FREE STATE

LAND & WATER USE

TABLE 1

Areas and percentage change of land cover groups between 1990 and 2013/14 for the Free State.

Land cover group	1990 Area (km²)	2013-14 Area (km²)	Change (%)
Waterbodies (WB)	1196	726	-0.481
Wetlands (WTL)	2802	1687	-1.141
Indigenous Forest (INF)	46	51	0.005
Thicket / Dense bush (TDB)	885	1130	0.251
Woodland / Open bush (WOB)	968	851	-0.119
Grassland (GRS)	43546	37728	-5.950
Low shrubland (LSB)	18025	25180	7.316
Mines (MNS)	182	180	-0.002
Bare non-vegetated (BNV)	282	627	0.353
Plantations / Woodlots (PWD)	395	382	-0.013
Cultivated commercial annuals (CCA)	28635	28228	-0.416
Cultivated perennial (CPE)	18	26	0.008
Cultivated subsistence (CSB)	143	224	0.083
Low shrubland (LSB)	0	0	0.000
Urban	674	777	0.106

WARMS DATABASE (updated up to August 2016)

Most water volumes are registered in the Free State for taking water (1.69 billion m^3 a^{-1}), disposing waste (0.41 billion mm^3 a^{-1}) and storing water (0.21 billion m^3).

By water resource types, water is taken mainly from water schemes (61.1%), boreholes (15.9%) and rivers/streams (14.7%).

The highest water withdrawals per sector were for agricultural irrigation (1.25 billion m^3 a^{-1} or 73.6% of the total), water supply services (0.38 billion m^3 a^{-1} or 22.4%) and mining (0.05 billion m^3 a^{-1} or 2.9%).

Free State **does not** have water uses registered for afforestation, recreation and in the category urban (excluding industrial and/or domestic).

NATIONAL LAND COVER (NLC) MAPS of 1990 & 2013/14:

The largest areas in the Free State are covered by grassland (37,728 km^2), low shrubland (25,180 km^2) and cultivated commercial annuals (28,228 km^2) (Figure 1).

The main changes in land cover between 1990 and 2013/14 occurred for **low shrubland (+7.316%) and grassland (-5.950%)** (Table 1).

ETLOOK ANNUAL EVAPOTRANSPIRATION (ET) DATA (from August 2014 to July 2015):

ET is relatively uniform spatially with an increasing gradient from west to east depending on rainfall (Figure 2).

Besides waterbodies, the highest median annual water use per unit area was from cultivated perennials (682 mm a^{-1}), wetlands (585 mm a^{-1}), plantations/woodlots (549 mm a^{-1}) and cultivated commercial annuals (532 mm a^{-1}), and the lowest from mines (315 mm a^{-1}) (Table 2).

In absolute terms, the largest water use was from **grassland (24,781 Mm^3 a^{-1}), cultivated commercial annuals (19,997 Mm^3 a^{-1}) and low shrubland (10,384 Mm^3 a^{-1}).**

FIGURE 1

Land cover groups based on the National Land Cover (NLC) map of 2013/14 for the Free State.

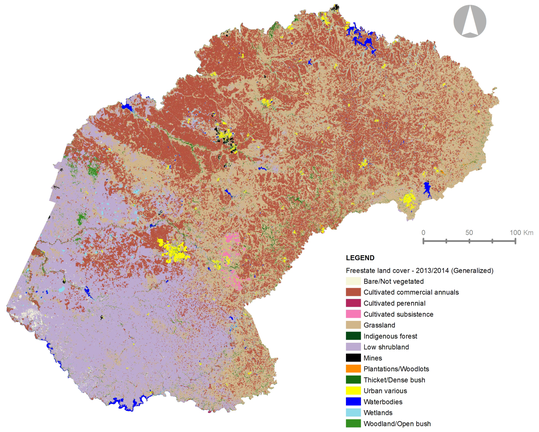


FIGURE 2

Annual ETLook evapotranspiration (ET) in 2014/15:

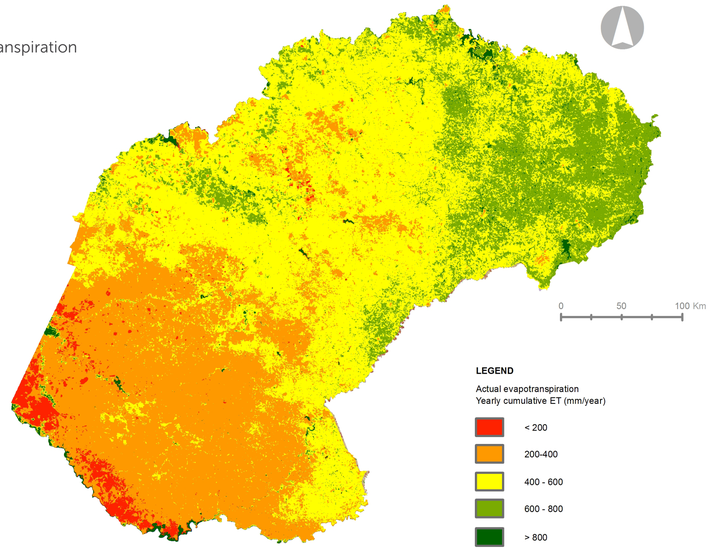


TABLE 2

Water use statistics for land cover groups based on annual ETLook data in 2014/15 for the Free State:

	Water use statistics						
Land use	MEAN mm (a^{-1})	MEDIAN (mm a^{-1})	MIN (mm a^{-1})	MAX (mm a^{-1})	STD (mm a^{-1})	AREA (km^2)	CUM (Mm^3 a^{-1})
Waterbodies (WB)	1659	1983	158	2550	754	925	1833
Wetlands (WTL)	587	585	158	2550	260	2146	1256
Indigenous Forest (INF)	513	508	238	2160	93	67	34
Thicket / Dense bush (TDB)	492	472	158	2547	216	1488	702
Woodland / Open bush (WOB)	436	416	158	2542	218	1117	465
Grassland (GRS)	502	495	158	2550	121	50025	24781
Shurbland fynbos (SHF)	-	-	-	-	-	-	-
Low shrubland (LSB)	323	318	158	2550	90	32617	10384
Cultivated commercial annuals (CCA)	531	532	158	2516	112	37567	19997
Cultivated perennial (CPE)	699	682	185	2384	251	34	23
Cultivated subsistence (CSB)	410	413	183	2014	53	292	121
Cultivated cane (CC)	-	-	-	-	-	-	-
Plantations / Woodlots (PWD)	546	549	158	2442	146	507	278
Mines (MNS)	336	315	158	2532	144	197	62
Bare non-vegetated (BNV)	382	336	158	2547	254	600	202
Urban industrial (UIND)	348	336	167	2208	116	38	13
Urban commercial (UC)	347	333	161	2203	106	36	12
Urban residential (UR)	341	332	158	2077	91	367	122
Urban sport and recreation (ORS)	385	380	161	2397	94	199	76
Urban informal (UINF)	452	418	158	2303	182	64	27
Urban Others (UO)	363	342	158	2426	128	326	111

FIGURE 3

Daily average air temperatures for Daily average air temperatures for different land covers in the Free State based on NASA/GMAO Modern Era Retrospective Analysis (MERRA) from 2000 to 2012.

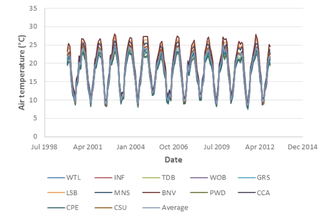


FIGURE 4

Monthly rainfall at representative stations in the Free State (South African Weather Services) from 2000 to 2012.

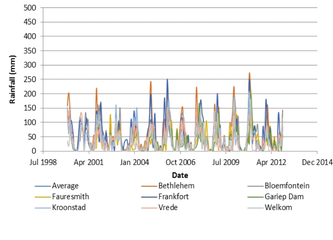
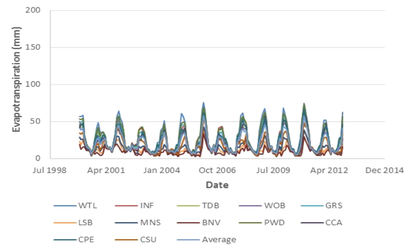


FIGURE 5

Monthly MOD16 evapotranspiration for different land cover groups in the Free State from 2000 to 2012.



MOD16 MONTHLY EVAPOTRANSPIRATION (ET) DATA (FROM 2000 TO 2012)

- Daily average air temperatures in the Free State range from about 8°C to 28°C (Figure 3).
- Monthly rainfall shows spatial variability with evident peaks occurring during summer months (Figure 4).
- MOD16 ET range from below 10 mm $month^{-1}$ in winter up to peaks of 70 mm $month^{-1}$ in summer (Figure 5).

GUIDELINES AND RECOMMENDATIONS

- Incentivizing smart farming practices may reduce the volumes used in agriculture and the burden on water resources.
- Discharging wastewater, removing underground water and especially disposing waste are substantial water uses due to industrial and mining activities. It is recommended that mining houses try and remediate wastewater and re-use it for irrigation and power generation in close vicinity to the waste generating streams.
- The existing pool of wastewater streams can potentially become a valuable water–reuse source (currently 0.3% of water abstracted is re-used for wastewater irrigation).
- There is potential for increasing groundwater use and conjunctive use of surface water and groundwater.
- Given rainfall is the main driver of ET, trade-offs in land use will not bring substantial benefits in water saving. However, indigenous grassland (water use 495 mm a^{-1}) needs to be conserved at the expense of encroaching low shrubland (water use 318 mm a^{-1}) and desertification.
- Non-commercial and non-conservation land under vast thicket/dense bush and grassland can be traded off to reduce encroachment and water use.

ACKNOWLEDGMENTS AND SOURCES OF INFORMATION:

Water Authorisation and Registration Management System (WARMS)
National Land Cover (NLC) maps for 1990 and 2013/14
Satellite-derived images and products (ETLook and MOD16 evapotranspiration)
Ground measurements of climatic variables (SAWS)
NASA/GMAO Modern Era Retrospective Analysis (MERRA)

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