

THE CAPABILITY,  
POTENTIAL, STATE & USE  
OF THE NATURAL  
AGRICULTURAL  
RESOURCES OF  
SOUTH AFRICA

**DEPARTMENT OF AGRICULTURE, LAND REFORM AND  
RURAL DEVELOPMENT**

**DIRECTORATE: LAND USE AND SOIL MANAGEMENT**

**PRETORIA**

**SEPTEMBER 2021**



agriculture, land reform  
& rural development

Department  
Agriculture, Land Reform and Rural Development  
REPUBLIC OF SOUTH AFRICA

## PREFACE

This publication contains a description of the capability, potential, state and use of the natural agricultural resources of South Africa. The information described in the report is derived from applicable natural agricultural resources spatial data as well as statistical data available as on the date of publication.

Although the utmost care was taken in ensuring the correctness of the information contained within this publication, neither the Department of Agriculture, Land Reform and Rural Development (DALRRD) nor its employees shall be held liable for any loss, damage, inconvenience or any other liability suffered as a consequence of the use of the report. DALRRD does not except any responsibility for any omissions, emissions, misuse or misinterpretation of the content of this report.

For ease of reading, the sources used for the compilation of this report are reflected in the “References” section and were not included within the text.

©Copyright of this publication resides with the Department of Agriculture, Land Reform and Rural Development. Any part of this publication may be reproduced but with the acknowledgement of the source. When referencing any part of this publication, please cite as follows:

### **Citation:**

Department of Agriculture, Land Reform and Rural Development. 2021. *The capability, potential, state and use of the natural agricultural resources of South Africa, 2021*. Pretoria: Department of Agriculture, Land Reform and Rural Development.

### **This publication is obtainable from the Department:**

-Directorate: Land and Soil Management. Ms Anneliza Collett Tel 012 – 319 7508 / [AnnelizaC@dalrrd.gov.za](mailto:AnnelizaC@dalrrd.gov.za) or Ms Lydia Bosoga Tel 012 -319 7685 / [LydiaB@dalrrd.gov.za](mailto:LydiaB@dalrrd.gov.za) or

-The Departmental website: Resource Centre/Scientific and Technical Information –

<https://www.dalrrd.gov.za/Resource-Centre?folderId=134&view=gridview&pageSize=10>

-The natural resource data used in the compilation of this publication can be viewed in “*The Natural Agricultural Resources Atlas*”, a web based application at the following web address:

<https://ndagis.nda.agric.za/portal/apps/webappviewer/index.html?id=cf56d2431dd8437da173144811d89ef7>

### **Publication compilation**

**Researched and authored by:** Ms Anneliza Collett.

**Photos provided by:** Ms Anneliza Collett, Mr Paul Avenant, Mr Gawie Avenant, Mr Ndefilani Mararakanye & Mr Hermann Strydom.

For more information on the publication, contact Ms Anneliza Collett: [annelizac@dalrrd.gov.za](mailto:annelizac@dalrrd.gov.za) / 012 319 7508.

## TABLE OF CONTENTS

LIST OF FIGURES.....	4
LIST OF TABLES.....	6
ABBREVIATIONS .....	7
1. EXECUTIVE SUMMARY .....	9
2. INTRODUCTION .....	12
South Africa - Demographics .....	13
3. FOOD SECURITY.....	17
4. LEGISLATION.....	19
5. THE NATURAL AGRICULTURAL RESOURCES OF SOUTH AFRICA – AN OVERVIEW .....	23
5.1 SOILS .....	25
5.2 CLIMATE .....	35
5.3 TERRAIN .....	45
5.4 VEGETATION .....	51
Use of rangeland for animal production.....	52
Grazing capacity.....	53
Wildlife management.....	57
5.5 WATER.....	61
6. AGRICULTURAL CAPABILITY & POTENTIAL.....	67
6.1 LAND CAPABILITY .....	67
6.2 AGRICULTURAL POTENTIAL .....	72
6.2.1 AGRICULTURAL POTENTIAL: CULTIVATION.....	73
6.2.2 AGRICULTURAL POTENTIAL: ANIMAL PRODUCTION .....	76
7. LAND DEGRADATION .....	79
8. AGRICULTURAL ECONOMIC AND LAND USE STATISTICS .....	83
8.1 ECONOMIC.....	83
8.2 AGRICULTURAL LAND USE .....	86
9. CONCLUSION .....	91
10. REFERENCES .....	94

## LIST OF FIGURES

Figure 1: The nexus of food security and factors affecting it.....	10
Figure 2: South Africa: Provinces and neighbouring countries.....	12
Figure 3: Clay % distribution in the A horizon.....	26
Figure 4: Structurally favourable soils in South Africa.....	27
Figure 5: Soil depth distribution across South Africa.....	27
Figure 6: Water holding capacity of soils (profile available water: mm) in South Africa.....	28
Figure 7: Plant available water capability of soils in South Africa.....	28
Figure 8: Wind erosion susceptibility of soils in South Africa.....	29
Figure 9: Water erosion susceptibility of soils in South Africa.....	30
Figure 10: Compaction susceptibility of soils in South Africa.....	31
Figure 11: Hardsetting (crusting) susceptibility of soils in South Africa.....	31
Figure 12: Soil capability methodology for South Africa.....	32
Figure 13: Soil capability percentage for South Africa.....	33
Figure 14: Soil capability evaluation values for South Africa.....	33
Figure 15: Three rainfall areas in South Africa.....	36
Figure 16: Rainfall distribution in South Africa.....	37
Figure 17: Moisture Supply Capacity (MSC) variance n South Africa.....	38
Figure 18: Rainfall hazard index for in South Africa.....	38
Figure 19: A-pan evapotranspiration rates in South Africa.....	39
Figure 20: Mean percentage sunshine hours per day in South Africa.....	40
Figure 21: Heat units accumulated over a 3-month period over a 12 month period in South Africa..	40
Figure 22: Heat wave hazard risk index for South Africa.....	41
Figure 23: Cold spell hazard risk index for South Africa.....	41
Figure 24: Frost hazard risk index for South Africa.....	42
Figure 25: Temperature hazard risk index for South Africa.....	42
Figure 26: Climate capability percentage distribution for South Africa.....	43
Figure 27: Climate capability for South Africa.....	43
Figure 28: Impact of curvature towards water run off.....	45
Figure 29: Slope % class distribution in South Africa.....	45
Figure 30: Moisture accumulation as a function of terrain.....	46
Figure 31: Flooding hazard as a result of terrain form.....	47
Figure 32: Erosion susceptibility as a result of the terrain form.....	47
Figure 33: Terrain capability evaluation values for the country.....	48
Figure 34: Terrain capability for South Africa.....	48
Figure 35: Biomes of South Africa.....	51
Figure 36: Broad veld type areas.....	52
Figure 37: Grazing Capacity norms for South Africa (CARA).....	53
Figure 38: Bankrupt bush encroachment in South Africa.....	54
Figure 39: Livestock suitability index classification for South Africa.....	56
Figure 40: Strategic Water Resources (ground and surface water) of the country.....	62
Figure 41: Cultivated areas (rainfed & irrigation) in South Africa (2019).....	63
Figure 42: Irrigation suitability classification for South Africa.....	64

Figure 43: Land capability classification in South Africa .....	68
Figure 44: Land Capability evaluation values distribution (%) per each class (raster data) .....	69
Figure 45: % distribution of land capability evaluation values representation within the various provinces, as a % of the provincial area.....	70
Figure 46: Land Capability evaluation values zonal statistics per province distribution, arranged per highest value present.....	71
Figure 47: Land Capability evaluation values zonal statistics per district municipality - distribution arrange per mean value.....	71
Figure 48: Generalised crop production potential for South Africa .....	73
Figure 49: High Potential Areas in South Africa .....	76
Figure 50: Gully erosion in South Africa.....	80
Figure 52: Degradation Index in South Africa .....	81
Figure 52: Conservation Index in South Africa.....	81
Figure 53: Gross value of agricultural production 2013 – 2018.....	83
Figure 54: Principle statistics in the agriculture and related services industry for 2016 -2017 .....	84
Figure 55: Comparative statistics on the gross income derived from major products compared between 2016/17 and 2017/18.....	84
Figure 56: Net farm income from 2013/14 to 2017/18 compared .....	85
Figure 57: Comparative analysis of the Agriculture’s sector contribution to the GDP.....	85
Figure 58: Agricultural land uses per land capability evaluation values.....	88
Figure 59: Land uses as a percentage of the land capability evaluation value.....	89
Figure 60: Agriculture sector analysis revolving around biophysical impacts of climate change, as well as knock-on effects and feedbacks .....	91

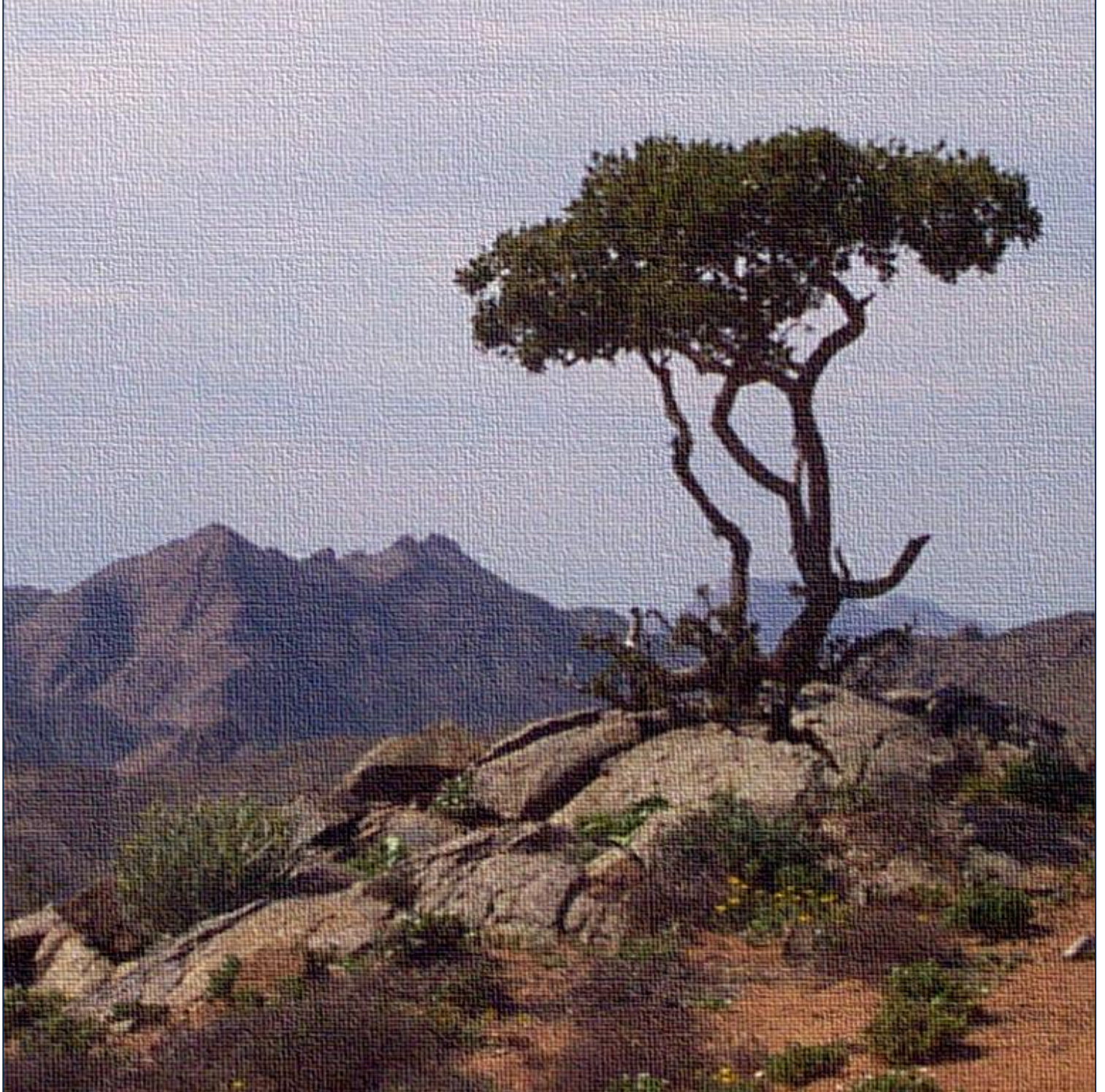
## LIST OF TABLES

Table 1: Percentage households experiencing food inadequacy, 2017 .....	14
Table 2: Land cover classification areas in South Africa for the years 2000 & 2013/14.....	14
Table 3: Extent of agricultural production per province, 2017.....	15
Table 4: Percentage distribution of the main reasons for agricultural involvement, 2017.....	17
Table 5: Rainfall distribution patterns in South Africa.....	37
Table 6: Effect of tree density on grass production.....	54
Table 7: Rangeland availability per province .....	55
Table 8: Rangeland availability per biome (Source: Avenant, 2018).....	55
Table 9: Livestock suitability index values for South Africa .....	57
Table 10: Carrying capacity norms for game farming per ecological region .....	59
Table 11: The ten largest dams in South Africa .....	61
Table 12: Groundwater resources in South Africa.....	62
Table 13: Irrigated cultivation per province, 2019 .....	64
Table 14: Irrigated suitability classes for South Africa.....	65
Table 15: Land Capability evaluation values per each class based on the raster data.....	69
Table 16: Land Capability evaluation values – zonal statistics per province .....	70
Table 17: Rainfed High Potential Areas in South Africa according to priority ratings for rainfed (A – F) .....	74
Table 18: Irrigation High Potential Areas in South Africa according to priority ratings for irrigation (A – D).....	75
Table 19: Combined Rainfed and irrigated High Potential Areas in South Africa according to priority ratings .....	75
Table 20: Extent of wind and water erosion in South Africa .....	81
Table 21: Cultivation (ha) per province, 2019.....	86
Table 22: Agricultural land uses per land capability evaluation value (Ha).....	87
Table 23: Land uses per land capability evaluation values in relation to the remaining land (Ha).....	89

## ABBREVIATIONS

ARC	Agricultural Research Council
CARA	Conservation of Agricultural Resources Act, 43 of 1983
CMA	Catchment Management Agency
DALRRD	Department of Agriculture, Land Reform and Rural Development
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
IPCC	International Panel on Climate Change
LADA	Land Assessment for Dryland Areas
LSU	Large Stock Unit
MSC	Moisture Supply Capacity
NEMA	National Environmental Management Act, 107 of 1998
NEMPA	National Environmental Management: Protected Areas Act, 57 of 2003
NLC	National Land Cover
NSSD	National Strategy for Sustainable Development
SALA	Sub-division of Agricultural Land Act, 70 of 1970
SDG	Sustainable Development Goal
WUA	Water Users Association

# 1. EXECUTIVE SUMMARY





generations, but with the ultimate aim of conducting land use in such a manner that optimally adheres to the potential and capability of the land.

South Africa as a country is exposed to extreme environmental conditions. Not only is the country subjected to a wide range of climatic conditions, but its soil and terrain characteristics also vary significantly. Most of the soils is regarded as marginal with severe constraints pertaining to its production potential. Limited high potential agricultural land is available for cultivation purposes and the management and protection of this land is therefore crucial for continued food security.

To date, the optimal utilization of South Africa's natural agricultural resources has, to a large extent, contributed to the country being independent in terms of food production and is therefore regarded as being food secure. The commercial agricultural sector has adapted to risks through effective cultivation practices and the optimal utilization of the land's resources. At the same time, the country's land reform programme has given new farmers access to land. On the other hand however, agricultural production has, in certain areas, unfortunately also resulted in a negative, degraded impact on the environment.

Being also a developing country, significant emphasis has also been placed on residential, industrial, infrastructure and economic development to facilitate growth and the advancement of citizens through job creation and the alleviation of poverty. These developments are mostly financially driven without proper consideration as to their impact on the environment. Legislation, strategic objectives and policies have raised awareness on ensuring that environmental and agricultural assessments should form part of any proposed development. Nevertheless, these directives are not always fully implemented.

If the mentioned pressures on the natural agricultural resources of the country are not managed according to the most suited land use option, taking cognisance of the limited non-renewable resources the country has, it may not only result in a loss of agricultural land with a productive potential and with a (possible) negative result in the ability of the country to produce its own food but may also contribute towards (further) degradation of the highly sensitive natural agricultural resources.

The purpose of this publication is to provide a brief overview of the natural agricultural resources, their potential and present utilization within South Africa.



**Figure 1: The nexus of food security and factors affecting it.**

SOURCE: Pamela Matson. Presentation. National Academics of Sciences, Engineering and Medicine. January 14, 2016. Newport Beach, California



Knowledge of the land, its potential and shortcomings as well as possibilities form the basis of any successful and sustainable farming production.

## 2. INTRODUCTION



## 2. INTRODUCTION

South Africa is a beautiful country with a diversity of fauna and flora not found elsewhere in the world. It is also a country characterized by extreme climatic conditions, with an annual rainfall varying from less than 200 mm in the western parts to more than 1000 mm in the eastern parts of the country. Therefore, certain areas can almost be classified as desert, whilst others tend to be more tropical.

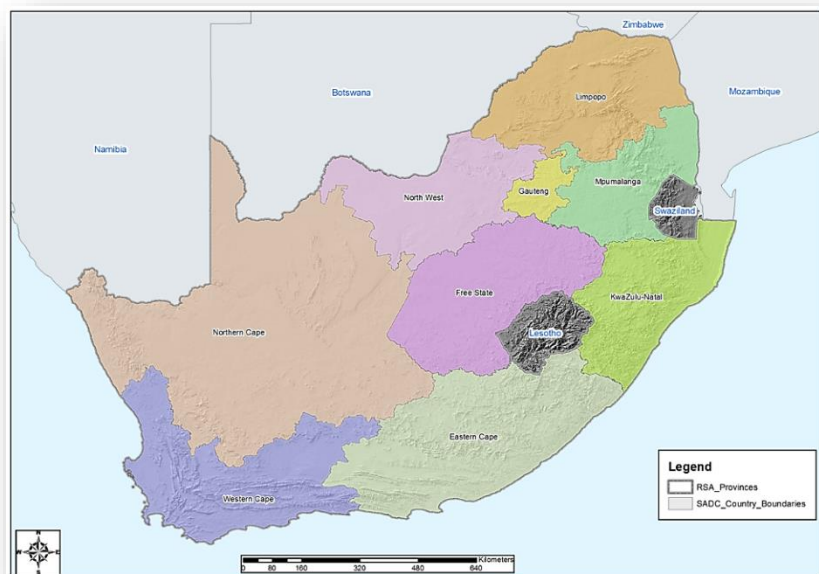
The variance in climate and topography enables the country to produce almost any kind of crop under applicable conditions, management and cultivation practices. The difference in the climate and types of soil places heavy demands on the producers, bearing in mind that the country has a limited amount of high potential agricultural land for sustained crop production.

Over the years, research in agriculture together with the practical experience gained by farmers has enabled South Africa, notwithstanding the harsh environmental conditions, to become largely self-sufficient in its agricultural production with agricultural produce exports contributing significantly towards the Gross Domestic Product (GDP) of the country.

In determining the role of agriculture in any country, it should be taken into consideration that agricultural production is also influenced by global trends and production factors, international and local prices, and fluctuations in domestic supply and demand. It is critical for a country to manage these fluctuations and work towards retaining its production capability to adhere to its food requirements, whilst realizing related economic opportunities through effective agro-ecosystem management. No country can afford to be too reliant on imports, or it could become a “hostage” to the demands of the supplying nation.

South Africa pledged to support the World Food Summit Plan of Action that was encapsulated in the 1996 Rome Declaration on World Food Security. The Declaration encouraged the optimal allocation of natural resources to achieve a global food security goal. In response to this goal, the South African Cabinet developed an Integrated Food Security Strategy, with the vision to attain physical, social and economic access to sufficient, safe and nutritious food by all South Africans.

For a country to be regarded as food secure, the international norm of 0.4 ha per person is required for the production of food. In view of the current population figures in relation to the land currently



**Figure 2: South Africa: Provinces and neighbouring countries**

under cultivation (inclusive of land under planted pastures, which do not directly contribute to food security), the norm in South Africa has dropped to below 0.25 ha per person per annum. This figure does not take into consideration prevailing climate change impacts, the increase in drought occurrences as well as other severe climatic conditions.

In 1997 already, urban expansion was estimated to have impacted on about 30 000 ha of agricultural land per annum that has a further impact on the availability of land for production purposes.

In light of the growing population, the demand for increased food production will place heavy demands on the natural agricultural resources, especially if one takes into consideration the limited extent of arable land within the country.

### South Africa - Demographics

South Africa is located at the southernmost part of the African continent. It shares its boundaries with Lesotho, Eswatini (Swaziland), Mozambique, Zimbabwe, Botswana and Namibia. The country lies between the 22° S and 35° S latitudes and the 17° E and 33° E longitudes.

It is a country of great diversity not only from a cultural and social perspective but also in terms of the natural agricultural resources. Surrounding the country is the cold Atlantic Ocean towards the west of the country and the warmer Indian Ocean on the east coast. Climatic conditions range from the eastern parts being relatively humid subtropical, whilst the western parts of the country are characterised by drier desert conditions. Conditions further vary from severe floods after heavy rainstorms to extreme droughts, snow in the winter and heat waves in the summer, summer rainfall areas as well as winter rainfall areas; barren sand dunes to areas having soils of a high production capability.

This variance allows the country to produce a wide variety of crops but in turn places heavy demands on the management and use of the agricultural resources in order to prevent the over exploitation of the resource base of the country.

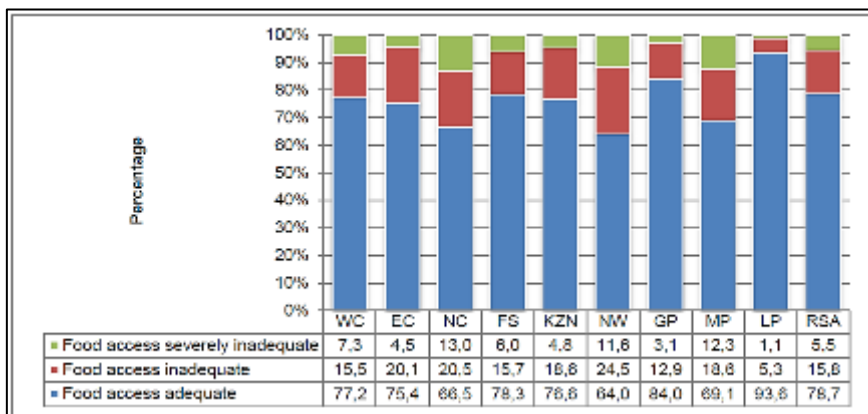
The total land area of South Africa consists of approximately 121 977 257 ha. Nine provinces, each with its own unique characteristics have been demarcated (Figure 2). The provinces with their percentage of the total land area are the Northern Cape (29.7%), Eastern Cape (13.9%), Western Cape (10.6%), Free State (10.6%), Limpopo (10.2%), North West (9.5%), KwaZulu Natal (7.6%), Mpumalanga (6.5%), and Gauteng (1.4%).

According to Statistics South Africa (Stats SA) Mid-Year estimates (2018) the population of South Africa was 57.726 million whereas in 2002 the population was 45.9 million people. This relates to an increase of 41.04 inhabitants per square kilometre in 2008 to an estimated 47.63 inhabitants per square kilometre in 2018, thus more people sharing less space. Gauteng province has the highest population figures with over 14 million people, followed by KwaZulu Natal with 11 million. The Northern Cape Province has the least number of people with just more than one million people.

Within the South African context, 58% of the population was urbanized in 2006 in comparison with 53% in 1996. This percentage has increased to 66.36% in 2018, confirming the fact that rural areas

are being “deserted” in favour of a more urbanized life. Fewer people thus remain in rural areas to attend to economic activities associated with these areas such as farming, thus placing more pressure on fewer farmers to produce sufficient food for the nation. According to Stats SA 97% of the Gauteng province’s population lives in urban areas, whilst only 3% resides in non-urban areas.

The percentage households with inadequate or severely inadequate access to food have however decreased from 23.6% in 2010 to 21.3% in 2017. In the same time, the number of individuals that were at risk of going hungry has also decreased from 29.1% to 24.7%. The percentage households that have experienced hunger have decreased from 24.2% to 10.4%, whilst the percentage



**Table 1: Percentage households experiencing food inadequacy, 2017**

(Source: Stats SA, 2017)

individuals decreased from 29.3% to 12.1%. The Northern Cape and North West provinces are the worst affected in terms of severely inadequate access to food.

Land uses and land cover within the country varies considerably with the larger part of the country still being regarded as natural rangeland areas with a varied conservation status. According to the 2000 and 2013/14 National Land Cover Classification), the percentage area for the categories are as follows:

<u>Land use / cover</u>	<u>% of RSA (2000)</u>	<u>% of RSA (2013/14)</u>
Transformed areas (including all built up areas; roads; mines and waterbodies)	3	3.28%
Formally protected areas (area not available for agricultural production, excluding conservation areas or protected environments)	6.11	6.11%
Forestry Plantations (including Indigenous forests)	1.8	1.65%
Cultivation	10.5	11.44%
Rangeland	78.59	77.52%

**Table 2: Land cover classification areas in South Africa for the years 2000 & 2013/14**

According to the 2017 Stats SA Household survey, only 15.6% of South Africans were involved in agricultural production. It was found that 41.2% of the households in Limpopo and 30.2% of

households in the Eastern Cape were engaged in some form of agricultural activity, whilst participation in Gauteng (4.5%) and the Western Cape (2.8%) were much lower. Most of the crop production took place in backyard home gardens (92.7%) whereas 9.9% were regarded as cultivated farm land.

In general, food production consisted of fruit and vegetable production (53.4%), grains (51.8%), livestock farming (47.1%) and poultry production (35.3%).

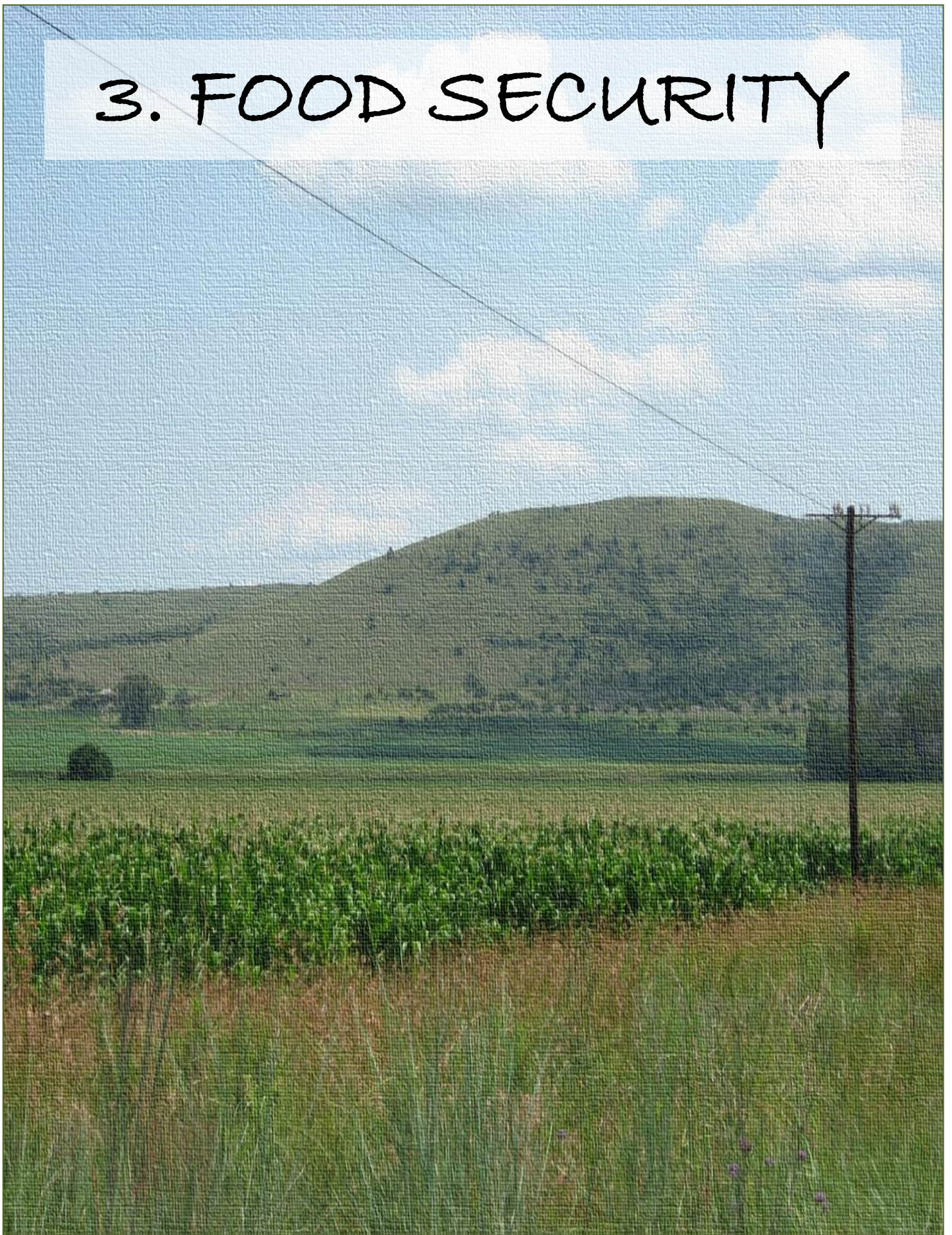
About 78.5% of the population are involved in agriculture as an extra source of food, an increase of 0.5% from the 2015 Stats SA Household survey, whilst only 2.2% uses the industry as main source of income (an increase from 1.8% in the 2015 survey).

Production activity	Statistic (Numbers in thousands)	Province									
		WC	EC	NC	FS	KZN	NW	GP	MP	LP	SA
Livestock production	Number	4	398	21	27	341	77	11	98	204	1 180
	Percentage	8,8	79,1	63,2	18,3	66,5	75,4	5,0	31,1	32,2	47,1
Poultry production	Number	2	328	9	22	262	57	11	72	122	884
	Percentage	3,6	65,3	26,7	14,6	51,1	55,9	5,1	23,0	19,3	35,3
Grains and food crops	Number	2	285	2	23	308	9	11	193	466	1 298
	Percentage	3,7	56,8	5,7	15,3	60,1	9,1	5,5	61,2	73,8	51,8
Industrial crops	Number	0	2	0	0	3	1	0	1	3	10
	Percentage	0,0	0,4	1,2	0,0	0,6	0,8	0,0	0,4	0,4	0,4
Fruit and vegetable crops	Number	46	231	13	130	126	26	191	209	364	1 337
	Percentage	91,2	45,9	39,3	87,6	24,7	25,6	91,7	66,4	57,6	53,4
Fodder grazing/ pasture grass of animals	Number	3	4	0	2	4	1	5	2	10	30
	Percentage	5,0	0,8	0,0	1,7	0,7	1,0	2,2	0,7	1,6	1,2

*A particular household can be involved in more than one activity and percentages therefore do not add up to 100%.*

**Table 3: Extent of agricultural production per province, 2017**

# 3. FOOD SECURITY



### 3. FOOD SECURITY

Food security is the single most important factor that should drive agricultural production. Any country needs to strive to be food secure and should therefore not only be reliant on the import of food.

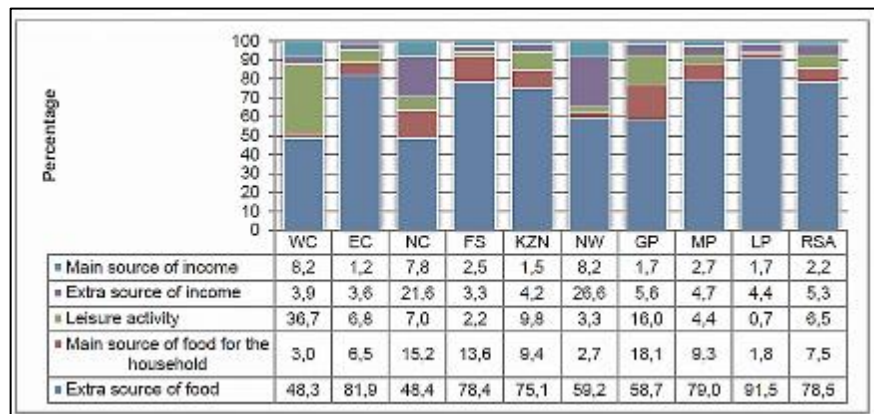
There is no clear consensus on the definition of food security. The most widely used definition is the World Bank’s (1986) definition of food security specified as “access by all people at all times to enough food for an active, healthy life”.

The global demand for food is expected to double by the year 2030 whereas an additional 120 million ha of crop production will be required to meet the global

demand. By 2050 it has been estimated that the world population would have increased to 9 billion people which will required an increase in agricultural production of 1 billion tons of cereal and 200 million tons of livestock production. In order to meet this demand, more land and water will be required for an increase in crop production. Although intensification of production, due to advances in the field of agriculture, has resulted in increased production, the consequences to the environment and the sustainability thereof is a matter of concern. According to Meyer (1998), the long-term sustainability of food supply is dependent on the relation between natural resources, demographic trends, applied technology and the agricultural research ability.

Taking into consideration that South Africa has about 14 million hectares of arable land and that the international norm is 0.4 ha of arable land required to feed a person, it amounts to South Africa only being able to feed about 35 million people. The USA, by comparison, has 350 million people but enough arable land to feed 800 million people.

The drive towards sustainable agriculture should be seen as a system that will be able to be productive in the future. Botha and Ikerd (1995) regarded sustainability as a continuous direction, rather than a destination. Agriculture must be the driver of shifting the ecological balance to favour humanity in terms of food production. Sustainable agriculture has to be to the benefit of humankind. Degradation of natural agricultural resources will result in a degrading agricultural sector and thus negatively influence human survival. At the same time, this should all be done within the concept of being economically viable and socially responsible. Society has to act responsibly and nature should not have to pay the price.



**Table 4: Percentage distribution of the main reasons for agricultural involvement, 2017**

(Source: Stats SA, 2017)

# 4. LEGISLATION



#### 4. LEGISLATION

A discussion of the potential and use of the natural agricultural resources requires a quick reference to relevant legislation addressing the management of these resources. Within the legislative environment, a few Acts govern the management and use of the natural agricultural resources and agricultural production. These Acts are briefly highlighted below.

##### *The Constitution of the Republic of South Africa Act, 108 of 1996*

The new Constitution of South Africa was published on 18 December 1996. It is regarded as the supreme law of the country and any law that is inconsistent with the Constitution is regarded as invalid.

Chapter 2 of the Constitution consists of the Bill of Rights. Section 24 of the Bill of Rights in the Constitution stipulates that -

“Everyone has the right -

- (a) To an environment that is not harmful to their health or well-being and
- (b) To have the environment protected for the benefit of present and future generations, through reasonable legislative and other measures that –
  - (i) Prevent pollution and ecological degradation;
  - (ii) Promote conservation; and
  - (iii) Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social developments”.

Section 27 of the Bill of Rights focuses on health care, food, water and social security, stipulating that

“(1) Everyone has the right to have access to -

- (a) Health care, including reproductive health care;
- (b) Sufficient food and water; and
- (c) Social security, including, if they are unable to support themselves and their dependants, appropriate social assistance.

(2) The state must take reasonable legislative and other measures, within its available resources, to achieve the progressive realization of each of these rights”.

##### *Conservation of Agricultural Resources Act, 43 of 1983 (CARA)*

This Act is one of the principal legislations governing the protection of natural agricultural resources. The Act was assented on 21 April 1983 and came into effect on 1 June 1984. The main aim of the Act is to control the utilization of natural agricultural resources to ensure the conservation of soil, water and vegetation, as well as the combating of alien and invasive plants. According to Section 1, conservation of natural agricultural resources includes the protection, recovery as well as the

reclamation thereof. Urban areas are excluded from the provisions of the Act, with the exception of the regulation of weeds and invasive plants.

The CARA Act is a replacement of the *Soil Conservation Act, 76 of 1969*. The objects of the Soil Conservation Act were to make provision for the combating and prevention of soil erosion and for the conservation, protection and improvement of the soil, the vegetation and the sources and resources of the water supplies of the Republic.

In an effort to conserve the country's natural heritage, especially the agricultural land, Act 43 of 1983 strives to act against any individual that deliberately misuses the natural resources. It provides control measures for the cultivation of virgin soil (soil that has not previously been cultivated or not cultivated for at least ten years), the utilization and cultivation of land, including irrigated land, and the protection of water sources such as vleis (marshes, small lakes) and wetlands. It also includes control measures on the use of water to prevent water logging and regulate water flow patterns, the protection of vegetation, grazing potential of the veld, prevention of erosion and land degradation, construction and management of soil conservation structures, as well as the combating of weeds and invasive plants.

#### *Sub-division of Agricultural Land Act, 70 of 1970 (SALA)*

The Sub-division of Agricultural Land Act (SALA) was assented on 28 September 1970 and commenced on 2 January 1971. The main objective of this Act is to manage the sub-division of agricultural land to prevent injudicious fragmentation of agricultural land and the creation of uneconomical units and to also manage and retain the use of agricultural land for agricultural production purposes.

Actions that the Act regulates include:

- Sub-division of agricultural land
- Transfer of agricultural land into undivided shares
- Leasing of agricultural land for periods longer than 10 years
- The registration of a servitude over agricultural land if wider than 15 metres
- The registration of a usufruct or right of *habitatio* over agricultural land
- Establishment or extension of a township
- Registration of a share block scheme and a sectional title scheme.

#### *National Environmental Management Act, 107 of 1998 (NEMA)*

The aim of the National Environmental Management Act is to allow for sustainable, effective and cooperative governance in all matters affecting the environment and forms the basis for people's right to an environment that is not harmful. The Act builds on the international declaration on sustainable development that should integrate social, economic and environmental factors within planning processes, ensuring that development serves both current as well as future generations. It

aims to promote conservation, ecologically sustainable development and the use of natural resources, including the prevention of pollution and ecological degradation.

According to Chapter 1, section 2 of the Act, national environmental management principles should place people and their needs at the forefront and aim at serving their physical, psychological, developmental, cultural and social interests equitably, whilst development should be socially, environmentally and economically sustainable. This relates to development not leading to the disturbance of ecosystems and the loss of biodiversity, but it should limit pollution and degradation of the environment, ensure responsible use of non-renewable natural resources and apply a risk-averse and cautious approach. It further states that environmental management should be an integrated process and based on inter-governmental co-ordination and alignment of policies, legislation and actions pertaining to the environment.

#### National Water Act, 36 of 1998

The core aim of this Act is to provide guidance on the protection, use, management and conservation of the country's water resources.

The South Africa Government is regarded as the custodian of all water resources and water is thus managed as a public trust. The Act acknowledges Government's responsibility towards the management and protection of the country's scarce water resources, the rehabilitation of water resources and the equal allocation of these resources as well as the protection of the quality thereof. The Act regards basic human needs and environmental sustainability as a right, whilst irrigation requirements are seen as secondary.

Further to the above, the Act regards the management of water resources as an integrated process. Institutions that functions under the Water Act include the National Water Advisory Council, the Catchment Management Agency (CMA) and Water Users Associations (WUA). The CMA's functions within water management areas. These water management areas are not linked to provincial boundaries, but functions across boundaries.

# 5. NATURAL AGRICULTURAL RESOURCES OF SOUTH AFRICA



## 5. THE NATURAL AGRICULTURAL RESOURCES OF SOUTH AFRICA – AN OVERVIEW

The Food and Agricultural Organization (FAO) defines natural resources as “resources of the land relevant to its potential for land use e.g. climate, water, soils, pastures, forests”. According to section 1 of the Conservation of Agricultural Resources Act (CARA), 43 of 1983, natural agricultural resources refer to “the soil, the water sources and the vegetation excluding weeds and invader plants”.

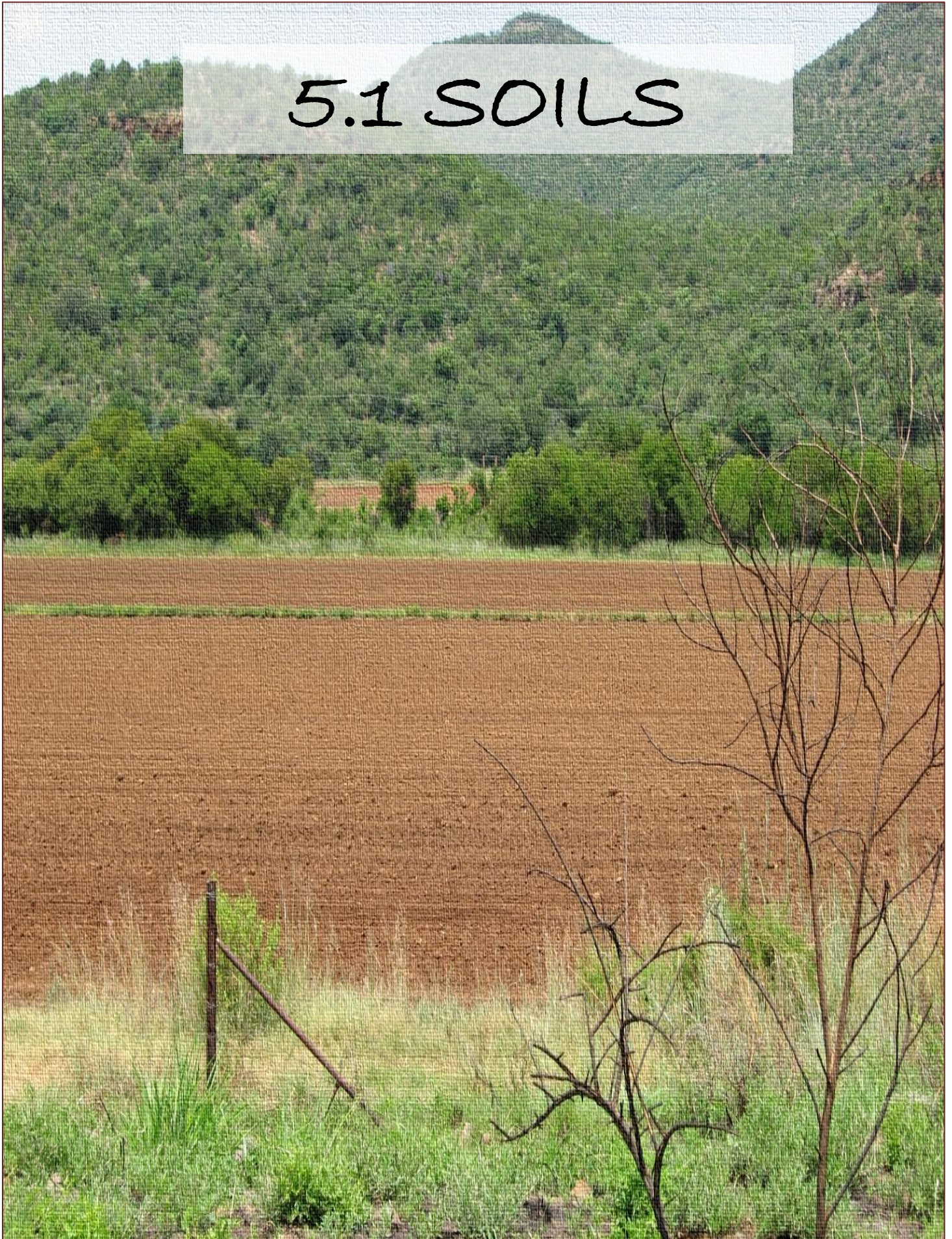
South Africa’s natural resources are highly diverse, sensitive and limited. This is illustrated by the fact that more than half of the country receives an annual rainfall of less than 500 mm per annum, the minimum amount needed for dry land crop production. This negative picture looks even worse if the country’s broad soil classification is taken into consideration, describing that only a limited number of soil forms can be used successfully for agricultural production, as well as the soil’s proneness to erosion.

Each land use has an impact, whether positive or negative, on the environment and the natural agricultural resources. The crux of the matter is to manage land uses to such an extent that the environment can benefit the most. Agricultural activities themselves can be most detrimental to the environment. Impacts, such as soil degradation, erosion, loss in water quality and biodiversity are some of the negative impacts. However, if managed properly and sustainably, agricultural activities can be productive, whilst also ensuring a properly managed environment. Unfortunately, in many instances corrective measures are mostly re-active instead of pro-active, which is not ideal.

Due to the estimated growth in the world’s population, the need for food and housing will increase with a resulting increase in agricultural production and pressure on the world’s natural resources. Natural resources should therefore be used sparingly and according to their capability, to adhere to the demand, but not to deplete the resource.

A proper balance is therefore required between any land use and the protection of non-renewable natural resources. Once again, the emphasis should be on sustainable development principles.

# 5.1 SOILS



## 5.1 SOILS

Without soil there would be no agriculture and without agriculture there will be no food and no food means..... no human race.



Soil means different things to different people depending on the purpose or “angle” of interpretation.

For some soil might be regarded as the main source used of the production of food, whilst for others it is perceived as an important resource from a conservation or soil health perspective.

From an agricultural production perspective, soil is regarded one of the most important components of plant growth as it acts as *the* growth medium and contributes towards the production of food. For a farmer the soil is his most precious resource, which needs to be well managed in order to sustain production. Soil is regarded as an infinite *and* a non-renewable resource within a human lifespan.

Key soil production aspects include:

- Soils provides the physical, chemical and biological medium for crop growth;
- Livestock graze on vegetation grown in soils to provide them, in turn, with food;
- Soil health is the foundation of productive farming;
- Fertile soil provides essential nutrients to agricultural crops;
- Soil types are a fundamental factor in deciding what crop to grow and where to grow it;
- Soils are also essential in maintaining natural vegetation – forests and grasslands;
- Soil properties play a fundamental role in the quality and distribution of the supply of water;
- Soil organic matter is a major contributor to carbon in the biosphere and an important driver of climatic change, acting both as a source and sink of carbon.

There is a renewed recognition of the important role soil plays in terms of food security and the provision of ecosystem services, including aspects pertaining to climate change adaption and mitigation and the impact thereof on soil resources. As a result thereof, there is a resulted number of initiatives to improve our knowledge and information base on soils in order to curb the continued degradation of the world’s soil resources.

Soil surveys have been done in South Africa for many years and have always formed part of any agricultural related activity, whether for soil classification purposes, irrigation development or determining agricultural potential or crop production and suitability analysis. Such surveys were first carried out in the 1920’s, although the first recorded soil investigation was carried out as far back as 1899. The first national South African soil map was published in 1940. In recent years, significant emphasis has also been placed on the role of soils in the field of environmental management with a larger focus on soil health aspects.

The soils in South Africa are categorized as the third major soil region of the world and differ significantly from the other two soil regions, namely the very fertile soils found in the developed northern countries (North America and Europe) and the infertile soils of the tropical areas.

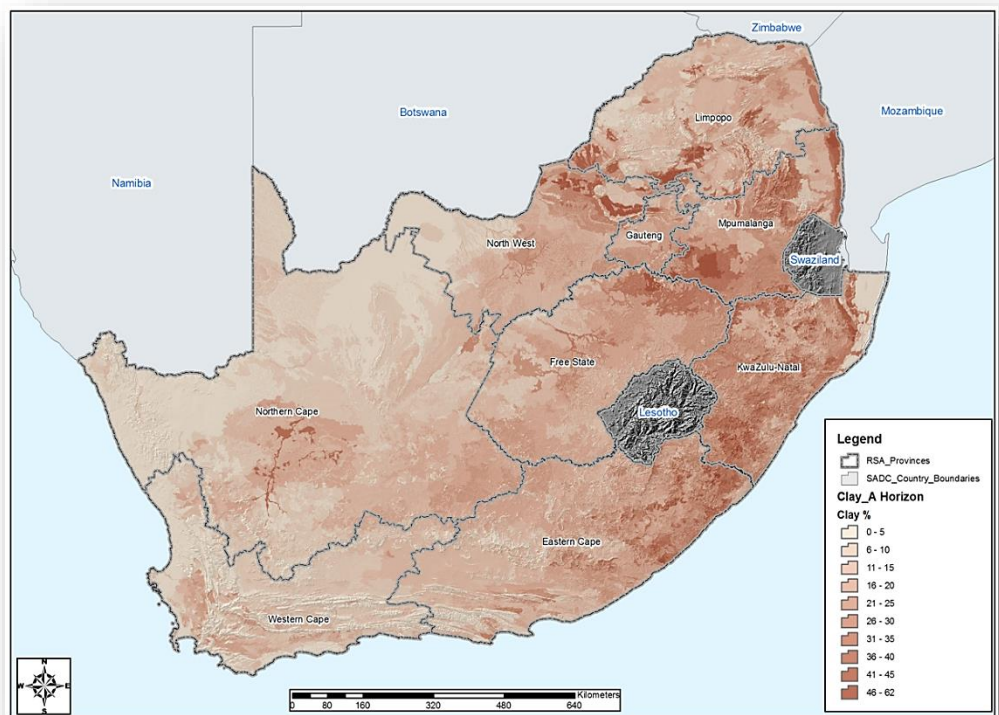
The only significant moderate to high potential soils are found in the higher rainfall, humid to sub-humid areas in the east, as these areas have enough water needed for the weathering of rocks and formation of soils. Only about 3% of South Africa’s surface is considered as having a high agricultural potential.

Factors influencing soil formation are defined by the parent material (passive soil forming factor) and modified by climate (regarded as the main factor behind soil formation), topography, biotic activity and time. In the case of South Africa, the presence of hard rock parent material combined with low rainfall limit soil formation, resulting in shallow soils. Soil formation is the foundation of demarcating areas suitable for cultivation for both agronomic and horticultural crops. *“Highly productive arable land with optimal physical and chemical characteristics is limited. It is thus of the utmost importance that such areas be identified and preserved. The best soils, such as deep, permeable red or yellow loams, are found where weathering has continued unbroken over a long period”*. The prime factor to realize is that the country’s soil cannot be renewed in a human lifetime, if lost. Factors responsible for soil formation may no longer be present. Even repairs to damaged or degraded soils cannot be done within a number of human life spans.

The only national survey on South African soils was the national Land Type survey that is till today being used as baseline data set with a high level of uniformity with regard to terrain form, soil patterns and macroclimate. The National Land Type survey commenced in 1972 and was completed in 2002. The survey was conducted on a 1:250 000 scale.

### Soil characteristics

From the Land Type survey it has been concluded that almost 60% of the soils have a low productivity and are prone to land degradation due to the low organic content. Many of the soils are also vulnerable to erosion and other forms of degradation.

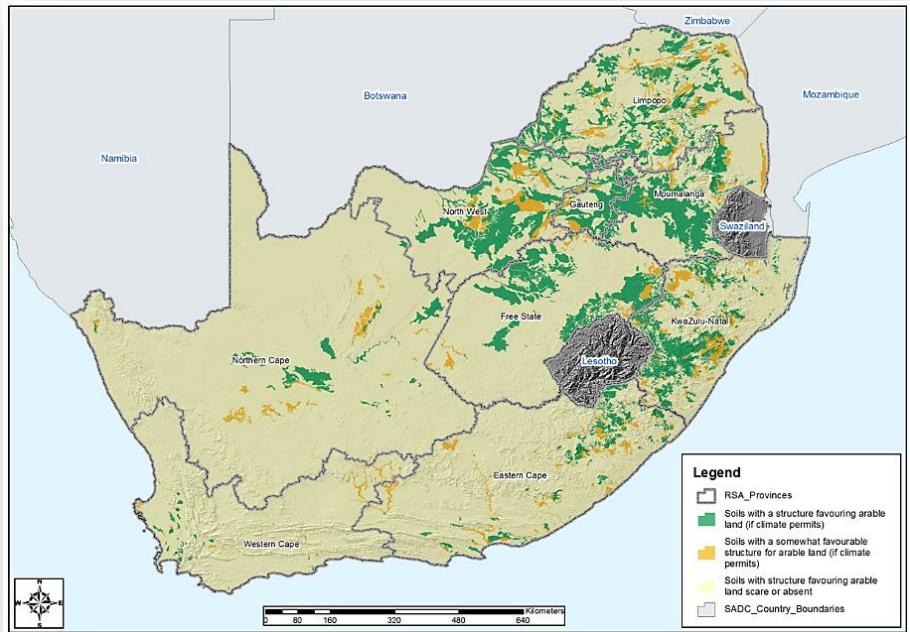


**Figure 3: Clay % distribution in the A horizon**

Shallow depths, extreme texture, rockiness, severe wetness and high erosion hazards are some of the most limiting factors. These high risks require careful use and management practices to preserve the status thereof.

The soils in South Africa is characterised as being slightly weathered and calcareous, whilst over 30% comprises of very sandy soils (< 10% clay).

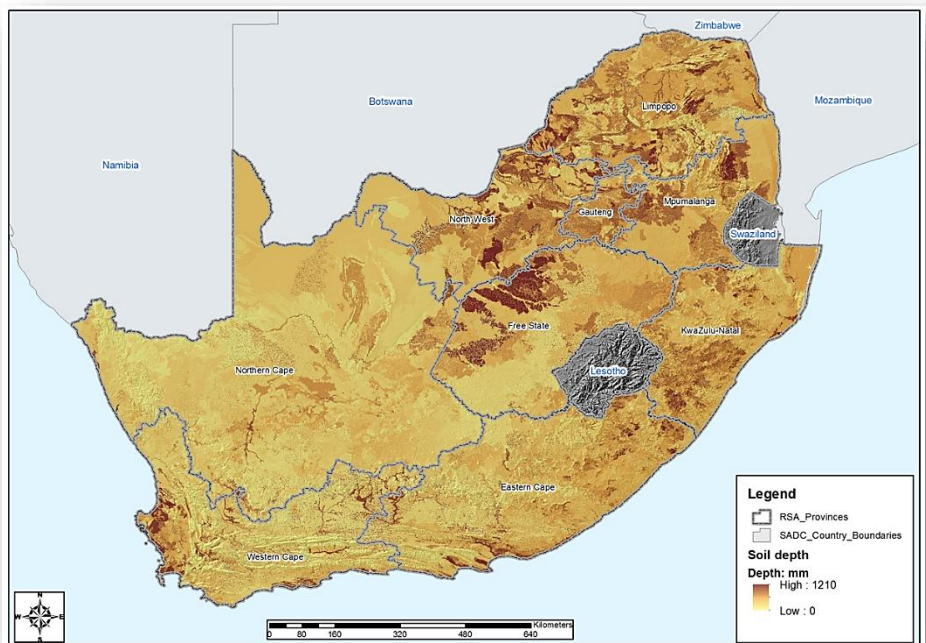
Only 24% of the country has soils with a favourable top- and subsoil structure that, depending on the climate, is suitable for crop production. Figure 4 depicts the distribution of soils with a favourable structure in South Africa.



**Figure 4: Structurally favourable soils in South Africa**

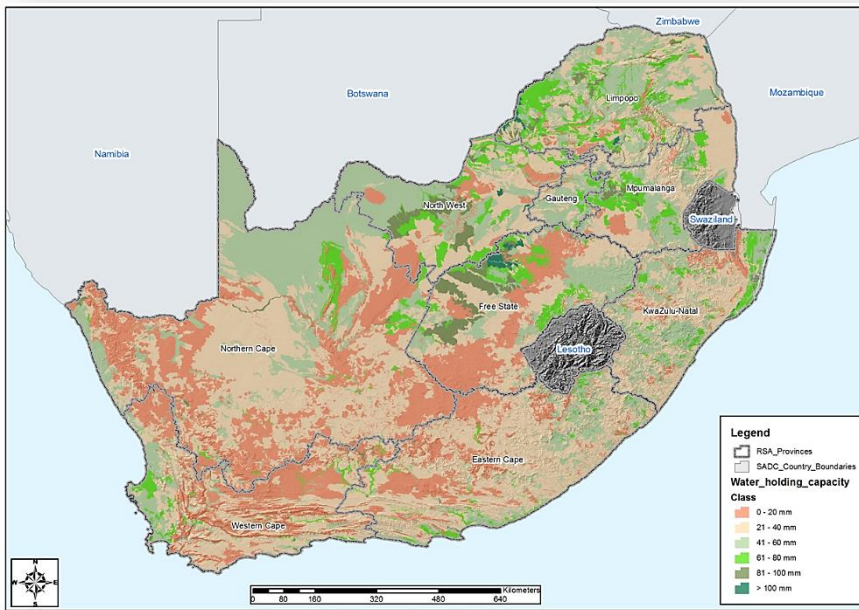
The most common soil form found in South Africa is the Hutton soil form, in all its variations, which covers about 25% of the country's surface, with Mispah (Ms10) the most common single series occurring in 5 682 of the 7 071 land types. The Mispah soil form takes up about 11 million ha. Exposed rock occupies 16 million ha (13.2%), more than any single soil series and soil form, except Hutton.

Soil depth is an important factor in crop production. For rainfed pastures, a soil depth of at least 300 mm is needed, whilst for crop production at least 500 mm of soil depth is required. A crop under irrigation requires 450 mm of soil depth, on the condition that the water table is below 1 m.



**Figure 5: Soil depth distribution across South Africa**

The average soil depth in the country is calculated at 577 mm, with only about 20% of the soils being deeper than 900 mm. The significance of the mentioned is that more than one third of the country's soils are shallow with limited development possibilities.



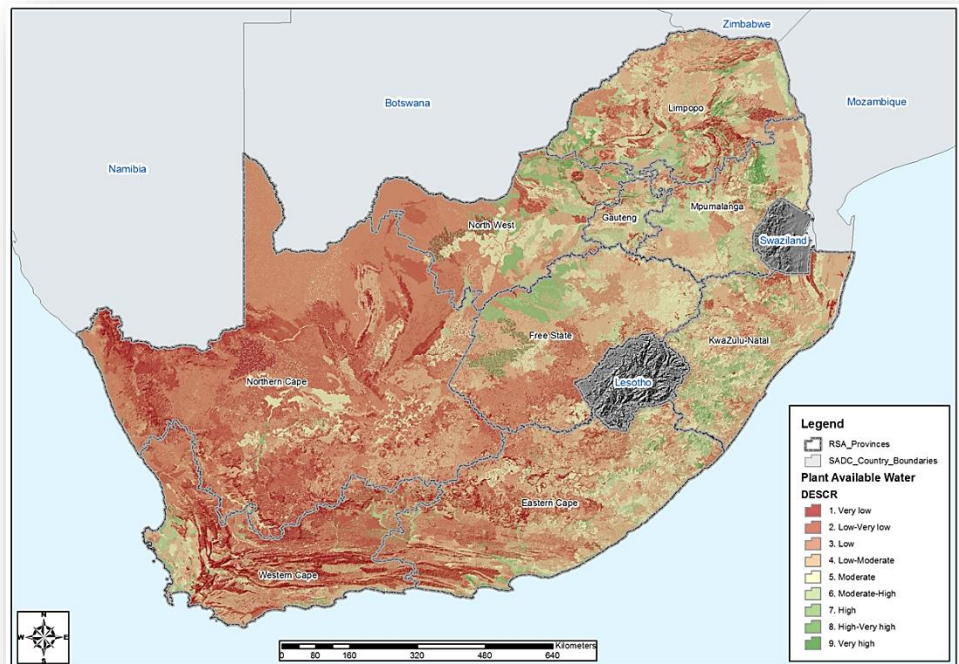
**Figure 6: Water holding capacity of soils (profile available water: mm) in South Africa**

Another important factor required for the especially rainfed cultivation, is the ability of soils to store water and release it, when needed, to the plant for growth.

Soil can process and contain considerable amounts of water. It will continue taking up water until saturated. Some water will drain through and end up in

waterways / streams. Much will however be retained for the use of plants and other organisms to contribute to the productivity of the land and soil health. This ability can extend arability, especially in marginal rainfall areas.

The soil's ability to retain water is strongly related to particle size. Water molecules hold more tightly to fine particles of a clay soil than coarser particles of sandy soil, therefore clay generally retain more water. Sands on the other hand transport water much easier through the profile. In addition clay type, organic content and soil structure further influence soil water retention.



**Figure 7: Plant available water capability of soils in South Africa**

Significantly, only 8% of the country's soils have favourable water retaining properties due to drainage-retaining layers below relatively deep rooting zones. This enhances the agricultural value of the land and the conservation of these soils is critical.

Further to the mentioned is the hydraulic properties of the soil that determine the ability of the soil water to flow through the soil profile under a specified hydraulic gradient. The spaces between the soil particles provide for the passage and or retention of moisture within the soil profile. Hydraulic conductivity (vertical movement of the water through the soil profile) depends on the intrinsic permeability of the soil and the degree of saturation as well as the density and viscosity of the fluid.

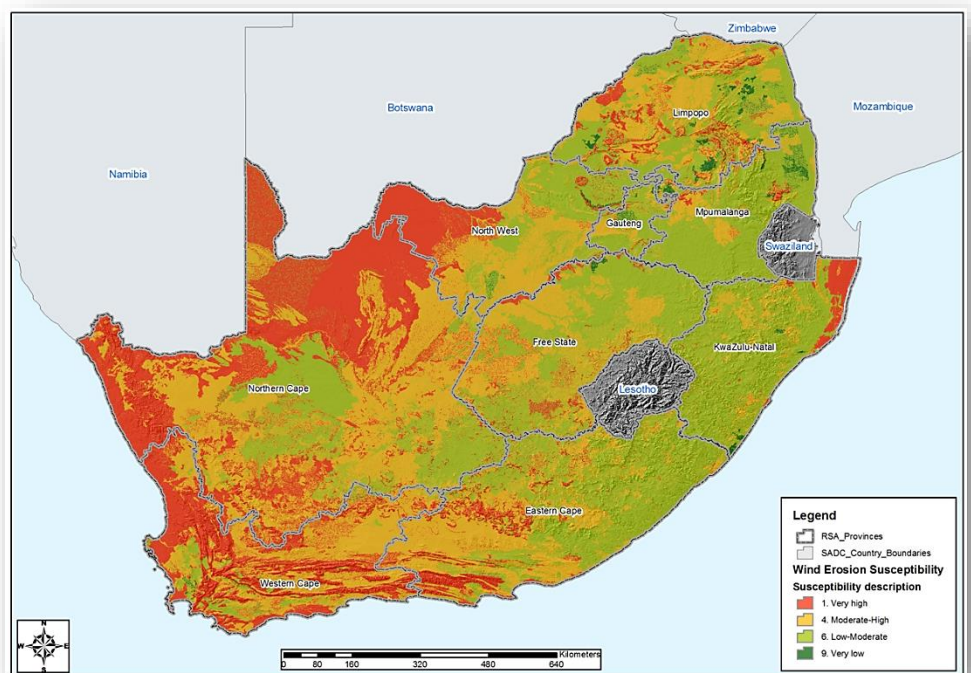
Available water capacity is the range of available water that can be stored in the soil and be utilised by the growing crop and the readiness with which the soil water moves in to replace those that have been taken up by the plant.

Hydraulic conductivity and available water capacity contribute towards the plant available water capability within the soil. Approximately 15.1% of soils in South Africa have low to very low plant available water capability, 23.9% low to moderate, 4.3% high and only 0.73% having a capability of high to very high available plant water. This again emphasized the limited capability of soils in the country to be used under rainfed conditions, with accompanied high risk for crop failure.

### **Soil sensitivity**

In as far back as 1923 the then Drought Investigation Commission stated that accelerated erosion and desiccation in South Africa could be attributed to people's misuse of the land. It is estimated that approximately 400 million tons of soil is washed from the land to the seas on an annual basis, which is equivalent to 3 tons / ha for the whole country.

Soil erosion is a natural phenomenon and all landscapes are subjected to some degree of erosion. Erosion problems occur when the rate of erosion is increased above natural levels. Soils with a low aggregate stability, usually soil with a particular range of textural values and parent materials are susceptible to the mobilization of clay and silt and in certain cases,



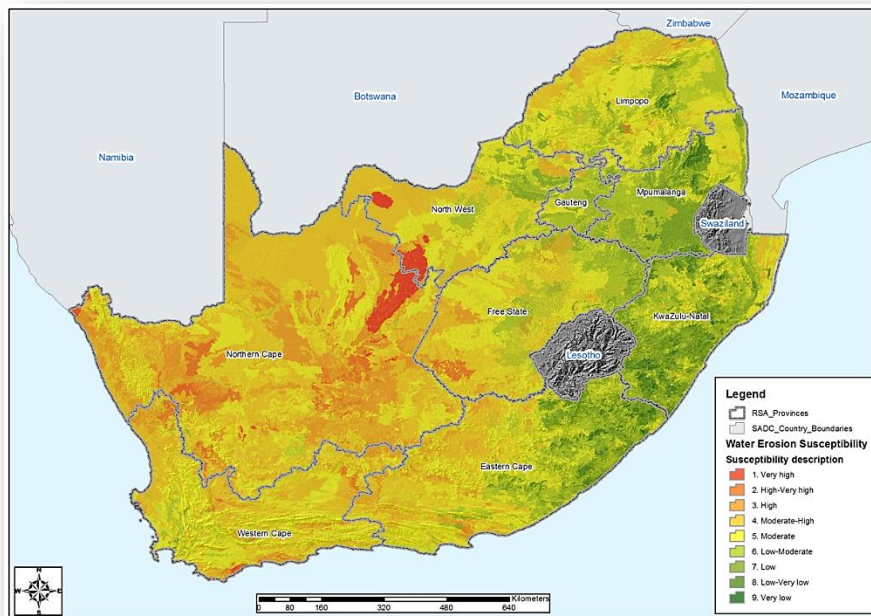
**Figure 8: Wind erosion susceptibility of soils in South Africa**

dispersion, resulting in decreased infiltration rates, increased run off and thus erosion.

This problem can however be increased due to poor agricultural management that can lead to desertification; a decrease in agricultural productivity as a result of land degradation, sedimentation and ecological collapse.

With about 30% of the country's soils being very sandy (less than 10% clay), soils are vulnerable to wind erosion. Under certain cropping conditions up to 60 tons / ha of soil is lost annually from such soils. It has been concluded that the higher the sand fraction, the more susceptible the soil will be to wind erosion. Schoeman, Koch, Kaempffer and Scotney (1992) concluded that all soils with less than 20% clay are regarded as potentially wind erodible.

From calculations on soils susceptible to wind erosion in the country, it has been found that 24.6% of the country's surface has a very high wind erosion susceptibility, 35.9% moderate to high, 38.67% having a moderate to low susceptibility, whilst only 0.71 has a very low risk for wind erosion.



Water erosion in turn is the process where water wears away at soil or rock. This causes fertile soil to be swept away.

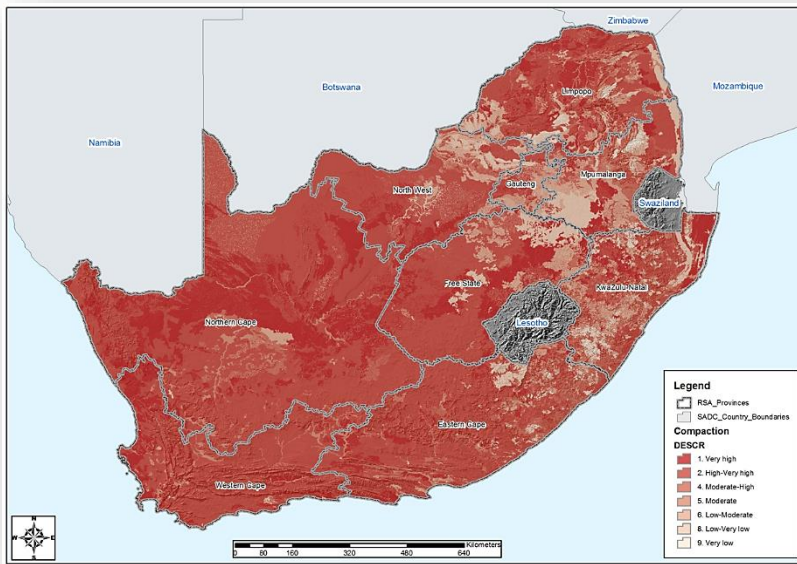
**Figure 9: Water erosion susceptibility of soils in South Africa**

There are three classes of water erosion namely:

- Splash erosion that occurs when raindrops strike bare soil, causing it to splash, as mud, to flow into spaces in the soil and to turn the upper layer of soil into a structureless, compacted mass that dries with a hard, largely impermeable crust;
- Surface flow occurs when soil is removed with surface run-off during heavy rain;
- Channelized flow occurs when a flowing mixture of water and soil cuts a channel, which is deepened by further scouring. A minor erosion channel is called a rill, a larger channel a gully.

An estimated 1.2% of the country's soils are susceptible to a very high risk for water erosion, 34.5% have a moderate susceptibility, whilst less than a 0.5% have a very low water erosion susceptibility risk.

Another form of soil sensitivity that can result in a form of erosion is soil compaction. Soil compaction occurs when soil particles are pressed together reducing the pore spaces between them, resulting in a reduced water infiltration rate and drainage from the compacted layer. Exchange of gases also slows down, causing an increase in the likelihood of aeration-related problems. It further results that roots must exert greater force to penetrate the compacted layer. Soil compaction results in an increase in bulk density; increased soil strength; decrease infiltration; decreased available water capacity and lower oxygen diffusion rates.



A calculated 59.2% of the country's surface are highly susceptible to compaction with less than 5% having a low to very low compaction susceptibility. Although these calculations are based on the soil's characteristics, intensive mechanization can also contribute towards intensified soil compaction.

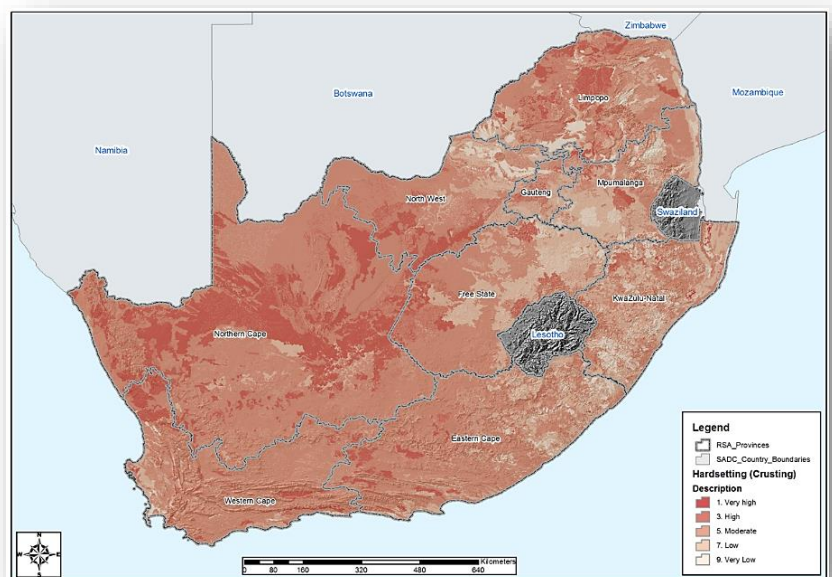
**Figure 10: Compaction susceptibility of soils in South Africa**

Hardsetting (crusting) is a further contributor towards

soil degradation. Aggregate stability depends on the arrangement of the actual soil particles, clay mineral type, their electro-chemical characteristics and the electrical concentration of the soil solution. Decline in aggregate stability are commonly found when grassland sites are cultivated for the first time. The effects of the cultivation are twofold:

- Firstly, in many agricultural systems fewer plant residues are returned to the soil. This leads to a decline in the amount of organic matter;
- Secondly, cultivation tends to break apart aggregates, exposing the temporary and transient organic matter to microbial attack.

Soil strength increases rapidly as the soil dries and seedlings must grow quickly before soil strength becomes too high for root growth or shoot emergence. Soil infiltration is



**Figure 11: Hardsetting (crusting) susceptibility of soils in South Africa**

commonly limited by surface crusting rather than by deeper profile properties. Decreased infiltration increases runoff, thus decreasing the water available for vegetation in situ. In severe cases, run-off is concentrated into small channels that can deepen and consequently lead to serious soil erosion.

Hardsetting is a serious problem in soils with high proportions of sand and silt. As aggregates break open, sand, silt and clay particles are released and washed into the soil pores and therefore preventing further infiltration. This seals the soil surface, rain water collects in puddles with limited, if any, infiltration where the water is then evaporated. It can also result in water run-off, causing soil erosion (gullies). Approximately 61.5% of soils in South Africa have a moderate susceptibility for hardsetting with 14.65% having a high susceptibility, whilst 19.5% have a moderate to low risk. Only about 4.2% have a very low hardsetting susceptibility risk.

In addition to the above constraints, approximately 15% of possible arable land in the country is affected by soil acidity. Studies are underway to obtain better insight into the extent of this problem in the country.

### Soil capability

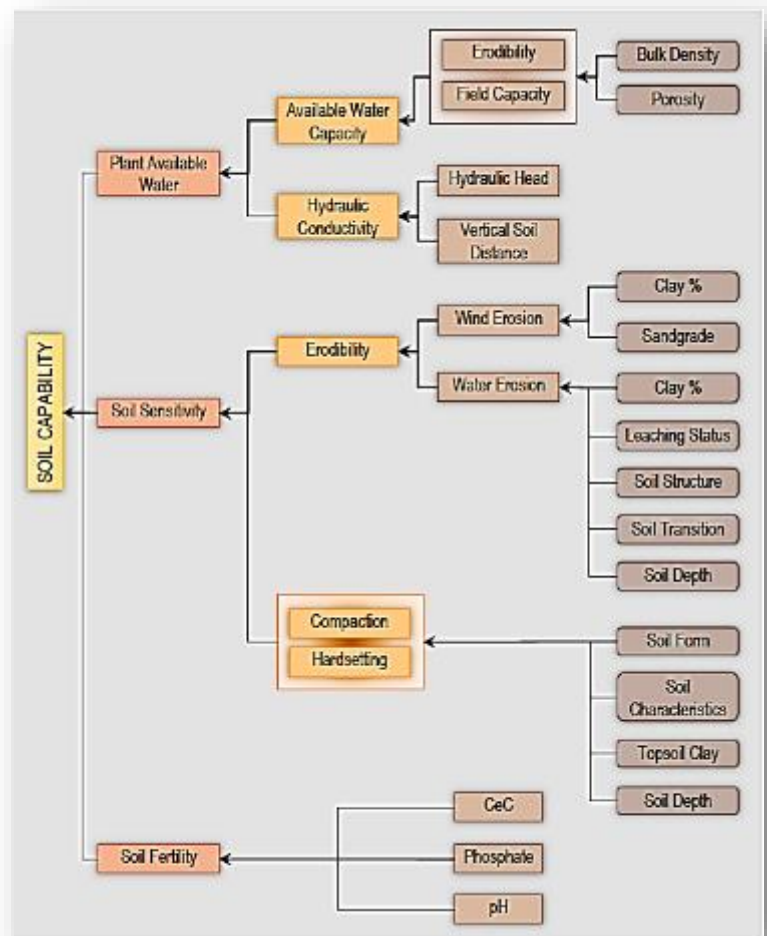
Agricultural soil capability is determined as a function of the:

- potential of the soil to hold and supply moisture to the plant;
- the sensitivity of the soil affecting productivity and
- the inherent potential of the soil to be fertile.

Soil capability therefore takes into consideration all aspects pertaining to the characteristics of the soil and their contributions towards plant production. Figure 12 gives an overview of the modelled approach towards the compilation of a soil capability evaluation for agricultural production in the country under rainfed conditions.

Soil capability is derived as a function of:

- Plant available water
  - Available water capacity
  - Hydraulic conductivity
- Soil sensitivity
  - Erosion (wind and water)
  - Compaction
  - Hardsetting &
- Soil fertility indicators



**Figure 12: Soil capability methodology for South Africa**

The capability of soil for rainfed cultivation therefore provides significant insight into the ability of soils to be used for cultivation purposes.

According to the national soil capability evaluation data layer for the country have more than 45% of the country's soils a low to very low soil capability, 24% have a moderate soil capability and only 11.4% have a high soil capability.

Only 270 ha in the country have soils with a very high soil capability that is significantly limited in term of the country's total surface area (0.00022%).

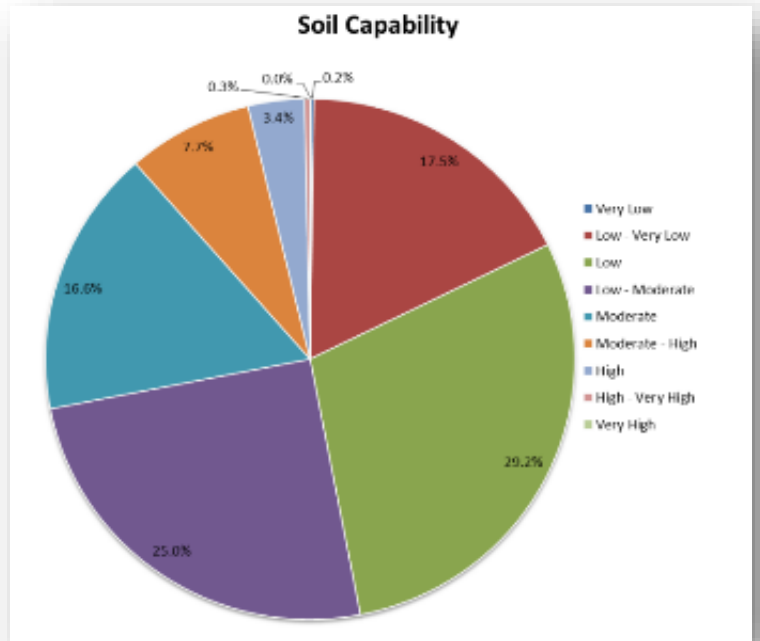


Figure 13: Soil capability percentage for South Africa

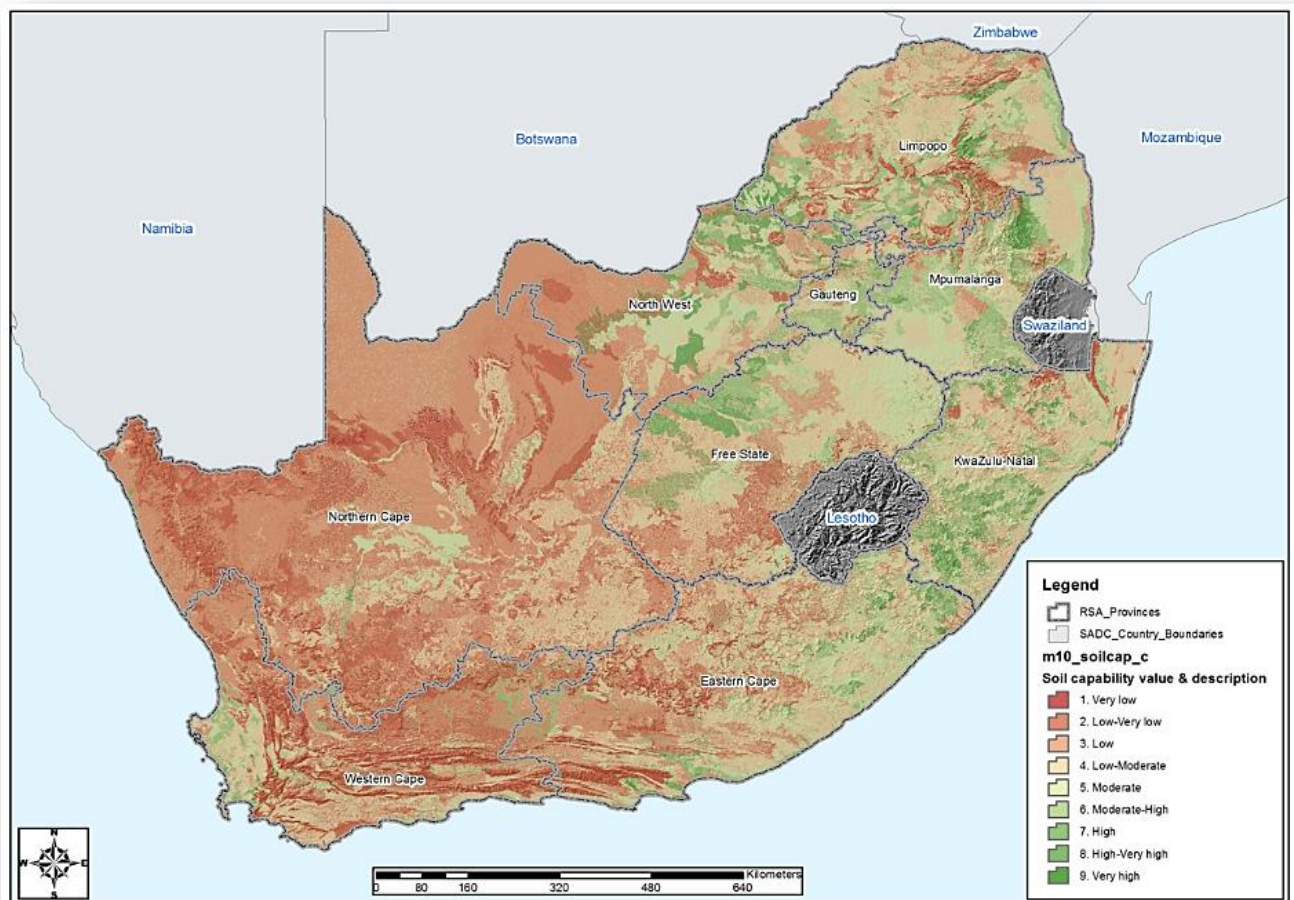
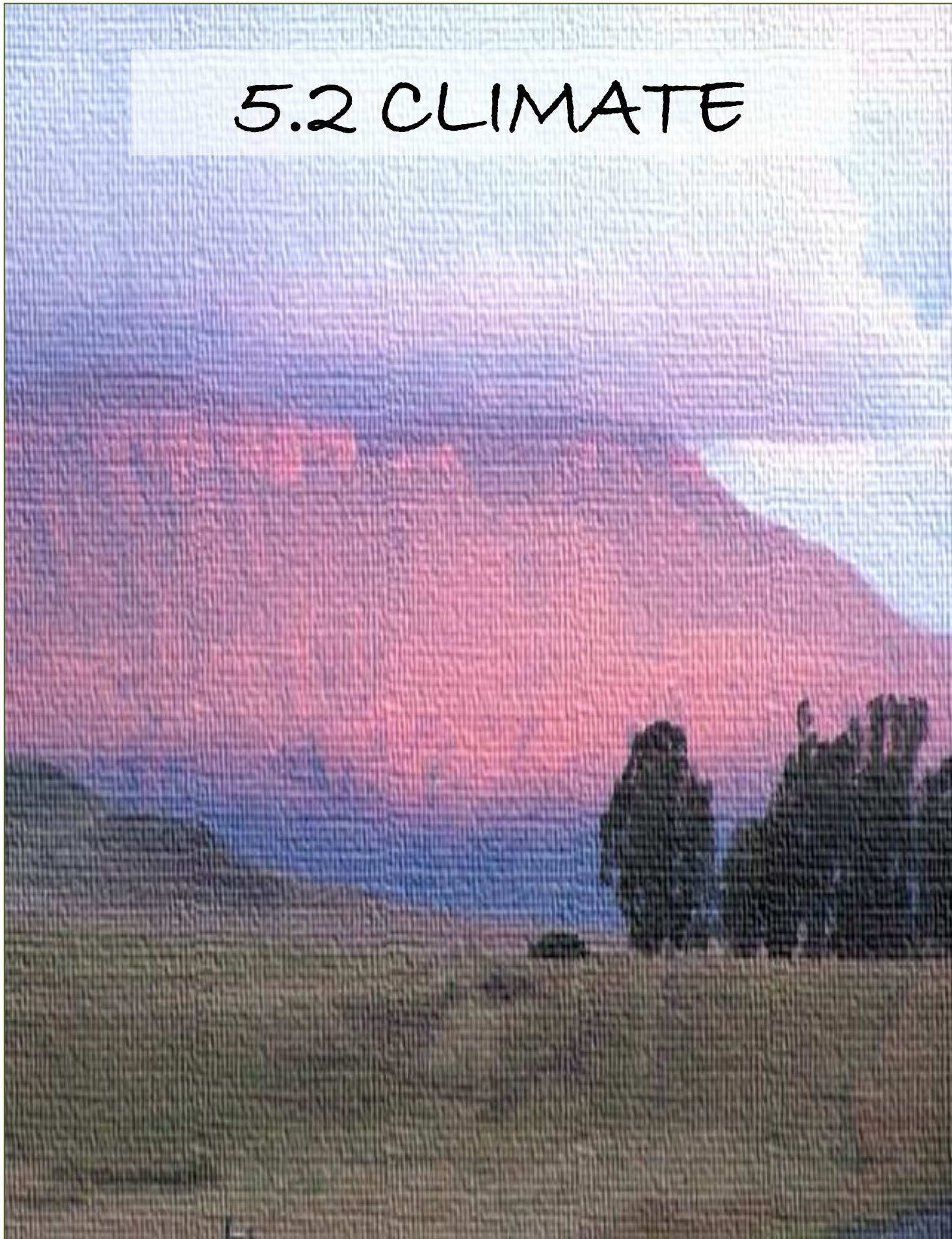


Figure 14: Soil capability evaluation values for South Africa

## 5.2 CLIMATE



## 5.2 CLIMATE

When referencing the natural resources 's patterns dominating the earth's environment (climate; plant distribution; soil), climate is perceived to be in principle the most dynamic component but also the most complex, independent variable impacting on the other components due to constant interactions and variability per geographic locality. Examples of a plant's life cycle sensitivity to climate include *inter alia* the rate of germination; intensity of flowering; biomass production, in short - plant growth. The last aspect is of extreme importance in ensuring continued food production to adhere to the country's food requirements, the main purpose for agricultural production.

The influence of climatic variables per geographic locality and with specific reference to agriculture is vital towards:

- The suitability for cultivating a specific crop for any given locality;
- The variety and number of crops suitable for a specific area;
- Phenological scheduling and avoidance during critical growth stages;
- Yield and productivity potential as a function of:
  - The supply of moisture,
  - Moisture supply balance considering evapotranspiration losses,
    - Plant-biochemical reactions that are sensitive to temperature e.g. the plant's physiological processes (photosynthesis, etc.);
- Recognition, response and prevention of livestock heat stress;
- Understanding and managing climate risk:
  - Cold (frost, freeze etc.)
  - Heat (extreme heat waves, temperature variance etc.)

South Africa is regarded as the 27<sup>th</sup> driest country in the world. It is located within a belt of high pressure, resulting in a large number of cloudless days and reduced rainfall.

Due to the location of the country at the far most southern point of the African continent in combination with the unique landscape, the climate of the country is affected by a number of factors such as the:

- Oceanic currents surrounding the country;
- The variance in latitude;
- Altitude variation;
- Topography.

The country is surrounded by the warm Indian Ocean on the east coast and the cold Atlantic Ocean on the west coast. These two important currents have a significant impact on the South African climate. eThekweni, located on the east coast of the country has a mean annual rainfall of a 1 000 mm and an average temperature of 21 °C, whilst the town of Port Nolloth, located on the same latitude but on the west coast has a mean annual rainfall of 65 mm and a mean annual temperature of 14 °C.

Severe droughts are a regular occurrence, which has devastating consequences for crop and animal production. In addition, severe floods are also not uncommon due erratic and varied rainstorms.

Climatic factors impacting directly on agricultural production includes *inter alia* rainfall, temperature (including heat waves), sunlight hours, hail and frost. Indirectly, altitude and aspect further impacts on the crop production potential.

## **Rainfall**

Rainfall plays a dominant role in determining the capability and potential for crop production, especially under rainfed production. Not only does it influence crop selection and the subsequent yield but also highlights the climatic risks for (rainfed) agricultural production. Farmers need to know the risk pertaining to rainfall in terms when rain is needed for the crop concerned and when it should be expected.

Therefore, not only is the amount of rainfall of importance but also the frequency (distribution patterns) as well as intensity, specifically during the production period of the crop.

Three rainfall areas can be classified in South Africa namely:

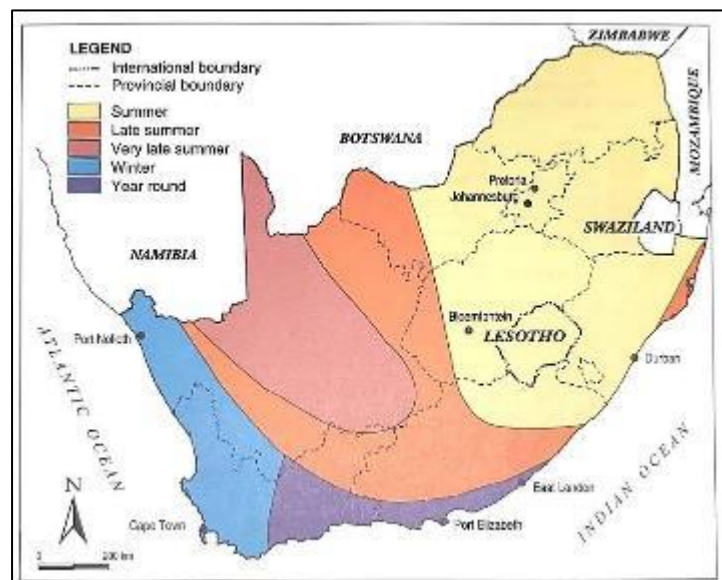
- the winter rainfall areas found in the south-western corner of the country;
- the all-year-round rainfall area along the south and south-eastern coasts, and
- the summer rainfall area over the remainder of the country.

The summer rainfall area covers the largest part of the country (86%). Summer rainfall is received during October to March, which is highly suited for summer crop production such as maize. The summer rains are followed by mostly dry winters. About 10% of the country received winter rainfall from April to September, which makes it suitable for planting of winter crops such as wheat. The all-year-round rainfall area is located along the south-eastern coastline of the country and covers about 3% of the country. These areas are mostly planted with pastures, used in dairy production.

South Africa has a mean annual precipitation of around 495 - 511 mm, which is very limited when comparing to the global average of 860 mm. More than 60% of the country receives less than 500 mm per annum with 21% receiving less than 200 mm per annum.

Less than 10% of the country receives annual rainfall of more than 750 mm.

Annual rainfall quantity is by itself not the only variable to consider when planting a crop. The seasonal (when), spatial (where) and frequency of rainfall distribution allow a farmer to plan for and



**Figure 15: Three rainfall areas in South Africa**

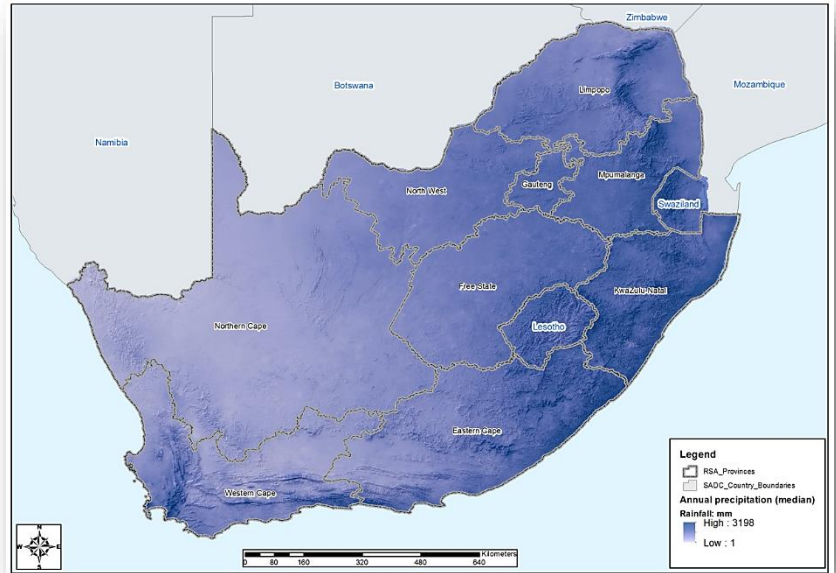
(Source: Smith, 2006)

mitigate, where possible, rainfall risk – “as long as it rains when rain is needed and expected” – type of approach.

The degree to which rainfall quantity varies over time for an area – thus the inter-annual variability (year-to-year) is equally important.

According to the Intergovernmental Panel on Climate Change (IPCC) rainfall variability and extreme droughts are predicted to have an adversely effect on the yield from rainfed farms in Africa by as much as 50% in the future.

It is well-known that rainfall patterns are distributed unevenly across the country. The rainfall increases from less than 125 mm along the arid west coast to more than 1 000 mm east of the Drakensberg escarpment. The highest average annual rainfall is recorded in the Stellenbosch area with an annual rainfall of more than 1 300 mm per annum.



**Figure 16: Rainfall distribution in South Africa**

The percentage area per annual rainfall distribution patterns in South Africa can be classified as follows:

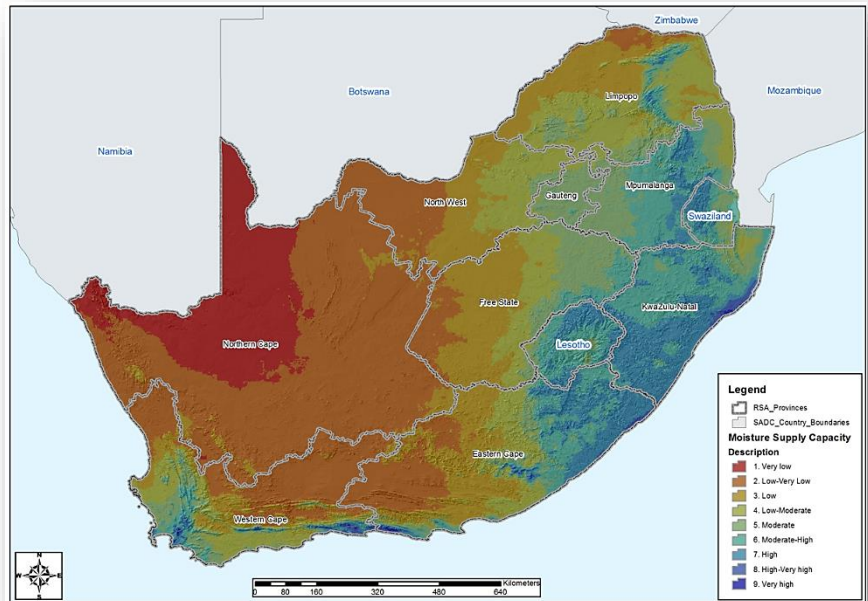
Annual rainfall (mm)	Percentage (%)
1 – 125	4
126 – 250	27
251 – 500	32
501 – 750	28
>750	9

**Table 5: Rainfall distribution patterns in South Africa**

The minimum amount of rainfall required for rainfed cultivation is 500 – 580 mm. Seen in the light of the mean annual precipitation of the country, the risk associated with rainfed cultivation is evident.

The limited amount of rainfall for crop production South Africa is also exposed to, within and between seasonal rainfall variability. During any growth period, the availability of rainfall in certain growth stages, such as the tasselling phase of maize, is of prime importance. During South Africa’s

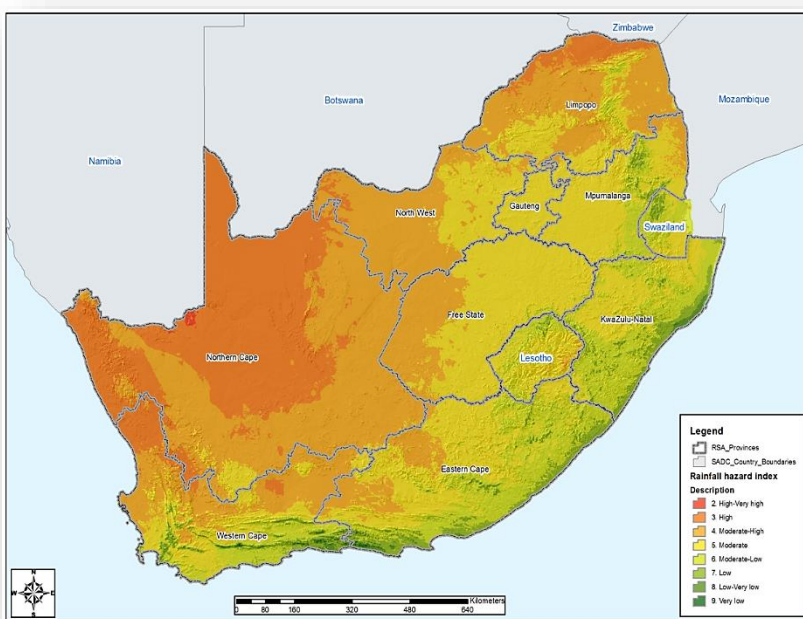
summer rainfall period, midsummer drought normally occurs in January, coinciding with the maize tasselling phase. Farmers therefore have to ensure that their planting dates are specific to the area in which they live and that there are sufficient moisture in the soils to sustain rainfed production throughout the growth period (moisture supply capacity). Of an advantage is if the soils can retain sufficient moisture for follow up seasons in cases of drought, taking cognisance of prevailing temperatures and the associated evapotranspiration rates. Evapotranspiration is the amount of water lost through the transpiration of leaves as well as the evaporation from the bare soil.



**Figure 17: Moisture Supply Capacity (MSC) variance n South Africa**

Production depends on the duration of a rainy season and whether the rain is concentrated over a short period or spread over a longer period. This in turn impacts on the moisture availability to the plant during its growth season. The availability of moisture to a plant at the end of the climatic moisture season has an important influence on the production of crops.

Moisture supply capacity (MSC) is determined by two factors namely:



**Figure 18: Rainfall hazard index for in South Africa**

- Length of the moisture growing season (Moisture growing season) – an average of a three-month growth season is used as reference;
- Available moisture balance, inclusive of prevailing rainfall patterns, temperature variance and evapotranspiration

About 32.5% of the country has a low to very low moisture supply

capacity for rainfed crop production during the growth season of the crop, whilst 22% have a moderate to slightly higher capacity with only 8% having a moisture supply capacity of high to very high. This illustrates the severe risks farmers are facing with rainfed crop production and the limitations that the country faces in terms of rainfall availability and retention.

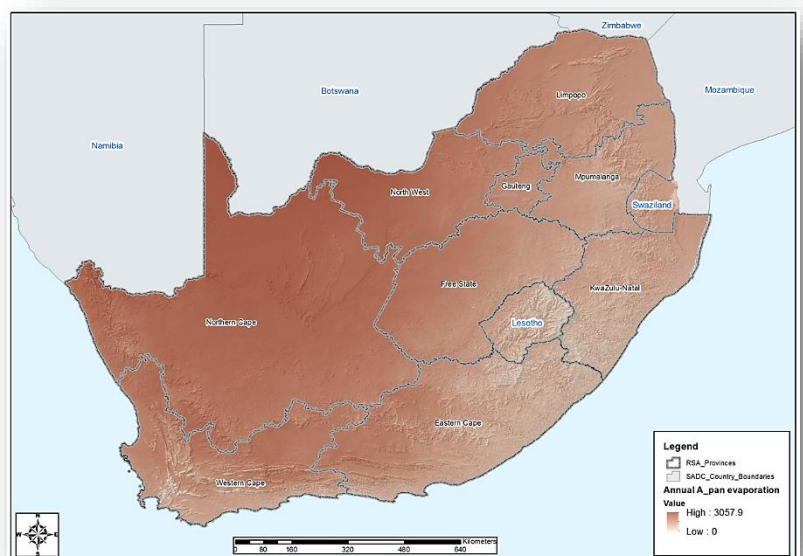
Combining rainfall variability and concentration provides an indication of the rainfall hazard index for the country. More than 86% of the country is subjected to a moderate to very high rainfall hazard risk, with less than 1% having a low to very low rainfall hazard risk (Figure 18).

## Temperature

Temperature is important factor influencing crop production and crop suitability.

It plays an important role during the plant's photosynthesis process. This forms part of the physiological capability of a plant to grow and develop. Photosynthesis slowly increases from 5°C to leaf temperatures of 30 – 35°C. Plant growth is negatively affected when temperatures are too high or too low. A variance of direct and indirect aspects relate to temperature influencing plant growth.

In addition, temperature impacts on the occurrence of pest and diseases and on the availability of soil moisture due to the rate of evaporation.



**Figure 19: A-pan evapotranspiration rates in South Africa**

South Africa's latitude ranges between 22 and 35 °S with a 100 km distance between one degree of latitude. Temperatures are affected by the variance in latitude as the annual temperature decrease with an increase in latitude. In addition, the aspect of the land orientation has a further impact on temperature. The north facing slopes are being warmed much more than the south facing slopes, whilst the west facing slope are warmer than the eastern slopes.

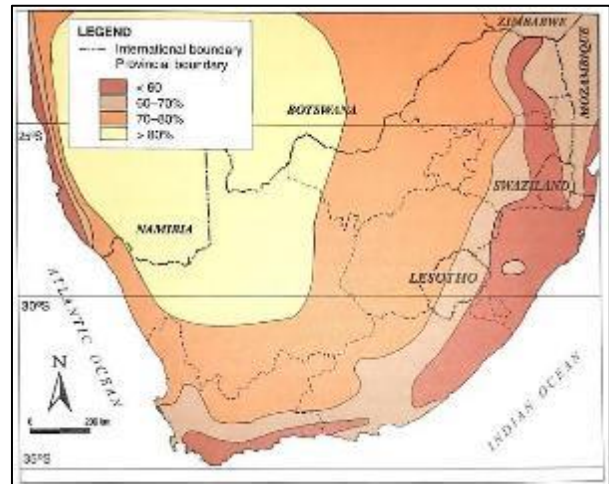
South Africa's altitude ranges from sea level (0 m) to 3 400 m above sea level. The variation in altitude has a further impact on temperature. Temperature increases by 0.5°C for every 100 m decrease in altitude, provided all other factors are equal.

The country is dominantly characterized with high temperatures with a very low relative humidity and high vapour saturation deficits. Less than 10% of the country can be regarded as humid. The surrounding seas as well as the cool Benguela and warm Agulhas currents have a significant effect on the coastal temperatures, resulting in a difference of up to seven degrees (7°C) in average temperatures between eThekweni in the east and Port Nolloth in the west.

About 22.2 % of the country has an average maximum temperature of 29.1 to 31.0°C, whilst 4.1% has an average maximum temperature of > 35°C. Only 9.8% of the country has an average maximum temperature of less than 25°C. In terms of minimum temperatures, 32.7% of the country resides within the minus 1.9 to 0.0°C temperature range with only 3.5% having an average minimum temperature of > 8.0°C.

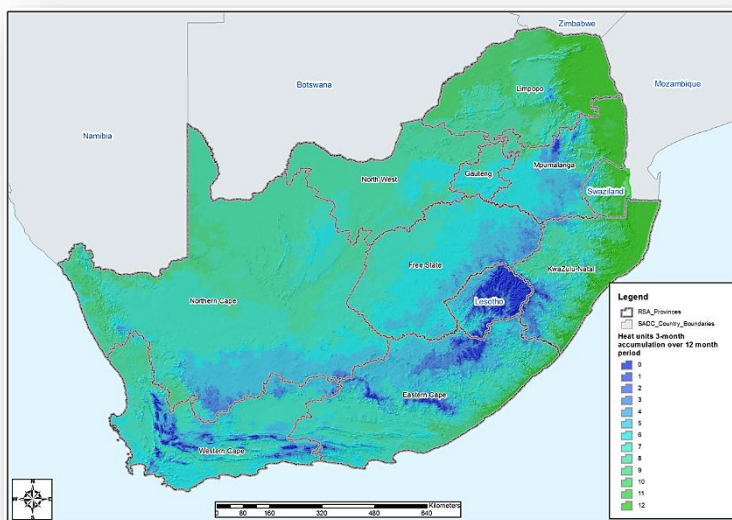
Cold spells are a regular occurrence during the winter months and may result in a drop of 5 to 10°C in temperature at least twenty times per year over large parts of the country, with resulting frost. During the late spring, hail also occurs, especially in the eastern escarpment areas.

On the other hand, South Africa is in the fortunate position that it enjoys more sunshine hours than many other countries in the world. This is a great advantage for crop growth as sunshine and radiation are two very important factors for plant growth that in turns contributes towards higher crop yields. From a production perspective the central and northern interior regions of the country, where rainfall is concentrated in a short summer season are sunnier than the higher rainfall areas of the eastern escarpment and coastal belt areas.



**Figure 20: Mean percentage sunshine hours per day in South Africa**

(Source: Smith, 2006)



**Figure 21: Heat units accumulated over a 3-month period over a 12 month period in South Africa**

All of the mentioned further contributes towards the crops' ability to accumulate heat used to predict plant development rates. The concept of a heat unit involves the development of a plant that is dependent on the accumulation of heat to which the plant is subjected during its growth period.

Heats unit are the upper and lower temperature limits wherein crop growth is either stunted or stopped. It accumulates over a period of time and are expressed in degree days.

On the other hand, a chill unit is regarded as a certain period of winter chilling required by deciduous fruit trees to complete their dormancy during the months of May, June July and August. This dormant period, in combination with the winter chilling and followed by the spring heat units

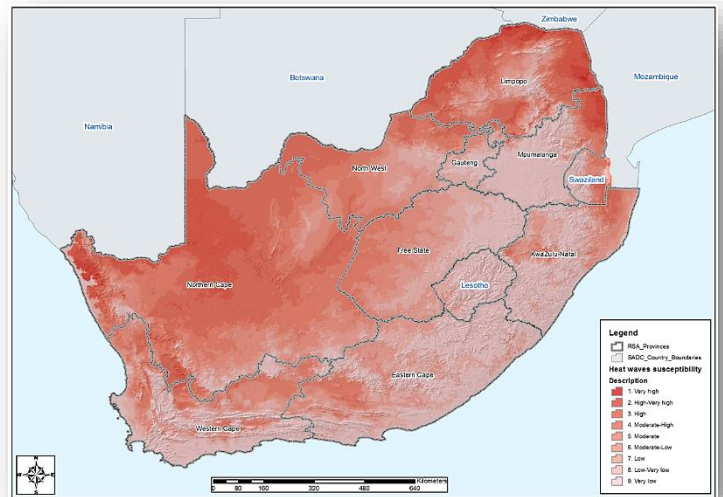
will encourage good flowering and fruit-set during the next season. Should insufficient chilling be experienced tree vigour will be adversely affected.

As with rainfall, a temperature hazard index is a useful tool for the farmer to determine temperature risks pertaining to the probability of the occurrence of heat waves, cold spells and frost.

- Heat waves

A heat wave is defined as a prolonged period of excessively hot weather that may be accompanied by a high level of humidity. A heat wave is measured relative to the usual weather in the area and relative to normal temperature for the season.

For South African conditions a heat wave is regarded as an area with a maximum temperature of  $> 30^{\circ}\text{C}$  for 3 or more consecutive days. Extreme heat waves is regarded as the occurrences of maximum temperatures of  $> 35^{\circ}\text{C}$  for 3 or more consecutive days or occurrences of temperatures of maximum  $30^{\circ}\text{C}$  for a period of 5 or more consecutive days.



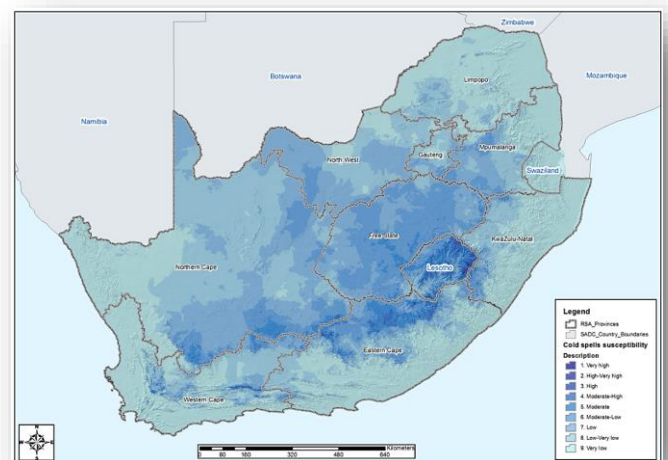
**Figure 22: Heat wave hazard risk index for South Africa**

- Cold spells

Cold spells that bring unexpected freezes and frosts during the growing season in mid-latitude zones can kill plants during the early and most vulnerable stages of growth, resulting in crop failure as plants are killed before they can be harvested economically.

The precise criterion for a cold spell is determined by the rate at which the temperature falls and the minimum to which it falls. This minimum temperature is dependent on the geographical region and time of year.

For South African conditions, a cold spell is regarded as an area with a minimum temperature of below  $2.5^{\circ}\text{C}$  for 3 or more consecutive days. Severe cold spells are regarded as the occurrences of minimum temperatures of below freezing point ( $0^{\circ}\text{C}$ ) for 3 or more consecutive days and extreme cold spells are the occurrences of temperatures of a minimum of below  $-2.5^{\circ}\text{C}$  for a period of 3 or more consecutive days.



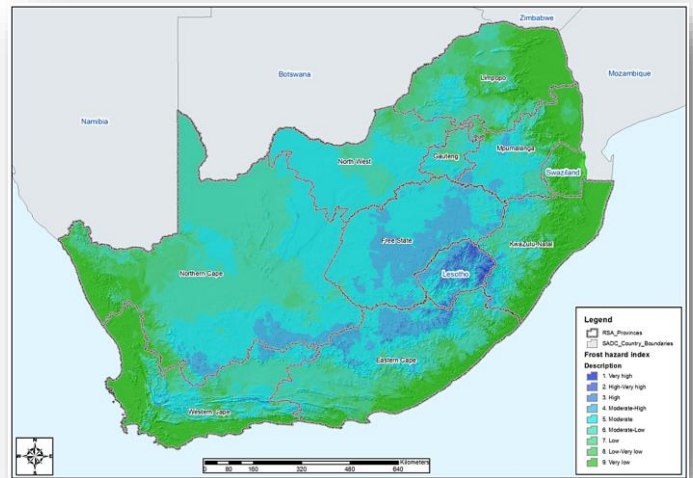
**Figure 23: Cold spell hazard risk index for South Africa**

- Frost

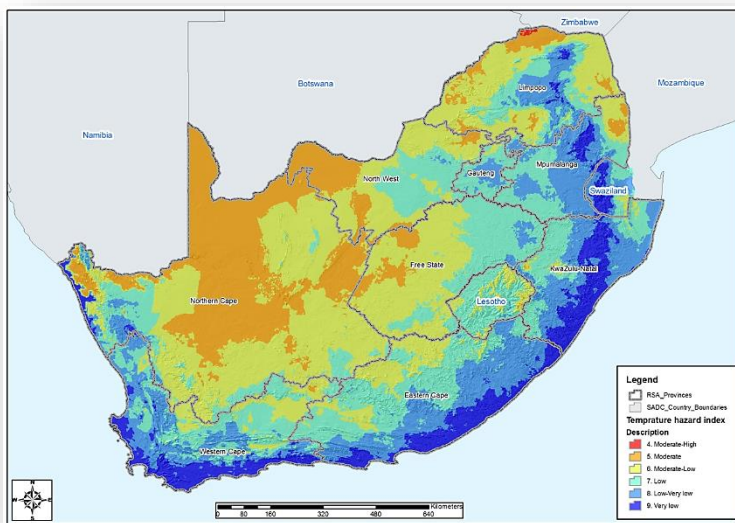
Frost is the solid deposition of water vapour from humid air.

It is not easy to add a fixed temperature to frost in relation to damage to a plant as the susceptibility to lower temperatures varies between plant species but also the stage of crop growth. Limited growth of agricultural importance takes place when temperatures reach an approximate 0°C, whilst the degree of damage can range from nearly undetectable cell damage to death of the entire plant.

The occurrence and intensity of frost is subjected to altitude, latitude and distance from the seas. Frost normally occurs on still, cold and cloudless nights. Its occurrence is normally from the end of April to the beginning of October on the interior plateau and escarpment, whilst the coastal areas and the Lowveld and Bushveld areas are mostly frost-free.



**Figure 24: Frost hazard risk index for South Africa**



**Figure 25: Temperature hazard risk index for South Africa**

The combined temperature hazard, inclusive of the heat wave, cold spell and frost indices depicts a combined approach towards indicating a temperature hazard for cultivation purposes.

Approximately 51% of the country have a low to very low temperature hazard risk with the remaining areas having a moderate to high temperature risk.

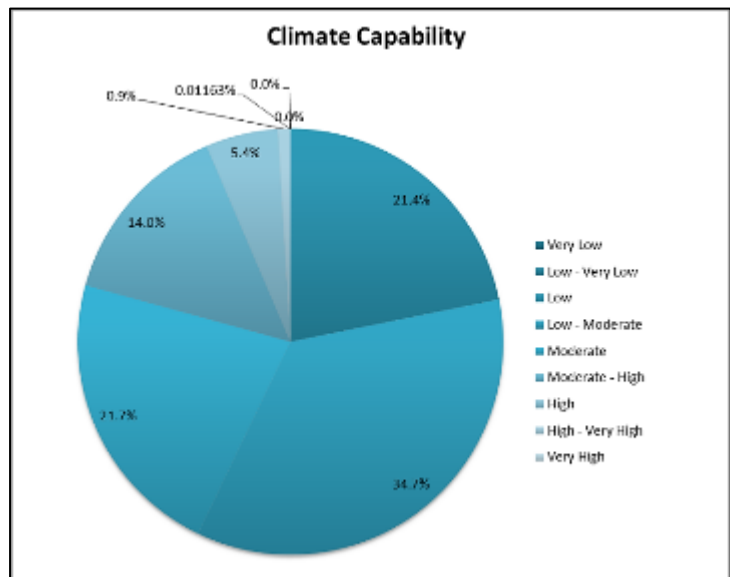
### **Climate Capability**

The overall agricultural climate capability is evaluated against its impact towards agricultural suitability.

Three major climatic factors impact the overall climate capability towards rainfed cultivation namely:

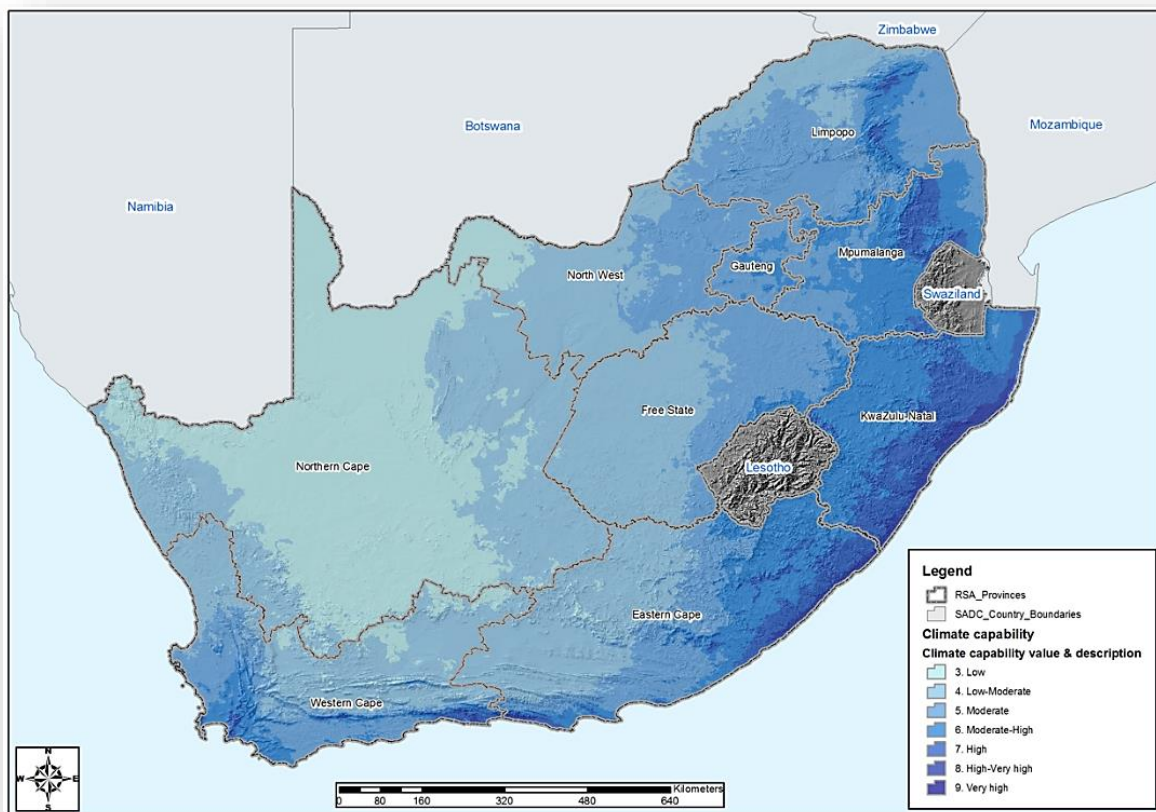
- Moisture supply capacity
- Physiological capacity
- Climatic hazards / constraints
  - Rainfall hazards
  - Temperature hazards

From the climate capability evaluation data layer it is concluded that more than 77% of the country have a moderate to low climate capability for rainfed cultivation, whilst slightly more than 20% have a moderate to high climate capability. This again stresses the climatic constraints for rainfed cultivation in the country and the associated risks attached thereto.



**Figure 26: Climate capability percentage distribution for South Africa**

Carefully planning should therefore be done when cultivation is to occur under rainfed conditions, given the climatic conditions of the applicable area and in relation to the capability of the soil to allow for sustainable production practices and resource protection.



**Figure 27: Climate capability for South Africa**

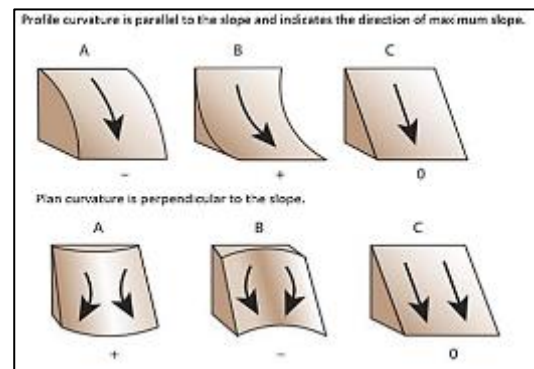
## 5.3 TERRAIN



### 5.3 TERRAIN

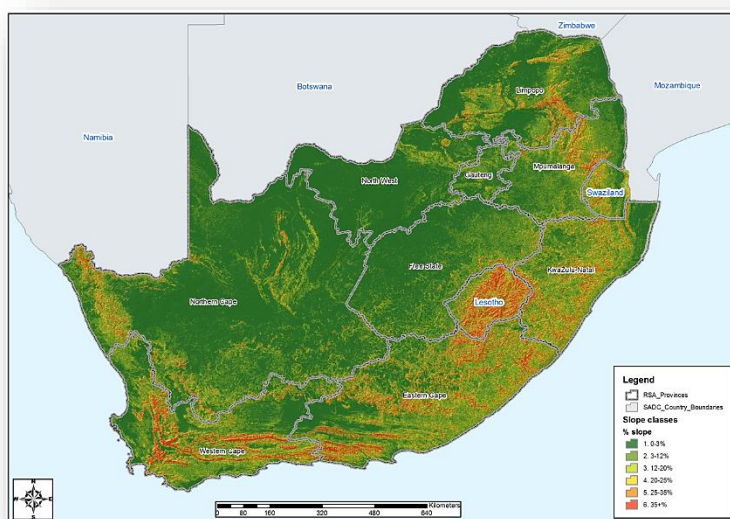
Although not directly regarded as a natural agricultural resource, the impact of terrain towards agricultural production cannot be ignored, not only from a plant's physiological growth requirements but also from a sensitivity and accessibility perspective, particularly in relation to cultivation. Terrain strongly influences agricultural productivity as a result of:

- The steepness of a slope affects plant growth through differential incidence of solar radiation, wind velocity and soil type;
- Steep slopes are susceptible to rapid surface runoff that causes soil erosion and –degradation;
- Slope is also an important variable in the selection of the most appropriate mechanisation practices (soil preparation, planting, harvesting, etc.);
- The curvature of the slope furthermore impacts on moisture and nutrient accumulation;
- Altitude of the land influences plant growth and development primarily through its effect on temperature. This abiotic factor is also an important variable in crop-selection;
- Aspect (direction of the slope) may have very significant influences on the micro-climate of an area.



**Figure 28: Impact of curvature towards water run off**

South Africa can be divided in three topographic areas namely the large interior plateau, the narrow coastal belt and the almost continuous range of mountains known as the “Great Escarpment”. The country consists of relatively level land (70%), making it favourable for crop production pending the soil and climate variables.



**Figure 29: Slope % class distribution in South Africa**

About 78% of the country consists of slopes of 12% and less. A slope of 12% is regarded as the maximum slope that can be cultivated without unusual protection, provided that the soil and climate qualities are sufficient. Of the 78%, 43% of these areas are level or have a slope of 0 to 2%. Only 6% of the country has steep slopes of more than 20%. These areas are used mainly for nature conservation purposes and water harvesting.

Topography is a static feature of the physical landscape with changes in altitude, slope gradient, slope form (shape) and aspect as well as in the rate of change over distance (relative relief). This in turn has an influence on all hydrological paths and associated agricultural responses.

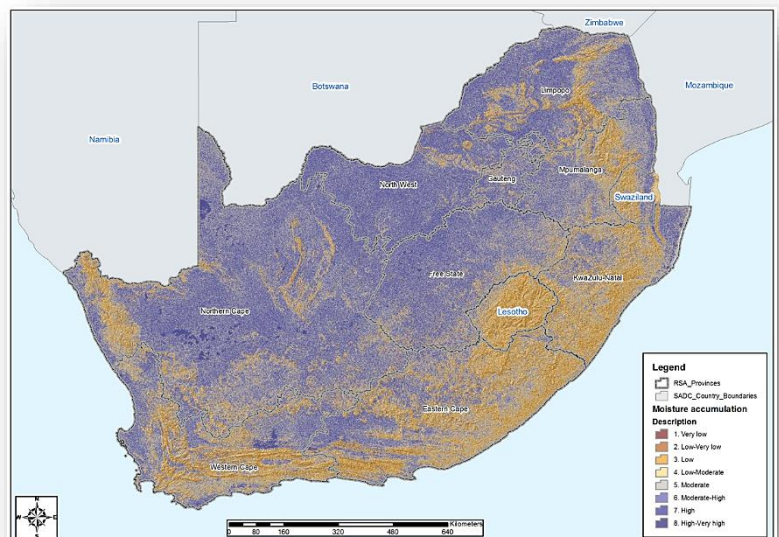
These variables therefore impact on:

- Soil forming processes
  - Steep slopes and hill tops tend to have shallower soils mainly due to erosion;
  - Leaching of nutrients and minerals tend to increase with an increase in slope gradient;
  - Bottom land soils tend to be deeper with an increase in nutrients (organic carbon);
  - Lower lying soils experience an increase in water accumulation due to downward leaching from the higher lying areas;
- Macro and micro features of climate
  - Mountainous areas tend to have more extreme weather conditions as it acts as a barrier to air movement and moisture;
  - Aspect and slope gradient correlates with solar radiation and plant physiological processes;
  - High altitude areas experience lower oxygen concentration and temperatures;
- Vegetation
  - Studies show a close relationship between topography and the types and structure of vegetation;
  - Lower density of vegetation is normally present on ridges in comparison with lower lying areas;
  - Surface curvature and slope aspect affect the distribution of vegetation.

The steepness of the slope but also the angle of the slope affects the manner in which water runs over the land and how soil is eroded from the land. Steeps slopes normally have thin unfertile dry soils whereas a flat slope tends to have thicker and more fertile soils as well as moist soil, suitable for plant growth.

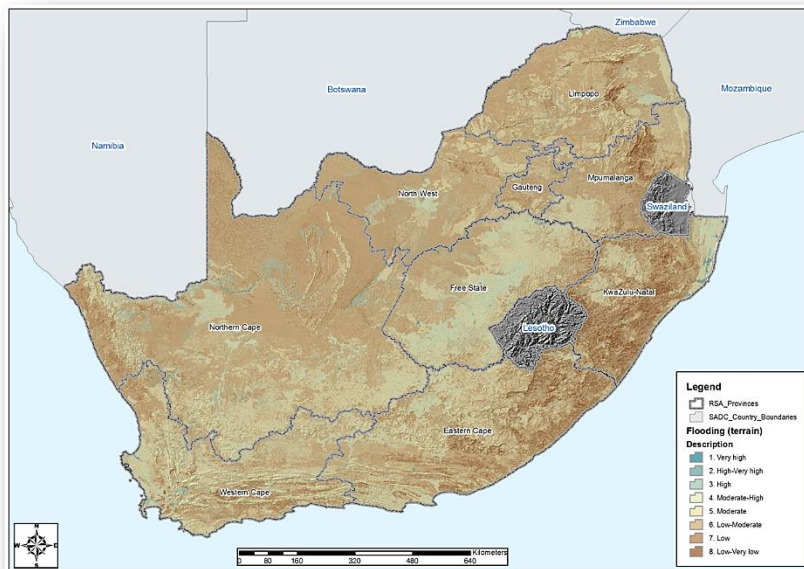
Aspect refers to the direction the slope faces. In the southern hemisphere slopes that face north (towards the equator) get more sunlight and are warmer than the south facing slopes. Altitude in turn again affects temperature.

From a production potential perspective terrain factors such as slope, aspect and altitude all contributes. Not only has the terrain an impact on the availability of water due to the landscape features but terrain can also bring about mechanical limitations making an area inaccessible for harvesting. Further to the mentioned, if an area is not well managed terrain can contribute to the degradation of the natural resources e.g. flooding with subsequent erosion.



**Figure 30: Moisture accumulation as a function of terrain**

In terms of availability of water as a result of the landscape (terrain form) two dominant issues influences crop growth namely the physiology of the plant that is determined by the impact of the terrain on moisture and slope gradient as well as solar radiation that in turn impacts on the ability of the crop to photosynthesize. Reviewing the moisture accumulation patterns in the country, similar patterns in relation to the slope classes is starting to form. The south-western as well as eastern parts of the country present lower accumulation values as a result of terrain constraints.



**Figure 31: Flooding hazard as a result of terrain form**

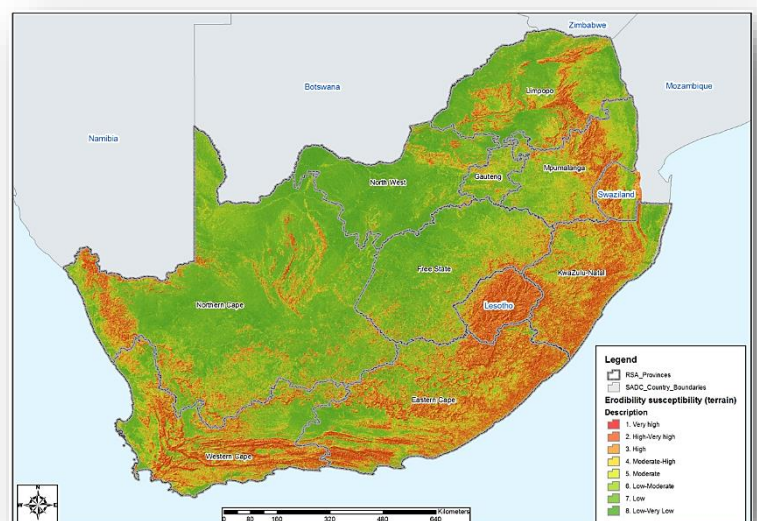
From a terrain sensitivity perspective, mechanical limitation to access cultivated areas, flooding and erodibility as a result of the run-off of water and flow acceleration needs to be acknowledged.

Flooding depends on the soil drainage properties, the surface run-off and accumulation of water. Long steady prolonged rainfall will produce rivers that can rise slowly resulting in flood, but heavy

short showers can cause rivers to rise quickly. Figure 31 provides an overview of the flooding hazard areas in the country.

In addition, the relief of the landscape further impacts on the possibility of flooding. Steep slopes tend to reduce the amount of infiltration into the ground. Steep slopes can also cause more through flow within the soil. Gentle slopes or flat land allow water to penetrate into the soil. Erosion further increases at steeper slopes due to increased angle and soil movement. On steep slopes, soils are mostly shallower and their nutrient and water storage capacities limited.

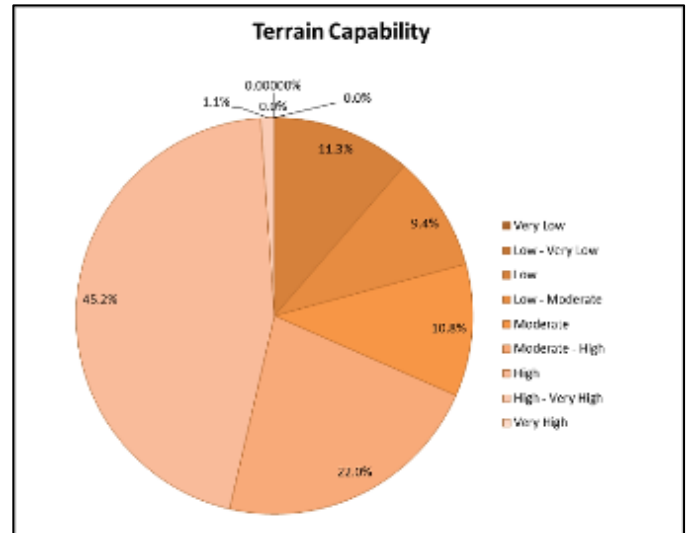
Vegetation type and coverage also play a major role e.g. forests intercepts more rainfall than as is the case with bare soil. Soil and rock type also influence precipitation when it reaches the ground. Impermeable soils and rocks such as clay or shale do not allow water to



**Figure 32: Erosion susceptibility as a result of the terrain form**

infiltrate that result in the run-off of water. Permeable rocks allow water through cracks but not through their pores such as limestones. Porous rocks allow water to infiltrate in their pores such as sandstone. Lastly, temperature also contributes to the risk of flooding. Hot days allow for more evaporation, thus reducing the risk of flooding.

More than 68% of the country have a moderate to very low erosion susceptibility as a result of terrain form, with only 35,6% have a moderate to high erodibility risk.

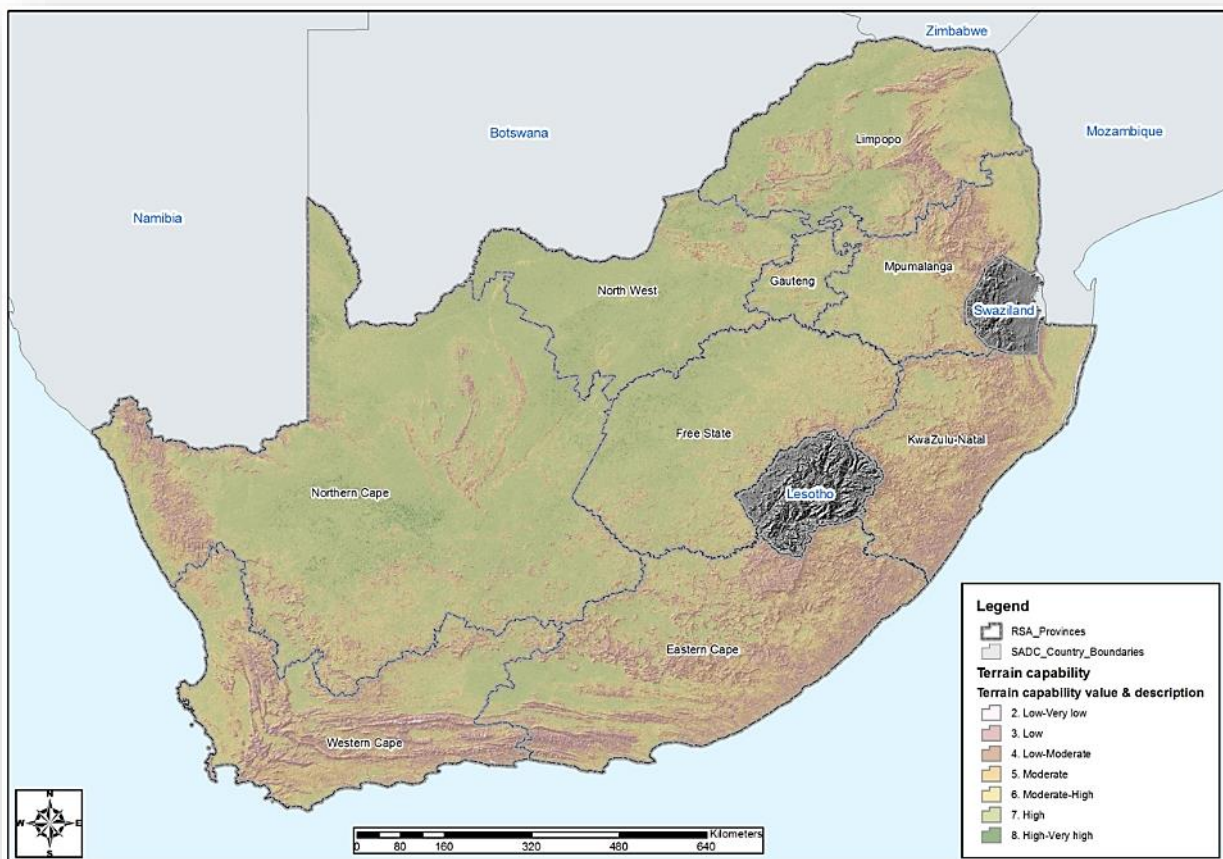


**Figure 33: Terrain capability evaluation values for the country**

### Terrain capability

Through the combination of the relevant plant physiological factors as well as the terrain sensitivity aspects, a comprehensive terrain capability evaluation for the country has been compiled.

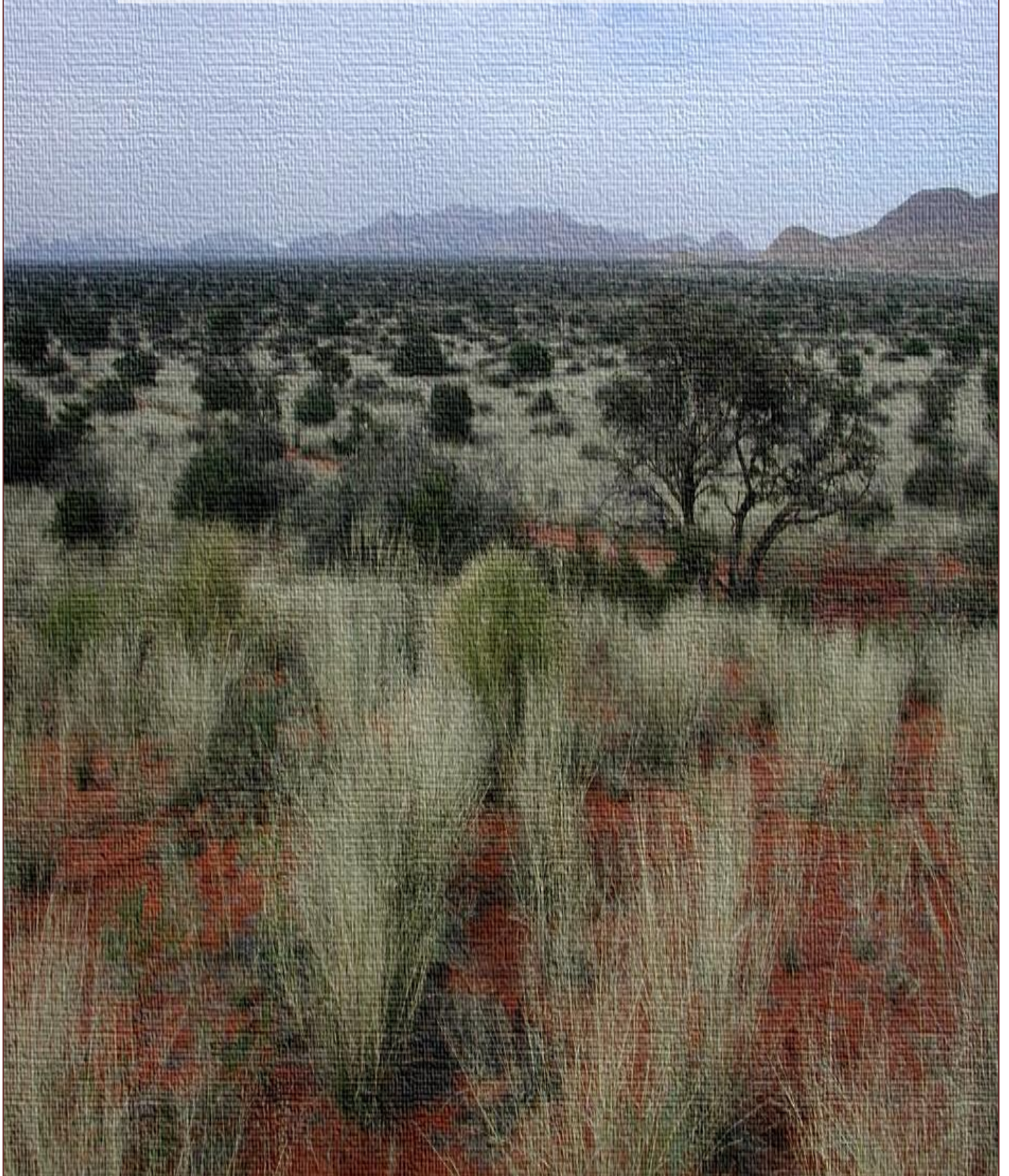
It was determined that nearly 70% of the country has a moderate to very high terrain capability, 10.8% have a moderate capability, whilst only 20.8% have a significant constraint in terms of terrain (low to very low terrain capability).



**Figure 34: Terrain capability for South Africa**

Given the discussion on soil, climate and terrain capabilities in the country, it can be concluded that nowhere in the country is a scenario where all three mentioned input factors will have a high capability towards rainfed cultivation. Given the locality in the country, one of the mentioned aspects (soil, climate or terrain) will bring about some kind of limitation that will test the farmer's skill towards optimal production, without resulting in the degradation of the resource.

## 5.4 VEGETATION



## 5.4 VEGETATION

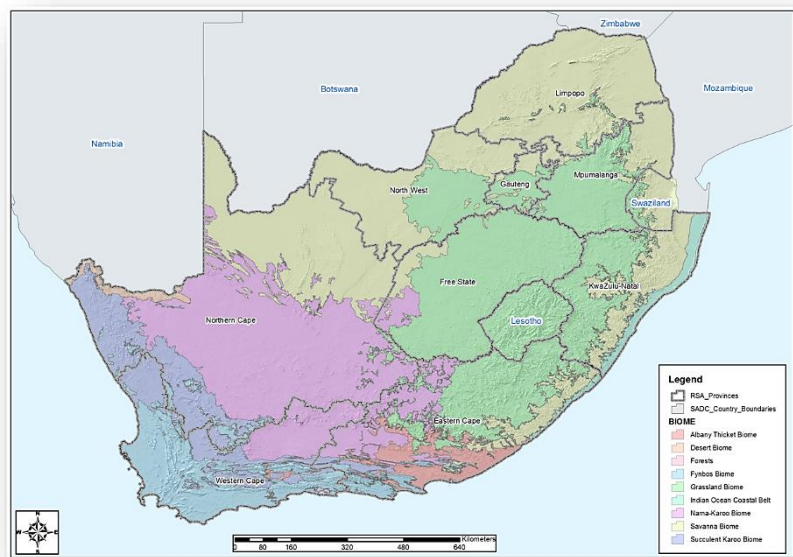
South Africa is in the unique position of being the country with the fifth highest number of plant species in the world. The country consists of only 2% of the world's land surface, but is home to nearly 10% of the world's plant species, and 7% of the bird, reptile and mammal species. It is also fortunate that one of the world's six floral kingdoms (the Cape Floral Kingdom) is totally contained within the country.

The natural vegetation covers approximately 102 010 434 ha or 83.63% of the country's surface (NLC 2013/14).

The country is characterized by nine biomes, inclusive of the forests areas in the country. Biomes' formation is influenced by climatic conditions where the plant communities adapt to the prevailing climatic conditions. As a result of climate, soil patterns and aspect, 459 veld types have been delineated in the country, each differing greatly in form and structure.

The winter rainfall area is characterised by the fynbos vegetation. Towards the east, in areas with a higher rainfall, natural indigenous forests extend to almost the coast. The drier areas of the Karoo in the central parts of the country, is characterised by succulent shrubs with intermittent grass species. A small desert area is present in the far western parts of the country where it extends into Namibia. The central inland plateau is mainly grassland, whilst the northern parts of the country consist of mixed savanna that is rich in *Senegalia* or *Vachellia* (former *Acacia*) and other woody species.

On average, terrestrial biodiversity is in a better condition than aquatic ecosystems. However, the areas with the highest biodiversity, such as the south-western Cape, the central grasslands and the eastern coastal regions, are also the areas under constant pressure for other land uses. Land degradation and desertification have a significant effect on the ecosystem's function, subsequently resulting in the loss of productivity of the land, and impacting on especially the livelihoods of poor people and the country's ability to feed the nation. In the Limpopo, Mpumalanga, North West and the Eastern Cape provinces, the conversion of stock farming to game farming has limited the loss of habitat and land degradation. Considerable action to reduce the clearing of land for cultivation purposes, as well as the implementation of stock reduction schemes on private land has also contributed to reducing habitat loss.



**Figure 35: Biomes of South Africa**

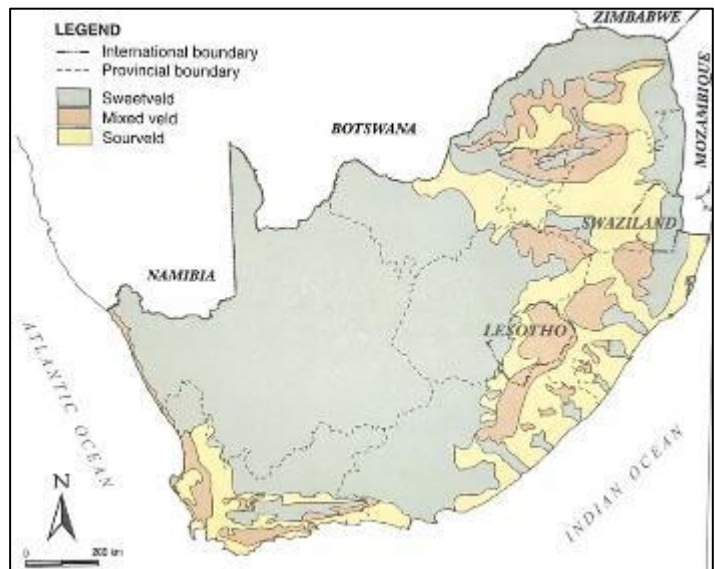
(Source: Vegmap data, 2018)

## Use of rangeland for animal production

Due to the variance in the South African climatic conditions and limitation of arable soils, many farmers rely on livestock and game farming as a source of income.

The natural rangeland areas in South Africa are divided into three broad veld type areas namely the sweet veld, sour veld and mixed veld.

Sweetveld is typically tall to moderate tall grassland. This veld remains palatable and nutritious when reaching maturity. In the summer rainfall areas sweetveld is mainly found at lower altitude areas with limited frost. The rainfall is normally below 600 mm per annum. This veld is therefore very sensitive to overgrazing but it recovers more rapidly than sour veld when disturbed. In the sweetveld parts of the country with rainfall throughout the year, the altitude varies over a large range. Rainfall in these areas are however erratic, which results in a low grazing capacity. Spring and autumn periods normally provided for the most reliable grazing. This veld is also easily invaded by fynbos plants. Recovery of disturbed veld is slow.



**Figure 36: Broad veld type areas**

(Source: Adapted from Tainton, Smith, 2006)

In the winter rainfall areas the grazing capacity of the sweetveld is also generally low as the portion of the veld composition is not grazed due to the presence of unpalatable species. In these areas, the veld is also very sensitive and prone to encroachment of especially fynbos species.

Sourveld is only palatable during the growing season. It occurs at higher altitudes and lower temperatures as is the case with the sweetveld. Rainfall is normally above 600 mm per annum. This veld has a higher grazing capacity than sweetveld. It is typically shorter grassland with grasses being palatable and nutritious during the growing season. Grazing is however of little value during the dry seasons and animals will require additional feeding. Sourveld can tolerate relative levels of over grazing but it may result in lower production.

Mixed veld represents the intermediate between sweetveld and sourveld, whereas sweet-mixed provides grazing for nine – eleven months of the year, whilst sour-mixed veld is only adequate for six to eight months.

Veld condition plays a significant role in determining the potential, productivity, capacity and seasonal duration of rangeland for the long-term sustainable use by livestock. Such condition is highly dependent on the vegetation composition, cover, rangeland management practices as well as prevailing climatic conditions.

## Grazing capacity

Plant density, species composition and productivity influences the grazing capacity of the natural veld and the potential for intensification, with specific reference to prevailing veld condition status. Veld production mainly depends on rainfall and veld condition, many times as a result of management practices.

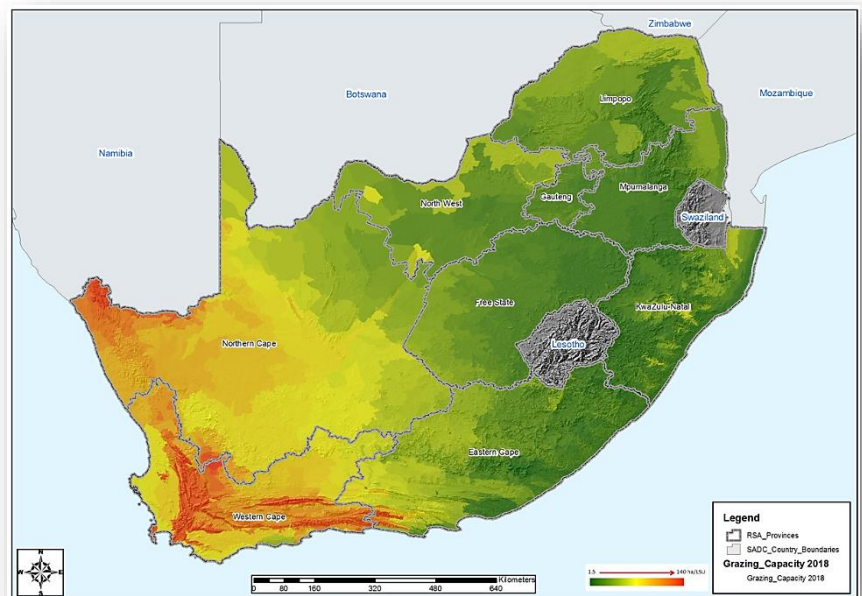
Management of veld condition is a high priority according to the Conservation of Agricultural Resources (CARA) Act, 43 of 1983. The Act describes grazing capacity in relation to veld as “the production capacity over the long term of that veld to meet the feed requirements of animals in such a manner that the natural vegetation thereon does not deteriorate or is not destroyed”.

Regulation 10 of CARA describes and regulates the long-term grazing capacity norm of natural rangeland and uses ha/ LSU (large stock unit) as prevailing reference base. Grazing capacity is thus the amount of grazing land allocated to an animal unit (LSU) on a sustained basis. The current formal grazing capacity norm was published in 2018.

The CARA defines a large stock unit (LSU) as a “unit which consists of the prescribed number of animals of a prescribed kind, type, breed, age or sex, or which is in a prescribed phase of production or is of a prescribed approximate live mass”.

To achieve high performance in animals, large quantities of food and water need to be consumed. A 450 kg cow has a daily intake of 10 kg of dry matter (3 650 kg dry matter per annum) or 40 kg of green grass whereas water is consumed at 10% of the body weight (in this instance 45 litres per day).

Factors that are affecting the production of a grazing animal include veld type, time of year and drought, some of which is beyond the control of the livestock manager. However, factors such as quantity, quality and height of herbage, selection of feed and relation to livestock numbers are within the control of the manager and if not done well can either result in the degradation of the natural agricultural resource or on livestock numbers and production. Bush encroachment has an additional impact on grazing capacity.



**Figure 37: Grazing Capacity norms for South Africa (CARA)**

Grazing capacity is thus the amount of grazing land allocated to an animal unit (LSU) on a sustained basis. The current formal grazing capacity norm was published in 2018.

Another aspect to take into consideration when determining grazing capacity is tree density, which is especially of relevance in the savanna biome areas.

The effect of tree density on grass production can be illustrated as follows:

Tree density (Tree equivalent / ha)*	Portion of grass yield in relation to the absence of trees (%)
900	90
1 200	85
1 500	70
1 800	50
2 100	30

\*Tree equivalent (TE) – 1.5 m high tree

**Table 6: Effect of tree density on grass production**

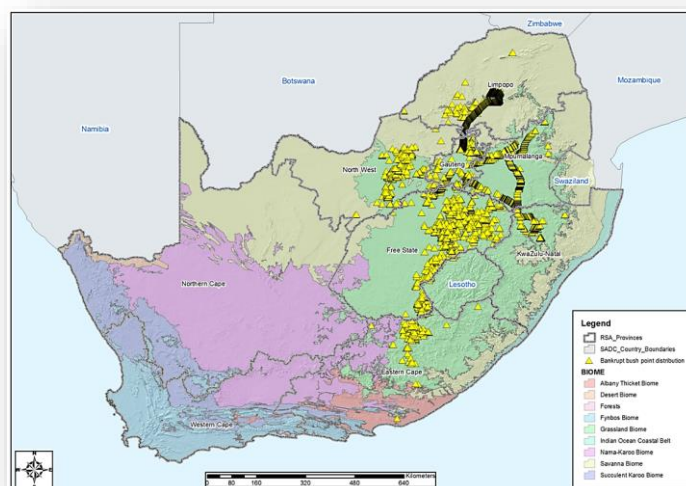
(Source: Smith, 2006)

Although natural vegetation covers 83.63% of the land surface in the country, 6.11% of this area is not available for agricultural use as it is within a gazetted Environmental Protected Area as defined under the National Environmental Management: Protected Areas Act, 57 of 2003.

It must however be mentioned that the long-term grazing capacity norm as defined under CARA should not be interpreted as either carrying capacity or stocking rate. Carrying capacity is defined as the amount of grazing land and fodder cropland allocated to an animal unit on a sustained basis. Stocking rate in turn refers to the amount of land allocated to an animal unit that can result in overutilization, if not managed correctly.

Generally, the stocking rate exceeds the grazing capacity of the veld. Unfortunately, large grazing areas in the country are subjected to poor condition as a result of over grazing, bush encroachment and alien invasive species. Bush encroachment *per se* has rendered three million ha unsuitable for grazing purposes.

One of the main culprits here is Bankrupt bush (*Seriphium plumosum*). Research results indicate that a rangeland area of almost 11 million ha can be lost for livestock production as a result of Bankrupt bush invasion. In some cases farmers have already lost most, if not all, of their natural veld despite their best efforts to control or eradicate this plant.



**Figure 38: Bankrupt bush encroachment in South Africa**

Using the 2013/14 National Landcover data set as reference and subtracting:

- permanently transformed areas either being lost to any form of agricultural production such residential or mined areas or
- areas used for other agricultural purposes such as cultivation or
- areas not available for agriculture such as Protected Environmental Areas under the NEMPA Act as well as
- natural vegetated areas not suitable for grazing purposes,

an estimation have been done as to the amount of available natural vegetation for livestock purposes and the number of livestock the country is able to retain without degrading the vegetation resource component.

Table 7 provides an overview of the available rangeland for livestock grazing and potential carrying capacity (excluded planted pastures) on natural veld.

Province	prov_ha	Avail_grazing_ha	% of province	LSU
Northern Cape	37 288 941	33 600 683	90.11%	1 446 536
Eastern Cape	16 896 597	14 058 833	83.21%	1 874 508
Limpopo	12 575 391	9 712 963	77.24%	1 158 536
Free State	12 982 516	8 538 734	65.77%	1 333 815
North-West	10 488 168	7 849 524	74.84%	846 667
Western Cape	12 946 219	6 594 827	50.94%	171 812
KwaZulu-Natal	9 305 166	6 079 373	65.33%	1 227 629
Mpumalanga	7 649 468	3 842 488	50.23%	760 968
Gauteng	1 817 831	1 055 489	58.06%	176 334
<b>RSA TOTAL</b>	<b>121 950 297</b>	<b>91 332 914</b>	<b>74.89%</b>	<b>8 996 806</b>

**Table 7: Rangeland availability per province**

(Source: Avenant, 2018)

From the above calculation approximately 74.8% of the country's surface is available for grazing purposes that can feed nearly 9 million heads of LSU.

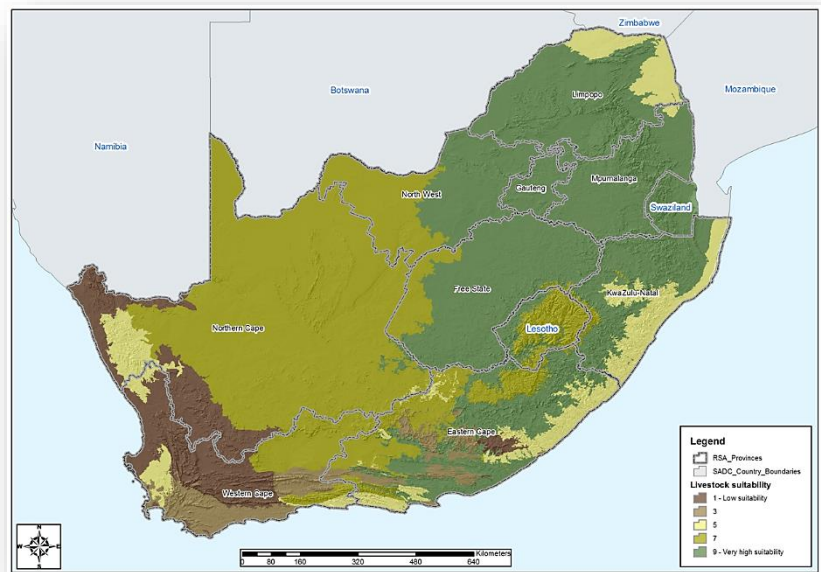
Biome	Biome_ha	Avail_grazing_ha	% of biome	LSU
Savanna	40 532 721	32 002 332	78.95%	3 358 117
Nama-Karoo	26 022 249	24 686 067	94.87%	967 570
Grassland	32 534 079	21 560 559	66.27%	3 934 838
Succulent Karoo	8 695 740	7 084 267	81.47%	157 717
Albany Thicket	3 148 853	2 717 654	86.31%	297 853
Fynbos	8 522 072	1 766 840	20.73%	53 352
Indian Ocean Coastal Belt	1 652 445	890 755	53.91%	216 791
Desert	735 932	609 377	82.80%	7 828
Forests	106 206	12 420	11.69%	2 427
<b>RSA TOTAL</b>	<b>121 950 297</b>	<b>91 330 272</b>	<b>74.89%</b>	<b>8 996 492</b>

**Table 8: Rangeland availability per biome** (Source: Avenant, 2018)

Referencing the above in terms of availability of natural veld per biome, as the biome represents specific livestock enterprises with associated risk factors, Table 8 displayed the outcome of thereof. Of specific importance is the Grassland biome, one of the most important biomes for grazing purposes, an estimated 66.2% is remaining, whereas for the Nama-Karoo areas, mostly used for small stock, 94.8% is still remaining.

The above calculations however does not reflect the fragmented component of available rangeland as a result of other non-available areas which have a significant negative impact on rangeland availability. Too small pockets of rangeland is not suited for livestock production and therefore the indicated figures above can be regarded as an over estimation of available rangeland.

It further does not reflect areas subjected to bush encroachment or the invasion of alien and invader plants or areas that are overgrazed. Overgrazing may be regarded as a “temporary impact” but in many instances the severity and intensity of overgrazing is of such an extent that the total ecosystem and related services have been completely destroyed with the resulted consequence that recovery of such an ecosystem may take decades for it to be rehabilitated back into a state of functional production.



**Figure 39: Livestock suitability index classification for South Africa**

Although the grazing capacity norm relates to the number of large stock units that are recommended, taking cognisance of the prevailing vegetation type (biome) and rainfall as well as veld condition, it does not reflect the suitability of the area for livestock production, whether it is for large or small stock. There is a general believe (incorrect though!) that the higher the grazing capability norm is the less important it is for animal production. Biomes such as the Nama-Karoo is not equally perceived to be as important as the Grassland biome mostly due to the larger number of ha required per LSU as per the grazing capacity norm. However, these areas are highly suited for the keeping of small stock (sheep and goats) as a result of their feeding requirements that makes these areas highly suited for animal production.

Through the combination of grazing capacity values as well as livestock suitability per geographic area (beef, sheep, goats, game), a livestock suitability index have been compiled. As per the index, areas suitability for livestock (irrespective if it small or large stock) is classified in Table 9. In addition, areas that is either permanently or not currently available for grazing purposes (same as above description pertaining to grazing capacity) have been excluded from the relevant livestock index value to obtain a better indication on the current state of rangeland availability.

<b>Suitability rating</b>	<b>% of the country's surface</b>	<b>% of the country's surface remaining</b>
Very high suitability	42.7	27.8
High suitability	38.9	33.4
Moderate suitability	9.4	5.9
Low suitability	4.2	2.2
Very low suitability	8.7	5.3

**Table 9: Livestock suitability index values for South Africa**

Of specific interest is the fact that nearly 50% of the very high suitable rangeland areas are no longer available for rangeland purposes. The main contributor thereto is however mostly as a result of cultivation practices, as there is a significant overlap between the intense cultivated areas of the country and those areas highly suited for livestock production.

However, the area normally perceived to be of little value (drier arid areas) is regarded as highly suited for especially small stock production and as these areas are mostly not suited for cultivation (rainfed), very little of it has been lost (lost can mostly be attributed to protected environments and to a lesser extent development - residential and mines).

Both cultivation and livestock are contributors to the agricultural economy and given the above, these two components has the ability to co-exist, given careful planning to provide for optimal land use.

### **Wildlife management**

Although the agricultural sector has placed a lot of emphasis on livestock production, wildlife management is also one of the sectors that require mentioning. The wildlife industry is built on four pillars namely breeding, hunting, ecotourism and game products.

Hunting is well established in South Africa, whilst game breeding has also growing steadily in the last number of years. Ecotourism has been slow to develop whereas the development of game products has even been slower. Within this sector, there is thus much room for growth and development, especially if one takes into consideration the arid nature of the country with many areas highly suited for game farming and the financial opportunities associated with wildlife farming.

According to a survey conducted by the Game industry in 2014/2015 it was found that the majority of game ranchers were located in the Limpopo province but provinces such as North West, Eastern Cape and the Northern Cape have shown tremendous growth in the establishment of game ranches or the transition from the conventional agricultural practices to game ranching. Strong drivers behind the locality was mostly due to economic reasons, whilst knowledge on the climate and

ecological characteristics of the specific province, which made management easier, was also a prominent driver. Other factors that influence locality were prices of the land, proximity to metropolises and security considerations.

The most popular species ranches with include (in order of priority) kudu, common impala, blesbok, waterbuck, blue wildebeest, and eland. Nyala was found to be the most popular in terms of high value animals.

The management components of wildlife farming however need to be well addressed, as it is a complex management system with many variables that needs to be taken into consideration. It was found that the majority of game farms in the country varies between 100 – 1 000 ha in size.

The survey found that in terms of extensive systems the following aspects need to be addressed:

- The farming unit should be of sufficient size for the management of free-roaming wildlife populations, irrespective if the area is fenced or not;
- Careful consideration should be given to the game composition on the farming unit so that provision is made for all species' feeding requirements, both browsing as well as grazing species and the combination thereof;
- Farming units should meet the ecological requirements of the wildlife populations on the land;
- No or minimal intervention is required for the provision of water, supplement feeding (except in times of drought), the control of parasites or predations or the provision of health care.

In the instance of small intensive breeding systems, skilled management is required to ensure optimal levels of production.

The wildlife industry has divided the country into 5 ecological regions:

- Grassland: This region is defined as the higher inner plateau and mountains with a rainfall ranging between 500 – 800 mm per annum. Vegetation is dominated by various grass types with few shrubs and trees;
- Lowveld: This region consists of the low-lying savannah areas east of the Northern Drakensberg escarpment, including the Kruger National Park, with a rainfall between 400 – 600 mm per annum;
- Bushveld: This region refers to the savannah areas in the northern parts of the country, west of the Drakensberg escarpment, including the upper Limpopo valley where rainfall varies from 300 – 600 mm per annum;
- Kalahari: This region is the arid savannah area with a rainfall between 200 – 400 mm per annum;
- Karoo: The Karoo is divided into three regions namely the Nama Karoo, Klein Karoo and Eastern Karoo. It is diverse in climate with rainfall that varies between 50 mm in the western parts to 500 mm on the higher parts of the mountains.

The carrying capacity norms for game animals per ecological region have been devised as follows:

Ecological region	Ecological carrying capacity (ha/LSU)		Ecological carrying capacity used in financial analysis (ha/LSU)
	Min	Max	
Grassland	3	20+	6
Lowveld	6	15+	10
Bushveld	6	17+	12
Kalahari	10	35+	13
Karoo	15	90+	20

**Table 10: Carrying capacity norms for game farming per ecological region**

The conclusion has been reached that game ranching is likely to yield better financial results than most other agricultural land use options. In fact, it has been stated that game farming may be regarded as one of the most profitable land use option in the country. The financial gain is however very locality specific, often determined by topography and climatic factors. This is also one of the main reasons for the transformation of livestock production to game farming.

Starting off however may require a large capital investment, but in order to continue thriving effective management, good veterinary support and stringent cost control is needed but above all, effective natural resource management, especially in the more arid regions of the country.

# 5.5 WATER



## 5.5 WATER

Water is one of the strategic resources of the country and essential for any social and economic development. Uses of water are not only limited to residential use, but industry as well as agriculture relies heavily on this resource. Unfortunately the supply thereof is very limited and of variable quality. Increasing demands are placed on water resources from the agricultural sector as well as for industry and human consumption. Due to the uneven distribution of the country's water resources, large amounts of water are distributed throughout the country.

Currently about 74% of South Africa's potential available rainwater is used by the agricultural sector and forestry. Of the 74%, about 60 is used for the maintenance of forest growth and natural vegetation used by livestock and game and 12% is used for rainfed crop production. Only 2% of the 74% available rainwater is used for irrigation purposes. Agriculture is regarded as the largest single user of run-off water.

According to the National Water Resources Strategy of 2005, cited in the draft National Strategy on Sustainable Development (NSSD), there should be sufficient water resources to meet the requirements, provided the resource is carefully managed, not taking into consideration the effects of climate change on water availability. It is predicted that climate change will have a significant influence on the availability of water. Furthermore, by 2025, requirements will exceed water availability with an increase in requirement for growth, especially in the industrial and urban domestic sectors.

There are more than 500 Government dams in South Africa with a total capacity of 37 000 million m<sup>3</sup> which is equal to 15 million Olympic sized swimming pools. Table 11 portrays the ten largest dams in the country with their feeding rivers respectively.

<u>Dam</u>	<u>Major feeding river</u>	<u>Million m<sup>3</sup></u>
Gariiep Dam	Orange river	5 340
Vanderkloof dam	Orange & Berg Rivers	3 187
Sterkfontein dam (include Driekloof dam)	Tugela river - redirected	2 616
Vaal dam	Vaal river. Wilge & Klip rivers	2 603
Pongolapoort Dam / Lake Jozini	Phongola river	2 267
Bloemhof dam	Vaal & Vet rivers	1, 240
Kruismansriver Dam	Kruismans river	1 500
Theewaterskloof dam	Sonderdend River	480
Greater Brandvlei dam	Breede river	459
Heyshoop Dam	Assegaai river	451

**Table 11: The ten largest dams in South Africa**

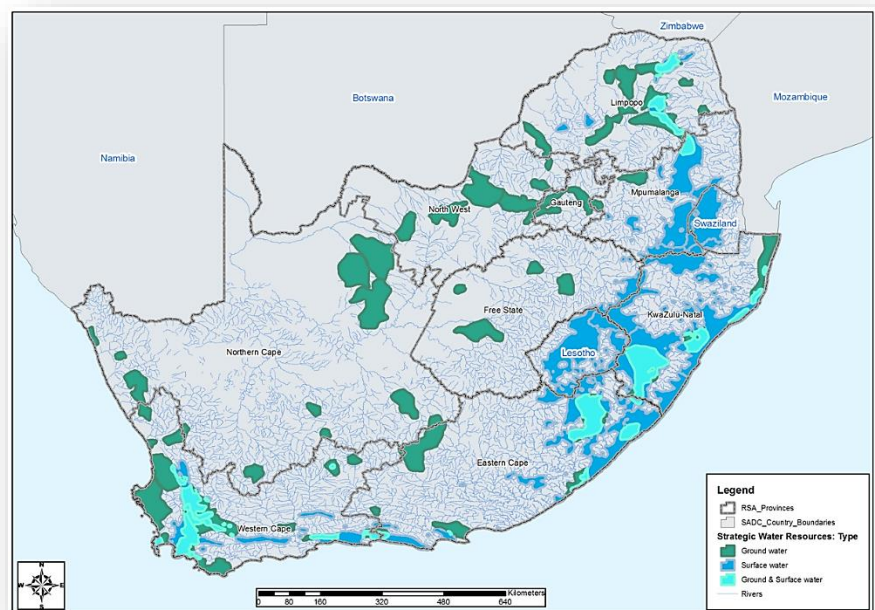
The previous Department of Water Affairs and Forestry initiated a project to conduct a groundwater resource assessment in order to quantify the ground water resources of the country on a national scale. Table 12 depicts the results of the study.

Type	Amount
Total volume of groundwater	235.5 billion m <sup>3</sup>
Groundwater resource potential	49 billion m <sup>3</sup> /a
Average groundwater exploitation potential	19 billion m <sup>3</sup> /a
Potable groundwater exploitation potential	14.8 billion m <sup>3</sup> /a
Utilizable groundwater exploitation potential	10.3 billion m <sup>3</sup> /a

**Table 12: Groundwater resources in South Africa**

(Source: Holtzhausen, 2005)

According to a Water Research Commission report on Strategic Water Resource Areas of the country (2017), the areas for groundwater covers 9% of the land surface of South Africa. 24% of this area overlaps with the areas delineated for surface water. These areas account for up to 42% of the base flow and their areas and play a key role in sustaining surface water flows during the dry season. These water sources also supply about 46% of the ground water used by agriculture. Of interest is that *only* 11% of the strategic water sources of South Africa are under protected areas.



**Figure 40: Strategic Water Resources (ground and surface water) of the country**

The total re-charge for South Africa is estimated to be 34 912 million m<sup>3</sup>/a with the recharge generated by the strategic resources surface water being 11 675 million m<sup>3</sup>/a (33%) and for ground water 5 397 million m<sup>3</sup>/a (15%).

On the other hand the total average run-off of South Africa's rivers are estimated to be 53 500 million m<sup>3</sup> but this is highly subjected to the variability in river flow, with significant losses due to evaporation. Only about 62% or 33 000 million m<sup>3</sup> of the mean annual run-off can be used economically, with an additional 5 400 million m<sup>3</sup> that may be obtained from underground water

sources as a result of limited exploitable aquifers. New groundwater contributions are very limited as over-exploitation thereof with a resulted significant drop in water table levels have already been reported in certain parts of the country.

According to the Department of Water, Sanitation and Human Settlements' latest available data, the water being used for irrigation purposes amounts to 62%, 23% is used for urban requirements and the remaining 15% is shared by other uses such as rural users, mining and bulk industrial, power generation and afforestation.

As indicated, due to the limitation of this resource the demand thereof will mostly likely in future exceeds the supply thereof. This is already the case in some of the catchments in the country. In 2000, 12 of the 19 water management areas in South Africa have already faced a water deficit. The World Wildlife Foundation has estimated that 98% of the country's water resources have already been allocated, therefore very few of this precious resource are still available, notwithstanding the increase in demand and the impact of climate change.

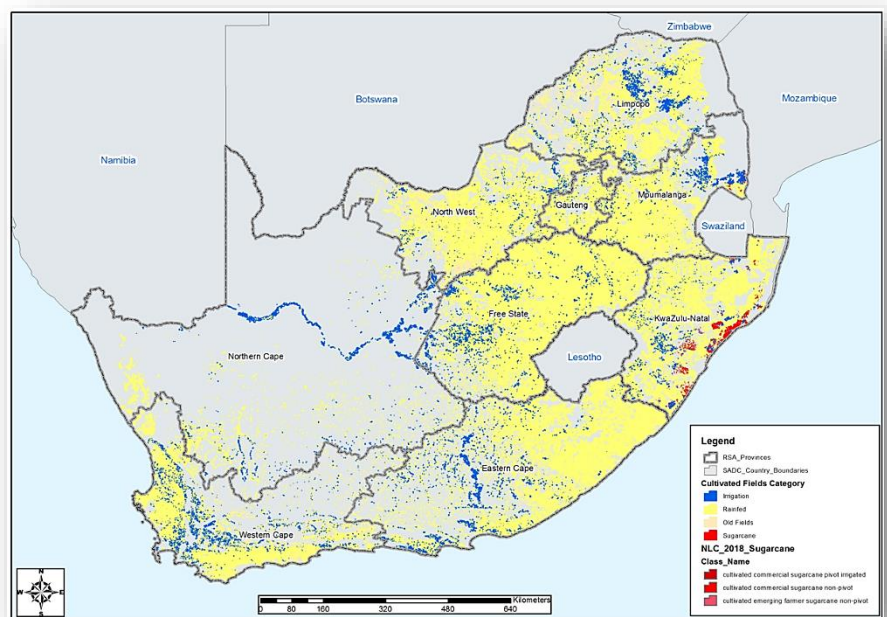
In addition, the status of water sources, such as rivers is also alarming at present. About 82% of the main river ecosystems are threatened, of which 44% can be regarded as critically endangered, 27% endangered and 11% vulnerable.

### **Irrigation potential and suitability**

The agricultural sector depends considerably on water for irrigation purposes. Irrigated cultivation plays a significant contribution towards agricultural production in South Africa, mostly as a result of the limited arable resources and the substantial risk that accompanied rainfed cultivation in the country due to severe climatic constraints.

Not only is irrigation potential dependant on the suitability of the soil to be used for irrigation purposes but the also the availability and quality of water for this specific purpose.

An estimated 1 521 480 ha are under irrigation. This amounts to about 10.7% of the total cultivated fields in the country. The total area under cultivation amounts to 14 208 116 ha or 11.65% of the country's total surface. These figures are based on the 2017/19 cultivated fields' data layer released by the



**Figure 41: Cultivated areas (rainfed & irrigation) in South Africa (2019)**

Department of Agriculture, Forestry and Fisheries. The Northern Cape Province has the largest amount of irrigated fields as a percentage of the total provincial cultivated fields, followed by the Limpopo and Western Cape provinces respectively.

Province	Irrigation per province (ha)	Total provincial cultivated areas (ha)	% irrigated areas of total provincial cultivated areas
EC	166 504.92	1 365 373.81	12.19%
FS	201 334.18	3 869 153.24	5.20%
GP	29 883.94	389 601.42	7.67%
KZN	132 002.94	1 193 785.79	11.06%
LP	250 214.99	1 382 540.92	18.10%
MP	156 786.58	1 457 334.75	10.76%
NC	161 658.25	286 717.24	56.38%
NW	114 341.60	2 311 378.62	4.95%
WC	308 752.93	1 952 231.09	15.82%
<b>Total:</b>	<b>1 521 480.34</b>	<b>14 208 116.89</b>	<b>10.71%</b>

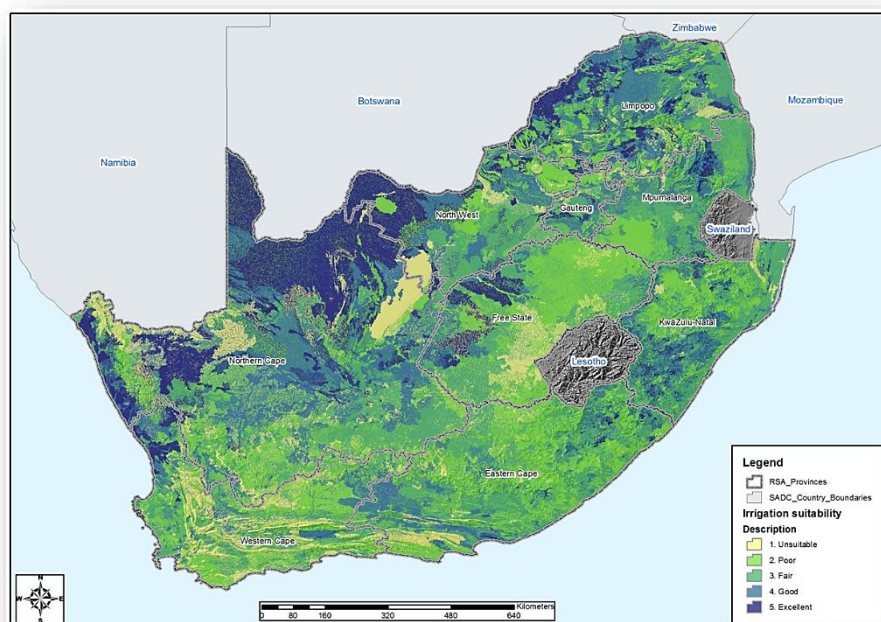
**Table 13: Irrigated cultivation per province, 2019**

Water sources for irrigation purposes vary regionally and can be from surface or underground water sources. The area registered for irrigation use is between 1.44 to 1.68 million ha. Due to the variance in seasonal cultivation practices and prevailing climatic conditions, the estimated water use for irrigation purposes is between 51 – 63% of South Africa’s total water resources.

The greatest allocation of surface water is to irrigation schemes in the middle Orange River but the greatest Gross Value Added is in the Western Cape, KwaZulu Natal, Gauteng and parts of Mpumalanga and Limpopo.

Ground water abstraction for agriculture only comprises 14% of the total water abstraction for agricultural purposes. About 47% of the groundwater abstraction for agriculture comes from the strategic groundwater areas.

Soils suitable for irrigation purposes are limited. Less than 10% of the soils on the larger irrigation schemes, such as Vaalharts and along the Fish River, are highly suitable



**Figure 42: Irrigation suitability classification for South Africa**

for irrigation, whilst on other irrigation schemes this amount seldom exceeds 30 to 40% of the area. It can therefore be concluded that most irrigation practices are conducted on sub-optimal to marginal land, requiring high levels of management.

Irrigation suitability is highly dependent on the properties of the soil such as soil depth and the depth of the water table as well as slopes (with the exception where sugarcane and irrigated pastures occur). Irrigation suitability using an indicator value has been calculated for the country.

Irrigation Suitability is divided in to 5 classes namely:

<b>Irrigation suitability class</b>	<b>Area in ha</b>	<b>% of South Africa</b>
Unsuitable	13 314 351.80	12.7%
Poor (poorly suitable)	32 185 375.73	26.39%
Fair	33 104 589.65	27.14%
Good	24 563 631.68	20.14%
Excellent	16 550 206.70	13.57%

**Table 14: Irrigated suitability classes for South Africa**

The country has limited land suitable and available for irrigation with the supporting and adequate water sources. Seen within the context of climate change, population growth and the decline in water quality a detailed assessment needs to be done on the water use for irrigation purposes in relation to the water capacity and availability of the relevant catchment area, specifically in terms of possible expansion of irrigated agriculture as described within the National Development Plan. This will allow for better planning within the agricultural sector in terms of production potential for long-term food security but also to allocate water use for ensuring its optimal use.

# 6. AGRICULTURAL CAPABILITY & POTENTIAL



## **6. AGRICULTURAL CAPABILITY & POTENTIAL**

All agricultural activities, whether cultivation of livestock production, take place within a defined ecosystem. Not only are these activities dependent on the capability, suitability and potential of the ecosystem, but the practices exercised impacts on the dynamics and also sustainability of such a system and the related ecosystem services. From an agricultural perspective, this concept is most commonly referred to as an agro-ecosystem (agro-ecology) and can be demarcated at any scale, from farm level to regional area.

Agro-ecology is the application of ecology to agriculture. It uses the interaction between an ecosystem's biotic and abiotic components within a farming environment with the aim of making the farming enterprise more successful for the farmer within a sustainable environment, thus ultimately the sustainable utilization of the natural agricultural resource base for agricultural production purposes. An agro-ecosystem is therefore an ecosystem that is used for agriculture.

The agro-ecosystem concept provides a framework within which to analyse food production systems as a whole (multidisciplinary, holistic approach), including the complex set of inputs and outputs and the interconnection of the various components / parts. It is based on ecological principles and natural ecosystems functioning.

An agro-ecosystem functioning is, in principle, complex and involves the interactive and interrelated use of the dynamics within an ecosystem but with the specific focus on agricultural land use taking cognisance of the physical, biological and human processes.

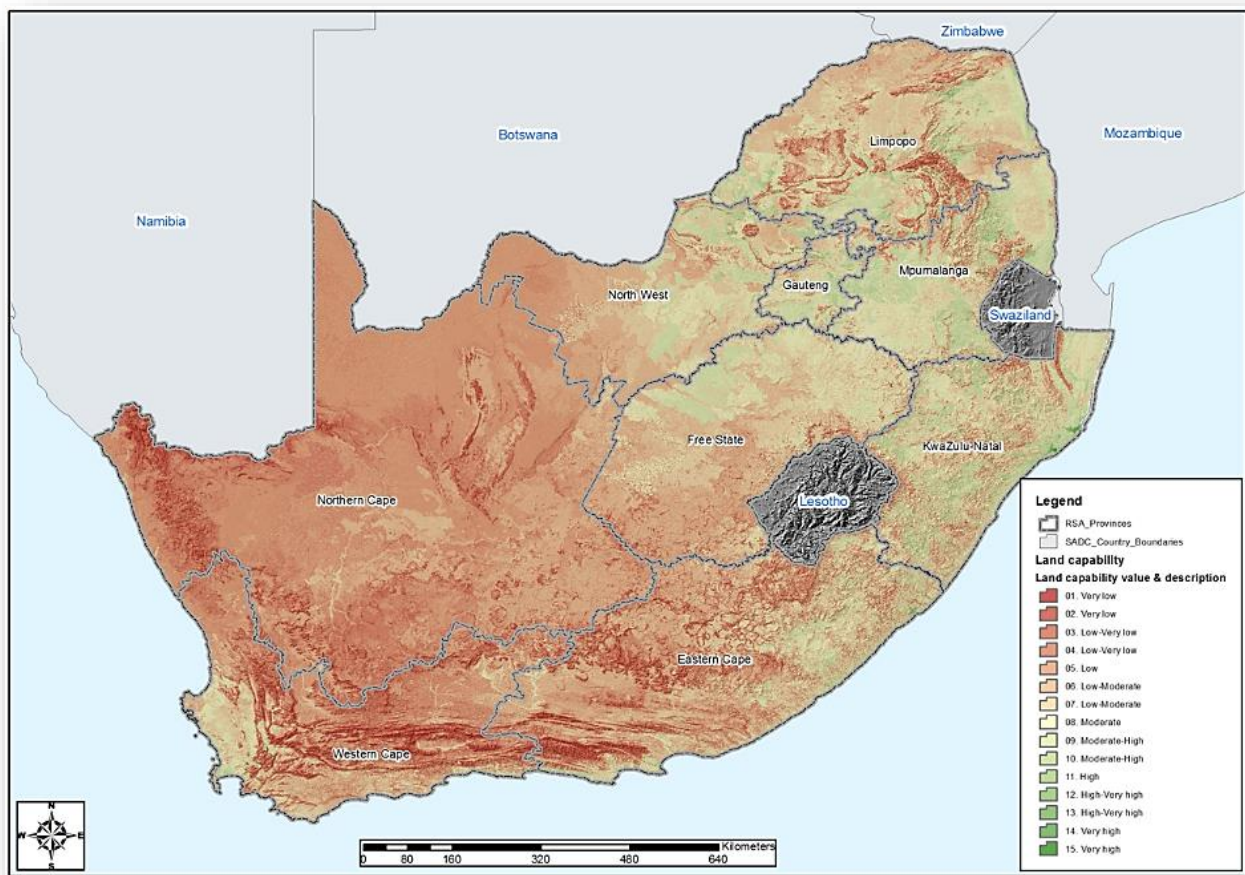
Given the complex, interdependent and interrelated relationships of the natural agro-ecosystem, the mentioned concepts should be properly interpreted and evaluated to be scientifically correct within a holistic spatial environment.

Understanding the complex interactions between the various components of an agro-ecosystem is not an easy task and the use of spatial models as building blocks to assist with a better understanding of these complex, but interrelated actions, will enable humankind to have a better understanding of the mentioned.

One such tool to have a better understanding of the complex dynamics and interactions between the relevant components of the applicable natural agricultural resource base is land capability.

### **6.1 LAND CAPABILITY**

Land capability is defined as “the most intensive long-term use of land for purposes of rainfed farming determined by the interaction of climate, soil and terrain”. It should not be seen as a substitute for the interpretation designed to show land suitability or agricultural potential.



**Figure 43: Land capability classification in South Africa**

Land capability in South Africa is based on spatial modelling approach through the identification of natural resource concerns (soil, climate and terrain) where in each of the concerns were broken down into a number of issues (three tier architecture) relevant to the use of the land for rainfed farming purposes and the relevance and relationship (intra and inter-) of the specific resource towards the ultimate goal – land capability.

Land capability is described as land capability evaluation values ranging from 1, being the lowest value to 15, being the highest possible value. These values are informed by a combination of climate, soil and terrain capability evaluation values in a 40:30:30 relationship respectively.

Table 15 gives an overview of the areas in ha per each land capability evaluation value as well as the percentage representation in relation to the country. It is important to acknowledge that these values do not take into consideration existing land uses, especially non-agricultural land uses that have resulted in many of the areas already been lost for agricultural production.

Land capability evaluation value : 2016	Area - ha	% of RSA Surface
Very low: 1	1 014 221.75	0.832%
2	3 566 739.09	2.927%
3	6 136 397.78	5.035%
4	13 051 928.01	10.71%
5	29 537 616.72	24.238%
6	24 306 414.92	19.945%
7	17 847 541.18	14.645%
8	14 837 391.59	12.175%
9	8 066 659.39	6.619%
10	2 879 755.30	2.363%
11	518 277.17	0.425%
12	72 119.16	0.059%
13	16 935.50	0.014%
14	9 902.47	0.008%
Very High: 15	4 013.33	0.003%
<b>Total:</b>	<b>121 865 903.35</b>	<b>100.00%</b>

Table 15: Land Capability evaluation values per each class based on the raster data

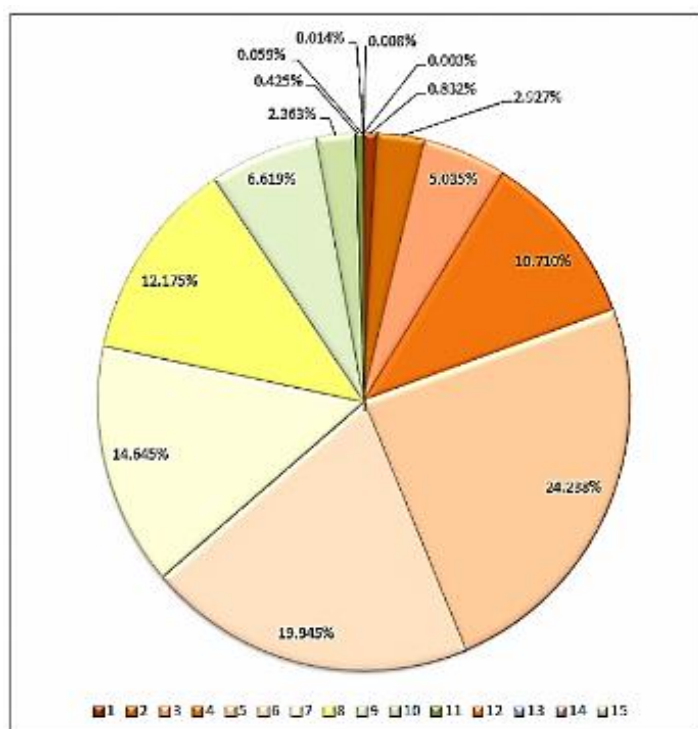


Figure 44: Land Capability evaluation values distribution (%) per each class (raster data)

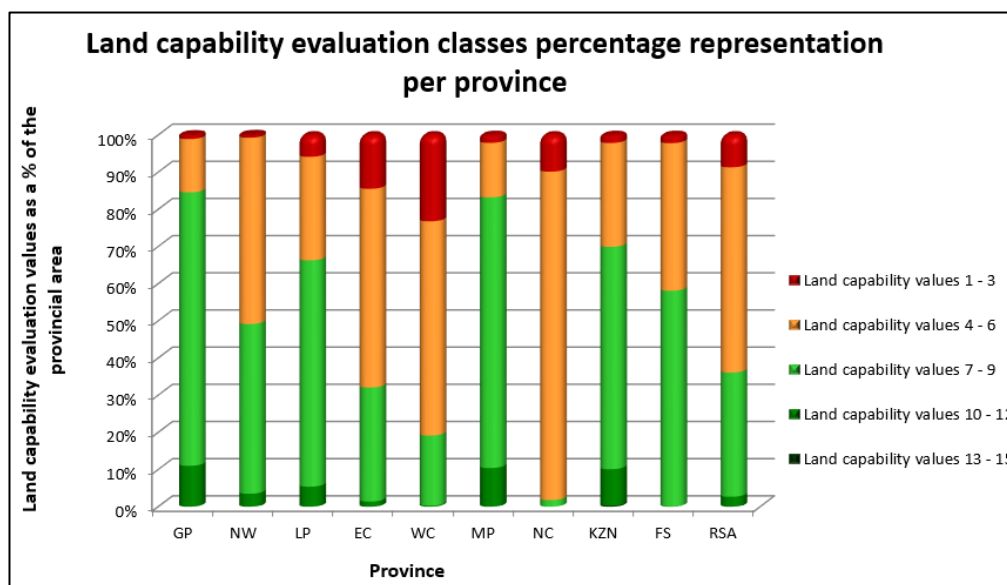
Significantly evident from the distribution of areas per each land capability evaluation value, is that there are very limited areas in the country with a high capability for agricultural production. Land capability evaluation values 11 – 15, which is regarded as areas having an above average production capability (very high land capability), only takes up 0.51% of the total country's surface, whilst values 9 - 10 (regarded as high land capability classes) add an additional 8.98%, totalling 9.49%. Value 8 (moderate land capability) takes up 12.18% or 14 837 391 ha. Figure 44 illustrates the distribution of the land capability evaluation values distribution.

There is a significant amount of areas residing under values 5 – 7 (58.82%) and to a large extent also areas having a value of 4 (10.71%), confirming that the larger part of the country has a low land capability for rainfed cultivation.

Figure 45 analysed the % land capability evaluation value as a % of the total provincial surface area.

Provincially compared, the Gauteng (7.88) and Mpumalanga (7.72) provinces have the highest average (mean) land capability evaluation values, followed by KwaZulu Natal (7.42), Limpopo (6.91), North West (6.65) and Free state (6.65) provinces, whilst the Western Cape (4.88) and Northern Cape (4.82) provinces have the lowest average evaluation values for rainfed production (Table 16 and Figure 45 and 46).

However, only KwaZulu Natal and the Eastern Cape provinces have land capability evaluation values of 15 – the highest possible value –, with Mpumalanga having an evaluation value of 13 as the province’s highest value. Northern Cape has the lowest “highest” value of 9.



**Figure 45: % distribution of land capability evaluation values representation within the various provinces, as a % of the provincial area**

LAND CAPABILITY EVALUATION VALUES – ZONAL STATISTICS				
PROVINCE	MIN	MAX	MEAN	MAJORITY
Gauteng	1	12	7.88	8
Mpumalanga	1	13	7.72	8
KwaZulu-Natal	1	15	7.42	8
Limpopo	1	13	6.91	7
North West	1	12	6.65	6
Free State	1	12	6.65	7
Eastern Cape	1	15	5.70	6
Western Cape	1	12	4.88	5
Northern Cape	1	9	4.82	5

**Table 16: Land Capability evaluation values – zonal statistics per province**

On a District municipal level (including the Metropolitan Municipalities) Ekurhuleni Metro has the highest mean land capability evaluation value (8.75), followed by Sedibeng (8.12) and Uthungulu (7.83). Eden Municipality (4.60), Central Karoo (4.43) and Namakwa (4.39) municipalities have the lowest average (mean) land capability evaluation values (Figure 47).

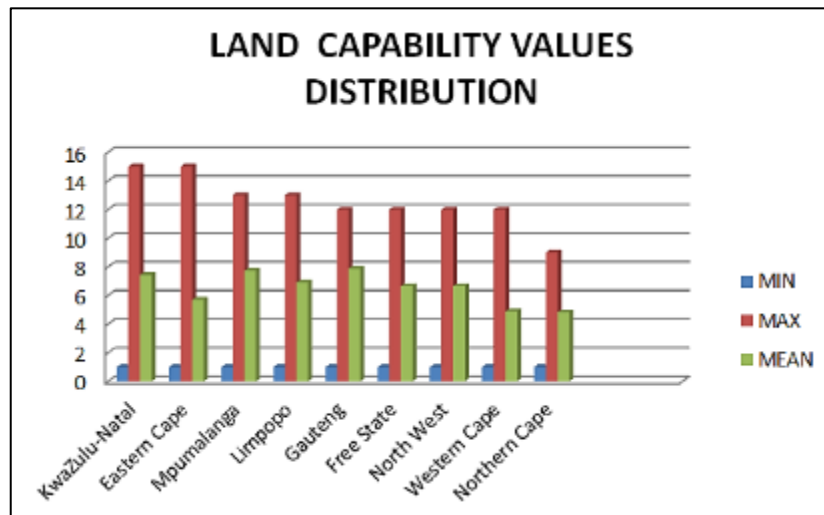


Figure 46: Land Capability evaluation values zonal statistics per province distribution, arranged per highest value present

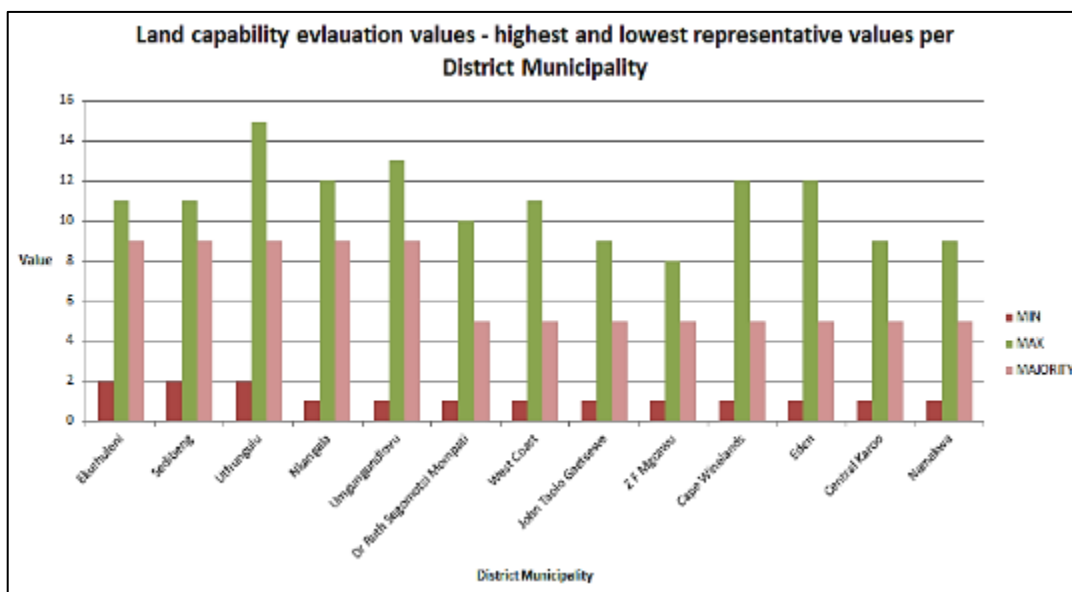


Figure 47: Land Capability evaluation values zonal statistics per district municipality - distribution arrange per mean value

## 6.2 AGRICULTURAL POTENTIAL

The value of land depends on the scarcity or rarity of its qualities in a specified area or region. This scarcity of quality often results in the land being irreplaceable and requires thus protection against uses that may be highly profitable.

Wood (1976) (cited in Smith 1998) maintains that the protection of agricultural land is crucial to the welfare of the state, especially prime agricultural land, in order to ensure food, fibre, open space and employment opportunities for current as well as future generations. Schoeman and Scotney (1987) pointed out that high potential agricultural land is not only limited, but competing non-agricultural land uses as well as the abuse, particularly of soil resources, constantly put this land under pressure. This has a serious impact on possible food production. It is therefore essential that the production potential for each country be determined and evaluated against the demand for food supply and population growth.

It has long been recognized that high potential agricultural land is a scarce resource in South Africa and should be protected. Research on dry land cropping potential found that less than 14% of the country's land is suitable for dry land cropping, with only about 3% regarded as land with a high agricultural potential.

Referencing the most recent statistics derived from the on land capability information, it has been stated that land capability evaluation values 9 – 15 amount to 9.49% of the country, whilst land capability evaluation value 8 adds an additional 12.18%, amounting to a total of 21.67%. The concern is however, from a land capability perspective, values 9 and higher is regarded a high capability values, whereas 8 is mostly moderate, creating the opportunity for not only possible degradation to the resource, if not well-managed, but also lower yields and higher risks. Rainfed cultivation is further also even occurring on land capability evaluation value 7 (and in certain parts of the country on even on lower values) but the sustainability of these areas and the impact of cultivation on the natural agricultural resources needs to be evaluated as these areas are severely marginal and limited in terms of resources.

As mentioned, land capability, as defined and compiled, does not take into consideration crop suitability, nor does it reflect on the use of irrigation as an additional resource. As per definition and approach, agricultural potential is perceived to be a better measuring tool.

According to Schoeman and Scotney (1987) agricultural potential is what is agriculturally possible on a piece of land and is "a measure of possible productivity per unit area, per unit time, achieved with specified inputs of management". They regard productivity as an indication of the agricultural potential for a given crop under a management level and for an identified portion of land as being dependent on precipitation, temperature, soil conditions, terrain and crop characteristics. The authors maintained that agricultural potential should be measured against the factors determining yield, namely management, climate, soil type and slope. The yield for a given climate, soil and slope depends on the production techniques a farmer applies that show very good results in practice. Moreover, should the management factor remain constant, the potential thus depends on soil, climate and terrain.

Agricultural potential is therefore defined as:

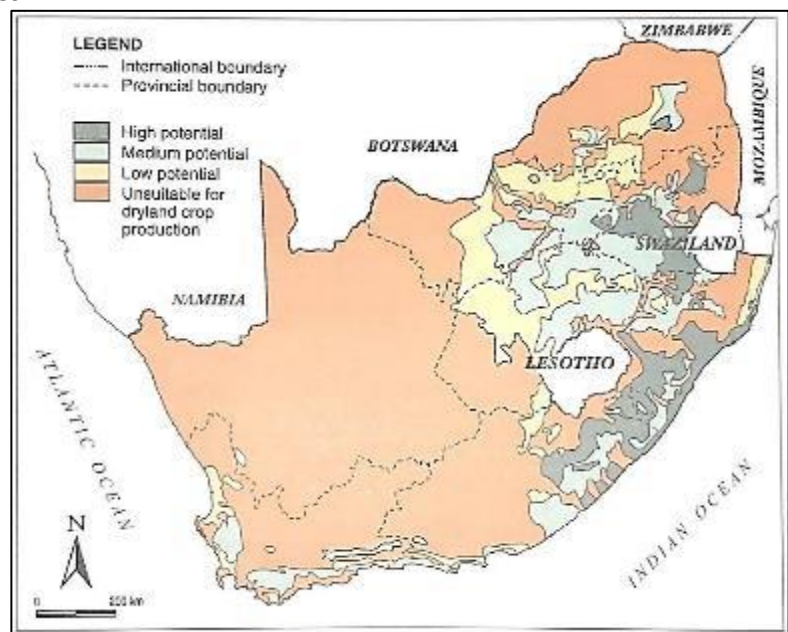
- “a measure of potential productivity per unit area and unit time achieved with specified management inputs”; and
- “for a given crop or veld type and level of management, is largely determined by the interaction of climate, soil and terrain” .

Agricultural potential within the context of the capability, suitability and potential of the natural agricultural resources can broadly be categorised into two categories namely the agricultural production potential for cultivation (crop production) either under rainfed or irrigation production practices and animal production potential.

### 6.2.1 AGRICULTURAL POTENTIAL: CULTIVATION

Through the years, various publications made reference to the extent of the agricultural cultivation potential in the country. As a result of variances in terms of the approach towards determining agricultural potential the outcome varies.

In a 1990 publication the country was divided into five rainfall zones (1 – 125 mm; 126 – 250 mm; 251 – 500 mm; 501 – 750 mm & >750mm) that were compared to each other in order to establish the influence of single factor (rainfall) on agricultural production potential. The percentage area of these rainfall zones then relate to the relative production potential of each rainfall zone. This analysis indicated that the production potential may increase eight to ten fold from less than 128 mm to over 750 mm per annum.



**Figure 48: Generalised crop production potential for South Africa**

(Source: Adapted from Scotney *et al* 1990, Smith, 2006)

Figure 48 indicates the distribution of the generalised crop production

in the country based on the above assessment. It was however mentioned that the extent of land suitable for cultivation may vary considerably within each potential class.

Given the definition of agricultural potential and advances in technology and spatial information, an approach has been followed to delineate, on cadastre boundaries, high potential crop production areas in the country, making also a clear distinction between agricultural potential for rainfed and irrigation production purposes.

Inputs factors towards the demarcation of high potential agricultural land, using a matrix classification approach, for cultivation purposes included:

- Land Capability
- Crop Suitability
- Agricultural Land Use-
  - Rainfed cultivation
  - Irrigated cultivation (including irrigation suitability)
  - Plantations

Throughout the demarcation process of agricultural potential cognisance was taken, where possible, of areas that have either been permanently transformed due to non-agricultural land uses or areas that are not available for agricultural production purposes such as areas not regarded as agricultural land under SALA or the formally Protected Environmental Areas. Where possible these areas were omitted from the demarcated areas.

The Rainfed High Potential Agricultural Areas have been assigned priority ratings ranging from A to F, whilst the Irrigation High Potential Agricultural Areas priority rating ranges from A - D. Cognisance was taken of potential areas currently under plantations or fragmented due to high density informal settlements in especially rural areas, as these may impact on the future management of such an area.

Table 17 and 18 illustrate the areas, per priority rating, for the demarcated Rainfed and Irrigation High potential agricultural areas respectively, whereas Figure 49 illustrates the distribution visually. Table 19, illustrates the total area (ha), combined for rainfed and irrigation, of the high potential agricultural areas in the country.

<b>Priority Rating:</b>	<b>Area (Ha)</b>	<b>% of country</b>
A	1 354 410.27	1.11%
B	5 155 940.16	4.23%
C	4 195 548.86	3.44%
D	2 717 797.61	2.23%
E	1 769 932.29	1.45%
F	1 159 893.86	0.95%
<b>Total</b>	<b>16 353 523.07</b>	<b>13.41%</b>

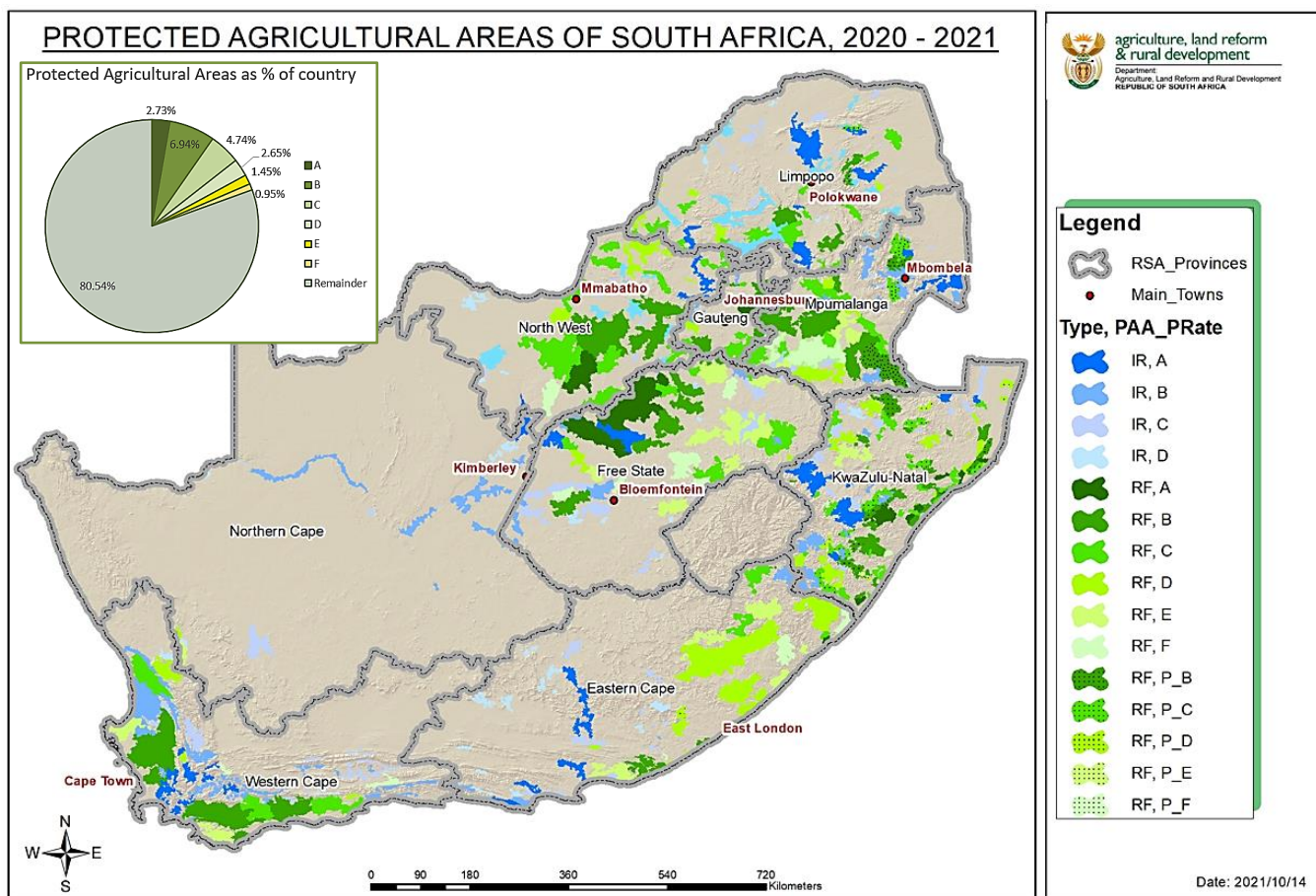
**Table 17: Rainfed High Potential Areas in South Africa according to priority ratings for rainfed (A – F)**

<b>Priority Rating:</b>	<b>Area (Ha)</b>	<b>% of country</b>
A	1 977 978.31	1.62%
B	3 305 272.31	2.71%
C	1 582 216.47	1.30%
D	519 663.63	0.43%
<b>Total</b>	<b>7 385 130.71</b>	<b>6.05%</b>

**Table 18: Irrigation High Potential Areas in South Africa according to priority ratings for irrigation (A – D)**

<b>Priority Rating:</b>	<b>Area (Ha)</b>	<b>% of country</b>
A	3 332 388.58	2.73%
B	8 461 212.60	6.94%
C	5 777 765.33	4.74%
D	3 237 461.24	2.65%
E	1 769 932.29	1.45%
F	1 159 893.86	0.95%
<b>Total</b>	<b>23 738 653.77</b>	<b>19.46%</b>

**Table 19: Combined Rainfed and irrigated High Potential Areas in South Africa according to priority ratings**



**Figure 49: High Potential Areas in South Africa**

(IR = Irrigation; RF = Rainfed)

For rainfed production the area of high agricultural production potential amounts to 16 353 523.07 ha or 13.41%, whilst the irrigation production potential areas amounts to 7 385 130.71 ha of 6.05%. The total area delineated as high potential agricultural areas amounts to 23 738 653.77 ha or 19.46%.

However, from a national food security perspective, priority areas A – D for rainfed and for irrigation priority areas A – C is regarded as the highest contributor whereas the remaining areas are contributors towards economic growth within the context of best available land.

### 6.2.2 AGRICULTURAL POTENTIAL: ANIMAL PRODUCTION

Indicating agricultural potential for animal production purposes are significantly complex due to the number of possible variables that can form part of this activity. Whereas agricultural potential for cultivation is strongly reliant on the potential of the natural agricultural resources for production, the scenario varies when it comes to animal production.

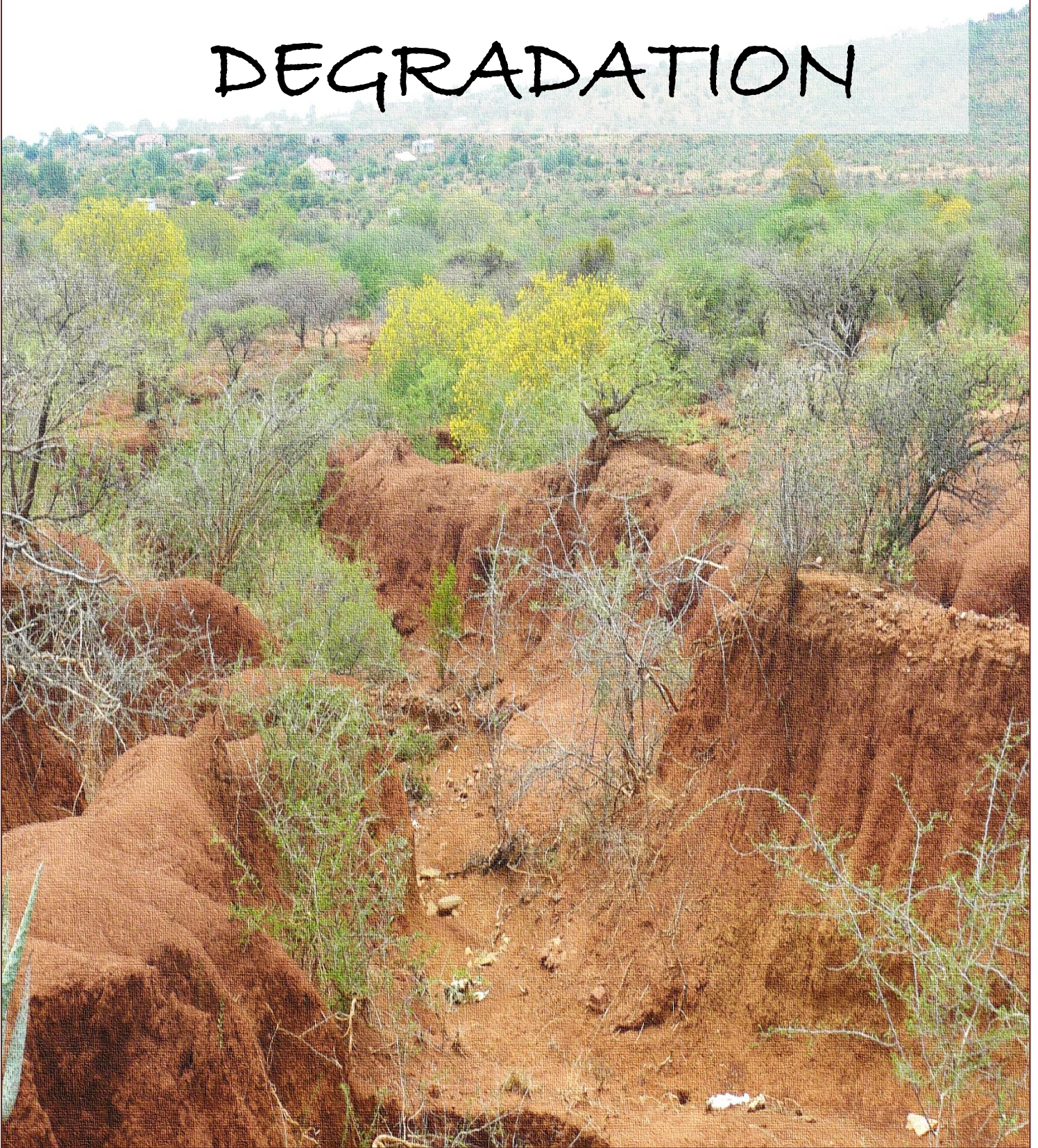
Agricultural potential in terms of animal production can either be extensive through the utilization of natural veld as the primary food source for livestock (inclusive of large and small stock as well as game) or intensive animal production such as poultry or piggeries production. Whereas poultry or piggery production has the potential to be located at the preference of the farmer, extensive livestock production is largely depended on the availability and suitability of the natural veld for production purposes, which is the focus of this publication. Therefore emphasis will thus be placed on the potential of the natural rangeland for livestock production potential.

As described for cultivation above, the 1990 publication did a similar exercise to determine the potential for grassland potential in the country. Clear reference was made to the fact that the extent of the improvement of the natural vegetation through veld reinforcement techniques or to be replaced by cultivated pastures provides for an overall indication of the degree to which the veld may be intensified. In this exercise strong reference was made to the grazing capacity of the veld in relation to the intensification or suitability.

The results of that exercise showed that 12% of the country is suitable for veld replacement (mostly areas with the then grazing capacity of < 3 ha/LSU); 23% is suitable for veld reinforcement (grazing capacity values of 3 – 6 ha/LSU), whilst 65% is suitable for improvement through veld management or reclamation (grazing capacity > 6 ha/LSU). The study indicated that if all cultivated land, timber areas as well as wilderness area are subtracted from the intensified area, only a small area remains for intensive grassland farming. This area was however regarded as the area towards relieving excessive stocking pressure exerted on the natural veld.

To date however limited information is available on livestock priority areas on natural veld (livestock agricultural potential areas) and reference is mostly made to either the prevailing grazing capacity as regulated under CARA with or without including the prevailing veld condition or using carry capacity. Therefore, use is made of the livestock suitability priority areas discussed under section 5.4 of this publication (Refer to Figure 37 and 39).

# 7. LAND DEGRADATION



## 7. LAND DEGRADATION

Publications have been written on the status of the natural agricultural resources in the country, although in general limited information is available to substantiate figures released. This is mainly due to the fact detailed information on this topic is either not freely available or is mostly project based which focus only on a small geographic area. National studies mostly either rely on remote sensing imagery or subjected but well informed local level knowledge and interpretation of specialists in varied fields.

On the other hand, certain types of resource degradation is seasonal related, such as overgrazing and could therefore be improved when the next seasonal rains fall. Drought is also a contributor towards possible degradation whereas conditions can improve after such an event, providing that correct management is applied during such an event, not to allow for long-term damage to the resource. Many ecosystems have been subjected to overstocking and poor grazing management. In some areas, degradation of the natural vegetation is irrevocable, especially in low rainfall areas.

Further to the above, non-agricultural land uses such as mining and industry can also contribute towards the degradation of the natural agricultural resources.

Hoffman and Ashwell's (2001) study on degradation has however been regarded as a national baseline pertaining to land degradation. Hoffman and Ashwell found a clear correlation between degradation and desertification and the communal rangelands. Human impact and the harsh climatic conditions have resulted in more than half of South Africa's land surface being under threat of desertification.

Soil erosion as a result of the impact of wind and water, are the major factors contributing to soil degradation, whilst vegetation degradation can be the result of change in species composition, bush encroachment, and loss of plant cover.

What is however evident, is the fact that especially soil resources in certain parts of the country are prone to degradation (wind & water erosion, crusting or compaction susceptibility). Reference on the susceptibility of soils to the mentioned degradation forms has been made under the section on soil resources in the country. The CARA Act describes erosion as "the loss of soil through the action of water, wind, ice or other agents, including the subsidence of the soil".

In addition, the long-term impacts as a result of cultivation have played its contributing role towards the degradation of soil health. In as far back as 1956 Matthews stated: *"We must be under no delusion, if we continue to ill use the soils, the land will die and the people will die with it"*.

One of the main contributing factors of soil degradation is intensification without optimal management.

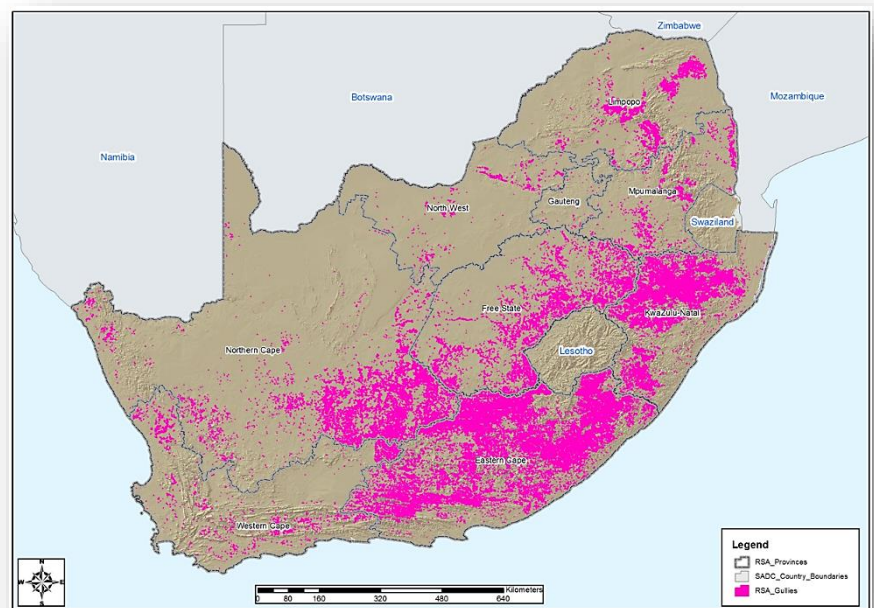
The annual average soil loss in South Africa is estimated at 2.5 tons per hectare in comparison with the soil formation rate of 0.3 tons per hectare annually. An estimated 25% of soils are lost due to water erosion. Scotney, *et al.*, (1990) estimated that about 81% of South Africa's soils can be regarded as slightly weathered and calcareous. About 30% comprise of sandy soils with a clay percentage of less than 10%, and 60% of the soils have a low organic matter content.

Water erosion is regarded as one of South Africa’s biggest environmental problems. Estimations indicate that up to 25% of topsoil has been lost due to water erosion in the twentieth century. In some areas, the extent of the erosion has declined because there is little or no soil left.

Factors that affect water erosion are regarded as complex and it is difficult to determine the impact of a specific factor if the data is not stratified. Some of the major factors that have an influence on erosion cannot be quantified and therefore do not form part of an equation or model. Laker (2004) lists parent material, the degree of weathering and pedogenesis, free iron oxides, clay mineralogy, sodium and magnesium, as well as organic matter, particle size distribution and soil structure, rainfall, slope, vegetation cover and land use, as the main factors impacting on erosion.

In a 2009 study conducted, determining the extent of gully erosion in the country, it was found that an estimated 559 781.38 ha have been subjected to significant gully erosion. This study was done on a 1:50 000 scale. Should the scale be more detailed it can be concluded that the extent of gully erosion will even be larger.

South Africa’s rangelands are mostly moderate to severely degraded, with the arid areas mostly affected. These areas also have a low recovery potential. Rangeland degradation includes the reduction of the basal cover, bush encroachment and densification, and negative changes in the composition of grass species.



**Figure 50: Gully erosion in South Africa**

Type of erosion and land use	Seriousness of erosion and area affected			Total (ha)
	Serious (ha)	Moderate (ha)	Not significant (ha)	
Wind erosion				
• Cultivated land	415 001	1 325 749	1 427 088	13 370 469
• Pastures	569 524	1 700 436	7 932 671	

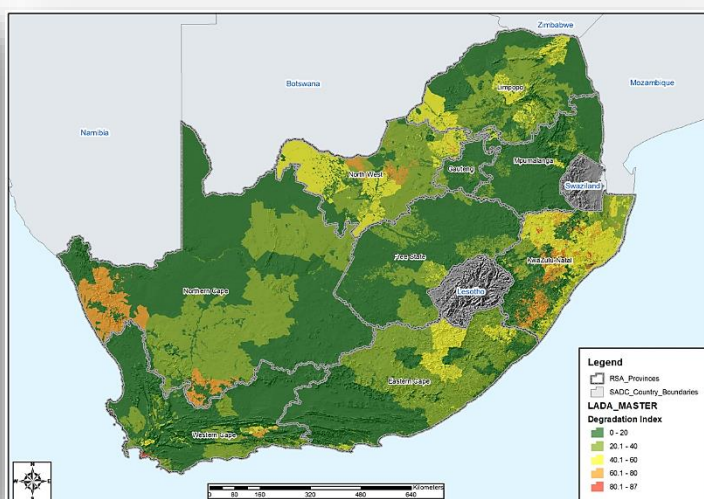
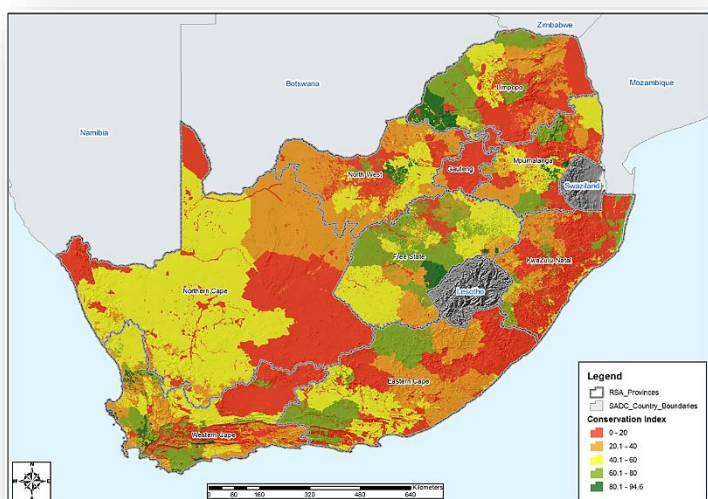
Water erosion				
• Cultivated land	930 735	2 258 193	2 886 727	16 978 705
• Pastures	801 288	3 128 613	6 973 149	
			<b>TOTAL:</b>	<b>30 349 174</b>

**Table 20: Extent of wind and water erosion in South Africa**

(Source: Department of Agriculture, 2004)

The FAO commissioned a national assessment of land degradation and conservation in South Africa as part of the Land Assessment for Dryland Areas (LADA) programme. The purpose of this assessment was to have a better delineation and understanding of degradation in the country. The methodology followed was through participatory expert assessment workshops using land utilization units on local municipal level as the basic unit for evaluation. The impact of land degradation on the biophysical components (soil properties, water and vegetation) as well as the impact on productivity, ecosystem services and livelihoods was evaluated. The result derived from these interactions allowed for the compilation of a land degradation and conservation index on local municipal level.

From the evidence derived it can be concluded that although the degradation index for the country tends to be not as severe as generally thought, the status pertaining to conservation is a matter of serious concern, especially if this is related to high potential cultivated areas of the country.



**Figure 52: Conservation Index in South Africa**

**Figure 52: Degradation Index in South Africa**

# 8. AGRICULTURAL ECONOMIC & LAND USE STATISTICS



## 8. AGRICULTURAL ECONOMIC AND LAND USE STATISTICS

Statistics on the status of agriculture in South Africa have been released at various times by different sources, some of them contradictory to others. There is presently no formal process to monitor these indicators on a continuous basis, with the exception of the ten yearly agricultural census of commercial agriculture in the country. Nevertheless, it can be concluded that the agricultural sector is one of the largest land users in the country.

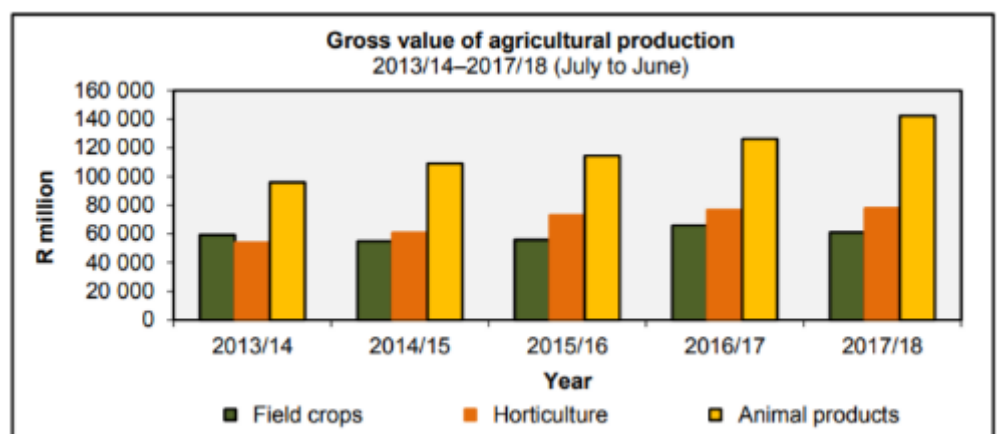
The Department of Agriculture in 2006, cited the Development Bank of South Africa's 1991 statistics of land utilization in South Africa, indicating that about 82% of the total area of South Africa is regarded as farmland, 13, 7% is potentially arable land, 68.6% is grazing land, 9.6% is conserved, 1.2% is utilized for forestry, and 6.9% for other land uses. Changes in these figures since then has however been seen.

The 2017 Commercial Agriculture Census concluded that 46.4 million ha, or 37.9% of the total land area of 122.5 million hectares in the country is used for commercial agriculture. It comprises mostly of grazing land (36.5 million ha) and 7.6 million ha arable land, defined as land used for crop production. However this figure differs significantly from the database used by the Department on cultivated fields in South Africa. Cultivated fields, according to this database, amount to 14.2 million ha in the country or 11.6% of the country's surface.

### 8.1 ECONOMIC

Agriculture has not only been a dominant land use within South Africa with a significant contribution towards the Gross Domestic Product (GDP) but it also contributes towards the creation of jobs and the subsequent alleviation of poverty, especially in rural areas.. Agriculture's role towards the economy is not only prevalent in the production of food, but its indirect role in the economic functioning linkages as a result of the backwards (purchasing of pesticides, fertilisers and implements) and forward linkages (supply of raw materials to the manufacturing sector). An estimated 70% of agricultural output is used as intermediate product in the sector.

Statistics between the years 2013/14 to 2017/18 indicates that Animal products are the largest contribution towards the sector's income, followed by horticulture and lastly field crops.



**Figure 53: Gross value of agricultural production 2013 – 2018**

(Source: Stats SA 2018)

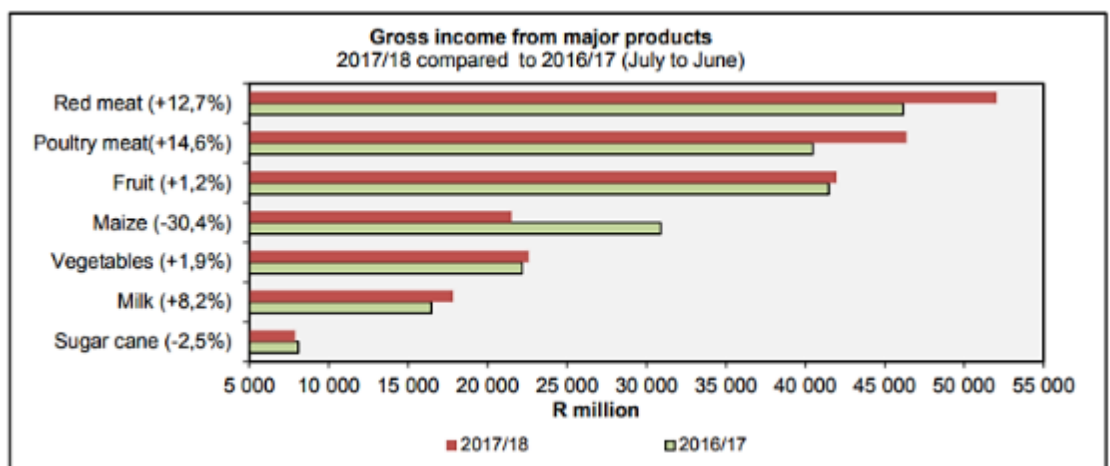
Figure 54 provides a comparison between the 2016 and 2017 production years pertaining to agricultural and related services. In each of the industries reviewed there had been a slight increase. However, it is important to note that such an evaluation needs to be done over a longer period as the agricultural sector is severely influenced by prevailing climatic conditions as well as market fluctuations.

Item	2016'	2017'	% change
	R'000		
Total income	278 143 676	302 769 433	8,8
Field crops	53 796 134	58 970 264	5,9
Horticultural crops and products	64 640 225	74 367 519	15,0
Animals and animal products	118 763 722	128 199 516	7,9
Other agricultural products	7 211 177	7 446 836	3,3
Other income	33 712 418	35 785 310	6,1
Total expenditure	260 225 780	277 625 827	6,7
Purchases	137 063 315	145 857 399	6,4
Salaries and wages	32 224 734	34 890 478	8,8
Other current expenditure	90 837 731	96 747 952	6,4
Capital expenditure	23 879 486	27 800 309	16,8
Land and book value of assets	168 321 172	173 496 189	3,1

**Figure 54: Principle statistics in the agriculture and related services industry for 2016 -2017**

Maize, soya beans, sunflower, sugarcane, wheat and oilseeds are among the major crops planted in South Africa. Maize is mainly produced in the summer rainfall areas, sugarcane mostly in KwaZulu Natal and the Lowveld areas of Mpumalanga, summer wheat in the Free State and winter wheat in the Western Cape.

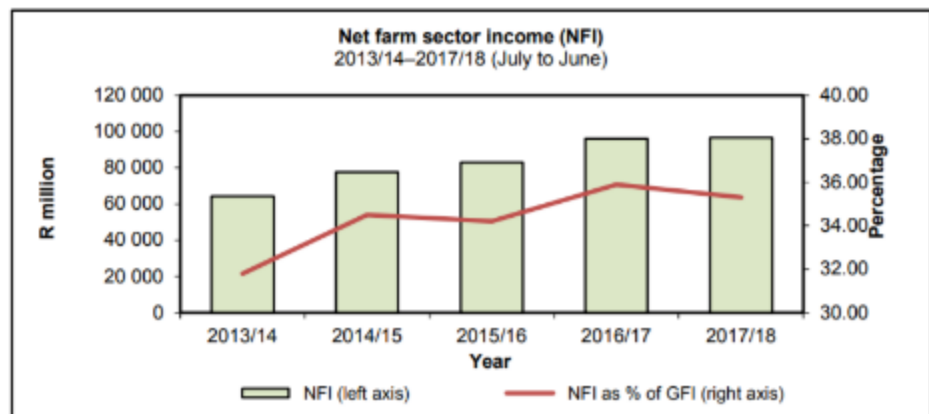
In terms of horticultural production, all major fruit groups are planted (deciduous, citrus and subtropical) as well as vegetables and flowers, with the locality depending on the growing requirements of the crop.



**Figure 55: Comparative statistics on the gross income derived from major products compared between 2016/17 and 2017/18**

The net farming income increase to R 96,3 billion in 2016 in comparison to R 76,0 billion in the previous year. In 2017/18 the net farming income increase slightly by 0.4% as a result of increase in intermediate expenditure caused by increased production costs.

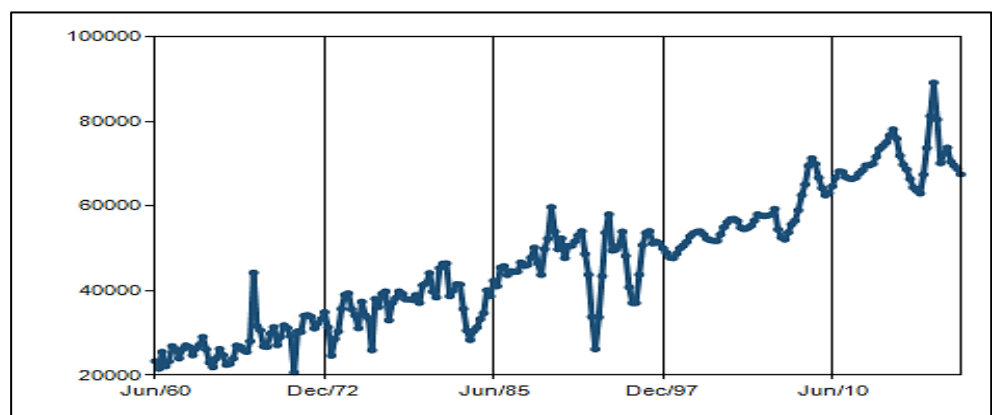
On the other hand Agriculture's value of imports in 2016 was an approximate R 82,3 billion, which is an increase of 22.5% from 2015 (R 67,2 billion). Exports however increase by 13,7% from R 86,0 billion in 2015 to about R 97, 9 billion in 2016. In order of highest export value citrus fruit earned the highest income (R 17,0 billion), followed by wine, grapes, apples, pears, quinces and wool. In terms of imports maize, rice, meat, wheat and meslin and palm oil were the five major import products in terms of value in 2016.



**Figure 56: Net farm income from 2013/14 to 2017/18 compared**

The Gross Domestic Product (GDP) of agriculture increased from R 35 million in 1911 to around R 45,0 billion in 1988. In 2015 the sector's contribution raised to R 70,0 billion and in 2017 this raised further to R 89.1 billion. It has however been indicated that the GDP derived from Agriculture decreased to R 67, 4 billion in the fourth quarter of 2019, most likely due to the increased drought being experienced by the country.

Over the years other sectors' contribution towards the economy have however grown faster than the agriculture, forestry and hunting sectors, with a resulted drop in agriculture's share to the GDP, dropping from more than 6% in the 1970's, to 3.9% in 1994 to 2.20% in 2017. It is of concern that in 1965 the contribution of agriculture to the GDP was 9.12%.



**Figure 57: Comparative analysis of the Agriculture's sector contribution to the GDP**

(Source: Reserve Bank of South Africa)

Meyer (1998) points out that, for every R1 million value added, the agricultural sector uses more workers than any other sector in the economy. In 2002, farm employees and domestic servants on farms were calculated at 940 800. In 2005, the workers in the agriculture, hunting, forestry and fishing industries were set at 628 200. As at the end of June 2017 the number of persons employed in the agricultural and related services was 748 113, which was an increase of 1.1% from the previous year.

## 8.2 AGRICULTURAL LAND USE

The 2002 Census of commercial agriculture found that there were 45 818 commercial farming units in South Africa, which was a decrease of 12 162 farming units as determined in the last Census of agriculture in 1993. In 2007 this number has again decreased to 39 966 farming units. The 2017 census on commercial agriculture indicated that the number of farming units involved in commercial agriculture amounts to 40 122 units. The province with the highest number of farms was the Free State (19.8% of the national total), followed by the Western Cape (17.3%), North West (12.3%) and Northern Cape (12.0%). The province with the lowest number of farming units was Gauteng (5.7%).

Production practices have varied over the years. The 2017 Commercial Agricultural Census indicated that the largest proportion of farms were used for livestock farming (33.9% of the total), followed by mixed farming (31.1%) and field crops (21.3%).

These changes can be attributed to a number of reasons that can include economic preferences, market demands and farmer requirements. Of importance however is that the production practice needs to take cognisance of the *capability, suitability, potential and state of the natural agricultural resource*.

The total area under cultivation during the 2017-2019 production seasons amount to 14 208 116.89 ha which is 11.65% of the total surface of the country. Of the total cultivated areas, 1 521 480.34 ha are under irrigation, which is 10.71% of the total cultivated areas in the country and 1.25% of the total country surface.

The total cultivated area (ha) per province is:

Province	Total Cultivation per province (ha)
EC	1 365 373.81
FS	3 869 153.24
GP	389 601.42
KZN	1 193 785.79
LP	1 382 540.92
MP	1 457 334.75
NC	286 717.24
NW	2 311 378.62
WC	1 952 231.09
<b>Total RSA:</b>	<b>14 208 116.89</b>

**Table 21: Cultivation (ha) per province, 2019**

From a cultivation perspective in relation to the capability of the natural agricultural resources, the largest amount of rainfed cultivation is mostly occurring on areas having a land capability evaluation value of 8, followed by 7 and 9 respectively, clearly illustrating that cultivation in the country are occurring mostly on moderate capability land. This again emphasize the fact that there are very limited amounts of higher land capability areas in the country, but given the limited capability, farmers have been able to produce crops, that are still regarded as economically viable. On the other hand however, due to the fact that cultivation is occurring on areas with a moderate to low capability value, the risk for crop failure in the case of severe droughts are very high as well as the possibility of increased degradation to the status of the natural agricultural resources.

Irrigated cultivation are mostly be found on land capability evaluation values 8 and 7 respectively, but is also significant visible on values 6 and 5. This phenomenon is attributed to the added advantage of having sufficient water available that limits the risk of drought (limited rainfall and high temperatures), but it also opens up additional resource capabilities for cultivation, especially in areas with shallower soils, enabling soil moisture to be regularly replenished by means of irrigation.

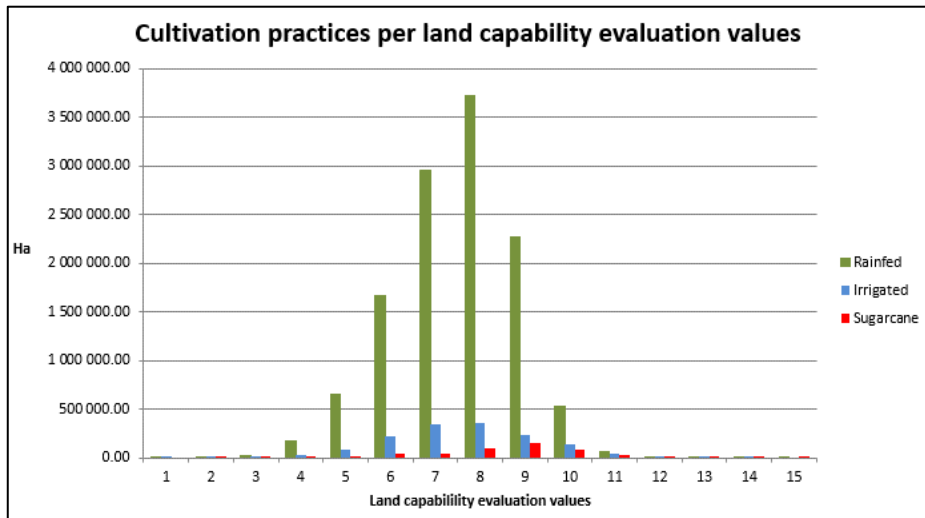
Sugarcane production (rainfed and irrigation) is mostly occurring on land capability evaluation values 8 – 10, which coincide with the dominant presence of these values within the KwaZulu Natal and Mpumalanga provinces, where most of the sugarcane production is occurring. Please refer to Table 22 for details on the agricultural land uses per land capability evaluation values distribution in ha whilst Figure 58 provides a visual representation.

<u>Land capability value</u>	<u>Total Area - Land capability</u>	<u>Total areas under cultivation (A+B+C)</u>	<u>A. Rainfed</u>	<u>B. Irrigated</u>	<u>C. Sugarcane</u>
1	972 122.87	534.22	332.14	202.08	0.00
2	4 143 787.99	9 192.65	6 492.21	2 697.76	2.68
3	5 491 524.81	32 204.77	26 215.59	5 744.96	244.22
4	12 460 719.96	200 866.43	170 291.97	28 971.55	1 602.91
5	30 856 405.68	735 360.59	646 273.94	80 690.78	8 395.87
6	24 033 913.84	1 920 439.88	1 664 106.66	218 913.78	37 419.44
7	17 561 611.39	3 341 588.85	2 952 936.54	342 704.65	45 947.66
8	15 271 415.59	4 168 926.71	3 722 896.26	352 010.47	94 019.98
9	7 924 060.09	2 645 064.96	2 268 998.90	227 978.21	148 087.85
10	2 784 577.26	751 511.76	529 878.19	133 518.26	88 115.31
11	405 975.92	125 905.70	61 069.03	35 681.23	29 155.44
12	40 347.24	14 673.94	4 803.86	2 955.65	6 914.43
13	16 258.38	7 098.17	2 199.03	34.37	4 864.77
14	11 461.43	5 298.55	1 405.24	1.12	3 892.19
15	3 075.21	986.03	165.76	0.00	820.27
<b>Totals:</b>	<b>121 977 257.66</b>	<b>13 959 653.21*</b>	<b>12 058 065.32</b>	<b>1 432 104.87</b>	<b>469 483.02</b>

*\*Values may differ slightly from table 21 in terms of cultivated areas due to the fact that the 2015/2017 cultivated areas were used as reference for the calculations below*

**Table 22: Agricultural land uses per land capability evaluation value (Ha)**

Transformation from agricultural land (uses) to non-agricultural land uses has been occurring within all the land capability evaluation classes. Transformed non-agricultural land uses can include residential, industrial as well as mined areas, all of which is regarded as a permanent loss of agricultural land. Of specific concern is the significant impact that such a loss has on the limited higher land capability areas as current or possible areas of production. In addition, the impact of land use change do not take into consideration the resulted fragmentation of the remaining areas for agricultural production, which is an enabler for the land to be still an economic viable unit nor does it look at the extent of the homogeneity and, or heterogeneity of the land capability evaluation values within a given landscape. The reason therefore is the fact that in many instances the variance within an ecosystem is just too high (few scattered higher land capability areas within a dominant lower land capability area) to retain its viability (and accessible) for production.



**Figure 58: Agricultural land uses per land capability evaluation values**

Table 23 compares in hectares, per each of the 15 land capability evaluation classes, the current uses pertaining to cultivation – irrigation and rainfed combined, plantations and the permanently transformed areas as well as the remaining areas.

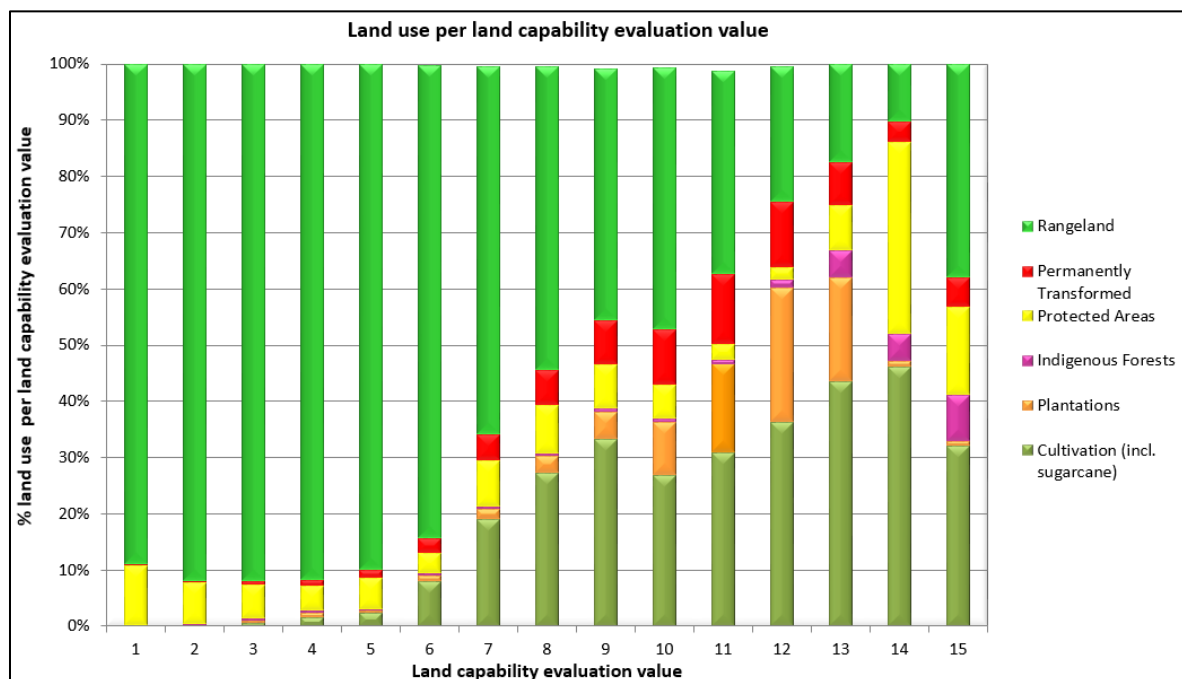
Figure 59 displays the mentioned land uses as a percentage of the total area of each land capability evaluation value but with the addition of areas regarded as indigenous forests as well as the areas protected as Environmental Protected Areas.

<u>Land capability value</u>	<u>Total Area</u>	<u>Cultivated</u>	<u>Plantations</u>	<u>Permanently Transformed</u>	<u>Remaining - Not transformed</u>
1	972 122.87	534.22	56.50	1 688.49	970 434.38
2	4 143 787.99	9 192.65	2 536.70	10 777.52	4 133 010.47
3	5 491 524.81	32 204.77	21 207.63	26 940.41	5 464 584.40
4	12 460 719.96	200 866.43	101 907.85	143 615.45	12 317 104.51
5	30 856 405.68	735 360.59	121 852.50	406 833.02	30 449 572.66
6	24 033 913.84	1 920 439.88	247 144.41	650 638.36	23 383 275.48
7	17 561 611.39	3 341 588.85	340 306.79	826 402.39	16 735 209.00
8	15 271 415.59	4 168 926.71	458 425.44	976 755.29	14 294 660.30
9	7 924 060.09	2 645 064.96	383 564.25	619 526.12	7 304 533.97

10	2 784 577.26	751 511.76	258 864.15	274 438.77	2 510 138.49
11	405 975.92	125 905.70	63 519.10	50 938.34	355 037.58
12	40 347.24	14 673.94	9 634.34	4 658.88	35 688.36
13	16 258.38	7 098.17	2 988.38	1 234.61	15 023.77
14	11 461.43	5 298.55	109.30	420.65	11 040.78
15	3 075.21	986.03	24.77	159.56	2 915.65
<b>Total:</b>	<b>121 977 257.66</b>	<b>13 959 653.21*</b>	<b>2 012 142.11</b>	<b>3 995 027.86</b>	<b>117 982 229.80</b>

**Table 23: Land uses per land capability evaluation values in relation to the remaining land (Ha)**

Important to mention however is that as the largest amount of cultivation in the country is occurring on land capability evaluation value 8, these areas should not be seen as marginal, when comparing it to international norms as this is the dominant areas available for production within the South African context. Nor should it be seen insignificant in terms of protection for cultivation purposes but these areas should receive serious attention in terms of correct crop selection and cultivation practices to not only ensure optimal production under these moderate conditions but also to protect the resource base from any form of degradation.



**Figure 59: Land uses as a percentage of the land capability evaluation value**

# 9. CONCLUSION



## 9. CONCLUSION

The future presents many challenges. South Africa is characterised by great diversity and is very vulnerable to over-exploitation with a limited potential for intensive agriculture. Climate, especially rainfall is highly variable, a factor that plays a determining role towards agricultural potential. Apart from the mentioned, water supplies are limited and are already over-taxed in some catchments. In addition, water quality is also declining in many areas.

With the increase in population, more demands will be placed for the production of food on the already stressed natural agricultural resources base. This, without taking in to consideration the increased demands for land for non-agricultural land uses such as mining, industrial and residential developments.

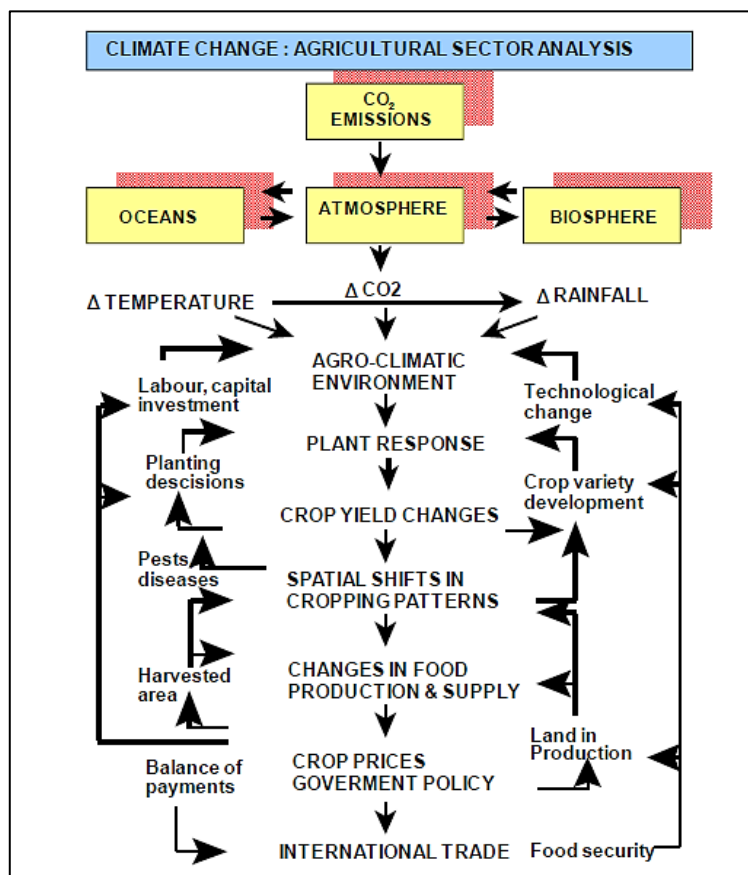
The resources of the country are of great value to its people. Development and use of these resources demands for a sustainable and regenerative approach towards the management of the applicable agro-ecosystem.

Despite improvements in technology, achieving a vertical expansion in agricultural production will be difficult to meet without ending up in the degradation of the natural agricultural resource base. Especially seen in the light of the impact climate change will have on the agricultural sector.

Many natural systems, including the human drivers and responders, are likely to adapt naturally to change and it may be less likely that they will be less vulnerable to potential impacts such as climate change. Vulnerabilities to climate change will depend on many factors and is depending as to whether one is reviewing:

- Rainfed vs irrigation farming;
- Supplementary or permanent irrigation;
- Crop vs livestock farming;
- Commercial vs subsistence farming;
- High potential vs marginal potential areas.

Meeting these challenges presupposes the continuation and expansion of well-



**Figure 60: Agriculture sector analysis revolving around biophysical impacts of climate change, as well as knock-on effects and feedbacks**

(Source: Bolin *et al.*, 1986)

directed research aimed at the development of sustainable agro-ecosystems. Many challenges on matters such as reducing soil losses, improving water use efficiency in both irrigated and rainfed farming systems, improving veld condition needs to be addressed.

Evaluating the importance of the protection of land with a high land capability value and suited for crop production in relation to development pressures, raises the question as to whether there will be sufficient natural resources available in future, given the growing population and increased demand. In addition to the utilization of open spaces for housing and infrastructure development, as well as recreational purposes, more pressure will be exerted on the intensive use of suitable natural resources for the production of food, to meet the demands of the growing population.

Current estimations predict that the demand will far exceed the supply. It is projected that a production growth of 4% per annum for the next twenty years (not including imports) is required in Africa to ensure food security. However, this target will not be sustainable, economically viable or environmentally supported.

In managing the pressures on land, it is important to conduct land use in a way that optimally adheres to the potential of the land. Consequently, it is imperative that all available land with the potential for producing sustained high crop yields, thus land with a high agricultural production potential, as well as land with a potential carrying capacity for livestock, be effectively utilized and protected for agricultural use. This will result in the continuous production of food, thereby addressing food security, and will further contribute to job creation, generation of income, and the upliftment of the community in general.

Agricultural production or the use of land for any other purpose should nevertheless not be conducted in a way that could result in the degradation or loss of the available natural agricultural resources.

# 10. REFERENCES

## 10. REFERENCES

- ARC - ISCW. 2004. *Overview of the status of the agricultural natural resources of South Africa*. ARC-ISCW Report No GW/A/2004/13. Pretoria: ARC-ISCW.
- Avenant, P. 2015. *Report on the national Bankrupt Bush (Seriphium plumosum) survey (2010 – 2012)*. Department of Agriculture, Forestry and Fisheries, Pretoria.
- Avenant, P. 2018. *Availability of rangeland in South Africa for livestock grazing*. Department of Agriculture, Forestry and Fisheries. Pretoria.
- Aventis CropScience. 2000. *Rio Declaration on Environment and Development*. Berlin: Technology Strategy and Resources. PowerPoint presentation.
- Botha, N & Ikerd, J. 1995. *What is sustainable agriculture?* Farmers Weekly, March 24:17-18.
- Charman, PEV. & Murphy, BW., 1998. *Soils: Their Properties and Management*. 5th edn. Oxford University Press, Melbourne.
- Cloete, PC., Van der Merwe, P. & Saayman, M. 2015 *Game ranch profitability in South Africa*. 2015 edition. ABSA. CTP Printers, Cape Town.
- Collett, A. 2009. *The determination, protection and management of high potential agricultural land in South Africa, with special reference to Gauteng*. Unpublished M.Sc thesis. University of Pretoria, Pretoria.
- Collett, A. 2018. *An evaluation report on the status and constraints of soil information in South Africa. August 2018*. Department of Agriculture, Forestry and Fisheries. Pretoria.
- Collett, A. 2019. *The refined land capability evaluation model for South Africa*. Department of Agriculture, Forestry and Fisheries, Pretoria.
- Crop Estimates Consortium, 2019. *Field Crop Boundary data layers (RSA), 2015 - 2019*. Pretoria. Department of Agriculture, Forestry and Fisheries.
- Del Mar Lopez, T, Mitchell, T and Thomlinson, JR. 2001. *Urban expansion and the loss of prime agricultural land in Puerto Rico*. *Ambio*, 30(1).
- Department of Agriculture (DoA). 1994. *Agriculture in South Africa, 1994*. Johannesburg: Chris van Rensburg.
- Department of Agriculture. 2004. *Strategic Plan for the Department of Agriculture, 2004*. Pretoria: Department of Agriculture.
- Department of Agriculture. 2006. *Strategic Plan for the Department of Agriculture, 2006*. Pretoria: Department of Agriculture.
- Department of Agriculture, Forestry and Fisheries. 2016. *Economic review of the South African Agriculture. 2016*. Pretoria: Department of Agriculture, Forestry and Fisheries.

Department of Agriculture, Forestry and Fisheries. 2017/18. *Economic review of the South African Agriculture. 2017/18*. Pretoria: Department of Agriculture, Forestry and Fisheries.

Department of Agriculture, Forestry and Fisheries. 2018. *Land capability evaluation and classification for South Africa Version 1: 2018*. Pretoria: Department of Agriculture, Forestry and Fisheries.

Department of Environmental Affairs and Tourism. 2006. *South Africa Environment Outlook. A report on the state of the environment*. Pretoria: Department of Environmental Affairs and Tourism.

Department of Environmental Affairs and Tourism. 2006. *South Africa Environment Outlook. Executive summary and key findings*. Pretoria: Department of Environmental Affairs and Tourism.

Food and Agricultural Organization of the United Nations. 1976. *A framework for land evaluation*. FAO Soils Bulletin 32. Rome: Food and Agricultural Organization (FAO). [www.fao.org/docrep](http://www.fao.org/docrep).

Food and Agricultural Organization of the United Nations. 1993. *Guidelines for land-use planning*. FAO Development Series I. Rome: Food and Agricultural Organization (FAO). [www.fao.org/docrep](http://www.fao.org/docrep).

Fraser, G, Nomakhaya, M and van Averbek, W. 2003. *Food security in South Africa: the challenge of change: Agriculture, land and the South African economy*. Pietermaritzburg: University of Natal Press.

Geoterrimage (GTI) 2015. *2013-14 South African National Land-Cover Dataset*. Available at <https://egis.environment.gov.za>

Hoffman, MT and Ashwell, A. 2001. *Nature divided: land degradation in South Africa*. Cape Town: University of Cape Town Press.

Holtzhausen, L. 2005. *Project shows what a lot we got – but cautions care on how we use it*. The Water Wheel, November/December 2005:14-17.

Laker, MC. 1995. *South Africa's soil resources and sustainable development*. Pretoria. [www.environment.gov.za/nssd\\_2005](http://www.environment.gov.za/nssd_2005).

Laker, MC. 2004. *Development of a general strategy for optimizing the efficient use of primary water resources for effective alleviation of rural poverty*. Report to the Water Research Commission. WRC Report No KV 149/04. March 2014. Pretoria.

Laker, MC. 2004. *Advances in soil erosion, soil conservation, land suitability evaluation and land use planning research in South Africa, 1978 – 2003*. South African Journal of Plant Soil, 21(5).

Leeper, GW., and Uren NC., 1993, *Soil Science: An introduction*. 4th Edition. Carlton, Vic.: Melbourne University Press, 1993.

Low, AB and Rebelo, AG. 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Pretoria: Department of Environmental Affairs and Tourism.

Maitre, le, D., Seyler, H., Holland, M., Smith-Adao, L., Maherry, A., Nel, J. & Witthuser, K. 2018. *Identification, delineation and Importance of the Strategic Water Source Areas of South Africa*,

*Lesotho and Swaziland for surface water and groundwater*. Report No TT 743/1/18. Water Research Commission, Pretoria.

Matson, P., 2016. Presentation (no title). National Academics of Sciences, Engineering and medicine. January 14, 2016. Newport Beach, California.

Meyer, NG. 1998. *The agricultural potential of South Africa: a provincial perspective on food security and land reform*. Unpublished PhD thesis. Pretoria: University of Pretoria.

Mucina L & Rutherford MC (eds.) 2006. *The vegetation of South Africa, Lesotho and Swaziland*. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Paterson, DG & van der Walt, M. 2003. *Soil patterns of South Africa from the Land Type Survey*. Soil Science Society of South Africa, Golden Jubilee Congress, 20 – 23 January 2003. PowerPoint presentation. Stellenbosch: Soil Science Society.

Schoeman, JL., Koch, FG., Kaempffer, LC. & Scotney, DM.,1992. *Wind erosion sensitive areas in South Africa*. Poster, 17th Cong. Soil Sci. Soc. S. Afr., 28-30 Jan., Stellenbosch.

Schoeman, JL and Scotney, DM. 1987. *Agricultural potential as determined by soil, terrain and climate*. South African Journal of Science, 83.

Scotney, DM, Volschenk, JE and van Heerden, PS. 1990. *The potential and utilization of the natural agricultural resources of South Africa*. Pretoria: Department of Agricultural Development.

Schulze, R.E. 2007. *South African Atlas of Climatology and Agrohydrology*. WRC Report 1489/1/06. Pretoria: Water Research Commission.

Schulze R. E. 2010. *Atlas of climate change and the South African Agricultural Sector: A 2010 perspective*. Department of Agriculture, Forestry and Fisheries. Pretoria.

Scotney, DM., Volschenk, JE. and Van Heerden, PS. June 1990. *The potential and utilization of the natural agricultural resources of South Africa*. Department of Agricultural Development. June 1990. Department of Agricultural Development, Republic of South Africa. 1990.

Smith, B. 2006. *The Farming Handbook*. University of KwaZulu Natal Press, Scottsville, South Africa.

Smith, HJ. 1998. *Definition and demarcation of high potential land for rain fed annual crop production*. Unpublished MInst Agrar dissertation. Pretoria: University of Pretoria.

South Africa (Republic) 2018. *Long-term grazing capacity for South Africa: Data layer*. Government Gazette Vol.638, No.41870. 31 August 2018. Regulation 10 of the Conservation of Agricultural Resources Act (CARA): Act 43 of 1983. Pretoria. Government Printer.

South Africa (Republic). 1970. *Sub-division of Agricultural Land Act, 70 of 1970*. Pretoria: Government Printer.

South Africa (Republic). 1983. *Conservation of Agricultural Resources Act, 43 of 1983*. Pretoria: Government Printer.

South Africa (Republic). 1998. *National Environmental Management Act, 107 of 1998*. Pretoria: Government Printer.

Stats SA, 2017. *General Household Survey, 2017 Statistical release P0318*. Report No P03182017. Stats SA; Government Printer, Pretoria

Stats SA. 2018. *Agricultural Survey (preliminary) 2017*. Report P1101. Stats SA, Government Printer, Pretoria South Africa

Stats SA. 2019. *Census of commercial agriculture (preliminary) 2019*. Stats SA, Government Printer, Pretoria.

Trade economics. [www.tradingeconomics.com](http://www.tradingeconomics.com). Accessed 22 March 2020.

United Nations. 2015 *Sustainable development*. Department of Economic and Social Affairs. United Nations. <https://sdgs.un.org/goals>

Van Niekerk, A, Jarman, C., Goudriaan, R., Muller, S.J., Ferreira, F., Munch, Z., Pauw, T., Stephenson, G. & Gibson, L. 2018. *An earth observation approach towards mapping irrigated areas and quantifying water used by irrigated crops in South Africa*. Report to the Water Research Commission and the Department of Agriculture, Forestry and Fisheries. Report No TT 745/17. 2018. Water Research Commission, Pretoria.

