

MAPPING LAND USE SYSTEMS AT A NATIONAL SCALE FOR LAND DEGRADATION ASSESSMENT ANALYSIS IN SOUTH AFRICA

IN SUPPORT OF THE SOIL PROTECTION
PROGRAMME

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1. INTRODUCTION

The implementation of the Land Degradation Assessment in Drylands (LADA) programme in South Africa has been included as one of the deliverables in the Strategic Plan of the Department of Agriculture since 2007. One of the most important activities in the LADA work plan is the development of a Land Use System for South Africa that could serve as the stratification layer for the National Land Degradation and Improvement Assessments as set out in the WOCAT/LADA guideline.

The LADA project has as objective to develop tools and methods to assess and quantify the nature, extent, severity and impacts of land degradation on dryland ecosystems, watersheds and river basins, carbon storage and biological diversity at a range of spatial and temporal scales. It should build the national, regional and international capacity to analyze, design, plan and implement interventions to mitigate land degradation and establish sustainable land use and management practices.

To achieve these objectives, LADA is developing standardized and improved methods for dryland degradation assessment, with guidelines for their implementation in a range of scales. Using these methods, it assesses the national baseline condition of land degradation with the view to highlighting the areas at greatest risk. These assessments are supplemented by detailed local assessments that focus on root cause analysis of land degradation and on local (traditional and adapted) technologies for the mitigation of land degradation. Areas where land degradation is well controlled are included in the analysis. 'Best practice' guidelines are being developed and the results widely disseminated in various media. The project is intended to make an innovative generic contribution to methodologies and monitoring systems for land degradation, supplemented by empirically-derived lessons from the six main partner countries involved in the project – Argentina, China, Cuba, Senegal, South Africa and Tunisia – up-scaled to countries within their regional remit.

During August 2005 the Minister of Agriculture requested the development of a "Soil Protection Strategy (SPS) for South Africa". One of the main reasons for this request was the approximation that three million hectares of moderate to high potential agricultural land have a moderate to high erosion risk in South Africa. As a first step in the development of the strategy priority areas for the implementation of integrated soil rehabilitation programmes were identified by means of a GIS model based on Land Capability and Predicted Soil Erosion data. The rationale followed in this approach was based on the principle that high potential soil in South Africa should be protected at all cost. The strategy further recommended the establishment of a National Advisory Board (NAB) on Soil Protection supported by three thematic (erosion, decline in organic matter / nutrient depletion and soil contamination) and two horizontal (monitoring and research) technical working groups. The main role of the NAB would be to coordinate all activities of the working groups and to formulate recommendations to the minister around the development of the final policy on soil protection. First recommendations from the initial strategy will be implemented in three selected study areas in the above mentioned provinces. These include integrated land use planning, mapping the extent of land degradation and the implementation of rehabilitation measures. The land degradation assessment phase of the SPS has been integrated with the LADA national level land degradation assessment due to similar aims and objectives of the 2 programmes. The SPS is implemented in collaboration with the provincial Departments of Agriculture and should therefore provide relevant information at provincial level.

2. Rationale developed by FAO

2.1 The Ecosystem-Land Use System Information Base

Land use, defined as the sequence of operations carried out with the purpose to obtain goods and services from the land, can be characterized by the actual goods and services obtained as well as by the particular management interventions undertaken by the land users. Land use is generally determined by socio-economic market forces and the biophysical constraints and potentials imposed by the ecosystems in which they occur. At regional and global scale information on the land use can be indirectly derived from agricultural census data, land cover information and from maps of the biophysical resource. Few global databases are available that allow the characterization of the land management interventions themselves (for instance information on mechanization or fertilizer use are often only available as national statistics): in fact only for irrigation, livestock presence and protected areas are consistent global databases available which allow refining the mapping and characterization of land use.

Land use is the single most important driver of land degradation as it focuses on interventions on the land which directly affect its status and impacts on goods and services. To characterize land use in a systematic and harmonized way allows evaluating the various aspects of land degradation, particularly when information on related ecosystem characteristics (on which land degradation has a major impact by affecting the good and services provided by each system) and socio-economic attributes of the area (which are often the indirect cause of land degradation) are associated with it.

Previous efforts to characterize land use globally were incomplete or fragmented. The farming system maps produced by Dixon et al. (FAO/World Bank 2001) covered the developing world only and were too generalized to be of practical use within countries. The farming system scheme developed however appears to be a valid scheme to define global and regional land use classes.

The Global land cover dataset (GLC-2000, JRC), although providing global coverage at much higher resolution than the farming systems map, recognizes only the land cover aspect and did not attempt to further characterize land use in terms of crops, goods and services or management interventions.

Other efforts have attempted to distribute national agricultural statistics in a rational way based on bio-physical conditions and the actual land cover (IIASA, 2007; You and Wood, 2006; Ramankutty, 2007).

Global thematic databases at sub-national level exist for agricultural crops and livestock. Agro-Maps (FAO/IFPRI/SAGE, 2006) provides sub-national statistics on crop production, area harvested and yields in a systematic way but the information is fragmented in time and space and limits itself to agricultural crops. A similar situation exists with livestock (ILRI Global livestock production systems (Thornton et al, 2002) and the FAO global per species livestock density database (Wint and Robinson, 2007).

F-CAM (George and Petri, 2006; unpublished) proposed a scheme that followed the principles applied by Dixon et al. (2001), but used a more systematic approach and consistent geo-referenced databases.

Here a similar scheme is adapted and applied at a global and regional scale, putting emphasis on the role of ecosystems in land use systems and making a more clear distinction between

what can be mapped (units) and what can be consulted and related to these units and their use as attributes.

There is no single accepted nomenclature for land use. As there are links with the scheme from Dixon (2001), it is tempting to use the word “farming systems”, but this does not fit well with forest based activities, or with the non-agricultural uses of land. The term Land Production Systems has also been proposed but this over-emphasizes the productive functions of land as compared to the environmental services it may render. Therefore in the following discussion the more generic term “Land Use Systems” is used.

It is important to note that the database provided includes all individual characteristics aggregated to a 5 arc minutes grid. However, in order to graphically represent Land use systems, certain groupings and simplifications are proposed here that are further documented in the sections that follow.

In the context of LADA, the land use system approach to land degradation assessment has as guiding principle that land use is the major driving force of land degradation. Mapping of land use systems has therefore become a major activity within the project at global and national level where it is land use units are considered the basic units in which land degradation and land improvements are mapped (Liniger et al, 2007). Land degradation status, causes and impacts are further modified by the ecosystem and socio economic factors in which land use takes place. These factors are therefore associated with the land use system as a whole.

The mapping and the accuracy of land use systems and their associated characteristics depends on scale and availability of information, which varies from global to regional to national. The methodology outlined here refers to the first two levels only (global, national) but with emphasis on the global applications. Preliminary results of the global scale approach by South Africa (Pretorius, 2007), Tunisia (Hamrouni, personal communication, 2007) China (2007) and Senegal (CSE, 2007) indicate that at national level refinements are certainly possible but a good balance should be found between the level of detail and the practical purpose of the exercise which remains to serve as units in which land degradation and land improvements is to be assessed.

As explained by George and Petri (2006), the descriptions of the farming systems as given by Dixon et al. (2001) were first taken as a guideline to define LUS. However, this approach proved to be too complex and did not result in readily recognizable land use units within countries, nor did certain major subdivisions have a direct or indirect link with land degradation. Therefore a much simpler scheme is proposed at global unit level which allows for accessing the characterization of the land use and eco-system attributes on-line and in GIS format. In this way, as all layers are present in the database and are connected to the final units obtained, no information is lost. It also allows the user to include some of these factors at national scale and refine them to create national land use information systems at higher resolution.

Dixon recognized different land use systems and correlations with the resource base in the different regions in the world. The same principle is applied here and regional rules and are used to reflect the cultural and historical differences in land use in various areas of the world, particularly for livestock.

2.2 Base data and Data Quality

Data quality is and remains a major concern. Putting together by simple overlay global data layers of variable quality and resolution is a risky exercise that is bound to result in erroneous

conclusions on the land use system practiced. Major problems with the individual databases used are well known (FAO, 2005), the main ones are discussed below:

GLC-2000: the global land cover dataset is an essential layer in that it distinguishes at the highest level if land use systems are forest, crop or grassland based. Any error here will result in errors in the end-product. Based on a limited number of tests in LADA countries the accuracy of GLC-2000 is variable (Senegal and South Africa found it lacking in several areas, while China considered it a good base product).

Agro-Maps: crop dominance and cropping patterns are derived from this database which is a joint product prepared by FAO, IFPRI and Sage and provides sub-national statistics on areas, yields and production of specific crops. Although not fully comprehensive it is the best global product available. In general perennial crop information is very scarce in this database. Moreover as administrative units are used as units this results in a variable resolution of information (Compare Ethiopia for instance –with very detailed sub administrative units- with other countries in Africa).

Livestock data: the livestock data are available at a relatively high resolution (3 arc minutes grid) but much of it has been obtained by modelling rather than actual inventories. The reliability of the modelling exercise and its variation is unknown, but was found to have a reasonable accuracy (China).

The Ecosystem and Biophysical resource base: although the individual resource base layers are relatively uniform in resolution, some of the underlying data were obtained from less detailed databases (for instance climatic data), while others, like terrain, were difficult to use to distinguish land use systems. Given the lower resolution and the different national traditions to classify “climatic ecosystems”, it was thought these and other resource base information to occur as attributes of the land use system rather than use their boundaries to delineate LUS.

Socio economic attributes: socio-economic data are the most scarcely available data worldwide and even within countries. Population data are by far the most comprehensive, while others such as poverty data are scarce globally and often sensitive nationally.

2.3 From a global to a national Land Use Systems Map

Regardless of the certain unreliability and low resolution of global datasets a reasonable estimate of the prevailing national Land Use Systems can be done as is illustrated in the following sections. However verification of each database layer will be undertaken by the LADA countries to eliminate gross errors or to fill major gaps at the same scale/resolution of the global LUS map. This will probably result in changes in boundaries and refining of the information contained in each pixel.

In a next step it will be the LADA country task to create a national LUS map at a higher resolution. This will allow to create sub-systems of land use in the different classes and is most likely to introduce land use factors that can not be distinguished at global scale because of lack of data or because they can only be discerned/mapped at higher resolution. This concerns in particular factors such as:

- **Land Tenure and Size of Farms:** large areas in a country may be reserved for commercial large farms which are quite distinct from other areas which are mostly used for small- holder farming.

- **Forest management and exploitation:** little can be done at global scale to characterize forest management because most data are only available at country scale. Countries who have the information sub-nationally and geo-referenced may be able to distinguish different forms of forest exploitations (including firewood gathering).
- **Water resources and Irrigation:** apart from the irrigation map little is known about other sources of water availability and their use at global scale (rivers, underground water reservoirs). It may be possible at sub-national scale to delineate areas which make use of this resource.
- **Fertilizer use, mechanization and other inputs:** although some more detailed information on fertilizer use by crop gathered by FAO for several countries (FAO, 2004) is available the country coverage is incomplete. LADA countries may wish to specify or subdivide the globally obtained LUS for these factors at national scale.
- **The climatic ecosystem, socio-economic and resource base factors:** information is available as attribute information. Uniform LUS systems may show different degradation features as a function of the soil and terrain in which they occur. If one is able to map those factors they may be used to subdivide major LUS units in the national LUS map.

It is advisable that one keeps in mind the readability of the maps produced and carefully considers that when a factor characterizing a specific land use system is added, the complexity of the map produced is exponentially increased. The national land use systems map provides the core units for the evaluation and mapping of land degradation and land improvements, therefore increasing the number of units results in a heavier workload for completing the QM questionnaire (WOCAT/LADA, 2007).

2.4 Technical Procedure to obtain the Major land use systems

In order to transform the GLC-2000 land cover classes into major land use systems a number of steps are required that make use of additional layers of information, notably the urban information layer, the global irrigation database, and the livestock density database. The various land use systems are recognized in a stepwise approach as illustrated below.

Step 1: Simplify the land classes of GLC-2000 to 8 basic classes: Forests, Shrubs, Herbaceous, Wetlands, Bare land, Sparse land, Agricultural land and Open Water. In addition use the urban layer to overlay and overrule the existing land cover and identify an urban Land Use System. These are the nine major subdivisions of the Land Use System Classification System.

Step 2: Overlay the remaining areas with irrigated area data base and classify any pixel with irrigation occupying more than 25 % of the pixel as irrigated agricultural land. (a subclass of agricultural land).

Step 3: Overlay the remaining land with the protected area layer and classify all land within the protected areas as protected land cover (eg protected forest).

Step 4: Calculate the livestock intensity of each pixel.

Step 5: For the 4 classes of bare, spare shrub, shrub and herbaceous cover follow the procedure below:

- 1/ High Livestock density → Intensive livestock rearing
 2/ Moderate Livestock density → Moderately intensive pastoral system
 3/ Low Livestock density → Extensive pastoralism
 4/ No livestock → unmanaged.bare/sparse/bush/herbaceous/

Step 6: For forests, wetlands and agricultural land if the overlay with livestock indicates a moderate or high livestock density consider the land use system as a combination of forestry (or wetlands) and livestock rearing or agro-pastoralism alternatively.

Step 7: For forests the remaining subdivision is Managed/Unmanaged Forests (no distinction can be made at a world's scale). For agriculture the remaining subclass is rainfed agriculture. For wetlands there remain two possibilities: mangroves and unmanaged.

Step 8: Classify all open water areas as inland fisheries.

Figure 1 illustrates the major land use systems globally. These are mapped and considered the basic units in the system. They are further characterized by a number of biophysical and socio-economic attributes that are attached to these LUS units.

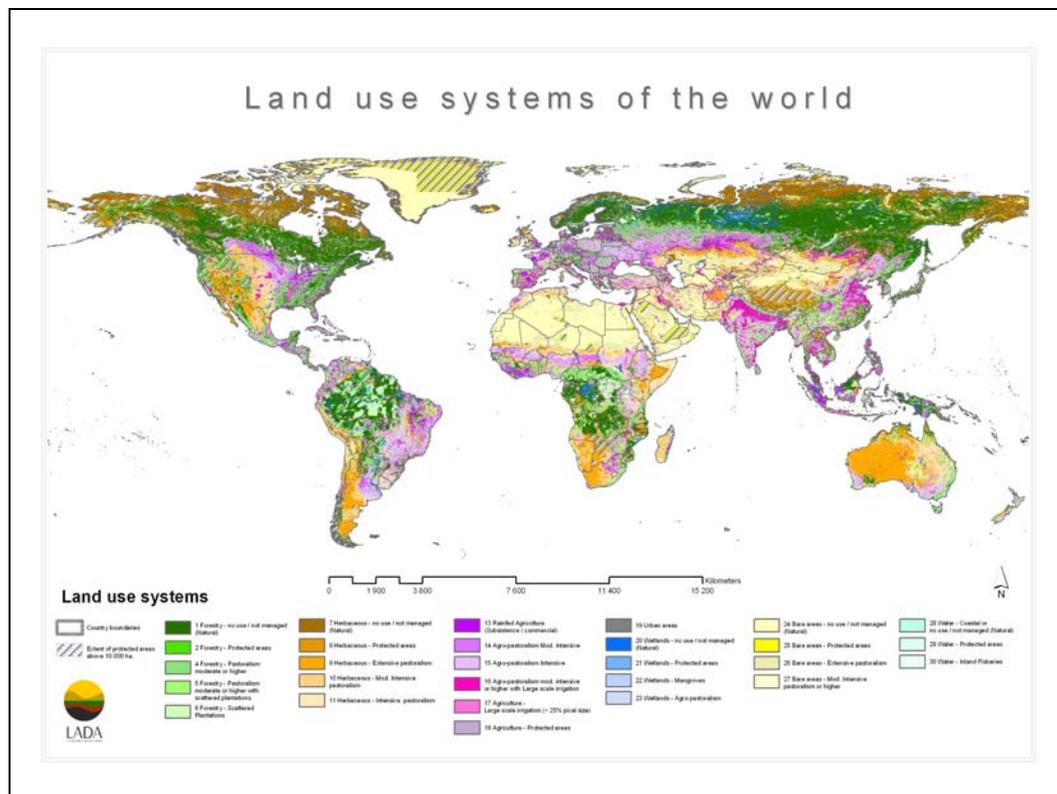


Figure 1. The major land use systems globally (Nachtergaele and Petri, 2008).

3. Land Cover/Use System developed for South Africa

3.1 First Land Degradation Assessment for SA

The Department of Environmental Affairs and Tourism (DEAT) contracted the National Botanical Institute (NBI) and the Programme for Land and Agrarian Studies (PLAAS) to report on the status of land degradation in South Africa in 1997. The primary aim of the project was to assess the extent, rate and causes of land degradation in South Africa through research and participatory workshops and to develop a series of [consensus maps](#) of land degradation based on the perceptions of people with knowledge of the region. **The basic stratification for the assessment was based on magisterial districts.** The workshops were held largely with agricultural extension officers and resource conservation technicians, and 453 people participated in the 34 workshops held between June 1997 and February 1998. Hoffman and co-workers (2001) adopted the same assessment approach in all workshops. This approach was similar to that used in the Global Map of Human-Induced Soil Degradation (GLASOD) (Oldeman *et al.*, 1991) but they modified the method considerably to suit project own needs and circumstances. Generally, they followed the procedure as laid out in Liniger & Van Lynden (1998) for the assessment of land use practices and soil degradation only. This methodology has emerged from several iterations of a WOCAT Task Force (World Overview of Conservation Approaches and Technologies), and has been shown to be robust enough to be used under a wide range of circumstances. The final report comprises, primarily, the literature review of the scientific and socio-economic debates around the desertification problem in South Africa. It also, however, incorporates the results of the 34 workshops and presents consensus maps of soil and vegetation degradation where appropriate (Figure 2). **Using administrative boundaries as stratification** and the repeatability of the data capturing were some of the main criticisms on the project. It was however always pointed out that this was the only feasible methodology to use due to the unavailability of more reliable national datasets and time and funding constraints.

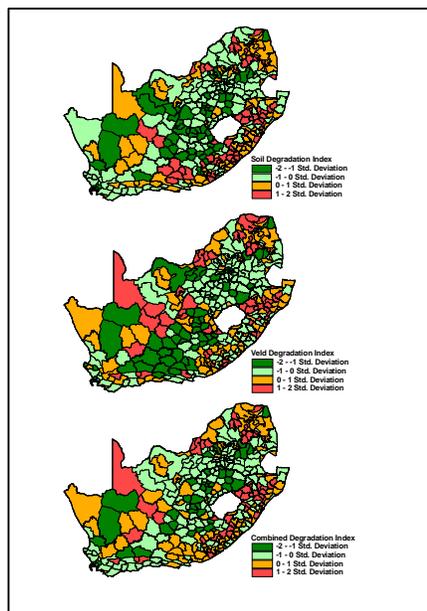


Figure 2. The relative extent of soil degradation (top), vegetation degradation (middle) and a combined index of soil and vegetation degradation (bottom) in South Africa as perceived by agricultural extension officers and resource conservation technicians (Hoffman *et al.*, 2001).

3.2 Methodology for the development of the South African LUS Map

The Land Use System Approach to land degradation assessment (as described by Nachtergaele and Petri, 2008) has been accepted as the guiding principle for the development of the South African Land Use System Map. As however stated in the LUS guidelines the mapping and the accuracy of land use systems and their associated characteristics depends on scale and availability of information, which varies from global to regional to national level. Due to the lack of reliable land use information at national level the above-mentioned methodology had to be adjusted for the South African scenario.

Although some land use information data do exist for South Africa at international level this information is not always readily available at national level at an acceptable level of accuracy. The first National Land Cover Map for South Africa was published in 1995. This map was based on visual interpretation of Landsat 5 satellite images. This map was followed in 2000 by a refined Land Cover Map based on the processing and interpretation of Landsat 7 satellite data. Although these maps contain some land use information (e.g. mining, plantations and urban areas) they don't contain any specific crop information. Due to the different methodologies used in the compilation of these maps there is a big difference in the accuracy and resolution of the maps and therefore no attempts were ever made to extract land cover change information from the maps. From the onset of the LUS development for SA it was realised that the Land Cover 2000 data would form the basis for the stratification. Information regarding crop type and animal numbers were insufficient to be included in the system. One of the main reasons for excluding these datasets was that the data was outdated and collected for a limited number of districts which changed names and also boundaries over the last few years. Attempts were made to summarise the data for the new local municipality but due to various reasons the attempts were unsuccessful.

Other stratification schemes, e.g. a fixed grid system (14/ degree grid) and using only administrative boundaries, were also evaluated but was disregarded due to various reasons.

The LUS to serve as the basis for the national degradation assessment in South Africa had to comply with the following criteria:

- **be in line with the SPS and LADA objectives;**
- **provide a realistic number of unique stratification units for the assessment to be completed within given time and budget frameworks;**
- **based on reliable data;**
- **limited verification needed;**
- **assist and not confuse workshop participants;**
- **workshop participants able to relate to stratification boundaries.**

The following GIS layers were found to be reliable enough and at an acceptable level of detail to be used in the production of the LUS map for South Africa:

- **National Land Cover 2000 (NLC Consortium) – Annexure 1**
- **Protected Areas in South Africa 2001 (Biodiversity GIS, South African Biodiversity Institute- SANBI) – Annexure 2**
- **VEGMAP 2006 (Mucina & Rutherford, SANBI) – Annexure 3**
- **Local Municipalities 2005 (Demarcation Board of South Africa) – Annexure 4**

The layout for the development of the LUS for South Africa is presented in Annexure 5.

3.3 LUS class descriptions

Open Water

Areas of (generally permanent) open water. The category includes both natural and man-made waterbodies, which are either static or flowing, and fresh, brakish and salt-water conditions. This category includes features such as rivers, major reservoirs, farm-level irrigation dams, permanent pans, lakes and lagoons.

Wetlands

Natural or artificial areas where the water level is permanently or temporarily at (or very near) the land surface, typically covered in either herbaceous or woody vegetation cover. The category includes fresh, brakish and salt-water conditions. Examples include pans (with non-permanent water cover), and reed-marsh or papyrus-swamp. Dry pans are included in this category unless they are permanently dry.

Cultivated

Land which has been ploughed and / or prepared for the raising of crops (excluding timber production). Unless otherwise stated, includes areas currently under permanent or temporary crop, fallow land, and land being prepared for planting. Class boundaries are broadly defined to encompass the main areas of agricultural activity, and are not defined on exact field boundaries. As such all sub-classes may include small inter-field cover types (e.g. hedges, grass strips, small windbreaks), as well as farm infrastructure.

Commercial – rainfed

Characterised by large, uniform, well managed field units (i.e. \pm 50 ha), with the aim of supplying both regional, national and export markets. Often highly mechanised.

Subsistence – rainfed

Characterised by numerous small field units (less than \pm 10 ha) in close proximity to rural population centres. Field units can either be grouped either intensive or widely spaced, depending on the extent of the area under cultivation and the proximity to rural dwellings and grazing areas. Includes both rainfed and irrigated (i.e. mechanical or gravity-fed), multi-cropping of annuals, for either individual or local (i.e. village) markets. May include fallow and 'old fields', and some inter-field grazing areas (which are often classified as degraded).

Irrigated

Major irrigation schemes (i.e. areas supplied with water for agricultural purposes by means of pipes, overhead sprinklers, ditches or streams), and are often characterised

Urban

Urban / Built-up

A generic urban class, essentially comprising all formal built-up areas, in which people reside on a permanent or near-permanent basis, identifiable by the high density of residential and associated infrastructure. Includes both towns, villages, and where applicable, the central nucleus of more open, rural clusters. This class should be used if it is not possible to identify more industrial and transportation land-uses.

Low-density smallholdings frequently located on the urban / peri-urban fringe should be mapped as a separate smallholding sub-classes, subdivided by the appropriate (level I) background vegetation type. If visible, individual farm units are to be mapped as isolated urban / built-up units (if no other class is applicable). Specific urban / built-up sub-classes as listed below – in such cases it could include residential, commercial,

Urban / Built-up (rural cluster)

Areas of clustered rural dwellings (i.e. kraals) whose structural density is too low to be classified as a formal village, but are of sufficient level to be easily identifiable as such on satellite imagery. Small scale cultivation / garden plots often form a major spatial component, and are located amongst the residential structures.

Urban / Built-up (residential, formal suburbs)

Permanent residential structures, either single or multi-level, located within new or well-established residential areas, i.e. 'garden-suburbs', (often refers to 'middle-class' and 'upper class' residential areas). Includes both low and high building densities.

Urban / Built-up (residential, flatland) Permanent residential structures, consisting mainly of 3 or more levels (often up to 10), resulting in a concentration of mid-to-high rise building, for example Hillbrow (Jhb) or Sunnyside (Pta).

Urban / Built-up (residential, mixed)

Mixture

Urban / Built-up (residential, hostels)

Permanent residential structures, typically located in formal township districts, consisting mainly of 1 or 2 levels in concentrated block-like structures.

Urban / Built-up (residential, formal township)

Permanent (i.e. brick etc) structures (predominately single level), usually located on serviced sites within former black residential areas, laid out in a organised, pre-planned manner. Includes both low and high building densities.

Urban / Built-up (residential, informal township)

Permanent / semi-permanent shack type dwellings (i.e. corrugated tin structures) laid out and established in an organised, pre-planned manner on both serviced and non-serviced sites. Includes both low and high building densities.

Urban / Built-up (residential, informal squatter camp)

Non-permanent shack type dwellings (i.e. tin, cardboard, wood etc) typically established on an informal, ad hoc basis, on non-serviced sites. Typically high building densities.

Urban / Built-up, (commercial, mercantile)

Non-residential areas used primarily for the conduct of commerce and other mercantile business, typically located in the central business district (CBD). Often consisting of a concentration of multi-level buildings, but also includes small commercial zones (i.e. spaza shops) within former black townships.

Urban / Built-up, (commercial, education, health, IT)

Non-residential, non-industrial sites or complexes associated with educational (i.e. schools, universities), business development centres such as industrial ‘techno-parks’, and / or social services (i.e. hospitals), often consisting of a concentration of multi-level buildings (Note : only mapped if clearly identifiable, otherwise included within ‘commercial / mercantile’ or ‘suburban’ categories).

Urban / Built-up, (industrial/transport : heavy)

Non-residential areas with major industrial (i.e. manufacture and/or processing of goods and products) or transport related infrastructure. Examples would include power stations, steel mills, dockyards, train stations and airports (i.e. Johannesburg).

Urban / Built-up, (industrial/transport : light)

Non-residential areas with major technology, manufacturing or transport related infrastructure. Examples would include light manufacturing units, warehouse dominated business development centres, and small airports (i.e. Lanseria). Also includes similar structures such as farm-based pig and battery hen breeding units.

Mines & QuarriesMines & Quarries (underground / subsurface mining)

Active or non-active underground or sub-surface based mining activities. Category includes all associated surface infrastructure etc.

Mines & Quarries (surface-based mining)

Active or non-active surface-based mining activities. Includes both hardrock or sand quarry extraction sites, and opencast mining sites i.e. coal. Category includes all associated surface infrastructure.

Mines & Quarries (mine tailings, waste dumps)

Primarily non-vegetated, exposed mining (and heavy industry) extraction or waste material. *Major areas* of managed vegetation re-habilitation on these sites can be mapped according to the appropriate vegetation category.

Plantations

All areas of systematically planted, man-managed tree resources, composed of primarily exotic species (including hybrids). Category includes both young and mature plantations that have been established for commercial timber production, seedling trials and woodlot / windbreaks of sufficient size to be identifiable on satellite imagery. Excludes all non-timber based plantations such as tea, sisal, citrus, nut crops etc.

Protected areas

National Parks, Provincial Nature Reserves, Bird Sanctuaries, Botanical Gardens, Conservation Areas, DWAF Forest Areas, Game Farms, Mountain Catchment Areas, National Heritage Sites, Nature Reserves, Private nature Reserves, State Land, Wildlife Management Areas

Albany Thicket

Albany Thicket is found in semi-arid areas of the Eastern and Western Cape, with 200-900 mm mean annual precipitation. The vegetation of this biome is described in general as dense, woody, semisucculent and thorny vegetation type of an average height of 2 – 3 meters and relatively impenetrable in an unaltered condition.

Desert

The concept of desert is roughly defined by two parameters: (1) the climatic limit of less than approximately 70 mm or approximately 80 mm of mean annual precipitation in the eastern most parts, and (2) by sparse perennial vegetation of less than 10% canopy cover. By this definition, most of the landscapes along the lower Orange River and the northernmost tip of the Namaqualand Coastal Plain near Alexander Bay are considered to be included in the Desert Biome.

Inland Azonal Vegetation

The Inland Azonal Vegetation biome include the wetland vegetation of all freshwater wetlands (including vleis, marshes, mires, lakes and alluvia) and vegetation of land-locked salt-laden habitats (including salt pans and river channels of intermittent rivers in arid and semi-arid regions).

Indian Ocean Coastal Belt

The region covers the seaboard in two provinces of South Africa namely KwaZulu-Natal and the northern half of the Eastern Cape. This coastal belt in its subtropical facies extends also beyond the national borders into Mozambique as far as the Limpopo river mouth. The tropical appearance of vegetation is a result of a mixture of growth forms such as trees, lianas and epiphytes that dominate the zonal (forest) vegetation of the region, while grasses play only a subordinate role in the zonal vegetation itself. The absence of an entirely rain-free dry period

and implied increased probability of winter rainfall is another feature distinguishing the region from the Savanna.

Succulent Karoo

The succulent Karoo is restricted to the year-round and winter rainfall areas and have the greatest summer aridity. This biome occurs mostly west of the western escarpment through the western belt of the Western Cape and inland towards the Little Karoo. This is the land of many spring flowers. Succulent plant species with thick, fleshy leaves are plentiful here, the diversity of which is unparalleled anywhere else in the world. This, together with many geophytes (plants that survive by means of bulbs, tubers, etc. in times of unfavorable climatic conditions) and annual plants, makes the succulent Karoo unique and of international importance in terms of conservation.

Nama Karoo

The Nama Karoo covers most of the vast central plateau region of the Western and Northern Cape Provinces. The area forms an ecotone or transition between the Cape flora to the south, and the tropical savanna in the north. Many of the plant species of the Nama-Karoo also occur in the savanna, grassland, succulent Karoo and fynbos biomes. Species that occur in the Nama-Karoo include the sweet-thorn (*Acacia karroo*), stone plant (*Lithops ruschiorum*) and blue Karoo daisy (*Felicia australis*). The former vast migratory herds of springbok (*Antidorcas marsupialis*) have been replaced by domestic stock, particularly sheep and goats. A rich variety of rodents and reptiles, also occurs in the Nama-Karoo. The few, endemic or near-endemic bird species include the Sclaters lark (*Spizocorys sclateri*). Sheep-farming is the main agricultural activity in this region.

Savannas

Savannas are the wooded grasslands of the tropics and subtropics that account for 46% of the South African landscape. They are second only to tropical forests in terms of their contribution to terrestrial primary production. They are the basis of the livestock industry and the wildlife in these areas is a key tourist drawcard. Savannas also include valley bushveld, the veld type containing the greatest range of rainfall seasonality in South Africa. Fire is a crucial factor in the ecology of all savannas and is therefore a regular natural feature of this environment.

Fynbos

Fynbos occupies 5,3 % of South Africa, occurring almost exclusively in the south-western and southern parts of the Western Cape Province. Fynbos comprises evergreen heathlands and shrublands in which fine-leaved low shrubs and leafless tufted grasslike plants are typical. Trees are rare and grasses comprise a relatively small part of the biomass. Fire is a very important component in fynbos. Most fynbos is highly flammable due to the common presence of flammable oils. Finely wooded fynbos plants are obligate seeders, which means that the whole plant dies after fire and can only reproduce through seed. This distinguishes fynbos from the other ecosystems where fire is common. Many plant species are dependent for pollination on small mammals or birds such as the Cape sugarbird (*Promerops cafer*).

Grasslands

The grasslands cover the high central plateau of South Africa, inland areas of Kwazulu-Natal and the mountain areas of the Eastern Cape Province. Grasslands are defined as those areas where grasses dominate the vegetation and where woody plants are absent or rare. They occupy 24,1% of the country's surface area. Most grassland occurs in high-rainfall areas, where thunderstorms and hail are common in summer and frost is common in winter. The grassland biome is regarded as the third-richest area in terms of plant species diversity, with a total number of 3 788 species. The most noteworthy species with a wide distribution is, *Themeda triandra*, more commonly referred to as 'rooigras'. In the past the ungulate fauna (hoofed animals) of the Highveld grasslands included vast herds of blesbok (*Damaliscus dorcas phillipsi*), black wildebeest (*Connochaetes gnou*) and the springbok (*Antidorcas marsupialis*). A surprisingly rich variety of birds are found in the grasslands, including the blue crane (*Anthropoides paradiseus*), black korhaan (*Eupodotis afra*) and helmeted guineafowl (*Numida meleagris*).

Forests

The forests of South Africa include the indigenous evergreen and semi-deciduous closed forests of the coastal lowlands and escarpment slopes and cover only about 0.25% of the land area. With a few exceptions such as the forests of the Knysna area and the KwaZulu-Natal coastal dune systems, forests are small, usually occupying less than 1 000 ha. These forests amount to little more than patches scattered through the higher rainfall areas. The total area of forests in South Africa is probably less than 2 000 km². The forest structure results in reduced light levels in the area beneath the canopy where species such as tree ferns are common. Typical mammals include the bushbuck (*Tragelaphus scriptus*), bush pig (*Potamochoerus porcus*) and blue duiker (*Philantomba monticola*). Birds found in forests include the Knysna lourie (*Tauraco corythaix*) and rameron pigeon (*Columba arquatrix*). Despite the small land surface area that they occupy, forests have relatively high species richness. Only fynbos exceeds the species richness found in forests.

3.4 Production of the LUS map for South Africa

The 18 land use/cover classes as described above were combined with administrative boundaries due to the large extent of some of the units (e.g. Karoo Biomes). Again the number of unique combinations (which were equal to the number of questionnaires to be completed) had to be kept in mind. A total of 2447 unique units were derived by integrating the Local Municipality (LM) boundaries with the LUS data. It was also noted that some of the LUS only occupied a very small percentage of the LMs – the decision to capture information for these small unique units were left to the discretion of the workshop facilitator and participants.

The LUS map for South Africa is presented in Annexure 6.

It is anticipated to include additional attribute data for each unique LUS unit at a later stage.

3.5 Example of first results of the assessment

Positive feedback regarding the LUS stratification was received from the initial provincial workshops. The fact that policy makers at this level consider the methodology and scale (resolution) acceptable for policy and programme development is very encouraging and an indication that the rationale behind the development of the LUS for South Africa was spot-on.

An example of one of the first maps produced from the assessment workshops where the LUS map was used is presented in Figure 3.

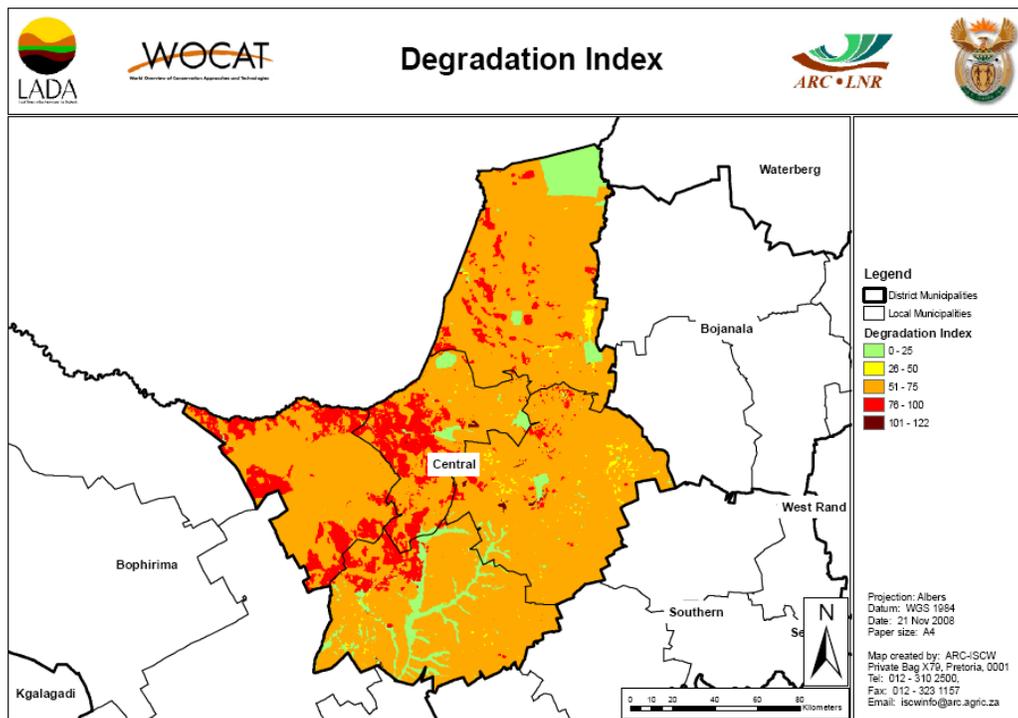


Figure 3. Example of the Degradation Index for a Local Municipality in the North West Province

4. References

- Mucinia, L & Rutherford, M.C. 2006. Vegetation Map of South Africa, Lesotho and Swaziland. SANBI, Pretoria.
- National Land Cover Consortium. 2005. national Land Cover 2000 Database, CSIR/ARC-ISCW, Pretoria.
- Nachtergaele, F & Petri M. 2008. Mapping Land Use Systems at global and regional scales for Land Degradation Assessment Analysis. FAO.

5. Acknowledgements

The following contributions are acknowledged:

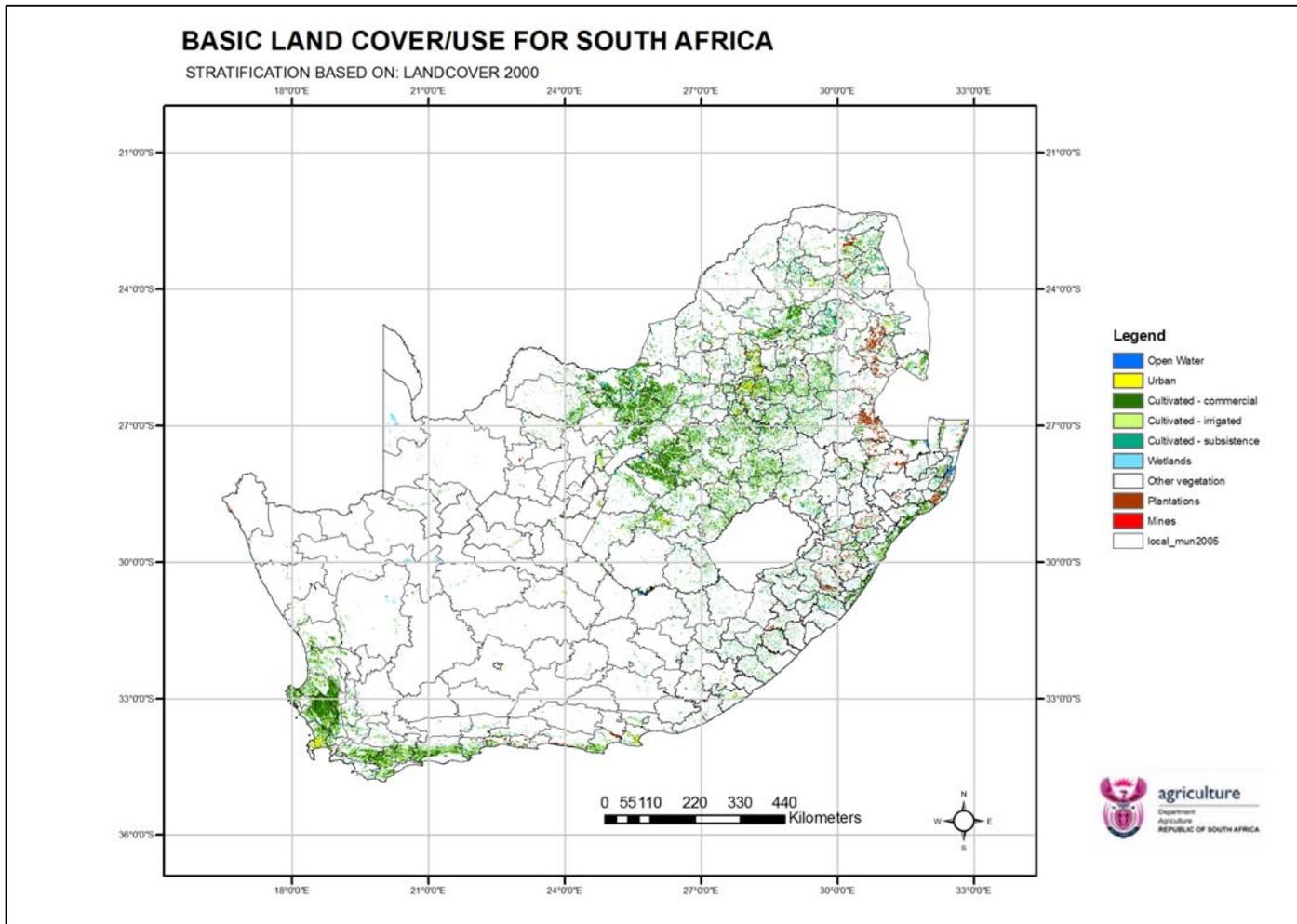
Mr. M Samadi, Ms. M de Villiers and Ms. L Stronkhorst for project management.

Personnel from DoA who assisted with data acquisition.

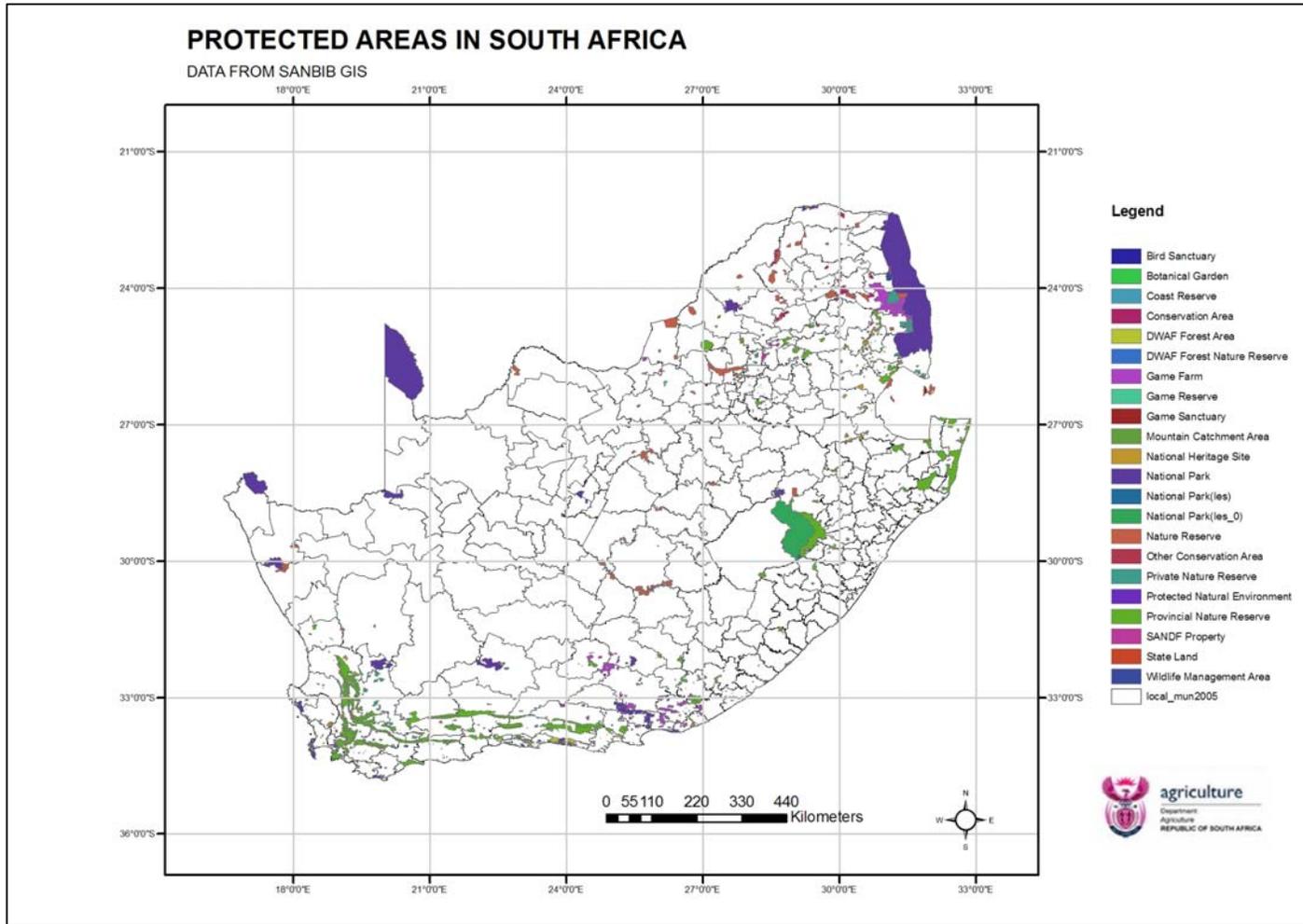
Mr. H J Lindemann for advice and support.

Mr. Freddy Nachtergaele from FAO for his support and advice.

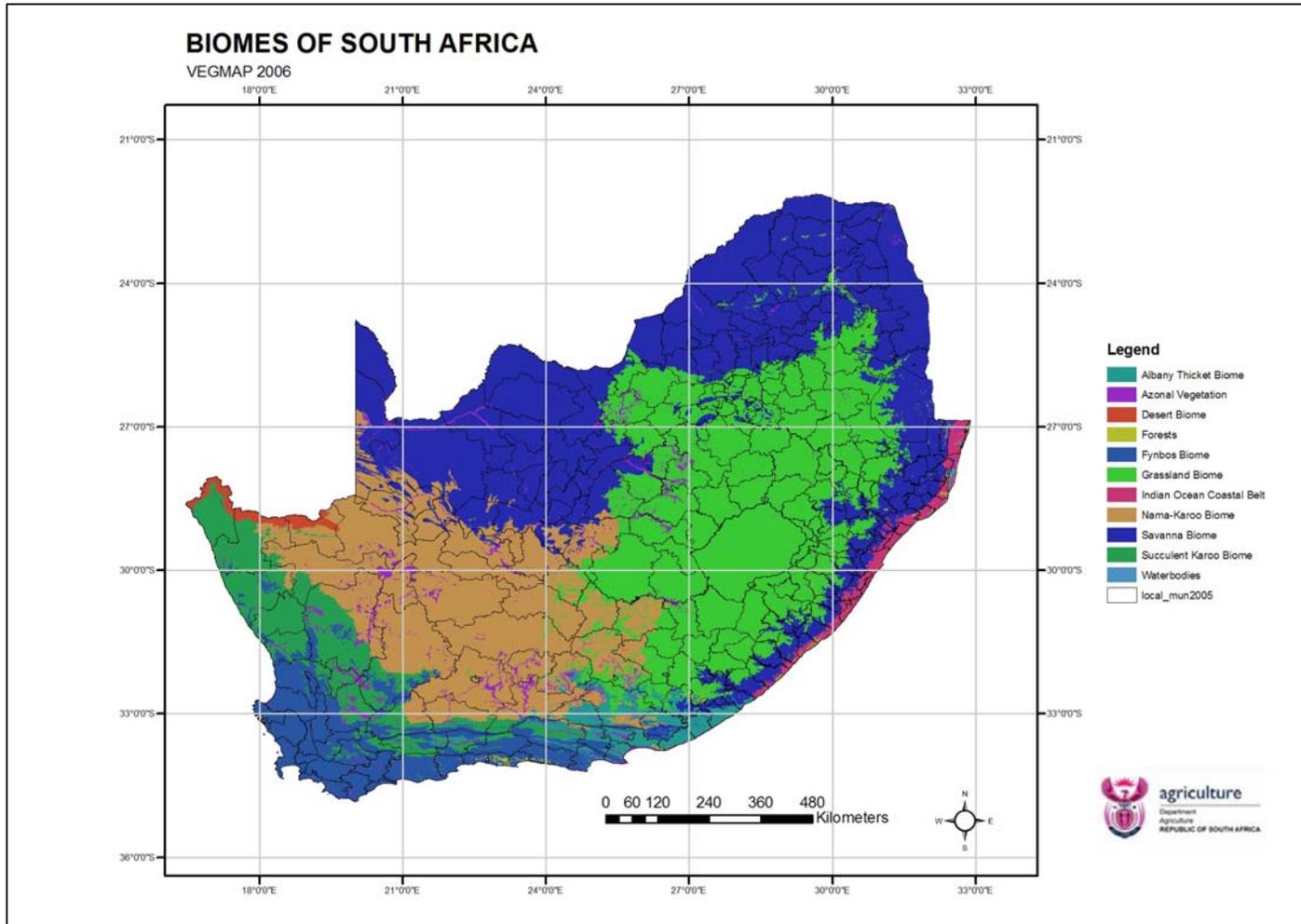
Annexure 1 - National Land Cover 2000 (NLC Consortium)



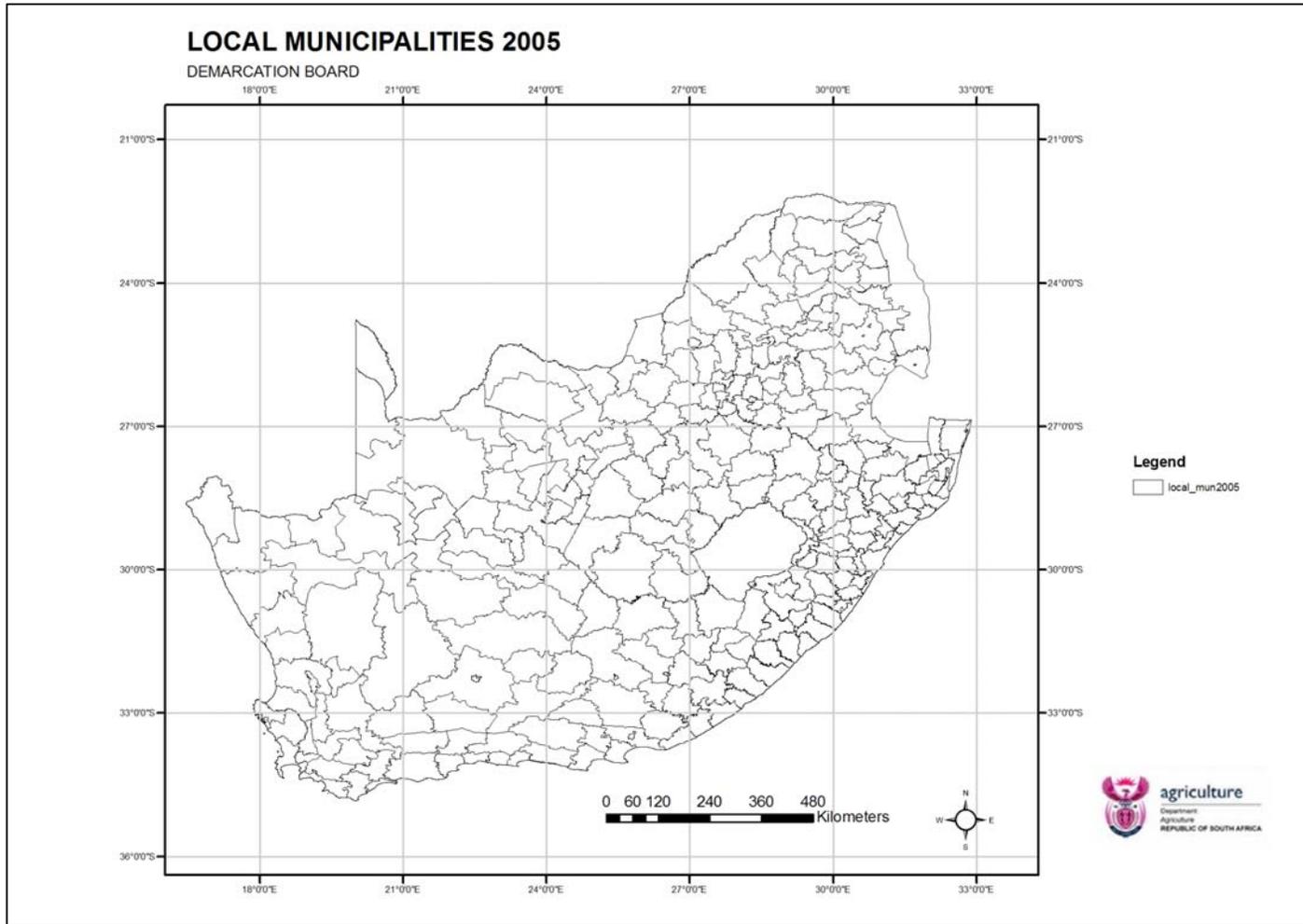
Annexure 2 - Protected Areas in South Africa 2001 (Biodiversity GIS, South African Biodiversity Institute - SANBI)



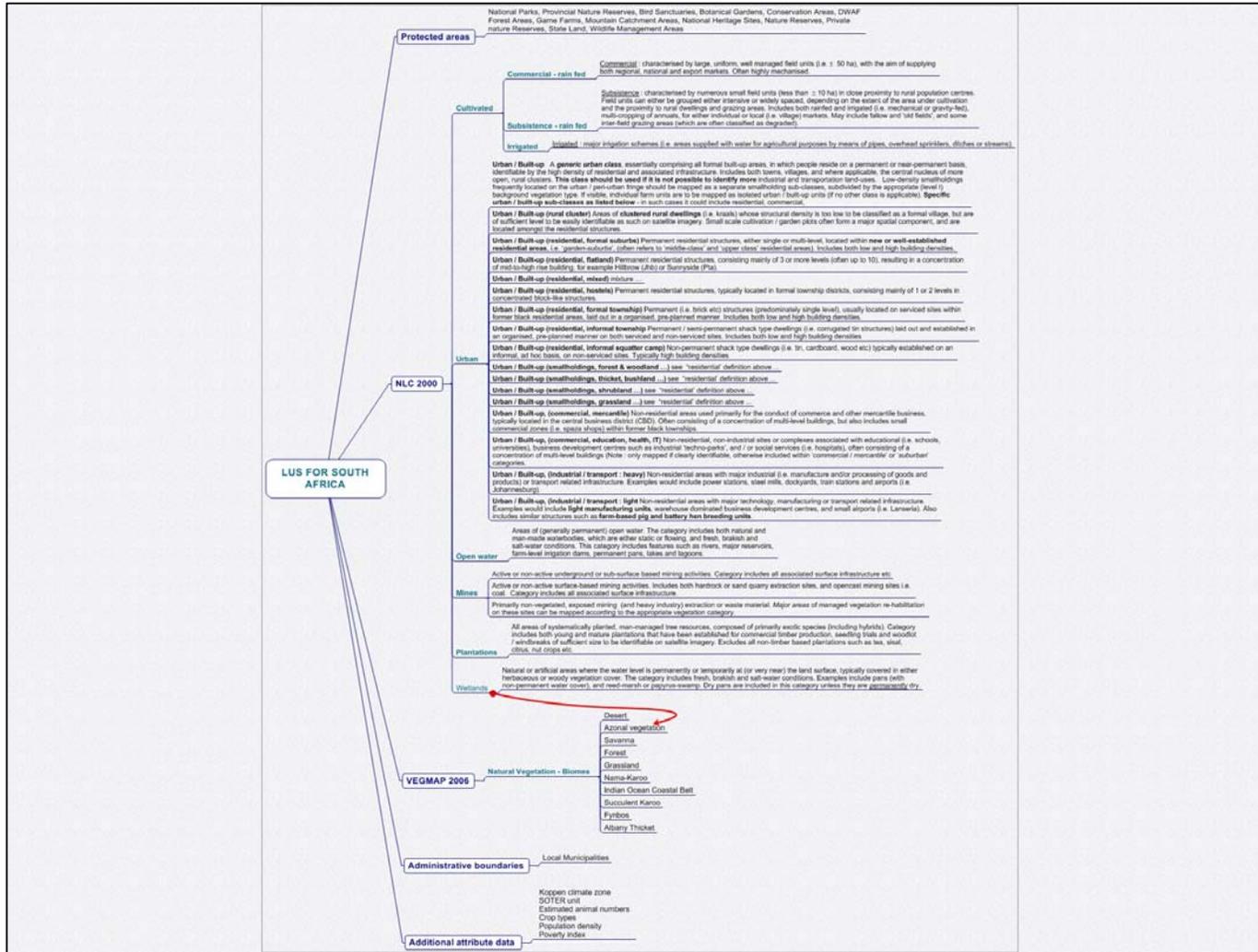
Annexure 3 - VEGMAP 2006 (Mucina & Rutherford, SANBI)



Annexure 4 - Local Municipalities 2005 (Demarcation Board of South Africa)



Annexure 5 - The layout for the development of the LUS for South Africa



Annexure 6. The LUS map for South Africa

