

# INKOMATI-USUTHU

## LAND & WATER USE

**TABLE 1**  
Areas and percentage change of land cover groups between 1990 and 2013/14 for Inkomati-Usuthu.

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 Inkomati-Usuthu Water Management Area for taking water (1.45 billion m³ a<sup>-1</sup>), storing water (1.03 billion m³), afforestation (0.42 billion m³ a<sup>-1</sup>) and disposing waste (0.07 billion m³ a<sup>-1</sup>).

The highest water withdrawals per sector were for agricultural irrigation (1.08 billion m³ a<sup>-1</sup> or 74.1% of the total), urban industry (0.17 billion m³ a<sup>-1</sup> or 12.0%), water supply services (0.17 billion m³ a<sup>-1</sup> or 11.4%), non-urban industry (0.02 billion m³ a<sup>-1</sup> or 1.2%) and mining (0.01 billion m³ a<sup>-1</sup> or 0.7%).

Commercial afforestation is widely practiced, especially in Ehlanzeni District (186 million m³ a<sup>-1</sup> or 72.5% of all municipalities). Ehlanzeni is the biggest user of water amongst districts (958 million m³ a<sup>-1</sup>) using about 70% of the resource in the catchment. Water user associations are the biggest users of water by customer type.

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

The largest areas in Inkomati-Usuthu are covered by woodland/open bush (5,085 km²), grassland (4,998 km²), thicket/dense bush (4,846 km²) and plantations/woodlots (2,861 km²) (Figure 1). Most of the area is covered by natural vegetation (73.6%), while cultivation makes up 22.2% of the land use.

Major changes in land cover were recorded between 1990 and 2013/14 with increases in thicket/dense bush (+7.037%) and cultivated perennials (+2.535%) at the expense of woodland/open bush (-6.153%), cultivated commercial annuals (-1.679%) cultivated subsistence (-0.761%) and plantations/woodlots (-0.715%) (Table 1). An increase in urban areas was also noticeable (+0.609%).

Two trends are discernible: cultivated commercial annuals and subsistence agriculture are making space for more profitable cultivated perennial crops; urban areas and encroachment by thicket/dense bush are increasing.

### MOD16 MONTHLY 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 ET per unit area was from cultivated perennials (1068 mm a<sup>-1</sup>), plantations/woodlots (1043 mm a<sup>-1</sup>) indigenous forests (1041 mm a<sup>-1</sup>) and cultivated cane (1032 mm a<sup>-1</sup>), and the lowest from woodland/open bush (404 mm a<sup>-1</sup>) (Table 2).

In absolute terms, the largest water use was from grassland (4,416 Mm³ a<sup>-1</sup>), plantations/woodlots (4,062 Mm³ a<sup>-1</sup> or 21% of the overall water use covering 13.6% of the area), thicket/dense bush (4,031 Mm³ a<sup>-1</sup>) and woodland/open bush (2,795 Mm³ a<sup>-1</sup>) that cover the largest areas.

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

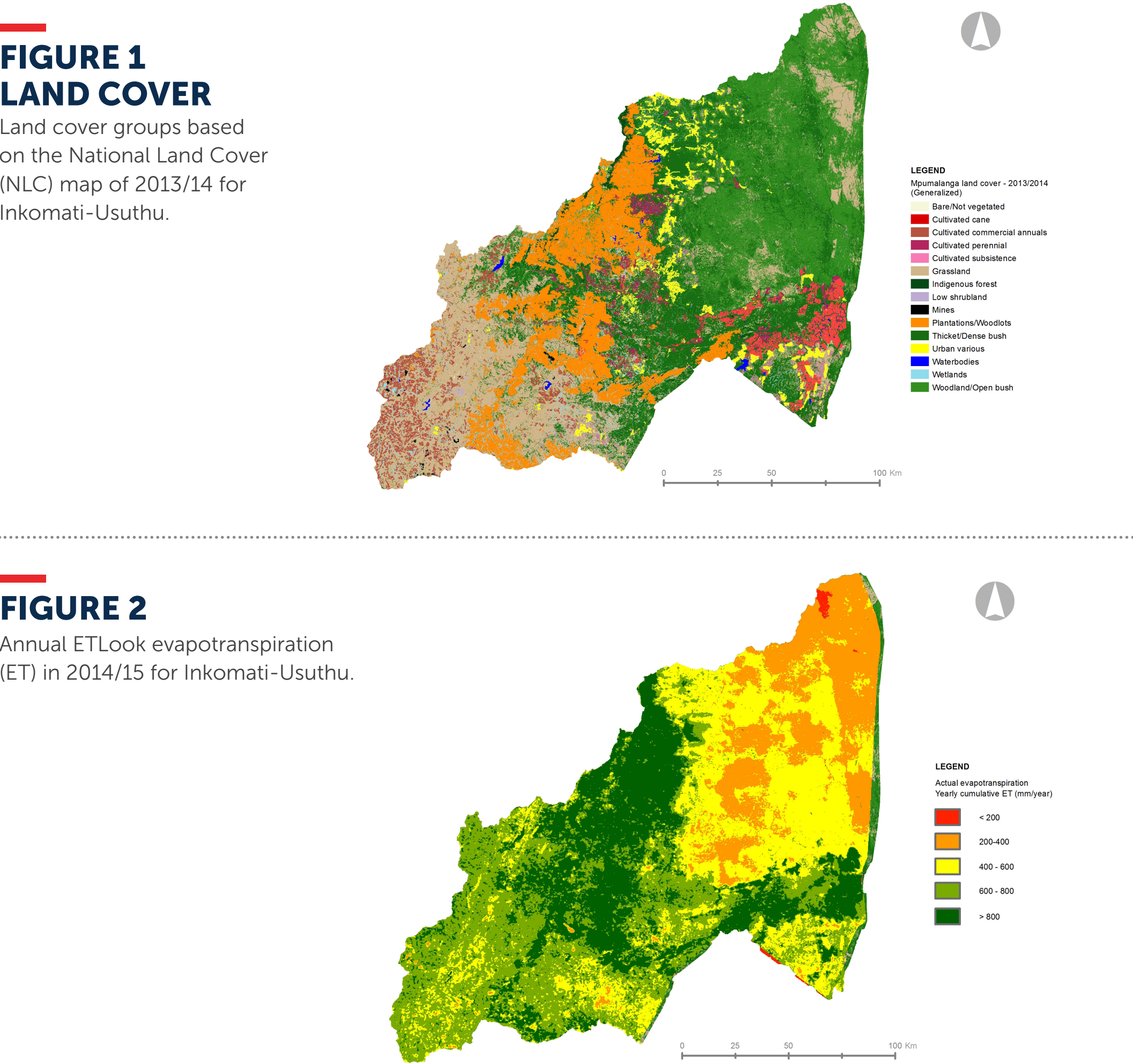
Land cover and mean annual rainfall are the most important drivers of ET. Monthly rainfall exhibits seasonal variability and some spatial variability depending on land cover in the lower range of values (Figure 3).

MOD16 ET follows the seasonal rainfall pattern and it ranges from about 10 mm month<sup>-1</sup> during winter up to >150 mm month<sup>-1</sup> in areas of indigenous forests and plantations/woodlots during summer (Figure 3).

### FIGURE 1 LAND COVER

Land cover groups based on the National Land Cover (NLC) map of 2013/14 for Inkomati-Usuthu.

**FIGURE 2**  
Annual ETLook evapotranspiration (ET) in 2014/15 for Inkomati-Usuthu.



**TABLE 2**  
Water use statistics for land cover groups based on annual ETLook data in 2014/15:

Water use statistics							
Land use	MEAN mm (a <sup>-1</sup> )	MEDIAN (mm a <sup>-1</sup> )	MIN (mm a <sup>-1</sup> )	MAX (mm a <sup>-1</sup> )	STD (mm a <sup>-1</sup> )	AREA (km²)	CUM (Mm³ a <sup>-1</sup> )
Waterbodies (WB)	1546	1917	165	2658	686	464	889
Wetlands (WTL)	742	721	169	2525	193	2103	1517
Indigenous Forest (INF)	1014	1039	349	2409	181	308	320
Thicket / Dense bush (TDB)	628	616	116	2658	193	8453	5208
Woodland / Open bush (WOB)	481	451	139	2658	158	13587	6127
Grassland (GRS)	626	623	111	2658	127	28761	17925
Shrubland fynbos (SHF)	-	-	-	-	-	-	-
Low shrubland (LSB)	547	550	150	2650	158	540	297
Cultivated commercial annuals (CCA)	660	645	166	2481	116	12006	7746
Cultivated perennial (CPE)	1067	1037	353	2463	285	533	553
Cultivated subsistence (CSB)	595	579	168	2369	136	691	400
Cultivated cane (CC)	1026	1033	400	2378	233	615	635
Plantations / Woodlots (PWD)	915	918	111	2478	212	7443	6830
Mines (MNS)	409	392	149	2425	128	821	322
Bare non-vegetated (BNV)	575	538	149	2658	271	308	166
Urban industrial (UIND)	415	397	239	2166	131	33	13
Urban commercial (UC)	425	396	211	2201	160	71	28
Urban residential (UR)	387	365	200	2284	103	280	102
Urban sport and recreation (ORS)	485	466	244	2164	114	218	102
Urban informal (UINF)	613	604	225	2420	219	43	26
Urban Others (UO)	452	425	220	2392	133	1413	601

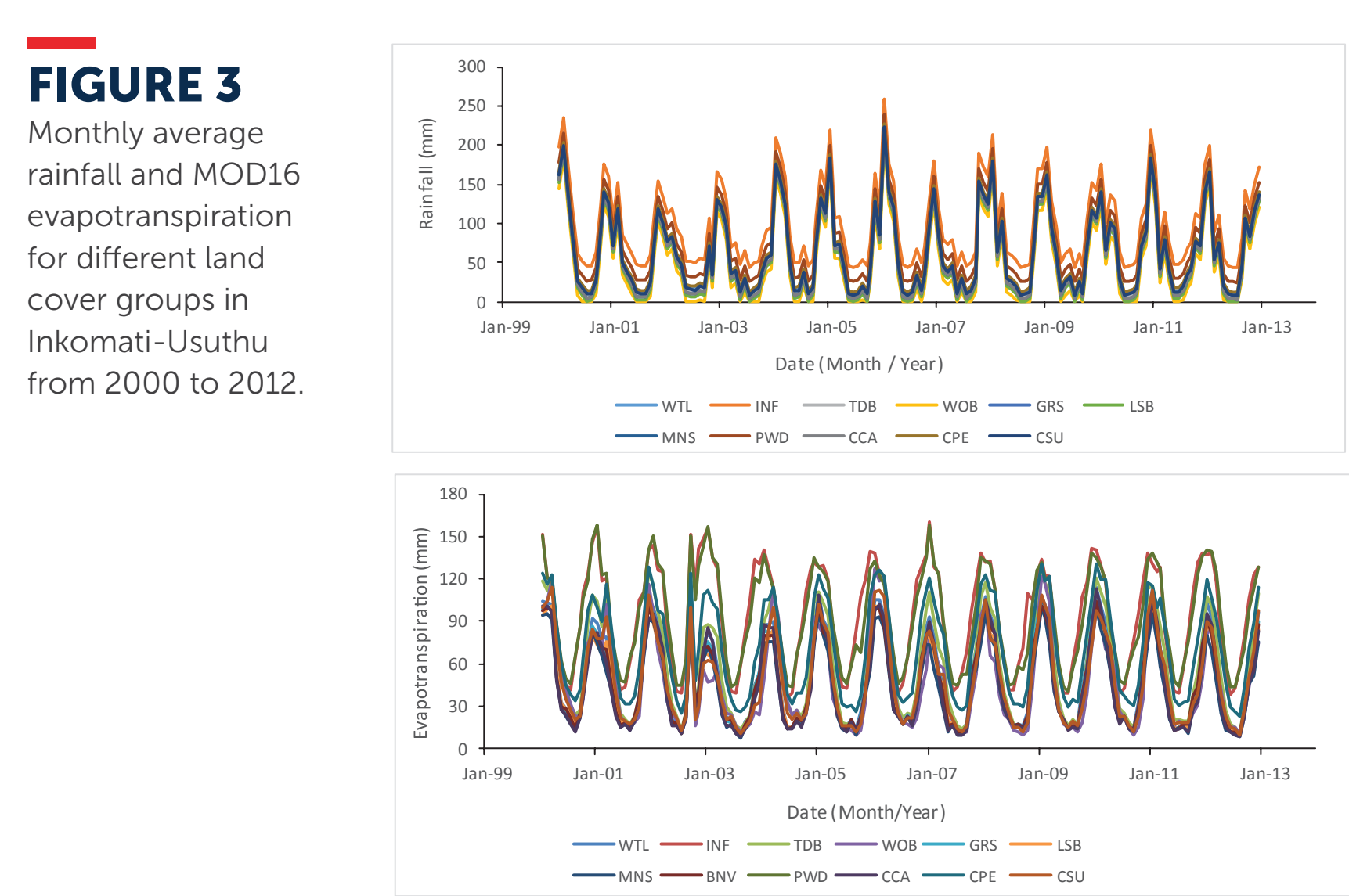
### WATER USE SCENARIOS

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 18,694 Mm³ a<sup>-1</sup> and a worst case scenario total water use of 21,075 Mm³ a<sup>-1</sup> if rainfall, air temperature and vapour pressure deficit increase.

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

**FIGURE 3**  
Monthly average rainfall and MOD16 evapotranspiration for different land cover groups in Inkomati-Usuthu from 2000 to 2012.

**FIGURE 4**  
Baseline water use estimated with MOD16 (top) and worst case climate change/variability scenario.



Landcover	Area (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (M m³/year)
Wetlands	404	41	37	32	20	11	8	6	7	11	15	24	35	247
Indigenous Forests	233	33	30	28	20	13	9	10	14	20	25	29	32	263
Thicket/Dense bush	6587	731	672	639	448	270	195	125	125	178	231	428	646	4658
Woodlands/Open bush	6910	622	574	560	401	249	152	124	111	145	159	304	518	3919
Grassland	6796	652	584	510	319	170	122	102	109	163	224	381	557	3893
Lower shrubland	89	8	7	6	4	2	2	1	1	2	3	5	7	48
Mines	43	4	3	3	2	1	1	1	1	1	1	2	3	23
Bare ground	45	4	4	3	2	1	1	1	1	1	2	2	4	26
Plantations / Woodlots	3893	553	498	471	345	253	179	175	234	304	354	440	522	4339
Cultivated commercial annuals	1103	108	98	82	46	24	19	15	15	24	33	54	83	601
Cultivated perennial	419	50	46	46	35	23	15	13	13	17	23	34	45	360
Cultivated subsistence	310	29	27	25	18	11	7	5	5	7	9	16	24	183
Urban - Low water use	789	4	4	4	4	4	4	4	4	4	4	4	4	48
Urban - Medium water use	213	7	7	7	7	7	7	7	7	7	7	7	7	84
Urban - High water use	10	1	1	1	1	1	1	1	1	1	1	1	1	12
Total (M m³/month)		2847	2592	2417	1673	1040	692	590	648	885	1091	1731	2488	18694

Landcover	Area (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (M m³/year)
Wetlands	404	42	39	35	24	16	14	13	11	14	16	26	36	286
Indigenous Forests	233	39	35	34	25	20	16	17	20	26	31	34	37	334
Thicket/Dense bush	6587	764	705	711	534	375	296	263	217	250	263	461	666	5504
Woodland/Open bush	6910	594	546	567	408	290	207	180	145	173	145	276	477	4008
Grassland	6796	652	584	530	353	231	197	177	156	190	231	394	550	4245
Lower shrubland	89	8	7	7	5	4	3	3	2	3	3	5	7	57
Mines	43	4	4	3	2	1	1	1	1	1	1	2	3	24
Bare ground	45	4	4	4	2	1	1	1	1	1	2	3	4	28
Plantations / Woodlots	3893	615	561	537	417	331	269	201	308	366	413	502	580	5360
Cultivated commercial annuals	1103	109	100	85	52	33	29	25	22	29	35	58	83	660
Cultivated perennial	419	53	49	50	40	30	23	21	19	22	26	37	48	418
Cultivated subsistence	310	29	27	27	20	14	11	10	8	10	10	17	24	207
Urban - Low water use	789	4	4	4	4	4	4	4	4	4	4	4	4	48
Urban - Medium water use	213	7	7	7	7	7	7	7	7	7	7	7	7	84
Urban - High water use	10	1	1	1	1	1	1	1	1	1	1	1	1	12
Total (M m³/month)		2925	2673	2502	1894	1358	1079	984	922	1097	1188	1827	2556	21075

### GUIDELINES AND RECOMMENDATIONS

- Inkomati-Usuthu is characterized by high water storage associated with high rainfall areas and high water flow reductions from afforestation. Agriculture and forestry are the dominant water users; incentivizing smart practices may reduce the burden on water resources.
- Increased industrial development will likely impact on industrial water use. Disposing waste is a substantial water use due to industrial activities. There is scope to increase the wastewater reuse because only a fraction of wastewater is reused for irrigation (0.8% of water taken). It is recommended that mining houses try and remediate wastewater and re-use it for irrigation, power generation or fire-fighting (depending on the quality) in close vicinity to the waste generating streams.
- The limited use of boreholes leaves scope for increased groundwater use as well as conjunctive use of surface water and groundwater.
- Cultivated commercial annuals and subsistence agriculture are making space for more profitable cultivated perennial crops, urban areas and encroachment by thicket/dense bush. Non-commercial and non-conservation land under vast thicket/dense bush can be traded off to reduce water use. Conservation efforts need to be strengthened to prevent loss of indigenous vegetation and wetlands.
- The total volume of water that evaporates from urban areas is more than double the water volumes registered to industry and domestic users. There may be therefore a case for capturing some of the rain water before it reaches the ground and evaporates in urban areas (e.g. rain water harvesting).

**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 Mbombela Municipality