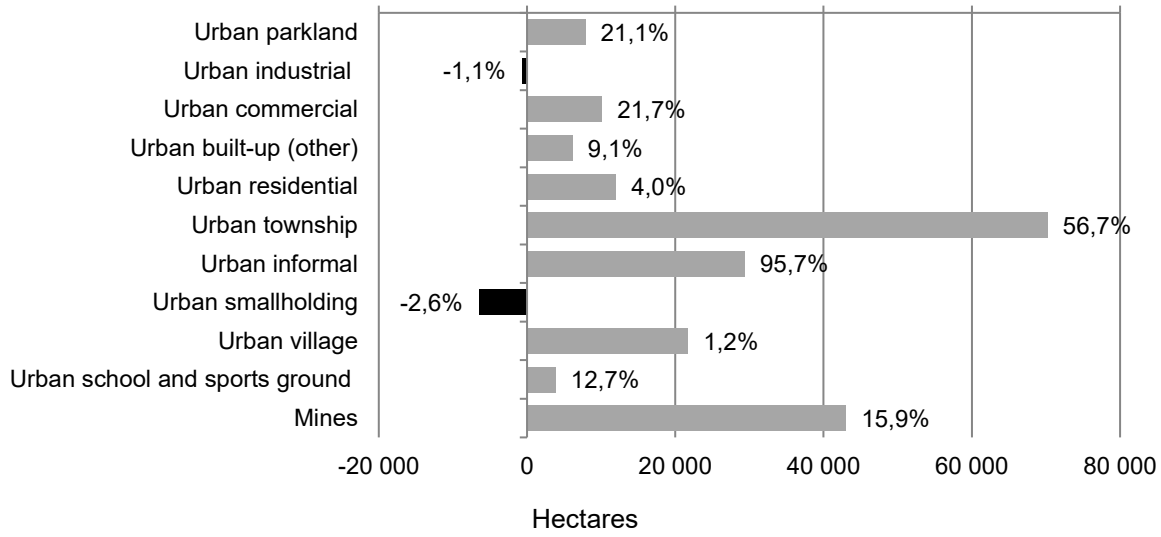
The largest increases by far in percentage terms were in urban informal areas (95,7%) and urban townships (56,7%), with urban townships also showing the largest absolute increase at more than 70 000 ha. This is likely to be linked to a growing and urbanising population, with people moving to cities and areas of economic growth — a trend that is further explored in Section 3.3 on district municipalities and in forthcoming land accounts for metropolitan municipalities.[13]

The change matrix[14] reveals that there was substantial switching between the urban classes over the accounting period. For example, more than 7 700 ha of urban smallholdings and urban school and sports grounds were converted to urban residential areas, and more than 1 700 ha of urban parkland were converted to urban residential areas. Urban smallholdings were also converted to cultivated commercial crops or returned to natural or semi-natural land cover (possibly having been abandoned). More than 1 700 ha of urban townships were converted to urban commercial areas.

Nearly 82 000 ha of natural or semi-natural land were converted to area under mines, with a net increase in mining extent of nearly 43 000 ha or 15,9%, from an opening stock in 1990 of 270 000 ha. This reflects only the extent of surface operations visible from satellite imagery, not the extent of underground mining operations.

[13] *Land accounts for metropolitan municipalities, 1990 to 2014,* will be published in future as part of the Natural Capital Series.
[14] Available separately in a supplementary spreadsheet that can be downloaded from the Stats SA website (http://www.statssa.gov.za/).

Figure 10. Net change in detailed built-up land cover classes (tier 3) at the national level, 1990–2014, in hectares (net percentage change shown at the end of each bar)



3.2 Land accounts by province

Land accounts can be disaggregated to provincial level to show variations in patterns and trends between provinces. The sections that follow illustrate this for broad, main and detailed land cover classes. Many further analyses are possible based on the accounting tables and change matrices for provinces.

3.2.1 Broad land cover classes (tier 1) by province

Figure 11 summarises land accounts per province by showing the proportional breakdown of broad land cover classes for each province, together with the percentage change in each class between 1990 and 2014. Because provinces vary considerably in size, the breakdown is given in percentage rather than absolute terms.

The provincial findings mirror, to a degree, the national results, with the greatest absolute changes between 1990 and 2014 in the natural or semi-natural land cover class. Gauteng has the smallest proportion of natural or semi-natural land cover of all the provinces, at less than 60,0%. Free State, KwaZulu-Natal and Mpumalanga have less than 75,0% natural or semi-natural land, while Northern Cape has the highest proportion of natural or semi-natural land at 98,6%. Natural or semi-natural land cover increased in all provinces except KwaZulu-Natal, where there was a 2,8% decrease.

The provinces with the highest proportion of cultivated land cover are Free State, Gauteng, Mpumalanga and North West. Cultivated land cover decreased in extent nationally but increased in Eastern Cape, KwaZulu-Natal and Northern Cape, with KwaZulu-Natal having the greatest percentage increase in cultivated land. In Section 3.2.2, this is explored in more detail for main land cover classes (tier 2) within the broad land cover class “cultivated”.

Built-up land cover increased in extent nationally, and this trend was mirrored in all but two provinces. Mpumalanga and Limpopo showed the greatest percentage increase in built-up land cover, while Gauteng remained the most built-up province, with 21,0% of its area classified as built-up by 2014. Built-up land cover decreased in Eastern Cape and KwaZulu-Natal. The decrease in built-up land cover in KwaZulu-Natal is interesting considering that Population Census data show an increase in the

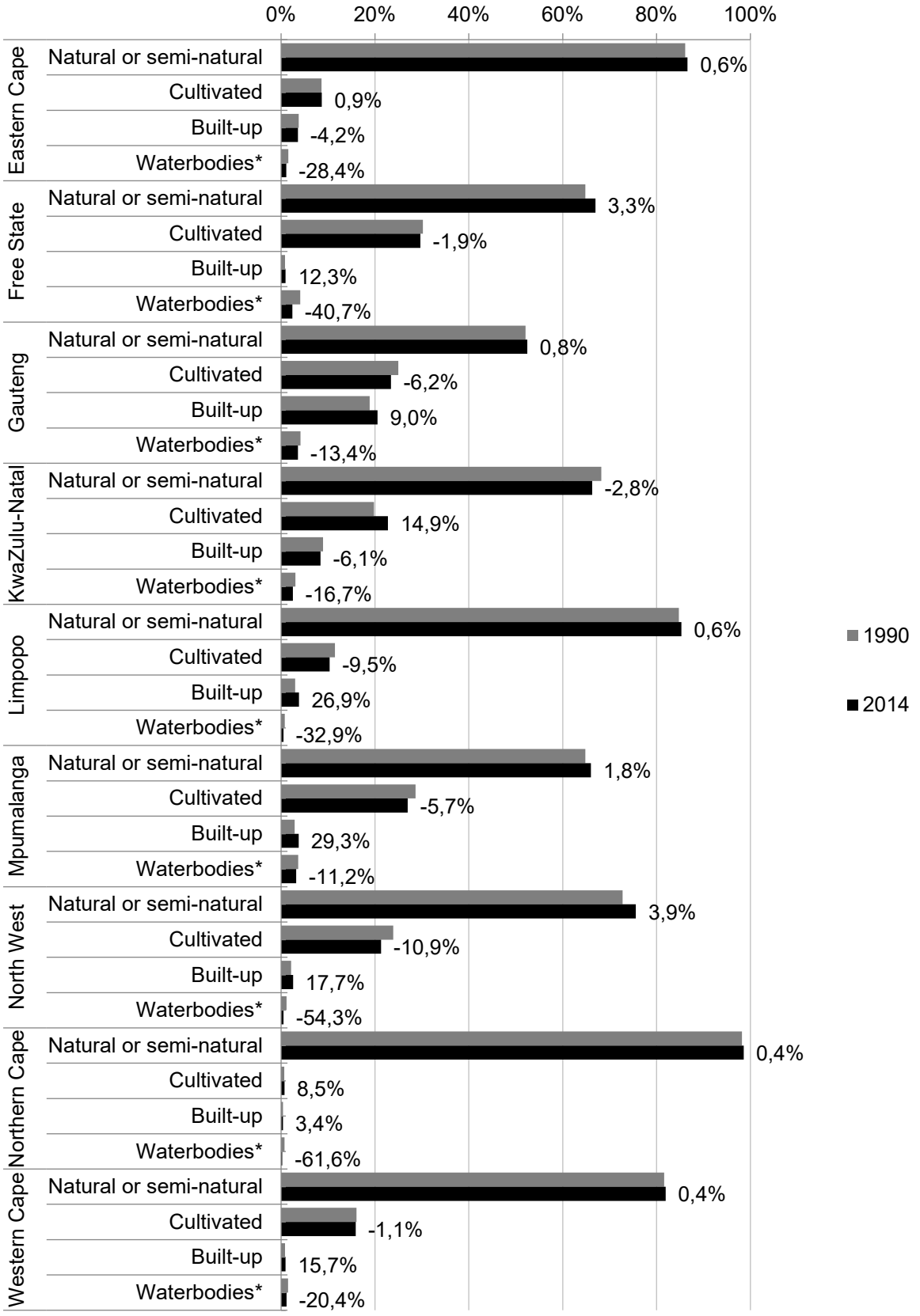
province's population. Section 3.2.3 gives more insight by exploring changes in the detailed land cover classes (tier 3) within the broad land cover class "built-up".

Waterbodies, as was the national trend, decreased in extent in all provinces. The smallest decreases were in Mpumalanga (11,2%), Gauteng (13,4%) and KwaZulu-Natal (16,7%) and the greatest decreases were in the more arid, interior parts of the country including Northern Cape (61,6%), North West (54,3%) and Free State (40,7%). As noted previously, these decreases reflect primarily that 1990 was a much wetter year than 2014.

3.2.2 Main land cover classes (tier 2) by province

Table 8 provides the accounting tables per province for main land cover classes (tier 2) for the period 1990 to 2014, and Appendix 3 provides the land cover change matrix per province. Table 9 and Table 10 draw directly from Table 8 to provide a summary of the main land cover classes per province in absolute and proportional terms, to facilitate comparison between provinces. Some of the key findings for each province are summarised in Table 11.

Figure 11. Proportional breakdown of broad land cover classes (tier 1) within each province in 1990 and 2014 (net percentage change for each class shown at the end of each pair of bars)



*Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

Table 8. Land account per province for main land cover classes (tier 2), 1990–2014, in hectares

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
Eastern Cape	**Opening stock 1990**	**14 537 488**	**559 959**	**705 645**	**41 560**	**147 501**	**628 363**	**5 376**	**258 822**	**16 884 714**
	Additions to stock	386 330	85 238	107 638	10 241	46 615	50 568	758	54 622	742 010
	Reductions in stock	299 939	111 626	70 900	8 162	45 579	74 436	3 232	128 136	742 010
	Net change in stock	86 391	-26 388	36 738	2 079	1 036	-23 868	-2 474	-73 514	
	Net change as % of opening	*0,6%*	*-4,7%*	*5,2%*	*5,0%*	*0,7%*	*-3,8%*	*-46,0%*	*-28,4%*	
	Unchanged (opening - reductions)	14 237 549	448 333	634 745	33 398	101 922	553 927	2 144	130 686	
	Unchanged as % of opening	*97,9%*	*80,1%*	*90,0%*	*80,4%*	*69,1%*	*88,2%*	*39,9%*	*50,5%*	
	Turnover (additions + reductions)	686 269	196 864	178 538	18 403	92 194	125 004	3 990	182 758	
	Turnover as % of opening	*4,7%*	*35,2%*	*25,3%*	*44,3%*	*62,5%*	*19,9%*	*74,2%*	*70,6%*	
	Closing stock 2014	**14 623 879**	**533 571**	**742 383**	**43 639**	**148 537**	**604 495**	**2 902**	**185 308**	**16 884 714**

*Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
Free State	**Opening stock 1990**	**8 419 831**	**3 869 264**	**18 557**	**2 291**	**34 405**	**90 467**	**21 545**	**526 161**	**12 982 521**
	Additions to stock	576 891	253 502	11 643	1 512	15 672	22 824	7 172	41 031	930 247
	Reductions in stock	302 967	337 573	525	427	17 472	9 481	6 683	255 119	930 247
	Net change in stock	273 924	-84 071	11 118	1 085	-1 800	13 343	489	-214 088	
	Net change as % of opening	*3,3%*	*-2,2%*	*59,9%*	*47,4%*	*-5,2%*	*14,7%*	*2,3%*	*-40,7%*	
	Unchanged (opening - reductions)	8 116 864	3 531 691	18 032	1 864	16 933	80 986	14 862	271 042	
	Unchanged as % of opening	*96,4%*	*91,3%*	*97,2%*	*81,4%*	*49,2%*	*89,5%*	*69,0%*	*51,5%*	
	Turnover (additions + reductions)	879 858	591 075	12 168	1 939	33 144	32 305	13 855	296 150	
	Turnover as % of opening	*10,4%*	*15,3%*	*65,6%*	*84,6%*	*96,3%*	*35,7%*	*64,3%*	*56,3%*	
	Closing stock 2014	**8 693 755**	**3 785 193**	**29 675**	**3 376**	**32 605**	**103 810**	**22 034**	**312 073**	**12 982 521**

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

Table 8. Land account per province for main land cover classes (tier 2), 1990–2014, in hectares (continued)

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
Gauteng	**Opening stock 1990**	**946 367**	**407 409**	**2 496**	**996**	**42 769**	**319 463**	**23 226**	**75 082**	**1 817 808**
	Additions to stock	141 557	74 381	787	1 137	7 374	71 588	7 216	16 936	320 976
	Reductions in stock	134 313	83 375	2 269	459	25 754	37 024	10 810	26 972	320 976
	Net change in stock	7 244	-8 994	-1 482	678	-18 380	34 564	-3 594	-10 036	
	Net change as % of opening	*0,8%*	*-2,2%*	*-59,4%*	*68,1%*	*-43,0%*	*10,8%*	*-15,5%*	*-13,4%*	
	Unchanged (opening - reductions)	812 054	324 034	227	537	17 015	282 439	12 416	48 110	
	Unchanged as % of opening	*85,8%*	*79,5%*	*9,1%*	*53,9%*	*39,8%*	*88,4%*	*53,5%*	*64,1%*	
	Turnover (additions + reductions)	275 870	157 756	3 056	1 596	33 128	108 612	18 026	43 908	
	Turnover as % of opening	*29,2%*	*38,7%*	*122,4%*	*160,2%*	*77,5%*	*34,0%*	*77,6%*	*58,5%*	
	Closing stock 2014	**953 611**	**398 415**	**1 014**	**1 674**	**24 389**	**354 027**	**19 632**	**65 046**	**1 817 808**

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
KwaZulu-Natal	**Opening stock 1990**	**6 363 912**	**759 202**	**397 744**	**14 686**	**677 293**	**830 234**	**4 535**	**282 920**	**9 330 526**
	Additions to stock	355 808	207 444	182 003	9 193	160 223	61 088	3 140	43 041	1 021 940
	Reductions in stock	534 049	84 998	70 249	2 754	124 667	112 324	2 621	90 278	1 021 940
	Net change in stock	-178 241	122 446	111 754	6 439	35 556	-51 236	519	-47 237	
	Net change as % of opening	*-2,8%*	*16,1%*	*28,1%*	*43,8%*	*5,2%*	*-6,2%*	*11,4%*	*-16,7%*	
	Unchanged (opening - reductions)	5 829 863	674 204	327 495	11 932	552 626	717 910	1 914	192 642	
	Unchanged as % of opening	*91,6%*	*88,8%*	*82,3%*	*81,2%*	*81,6%*	*86,5%*	*42,2%*	*68,1%*	
	Turnover (additions + reductions)	889 857	292 442	252 252	11 947	284 890	173 412	5 761	133 319	
	Turnover as % of opening	*14,0%*	*38,5%*	*63,4%*	*81,3%*	*42,1%*	*20,9%*	*127,0%*	*47,1%*	
	Closing stock 2014	**6 185 671**	**881 648**	**509 498**	**21 125**	**712 849**	**778 998**	**5 054**	**235 683**	**9 330 526**

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

Table 8. Land account per province for main land cover classes (tier 2), 1990–2014, in hectares (continued)

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
Limpopo	**Opening stock 1990**	**10 662 408**	**799 449**	**459 090**	**79 129**	**102 844**	**352 819**	**26 974**	**95 513**	**12 578 226**
	Additions to stock	468 561	146 119	115 312	43 445	2 722	127 410	12 794	18 282	934 645
	Reductions in stock	402 751	212 147	190 087	13 198	28 692	26 463	11 627	49 680	934 645
	Net change in stock	65 810	-66 028	-74 775	30 247	-25 970	100 947	1 167	-31 398	
	Net change as % of opening	*0,6%*	*-8,3%*	*-16,3%*	*38,2%*	*-25,3%*	*28,6%*	*4,3%*	*-32,9%*	
	Unchanged (opening - reductions)	10 259 657	587 302	269 003	65 931	74 152	326 356	15 347	45 833	
	Unchanged as % of opening	*96,2%*	*73,5%*	*58,6%*	*83,3%*	*72,1%*	*92,5%*	*56,9%*	*48,0%*	
	Turnover (additions + reductions)	871 312	358 266	305 399	56 643	31 414	153 873	24 421	67 962	
	Turnover as % of opening	*8,2%*	*44,8%*	*66,5%*	*71,6%*	*30,5%*	*43,6%*	*90,5%*	*71,2%*	
	Closing stock 2014	**10 728 218**	**733 421**	**384 315**	**109 376**	**76 874**	**453 766**	**28 141**	**64 115**	**12 578 226**

*Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
Mpumalanga	**Opening stock 1990**	**4 960 241**	**1 324 758**	**89 671**	**32 326**	**743 633**	**178 169**	**42 830**	**278 968**	**7 650 596**
	Additions to stock	428 959	133 765	15 435	20 496	121 650	52 784	52 390	50 133	875 612
	Reductions in stock	337 669	258 858	43 349	9 689	104 348	19 902	20 478	81 319	875 612
	Net change in stock	91 290	-125 093	-27 914	10 807	17 302	32 882	31 912	-31 186	
	Net change as % of opening	*1,8%*	*-9,4%*	*-31,1%*	*33,4%*	*2,3%*	*18,5%*	*74,5%*	*-11,2%*	
	Unchanged (opening - reductions)	4 622 572	1 065 900	46 322	22 637	639 285	158 267	22 352	197 649	
	Unchanged as % of opening	*93,2%*	*80,5%*	*51,7%*	*70,0%*	*86,0%*	*88,8%*	*52,2%*	*70,9%*	
	Turnover (additions + reductions)	766 628	392 623	58 784	30 185	225 998	72 686	72 868	131 452	
	Turnover as % of opening	*15,5%*	*29,6%*	*65,6%*	*93,4%*	*30,4%*	*40,8%*	*170,1%*	*47,1%*	
	Closing stock 2014	**5 051 531**	**1 199 665**	**61 757**	**43 133**	**760 935**	**211 051**	**74 742**	**247 782**	**7 650 596**

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

Table 8. Land account per province for main land cover classes (tier 2), 1990–2014, in hectares (continued)

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
North West	**Opening stock 1990**	**7 630 191**	**2 222 618**	**267 055**	**5 239**	**13 656**	**186 435**	**39 972**	**124 130**	**10 489 296**
	Additions to stock	511 085	131 678	28 027	1 039	3 918	45 057	27 526	7 544	755 874
	Reductions in stock	211 086	367 087	61 848	972	7 475	19 453	12 960	74 993	755 874
	Net change in stock	299 999	-235 409	-33 821	67	-3 557	25 604	14 566	-67 449	
	Net change as % of opening	*3,9%*	*-10,6%*	*-12,7%*	*1,3%*	*-26,0%*	*13,7%*	*36,4%*	*-54,3%*	
	Unchanged (opening - reductions)	7 419 105	1 855 531	205 207	4 267	6 181	166 982	27 012	49 137	
	Unchanged as % of opening	*97,2%*	*83,5%*	*76,8%*	*81,4%*	*45,3%*	*89,6%*	*67,6%*	*39,6%*	
	Turnover (additions + reductions)	722 171	498 765	89 875	2 011	11 393	64 510	40 486	82 537	
	Turnover as % of opening	*9,5%*	*22,4%*	*33,7%*	*38,4%*	*83,4%*	*34,6%*	*101,3%*	*66,5%*	
	Closing stock 2014	**7 930 190**	**1 987 209**	**233 234**	**5 306**	**10 099**	**212 039**	**54 538**	**56 681**	**10 489 296**

*Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
Northern Cape	**Opening stock 1990**	**36 627 149**	**212 044**	**4 199**	**36 776**	**1 260**	**44 606**	**100 677**	**262 441**	**37 289 152**
	Additions to stock	238 110	51 953	386	9 864	371	13 735	12 899	24 158	351 476
	Reductions in stock	102 887	33 612	740	5 770	937	5 665	16 015	185 850	351 476
	Net change in stock	135 223	18 341	-354	4 094	-566	8 070	-3 116	-161 692	
	Net change as % of opening	*0,4%*	*8,6%*	*-8,4%*	*11,1%*	*-44,9%*	*18,1%*	*-3,1%*	*-61,6%*	
	Unchanged (opening - reductions)	36 524 262	178 432	3 459	31 006	323	38 941	84 662	76 591	
	Unchanged as % of opening	*99,7%*	*84,1%*	*82,4%*	*84,3%*	*25,6%*	*87,3%*	*84,1%*	*29,2%*	
	Turnover (additions + reductions)	340 997	85 565	1 126	15 634	1 308	19 400	28 914	210 008	
	Turnover as % of opening	*0,9%*	*40,4%*	*26,8%*	*42,5%*	*103,8%*	*43,5%*	*28,7%*	*80,0%*	
	Closing stock 2014	**36 762 372**	**230 385**	**3 845**	**40 870**	**694**	**52 676**	**97 561**	**100 749**	**37 289 152**

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

Table 8. Land account per province for main land cover classes (tier 2), 1990–2014, in hectares (concluded)

	Land cover classes (tier 2) (8 land cover classes)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total
Western Cape	**Opening stock 1990**	**10 562 429**	**1 719 131**	**938**	**241 242**	**119 191**	**102 993**	**5 199**	**192 491**	**12 943 614**
	Additions to stock	259 258	142 989	126	43 589	9 846	24 948	5 972	33 007	519 735
	Reductions in stock	214 514	149 489	367	20 150	48 996	11 500	2 460	72 259	519 735
	Net change in stock	44 744	-6 500	-241	23 439	-39 150	13 448	3 512	-39 252	
	Net change as % of opening	*0,4%*	*-0,4%*	*-25,7%*	*9,7%*	*-32,8%*	*13,1%*	*67,6%*	*-20,4%*	
	Unchanged (opening - reductions)	10 347 915	1 569 642	571	221 092	70 195	91 493	2 739	120 232	
	Unchanged as % of opening	*98,0%*	*91,3%*	*60,9%*	*91,6%*	*58,9%*	*88,8%*	*52,7%*	*62,5%*	
	Turnover (additions + reductions)	473 772	292 478	493	63 739	58 842	36 448	8 432	105 266	
	Turnover as % of opening	*4,5%*	*17,0%*	*52,6%*	*26,4%*	*49,4%*	*35,4%*	*162,2%*	*54,7%*	
	Closing stock 2014	**10 607 173**	**1 712 631**	**697**	**264 681**	**80 041**	**116 441**	**8 711**	**153 239**	**12 943 614**

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

Table 9. Land cover composition by main land cover class (tier 2) for provinces, in absolute and percentage terms, 1990 and 2014

		Eastern Cape		Free State		Gauteng		KwaZulu-Natal		Limpopo		Mpumalanga		North West		Northern Cape		Western Cape	
		1990	2014	1990	2014	1990	2014	1990	2014	1990	2014	1990	2014	1990	2014	1990	2014	1990	2014
Natural or semi-natural	000 ha	14 537	14 624	8 420	8 694	946	954	6 364	6 186	10 662	10 728	4 960	5 052	7 630	7 930	36 627	36 762	10 562	10 607
	%	86,1%	86,6%	64,9%	67,0%	52,1%	52,5%	68,2%	66,3%	84,8%	85,3%	64,8%	66,0%	72,7%	75,6%	98,2%	98,6%	81,6%	81,9%
Commercial crops	000 ha	560	534	3869	3 785	407	398	759	882	799	733	1 325	1 200	2 223	1 987	212	230	1 719	1 713
	%	3,3%	3,2%	29,8%	29,2%	22,4%	21,9%	8,1%	9,4%	6,4%	5,8%	17,3%	15,7%	21,2%	18,9%	0,6%	0,6%	13,3%	13,2%
Subsistence crops	000 ha	706	742	19	30	2	1	398	509	459	384	90	62	267	233	4	4	1	1
	%	4,2%	4,4%	0,1%	0,2%	0,1%	0,1%	4,3%	5,5%	3,6%	3,1%	1,2%	0,8%	2,5%	2,2%	0,0%	0,0%	0,0%	0,0%
Orchards & vines	000 ha	42	44	2	3	1	2	15	21	79	109	32	43	5	5	37	41	241	265
	%	0,2%	0,3%	0,0%	0,0%	0,1%	0,1%	0,2%	0,2%	0,6%	0,9%	0,4%	0,6%	0,0%	0,1%	0,1%	0,1%	1,9%	2,0%
Timber plantations	000 ha	148	149	34	33	43	24	677	713	103	77	744	761	14	10	1	1	119	80
	%	0,9%	0,9%	0,3%	0,3%	2,4%	1,3%	7,3%	7,6%	0,8%	0,6%	9,7%	9,9%	0,1%	0,1%	0,0%	0,0%	0,9%	0,6%
Urban	000 ha	628	604	90	104	319	354	830	779	353	454	178	211	186	212	45	53	103	116
	%	3,7%	3,6%	0,7%	0,8%	17,6%	19,5%	8,9%	8,3%	2,8%	3,6%	2,3%	2,8%	1,8%	2,0%	0,1%	0,1%	0,8%	0,9%
Mines	000 ha	5	3	22	22	23	20	5	5	27	28	43	75	40	55	101	98	5	9
	%	0,0%	0,0%	0,2%	0,2%	1,3%	1,1%	0,0%	0,1%	0,2%	0,2%	0,6%	1,0%	0,4%	0,5%	0,3%	0,3%	0,0%	0,1%
Waterbodies	000 ha	259	185	526	312	75	65	283	236	96	64	279	248	124	57	262	101	192	153
	%	1,5%	1,1%	4,1%	2,4%	4,1%	3,6%	3,0%	2,5%	0,8%	0,5%	3,6%	3,2%	1,2%	0,5%	0,7%	0,3%	1,5%	1,2%
Total	**000 ha**	**16 885**	**16 885**	**12 983**	**12 983**	**1 818**	**1 818**	**9 331**	**9 331**	**12 578**	**12 578**	**7 651**	**7 651**	**10 489**	**10 489**	**37 289**	**37 289**	**12 944**	**12 944**
	%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 10. Proportion of national extent of each main land cover class (tier 2) per province, 1990 and 2014

Provinces	Year	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards & vines	Timber plantations	Urban	Mines	Waterbodies
Eastern Cape	1990	14,4%	4,7%	36,3%	9,1%	7,8%	23,0%	2,0%	12,3%
	2014	14,4%	4,7%	37,8%	8,2%	8,0%	20,9%	0,9%	13,0%
Free State	1990	8,4%	32,6%	1,0%	0,5%	1,8%	3,3%	8,0%	25,1%
	2014	8,6%	33,0%	1,5%	0,6%	1,8%	3,6%	7,0%	22,0%
Gauteng	1990	0,9%	3,4%	0,1%	0,2%	2,3%	11,7%	8,6%	3,6%
	2014	0,9%	3,5%	0,1%	0,3%	1,3%	12,3%	6,3%	4,6%
KwaZulu-Natal	1990	6,3%	6,4%	20,4%	3,2%	36,0%	30,4%	1,7%	13,5%
	2014	6,1%	7,7%	25,9%	4,0%	38,6%	27,0%	1,6%	16,6%
Limpopo	1990	10,6%	6,7%	23,6%	17,4%	5,5%	12,9%	10,0%	4,6%
	2014	10,6%	6,4%	19,5%	20,5%	4,2%	15,7%	9,0%	4,5%
Mpumalanga	1990	4,9%	11,2%	4,6%	7,1%	39,5%	6,5%	15,8%	13,3%
	2014	5,0%	10,5%	3,1%	8,1%	41,2%	7,3%	23,9%	17,4%
North West	1990	7,6%	18,7%	13,7%	1,2%	0,7%	6,8%	14,8%	5,9%
	2014	7,8%	17,3%	11,9%	1,0%	0,5%	7,3%	17,4%	4,0%
Northern Cape	1990	36,4%	1,8%	0,2%	8,1%	0,1%	1,6%	37,2%	12,5%
	2014	36,2%	2,0%	0,2%	7,7%	0,0%	1,8%	31,1%	7,1%
Western Cape	1990	10,5%	14,5%	0,0%	53,1%	6,3%	3,8%	1,9%	9,2%
	2014	10,4%	14,9%	0,0%	49,6%	4,3%	4,0%	2,8%	10,8%
Total %		**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**
Total 000 ha	1990	100 710	11 874	1 945	454	1 883	2 734	270	2 097
	2014	101 536	11 462	1 966	533	1 847	2 887	313	1 421

Table 11. Summary of key findings from land cover account for main land cover classes (tier 2) for provinces (drawing on Table 8, Table 9, Table 10 and Appendix 3)

Province	Key findings
Eastern Cape	• Contains more than a third of the country's subsistence crop land cover, and just more than a fifth of the country's urban land cover. Much of the "urban" land cover takes the form of villages and rural settlements (see Section 3.2.3 on detailed land cover classes by province). • Only province for which subsistence crop land cover is greater than commercial crop land cover, at around 700 000 ha and 660 000 ha, respectively . • Increase in natural or semi-natural land cover, mostly from commercial crops, where net change was -4,7%. • Large percentage decrease in mining land cover (46,0%), but mining land cover small in absolute terms (around 3 000 ha in 2014).
Free State	• Contains a third of the country's commercial crop land cover, with more than 3,7 million ha of commercial crops, by far the highest of all provinces. • Decrease in commercial crop land cover converting to semi-natural and urban land cover. • Large percentage increases in subsistence crop land cover (59,9%) and orchards and vines (47,7%). The conversions were mostly from commercial crops in both instances.
Gauteng	• Even though about half of Gauteng's land cover is natural or semi-natural, as the smallest province it accounts for less than 1,0% of the country's natural or semi-natural land cover. • Large increase in urban land cover from natural or semi-natural land cover, timber plantations and commercial crops. • Substantial percentage decrease in subsistence crops (59,4%) and timber plantations (43,0%) primarily due to conversion to commercial crops and urban land cover, respectively.
KwaZulu-Natal	• Contains around a quarter of the country's subsistence crop land cover and more than a quarter of the country's urban land cover. Like Eastern Cape, much of the "urban" land cover takes the form of villages and rural settlements (see Section 3.2.3 on detailed land cover classes by province). • Contains nearly 40,0% of the country's timber plantations, with more than 700 000 ha of timber plantations in 2014. • Only province with a decrease in natural or semi-natural land cover. • Largest absolute and percentage decrease in urban land cover relative to other provinces. • Highest absolute increases in commercial and subsistence crops (>100 000 ha each) relative to other provinces. • High percentage increases in subsistence crops (28,1%) and orchards and vines (43,8%) relative to other provinces, primarily from natural or semi-natural land cover.
Limpopo	• Contains around a fifth of the country's subsistence crop land cover, notwithstanding a decrease from around 460 000 ha of subsistence crops in 1990 to around 380 000 ha in 2014. • Large net increase in urban land cover (28,6%). • Increases in orchards and vines that were previously commercial crops. Orchards and vines had the greatest percentage change relative to other provinces, and in 2014 accounted for around a fifth of the country's orchards and vines, second only to Western Cape. • Second largest decrease in timber plantations, converting mostly to semi-natural land cover.
Mpumalanga	• Contains more than 40,0% of the country's timber plantations, with around 760000 ha of timber plantations in 2014 (just more than KwaZulu-Natal). • Second largest decrease in commercial crop land cover (>125 000 ha). • Largest absolute and percentage (74,5%) increase in mining land cover, converted from commercial crops and natural or semi-natural land cover. In 2014 accounted for 23,9% of the country's mining land cover (second only to Northern Cape), up from 15,8% in 1990. • High percentage decrease in subsistence crops (31,1%) and increase in orchards and vines (33,4%), mostly replacing commercial crops.

Province	Key findings
North West	• Largest decrease in commercial crop land cover relative to other provinces (>235 000 ha). • High absolute and percentage (36,4%) increase in mining land cover, mostly from natural or semi-natural land cover. Contained 17,4% of the country's mining land cover in 2014. • High net increase in natural or semi-natural land cover from commercial crops (>350 000 ha).
Northern Cape	• Contains more than a third of the country's natural or semi-natural land cover, as the country's largest province with more than 98,0% of its area natural or semi-natural. • Contains about a third of the country's mining land cover, although mining land cover decreased by 3,1% from around 100 000 ha in 1990 to around 97 000 in 2014. • Large percentage increase in urban land cover (18,1%), almost entirely from natural or semi-natural land cover, but still the smallest urban land cover of all provinces in absolute terms.
Western Cape	• Contains around half the country's orchards and vines, with around 265 000 ha of orchards and vines in 2014, up from around 240 000 ha in 1990. • Large net increases in urban land cover and orchards and vines, replacing natural or semi-natural land cover primarily. • Largest decrease in extent of timber plantations (>39 000 ha). • A 67,6% increase in mining land cover, almost exclusively replacing natural or semi-natural land.

3.2.3 Detailed land cover classes (tier 3) by province

As noted earlier, the accounting tables and associated change matrices at tier 3 are too large to be included in this report.[15] A summary of changes in detailed land cover classes (tier 3) per province over the period 1990 to 2014 is presented in Table 12, in absolute and percentage terms, with some key findings highlighted for each detailed land cover class below.

Overall there were small percentage changes in **natural or semi-natural land cover,** ranging from -2,8% in KwaZulu-Natal to 3,9% in North West. Percentage changes tend to be smaller for the more widespread land cover classes, even though the changes can be quite large in absolute terms.

Cultivated commercial fields decreased in area in every province except for KwaZulu-Natal. The decreases were greatest in percentage terms in Northern Cape (19,4%), and Mpumalanga (14,5%).

Cultivated commercial pivots increased substantially in every province. This land cover class more than doubled in area from 1990 to 2014 in every province, with increases of more than 400,0% in Eastern Cape and Free State. Limpopo had the highest absolute increase (nearly 90 000 ha).

Sugarcane crops increased in extent in both of the provinces where it is grown (KwaZulu-Natal and Mpumalanga) and there were no new plantings in other provinces. The extent increased by 70,7% in Mpumalanga.

Subsistence crops increased in extent in only three provinces – Eastern Cape, Free State and KwaZulu-Natal. The greatest absolute increase was in KwaZulu-Natal, with an increase of more than 110 000 ha. The largest percentage increase (59,9%) was in Free State, but from a low base. Limpopo had the largest net decrease of nearly 75 000 ha. There were also large percentage decreases in Mpumalanga and Western Cape.

Orchards increased in extent in all provinces except Western Cape, with large percentage increases in several provinces, although generally off a low base. Western Cape and Limpopo account for the majority of the country's orchards, followed by Mpumalanga.

Vines occur only in Western Cape and Northern Cape, and increased in extent in both of these provinces, with a substantial percentage increase of 18,7% in Western Cape.

[15] They are available in a supplementary spreadsheet of tables and matrices that can be downloaded from the Stats SA website (http://www.statssa.gov.za/).

Timber plantations decreased in extent in all but three provinces. There were notable percentage decreases in Western Cape, Northern Cape, Gauteng and Limpopo, but from a relatively low base as around 80,0% of the country's timber plantations occur in Mpumalanga and KwaZulu-Natal. The highest absolute decreases were in Western Cape (around 39 000 ha) and Limpopo (around 26 000 ha). In KwaZulu-Natal, timber plantations increased by nearly 36 000 ha.

Urban parkland increased in every province apart from Northern Cape. In Limpopo, urban parkland increased by over 150,0% or around 2 800 ha, going hand in hand with the growth in overall urban land cover in the province. With nearly 10 000 ha of urban parkland, Gauteng had a large net increase of 24,1%. Next highest in percentage terms were North West and Eastern Cape, and Western Cape and KwaZulu-Natal in absolute terms.

Urban industrial land cover increased overall, with the largest increase in Limpopo in both absolute (650 ha) and percentage (39,1%) terms. The largest decrease was in Free State in both absolute (>1 000 ha) and percentage (22,4%) terms. Gauteng, the industrial heartland of the country, had by far the highest closing stock with more than 18 000 ha of urban industrial land cover.

Urban commercial land cover increased in all provinces except North West. The greatest net increases in absolute terms were in Gauteng (>3 500 ha), Western Cape (>2 300 ha) and KwaZulu-Natal (>1 700 ha), with the highest percentage increase in Western Cape (33,9%).

Urban residential land cover trends were variable across the country and generally modest, with net increases or decreases of less than 10,0%. The largest percentage increase by far was in Limpopo (30,5%). The largest absolute increase by far was in Gauteng (>8 000 ha). Gauteng had the highest closing stock of urban residential area, accounting for over a third of the national total.

There were large net increases in **urban township** land cover in all provinces. The largest percentage increases were in North West (137,8%) and Limpopo (124,4%), with very substantial increases in most other provinces. The smallest percentage increases were in KwaZulu-Natal and Western Cape (both 19,6%). The largest absolute increase was in Gauteng (>16 000 ha), followed by Mpumalanga (>11 000 ha) and Free State (>10 000 ha).

Similarly, **urban informal areas** increased in every province. There were very large percentage increases in Northern Cape (>900,0%), Free State (>800,0%), Limpopo (>600,0%), Mpumalanga (>400,0%) and Western Cape (>200,0%). The largest absolute increases were in Gauteng (close to 12 000 ha) and North West (nearly 4 000 ha). There were absolute increases of over 2 000 ha in Free State, KwaZulu-Natal, Mpumalanga and Western Cape. In future work it would be useful to explore this at finer scale for more detail, for instance for particular local municipalities or towns. The stock of urban informal areas increased from 31 000 ha in 1990 to 60 000 ha in 2014.

Areas classified as **urban smallholdings** decreased in all provinces except Limpopo and Northern Cape. The largest absolute decreases were in Gauteng (just under 15 000 ha) and North West (>5 000 ha or 32,5% – also the largest percentage decrease). The large increase in Limpopo contrasts with decreases in other provinces, at more than 19 000 ha or 69,8%.

Urban village land cover increased in all provinces except in Eastern Cape and KwaZulu-Natal. As noted in Table 7, the class "urban village" includes rural villages (both traditional and modern building formats) and dense rural settlements. The largest increase in absolute terms was in Limpopo (>68 000 ha or 23,2%), followed by Mpumalanga (just less than 20 000 ha or 20,2%). The largest percentage increase was in Gauteng (76,2%), but this was relatively small in absolute terms at around 2 400 ha. Both KwaZulu-Natal and Eastern Cape had large decreases in absolute terms, at more than 68 000 ha and more than 31 000 ha, respectively, but the large opening stock of this land cover class in both provinces means that these decreases were relatively modest in percentage terms (8,2% in KwaZulu-Natal and 5,7% in Eastern Cape).

Urban school and sports grounds increased in most provinces, but decreased in KwaZulu-Natal, Eastern Cape and Western Cape. Eastern Cape had the greatest net decrease (356 ha). Gauteng had the highest absolute (>3 000 ha) and percentage (35,3%) increases.

Mining land cover increased in six provinces. Western Cape and Mpumalanga had the highest percentage increases (> 50,0%), with Mpumalanga also having the greatest absolute increase – nearly

32 000 ha owing to the large expansion of coal mining in the Gert Sibande and Nkangala District Municipalities (see Section 3.3). Both Gauteng and Northern Cape had net decreases of over 3 000 ha. Eastern Cape that had the greatest percentage decrease (46,0%) although this was small in absolute terms.

As discussed earlier, the decrease in **waterbodies** reflects the fact that 2014 was a drier year than 1990, with a net decrease in extent of waterbodies in every province.

Table 12. Net change in detailed land cover classes (tier 3) in each province, 1990–2014, in absolute and percentage terms

	Eastern Cape		Free State		Gauteng		KwaZulu-Natal		Limpopo		Mpumalanga		North West		Northern Cape		Western Cape	
Land Cover	Net change	% Δ	Net change	% Δ	Net change	% Δ	Net change	% Δ	Net change	% Δ	Net change	% Δ	Net change	% Δ	Net change	% Δ	Net change	% Δ
Natural or semi-natural	86 391	0,6%	273 924	3,3%	7 244	0,8%	-178 241	-2,8%	65 810	0,6%	91 290	1,8%	299 999	3,9%	135 223	0,4%	44 744	0,4%
Cultivated commercial fields	-68 578	-12,5%	-219 493	-5,7%	-24 091	-6,0%	6 850	1,7%	-154 406	-21,4%	-185 505	-14,5%	-296 084	-13,5%	-32 409	-19,4%	-61 363	-3,6%
Cultivated commercial pivots	42 190	416,7%	135 422	489,7%	15 097	218,0%	46 693	291,0%	88 378	112,2%	34 342	282,7%	60 675	254,8%	50 750	113,9%	54 863	294,5%
Sugarcane	0	0,0%	0	0,0%	0	0,0%	68 903	19,6%	0	0,0%	26 070	70,7%	0	0,0%	0	0,0%	0	0,0%
Subsistence crops	36 738	5,2%	11 118	59,9%	-1 482	-59,4%	111 754	28,1%	-74 775	-16,3%	-27 914	-31,1%	-33 821	-12,7%	-354	-8,4%	-241	-25,7%
Orchards	2 079	5,0%	1 085	47,4%	678	68,1%	6 439	43,8%	30 247	38,2%	10 807	33,4%	67	1,3%	1 491	25,5%	-1 716	-1,6%
Vines	0	0,0%	0	0,0%	0	0,0%	0	0,0%	0	0,0%	0	0,0%	0	0,0%	2 603	8,4%	25 155	18,7%
Timber plantations	1 036	0,7%	-1 800	-5,2%	-18 380	-43,0%	35 556	5,2%	-25 970	-25,3%	17 302	2,3%	-3 557	-26,0%	-566	-44,9%	-39 150	-32,8%
Urban parkland	662	14,7%	351	11,6%	1 879	24,1%	753	13,7%	2 816	154,2%	66	2,8%	365	16,0%	-145	-6,3%	1 079	14,4%
Urban industrial	-392	-7,3%	-1 141	-22,4%	261	1,5%	-113	-1,1%	650	39,1%	210	3,0%	-392	-10,1%	223	13,1%	26	0,3%
Urban commercial	513	15,5%	489	13,7%	3 586	27,2%	1 780	22,5%	529	24,8%	566	20,2%	-143	-3,3%	360	17,6%	2 385	33,9%
Urban built-up	-1 724	-12,1%	1 466	157,5%	1 876	10,9%	911	214,9%	-100	-0,8%	-20	-0,1%	1 115	75,9%	1 082	54,5%	1 484	144,4%
Urban residential	380	1,3%	-1 056	-5,0%	8 162	8,3%	-1 468	-2,6%	2 417	30,5%	631	3,2%	-113	-0,8%	-546	-7,1%	3 541	7,6%
Urban township	7 781	65,9%	10 682	45,5%	16 309	81,0%	3 739	19,6%	6 491	124,4%	11 238	77,9%	8 260	137,8%	2 505	34,3%	3 164	19,6%
Urban informal	1 160	78,7%	2 752	811,8%	11 893	116,6%	2 454	23,4%	701	631,5%	2 377	487,1%	3 987	62,0	1 854	913,3%	2 143	235,0%
Urban smallholding	-883	-7,9%	-972	-3,4%	-14 983	-12,2%	-1 442	-11,4%	19 250	69,8%	-1 961	-13,0%	-5 423	-32,5%	32	1,3%	-82	-0,8%
Urban village	-31 009	-5,7%	111	5,7%	2 394	76,2%	-57 702	-8,2%	68 017	23,2%	19 560	20,2%	17 591	13,6%	2 703	15,6%	0	0,0%
Urban school and sports ground	-356	-7,4%	661	24,0%	3 187	35,3%	-148	-5,0%	176	16,6%	215	17,3%	357	22,1%	2	0,1%	-292	-5,9%
Mines	-2 474	-46,0%	489	2,3%	-3 594	-15,5%	519	11,4%	1 167	4,3%	31 912	74,5%	14 566	36,4%	-3 116	-3,1%	3 512	67,6%
Waterbodies*	-73 514	-28,4%	-214 088	-40,7%	-10 036	-13,4%	-47 237	-16,7%	-31 398	-32,9%	-31 186	-11,2%	-67 449	-54,3%	-161 692	-61,6%	-39 252	-20,4%

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

3.3 Land accounts by district municipality

3.3.1 Broad land cover classes (tier 1) by district municipality

Land cover accounts were compiled for each of the 44 district municipalities and eight metropolitan municipalities in South Africa. For simplicity, these 52 district and metropolitan municipalities are referred to collectively here as district municipalities. The full set of accounting tables for district municipalities is too large to be included in this report.[16] Instead, changes in land cover per district are summarised below in the form of maps. Figure 12 shows the net percentage change in natural or semi-natural land cover per district municipality, Figure 13 shows the net percentage change in cultivated land cover, and Figure 14 shows the net percentage change in built-up land cover.

District municipalities are assigned a district code (DC) and metropolitan municipalities are assigned a code associated with the municipality name. These codes are used on the maps – see Appendix 5 for the names associated with these codes.

Most districts experienced a small increase in **natural or semi-natural land cover** between 0,1% and 2,5% relative to the opening stock in 1990 (Figure 12). The exception is in KwaZulu-Natal, where several districts experienced a net percentage decrease in natural or semi-natural land cover. Of the ten districts with the greatest net decrease in natural or semi-natural land cover, seven were within KwaZulu-Natal (Figure 12). Nationally, Harry Gwala (previously Sisonke) District (DC43) had the greatest decrease in natural or semi-natural land cover (7,7%), followed by Zululand (DC26; 5,3%), and Amajuba (DC25; 3,8%). Outside of KwaZulu-Natal province, the Johannesburg (JHB) and Tshwane (TSH) metropolitan municipalities (metros), as well as Sekhukhune District (DC47) in Limpopo complete the ten districts with the highest net percentage decreases in natural or semi-natural land cover. In the western part of the country, only the West Coast District (DC1) and City of Cape Town (CPT) had net decreases in natural or semi-natural land cover. A number of districts had relatively large percentage increases in natural or semi-natural land cover, with several districts along the Vaal River (DC40, 48, 18 and 20) having had the greatest net increases of between 5,1% and 6,3%.

Large percentage increases in **cultivated land cover** took place in most of the districts in KwaZulu-Natal, with seven of the ten districts with the largest net increases in cultivated land (Figure 13) occurring in this province. Districts in Northern Cape also showed net percentage increases in cultivated land cover, except for John Taolo Gaetsewe District (DC45), which had a 49,0% decrease in cultivated land cover. Although the opening stock of cultivated land cover in metros (such as Ekurhuleni (EKU), City of Johannesburg (JHB) and Nelson Mandela Bay (NMA)) was low, this decreased further between 1990 and 2014. Of the metros, only eThekwini (ETH) and City of Tshwane (TSH) had net percentage increases in cultivated land. The Vhembe District (DC34) in Limpopo province had a 22,0% net decrease in cultivated land cover.

Built-up land showed a net percentage increase in two thirds of South Africa's districts (Figure 14). The greatest percentage increases were in the Nkangala District (DC31; 45,0%) in Mpumalanga and the Sekhukhune District (DC47; 34,0%) in Limpopo. Six of the ten districts with the largest net decreases in built-up land cover were in KwaZulu-Natal. eThekwini (ETH) was the only metro where a net decrease in built-up land cover was recorded. All districts in Eastern Cape had a decrease in built-up land cover, with only the two metros in the province showing an increase in built-up land.

[16] They are available in a supplementary spreadsheet of tables that can be downloaded from the Stats SA website (http://www.statssa.gov.za/).

Figure 12. Net percentage change in natural or semi-natural land cover (tier 1) by district municipality, 1990–2014

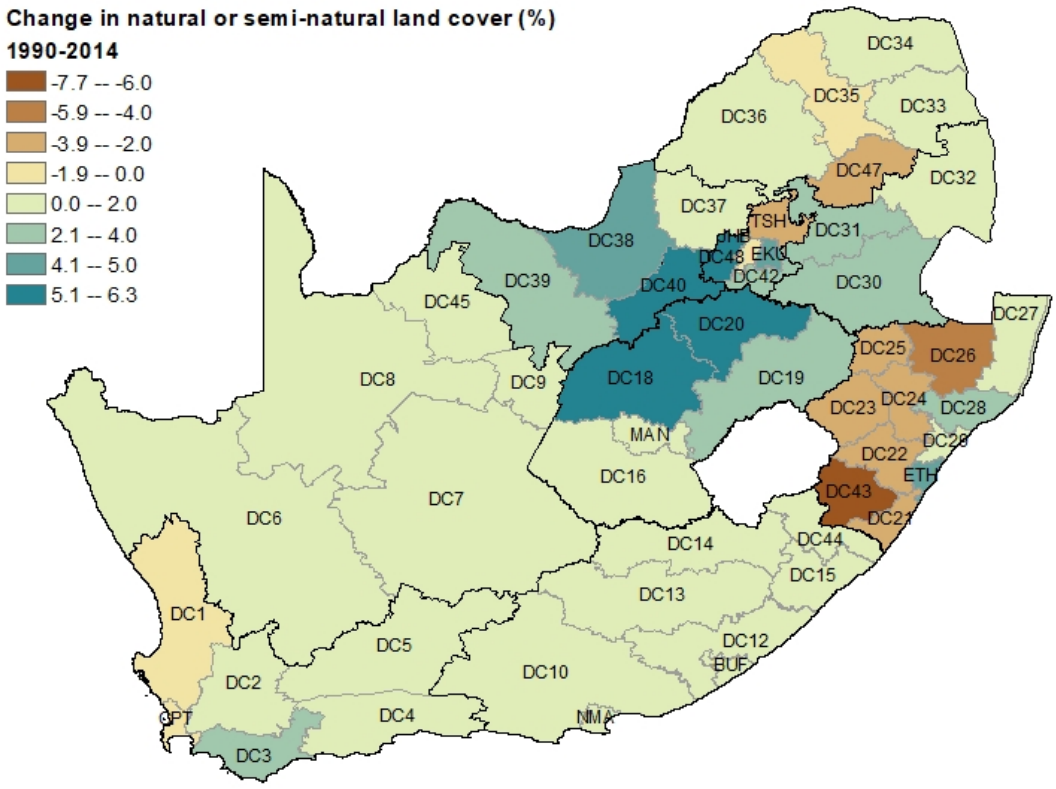


Figure 13. Net percentage change in cultivated land cover (tier 1) by district municipality, 1990–2014.

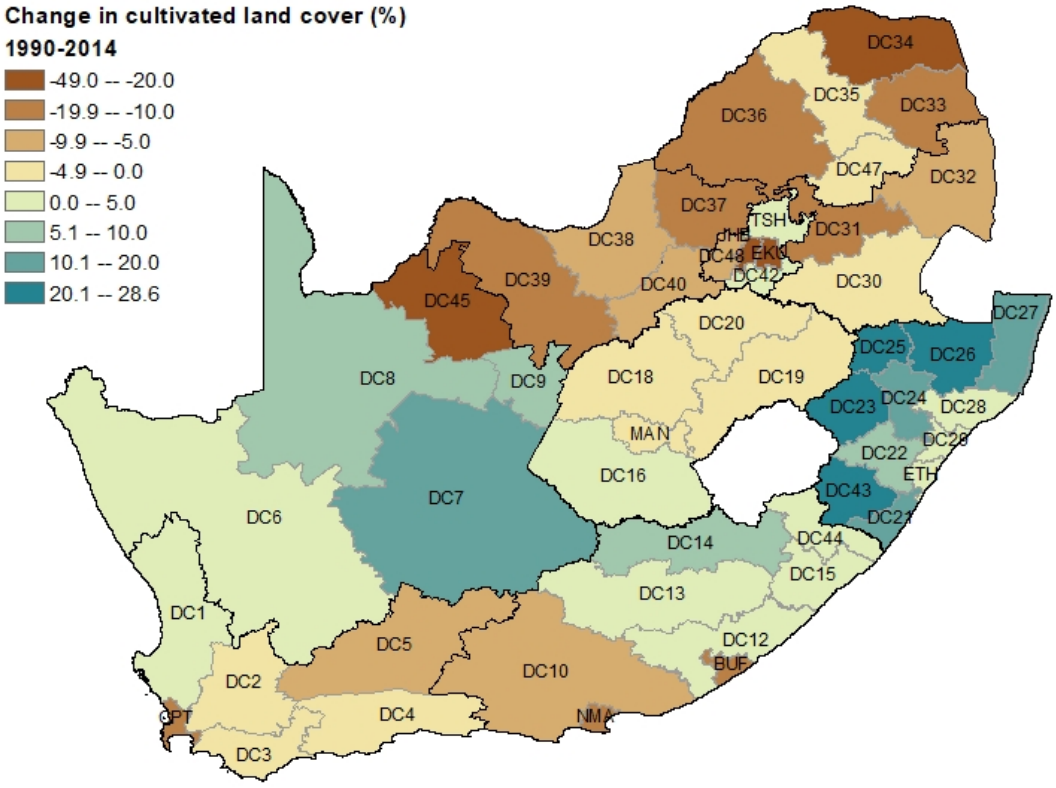


Figure 14. Net percentage change in built-up land cover (tier 1) by district municipality, 1990–2014.

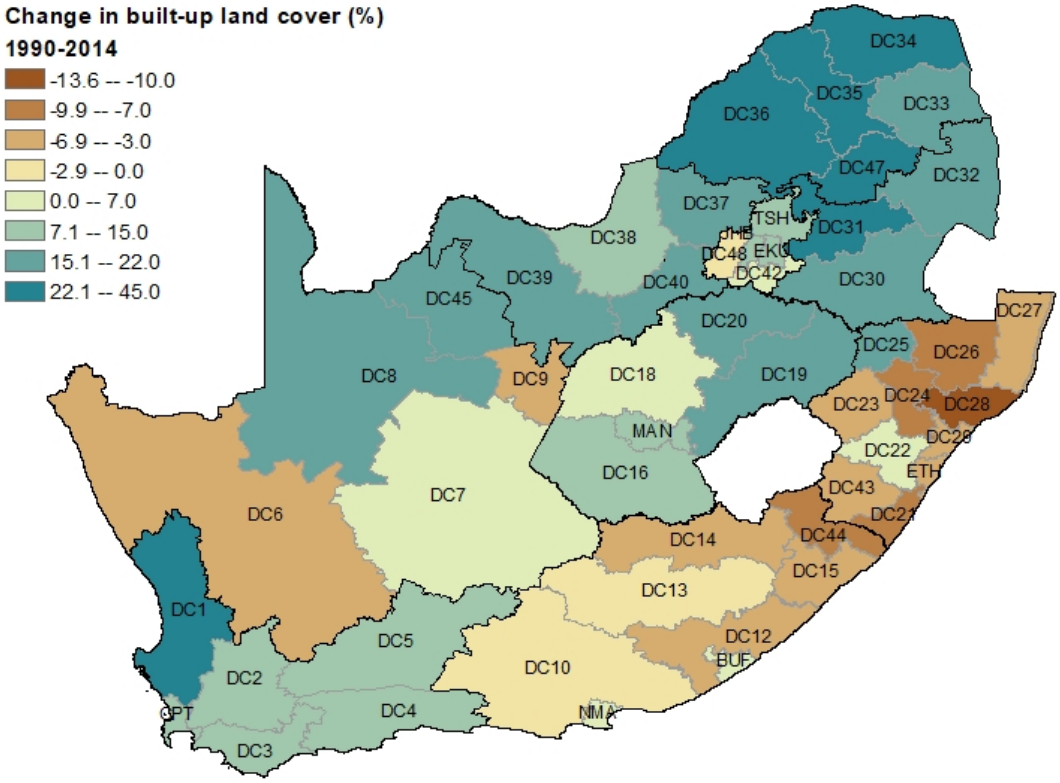
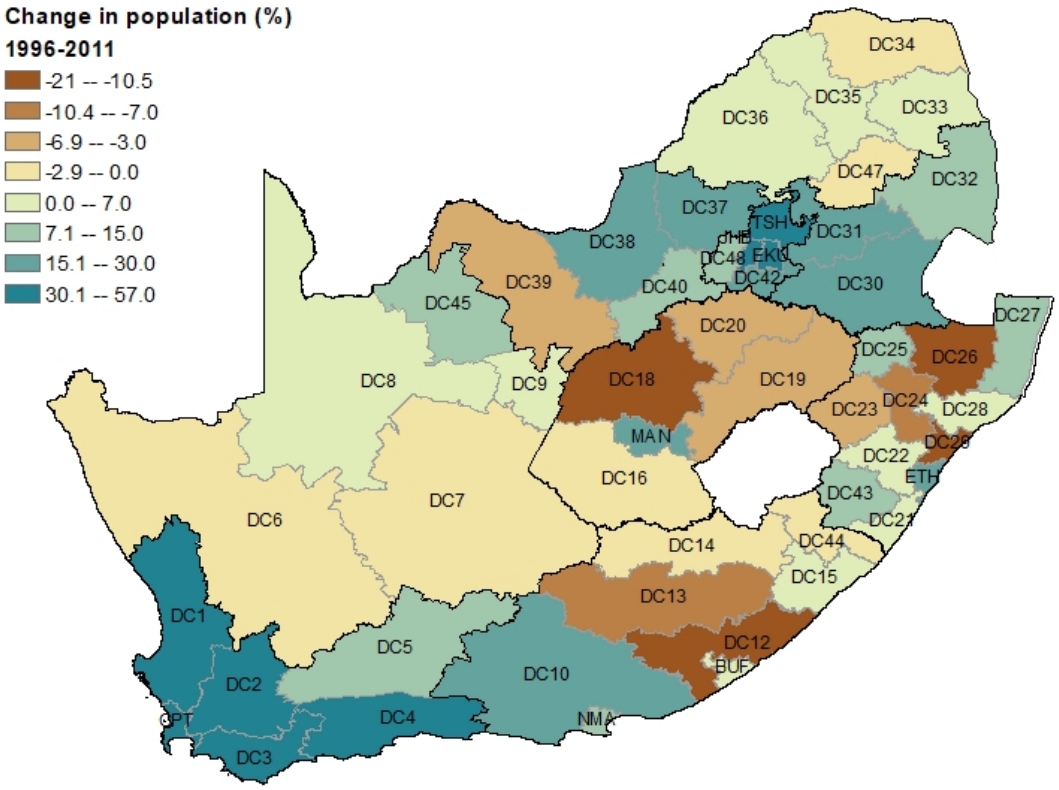


Figure 15. Percentage change in population by district municipality, 1996–2011, based on Population Census data



Population Census data in South Africa are collected in enumerator areas that are spatially explicit. This makes it possible in principle to compare changes in land cover with spatial changes in the distribution of people and with a range of demographic indictors that are collected as part of the Population Census, such as income and employment status. Although it has not been possible to explore this in detail as part of these accounts, this could be a valuable direction for future work.

Figure 15 shows the percentage change in population by district municipality between 1996 and 2011, based on data from the Population Census. A simple visual comparison between percentage changes in population between 1996 and 2011 and percentage changes in built-up land cover per district between 1990 and 2014 (Figure 14) shows some similarities and some differences in spatial patterns. The net decreases in built-up land cover in most of Eastern Cape, for example, may be related to the net decreases in population in parts of the province, possibly linked to urbanisation. Similarly, the net increases in built-up land cover in all districts in Western Cape may be related to the increases in population in those districts. Further work would be required, including at a finer spatial scale than districts, to investigate these possible links.[17]

3.3.2 Main land cover classes (tier 2) by district municipality

Land accounts for main land cover classes (tier 2) for district municipalities provide more detail than the accounts for broad land cover classes (tier 1) discussed above. The district municipalities with the highest net percentage change between 1990 and 2014 in each of the land cover classes at tier 2 are highlighted in Table 13. For descriptions of the land cover classes see Table 6 and Table 7.

Eight of the top ten district municipalities in terms of net increases in **commercial crops** were in KwaZulu-Natal, with the highest net percentage increase in the King Cetshwayo District (formerly uThungulu; DC28) and the highest net absolute increase in Harry Gwala District (DC43, 23 000 ha). Unsurprisingly, the metros accounted for most of the high percentage decreases in commercial crops with four of the ten highest decreases. In John Taolo Gaetsewe District (DC45) there was a near 50,0% net decrease in commercial crops while neighbouring Dr Ruth Segomotsi Mompati District Municipality (DC39) had the highest absolute decrease in commercial crops (not shown in Table 13, because the selection is based on percentages).

Three district municipalities (two in Northern Cape, and one in Gauteng) had no **subsistence crop** land cover in 1990. Interestingly, whereas West Rand District (DC48) had gained subsistence crops by 2014, its neighbouring district municipality, Sedibeng District (DC42), had the greatest percentage decrease. uMkhanyakude District (DC27) had the highest absolute increase, with nearly 30 000 ha more subsistence cropland in 2014 than in 1990. The greatest absolute decrease was in Vhembe District (DC34).

Orchards and vines increased in extent by over 10 000 ha between 1990 and 2014 in the Mopani (DC33), Cape Winelands (DC2), Vhembe (DC34) and Ehlanzeni (DC32) Districts. Only Capricorn District (DC35) in Limpopo had a net decrease exceeding 1 000 ha.

Timber plantations more than doubled in the Amajuba District (DC25), but the largest absolute increase was in the Gert Sibande District (DC30) where timber plantations increased by nearly 49 000 ha. The Waterberg District (DC36) had a net decrease of nearly three-quarters in timber plantations, while Ehlanzeni (DC32) was the only district with more than 20 000 ha net decrease in timber plantations.

Four of the five district municipalities with the largest percentage increases in **urban** land cover were in Limpopo, while four of the five district municipalities with the greatest decreases were in KwaZulu-Natal. Both Sekhukhune (DC47) and Capricorn (DC35) Districts had net increases of over 20 000 ha of urban land cover, while King Cetshwayo District (DC28) had a net decrease of just less than 14 000 ha. The 15 district municipalities with the highest net absolute decreases in urban land cover were all in Eastern Cape and KwaZulu-Natal.

[17] Population Census data have been intersected with the Basic Spatial Unit (BSU) layer (see Section 2), which provides a consistent spatial framework for integrating data on land and ecosystems as well as demographic and economic data. This will enable such further work.

The Nkangala District (DC31) had by far the greatest absolute increase in **mining** land cover, with over 30 000 ha more mining land cover in 2014 than in 1990 – substantially higher than the next highest, Bojanala Platinum District Municipality (DC37) at 7 511 ha. These increases highlight the expansion of mining activity in the coal fields of Mpumalanga and platinum belt of North West. These districts are in South Africa's mining belt on the geological region known as the Bushveld Complex. Most of South Africa's coal, platinum, andalusite, chromite and platinum are extracted in and around these districts (Vorster 2001). GCIS (2019) reports that the eMalahleni area in the Nkangala District Municipality (DC31) produces more coal than anywhere in Africa, while the Bojanala Platinum District Municipality (DC37) contributes 94,0% of South Africa's platinum, the highest for any area globally. Eastern Cape had several district municipalities which had a high net percentage decrease in mining land cover, while absolute decreases were highest in two Northern Cape district municipalities – Namakwa (DC6) and Frances Baard (DC9).

Table 13. District municipalities with the highest net percentage change for each main land cover class (tier 2). "New" means the class was not present in that district municipality in 1990.

Main land cover class (tier 2)	District municipalities with highest % increase			District municipalities with highest % decrease		
	Name (code, province*)	Net change (%)	Net change (ha)	Name (code, province*)	Net change (%)	Net change (ha)
Natural or semi-natural	West Rand (DC48, GP)	6,3%	14 721	Harry Gwala (DC43, KZN)	-7,7%	-54 942
	Dr Kenneth Kaunda (DC40, NW)	6,3%	54 568	Zululand (DC26, KZN)	-5,3%	-60 853
	Fezile Dabi (DC20, FS)	6,0%	61 659	Amajuba (DC25, KZN)	-3,8%	-20 610
	Lejweleputswa (DC18, FS)	6,0%	104 741	City of Tshwane (TSH, GP)	-3,7%	-14 577
	Ngaka Modiri Molema (DC38, NW)	4,9%	82 279	uThukela (DC23, KZN)	-3,2%	-29 961
Commercial crops	King Cetshwayo (DC28, KZN)	27,5%	17 459	John Taolo Gaetsewe (DC45, NC)	-46,1%	-2 008
	Harry Gwala (DC43, KZN)	24,4%	23 202	City of Johannesburg (JHB, GP)	-44,5%	-5 230
	uThukela (DC23, KZN)	22,0%	16 552	Amathole (DC12, EC)	-26,0%	-10 711
	Pixley ka Seme (DC7, NC)	21,2%	13 868	Buffalo City BUF, (EC)	-22,5%	-4 116
	Zululand (DC26, KZN)	17,3%	10 693	Nelson Mandela Bay (NMA, EC)	-19,3%	-1 975
Subsistence crops	West Rand (DC48, GP)	New	32	Sedibeng (DC42, GP)	-98,0%	-49
	Pixley ka Seme (DC7, NC)	New	18	John Taolo Gaetsewe (DC45, NC)	-75,9%	-280
	Frances Baard (DC9, NC)	New	10	City of Tshwane (TSH, GP)	-70,9%	-637
	Xhariep (DC16, FS)	261,0%	154	City of Johannesburg (JHB, GP)	-58,3%	-88
	Thabo Mofutsanyane (DC19, FS)	79,6%	433	Vhembe (DC34, LP)	-53,7%	-45 746
Orchards and vines	City of Johannesburg (JHB, GP)	New	4	Sedibeng (DC42, GP)	-54,2%	-91
	Gert Sibande (DC30, MP)	183,1%	346	Dr Ruth Segomotsi Mompati (DC39, NW)	-52,7%	-355
	Frances Baard (DC9, NC)	128,2%	1 575	Nelson Mandela Bay (NMA, EC)	-30,5%	-118
	Ekurhuleni (EKU, GP)	109,8%	56	Capricorn (DC35, LP)	-27,3%	-1 627
	City of Tshwane (TSH, GP)	101,9%	374	Chris Hani (DC13, EC)	-19,0%	-376
Timber plantations	Amajuba (DC25, KZN)	136,6%	13 146	Waterberg (DC36, LP)	-73,8%	-2 059
	Joe Gqabi (DC14, EC)	106,7%	15 370	John Taolo Gaetsewe (DC45, NC)	-66,5%	-111
	Xhariep (DC16, FS)	44,1%	968	ZF Mgcawu (DC8, NC)	-60,3%	-85
	Zululand (DC26, KZN)	38,9%	30 881	iLembe (DC29, KZN)	-59,7%	-5 503
	Harry Gwala (DC43, KZN)	18,5%	19 898	Sekhukhune (DC47, LP)	-58,6%	-773
Urban	Waterberg (DC36, LP)	38,8%	16 379	King Cetshwayo (DC28, KZN)	-14,3%	-14 695
	Sekhukhune (DC47, LP)	34,4%	28 212	Ugu (DC21, KZN)	-9,9%	-9 426
	Capricorn (DC35, LP)	25,5%	22 163	uMzinyathi (DC24, KZN)	-8,0%	-3 839
	Frances Baard (DC9, NC)	24,5%	2 083	Alfred Nzo (DC44, EC)	-7,0%	-8 187
	Mopani (DC33, LP)	24,3%	15 163	Zululand (DC26, KZN)	-6,5%	-4 701
Mines	uMkhanyakude (DC27, KZN)	986,3%	503	Sarah Baartman (DC10, EC)	-65,6%	-648
	King Cetshwayo (DC28, KZN)	133,7%	607	Alfred Nzo (DC44, EC)	-63,8%	-139
	Bojanala Platinum (DC37, NW)	98,4%	7 511	Amathole (DC12, EC)	-63,6%	-124
	Nkangala (DC31, MP)	95,3%	30 274	Zululand (DC26, KZN)	-57,7%	-486
	West Coast (DC1, WC)	93,2%	3 241	Capricorn (DC35, LP)	-53,0%	-1 664

* Provincial codes used in this table: EC = Eastern Cape; FS = Free State; GP = Gauteng; KZN = KwaZulu-Natal; LP = Limpopo; MP = Mpumalanga; NW = North West; NC = Northern Cape; WC = Western Cape.

3.4 Key findings for particular land cover classes

Key findings from the accounts can be distilled for land cover classes that are of particular social or economic interest, by drawing together findings from across the different spatial scales of analysis (national, provincial and district municipality) and across all levels of the land cover hierarchy (broad, main and detailed land cover classes; tiers 1 to 3). The sub-sections below draw together findings for urban, mining and cultivated land cover.

3.4.1 Urban

At the national level, urban land cover increased by nearly 6,0% between 1990 and 2014, to just under 2,9 million ha. Most change was from natural or semi-natural land cover while nearly 16 000 ha of timber plantations were converted to urban land cover. Limpopo accounted for the highest absolute and percentage increase in urban land cover; four of the five greatest percentage increases at the district level were in Limpopo with Waterberg District Municipality (DC36) the highest (38,8%).

As the national population has increased and become increasingly urbanised there has been expansion of urban land cover classes such as urban residential, urban townships, urban informal areas, urban parkland and urban commercial. Urban informal areas increased by nearly 96,0% as more people seek opportunities around urban centres. While urban informal areas expanded by over 11 000 ha in Gauteng, it was Free State, Limpopo, Northern Cape and Mpumalanga that had the highest net percentage increases between 1990 and 2014. In future work it would be useful to explore these large increases at finer scale, for instance for particular local municipalities or towns, and compare with Population Census data from 1996 and 2011 to better understand the timeframes for these increases.

At the tier 3 level, the only urban classes that decreased were urban smallholdings and, perhaps surprisingly, urban industrial areas (although by very small amounts). Gauteng, Limpopo, Mpumalanga, Northern Cape and Western Cape had increases in both urban industrial and urban commercial areas. At the tier 2 level, urban land cover as a whole decreased only in Eastern Cape and KwaZulu-Natal, where there were large decreases in the urban village land cover class (which includes dense rural settlements).

3.4.2 Mining

At the national level, mining land cover increased from 270 000 ha in 1990 to 313 000 ha in 2014. More than 83 000 ha of land was converted from natural or semi-natural land to mines (refer to Table 5), and over 37 500 ha of commercial crops and over 3 500 ha of timber plantations were converted to mines. The majority of this change took place in Mpumalanga and North West (see Appendix 3). Overall the highest net change was from commercial crops (primarily fields rather than pivots).

Looking at net change across the provinces (refer to Table 8), there were notable differences. In percentage terms, Mpumalanga, Western Cape and North West experienced the largest increase in mining land cover with increases of 74,5%, 67,6% and 36,4%, respectively. Mpumalanga had the highest absolute additions to mining areas (nearly 32 000 ha being converted from different land cover classes to mines), particularly in the Nkangala District (DC31). In North West and Western Cape mining areas replaced natural or semi-natural areas. Mining area decreased in three provinces, Eastern Cape (46,0%), Gauteng (15,5%) and Northern Cape (3,1%), with Gauteng showing the highest absolute reduction (3 594 ha).

3.4.3 Cultivation

Nationally there was a net decrease in cultivated land cover (including commercial crops, subsistence crops, orchards and vines, and timber plantations) between 1990 and 2014, from just over 16 million ha to 15,8 million ha. The net decrease was around 350 000 ha or 2,0%. Most of this was to natural or semi-natural land cover. Within the broad (tier 1) class of cultivated land, the most notable shift in cultivated land was the net decrease in cultivated commercial fields. These areas either fell fallow and reverted to a semi-natural state, or in many areas shifted to more intensive pivot agriculture systems

where more crop tonnage can be produced on a smaller area. Cultivated commercial pivots area more than doubled from just under 240 000 ha to just under 770 000 ha. Pivot-driven agriculture requires more intensive infrastructural investments, nutrient applications and significantly greater water use.

The overall net decrease in cultivated land cover disguises some increases. The clearest additions to cultivated land cover was the expansion of cultivated areas in KwaZulu-Natal, primarily from natural or semi-natural areas. Every district municipality in the province had a net increase in cultivated land cover. Although cultivated commercial crops decreased nationally, KwaZulu-Natal was a distinct exception. Four of the five highest percentage increases were in KwaZulu-Natal district municipalities.

The increase in cultivated commercial pivots was seen across all provinces, with Free State and Eastern Cape having the highest percentage increases (> 400,0%). Free State's net increase was 135 422 ha, the highest absolute increase of any province. Sugarcane crops increased in both provinces in which they occur, KwaZulu-Natal (19,6%) and Mpumalanga (70,7%), but there were no new sugarcane crops in any other provinces.

Although subsistence crop land cover increased by just over 21 000 ha, only three provinces had net additions; Free State (59,9%), Eastern Cape (5,2%) and KwaZulu-Natal (28,1%). KwaZulu-Natal in particular had a very large increase in subsistence crop area, with net additions of 111 754 ha, while two Free State district municipalities, Xhariep (DC16) and Thabo Mofutsanyane (DC19), had the highest percentage increases in the country. Subsistence crop area decreased by more than 25,0% in Gauteng, Western Cape and Mpumalanga, and by 16,3% in Limpopo.

Nationally, orchards expanded by nearly 18,0%, and across all provinces but Western Cape. Limpopo accounted for the highest net increase (30 247 ha), replacing large areas of natural or semi-natural land and cultivated commercial crops. The biggest increases were in the Mopani and Vhembe Districts (although there was a decrease in Capricorn District (DC35), where the well-known Zebediela citrus farms are located). Although relatively small in absolute terms, Gauteng had the highest percentage increase in orchards (68,1%), with their extent more than doubling in the three metropolitan municipalities in Gauteng. Vines areas expanded in both provinces in which they are found, Northern Cape (8,4%) and Western Cape (18,7%), but there were no new vineyards in any other provinces. Both the Namakwa (DC6) and Cape Winelands (DC2) Districts had percentage increase in of vines of over 25,0%.

4 TERRESTRIAL ECOSYSTEM EXTENT ACCOUNTS: KEY FINDINGS

4.1 More about the ecosystem extent account

The terrestrial ecosystem accounts presented here focus on an **ecosystem extent account**, measuring changes in the spatial extent of terrestrial ecosystem types over time. As shown in Figure 1 in Section 1.1, ecosystem extent accounts are one of five core sets of ecosystem accounts and are foundational for several other ecosystem accounts.[18] Future terrestrial ecosystem accounts in South Africa will build on this extent account to include ecosystem condition and ecosystem service accounts.

As discussed in Section 2.2, terrestrial ecosystem types are represented by the 458 vegetation types from the National Vegetation Map, which are grouped into nine biomes (Figure 16). Vegetation types are relatively homogenous units in the landscape, identified based on their biophysical characteristics such as species distribution, community composition, underlying geology and soil types, altitude, and rainfall gradients. The vegetation types have been delineated based on their **historical extent**, in other words prior to major human modification. The terrestrial ecosystem extent account uses the historical extent of each of these ecosystem types as a constant historical baseline, and then reflects how much of each ecosystem type was intact (i.e. still in natural or semi-natural condition) in 1990 and 2014 relative to its historical extent, and conversely how much had been converted to intensive land uses such as cultivation, mining and urban development. The fact that terrestrial ecosystem types have been mapped based on their historical extent, which remains constant, provides a stable set of spatial units against which to assess changes in the extent of more recent intensive land uses. The extent account reflects these changes not only relative to the historical extent of each ecosystem type but also from one accounting period to another.

The portion of each ecosystem type that remains intact (i.e. in a natural or semi-natural state, not converted to intensive land uses) is referred to as the **remaining extent**. Tracking the remaining natural or semi-natural extent of terrestrial ecosystem types relative to their historical extent and from one accounting period to another is useful because it enables an analysis of which ecosystem types are under pressure from loss of natural vegetation, which in turn may have negative impacts on the supply of ecosystem services associated with those ecosystem types.

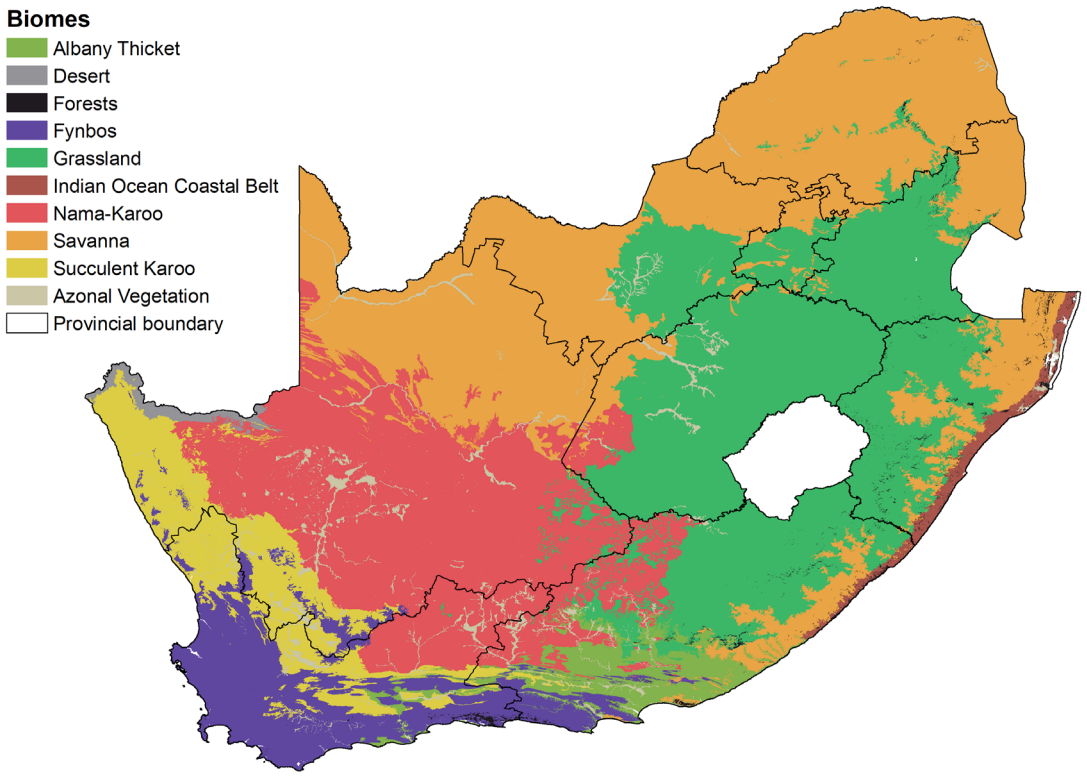
The ecosystem extent account is used to derive an **Ecosystem Extent Index (EEI)**, calculated as the remaining extent of an ecosystem type as a proportion of its historical extent. The EEI can be evaluated against critical thresholds for ecosystem functioning, to identify those ecosystem types that are close to or beyond such thresholds. The extent account can also highlight those ecosystem types that have experienced high recent rates of loss of natural cover, indicated by large recent declines in the EEI. This provides a useful tool for identifying specific ecosystem types that are in need of management or conservation interventions.

As mentioned in Section 1.4, the intention is for these ecosystem accounts to include a condition account for terrestrial ecosystems at a future stage, which will provide an **Ecological Condition Index (ECI)** to complement the EEI. The ECI will provide information about the ecological condition of the remaining intact (i.e. natural or semi-natural) portion of each ecosystem type, assessed relative to a reference condition of natural.[19] Although the EEI does not give information directly about the ecological condition of the remaining intact portion of an ecosystem type, it is likely that ecosystem types that have experienced large declines in extent will also have experienced declines in condition.

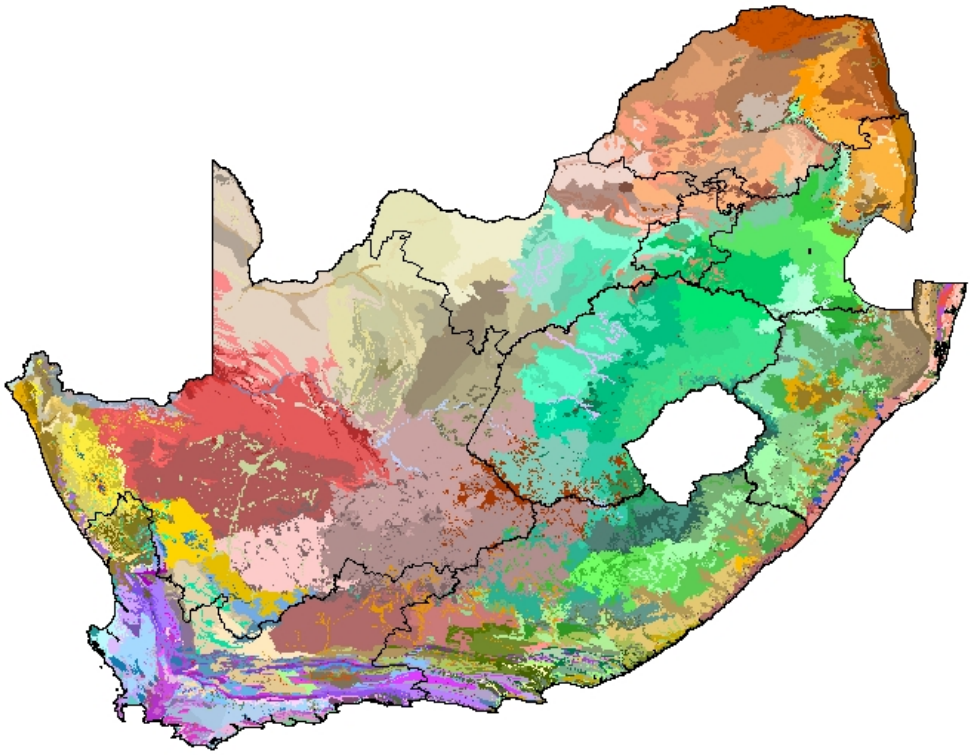
[18] Ecosystem extent accounts are also foundational for several of the indicators for SDGs, including SDG 6, 14 and 15, on which countries are obliged to report regularly.

[19] In South Africa's national river ecosystem accounts (Nel & Driver 2015), an ECI was developed based on four indicators of the condition of rivers (dealing with flow of water, water quality, condition of instream habitat and condition of riparian habitat). An equivalent ECI for terrestrial ecosystems still needs to be developed.

Figure 16. Terrestrial ecosystem types are (a) aggregated into nine biomes, within which (b) 458 vegetation types in the National Vegetation Map are nested



a)



b)

Source: SANBI (updated shapefile and documents describing vegetation types are available on request from vegmap@sanbi.org.za).

One reason for this is that a decline in extent would often be accompanied by fragmentation of the ecosystem type, which would in turn impact on the condition of those portions that do remain intact. This means that a low EEI for an ecosystem type suggests that its ECI may also be low. This likely correlation will be further explored once ecosystem condition accounts for terrestrial ecosystems have been developed. Other factors that would be likely to have a negative impact on the condition of terrestrial ecosystems include, for example, invasion by woody plant species, overgrazing and altered fire regimes.

As mentioned in Section 1.3, intensively modified areas in the landscape can be viewed from two perspectives: they can be seen as land cover classes, or they can be seen as human-made ecosystem types. For the purposes of the land account presented in Section 3, intensively modified areas are treated straightforwardly as land cover classes, at three different tiers from broad to detailed. For the purposes of the ecosystem extent account presented in this section, intensively modified land cover classes are treated as ecosystem types. They are delineated in exactly the same way as the equivalent land cover classes, so the switch is simply in perspective, with no impact on the measurement of their spatial extent. This dual perspective on intensively modified areas as both land cover classes and ecosystem types provides the link between the land account and the ecosystem extent account. For simplicity and to avoid confusion, natural or semi-natural ecosystem types are referred to in this report simply as “ecosystem types”, while the intensively modified ecosystem types are always referred to as “intensively modified ecosystem types”.[20]

4.2 Ecosystem extent account for biomes

The terrestrial ecosystem extent account and EEI are presented below, focusing on a summary at the biome level, which provides a useful overall picture.

Table 14 presents the extent account for biomes. The table includes the nine natural or semi-natural biomes as well as the broad land cover classes “cultivated” and “built-up” to which parts of the natural or semi-natural biomes have been converted. In line with the treatment of intensively modified detailed land cover classes as intensively modified ecosystem types (as explained above), these broad land cover classes are treated as intensively modified biomes for the purposes of the extent account. The table also includes azonal vegetation (wetland vegetation cutting across bioclimatic zones and thus not belonging to a particular biome) and waterbodies. As discussed in Section 2.1, no reliable data exist on the historical extent of waterbodies, so it is not possible at this stage to include a historical extent for them. The SAIIAE provides a much more comprehensive map of wetlands and waterbodies than is provided by the NLC or the National Vegetation Map, and will provide the basis for future accounts for inland water ecosystems.

It is important to note that Table 14 is not simply a land account presented as an ecosystem extent account. This is because only the intensively modified biomes are derived from the NLC. The natural or semi-natural biomes are defined based on the National Vegetation Map. Natural or semi-natural biomes cannot be accurately discerned or delineated from land cover data.[21]

Figure 17 shows a map of the extent of each biome in 2014, including the intensively modified biomes that have replaced and fragmented parts of the natural or semi-natural biomes. The map in Figure 17 should be compared with the map of historical extent of the biomes (shown here as an inset map and in Figure 3 in Section 2.2).

[20] It may be possible in future to develop an ecosystem condition account for these intensively modified ecosystem types. It would need to be based on a different set of condition indicators to those for natural or semi-natural ecosystem types, but could in principle provide a condition index in some form.

[21] For example, areas classified as “Low shrubland” in the NLC could be areas within the Nama-Karoo biome or the Succulent Karoo biome or could represent degraded areas within other biomes (such as Fynbos). Areas classified as “Woodland/Open bush” in the NLC could be part of the Savanna biome or could be areas within the Grassland biome that have become bush encroached or invaded by exotic woody plants. There is thus not a one-to-one match between the natural or semi-natural classes in the NLC dataset and the natural or semi-natural biomes, either conceptually or spatially, even though in some cases the NLC classes share a name with one of the biomes.

Table 14. Extent account for terrestrial ecosystem types summarised by biome, 1990 and 2014, in hectares***

	Albany Thicket	Desert	Forest	Fynbos	Grassland	IOCB	Nama-Karoo	Savanna	Succulent Karoo	Azonal vegetation	Culti-vated*	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.
** Changes in the extent of waterbodies between 1990 and 2014 reflect primarily that 1990 was a much wetter year than 2014. Waterbodies include both natural and artificial water bodies (such as dams).
*** Blank cells represent no data.

Figure 17. Extent of biomes in 2014, including intensively modified biomes that have replaced portions of the natural or semi-natural biomes

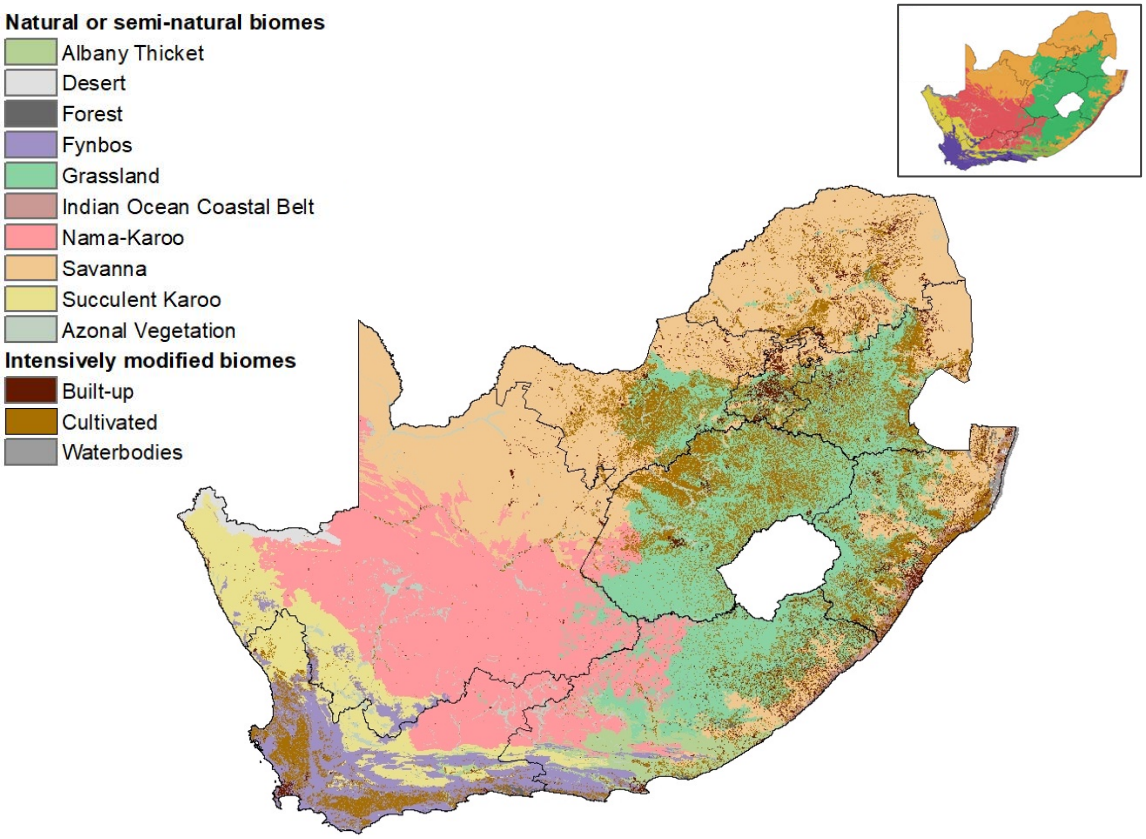


Figure 18 shows the historical extent of each biome in absolute terms, as well as its remaining natural or semi-natural extent in 1990 and 2014. This highlights the wide variations in the size of different biomes. It also shows clearly that the largest decrease in natural or semi-natural land in absolute terms took place in the Grassland biome, South Africa's second largest biome, from just more than 33 million ha historically to just more than 22 million ha in 2014.

A key indicator that can be derived from the ecosystem extent account is the EEI, introduced in Section 4.1. The EEI for each biome is calculated as the remaining extent (i.e. the portion of the biome that remains in a natural or semi-natural state) as a proportion of the biome's historical extent, and is shown in Table 15.

Figure 18. Extent of natural or semi-natural land cover per biome, historically, in 1990 and in 2014, in hectares

Table 15. Historical extent, remaining extent and EEI for natural or semi-natural biomes, in 1990 and 2014

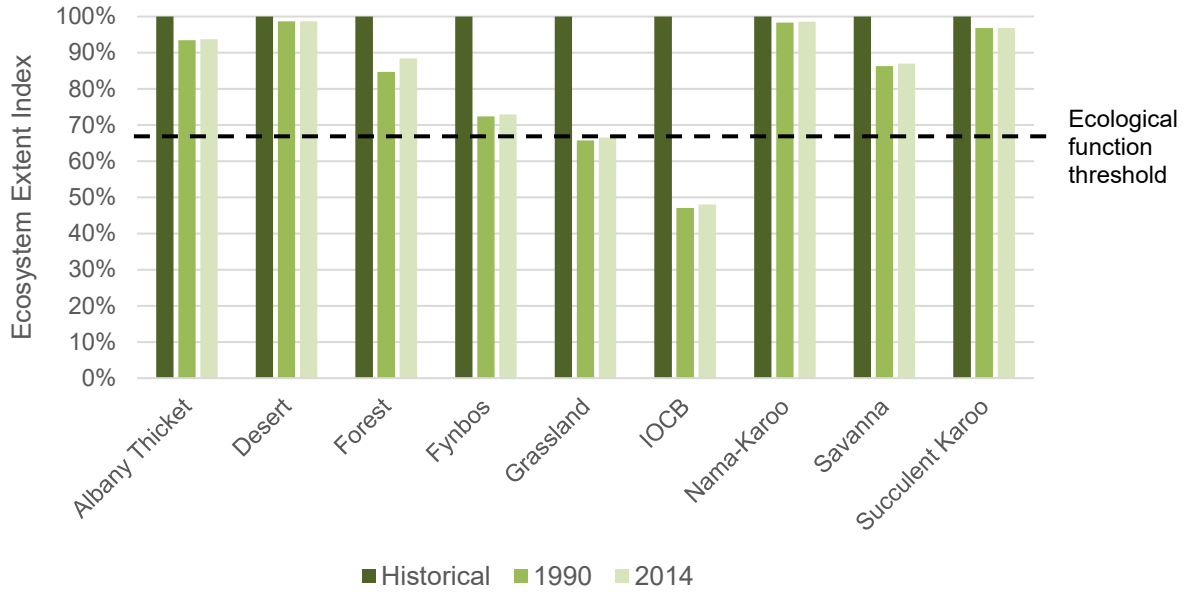
Biome	Historical extent (ha)	EEI historical	Remaining extent 1990 (ha)	EEI 1990	Remaining extent 2014 (ha)	EEI 2014
Albany Thicket	3 531 231	100,0%	3 301 140	93,5%	3 309 564	93,7%
Desert	626 207	100,0%	617 970	98,7%	617 852	98,7%
Forest	462 518	100,0%	391 845	84,7%	409 056	88,4%
Fynbos	8 165 366	100,0%	5 911 991	72,4%	5 957 140	73,0%
Grassland	33 090 325	100,0%	21 759 719	65,8%	22 023 982	66,6%
Indian Ocean Coastal Belt	1 171 284	100,0%	551 628	47,1%	562 959	48,1%
Nama-Karoo	24 936 548	100,0%	24 515 553	98,3%	24 584 425	98,6%
Savanna	39 418 522	100,0%	34 022 403	86,3%	34 297 155	87,0%
Succulent Karoo	7 821 579	100,0%	7 570 206	96,8%	7 574 997	96,8%

The EEI can be viewed in relation to ecological thresholds. Ecosystems can tolerate a certain amount of decline in natural area before their essential characteristics are compromised. Critical thresholds are often difficult to determine even in retrospect, and almost always difficult to predict. Nevertheless, the ecological literature[22] suggests that, as a rule of thumb, when less than approximately 60,0% of the natural area within an ecosystem remains its ecological functioning begins to break down. In practice the exact level of this threshold varies between ecosystems depending on landscape structure and other characteristics, but is nevertheless useful as a guide.[23]

[22] For example, Andren (1999), Desmet (2018), Fahrig (2001), SANBI (2013).
[23] The application of this landscape-level threshold in an ecosystem accounting context was explored in the land and terrestrial ecosystem accounts piloted in KwaZulu-Natal in 2014 (Driver et al. 2015).

Figure 19 shows that by 2014 the Grassland biome was approaching the 60,0% threshold with an EEI of 67,0%, while the Indian Ocean Coastal Belt had crossed it with an EEI of 48,0%. The Grassland biome is the second largest biome in South Africa and plays an important role in water provision as well as providing extensive agricultural rangelands. Several ecosystem types within the Indian Ocean Coastal Belt ecosystems play an important role in buffering settlements and infrastructure in the event of coastal storms. The Fynbos biome, which has the next lowest EEI at 73,0%, is of global biodiversity significance because of its exceptional species diversity.

Figure 19. EEI for natural or semi-natural biomes, historically, in 1990 and in 2014, in relation to an ecological function threshold



The land account can be reported by biome to analyse changes in land cover classes per biome in more detail.

Table 16 shows the change in the four broad land cover classes (natural or semi-natural, cultivated, built-up and waterbodies) per biome between 1990 and 2014. It shows how much of each biome remained in a natural or semi-natural state in 1990 and 2014, how much had been converted to intensively modified land cover classes, and the net change in each broad land cover class per biome over this period. Figure 20 shows the land cover composition for each of South Africa's biomes in 2014.

Net increases of greater than 10,0% in intensively modified land cover classes between 1990 and 2014 at the biome level took place as follows: an increase in cultivated land of 43,4% in the Desert biome (although in absolute terms this was a small change relative to other biomes), and increases in built-up land in the Forest (20,8%), Fynbos (11,9%) and Savanna (10,5%) biomes. There were net additions to built-up land in all biomes except Desert and Indian Ocean Coastal Belt.

Further information about changes in land cover per biome is provided in Appendix 4 in the form of a change matrix for broad land cover classes at the biome level between 1990 and 2014.

Table 16. Land account for biomes, 1990–2014, in hectares

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Albany Thicket	**Opening stock 1990**	**3 301 140**	**161 921**	**51 474**	**16 696**	**3 531 231**
	Additions to stock	44 432	23 941	8 605	5 375	82 353
	Reductions in stock	36 008	29 256	8 266	8 823	82 353
	Net change in stock	8 424	-5 315	339	-3 448	
	Net change as % of opening	*0,3%*	*-3,3%*	*0,7%*	*-20,7%*	
	Unchanged (opening - reductions)	3 265 132	132 665	43 208	7 873	
	Unchanged as % of opening	*98,9%*	*81,9%*	*83,9%*	*47,2%*	
	Turnover (additions + reductions)	80 440	53 197	16 871	14 198	
	Turnover as % of opening	*2,4%*	*32,9%*	*32,8%*	*85,0%*	
	Closing stock 2014	**3 309 564**	**156 606**	**51 813**	**13 248**	**3 531 231**

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Desert	**Opening stock 1990**	**617 970**	**861**	**7 265**	**111**	**626 207**
	Additions to stock	1 142	769	505	4	2 420
	Reductions in stock	1 260	395	654	111	2 420
	Net change in stock	-118	374	-149	-107	
	Net change as % of opening	*0,0%*	*43,4%*	*-2,1%*	*-96,4%*	
	Unchanged (opening - reductions)	616 710	466	6 611	0	
	Unchanged as % of opening	*99,8%*	*54,1%*	*91,0%*	*0,0%*	
	Turnover (additions + reductions)	2 402	1 164	1 159	115	
	Turnover as % of opening	*0,4%*	*135,2%*	*16,0%*	*103,6%*	
	Closing stock 2014	**617 852**	**1 235**	**7 116**	**4**	**626 207**

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Forest	**Opening stock 1990**	**391 845**	**50 988**	**6 718**	**12 967**	**462 518**
	Additions to stock	24 900	4 818	2 921	1 403	34 042
	Reductions in stock	7 689	18 228	1 527	6 598	34 042
	Net change in stock	17 211	-13 410	1 394	-5 195	
	Net change as % of opening	*4,4%*	*-26,3%*	*20,8%*	*-40,1%*	
	Unchanged (opening - reductions)	384 156	32 760	5 191	6 369	
	Unchanged as % of opening	*98,0%*	*64,3%*	*77,3%*	*49,1%*	
	Turnover (additions + reductions)	32 589	23 046	4 448	8 001	
	Turnover as % of opening	*8,3%*	*45,2%*	*66,2%*	*61,7%*	
	Closing stock 2014	**409 056**	**37 578**	**8 112**	**7 772**	**462 518**

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Fynbos	**Opening stock 1990**	**5 911 991**	**2 002 460**	**112 291**	**138 624**	**8 165 366**
	Additions to stock	241 184	164 735	26 996	26 446	459 361
	Reductions in stock	196 035	193 606	13 646	56 074	459 361
	Net change in stock	45 149	-28 871	13 350	-29 628	
	Net change as % of opening	*0,8%*	*-1,4%*	*11,9%*	*-21,4%*	
	Unchanged (opening - reductions)	5 715 956	1 808 854	98 645	82 550	
	Unchanged as % of opening	*96,7%*	*90,3%*	*87,8%*	*59,5%*	
	Turnover (additions + reductions)	437 219	358 341	40 642	82 520	
	Turnover as % of opening	*7,4%*	*17,9%*	*36,2%*	*59,5%*	
	Closing stock 2014	**5 957 140**	**1 973 589**	**125 641**	**108 996**	**8 165 366**

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Grassland	**Opening stock 1990**	**21 759 719**	**9 056 872**	**1 200 005**	**1 073 729**	**33 090 325**
	Additions to stock	1 444 446	986 871	232 501	151 024	2 814 842
	Reductions in stock	1 180 183	1 017 148	167 944	449 567	2 814 842
	Net change in stock	264 263	-30 277	64 557	-298 543	
	Net change as % of opening	*1,2%*	*-0,3%*	*5,4%*	*-27,8%*	
	Unchanged (opening - reductions)	20 579 536	8 039 724	1 032 061	624 162	
	Unchanged as % of opening	*94,6%*	*88,8%*	*86,0%*	*58,1%*	
	Turnover (additions + reductions)	2 624 629	2 004 019	400 445	600 591	
	Turnover as % of opening	*12,1%*	*22,1%*	*33,4%*	*55,9%*	
	Closing stock 2014	**22 023 982**	**9 026 595**	**1 264 562**	**775 186**	**33 090 325**

Table 16. Land account for biomes, 1990–2014, in hectares (concluded)

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Indian Ocean Coastal Belt	**Opening stock 1990**	**551 628**	**348 562**	**252 402**	**18 692**	**1 171 284**
	Additions to stock	75 114	67 165	17 721	1 799	161 799
	Reductions in stock	63 783	49 081	35 540	13 395	161 799
	Net change in stock	11 331	18 084	-17 819	-11 596	
	Net change as % of opening	*2,1%*	*5,2%*	*-7,1%*	*-62,0%*	
	Unchanged (opening - reductions)	487 845	299 481	216 862	5 297	
	Unchanged as % of opening	*88,4%*	*85,9%*	*85,9%*	*28,3%*	
	Turnover (additions + reductions)	138 897	116 246	53 261	15 194	
	Turnover as % of opening	*25,2%*	*33,4%*	*21,1%*	*81,3%*	
	Closing stock 2014	**562 959**	**366 646**	**234 583**	**7 096**	**1 171 284**

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Nama-Karoo	**Opening stock 1990**	**24 515 553**	**196 737**	**29 304**	**194 954**	**24 936 548**
	Additions to stock	146 910	54 090	6 322	24 316	231 638
	Reductions in stock	78 038	38 807	4 788	110 005	231 638
	Net change in stock	68 872	15 283	1 534	-85 689	
	Net change as % of opening	*0,3%*	*7,8%*	*5,2%*	*-44,0%*	
	Unchanged (opening - reductions)	24 437 515	157 930	24 516	84 949	
	Unchanged as % of opening	*99,7%*	*80,3%*	*83,7%*	*43,6%*	
	Turnover (additions + reductions)	224 948	92 897	11 110	134 321	
	Turnover as % of opening	*0,9%*	*47,2%*	*37,9%*	*68,9%*	
	Closing stock 2014	**24 584 425**	**212 020**	**30 838**	**109 265**	**24 936 548**

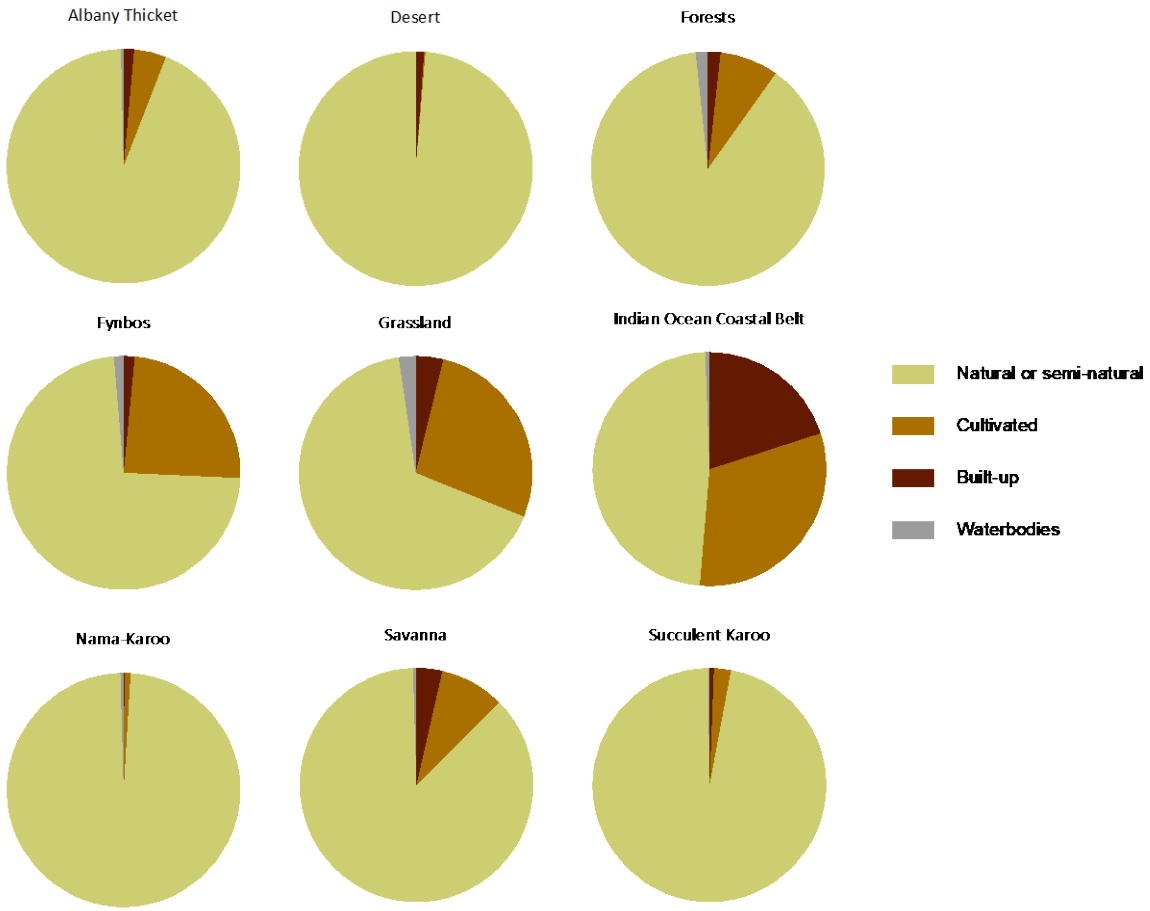
	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Savanna	**Opening stock 1990**	**34 022 403**	**3 821 866**	**1 272 016**	**302 237**	**39 418 522**
	Additions to stock	1 160 055	625 576	289 933	49 503	2 125 067
	Reductions in stock	885 303	922 920	156 442	160 402	2 125 067
	Net change in stock	274 752	-297 344	133 491	-110 899	
	Net change as % of opening	*0,8%*	*-7,8%*	*10,5%*	*-36,7%*	
	Unchanged (opening - reductions)	33 137 100	2 898 946	1 115 574	141 835	
	Unchanged as % of opening	*97,4%*	*75,9%*	*87,7%*	*46,9%*	
	Turnover (additions + reductions)	2 045 358	1 548 496	446 375	209 905	
	Turnover as % of opening	*6,0%*	*40,5%*	*35,1%*	*69,5%*	
	Closing stock 2014	**34 297 155**	**3 524 522**	**1 405 507**	**191 338**	**39 418 522**

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Succulent Karoo	**Opening stock 1990**	**7 570 206**	**181 947**	**47 632**	**21 794**	**7 821 579**
	Additions to stock	38 422	23 830	7 053	4 496	73 801
	Reductions in stock	33 631	22 365	6 802	11 003	73 801
	Net change in stock	4 791	1 465	251	-6 507	
	Net change as % of opening	*0,1%*	*0,8%*	*0,5%*	*-29,9%*	
	Unchanged (opening - reductions)	7 536 575	159 582	40 830	10 791	
	Unchanged as % of opening	*99,6%*	*87,7%*	*85,7%*	*49,5%*	
	Turnover (additions + reductions)	72 053	46 195	13 855	15 499	
	Turnover as % of opening	*1,0%*	*25,4%*	*29,1%*	*71,1%*	
	Closing stock 2014	**7 574 997**	**183 412**	**47 883**	**15 287**	**7 821 579**

	Broad land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	TOTAL
Azonal Vegetation	**Opening stock 1990**	**2 067 561**	**333 812**	**24 776**	**316 724**	**2 742 873**
	Additions to stock	189 954	40 164	4 681	24 388	259 187
	Reductions in stock	58 021	47 420	4 875	148 622	258 938
	Net change in stock	131 709	-7 256	-213	-124 240	
	Net change as % of opening	*6,4%*	*-2,2%*	*-0,9%*	*-39,2%*	
	Unchanged (opening - reductions)	2 009 540	286 392	19 901	168 102	
	Unchanged as % of opening	*97,2%*	*85,8%*	*80,3%*	*53,1%*	
	Turnover (additions + reductions)	247 975	87 584	9 556	173 010	
	Turnover as % of opening	*12,0%*	*26,2%*	*38,6%*	*54,6%*	
	Closing stock 2014	**2 199 270**	**326 556**	**24 563**	**192 484**	**2 742 873**

*Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

Figure 20. Land cover composition per biome in 2014, based on broad land cover classes (tier 1)



4.3 Extent account for individual ecosystem types

The biome-level summary of the ecosystem extent account presented above masks important variation within each biome. This means that in addition to a biome-level analysis, it is useful to look at changes in ecosystem extent at the more detailed level of the terrestrial ecosystem types in South Africa, represented by vegetation types from the National Vegetation Map as discussed in Section 4.1. The ecosystem extent account for all 458 individual ecosystem types is too large to present in this report, but some of the key findings are extracted below.

The EEI for terrestrial ecosystem types is summarised in Figure 21 in the form of a frequency distribution. About half of the ecosystem types (238) had more than 90,0% of their historical extent remaining intact in 2014, in other words an EEI of more than 90,0%. Of the remainder, 82 ecosystem types (around 18,0%) had an EEI of 60,0% or lower in 2014, and six had an EEI of 20,0% or lower.

Figure 21. Frequency distribution of EEI for terrestrial ecosystem types in 1990 and 2014

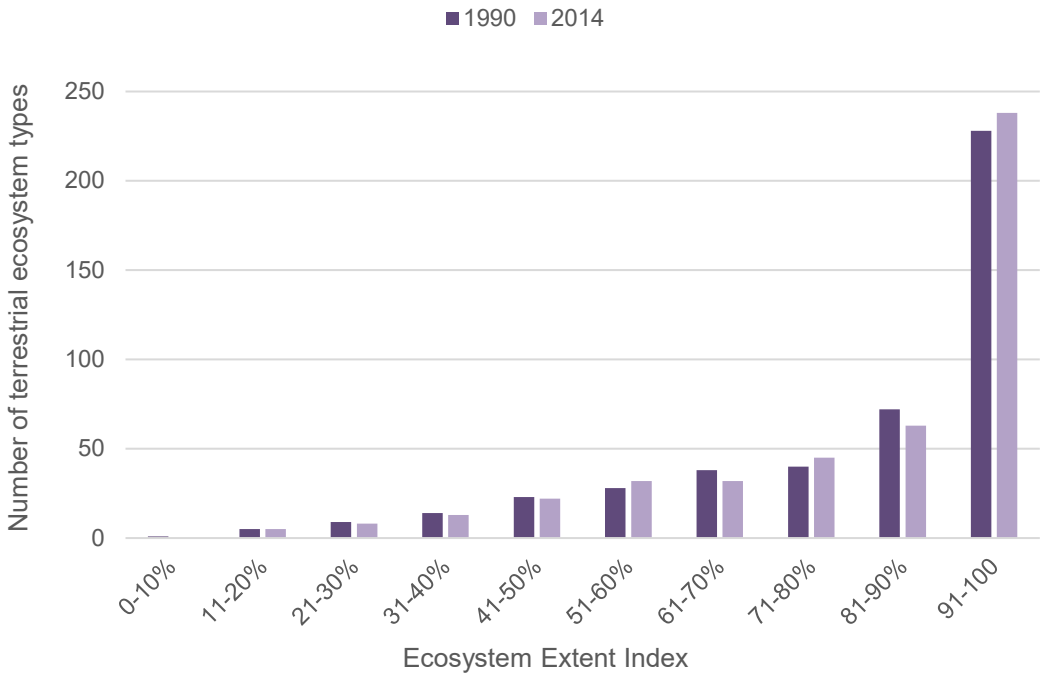


Table 17 shows the number of ecosystem types per biome as well as the minimum and maximum EEI for the ecosystem types within each biome. While the IOCB and Grassland biome as a whole each had a lower EEI than the Fynbos biome in 2014, the Fynbos biome had the highest number of individual ecosystem types with a very low EEI. This reflects the fact that large proportions of the lowland areas within the Fynbos biome have been converted to intensive land uses, especially cultivation (also see Table 18).

Table 17. Number of ecosystem types per natural or semi-natural biome, biome-level EEI in 2014, minimum and maximum EEI for ecosystem types within each biome, and number of ecosystem types per biome with EEI below certain thresholds in 2014

Biome	No. of ecosystem types	Biome EEI in 2014	Min EEI for ETs in 2014	Max EEI for ETs in 2014	Number of ETs with EEI below biodiversity target	Number of ETs with EEI below 60,0%
Albany Thicket	44	93,7%	53,1%	100,0%	0	2
Desert	15	98,7%	14,5%	100,0%	1	1
Forest	12	88,4%	59,2%	100,0%	0	1
Fynbos	122	73,0%	13,7%	100,0%	7	36
Grassland	73	66,6%	23,6%	100,0%	1	23
Indian Ocean Coastal Belt	6	48,1%	30,6%	68,5%	0	3
Nama-Karoo	13	98,6%	93,9%	100,0%	0	0
Savanna	91	87,0%	23,5%	100,0%	1	8
Succulent Karoo	64	96,8%	25,7%	100,0%	1	1
TOTAL	458				11	75

The EEI can provide information about which ecosystem types are declining in extent. This may be useful in land-use planning and decision-making processes in order to avoid declines below critical thresholds.

As part of the SA-NECS, every ecosystem type in South Africa is assigned a biodiversity target. The biodiversity target represents the minimum proportion of the historical extent of each ecosystem type that should remain in a natural or near-natural state, in order to ensure that a viable representative sample of all the country's ecosystem types and the species associated with them is maintained (SANBI, 2016).

In the terrestrial realm, biodiversity targets have been set based on species-area relationships (Desmet and Cowling, 2004). Targets for the 458 terrestrial ecosystem types range from 16,0% of historical extent for ecosystem types that are less species-rich to 36,0% of historical extent for the most species-rich ecosystem types (mainly in the Fynbos biome) (Skowno et al., 2019).[24]

Biodiversity targets are used primarily to provide a quantitative basis for the development of spatial biodiversity plans, including maps of Critical Biodiversity Areas (CBA) and Ecological Support Areas (ESA) that are used to inform planning and decision-making across a range of sectors (SANBI, 2017). Biodiversity targets can also provide a useful threshold against which to assess the EEI to indicate those ecosystem types for which it is no longer possible to maintain a representative sample, making it especially important to avoid conversion of the remaining natural areas within those ecosystem types to intensive land uses.

In 2014, 11 terrestrial ecosystem types had an EEI of less than their biodiversity target (Table 17). Seven of these are part of the Fynbos biome, with an additional one each in the Desert, Grassland, Savanna and Succulent Karoo biomes. Of particular concern are the ecosystem types that were very small to begin with (i.e. that have a very small historical extent), in which several species may be highly range-restricted or only found within that ecosystem type, which are more predisposed to impacts resulting from conversion to intensive land uses. This is the case for many ecosystem types within the Fynbos biome, which is highly diverse both in structure and species composition.

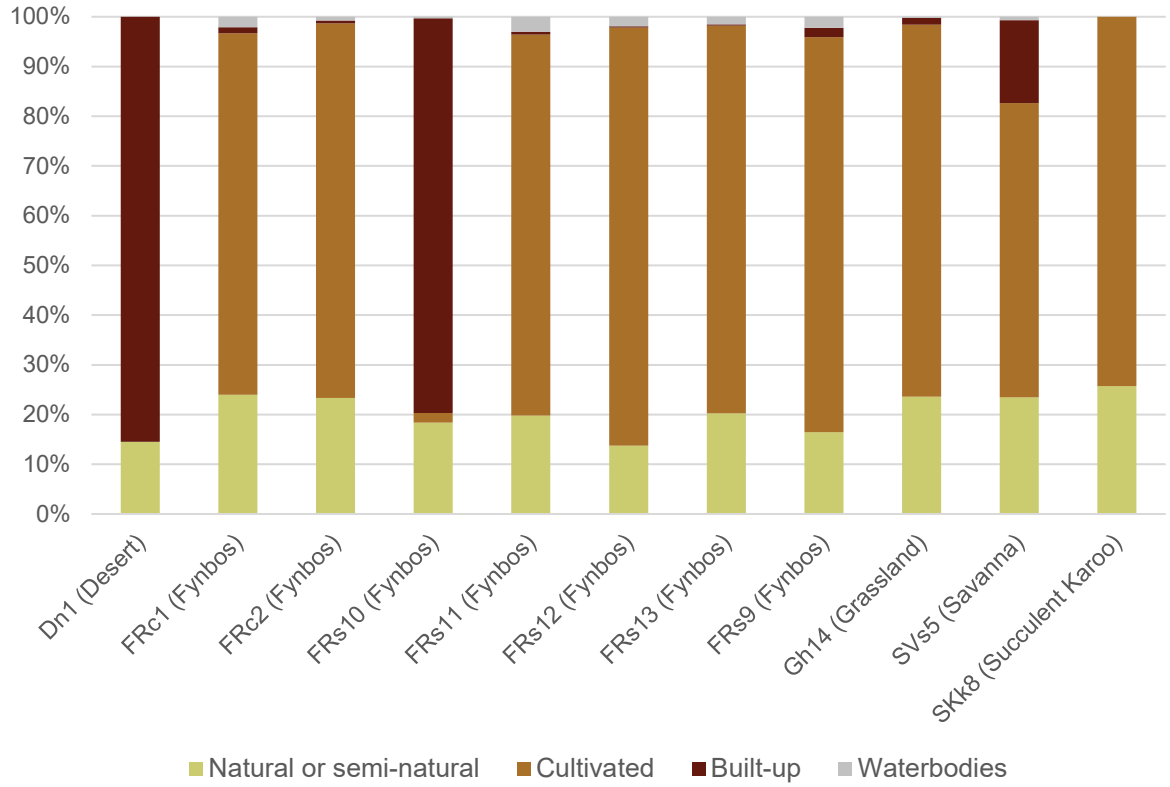
Figure 22 gives more detail about land cover composition within these 11 ecosystem types, showing the proportion of each that had been converted to cultivated or built-up areas by 2014. For almost all of these ecosystem types, the conversion from natural or semi-natural areas has been predominantly either to cultivated land or to built-up land rather than a combination of the two.

In future, it may be possible to identify thresholds for particular ecosystem types that are associated with their capacity to continue to provide particular ecosystem services. These may be different for different ecosystem types and different ecosystem services. The EEI could then be assessed against those thresholds.

The ecosystem extent account can be used to examine in some detail which land uses have replaced natural or semi-natural areas within particular ecosystem types and how this has changed over time, which could reflect socio-economic patterns or trends. To demonstrate this type of analysis, Table 18 shows the ecosystem types with the largest conversions to cultivated or built-up land in two different periods (prior to 1990 and from 1990 to 2014), in both proportional and absolute terms. Figure 23 (a-d) below the table shows the composition by broad land cover class in 2014 for the ecosystem types that have experienced the largest recent conversions to cultivated or built-up land. Full names of the ecosystem types, represented by codes in Table 18 and Figure 23, are given in Table 19.

[24] In the aquatic realms, a flat 20,0% biodiversity target is currently used for all ecosystem types, although this might change in future.

Figure 22. Land cover composition by broad land cover class (tier 1) in 2014 for ecosystem types with an EEI less than their biodiversity target



* See Table 19 for names of ecosystem types, represented here by codes with the relevant biome in brackets.

The top ten ecosystem types in terms of conversion to intensive land uses are different depending on whether cultivated or built-up land is considered, whether percentage or absolute changes are considered, and for the two different time periods (prior to 1990 or recent). The different results for the period prior to 1990 compared with 1990 to 2014 illustrate that, as spatial patterns in intensive land uses shift over time, different ecosystem types are impacted, with potential changes to the impacts on ecosystem services.

The largest proportional conversion to intensive land uses has taken place predominantly in Fynbos ecosystem types while the largest net conversions in hectare terms have taken place predominantly in Grassland and Savanna ecosystem types, both prior to 1990 and more recently. However, within these biomes different individual ecosystem types appear in the top ten list across the two time periods. Large conversions to built-up land have also taken place in some Indian Ocean Coastal Belt ecosystem types in more recent years, most likely reflecting urban expansion along the KwaZulu-Natal coast.

There is little overlap between the ecosystem types with the largest conversions to cultivated land and those with the largest conversions to built-up land. Only FFh11 (Peninsula Shale Fynbos), Gm8 (Soweto Highveld Grassland), SVcb12 (Central Sandy Bushveld) and SVl3 (Granite Lowveld) are in the top ten ecosystem types for both.

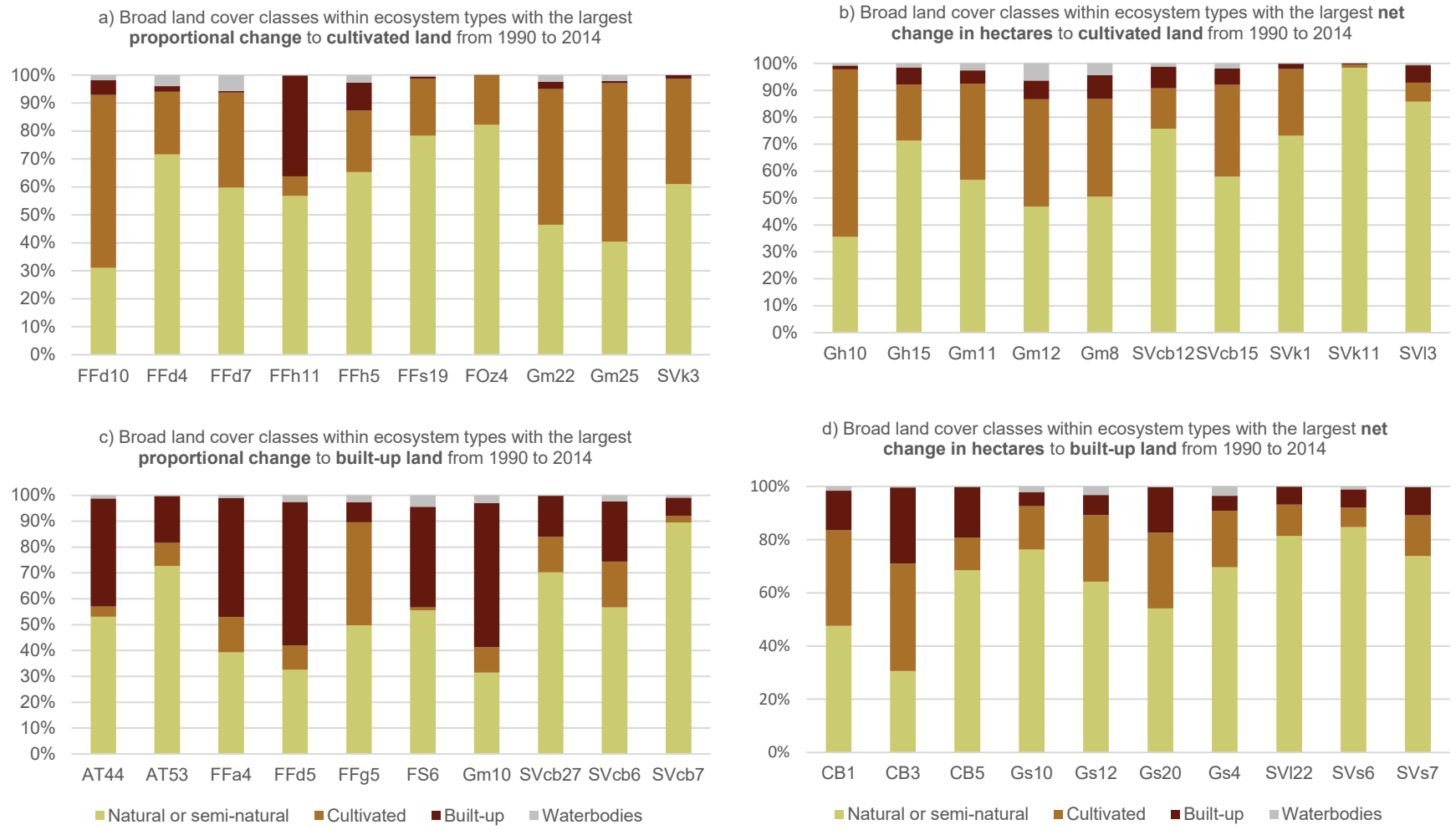
The changes presented in Table 18 could reflect either conversions from natural or semi-natural areas to cultivation or built-up land, or conversions between cultivated and built-up land. For example, an increase in built-up land could be the result of built-up areas replacing either cultivated areas or natural areas. A change matrix for broad land cover classes per ecosystem type (as provided for biomes in Appendix 4) would provide insight into this. Similarly, it would be possible to examine in more detail what forms of cultivation and what forms of built-up areas have increased in extent per ecosystem type by doing this analysis with main (tier 2) or detailed (tier 3) land cover classes rather than broad (tier 1) land cover classes.

Table 18. Terrestrial ecosystem types with the largest conversion to cultivated land cover or built-up land cover, as a percentage of opening extent of natural or semi-natural land cover or as net change in hectares, broken down into past conversion (prior to 1990) and more recent conversion (1990 to 2014), and grouped by biome **

	Conversion to cultivated land cover				Conversion to built-up land cover			
	Largest **percentage change** (calculated as percentage of opening extent of natural or semi-natural)		Largest **net change** in hectares		Largest **percentage change** (calculated as percentage of opening extent of natural or semi-natural)		Largest **net change** in hectares	
Biome	**Prior to 1990**	**Recent (1990 – 2014)***	**Prior to 1990**	**Recent (1990 – 2014)***	**Prior to 1990**	**Recent (1990 – 2014)***	**Prior to 1990**	**Recent (1990 – 2014)***
Albany Thicket					AT20 AT44	AT44 AT53		
Desert					Dn1			
Fynbos	FFd10 FRc1 FRc2 FRs11 FRs12 FRs13 FRs9	FFd10 FFd4 FFd7 FFh11 FFh5 FFs19	FRs9		FFd5 FFg3 FFh11 FFs29 FRs10	FFa4 FFd5 FFg5 FS6		
Forest		FOz4						
Indian Ocean Coastal Belt							CB3	CB3 CB1 CB5
Grassland	Gh14 Gm25	Gm25 Gm22	Gh14 Gh6 Gh10 Gm11 Gm12 Gm3 Gm8	Gh10 Gm11 Gm12 Gm8 Gh15	Gm10	Gm10	Gm8 Gs12 Gs14 Gs20 Gs9	Gs10 Gs12 Gs20 Gs4
Savanna		SVk3	SVk1 SVk4	SVk1 SVcb15 SVcb12 SVk11 SVl3	SVl17	SVcb6 SVcb7 SVcb27	SVcb12 SVl3 SVs6 SVs7	SVl22 SVs6 SVs7
Succulent Karoo	SKk8							

* The graphs in Figure 23 show the composition of broad land cover classes in 2014 for the ecosystem types in these columns.
** See Table 19 for names of ecosystem types, represented here by codes. The first letter of the code indicates the biome to which the ecosystem type belongs.

Figure 23. Land cover composition by broad land cover class (tier 1) in 2014 for ecosystem types with the largest changes in cultivated land cover or built-up land cover, 1990–2014 *



* See Table 19 for names of ecosystem types, represented here by codes. The first letter of the code indicates the biome to which the ecosystem type belongs.

Table 19. Full names of ecosystem types that are shown as codes in Table 18, Figure 22 and Figure 23

Biome	ET code*	Name of ecosystem type	Figure 22	Table 18	Figure 23
Albany Thicket	AT20	Bethelsdorp Bontveld		✓	
	AT44	Motherwell Karroid Thicket		✓	c
	AT53	Umtiza Forest Thicket		✓	c
Desert	Dn1	Alexander Bay Coastal Duneveld	✓	✓	
Forest	FOz4	Northern Mistbelt Forest		✓	a
Fynbos	FFa4	Lourensford Alluvium Fynbos		✓	c
	FFd10	Knysna Sand Fynbos		✓	a
	FFd4	Atlantis Sand Fynbos		✓	a
	FFd5	Cape Flats Sand Fynbos		✓	c
	FFd7	Agulhas Sand Fynbos		✓	a
	FFg3	Peninsula Granite Fynbos		✓	
	FFg5	Garden Route Granite Fynbos		✓	c
	FFh11	Peninsula Shale Fynbos		✓	c
	FFh5	Cape Winelands Shale Fynbos		✓	a
	FFs19	South Outeniqua Sandstone Fynbos		✓	a
	FFs29	Algoa Sandstone Fynbos		✓	
	FRc1	Swartland Silcrete Renosterveld	✓	✓	
	FRc2	Ruens Silcrete Renosterveld	✓	✓	
	FRs10	Peninsula Shale Renosterveld	✓	✓	
	FRs11	Western Ruens Shale Renosterveld	✓	✓	
	FRs12	Central Ruens Shale Renosterveld	✓	✓	
	FRs13	Eastern Ruens Shale Renosterveld	✓	✓	
	FRs9	Swartland Shale Renosterveld	✓	✓	
	FS6	Cape Flats Dune Strandveld		✓	c
Grassland	Gh10	Vaal-Vet Sandy Grassland		✓	b
	Gh14	Western Highveld Sandy Grassland	✓	✓	
	Gh15	Carletonville Dolomite Grassland		✓	b
	Gh6	Central Free State Grassland		✓	
	Gm10	Egoli Granite Grassland		✓	c
	Gm11	Rand Highveld Grassland		✓	b
	Gm12	Eastern Highveld Grassland		✓	b
	Gm22	Northern Escarpment Dolomite Grassland		✓	a
	Gm25	Woodbush Granite Grassland		✓	a
	Gm3	Eastern Free State Clay Grassland		✓	
	Gm8	Soweto Highveld Grassland		✓	b
	Gs10	Drakensberg Foothill Moist Grassland		✓	d
	Gs12	East Griqualand Grassland		✓	d
	Gs14	Mthatha Moist Grassland		✓	
	Gs20	Moist Coast Hinterland Grassland		✓	d
	Gs4	Northern KwaZulu-Natal Moist Grassland		✓	d
	Gs9	Midlands Mistbelt Grassland		✓	
Indian Ocean Coastal Belt	CB1	Maputaland Coastal Belt		✓	d
	CB3	KwaZulu-Natal Coastal Belt Grassland		✓	d
	CB5	Transkei Coastal Belt		✓	d
Savanna	SVcb12	Central Sandy Bushveld		✓	b
	SVcb15	Springbokvlakte Thornveld		✓	b
	SVcb27	Sekhukhune Plains Bushveld		✓	c
	SVcb6	Marikana Thornveld		✓	c
	SVcb7	Norite Koppies Bushveld		✓	c
	SVk1	Mafikeng Bushveld		✓	b
	SVk11	Molopo Bushveld		✓	b
	SVk3	Schweizer-Reneke Bushveld		✓	a
	SVk4	Kimberley Thornveld		✓	
	SVl17	Lebombo Summit Sourveld		✓	
	SVl22	Northern Zululand Sourveld		✓	d
	SVl3	Granite Lowveld		✓	b
	SVs5	KwaZulu-Natal Sandstone Sourveld	✓		
	SVs6	Eastern Valley Bushveld		✓	d
	SVs7	Bhisho Thornveld		✓	d
Succulent Karoo	SKk8	Piketberg Quartz Succulent Shrubland	✓	✓	

* ET = ecosystem type

4.4 Ecosystem asset accounts and the Red List of Ecosystems

Ecosystem accounts are not the only tool for quantifying and tracking the state of South Africa's ecosystem assets. The National Biodiversity Assessment (NBA), undertaken in 2004, 2011 and 2018, provides a systematic assessment of the threat status and protection level of all South Africa's ecosystem types across all realms, using the same maps and classifications of ecosystem types as those used for ecosystem accounting.

Ecosystem threat status is assessed according to a framework provided by the IUCN's Red List of Ecosystems, which provides a set of categories and criteria for assessing the risk of ecosystem collapse (IUCN, 2016; Bland et al., 2017).[25] The NBA categorises ecosystem types as Critically Endangered, Endangered, Vulnerable or Least Concern based on the Red List criteria, and in 2018 found that 22,0% of South Africa's terrestrial ecosystem types are threatened (SANBI, 2019).

The Red List of Ecosystems has been developed from a biodiversity perspective, with a primary focus on ecosystem collapse and biodiversity loss. It is especially useful for focusing conservation action on those ecosystem types that are most threatened. The perspective of ecosystem accounting is broader, with a strong focus on ecosystem services and the links between ecosystems and the economy. Ecosystem accounts and the indicators drawn from them are flexible, multi-purpose tools with a range of potential applications. For example, thresholds in the EEI and ECI could be linked directly to the capacity of an ecosystem asset or ecosystem type to supply certain ecosystem services, with different thresholds for different ecosystem types and different services. As seen in the previous section, terrestrial ecosystem extent accounts can be linked directly to land accounts, which enables consistent analysis of changes in land cover/use in particular ecosystem types, which can in turn be linked to demographic and economic information. Further applications and uses will be explored as the accounts become more developed over time.

Red List assessments and ecosystem asset accounts rely on some of the same foundational data, including mapping and classification of ecosystem types and spatial information on ecosystem condition, and the criteria used in the Red List of Ecosystems relate to both the extent and condition of ecosystems.[26] The NBA in South Africa has provided essential data for the development of ecosystem asset accounts, and the regular production of ecosystem accounts may help to provide systematic, time series data that can be used in the NBA. Specific links between ecosystem asset accounts and the Red List of Ecosystems as assessed in the NBA will be explored further as more ecosystem accounts are developed in South Africa.

[25] https://www.iucn.org/theme/ecosystem-management/our-work/red-list-ecosystems
[26] For example, the EEI is similar to Criterion A3 in the Red List of Ecosystems. Criterion A deals with reduction in geographic distribution, with Criterion A3 being reduction in geographic distribution since 1750.

5 DIRECTIONS FOR FUTURE WORK

Natural capital accounts provide standardised approaches and methods that facilitate comparison over time, and enable the integration of environmental, social and economic information. This report presents the first national land and terrestrial ecosystem accounts, reported at a range of scales. Through the process of developing these accounts, several directions for future work have been identified, which would further enhance and add richness to the work undertaken so far. These are discussed below.

1. Invest in updates of the National Land Cover

The regular production of land and terrestrial ecosystem accounts at predictable intervals would enhance their value, enabling analysis of trends and other statistical analysis. This is dependent on updated land cover data at relatively frequent intervals. The NLC 1990 and 2014 have been purchased with an open licence by DEFF and both are thus freely available as open access datasets. DEFF has finalised the NLC 2018 and committed to continued funding for future updates of the NLC, to provide a time series going forward.

The direction for future work is firstly to update the Land and Terrestrial Ecosystem Accounts with the NLC 2018. In doing so, it is recommended that there be further investigation at finer scales, for instance accounts for local municipalities.

A further direction for future work is to ensure that a full update of the NLC is undertaken at least every five years, and that every second update is aligned with the Population Census, which takes place every ten years. The potential for developing land accounts to analyse change in sub-national areas identified as having high rates of land cover change (in-between full national updates) could also be explored.

Another direction for future work would be to explore the use of change analysis of NLC data to inform large sample surveys and the Population Census. In preparing and planning for undertaking large sample surveys and the Population Census, Stats SA bases decisions regarding what information to gather and where to gather it on a range of factors. Areas of high land cover change could be used to indicate areas likely to be undergoing high levels of social and economic change and thus inform planning for large sample surveys.

2. Develop ecosystem condition accounts for inclusion in terrestrial ecosystem accounts

The terrestrial ecosystem accounts presented here focus on an ecosystem extent account, measuring changes in the spatial extent of terrestrial ecosystem types over time. As shown in Figure 1 in Section 1.1, ecosystem extent accounts are one of five core sets of ecosystem accounts and are foundational for several other ecosystem accounts. Future terrestrial ecosystem accounts in South Africa will build on this extent account to include ecosystem condition and ecosystem service accounts.

The ecosystem condition account will provide an ECI to complement the EEI. The ECI will provide information about the ecological condition of the remaining intact (i.e. natural or semi-natural) portion of each ecosystem type, assessed relative to a reference condition of natural.

At this stage it is not possible to reliably distinguish natural from semi-natural areas in the terrestrial realm based on remotely sensed imagery. The line between semi-natural areas and intensively modified areas (such as cultivated fields and urban areas) is much easier to draw based on remotely sensed imagery. In future terrestrial ecosystem accounts it would be ideal to distinguish spatially between natural and semi-natural areas. Such spatial information would feed into the development of an ecosystem condition account and ECI for terrestrial ecosystems.

The direction for future work is to collaborate with other organisations applying themselves to map and measure ecosystem conditions in a sufficiently consistent way. This involves collaboration between a range of government departments and agencies as well as research institutions.

3. Develop a full suite of ecosystem asset accounts across all realms

The accounts presented here deal only with terrestrial ecosystems. However, South Africa has well developed national maps and classifications of ecosystem types across the terrestrial, freshwater, estuarine, and marine realms, as part of the SA-NECS (see Section 2.2). In future, ecosystem accounts should be expanded to encompass marine, estuarine and freshwater (river[27] and inland wetland) ecosystems, in order to produce a comprehensive set of national ecosystem asset accounts for South Africa.

Another future direction of work would be to develop accounts focused on the small high-value ecosystem types highlighted as vital ecological infrastructure in South Africa's NBA 2018. These occur across aquatic and terrestrial realms and include indigenous forests, wetlands, lakes, estuaries, mangroves, dunes, beaches, rocky shores, kelp forests, reefs, seamounts, pinnacles and islands. Together these ecosystem types make up less than 5,0% of South Africa's territory, but contribute disproportionately to a large number of benefits to people and the economy, such as water purification, carbon storage, storm protection, recreation and food (SANBI, 2019). Declines in the EEI or ECI for these small high-value ecosystem types would be of particular concern from the perspective of the services and benefits they provide to people and the economy.

Accounts for Strategic Water Source Areas, the ten percent of land that delivers fifty percent of South Africa's water, would provide valuable information to inform planning and decision-making. Strategic Water Source Areas are high-value ecological infrastructure assets that are important for water security.

4. Explore development of national level ecosystem service accounts in physical terms

The suite of ecosystem accounts should ideally be expanded in future to include not only ecosystem asset accounts but also ecosystem services accounts (as shown in Figure 1 in Section 1.1).

Ecosystem services accounts have been piloted for KwaZulu-Natal (Turpie et al., 2020).[28] Lessons can be drawn from this pilot and methods for replication in other parts of the country explored. Future work would be focused on ecosystem services accounts that are feasible to produce at a national level and on standardising methods for measuring selected ecosystem services.

It may be possible to identify thresholds for particular ecosystem types that are associated with their capacity to continue to provide particular ecosystem services. These may be different for different ecosystem types and different ecosystem services. The EEI could then be assessed against those thresholds.

5. Further analysis and development of indicators

Natural capital accounts can be applied to monitor and report on progress against achieving the goals of the NDP and the global SDGs. They provide a source of statistical information that adds to the richness of evidence available to policy and decision-makers.

This report has provided several statistics and indicators, such as net change in land cover classes, percentage turnover in land cover classes, and the EEI, reported at various spatial scales (such as provinces, district municipalities and biomes). Ecosystem accounts and the indicators drawn from them are flexible, multi-purpose tools with a range of potential applications. There is considerable scope for the accounting process to deliver appropriate indicators for reporting against national and international targets. Exploring the application of these indicators for reporting on national and international obligations is a direction for future work.

[27] South Africa already has a set of national river ecosystem accounts that were piloted as part of an earlier project on ecosystem accounting and published by SANBI (Nel & Driver, 2015). These river accounts will be updated and published as part of the *Natural Capital Series* in future.
[28] This pilot was part of the NCAVES project.

6. Exploring in more detail the links to social and economic data

There is scope to explore links between land accounts and socio-economic data, including data from the National Accounts (such as gross value added per industry) and data from the Population Census and other household-based surveys (such as household income and employment). This could be useful for understanding the drivers of land use change in South Africa, as well as for determining the influence of land use change on economic outputs. Inclusion of information on land ownership could also be explored for inclusion in future accounts.

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APPENDIX 1: NATIONAL LAND COVER CLASSES

South Africa's NLC dataset for 1990 and 2014 has 72 land cover classes. These have been grouped into four tiers as described in Section 2.1. At the broadest scale (tier 1), land cover was grouped into four classes – natural or semi-natural, cultivated, built-up, and water. In tier 2 and tier 3, land cover was grouped into eight and 20 classes, respectively. These tiers allowed for more manageable summaries of land cover changes than the 72 original land cover classes (which encompass density and intensity of production for some classes). Only in specific instances, where there are particular changes of interest, are the original classes used.

The table below shows the hierarchical grouping of land cover classes from tier 1 (broad land cover classes) to tier 4 (full set of NLC classes). It also provides a description of how each of the 72 land cover classes is distinguished from satellite imagery. More detailed information can be found in GTI (2015).

Broad land cover classes	Main land cover classes	Detailed land cover classes	Full set of National Land Cover classes	Description of land cover class
Tier 1 (4 classes)	*Tier 2 (8 classes)*	*Tier 3 (20 classes)*	*Tier 4 (72 classes)*	
Natural or semi-natural	Natural or semi-natural	Natural or semi-natural	Indigenous Forest	Natural / semi-natural indigenous forest, dominated by tall trees, where tree canopy heights are typically > ± 5 m and tree canopy densities are typically > ± 75%, often with multiple understory vegetation canopies.
			Woodland/Open bush	Natural / semi-natural tree and / or bush dominated areas, where typically canopy heights are between ± 2 - 5 m, and canopy densities typically between 40 - 75%, but may include localised sparser areas down to ± 15 - 20%. Includes sparse - open bushland and woodland, including transitional wooded grassland areas. Can include self-seeded bush encroachment areas. In the arid western regions (i.e. Northern Cape), this cover class may be associated with a transitional bush / shrub cover that is lower than typical Open Bush / Woodland cover but higher and/or more dense than typical Low Shrub cover.
			Thicket/Dense bush	Natural / semi-natural tree and / or bush dominated areas, where typically canopy heights are between 2 - 5 m, and canopy density is typically > ± 75%, but may include localised sparser areas down to ± 60%. Includes dense bush, thicket, closed woodland, tall, dense shrubs, scrub forest and mangrove swamps. Can include self-seeded bush encroachment areas if sufficient canopy density.
			Low shrubland	Natural / semi-natural low shrub dominated areas, typically with ≤ 2m canopy height. Includes a range of canopy densities encompassing sparse to dense canopy covers. Very sparse covers may be associated with the bare ground class. Typically associated with low, woody shrub, karoo-type vegetation communities, although can also represent locally degraded vegetation areas where there is a significantly reduced vegetation cover in comparison with surrounding, less impacted vegetation cover, including long-term wildfire scars in some mountainous areas in the western Cape. Note that taller tree / bush / shrub communities within this vegetation type are typically classified separately as one of the other tree or bush dominated cover classes.
			Shrubland fynbos	Natural / semi-natural low shrub dominated areas, typically with < ± 2 m canopy height, specifically associated with the Fynbos biome. Includes a range of canopy densities encompassing sparse to dense canopy covers. Very sparse covers may be associated with the bare ground class. Note that taller tree / bush / shrub communities within this vegetation type are typically classified separately as one of the other tree or bush dominated cover classes.

Broad land cover classes	Main land cover classes	Detailed land cover classes	Full set of National Land Cover classes	Description of land cover class
			Grassland	Natural / semi-natural grass dominated areas, where typically the tree and / or bush canopy densities are typically < ± 20%, but may include localised denser areas up to ± 40%, (regardless of canopy heights). Includes open grassland, and sparse bushland and woodland areas, including transitional wooded grasslands. May include planted pasture (i.e. grazing) if not irrigated. Irrigated pastures will typically be classified as cultivated, and urban parks and golf courses etc. under urban.
			Bare non-vegetated	Bare, non-vegetated ground, with little or very sparse vegetation cover (i.e. typically < ± 5 - 10% vegetation cover), occurring as a result of either natural or man-induced processes. Includes but not limited to natural rock exposures, dry river beds, dry pans, coastal dunes and beaches, sand and rocky desert areas, very sparse low shrublands and grasslands, surface (sheet) erosion areas, severely degraded areas, and major road networks etc. May also include long-term wildfire scars in some mountainous areas in Western Cape.
			Erosion (donga)	Non-vegetated donga and gully features, typically associated with significant natural or man-induced erosion activities along or in association with stream and flow lines. The mapped extent of the dongas and gullies is represented by bare ground conditions in all or the majority of the multi-date Landsat images used in the land-cover modelling. In general, sparsely vegetated sheet eroded areas and degraded areas with significantly reduced local vegetation cover are not included in this class, but will be represented by local areas of low shrub or bare ground (see classes 9 and 41).
Cultivated	Commercial crops	Cultivated commercial fields	Cultivated commercial fields (high) Cultivated commercial fields (med) Cultivated commercial fields (low) Cultivated permanent pineapple	Commercial annuals - Cultivated lands used primarily for the production of rain-fed, annual crops for commercial markets. Typically represented by large field units, often in dense local or regional clusters. In most cases the defined cultivated extent represents the actual cultivated or potentially extent.
		Cultivated commercial pivots	Cultivated commercial pivots (high) Cultivated commercial pivots (med) Cultivated commercial pivots (low)	Commercial Pivot - Cultivated lands used primarily for the production of centre pivot irrigated, annual crops for or potentially extent.
		Sugarcane	Cultivated cane commercial - crop Cultivated cane commercial - fallow Cultivated cane emerging - crop Cultivated cane emerging - fallow	Sugarcane non-pivot - Commercial and semi-commercial / emerging farmer status, non-pivot fields, that appear to be used continuously for growing sugarcane on the majority of multi-date Landsat images used in the 2013-14 analysis period. Semi-commercial / emerging farmer fields are both represented by field units that are typically larger, either individually or locally collectively, than the smaller fields typically more representative of subsistence level sugarcane production.
			Cultivated cane pivot - crop Cultivated cane pivot - fallow	Sugarcane pivot - Commercial, pivot irrigated fields that appear to be used continuously for growing sugarcane on the majority of multi-date Landsat images used in the 2013-14 analysis period.
	Subsistence crops	Subsistence crops	Cultivated subsistence (high)	

Broad land cover classes	Main land cover classes	Detailed land cover classes	Full set of National Land Cover classes	Description of land cover class
			Cultivated subsistence (med) Cultivated subsistence (low)	Subsistence - Cultivated lands used primarily for the production of rain-fed, annual crops for local markets and / or home use. Typically represented by small field units, often in dense local or regional clusters.
	Orchards and vines	Orchards	Cultivated orchards (high) Cultivated orchards (med) Cultivated orchards (low)	Commercial permanent (Orchards / Vines) - Cultivated lands used primarily for the production of both rain-fed and irrigated permanent crops for commercial markets. Includes both tree, shrub and non-woody crops, such as citrus, tea, coffee, grapes, lavender and pineapples etc. In most cases the defined cultivated extent represents the actual cultivated or potentially extent.
		Vines	Cultivated vines (high) Cultivated vines (med) Cultivated vines (low)	
	Timber plantations	Timber plantations	Plantations/Woodlots mature	Planted forestry plantations used for growing commercial timber tree species. The class represents mature tree stands which have approximately 70% or greater tree canopy closure (regardless of canopy height), on all the multi-date Landsat images in the 2013-14 analysis period. The class includes spatially smaller woodlots and windbreaks with the same cover characteristics.
			Plantations/Woodlots young	Planted forestry plantations used for growing commercial timber tree species. The class represents young tree stands which have approximately 40 - 70% tree canopy closure (regardless of canopy height), on all the multi-date Landsat images in the 2013-14 analysis period. The class includes spatially smaller woodlots and windbreaks with the same cover characteristics. Note that young saplings are very difficult to identify on 30 metre resolution Landsat imagery if the actual tree canopy cover density is below ± 30 - 40%, because the background cover, for example grassland, then dominates the spectral characteristics in that pixel area.
			Plantations/Woodlots clear-felled	Planted forestry plantations used for growing commercial timber tree species. The class represents temporarily clear-felled stands (as a result of timber harvesting). Typically clear-felled stands are those stands that did not appear to have any tree cover in the most recent (i.e. latest) of the multi-date Landsat images used in the land-cover modelling, irrespective of the tree cover conditions in the earlier image dates.
Built-up	Urban	Urban parkland	Urban sports and golf (dense tree/bush) Urban sports and golf (open tree/bush) Urban sports and golf (low veg/grass) Urban sports and golf (bare)	Sports and golf - Areas containing a low density mix of buildings and other built-up structures associated with golf courses. The class includes both residential golf estates and non-residential golf courses, and typically represents the border extent of the entire estate or course.
		Urban industrial	Urban industrial	Areas containing buildings and other built-up structures associated with mainly non-residential, industrial and manufacturing activities, including power stations.
		Urban commercial	Urban commercial	Areas containing high density buildings and other built-up structures associated with mainly non-residential, commercial, administrative, health, religious or transport (i.e. train station) activities. Note that in some areas this class may include tall, multi-storey residential flat units.
		Urban built-up	Urban built-up (dense trees/bush)	

Broad land cover classes	Main land cover classes	Detailed land cover classes	Full set of National Land Cover classes	Description of land cover class
			Urban built-up (open trees/bush) Urban built-up (low veg/grass) Urban built-up (bare)	Built-up - Areas containing variable densities of buildings, other built-up structures, or no structures at all, that are not clearly identifiable as one of the other Built-up classes. May include runways, major infrastructure development sites, holiday chalets, roads, car parks, cemeteries etc.
		Urban residential	Urban residential (dense trees/bush) Urban residential (open trees/bush) Urban residential (low veg/grass) Urban residential (bare)	Residential - Areas containing variable density buildings and other built-up structures typically associated with formal, regulated, residential housing. Includes well established suburbs, townhouses, hostel complexes, flats etc.
		Urban township	Urban township (dense trees/bush) Urban township (open trees/bush) Urban township (low veg/grass) Urban township (bare)	Township - Areas containing high density buildings and other built-up structures typically associated with formal, regulated, residential housing associated with townships and "RDP" type housing developments.
		Urban informal	Urban informal (dense trees/bush) Urban informal (open trees/bush) Urban informal (low veg/grass) Urban informal (bare)	Informal - Areas containing high density buildings and other built-up structures typically associated with informal, often non-regulated, residential housing. Note that in some areas this class may include new formal developments within township areas that appear on Landsat imagery as primarily non-vegetated areas with limited infrastructure development.
		Urban smallholding	Urban smallholding (dense trees/bush) Urban smallholding (open trees/bush) Urban smallholding (low veg/grass) Urban smallholding (bare)	Smallholding - Areas containing a low density mix of buildings, other built-up structures within open areas, which may or may not be cultivated, that are representative of both formally declared agricultural holdings, and similar smallholdings / small farms, typically located on the periphery of urban areas.
		Urban village	Urban village (dense trees/bush) Urban village (open trees/bush) Urban village (low veg/grass) Urban village (bare)	Village - Areas containing variable density structures typically associated with rural villages, including both traditional and modern building formats.
		Urban school and sports ground	Urban school and sports ground	Areas containing buildings, other built-up structures and open sports areas typically associated with schools and school sports grounds. Image identification of such features is based on the local spatial relationship between the buildings and open area.

Broad land cover classes	Main land cover classes	Detailed land cover classes	Full set of National Land Cover classes	Description of land cover class
	Mines	Mines	Mine buildings	Areas containing buildings and large surface infrastructure associated with the extraction, processing or administration of the associated mining area.
			Mines 1 bare	Mining activity footprint, based on pure, non-vegetated, bare ground surfaces. Includes extraction pits, tailings, waste dumps and associated surface infrastructure such as roads and buildings (unless otherwise indicated), for both active and abandoned mining activities. Class may include open cast pits, sand mines, quarries and borrow pits etc.
			Mines 2 semi-bare	Mining activity footprint, based on semi-bare ground surfaces, which may be sparsely vegetated. Includes extraction pits, tailings, waste dumps and associated surface infrastructure such as roads and buildings (unless otherwise indicated) and surrounding dust-impacted areas, for both active and abandoned mining activities. Class may include open cast pits, sand mines, quarries and borrow pits etc.
			Mines water permanent	Water bodies inside mining areas which represent permanent water extents (see class 1).
			Mines water seasonal	Water bodies inside mining areas which represent non-permanent water extents (see class 2).
Waterbodies	Waterbodies	Waterbodies	Wetlands	Wetland areas that are primarily vegetated on a seasonal or permanent basis. Defined on the basis of seasonal image identifiable surface vegetation patterns (not subsurface soil characteristics). The vegetation can be either rooted or floating. Wetlands may be either daily (i.e. coastal), temporarily, seasonal or permanently wet and/or saturated. Vegetation is predominately herbaceous. Includes but not limited to wetlands associated with seeps/springs, marshes, floodplains, lakes / pans, swamps, estuaries, and some riparian areas.
			Water permanent	Areas of open, surface water, that are detectable on all image dates used in the Landsat 8 based water modelling processes. Permanent water extent typically refers to the minimum water extent, which occurs throughout the 2013-14 assessment period. Includes both natural and man-made water features.
			Water seasonal	Areas of open, surface water, that are detectable on one or more, but not all image dates used in the Landsat 8 based water modelling processes. Seasonal water extent typically refers to the maximum water extent, which may only occur for a limited time within the 2013-14 assessment period. Includes both natural and man-made water features.

APPENDIX 2: BRIEF DESCRIPTION OF THE BIOMES OF SOUTH AFRICA

South Africa has nine biomes, which are characterised by certain physiognomy and climatic conditions, and into which South Africa's 458 vegetation types are grouped, as described in Section 2.2. The table below provides a brief description of each biome and gives the number of vegetation types that make up each biome. Vegetation types are identified in the South African portion of the Vegetation Map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006; SANBI, 2006–2018) (referred to as the National Vegetation Map). Vegetation types are relatively homogenous units in the landscape, identified based on their biophysical characteristics such as species distribution, community composition, underlying geology and soil types, altitude, and rainfall gradients. They are used to represent terrestrial ecosystem types in ecosystem accounts.

Biome name	Short description	No. of vegetation types
Albany Thicket	Subtropical thicket is closed shrubland to a low forest dominated by evergreen, sclerophyllous or succulent trees, shrubs, and vines, many of which have stem spines. The vegetation cover is usually very dense, in places almost impenetrable. The vegetation is generally not divided into strata and has little herbaceous cover. Grass cover is absent or low. Thus fire is not as important in the disturbance regime as it is in Savannas. The Thicket biome shares floristic components with many other phytochoria. At its core distribution, Thicket is semi-arid to sub-humid (250-800 mm/yr) with bimodal rainfall peaking in spring and autumn, although rainfall may occur throughout the year. The biome can be subtropical to warm-temperate and is mostly frost-free. Thicket is dominated by trees and shrubs that are very long-lived and re-sprout after frost and fire. Flowers tend to be inconspicuous and predominantly bird-dispersed and appear throughout the year. The biome supports a diverse mammal fauna, and megaherbivores are a key part of defoliation with drought, fire and tree mortality playing lesser roles.	44
Desert	The Desert biome is found under very harsh environmental conditions that are more extreme than those found in the Succulent Karoo biome and Nama Karoo biome. Rainfall is highly variable between years but usually falls in summer (MAR 10 mm in the west, to 70 or 80 mm inland) with high levels of summer aridity. The Desert biome of South Africa is the southernmost extension of the extensive Namib Desert that covers the western parts of Namibia and stretches to southern Angola. Annual plants (often annual grasses) dominate, especially after rains. During dry periods the plains can appear completely bare. Perennial plants are usually encountered in specialised habitats associated with local concentrations of water. Common examples of these are broad drainage lines. The perennial grass Stipagrostis sabulicola occurs sporadically on large sand dunes which contain substantial stores of water. The Desert biome includes an abundant insect fauna which includes many tenebrionid beetles, some of which can utilise fog water.	15
Forest	Forests are restricted to frost-free areas with a mean annual rainfall of more than 525 mm in the winter rainfall region and more than 725 mm rainfall in the summer rainfall region. They occur from sea level to over 2 100 m above sea level. Forests rarely burn, mainly due to the high humidity - under extremely hot and dry (berg wind) conditions fires may occur and destroy the forest structure. Forests tend to occur in patches, few of which cover areas greater than 1 km^2, with areas greater than this only common in the southern Cape and Lowveld Escarpment. Even added together, forests cover less than 0,5% of southern Africa's surface area, making this the smallest biome in the country. The canopy cover of forests is continuous, comprising mostly evergreen trees, and beneath it the vegetation is multi-layered. Herbaceous plants, particularly ferns, are only common in the montane forests, whereas lianas and epiphytes are common throughout. A herbaceous ground layer is almost absent due to the dense shade. On the edges of the patches of forest are distinctive communities, the so-called fringe, and ecotonal communities, which are able to tolerate fire. Some 649 woody and 636 herbaceous plant species are recorded from forests. However, forests are not floristically uniform.	12

Biome name	Short description	No. of vegetation types
Fynbos	Fynbos is dominated by small-leaved, evergreen shrubs whose regeneration is intimately related to fire. The four complex factors paramount in fynbos ecology are: (1) generally nutrient-poor soils, (2) hot, dry summers alternating with cool, wet winters, typical of other Mediterranean-type regions (more pronounced in the western portions of the biome), (3) recurrent fires at 5–50 year intervals, (4) an intricate complex of animal-plant interactions, especially involving grazing, pollination, and dispersal. Like other Mediterranean-type ecosystems, the Fynbos biome has exceptionally high plant endemism and species richness.	122
Grassland	The Grassland biome is found chiefly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and Eastern Cape. The topography is mainly flat and rolling but includes the escarpment itself. The altitude varies from near sea level to 2 850 m above sea level. Grasslands are dominated by Poaceae. Trees are mostly absent, except in a few localised habitats. Forbs, particularly geophytes (bulbs) are abundant and comprise more than two-thirds of the biomass. Frosts, fire, and grazing maintain the grass and forb dominance and limit the establishment of trees. At higher rainfall and on more acidic soils, sour grasses prevail, with 625 mm per year taken as the level at which unpalatable grasses predominate. C4 grasses dominate throughout the biome, except at the highest altitudes where C3 grasses become prominent.	73
Indian Ocean Coastal Belt	This region occurs as an almost 800 km long coastal strip between the South African border with Mozambique as far south as the mouth of the Great Kei River. This high-level vegetation unit comprises a dominant forest cover interrupted by edaphically or hydrologically controlled areas of grassland, with at least a significant part of the belt being open to dense savanna vegetation, interspersed with many areas of forest and grassland.	6
Nama-Karoo	The Nama-Karoo biome occurs in the central/western interior of South Africa, at altitudes between 500 and 2 000 m, with most of the biome falling between 1 000 and 1 400 m. It is the second-largest biome in the region. The geology underlying the biome is varied, as the distribution of this biome is determined primarily by rainfall. The rain falls in summer and varies between 100 and 520 mm per year. This also determines the predominant soil type - over 80% of the area is covered by a lime-rich, weakly developed soil over rock. Although less than 5% of rain reaches the rivers, the high erodibility of soils poses a major problem where overgrazing occurs. The dominant vegetation is a grassy, dwarf shrubland. Grasses tend to be more common in depressions and on sandy soils, and less abundant on clayey soils. Grazing rapidly increases the relative abundance of shrubs. Most of the grasses are of the C4 type and, like the shrubs, are deciduous in response to rainfall events. The amount and nature of the fuel load are insufficient to carry fires and fires are rare within the biome. The large historical herds of Springbok and other game no longer exist. Like the many bird species in the area - mainly larks - the game was probably nomadic between patches of rainfall events within the biome. The Brown Locust and Karoo Caterpillar exhibit eruptions under similarly favourable, local rainfall events, and attract large numbers of bird and mammal predators.	13
Savanna	The Savanna biome is the largest biome in southern Africa, occupying 46% of its area, and over one-third the area of South Africa. It is well developed over the Lowveld and Kalahari region of South Africa and is also the dominant vegetation in Botswana, Namibia, and Zimbabwe. It is characterised by a grassy ground layer and a distinct upper layer of woody plants. Where this upper layer is near the ground the vegetation may be referred to as Shrubveld, where it is dense as Woodland. Intermediate stages are locally known as Bushveld. The environmental factors delimiting the biome are complex: altitude ranges from sea level to 2 000 m; rainfall varies from 235 to 1 000 mm per year; frost may occur from 0 to 120 days per year, and almost every major geological and soil type occurs within the biome. A major factor delimiting the biome is low and highly seasonal rainfall which prevents the upper layer from dominating, coupled with fires and grazing, which keep the grass layer dominant. Summer rainfall is essential for the grass dominance, which, with its fine material, fuels near-annual fires. Almost all species are adapted to survive fires. The grass layer is dominated by C4-type grasses, which are at an advantage where the growing season is hot, but where rainfall has a stronger winter component, C3-type grasses dominate. The shrub-tree layer may vary from 1 to 20 m in height, but in Bushveld typically varies from 3 m to 7 m.	91

Biome name	Short description	No. of vegetation types
Succulent Karoo	The Succulent Karoo biome has equal status to the other biomes in South Africa - it is not a subtype of "a Karoo biome." Most of the biome covers a flat to gently undulating plain, with some hilly and "broken" veld, mostly situated to the west and south of the escarpment, and north of the Cape Fold Belt. The altitude is mostly below 800 m, but in the east it may reach 1 500 m. Soils are lime-rich and often weakly developed. The Succulent Karoo biome is primarily determined by the presence of low winter rainfall and extreme summer aridity. Rainfall varies between 20 and 290 mm per year. Because the rains are cyclonic, and not due to thunderstorms, the erosive power is far less than that of the summer rainfall biomes. During summer, temperatures in excess of 40°C are common. Fog is common nearer the coast. Frost is infrequent. Desiccating, hot, north-westerly wind may occur throughout the year. The vegetation is dominated by dwarf, succulent shrubs, of which the Mesembryanthemaceae Crassulaceae are particularly prominent. Mass flowering displays of annuals (mainly Asteraceae) occur in spring, often on degraded lands. Grasses are rare, except in some sandy areas, and are of the C3 type. The number of plant species - mostly succulents - is very high and unparalleled elsewhere in the world for an arid area of this size.	64

APPENDIX 3: CHANGE MATRIX FOR MAIN LAND COVER CLASSES (TIER 2) PER PROVINCE

This appendix provides the change matrix for main land cover classes (tier 2) for each of South Africa's nine provinces between 1990 and 2014, in hectares. Reductions in land cover classes are read in rows, additions are read in columns, and shaded cells are the extent that remained in the same land cover class in both time periods.**

	Land cover classes (tier 2)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total reductions
Eastern Cape	Natural or semi-natural	14 237 549	70 160	88 297	5 596	41 395	46 296	625	47 570	**299 939**
	Commercial crops	98 358	448 333	2 527	3 413	1 530	907	38	4 853	**111 626**
	Subsistence crops	66 730	1 248	634 745		853	1 365	16	688	**70 900**
	Orchards and vines	2 972	4 615	9	33 398	286	113		167	**8 162**
	Timber plantations	41 023	1 426	431	599	101 922	1 481	4	615	**45 579**
	Urban	60 496	1 074	10 148	310	1 734	553 927	30	644	**74 436**
	Mines	2 979	27	97		1	43	2 144	85	**3 232**
	Waterbodies*	113 772	6 688	6 129	323	816	363	45	130 686	**128 136**
	Total additions	**386 330**	**85 238**	**107 638**	**10 241**	**46 615**	**50 568**	**758**	**54 622**	
Free State	Natural or semi-natural	8 116 864	233 514	1 849	354	11 929	17 214	5 212	32 895	**302 967**
	Commercial crops	313 911	3 531 691	9 614	1 110	1 689	3 347	1 048	6 854	**337 573**
	Subsistence crops	469	23	18 032		8	21		4	**525**
	Orchards and vines	153	239		1 864	9	1		25	**427**
	Timber plantations	13 022	1 975	30	9	16 933	1 616	318	502	**17 472**
	Urban	7 686	868	26	1	346	80 986	89	465	**9 481**
	Mines	6 282	50	2		42	21	14 862	286	**6 683**
	Waterbodies*	235 368	16 833	122	38	1 649	604	505	271 042	**255 119**
	Total additions	**576 891**	**253 502**	**11 643**	**1 512**	**15 672**	**22 824**	**7 172**	**41 031**	
Gauteng	Natural or semi-natural	812 054	62 975	510	366	3 451	51 066	5 016	10 929	**134 313**
	Commercial crops	68 165	324 034	77	678	593	9 061	1 562	3 239	**83 375**
	Subsistence crops	794	1 294	227			155	4	22	**2 269**
	Orchards and vines	59	385		537		13		2	**459**
	Timber plantations	13 030	1 798		20	17 015	10 090	128	688	**25 754**
	Urban	27 510	4 380	21	59	2 996	282 439	399	1 659	**37 024**
	Mines	10 030	106		1	147	129	12 416	397	**10 810**
	Waterbodies*	21 969	3 443	179	13	187	1 074	107	48 110	**26 972**
	Total additions	**141 557**	**74 381**	**787**	**1 137**	**7 374**	**71 588**	**7 216**	**16 936**	

	Land cover classes (tier 2)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total reductions
KwaZulu-Natal	Natural or semi-natural	5 829 863	150 849	152 738	6 090	140 096	47 680	2 458	34 138	**534 049**
	Commercial crops	63 542	674 204	1 039	2 521	12 610	1 378	76	3 832	**84 998**
	Subsistence crops	42 630	24 374	327 495	40	343	2 400	13	449	**70 249**
	Orchards and vines	981	1 610	29	11 932	85	29		20	**2 754**
	Timber plantations	97 570	11 757	1 321	392	552 626	9 151	492	3 984	**124 667**
	Urban	74 260	11 702	20 312	36	5 350	717 910	94	570	**112 324**
	Mines	2 169	79	75		212	38	1 914	48	**2 621**
	Waterbodies*	74 656	7 073	6 489	114	1 527	412	7	192 642	**90 278**
	Total additions	**355 808**	**207 444**	**182 003**	**9 193**	**160 223**	**61 088**	**3 140**	**43 041**	
Limpopo	Natural or semi-natural	10 259 657	131 501	108 083	20 599	2 218	113 713	11 090	15 547	**402 751**
	Commercial crops	182 797	587 302	1 979	16 492	156	8 395	427	1 901	**212 147**
	Subsistence crops	175 979	7 027	269 003	2 487	26	3 432	1 087	49	**190 087**
	Orchards and vines	7 928	3 243	1 616	65 931	131	207	3	70	**13 198**
	Timber plantations	23 400	684	159	2 849	74 152	1 082	11	507	**28 692**
	Urban	22 815	469	2 519	260	98	326 356	133	169	**26 463**
	Mines	11 017	48	106	5	1	411	15 347	39	**11 627**
	Waterbodies*	44 625	3 147	850	753	92	170	43	45 833	**49 680**
	Total additions	**468 561**	**146 119**	**115 312**	**43 445**	**2 722**	**127 410**	**12 794**	**18 282**	
Mpumalanga	Natural or semi-natural	4 622 572	112 565	11 357	7 853	107 796	45 095	22 885	30 118	**337 669**
	Commercial crops	200 656	1 065 900	1 192	9 763	9 668	2 700	25 334	9 545	**258 858**
	Subsistence crops	35 382	5 051	46 322	107	354	1 329	97	1 029	**43 349**
	Orchards and vines	3 394	5 075	461	22 637	151	508	38	62	**9 689**
	Timber plantations	86 471	2 617	296	2 125	639 285	2 335	2 642	7 862	**104 348**
	Urban	14 898	1 777	878	231	862	158 267	445	811	**19 902**
	Mines	18 649	526	42	2	314	239	22 352	706	**20 478**
	Waterbodies*	69 509	6 154	1 209	415	2 505	578	949	197 649	**81 319**
	Total additions	**428 959**	**133 765**	**15 435**	**20 496**	**121 650**	**52 784**	**52 390**	**50 133**	
North West	Natural or semi-natural	7 419 105	116 817	23 975	577	3 173	41 781	18 900	5 863	**211 086**
	Commercial crops	353 045	1 855 531	2 798	340	370	1 553	7 948	1 033	**367 087**
	Subsistence crops	51 917	8 803	205 207		11	869	224	24	**61 848**
	Orchards and vines	504	446		4 267	8	7		7	**972**
	Timber plantations	5 721	938	51	67	6 181	451	30	217	**7 475**
	Urban	16 646	1 555	704	9	138	166 982	179	222	**19 453**
	Mines	12 527	58	22	2	31	142	27 012	178	**12 960**
	Waterbodies*	70 725	3 061	477	44	187	254	245	49 137	**74 993**
	Total additions	**511 085**	**131 678**	**28 027**	**1 039**	**3 918**	**45 057**	**27 526**	**7 544**	

	Land cover classes (tier 2)	Natural or semi-natural	Commercial crops	Subsistence crops	Orchards and vines	Timber plantations	Urban	Mines	Waterbodies*	Total reductions
Northern Cape	Natural or semi-natural	36 524 262	46 890	247	7 662	210	13 369	11 719	22 790	**102 887**
	Commercial crops	29 472	178 432	138	1 695	58	86	940	1 223	**33 612**
	Subsistence crops	690	50	3 459						**740**
	Orchards and vines	4 772	929		31 006	3	31	2	33	**5 770**
	Timber plantations	803	51		5	323	52	3	23	**937**
	Urban	5 441	58	1	24	16	38 941	85	40	**5 665**
	Mines	15 776	94			4	92	84 662	49	**16 015**
	Waterbodies*	181 156	3 881		478	80	105	150	76 591	**185 850**
	Total additions	**238 110**	**51 953**	**386**	**9 864**	**371**	**13 735**	**12 899**	**24 158**	
Western Cape	Natural or semi-natural	10 347 915	129 823	104	25 536	7 971	21 374	5 559	24 147	**214 514**
	Commercial crops	128 052	1 569 642		13 365	1 297	763	332	5 680	**149 489**
	Subsistence crops	94	10	571	259		3		1	**367**
	Orchards and vines	13 853	4 345		221 092	277	586	4	1 085	**20 150**
	Timber plantations	43 236	1 673		1 069	70 195	1 417	18	1 583	**48 996**
	Urban	10 167	383	1	384	157	91 493	22	386	**11 500**
	Mines	2 257	31			7	40	2 739	125	**2 460**
	Waterbodies*	61 599	6 724	21	2 976	137	765	37	120 232	**72 259**
	Total additions	**259 258**	**142 989**	**126**	**43 589**	**9 846**	**24 948**	**5 972**	**33 007**	

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.
** Blank cells represent no data.

APPENDIX 4: CHANGE MATRIX FOR BROAD LAND COVER CLASSES (TIER 1) PER BIOME

This appendix provides the change matrix for broad land cover classes (tier 1) for each of South Africa's nine biomes between 1990 and 1994, in hectares. Reductions in land cover classes are read in rows, additions are read in columns, and shaded cells are the extent that remained in the same land cover class in both time periods.

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Albany Thicket	Natural or semi-natural	3 265 132	22 793	8 207	5 008	**3 301 140**	36 008
	Cultivated	28 682	132 665	308	266	**161 921**	29 256
	Built-up	7 446	719	43 208	101	**51 474**	8 266
	Waterbodies*	8 304	429	90	7 873	**16 696**	8 823
	Closing in 2014	**3 309 564**	**156 606**	**51 813**	**13 248**	**3 531 231**	**82 353**
	Total additions	44 432	23 941	8 605	5 375		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Desert	Natural or semi-natural	616 710	764	493	3	**617 970**	1 260
	Cultivated	383	466	11	1	**861**	395
	Built-up	654	0	6 611	0	**7 265**	654
	Waterbodies*	105	5	1	0	**111**	111
	Closing in 2014	**617 852**	**1 235**	**7 116**	**4**	**626 207**	**2 420**
	Total additions	1 142	769	505	4		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Forests	Natural or semi-natural	384 156	4 045	2 494	1 150	**391 845**	7 689
	Cultivated	17 582	32 760	413	233	**50 988**	18 228
	Built-up	1 392	115	5 191	20	**6 718**	1 527
	Waterbodies*	5 926	658	14	6 369	**12 967**	6 598
	Closing in 2014	**409 056**	**37 578**	**8 112**	**7 772**	**462 518**	**34 042**
	Total additions	24 900	4 818	2 921	1 403		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Fynbos	Natural or semi-natural	5 715 956	154 705	23 098	18 232	**5 911 991**	196 035
	Cultivated	182 703	1 808 854	3 137	7 766	**2 002 460**	193 606
	Built-up	11 834	1 364	98 645	448	**1 12 291**	13 646
	Waterbodies*	46 647	8 666	761	82 550	**138 624**	56 074
	Closing in 2014	**5 957 140**	**1 973 589**	**125 641**	**108 996**	**8 165 366**	**459 361**
	Total additions	241 184	164 735	26 996	26 446		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Grassland	Natural or semi-natural	20 579 536	908 080	161 189	110 914	**21 759 719**	1 180 183
	Cultivated	914 340	8 039 724	67 223	35 585	**9 056 872**	1 017 148
	Built-up	133 950	29 469	1 032 061	4 525	**1 200 005**	167 944
	Waterbodies*	396 156	49 322	4 089	624 162	**1 073 729**	449 567
	Closing in 2014	**22 023 982**	**9 026 595**	**1 264 562**	**775 186**	**33 090 325**	**2 814 842**
	Total additions	1 444 446	986 871	232 501	151 024		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Indian Ocean Coastal Belt	Natural or semi-natural	487 845	50 246	12 563	974	**551 628**	63 783
	Cultivated	43 259	299 481	5 081	741	**348 562**	49 081
	Built-up	19 665	15 791	216 862	84	**252 402**	35 540
	Waterbodies*	12 190	1 128	77	5 297	**18 692**	13 395
	Closing in 2014	**562 959**	**366 646**	**234 583**	**7 096**	**1 171 284**	**161 799**
	Total additions	75 114	67 165	17 721	1 799		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Nama-Karoo	Natural or semi-natural	24 437 515	49 983	5 740	22 315	**24 515 553**	78 038
	Cultivated	36 473	157 930	446	1 888	**196 737**	38 807
	Built-up	4 420	255	24 516	113	**29 304**	4 788
	Waterbodies*	106 017	3 852	136	84 949	**194 954**	110 005
	Closing in 2014	**24 584 425**	**212 020**	**30 838**	**109 265**	**24 936 548**	**231 638**
	Total additions	146 910	54 090	6 322	24 316		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Savanna	Natural or semi-natural	33 137 100	588 110	257 126	40 067	**34 022 403**	885 303
	Cultivated	882 842	2 898 946	31 866	8 212	**3 821 866**	922 920
	Built-up	131 711	23 507	1 115 574	1 224	**1 272 016**	156 442
	Waterbodies*	145 502	13 959	941	141 835	**302 237**	160 402
	Closing in 2014	**34 297 155**	**3 524 522**	**1 405 507**	**191 338**	**39 418 522**	**2 125 067**
	Total additions	1 160 055	625 576	289 933	49 503		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Succulent Karoo	Natural or semi-natural	7 536 575	22 971	6 700	3 960	**7 570 206**	33 631
	Cultivated	21 504	159 582	343	518	**181 947**	22 365
	Built-up	6 732	52	40 830	18	**47 632**	6 802
	Waterbodies*	10 186	807	10	10 791	**21 794**	11 003
	Closing in 2014	**7 574 997**	**183 412**	**47 883**	**15 287**	**7 821 579**	**73 801**
	Total additions	38 422	23 830	7 053	4 496		

Biome	Land cover classes (tier 1)	Natural or semi-natural	Cultivated	Built-up	Waterbodies*	Opening in 1990	Total reductions
Azonal Vegetation	Natural or semi-natural	2 009 316	33 429	3 442	21 374	**2 067 561**	58 245
	Cultivated	43 807	286 392	945	2 668	**333 812**	47 420
	Built-up	3 801	747	19 882	346	**24 776**	4 894
	Waterbodies*	142 346	5 988	294	168 096	**316 724**	148 628
	Closing in 2014	**2 199 270**	**326 556**	**24 563**	**192 484**	**2 742 873**	**259 187**
	Total additions	189 954	40 164	4 681	24 388		

* Changes in the extent of waterbodies reflect primarily that 1990 was a much wetter year than 2014.

APPENDIX 5: DISTRICT AND METROPOLITAN MUNICIPALITY CODES

South African District Municipalities and Metropolitan Municipalities are assigned a unique code. These codes are used on maps in Section 3.3 (Figures 12 to 15) and in some tables. The full municipality name and the province in which the municipality occurs are provided in the table below. The table is organised in alphabetical order by municipality name.

Code	District or Metropolitan Municipality	Province
DC44	Alfred Nzo	Eastern Cape
DC25	Amajuba	KwaZulu-Natal
DC12	Amathole	Eastern Cape
DC37	Bojanala Platinum	North West
BUF	Buffalo City	Eastern Cape
DC2	Cape Winelands	Western Cape
DC35	Capricorn	Limpopo
DC5	Central Karoo	Western Cape
DC13	Chris Hani	Eastern Cape
CPT	City of Cape Town	Western Cape
JHB	City of Johannesburg	Gauteng
TSH	City of Tshwane	Gauteng
DC40	Dr Kenneth Kaunda	North West
DC39	Dr Ruth Segomotsi Mompati	North West
DC32	Ehlanzeni	Mpumalanga
EKU	Ekurhuleni	Gauteng
ETH	eThekwini	KwaZulu-Natal
DC20	Fezile Dabi	Free State
DC9	Frances Baard	Northern Cape
DC4	Garden Route	Western Cape
DC30	Gert Sibande	Mpumalanga
DC43	Harry Gwala	KwaZulu-Natal
DC29	iLembe	KwaZulu-Natal
DC14	Joe Gqabi	Eastern Cape
DC45	John Taolo Gaetsewe	Northern Cape
DC28	King Cetshwayo	KwaZulu-Natal
DC18	Lejweleputswa	Free State
MAN	Mangaung	Free State
DC33	Mopani	Limpopo
DC6	Namakwa	Northern Cape
NMA	Nelson Mandela Bay	Eastern Cape
DC38	Ngaka Modiri Molema	North West
DC31	Nkangala	Mpumalanga
DC15	OR Tambo	Eastern Cape
DC3	Overberg	Western Cape
DC7	Pixley ka Seme	Northern Cape
DC10	Sarah Baartman	Eastern Cape
DC42	Sedibeng	Gauteng
DC47	Sekhukhune	Limpopo
DC19	Thabo Mofutsanyane	Free State
DC21	Ugu	KwaZulu-Natal
DC22	uMgungundlovu	KwaZulu-Natal
DC27	uMkhanyakude	KwaZulu-Natal
DC24	uMzinyathi	KwaZulu-Natal
DC23	uThukela	KwaZulu-Natal
DC34	Vhembe	Limpopo
DC36	Waterberg	Limpopo
DC1	West Coast	Western Cape

Code	District or Metropolitan Municipality	Province
DC48	West Rand	Gauteng
DC16	Xhariep	Free State
DC8	ZF Mgcawu	Northern Cape
DC26	Zululand	KwaZulu-Natal