WIDER CAPE TOWN

LAND & WATER USE

TABLE 1

Areas and percentage change of land cover groups between 1990 and 2013/14.

Land cover group	1990 Area (km²)	2013-14 Area (km²)	Change (%)
Waterbodies (WB)	50	70	0.097
Wetlands (WTL)	329	296	-0.154
Indigenous Forest (INF)	127	172	0.214
Thicket / Dense bush (TDB)	3369	4846	7.037
Woodland / Open bush (WOB)	6350	5058	-6.153
Grassland (GRS)	5153	4998	-0.737
Low shrubland (LSB)	147	66	-0.388
Mines (MNS)	29	32	0.015
Bare non-vegetated (BNV)	16	33	0.081
Plantations / Woodlots (PWD)	3011	2861	-0.715
Cultivated commercial annuals (CCA)	1165	812	-1.679
Cultivated perennial (CPE)	227	759	2.535
Cultivated subsistence (CSB)	397	237	-0.761
Shrubland fynbos (SHF)	0	0	0.000
Urban	618	746	0.609

WARMS DATABASE (updated up to August 2016)

Most water volumes are registered in the wider Cape Town area (Figure 1) for taking water (798 million $m^3 a^{-1}$).

Discharging water (229 million $m^3 a^{-1}$) and disposing of waste (194 million $m^3 a^{-1}$) account for more than half of the water taken (53%).

The largest water use sectors are domestic water supply, agricultural irrigation and industry (urban). Water is predominantly sourced from schemes and rivers/streams, with boreholes, dams and springs showing minor water use. Boland municipality has the largest registered volumes of water stored in large dams.

Commercial afforestation is practised predominantly by companies and water services providers, in the Boland and Overberg municipalities (flow reduction of 5.5 million $m^3 a^{-1}$).

Re-use of water containing waste for irrigation was 0.02 million $m^3 a^{-1}$, including industry-agro processing, nonpoint source and wineries.

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

The largest areas in wider Cape Town are covered by fynbos (1,632 km²), cultivated commercial annuals (1,081 km²), urban areas (584 km²), cultivated perennials (564 km²) and thicket/dense bush (467 km²) (Figure 1).

Major changes in land cover were recorded between 1990 and 2013/14 with increases in grassland (+5.379%), thicket/dense bush (+2.724%), woodland/open bush (+1.573%) and urban areas (+1.276%) at the expense of fynbos (-8.374%), plantations/woodlots (-1.760%) and cultivated commercial annuals (-0.919%) (Table 1).

In general, an increase in urban areas is accompanied by an increase in marginal land with a large loss in fynbos.

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

ET is variable depending on geographic position, climate and land cover (Figure 2).

Besides waterbodies, the highest median annual water use per unit area was from indigenous forest (698 mm a^{-1}) and cultivated perennial crops (532 mm a^{-1}). Evapotranspiration from urban areas was generally the lowest (Table 2).

In absolute terms, the largest water use was from fynbos (725 $Mm^3 a^{-1}$ or 26.6% of the total water use covering 31.5% of land), cultivated commercial annuals (440 $Mm^3 a^{-1}$), cultivated perennials (378 $Mm^3 a^{-1}$) and thicket/dense bush (235 $Mm^3 a^{-1}$) that cover the largest areas.

The volume of water evaporating from cultivated land was 818 $Mm^3 a^{-1}$ (irrigated and rainfed) compared to 433 $Mm^3 a^{-1}$ registered in WARMS for sector agriculture – irrigation. The volume of water evaporating from non-agricultural vegetated land amounts at 1,281 $Mm^3 a^{-1}$ and it outweighs the agricultural water consumption estimated with ETLook.

The total volume of water registered in WARMS for industry, mining, urban and water supply services is 358 $Mm^3 a^{-1}$. The total volume of water that evaporates from urban land uses (commercial, industrial, informal, residential, sports and recreation and others) is 147 $Mm^3 a^{-1}$.

MOD16 MONTHLY EVAPOTRANSPIRATION (ET) DATA (from 2000 to 2012):

Land cover and mean annual rainfall are the most important drivers of ET, with soil depth and elevation having an influence. Monthly rainfall exhibits seasonal variability and some spatial variability depending on land cover in the lower range of values (Figure 3).

MOD16 ET follows the seasonal rainfall pattern and it ranges from about 15 mm $month^{-1}$ during summer up to >120 mm $month^{-1}$ in areas of indigenous forests (Figure 3) that cover, however, only 0.1% of the area.

FIGURE 1

Land cover groups based on the National Land Cover (NLC) map of 2013/14 for wider Cape Town.

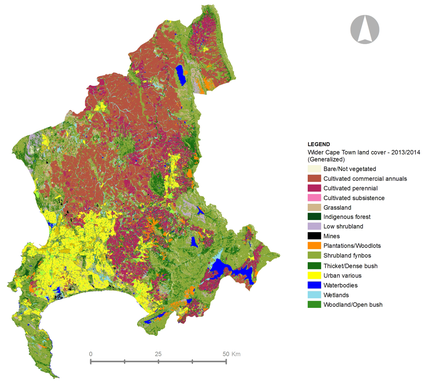

FIGURE 2

Annual ETLook evapotranspiration (ET) in 2014/15 for wider Cape Town.

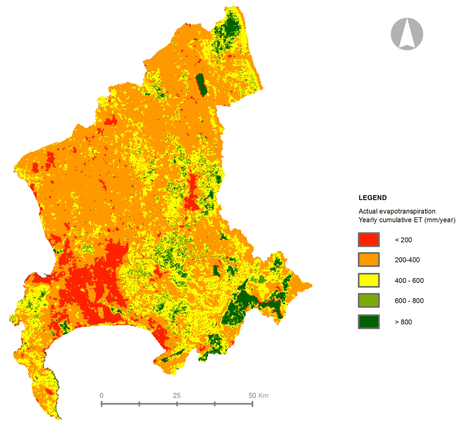

TABLE 2

Water use statistics for land cover groups based on annual ETLook data in 2014/15 for wider Cape Town.

	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 (km²)	CUM ($Mm^3 a^{-1}$)
Waterbodies (WB)	1227	1586	41.7	1881	611	127	202
Wetlands (WTL)	455	376	41.7	1881	269	183	68.7
Indigenous Forest (INF)	682	698	361.2	923	112	5	3.32
Thicket / Dense bush (TDB)	430	400	41.7	1875	191	586	235
Woodland / Open bush (WOB)	413	402	41.7	1879	152	102	41.1
Grassland (GRS)	337	317	41.7	1879	137	365	116
Shurbland fynbos (SHF)	369	354	41.7	1879	139	2047	725
Low shrubland (LSB)	305	314	57.7	1865	113	99	31
Cultivated commercial annuals (CCA)	335	323	43	1881	92	1361	440
Cultivated perennial (CPE)	584	532	41.7	1875	230	710	378
Cultivated subsistence (CSB)	0	0	0	0	0	0	0
Cultivated cane (CC)	0	0	0	0	0	0	0
Plantations / Woodlots (PWD)	485	465	104	1869	186	131	60.9
Mines (MNS)	268	201	74.8	1850	236	12	2.51
Bare non-vegetated (BNV)	313	297	45.7	1881	240	32	9.49
Urban industrial (UIND)	197	155	69	1812	134	59	9.16
Urban commercial (UC)	196	177	68.4	1783	104	74	13
Urban residential (UR)	232	207	68.3	1806	110	299	62
Urban sport and recreation (ORS)	307	269	68.9	1787	170	72	19.4
Urban informal (UINF)	165	154	71.5	1824	72	140	21.5
Urban Others (UO)	268	247	68.4	1849	142	90	22.2

WATER USE SCENARIOS

An interactive Water Use Scenario Builder was developed for projecting future water use changes as a function of land cover change and designed scenarios of climatic variability (combinations of +/- standard deviations of rainfall, air temperature and vapour pressure deficit calculated from historic data of MOD16). Fig. 4 shows the baseline total water use of 2,224 $Mm^3 a^{-1}$ and a scenario with total water use of 2,451 $Mm^3 a^{-1}$ if rainfall decreases, and air temperature and vapour pressure deficit increase during the winter months

The Water Use Scenario Builder is available at https://csirwateruse.firebaseapp.com/

FIGURE 3

Monthly average rainfall and monthly MOD16 evapotranspiration for different land cover groups in wider Cape Town from 2000 to 2012.

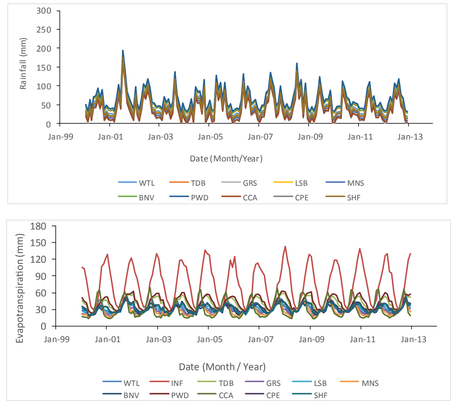

FIGURE 4

Baseline water use estimated with MOD16 (top) and worst case climate change/variability scenario (bottom).

Landcover	Area (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (M m^3/year)
Wetlands	183	5	4	4	4	5	5	5	7	9	9	7	6	70
Indigenous Forest	5	1	1	0	0	0	0	0	0	0	0	1	1	4
Thicket/ Dense bush	586	29	23	21	16	16	15	16	21	25	29	30	31	272
Grassland	365	9	8	8	8	9	9	10	12	15	14	12	11	125
Low shrubland	99	3	3	3	2	2	2	2	3	4	4	4	3	35
Mines	12	0	0	0	0	0	0	0	0	0	0	0	0	0
Bare ground	32	1	1	1	1	1	1	1	1	1	1	1	1	12
Plantations/ Woodlots	131	7	6	6	4	4	4	4	5	6	7	7	8	68
Cultivated commercial annuals	1361	24	20	22	23	30	34	49	73	86	57	33	26	477
Cultivated perennial	710	27	23	21	17	18	18	20	24	28	29	28	28	281
Shrubland fynbos	2047	76	59	57	49	53	51	53	68	82	86	82	80	796
Urban - Low water use	624	5	5	5	5	5	5	5	5	5	5	5	5	60
Urban - Medium water use	103	2	2	2	2	2	2	2	2	2	2	2	2	24
Urban - High water use	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (M m^3/month)		189	155	150	131	145	146	167	221	263	243	212	202	2224

Landcover	Area (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (M m^3/year)
Wetlands	183	5	4	4	3	5	6	7	8	10	9	7	6	74
Indigenous Forest	5	1	1	0	0	0	0	0	0	0	0	1	1	4
Thicket/ Dense bush	586	29	23	21	19	24	28	28	32	35	29	30	31	329
Grassland	365	9	8	8	6	8	9	10	12	15	14	12	11	122
Low shrubland	99	3	3	3	1	3	4	4	4	4	4	4	3	40
Mines	12	0	0	0	0	0	0	0	0	0	0	0	0	0
Bare ground	32	1	1	1	1	1	1	1	2	2	1	1	1	14
Plantations/ Woodlots	131	7	6	6	5	6	7	7	8	8	7	7	8	82
Cultivated commercial annuals	1361	24	20	22	16	26	29	45	69	80	57	33	26	447
Cultivated perennial	710	27	23	21	17	24	28	29	34	36	29	28	28	324
Shrubland fynbos	2047	76	59	57	39	68	88	88	102	106	86	82	80	931
Urban - Low water use	624	5	5	5	5	5	5	5	5	5	5	5	5	60
Urban - Medium water use	103	2	2	2	2	2	2	2	2	2	2	2	2	24
Urban - High water use	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (M m^3/month)		189	155	150	114	172	207	226	278	303	243	212	202	2451

GUIDELINES AND RECOMMENDATIONS

- The wider Cape Town area is characterized by high water storages associated with high rainfall areas, large urban and industrial areas, as well as intensive agriculture.
- Discharging and disposing waste are substantial water uses due to industrial activities. There is more room for re-use of water especially in Cape Town. Better sewerage treatment methods may avail large volumes of water for re-use to the City of Cape Town. Non-potable water can be used for alternative uses such as fire-fighting or water features and possibly gardening depending on the quality.
- Agriculture is one of the dominant water users; incentivizing smart practices may reduce the burden on water resources.
- The limited use of boreholes (6% of total registered water volumes) leaves scope for increased groundwater use as well as conjunctive use of surface water and groundwater.
- In general, an increase in urban areas is accompanied by an increase in marginal land. Conservation of indigenous vegetation should be strengthened. Perennial crops are cultivated/irrigated for longer periods in the year compared to commercial annual crops and therefore they exhibited higher water consumption. Grassland consumes slightly less water than cultivated annuals. Shrubland fynbos and wetlands are somewhere in the mid-range of water consumption, but they consume less than thicket/dense bush and woodland/open bush (often alien vegetation), which gives the opportunity for development trade-offs and improved land management and restoration, although this is influenced by many environmental, social and economic factors, and local conditions.
- The total volume of water that evaporates from urban areas is less than half the water supplied to industry and domestic users. There may be therefore a case for re-use of some of the water in urban areas.

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)
Water use data by suburb from City of Cape Town

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