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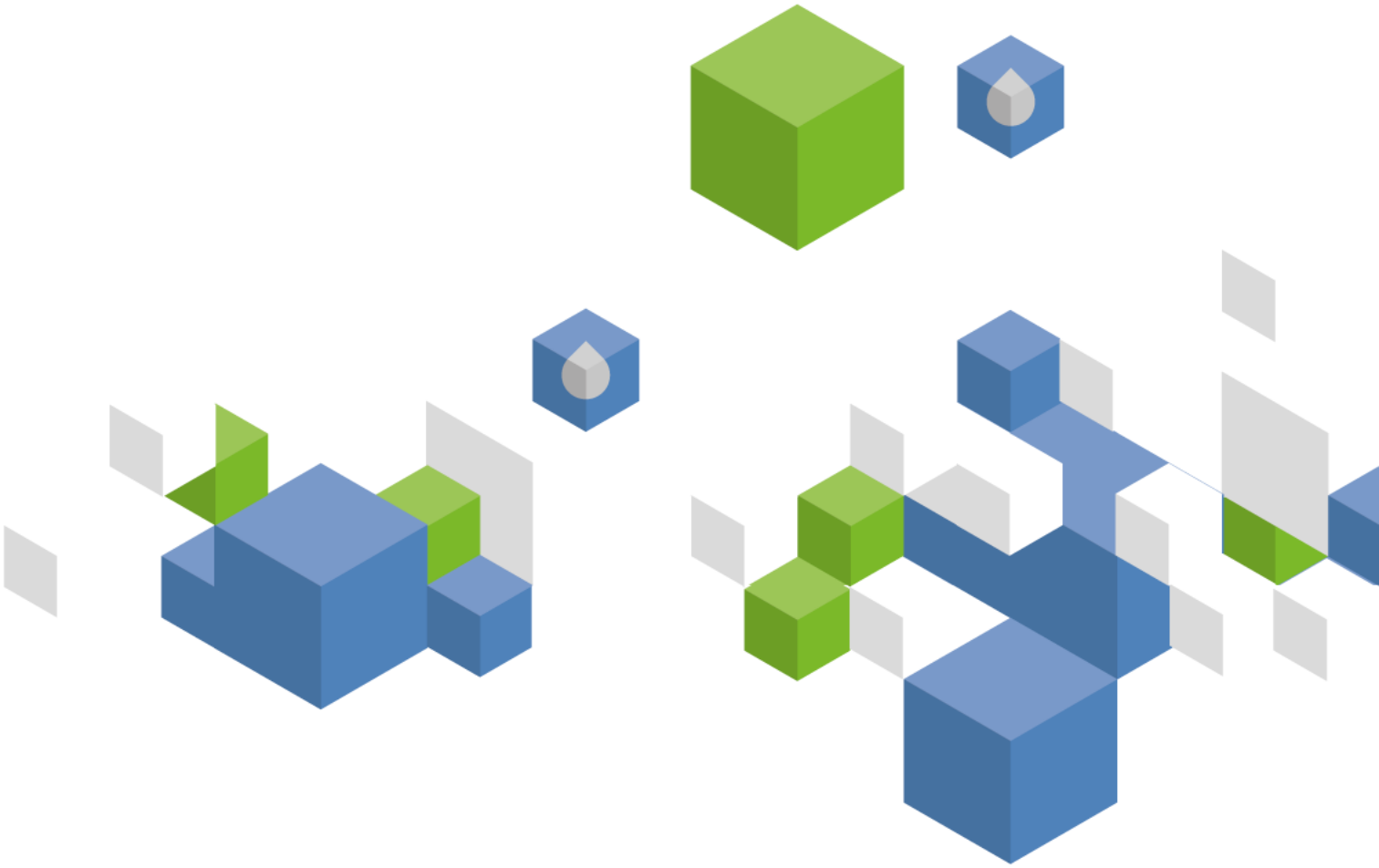

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South Africa

GEOGRAPHY, CLIMATE AND POPULATION

Geography

South Africa is the southernmost country on the African continent. Its coastline of over 3 000 km links the east and west coasts of Africa. The country stretches on almost 1 600 km from north to south as well as from east to west, totalling an area of 1.22 million km² (Table 1). South Africa is bordered by Botswana and Zimbabwe to the north, Mozambique and Swaziland to the northeast and east, the Indian Ocean to the southeast and south, the Atlantic Ocean to the southwest and west and Namibia to the northwest. Lesotho, an independent constitutional monarchy, is entirely surrounded by South African territory in the south-eastern part of the country.

A plateau that covers the largest part of the country dominates the topography. The plateau drops from 2 400 metres in the Lesotho region in the east to 600 meters in the sandy Kalahari in the west. The plateau comprises the Highveld in its centre and is separated from the surrounding areas of generally lower elevation by the Great Escarpment, reaching nearly 3 300 meters. The latter is known by various local names: the Drakensberg, the Stormberg, the Nuweveld Range and the Roggeveld Mountains. On both sides of the Great Escarpment, the topography tends to be relatively broken, with common mountains and deeply incised valleys but little genuine coastal plain. For most of its 2 900 km length, the coastline is characterized by fairly steep slopes rising rapidly inland. South of the Orange river lies the Great Karoo region. Cape Fold mountains–between 1 000 and 2 500 metres–lie in the southwest of the country including Table Mountain associated with Cape Town.

TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2013	121 909 000	ha
Agricultural land (permanent meadows and pasture + cultivated land)	2013	96 841 000	ha
• As % of the total area of the country	2013	79	%
• Permanent meadows and pasture	2013	83 928 000	ha
• Cultivated area (arable land + area under permanent crops)	2013	12 913 000	ha
- As % of the total area of the country	2013	11	%
- Arable land (temp. crops + temp. fallow + temp. meadows)	2013	12 500 000	ha
- Area under permanent crops	2013	413 000	ha
Population:			
Total population	2015	54 490 000	inhabitants
- Of which rural	2015	36	%
Population density	2015	45	inhabitants/km^2
Economy and development:			
Gross Domestic Product (GDP) (current US$)	2014	350 000	million US$/year
• Value added in agriculture (% of GDP)	2014	2	%
• GDP per capita	2014	6 586	US$/year
Human Development Index (highest = 1)	2014	0.666	-
Gender Inequality Index (equality = 0, inequality = 1)	2013	0.461	-
Access to improved drinking water sources:			
Total population	2015	93.2	%
Urban population	2015	99.6	%
Rural population	2015	81.4	%

FIGURE 1
Map of South Africa

SOUTH AFRICA

FAO - AQUASTAT, 2015

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The agricultural land of 96.8 million ha consists mostly of permanent meadows and pastures (87 percent) (Table 1). The cultivated area is estimated at 12.9 million ha in 2013 (FAO, 2016). Natural forests cover less than one million ha, plantation forestry less than 1.27 million ha and the woodlands, also known as savannahs, collectively cover about 30 million ha (DAFF, 2015). The natural vegetation includes shrubs and desert grasses in the dry central and western parts of the plateau, fynbos in the southwestern parts of the country with its Mediterranean climate and grasslands, savannah, bushveld and forest depending on the altitude in the eastern parts. There are 528 protected areas, including 20 marine areas. Over 3.75 million ha are protected in 20 national parks and 7 transboundary conservation areas (DAFF, 2015).

Climate

South Africa is a semi-arid country with an average annual rainfall of 495 mm, ranging from less than 100 mm/year in the western deserts to about 1 200 mm/year in the eastern part of the country. Only 35 percent of the country has a precipitation of 500 mm or more, 21 percent has a precipitation of less than 200 mm.

Based on annual rainfall, three climate zones can be distinguished:

- The eastern parts of the country, which are summer rainfall areas with an annual precipitation of 500 mm and more;
- The central and the western parts of the great plateau, which are semi-arid to arid and are characterized by late summer rains, varying from less than 100 mm/year to approximately 500 mm/year;
- The Cape Fold mountains and the area between them and the sea have a winter rainfall season in the west and rainfall throughout the year in the more south-easterly parts. Annual precipitation in this region varies from about 300 mm to more than 900 mm.

Therefore, 65 percent of the country does not receive enough rainfall for successful rainfed crop production and is used as grazing land. Crops grown in this area are grown under irrigation. Except for the Western Cape, with a Mediterranean climate and winter rainfall, the rest of the country has summer rainfall. Summer is from October to March with temperatures from 15ºC at night to 30ºC at noon. Winter is from April to September with temperatures from 0ºC at night to 18ºC at noon. Winter temperatures in the interior often drop below zero and frost is common on the great plateau limiting the choice of crops and resulting in strong seasonal patterns for most crops grown. South Africa ranks very high as far as sunshine days are concerned and high levels of evaporation are common due to the hot climate.

Population

The total population of the country is estimated at 54.5 million in 2015, of which 36 percent is rural (Table 1). The annual population growth rate over the period 2005-2015 is 1 percent, down from almost 2 in the 1990s. The average population density is 45 inhabitants/km², ranging from 21 in rural areas to more than 100 inhabitants/km^2 in more densely populated areas.

In 2014, the Human Development Index ranks South Africa 116 among 188 countries (UNDP, 2016). Life expectancy in South Africa is 57 years and the under-five mortality is 41 per 1000 births, the latter progressing from 95 per 1000 in the 1990s while the former declined from over 60 years in the 1990s. With no significant distinction between boys and girls, almost all children in 2013 are enrolled in primary and secondary education (WB, 2016). Adult literacy is 94 percent in 2012, with less than 2 points difference between female and male. Poverty concerns more than half of the population (54 percent) and is mainly a rural phenomenon where 75 percent of the poor live. It affects mostly women and children, in particular the female headed households (RSA, 2013). In 2015, 99.6 percent of the urban and 81.4 percent of the rural population were using improved drinking water sources, that is 93.4 percent of the total population This improved since 2002 when only 87 percent of the population had access to an improved drinking water source (JMP, 2015).

ECONOMY, AGRICULTURE AND FOOD SECURITY

The South African economy is largely based on services, manufacturing and mining. In 2014, the gross domestic product (GDP) was US$ 350 billion (current US$), with an annual growth of 1.5 percent, down from over 5 percent in 2005. Unemployment affects 32 percent of the active population (RSA, 2013). Mineral rents account for almost 4 percent of the GDP in 2013 and are dominated by gold, the country's largest export commodity. Gem diamonds, platinum and other metals are also produced. Manufacturing accounts for over 13 percent and services almost 68 percent in 2013.

Agriculture contributed 2.5 percent to the GDP in 2014 (WB, 2016) but if the entire value chain is taken into account, the agricultural sector contributes up to 12 percent to the GDP (DAFF, 2015). The sector employs 7 percent of active population. About 8.5 million people are directly or indirectly dependent on agriculture for employment and income (DWA, 2013). The agricultural sector consists in commercial farmers and subsistence smallholder farmers and ranges from intensive crop production and mixed farming to cattle-ranching in the bushveld and sheep-farming in the more arid regions (DAFF, 2015). The main crops are maize, wheat and to a lesser extent sugarcane, sunflower, potatoes, groundnuts, citrus and grapes. About 48 percent of the agricultural production value is from animal production. The forestry industry is strategic with a significant potential in terms of growth and employment (DAFF, 2015).

South Africa is a net agricultural exporter and a net food exporter in 2013. Although it is a net exporter of primary agricultural products, it is a net importer of processed agricultural products. Netherlands, United Kingdom and Zimbabwe rank as South Africa's top three export destinations for agricultural products, while imports come from China, Argentina and Brazil (DAFF, 2015). Prevalence of undernourished people is below 5 percent since 1990 in South Africa, hence achieving the Millennium Development Goal of hunger (FAO, 2015).

WATER RESOURCES

South Africa drains into four major systems:

- The Orange river, rising in the Lesotho Highlands and draining approximately 48 percent of the country (606 000 km²) to the Atlantic Ocean together with its tributaries, in particular the Caledon and the Vaal rivers. Total mean annual runoff is 11 100 million m³.
- The Limpopo river basin, draining the plateau north of the Witwatersrand ridge, i.e. approximately 14 percent of the country, to the Indian Ocean with its major tributaries such as the Crocodile and the Olifants river. This basin has a mean annual runoff of 5 100 million m³.
- All other rivers draining into the Indian Ocean, the largest of which is the Tugela river. They cover in total approximately 29 percent of the country with a mean annual runoff of 28 000 million m³.
- Rivers draining the Fold mountains of the south-western Cape into the Atlantic and Indian Oceans. They cover in total approximately 9 percent of the country, with a mean annual runoff of 5 000 million m³. The most important rivers in this area are the Olifants and the Breede rivers.

River flows reflect the rainfall pattern. Rivers that have their origin on the eastern great escarpment and in the Fold mountains of Western Cape normally have perennial flows. Rivers that originate in the immediate adjoining areas have periodic flows, whereas rivers that originate on the western great plateau have highly episodic flows.

The 19 Water Management Areas (WMAs) that were defined according hydrological catchments by the first National Water Resources Strategy (NWRS), have been merged into 9 WMAs corresponding to the 9 regional offices of the Department of Water and Sanitation (DWS) in the second NWRS. These 9 WMAs are: Berg Olifants, Breede Gouritz, Inkomati Usuthu, Limpopo, Mzimvubu Tsitsikamma, Olifants, Orange, Pongola Mtamvuna and Vaal (DWS, 2014).

Although groundwater is limited due to the geology of the country and large porous aquifers occur only in a few areas, it is often the primary source in the rural and more arid areas, as well as for many towns. It also supplies water to large irrigated areas, livestock and many mines and industries (DWA, 2013). It is expected that groundwater use for human consumption will further increase, especially in the western part of the country which lacks perennial rivers.

Internal renewable surface water resources are estimated at 43 000 million m³/year and renewable groundwater resources at around 4 800 million m³/year, but 3 000 million m³/year is considered to overlap between surface water and groundwater, which gives a value of total internal renewable water resources (IRWR) of 44 800 million m³/year (Table 2). Surface water entering the country is estimated at 6 600 million m³/year, which is the inflow from Lesotho through the Orange river (5 200 million m³/year), from Swaziland through the Maputo and Komati rivers (1 100 million m³/year) and from Botswana through the bordering Limpopo river (300 million m³/year). South Africa receives from the Orange river an increasing, guaranteed amount of water, from 57 in 1995 to 2 208 million m³/year in 2020 through the Lesotho Highlands Water Project. Surface water leaving the country to other countries is estimated at 10 850 million m³/year of which 50 million m³/year according to an agreement through the Orange river to Namibia, resulting in 6 550 million m³/year of external renewable water resources, as no groundwater enter the country. This brings the total renewable water resources to 51 350 million m³/year, or 942 m³/year per capita in 2015, and the dependency ratio is thus around 13 percent.

TABLE 2
Water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	495	mm/yr
	-	603 400	million m³/yr
Internal renewable water resources (Long-term average)	-	44 800	million m³/yr
Total renewable water resources	-	51 350	million m³/yr
Dependency ratio	-	13	%
Total renewable water resources per inhabitant	2015	942	m³/yr
Total dam capacity	2015	31 022	million m³

Wetlands mapped in South Africa cover a total area of 2.9 million hectares in 2012. About 35 to 60 percent of the wetlands have been lost or severely degraded (DWA, 2013b) from the initial 4 million ha cumulated by about 115 000 wetlands (DAFF, 2015). Degradation originates from pollution and unsustainable developments of various activities, in particular mining. In 2013, South Africa had listed 21 Ramsar sites extending over 554 136 ha, including the Natal Drakensberg Park and the Saint Lucia system (Ramsar, 2013).

South Africa's inland water area covers 600 000 ha, including its main natural lakes Lake St Lucia and Lake Sibaya in the iSimangaliso Wetland Park and artificial lakes or reservoirs created by dams. The total dam capacity is estimated at 31 020 million m³ stored in over 5 100 dams of which 320 are managed by the Department of Water Affairs (DWA), including 756 large dams, i.e. dams with wall height over 15m and capacity exceeding 3 million m³ (DWA, 2013c). The new De Hoop dam in the Mpumalanga province on the Steelpoort river, an important tributary of the Olifants river in the Limpopo river basin, was completed in 2014. Some existing dams, the Hazelmere and Clanwilliam dams, are planned to be heightened and several new dams are under construction (SANCID, 2015):

- Spring Grove dam on the Mooi River (KwaZulu Natal province)
- Nwamitwa dam on the Groot Letaba river (Limpopo province)
- Mzimvubu dam (East Cape province)
- Nwamithwa dam on the Great Letaba (Mpumalanga province)

Because of uneven temporal and spatial distribution of rainfall (43 percent of the rain falls on 13 percent of the land), and major cities being located far from the largest rivers, large transfers of water are made

between catchments: 28 inter-basin transfer schemes have a total discharge exceeding 7 000 million m³/year (DWA, 2013c).

INTERNATIONAL WATER ISSUES

South Africa shares four major rivers systems with six neighbouring countries (Table 3) and has a long history of water sharing agreements. The first international agreement was signed by South Africa in 1964 with the Portugal, regarding the Cunene River, shared between Angola–then Portugal's colony– and the current Namibia, which gained independence from South Africa in 1990. More recently, South Africa signed and ratified the SADC Shared Water Course System Protocol in 1995 and its revised version in 2000. In addition, South Africa is also member of the transboundary institutions dedicated to specific rivers (Table 3).

TABLE 3
Transboundary rivers and respective institutions

River	South Africa shares with	Transboundary institutions
Orange/Senqu	Botswana, Lesotho and Namibia	Orange/Senqu River Basin Commission (2000)
Limpopo	Botswana, Mozambique and Zimbabwe	Limpopo Watercourse Commission (LIMCOM, 2014) replacing the Limpopo Basin Permanent Technical Committee (LBPTC, 1986)
Komati	Mozambique and Swaziland	Komati River Basin Water Authority
Maputo- Usuthu/Pongola	Mozambique and Swaziland	-

Several bilateral and multilateral commissions have also been established with neighbouring countries (DWA, 2013; DWAF, 2009; SANCID, 2015):

- Joint Permanent Technical Water Committee (JPTC) with Botswana
- Permanent Water Commission (PWC) with Namibia (1992)
- Joint Water Commission with Swaziland
- Joint Water Commission with Mozambique (1994)
- Joint Water Commission with Zimbabwe (2014)
- Inco-Maputo Tripartite Permanent Technical Committee (TPTC) with Mozambique and Swaziland.

More temporary agreements complete the transboundary management of these shared water resources:

- Cross Border Water Supply Agreement with Botswana (2007) to enable water supply authorities to supply water across the borders
- Tripartite Interim Agreement with Mozambique and Swaziland (2002) to rehabilitate the Usuthu River and initiate a Joint Maputo Basin Study.

In 1986, South Africa signed with Lesotho the Treaty on the Lesotho Highlands Water Project (LHWP) leading to establishment of the Lesotho Highlands Water Commission to implement the scheme. The objective of the LHWP is to export water from Lesotho to the north of South Africa. This 30-year scheme consisted of five vast reservoirs, including the Katse and Mohale dams in Lesotho, and more than 200 km of tunnels diverting northwards water from an upstream sub-basin of the Orange river basin in Lesotho highlands, to deliver 780 million m³ per year to the Vaal river basin–another sub-basin of the Orange river basin–to secure water supplies in the Pretoria-Witwatersrand-Vereniging area. Most of the constructions (roads, bridges, power lines, hydro-electricity generation) took place inside Lesotho, which benefits from infrastructures mostly financed by South Africa, in addition to revenue. Phase two of the project, aiming to increase the volume of water delivered to South Africa, has been signed in 2011 (DAFF, 2015) and will launch the construction of the Polihali dam and tunnel. The Trans-Caledon Tunnel Authority (TCTA) was created in 1986 to develop the LHWP.

In addition, South Africa shares also a number of aquifers (Table 4).

TABLE 4
Transboundary aquifers (Source: IGRAC, 2014; ISARM, 2004)

Aquifer name	Total aquifer area (km²)	Sharing countries
Karoo Sedimentary Aquifer	165 936	Lesotho, South Africa
Coastal Sedimentary Basin V	797	Namibia, South Africa
Coastal Sedimentary Basin VI	11 000	Mozambique, South Africa
Rhyolite-Breccia Aquifer	4 916	Mozambique, South Africa, Swaziland
SE Kalahri Karoo Basin	85 077	Botswana, Namibia, South Africa
Khakhea/Bray Dolomite	29 689	Botswana, South Africa
Ramotswa Dolomite Basin	3 144	Botswana, South Africa
Limpopo Basin	19 961	Mozambique, South Africa, Zimbabwe
Tuli Karoo sub-basin	14 330	Botswana, South Africa, Zimbabwe
Medium Zambezi Aquifer	-	Botswana, Mozambique, South Africa, Zimbabwe

WATER USE

Total water withdrawal in South Africa was estimated at 12 496 million m³ in 2000, with irrigation accounting for 62 percent. The total registered water use volume in 2013 amounts to 17 300 million m³ in the Department of Water Affairs' database WARMS–Water Authorization and Registration Management System–reaching the 2025 high estimate water requirement. However, there is no data concerning the actual use of water. It is estimated between 15 000 and 16 000 million m³ in 2013 (Table 5). Irrigation is still the most important water user with 60 percent of water withdrawn, while livestock and nature conservation uses 2.5 percent. Municipalities are second with 24 and 3 percent respectively in urban and rural areas. Industries use the remaining, including 3.5 percent for mining and 4 percent of power generation (DWA, 2013c).

TABLE 5
Water use

Water withdrawal:			
Total water withdrawal	2013	15 500	million m³/year
- Irrigation	2013	9 300	million m³/year
- Livestock	2013	390	million m³/year
- Municipalities	2013	4 185	million m³/year
- Industry	2013	1 625	million m³/year
• Per inhabitant	2013	294	m³/year
Surface water and groundwater withdrawal (primary and secondary)	2013	13 890	million m³/year
• As % of total renewable water resources	2013	27	%
Non-conventional sources of water:			
Produced municipal wastewater	2009	3 542	million m³/year
Treated municipal wastewater	2009	1 919	million m³/year
Direct use of treated municipal wastewater	2009	1 610	million m³/year
Direct use of agricultural drainage water		-	million m³/year
Desalinated water produced		-	million m³/year

Total groundwater withdrawal was estimated at 1 770 million m³ in 2010, of which 64 percent for irrigation (CSIR, 2010, Figure 2). Although its volume is limited at national level, groundwater is extensively used in rural and arid areas (Figure 3).

The total produced municipal wastewater volume amounts to 3 542 million m³ in 2009, of which 54 percent is treated. However, half of the treatment plants, especially the smaller ones, do not meet the effluent standards, resulting in the quality of surface water being particular poor in urban areas (OECD, 2013).

Small desalination plants (less 0.5 million m³/year) have been installed in Knysna, Bitou, Sedgefield, Cannon Rocks and Boknes (DWA, 2010). Their cumulative capacity in 1990 was 18 million m³/year.

Opened in 2011, Mossel Bay is the largest desalination plant in the country with a capacity of 5.5 million m³/year.

Development and use of water resources differ widely between the northern arid parts of the country, where both surface water and groundwater resources are nearly fully developed and utilized, while in the well-watered south-eastern regions of the country significant undeveloped and little-used resources exist.

FIGURE 2
Water withdrawal by sector
Total 15 500 million m³ in 2013

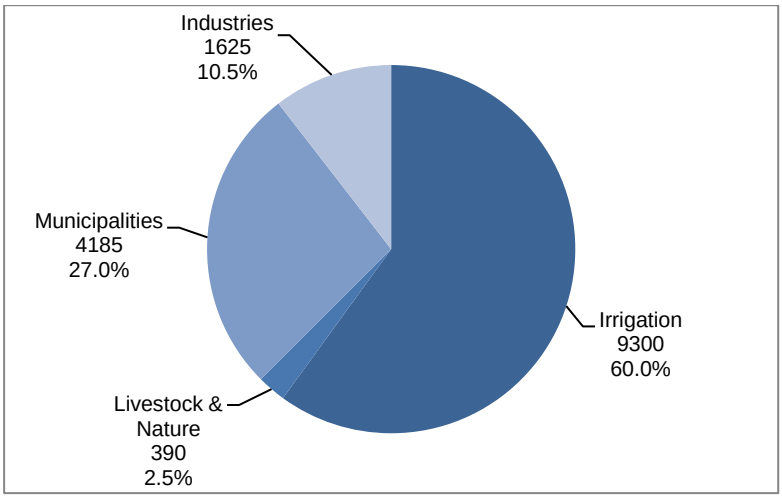
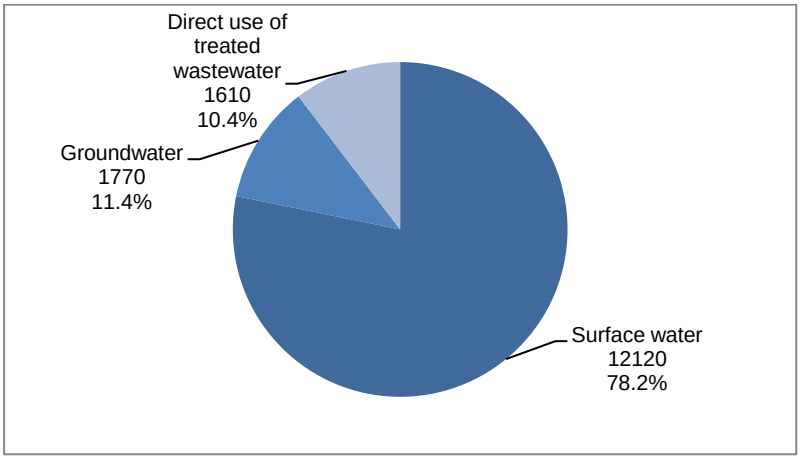


FIGURE 3
Water withdrawal by source
Total 15 500 million m³ in 2013



IRRIGATION AND DRAINAGE

Evolution of irrigation development

The irrigation potential of South Africa was estimated at 1 445 000 ha in the late 1990s, of which 60 percent are located in the Indian Ocean Coast basin (FAO, 1997). However, at present the area equipped for irrigation is already larger than the above figure, which was based on water availability. In the central and western parts of the country, suitable soils are available for an increase in the irrigated area, but the expansion potential is limited by lack of water. In the eastern parts of the country steep slopes and a lack of suitable soils restrict an expansion of irrigable areas.

Pre-colonial flood irrigation was evidenced with traces of canals and dams from the Gemsbokspruit (Tempelhoff, 2009). But only by late 18th century, small-scale irrigation was well established in the Olifants river valley in the Western Cape region, where famers cropped the overflowed river banks. However, it caused the banks to widen due to destruction of the riparian vegetation and progressively overflow disappeared. Before dams and weirs projects actually concretized, local farmers started irrigation using pumps (steam, wind or bucket) (Water Wheel, 2010). In parallel, in the arid Northern Cape, farmers used saaidams–a traditional water storage method constructing 1-2m high walls across basins to retain floodwater, still in use today in the more arid areas–to plant cereals and later lucerne. Lucerne pastures were indeed the preferred fodder of ostrich, whose feathers were exported to Europe for fashion, and stimulated irrigation development in the early 20th century (van Vuuren and Backeberg, 2015). The 1st irrigation district was proclaimed in 1911 (Water Wheel, 2010) and the 1st Irrigation and Water Conservation Act was passed in 1912. And the largest irrigation schemes were constructed between the two world wars, such as Vaalhart and Loskop schemes, the two largest in South Africa with respectively over 29 000 and 16 000 ha (van Vuuren and Backeberg, 2015). These irrigation schemes not only produced food but also alleviated poverty caused by the Great Depression by settling returning soldiers and reducing unemployment. There was also then a shift from flood to more efficient irrigation techniques (DAFF, 2012). From the 1930s to the 1960s the public water storages were developed to face unreliable rains and variable flows (DAFF, 2012), mostly for white irrigated farming (van Koppen, Schreiner and Karar, 2011). During this period, smallholder irrigation was also developed through canal irrigation. These smallholder canal schemes were mostly located in the "Bantu" areas, which were areas designated by the Land Act 1913 for black people on state lands and under state control. Inter-basins transfers of water were developed between the 1960s and 1980s to supply some irrigation schemes without enough water. From 1970 to 1990, also called the Independent homeland era, irrigation was modernized with pressurized systems on small schemes and very large parastatal irrigation schemes were developed. After South Africa's democratization in 1994, these parastatals were dismantled by the provinces, and the new focus toward equitable and sustainable use of water resources resulted in the irrigation management transfer of the smallholder irrigation schemes (Ledwaba, 2013), as well as optimization of existing equipped areas rather than construction of new large schemes (van Vuuren and Backeberg, 2015) and revitalization of smallholder schemes (DAFF, 2012).

In 2002, 1 498 000 hectares were equipped for full control irrigation. In 2012, the equipped area increased to 1 670 000, of which 920 000 ha or 55 percent are equipped with sprinkler irrigation including moving devices, while the rest is divided almost equally between surface irrigation (23 percent) and localized irrigation (22 percent) (Table 6 and Figure 4). Irrigation is South Africa can be divided into smallholder irrigation schemes and large-scale commercial irrigation schemes and by far the largest area is covered by large-scale commercial schemes.

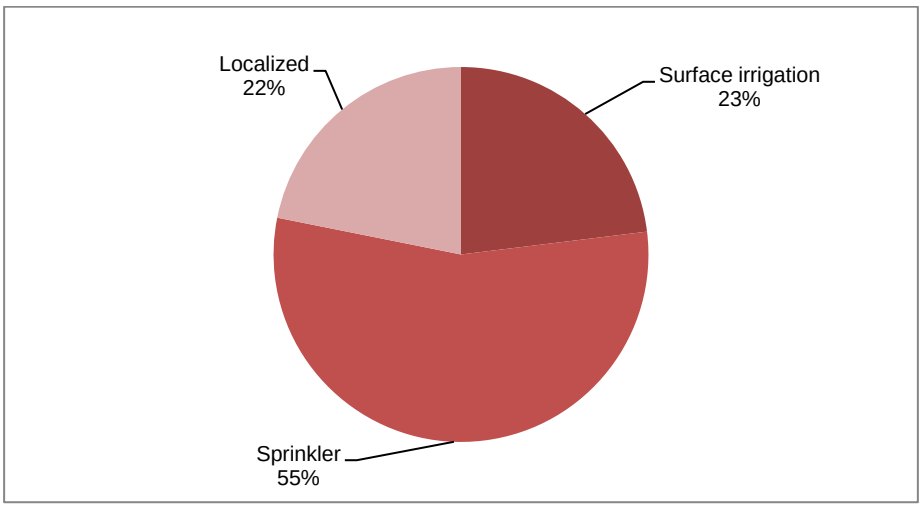
TABLE 6
Irrigation and drainage

Irrigation potential		-	ha
Irrigation:			
1. Full control irrigation: equipped area	2012	1 670 000	ha
- Surface irrigation	2012	385 000	ha
- Sprinkler irrigation	2012	920 000	ha
- Localized irrigation	2012	365 000	ha
• Area equipped for full control irrigation actually irrigated	2008	1 399 000	ha
- As % of area equipped for full control irrigation	2008	90	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha

TABLE 6 (Continued)
Irrigation and drainage

Irrigation:			
Total area equipped for irrigation (1+2+3)	**2012**	**1 670 000**	**ha**
• As % of cultivated area	2012	12.9	%
• % of area irrigated from surface water		-	%
• % of area irrigated from groundwater		-	%
• % of area irrigated from mixed surface water and groundwater		-	%
• % of area irrigated from non-conventional sources of water		-	%
• Area equipped for irrigation actually irrigated		-	ha
- As % of total area equipped for irrigation		-	%
• Average increase per year	2002-2012	1.1	%
• Power irrigated area as % of total area equipped for irrigation		-	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	ha
5. Non-equipped flood recession cropping area		-	ha
Total water-managed area (1+2+3+4+5)	**2012**	**1 670 000**	**ha**
• As % of cultivated area	2012	12.9	%
Size of full control irrigation schemes: **Criteria**:			
Small schemes < - ha		-	ha
Medium schemes > - ha and < - ha		-	ha
large schemes > - ha		-	ha
Total number of households in irrigation	2010	280 000	
Irrigated crops in full control irrigation schemes:			
Total irrigated grain production		-	metric tons
• As % of total grain production		-	%
Harvested crops:		-	
Total harvested irrigated cropped area	2008	1 665 135	ha
• Temporary crops: total	2008	1 108 935	ha
- Wheat	2008	216 600	ha
- Maize	2008	231 000	ha
- Other cereals	2008	23 786	ha
- Vegetables	2008	136 200	ha
- Sunflower	2008	8 186	ha
- Other oil crops	2008	20 142	ha
- Potatoes and other tubers	2008	48 900	ha
- Pulses	2008	143 400	ha
- Sugarcane	2008	90 000	ha
- Tobacco	2008	32 600	ha
- Cotton	2008	75 000	ha
- Temporary fodder	2008	83 121	ha
• Permanent crops: total	2008	556 200	ha
- Fruits	2008	237 900	ha
- Citrus	2008	67 100	ha
- Bananas	2008	13 300	ha
- Tea & Coffee	2008	4 000	ha
- Other permanent crops	2008	233 900	ha
Irrigated cropping intensity (on full control area actually irrigated)	2008	119	%
Drainage - Environment:			
Total cultivated area drained	1990	54 000	ha
• Non-irrigated cultivated area drained		-	ha
• Area equipped for irrigation drained		-	ha
- As % of total area equipped for irrigation		-	%
Area salinized by irrigation		-	ha
Area waterlogged by irrigation		-	ha

FIGURE 4
Techniques of irrigation
Total 1 670 000 ha equipped for full control irrigation in 2012



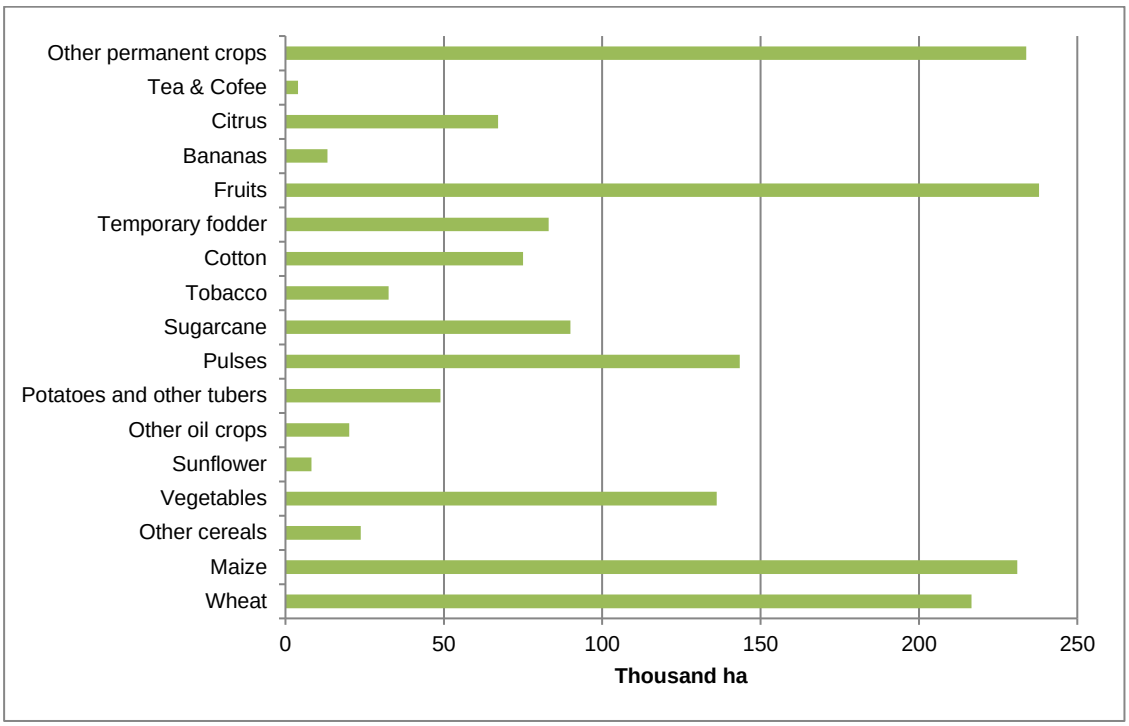
Conservation agriculture is practiced on 368 000 ha in 2008. Water harvesting at small-scale also occurs. Terraces are common in in the Soutpansberg mountain range and along the Drakensberg escarpment into the Mpumalanga Lowveld (Tempelhoff, 2009).

Role of irrigation in agricultural production, the economy and society

Irrigation can either be permanent, supplementary or occasional in South Africa. Permanent irrigation mostly occurs in the 250-750 mm rainfall zone. Most commercial irrigation occurs in the Orange, Crocodile, Lower Vaal, Sundays & Fish rivers basins and in the Western Cape region (UNEP, 2000). Irrigated agriculture contributes to about 30 percent of the agricultural production of South Africa (DWA, 2013c) and has a huge potential impact in rural areas (DWA, 2013). Irrigation farmers are estimated at 230 000 to 280 000, including 200 000 to 250 000 smallholders, most of which have very small plots for self-consumption, and less than 30 000 commercial farmers (WRC, 2011; DWA, 2013b). In addition, some 120 000 permanent workers as well as numerous seasonal workers (Oosthuizen, 2002) totalling 10 to 15 percent of the total agricultural employment in irrigated agriculture (DWA, 2002).

About 80 to 90 percent of high-value crops such as potatoes, vegetables, grapes, fruits and tobacco are irrigated, and between 25 to 73 percent of industrial crops, such as sugarcane and cotton depending on the crops and years (Backeberg, 2005; DAFF, 2012). As far as cereals are concerned, in 2008 about 34 percent of the planted area of wheat is irrigated, 9 percent of the planted area of maize and some areas of barley in North West and Limpopo provinces. In the early 1990s, potatoes previously mostly grown as a rainfed crops shifted to an irrigated crop (DAFF, 2012). Cotton yields under irrigation reach 3.9 t/ha in average, compared to 0.7 t/ha in dryland. Fruits are grown in the Western and Eastern Cape while vineyards are mostly grown in the Lower Orange area. Together, fruits including grapes, represent up to 40 percent of the agricultural exports in some years (UNEP, 2000). The main irrigated crops are cereals representing almost 30 percent of the irrigated area in 2008, in particular maize in summer and wheat in winter, vegetables, pulses and fruits (Table 5 and Figure 5).

FIGURE 5
Harvested irrigated area
Total 1 665 135 ha harvested irrigated in 2008



Women and irrigation

Gender equity is enshrined in the South African constitution, together with the right to water. Lack of improved access to water and sanitation impacts most heavily on women–responsible for collecting water–and children–victims of poor sanitation–in rural and peri-urban areas (DWA, 2013d). Most women, as well as other historically disadvantaged individuals in the country such as black people, had been systematically excluded to proper water access and its benefits. As a result, almost no black women had land and/or water entitlement in her name (van Koppen, Schreiner and Karar, 2011).

In South Africa, a number of examples have shown that in the field of domestic water supply the substantial presence of women in water committees is more likely to result in a well-managed and sustainable project. As the carriers of water, and the custodians of family health, women are more likely to benefit directly from a closely located tap than their male counterparts, and therefore to play an active role in maintaining the service (DWAF, 2000). While women benefited the higher level of domestic water services since 1994, their access to the resources for agriculture does not seem to improve (van Koppen, Schreiner and Karar, 2011).

Regarding water for irrigation, several issues arise for women. First, even when being the main farmer, it's unlikely that the land will be registered under the women's names. In the Arabie/Olifants irrigation scheme, an estimated 90 percent of the farmers are women, due to traditional cultural practices in which women are responsible for cultivation, while men focus on cattle rearing, land clearing and plowing, and due to the fact that men migrate towards urban areas in search of jobs. However, few have the land and water registered under their name, resulting in administrative difficulties for them (WRC, 2009). Second, efforts have been made for gender equity in the constitution of newly created institutions such as Catchment Management Agencies (CMAs) and Water Users Associations (WUAs), where a 50 percent quota for women has been set, but changes are difficult in existing male-dominated institutions. In a study in the Limpopo and Kwazulu-Natal provinces, while none of the six selected WUAs had achieved the gender quota, efforts were made as it was a condition to obtain subsidies. But transforming irrigation boards, which were self-sustaining, had no incentive to include women in their management

structures. Gender quotas alone were not enough to bring about gender equity and poverty reduction in WUAs because the required enabling environment for the empowerment of rural women was not created. The same study showed that women were not getting any benefits from their involvement in WUAs because they did not own land and water rights in their individual capacity. This is contrary to men who owned land and water rights and thus had the power to influence the decisions on the allocation of water resources (WRC, 2009).

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

Institutions

Two Departments are involved in water management and irrigation development:

- The Department of Water and Sanitation (DWS), replacing the Department of Water Affairs (DWA), is the custodian of South Africa's water resources. It is primarily responsible for the formulation and implementation of policy governing this sector. It also has an overriding responsibility for water services provided by local government. While striving to ensure that all South Africans gain access to clean water and safe sanitation, the water sector also promotes effective and efficient water resources management to ensure sustainable economic and social development.
- The Department of Agriculture, Forestry and Fisheries (DAFF), through its Directorate of Water and Irrigation Development (DWID) in its Forestry and Natural Resources Management branch is to ensure the efficient development and revitalization of irrigation schemes and water use.

The Department of Environmental Affairs (DEA) has no specific branch related to water.

At regional level, the DWS has 9 regional offices, one in each region, implementing the DWS's policy, as well as controlling and monitoring services. To these regional offices correspond 9 WMAs–detailed in the Water Resources section–each managed by a Catchment Management Agency (CMAs) involving local communities. A Water Tribunal was established in 1998 to decide over issues related to water management and actions taken by CMAs.

SANCID is the South African National Committee of the International Commission on Irrigation and Drainage (ICID). The South African Irrigation Institute (SABI) is a national NGO providing irrigation standards and norms.

Most of the research on the various aspects of water use is promoted, funded and coordinated by the Water Research Commission (WRC), whose funds are generated by a levy on water use. Various institutes of the Agricultural Research Council (ARC) are to a greater or lesser degree involved in irrigation-related research, as are some of the universities. Very little irrigation-related research and extension is done by the departments of agriculture. This is offset by one private organization, the South African Sugar Association, which does some irrigation-related research and extension work.

Regarding water supply and sanitation at regional levels, the Water Boards provide water services (bulk potable water and wastewater treatment) in their respective service areas. Water Services Authorities (WSA) are municipalities ensuring that same service within their area of jurisdiction and the Water Services Provider (WSP) is contracted to sell water or treat wastewater (DWA, 2013d).

Water management

Prior to the National Water Act 1998, the management of water resources was mainly demand driven, with emphasis on the development of new water resources (DWA, 2002) and the riparian principle–originating from the English common law, which allocates water of a river to the farmers possessing land along its path up to "reasonable use"–encouraged white landowners to use water to develop their

land with irrigated agriculture (RSA, 2013). Since 1998, water is allocated through five entitlements: reserve, scheduled use (household, stock, rainwater harvesting), general authorization, licensed water use, existing lawful use. A water allocation reform targets the last three forms (DAFF, 2012b).

The National Water Act 1998 stipulates water management by Water User Associations (WUAs) at the local level. Each WUA is to include all individual water users in an area and is responsible for the local water management. Previous irrigation boards, private schemes and government water schemes are or were transformed into WUAs. Catchment Management Agencies (CMAs) are responsible for the WUAs in their respective areas. Establishment of WUAs, in particular for smallholders, used a top-down approach contrary to the National Water Act envisaged process, as bottom-up driven by water users (WRC, 2009). Indeed, programmes of revitalization of smallholder irrigation schemes were initiated with the aim to transfer ownership of the schemes to farmers after technical and financial assistance (Ledbawa, 2013).

Finances

Ageing water infrastructures, either for water supply or for irrigation, require maintenance and upgrades. Government is the main source of funding for development and rehabilitation of infrastructures with raw water tariffs per volume, varying significantly depending on regions and sources, but recovery rate is low. The raw water pricing strategy was under review in 2015. In irrigation, water is mostly unmeasured and thus uncharged, resulting in underinvestment. In addition, not all irrigators have a water licence yet (OECD, 2013). A water market, enabling irrigators to save and sell excess water, has been initiated.

Policies and legislation

The right to access water is specified in the Constitution of South Africa (RSA, 2013). However, the main legislation is the National Water Act 1998 (Act 36), replacing the previous Water Act 1956 which was based on European laws and thus inappropriate for the country's climate condition and which was racially discriminating for water allocation (DWS, 2014). The 1998 Act requires licensing for water, a public resource, while it was previously considered attached to the land. Finally, it also declared afforestation as a “stream flow reduction activity” due to its impact on the flow of rainwater into streams, and downstream hydrological balance. The Water Services Act 1997 (Act 108) prescribes the duty of municipalities to provide water supply and sanitation according to national standards and norms. Both acts are being reviewed and it is expected that they might be merged into one act only to improve integration of the resources' management (DWA, 2013b). In addition, the National Environmental Management Act 1998 (Act 107) and its amendments of 2003, 2004, 2008 on waste and of 2009 on integrated management complete the legislation in relation with water.

The three main policies related to water, especially for agriculture, are:

- The National Water Resource Strategy 2004, indicating the water management, including water quality of the national water resources, and the expected water supply and sanitation services. It is underpinned by three fundamental principles: equity, environmental sustainability and efficiency. It was reviewed in 2012 with the Second National Water Resources Strategy (NWRS 2) to operationalize the establishment of CMAs (OECD, 2013), in particular from finances perspectives with framework for water allocation and taxes.
- The Integrated Water for Growth and Development Framework 2009 for agriculture, forestry and fisheries, guiding water development in order to alleviate poverty through the many activities depending on water supply.
- The National Groundwater Strategy 2010, intended to make the best use of this resource while protecting it.

In addition, drafts have been produced on specific themes but are still to be finalized and published: a draft national agriculture development strategy, a draft irrigation strategy and a draft irrigation policy framework. The latter is to focus on the revitalization of irrigation. Finally, strategies for non-conventional sources of water have also been detailed: a reuse strategy and a desalination strategy aimed particularly to coastal cities.

ENVIRONMENT AND HEALTH

Water quality

Overall, water quality is comparatively high (OECD, 2015). However, only one third of the mainstream rivers are in good condition and one quarter of the river ecosystems are critically endangered. This last ratio reaches almost half of the river ecosystems when considering only the main rivers without the tributaries (OECD, 2015). Water monitoring since 2006 shows a decline of biological and chemical water quality of surface water and groundwater due to various factors:

- Wastewater: the wastewater treatment capacity is not sufficient in South Africa to treat all wastewater (DWA, 2013), resulting in pollution both from untreated wastewater and from treated effluents not meeting the standards and causing microbial contamination, in particular due to rapid urbanization in informal shanty towns that rise near cities.
- Acid Mine Drainage (AMD): water flowing from closed mines contains high concentrations of metals, sulphides and salts contaminating both surface water and groundwater. This occurs particularly in Gauteng province, as well as in the Witbank and Vryheid areas. AMD also originates from runoff from open pits, stockpiles and mine tailings (OECD, 2013). The Olifants and Vaal rivers, located in highly concentrated mining activity areas, are rich in sulphates, alkalinity and magnesium among others (DWA, 2012). It is considered as the most pressing issue in water management in South Africa.
- Salinization: it is widespread in the country, both naturally by leaching from geological features or groundwater discharge, or due to human activity. Natural salinization from sodium and chloride affects mostly the Sout and Berg rivers in the Western Cape, but it is coupled with seawater intrusion and intensive agricultural activities such as citrus and grapes cultivation using extensive fertilization. Rise in salinity in groundwater reflects local land-based activities such as in the Lower Vaal and the Upper Orange. The Nossob and Auob rivers flowing from Namibia–northern sub-catchment of the Lower Orange–experience rapidly increasing salinity. On the contrary, improvement of the salinity levels occurs in the Limpopo and Olifants basins and small aquifers of the western Crocodile, Marico and northern Lower Vaal basins (DWA, 2012). An estimated 260 000 ha of irrigated land in South Africa is affected by waterlogging and/or salinization.
- Eutrophication: this is a serious problem in Haartebeespoort, Rietvlei and Roodekoppies dams, where efforts to control it are in place (DWA, 2012).

Water contamination also occurs through toxicants, altered flow regime, suspended solid, radioactivity and agrichemicals (DWA, 2013). As agriculture mostly uses water that was not previously treated, except for the small portion using treated wastewater, there is thus a concern on its impact when irrigating agricultural products (DAFF, 2012b).

Ecological reserve

The *National Water Act 1998* specifies that a specific amount of water be kept earmarked to satisfy ecological requirements. All water balance calculations must include a provision for this ecological reserve to remain in the river, although the application of this principle has not been practically described. However, it has a positive impact by stopping unbridled development. It is nonetheless, difficult to meet environmental needs in fully developed rivers, such as the Vaal, Mgeni and Crocodile East, without reallocation of water licences. For partially developed rivers, such as the Olifants and Mkuze rivers in particular, ecological reserve will help to avoid any further degradation. For the few

rivers that have not been developed, the Mzimvubu and Mkomazi in particular but small coastal rivers also, applying the ecological reserve will be easier but should not be overlooked (DWAF, 2009).

Sedimentation

Sedimentation of dams is a problem, especially in the dams that impound parts of the Central Plateau that are covered by the very old rock of the Karoo (Karroo) System and its sediments. As a general rule the soils that develop from this material are prone to erosion and hence some dams in the central parts of the country have lost a substantial amount of their capacity. The exact dimensions of this problem have not been determined but some exceptional cases are known where dams have lost more than 25 percent of their capacity over the last 90 years.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Demand for water in South Africa is estimated at 17 700 million m³ in 2030, with no difference in the sector repartition compared to the actual withdrawal: 8 400 million m³ for agriculture, 3 300 million m³ for industry and 6 000 million m³ for municipalities (Boccaletti, Stuchtey and van Olst, 2010).

In the Water for Growth and Development Framework 2009, DAFF proposes an additional 600 000 ha of land under irrigation including rehabilitation of existing irrigation schemes and the revival of food plots in the former homelands schemes and enhanced use of 70 000 ha of underutilized irrigation land in government schemes. This addition is not supposed to demand extra water but to use the water saved by reducing water losses and improving irrigation efficiency, as well as water already allocated to agriculture but not used until now (DWAF, 2009). However, a more recent survey indicates that only an additional 80 000 ha could be developed for irrigation based on surface water availability in the high rainfall areas along the east coast. Additional development would require dam building in these areas but would be costly. A study recently looked at the feasibility of a dam on the Mzimvubu river, one of the last ‘pristine' and not developed river in the southeast. Implementation of Phase 2 of the LHWP is expected to deliver additional water to Gauteng by 2020 (DWA, 2013).

Recommendation for the improvement of irrigation efficiency includes (DWAF, 2009):

- For commercial irrigation: irrigation scheduling, measurement of the quantity of water applied, change in technology.
- For household and community irrigation: revitalization of food plots in homeland irrigation schemes and support from the DAFF for this miniature irrigation including allocation of water, water harvesting and storage, water efficient technology such as clay pot.
- For groundwater irrigation: development of groundwater for small-scale irrigation and food plots, in particular in isolated communities.

Finally, the government has set a target of producing desalinated water up to 2 percent in 2025, 3 percent in 2040 and 7 to 10 percent of all water withdrawals in the even longer term, promoting this technology in the coastal cities. Increase of the share of groundwater in the water withdrawal as well as increased use of water either treated wastewater or drainage water, are also planned in order to reduce the dependence on surface water.

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