The Socio-Economic Benefits of investing in Ecological Infrastructure (SEBEI)

Study Site Descriptions: Working Paper

December 2018

Compiled by: Alanna Rebelo (Stellenbosch University) and Petra Holden (University of Cape Town)

Three subcatchments have been delineated for fine-scale hydrological modelling in each of the greater Berg/Breede and uMngeni secondary catchments of South Africa (Table 1; Figure A1). The aim of this document is to briefly describe landcover and major interventions that have been implemented in each of these subcatchments in turn, followed by an analysis of a few key socio-economic indicators.

Contents:

This working paper was conducted under the Socio-Economic Benefits of Ecological Infrastructure (SEBEI) project funded by the Danish Ministry of Foreign Affairs (MFA) [grant number 17-M07-KU].

Table 1: Summary socio-economic and political information for each site (adapted from the SEBEI proposal)

Site	River	Location in catchment	Municipality	Target communities	Dominant sectors	EI restoration / rehabilitation	Water security challenge	Climate risk
1	Upper Breede	Molenaars & Holsloot Rivers	Witzenberg (Breede Valley Local Municipality), Cape Winelands District Municipality	Rawsonville, Worcester	Commercial agriculture (deciduous fruit, wine); agri-tourism; eco-tourism; agri-processing; conservation	Clearing of invasive alien plants	Water infiltration and runoff; water security of City of Cape Town	Flood, drought, fire
2	Upper Berg	Dwarsrivier, and the mountains feeding the Berg River Dam	Stellenbosch Local Municipality, Cape Winelands District Municipality	Pniel, Kylemore, Lanquedoc	Commercial agriculture (deciduous fruit, wine); agri-tourism; eco-tourism; agri-processing; conservation	Clearing of invasive alien plants and selective riparian rehabilitation	Water infiltration and runoff; water quality; water security of City of Cape Town	Drought, fire
3	Rivier-sonderend (tributary of Breede)	The river above and below Theewaters-kloof Dam	Theewaterskloof Local Municipality, Overberg District Municipality	Genadendal, Bereaville, Villiersdorp	Commercial and smallholder agriculture (crops and livestock); agri-tourism; eco-tourism; agri-processing; conservation	Clearing of invasive alien plants and riparian rehabilitation supported by a local nursery	Water infiltration and runoff, water security of City of Cape Town	Drought, fire
4	Mthinzima	Above Midmar Dam	uMngeni Local Municipality, uMgungundlovu District Municipality	Mphopomeni	Forestry; commercial agriculture; recreation / lifestyle; limited smallscale agriculture; conservation (Ramsar Site)	Clearing of invasive alien plants	Water infiltration and runoff; water quality (sewage), water security of City of Durban	Drought, fire
5	Baynespruit	Upper-middle of uMngeni catchment (flowing through Pieter-maritzberg)	Msunduzi Local Municipality, uMgungundlovu District Municipality	Madiba, Sobantu	Industry; urban residential; semi-formal settlements; urban farming	Revegetation of river banks to control erosion; Clearing of invasive alien plants	Water quality (sewage)	Flood
6	Palmiet	Lower uMngeni (Kloof to Durban)	eThekwini Metropolitan Municipality	Quarry Road Settlement	Upmarket formal homes; industry (light and heavy); informal settlements; conservation	Clearing of invasive alien plants and revegetation of river banks	Water quality, Flooding	Flood

Figure A1. Location of six study catchments in South Africa

The six subcatchments range in size from 34.73 km^2 (site 5) to 895.42 km^2 (site 3) (Table 2). Mean Annual Precipitation (MAP) is high for all subcatchments in these important water-providing catchments (strategic water source areas), ranging from 833.8-1767.0 mm/a. Mean Annual Runoff (MAR), varies considerably among subcatchments, ranging from 110.4-628.9 mm/a, representing as little as 12% (site 5) of the rainfall, to as much as 50% (site 1). Soils in the Berg/Breede subcatchments are mainly shallow on the mountains, with highly leached, low nutrient soil that lacks any significant soil profile development in the valleys. The subcatchments higher in the uMngeni catchment tend to have layered soils with high nutrients and good drainage, highly suitable for agriculture, whilst lower in the catchment the soils are more similar in nature to the Berg/Breede.

In terms of geology, the upper reaches of the Berg/Breede subcatchments are dominated by sandstones of the Cape Supergroup, mainly the Peninsula in the lower mountains and Nardouw formation sandstones, with narrow incised, cascading streams. The lower valleys have eroded through these to the basement Cape Granites, which dominate the lower catchment areas with gentle open valleys. The uMngeni subcatchments are dominated by shales, both the Volksrust and Pietermaritzburg formations, sandstone (Natal) with some mudstone, dolerite and tillite. In terms of land cover, subcatchments range from relatively untransformed (site 1: 11%), to highly transformed (site 6: 73%). According to a coarse national alien invasive plant survey from 2010 (Kotzé et al. 2010), all subcatchments are invaded by alien invasive plants, with infestations ranging from 7-81%, but with far less high density (>50% density) infestations, from 0-4%.

Table 2: Physical information and condition of each subcatchment. Area is calculated for each subcatchment based on Albers Equal Area projection. Mean Annual Precipitation (MAP) and Mean Annual Runoff (MAR) are area-weighted means are taken from the WR2012 (Bailey and Pitman 2012). Soil types are listed in order of dominance, and are taken from Dijkshoorn et al. (2008). Dominant geology is listed in order of prevalence and is taken from the national geology layer from WR2012. Percentage transformation was calculated from land use in the national land cover map (GeoterraImage 2014) and percentage alien invasion was taken from the national layer (Kotzé et al. 2010), two values are given: total area infested, followed by the area infested with a density of greater than 50%.

Site	**Size (km^2)**	**MAP (mm)**	**MAR (mm)**	**Runoff/ Rainfall (%)**	**Soils**	**Geology**	**Transfor-mation (km^2, %)**	**Alien Invasion (km^2, %)**
Site 1 Upper Breede	482.80	1254.7	628.9	50.1	Lithic Leptosols, Albic Arenosols	Sandstone (Peninsula, Nardouw & Franschhoek), Sedimentary, Granite.	53.65 (11%)	390.75 (81%); 17.31 (3.6%)
Site 2 Upper Berg	137.39	1767.0	554.9	31.4	Lithic Leptosols, Acrisols	Sandstone (Peninsula), Granite, Sedimentary.	19.62 (14%)	38.06 (28%); 1.81 (1.3%)
Site 3 Rivier-sonderend	895.42	958.2	435.9	45.5	Leptosols, Albic Arenosols, Acrisols, Rhodic Cambisols, Albic/Haplic Solonetz, Eutric Regosols	Sandstone (Franschhoek, Nardouw, Peninsula, & Weltevrede), Shale (Ceres, Bidouw and Lake Mentz) Sedimentary, Granite.	270.57 (30%)	300.5 (34%); 6.81 (1%)
Site 4 Mthinzima	168.36	833.8	231.9	27.8	Ferric Luvisols, Rhodic Ferralsols, Acrisols	Volksrust Shale, Beaufort Mudstone, Karoo Dolerite	84.58 (50%)	12.31 (7%); 0.56 (0%)
Site 5 Baynespruit	34.73	921.2	110.4	12.0	Rhodic Ferralsols, Acrisols	Pietermaritzberg Shale & Dwyka Tillite.	22.25 (64%)	8.63 (25%); 0 (0%)
Site 6 Palmiet	35.05	918.3	170.0	18.5	Dystric Leptosols, Acrisols	Natal Sandstone, Dwyka Tillite & Pietermaritzberg Shale.	25.73 (73%)	10.50 (30%); 0 (0%)

Site 1: Upper Breede

Plate 1. The Molenaars River, in the headwaters of the Breede River Catchment.

The Upper Breede catchment is a predominantly mountainous area which opens into a flat plain with an extensive wetland system called the Papenkuils Wetlands. This wetland is transformed by water impoundments and diversions upstream which have altered the hydrological regime of the catchment, agriculture (mainly vineyards) and also sand and stone mining in the Breede river channel. The Papenkuils Wetland is designated a priority site by UNESCO and WWF and has seven red-listed plant species. Worcester is the main town in the catchment, and Rawsonville is a smaller settlement nearby, originally formed by seasonal farm workers.

The Molenaars and Holsloot Rivers are the major tributaries draining the Upper Breede catchment (Figure 1a). The Molenaars River is a relatively pristine perennial system in its upper reaches, with vineyards alongside its lower reaches (Figure 1b). It was one of the early sites of alien clearing by the Working for Water programme. The Holsloot River is also perennial and is thought to originally have been braided. With an increase in agriculture the Holsloot was channelized, especially in its lower reaches, and berms were built to protect the surrounding farms from flood damage (RMMP 2017). In its upper reaches, the Holsloot River is impounded by the Stettynskloof Dam (Figure 1c), which supplies water to the towns of Rawsonville and Worcester, as well as summer water releases for agricultural irrigation and an ecological flow release (RMMP 2017). Surplus flow from the Holsloot River feeds into the Brandvlei Dam via a concrete canal. The dominant agriculture in the lower part of the Holsloot subcatchment is vineyards with a recent shift towards fruit farming (Figure 1b).

In summer 2013, the Holsloot River received 360 mm of rainfall over 24 hours, and the resultant flood caused damage to infrastructure as well as erosion of the floodplain (RMMP 2017). The most recent interventions in this catchment has been a response to this damage, fixing roads and infrastructure. Emergency flood funding has enabled the building of a weir

(starting 2019) in the upper reaches of the Holsloot River, with the dual aim of providing irrigation water to farmers and attenuating future floods. Alien trees above this point will be cleared by private landowners to improve water yield for their agriculture. To offset the biodiversity and ecological impacts of this impoundment, the stakeholders have agreed to set aside land in the lower reaches of the Holsloot River, and to remove the berms from the system.

Figure 1.a. Terrain, rivers and towns in the Upper Breede subcatchment

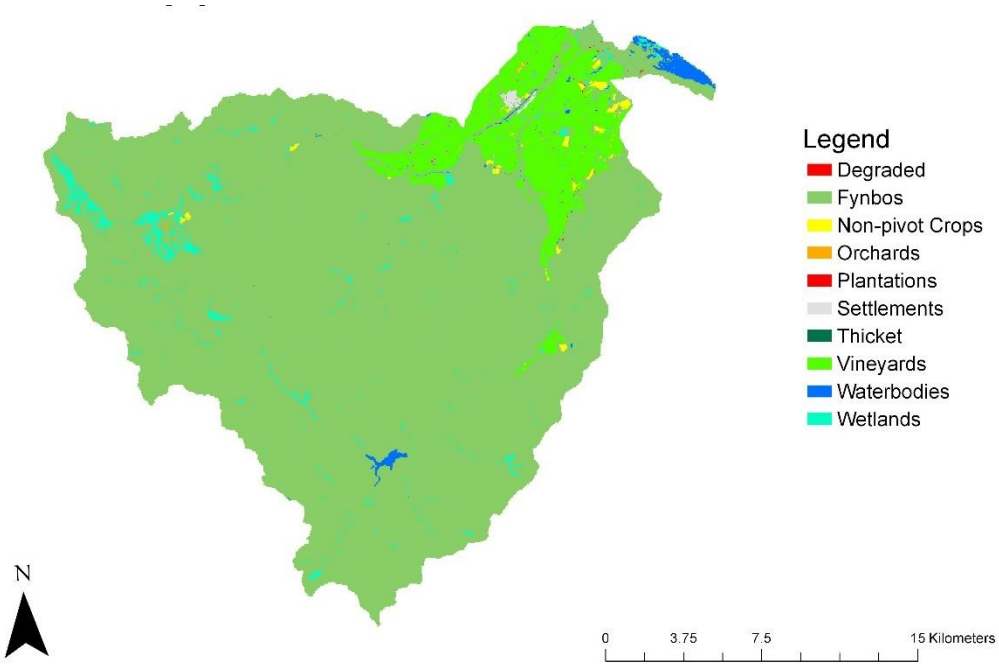

Figure 1.b. Land cover in the Upper Breede subcatchment

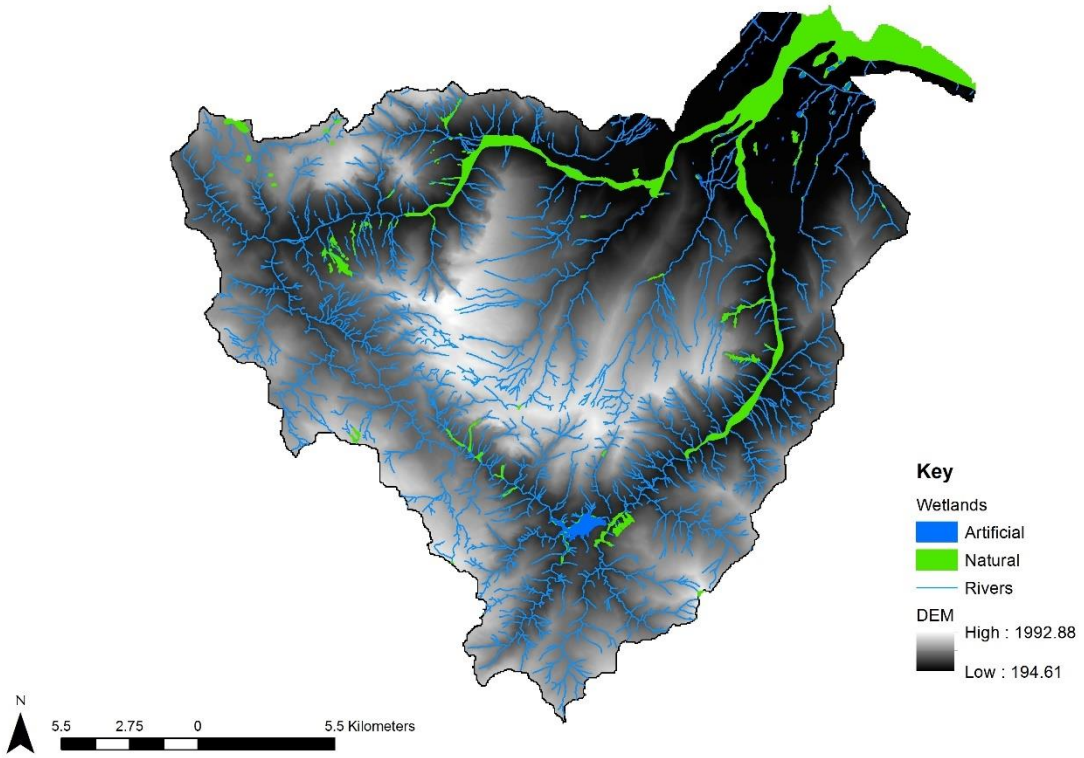

Figure 1.c. Wetlands and detailed river systems in the Upper Breede overlain on a digital elevation model.

Major Ecological Infrastructure Interventions

The Upper Breede Collaborative Extension Group is active in this subcatchment, and actively collates information on ecological infrastructure interventions. The Breede Valley Local Municipality is the major implementor doing alien tree clearing, mainly of *Acacias*, along the Holsloot and Molenaars Rivers (using funding from Working for Water (WfWater), Department of Environmental Affairs, Natural Resource Management (DEA-NRM)) (Figure 1e). LandCare (Department of Agriculture) has also been involved in some alien clearing and revegetation in the Papenkuils Wetland (Figure 1d), and have also drawn up a river maintenance management plan (RMMP 2017). The Cape Winelands District Municipality and the Central Breede Water Users Association (WUA), have also been alien clearing through the WfWater programme in the Papenkuils Wetland. Cape Nature is involved with clearing alien trees from the mountain slopes, primarily in nature reserves, using funding from Working for Water. Other organizations that have been involved in various smaller initiatives include the Berg and Breede Riparian Rehabilitation Programme (Western Cape Government: DEADP), some private consultancies, Working on Fire (high altitude/steep slope clearing), the Holsloot Irrigation Board, Breedekloof Wine & Tourism, the Breede-Gouritz Catchment Management Agency, and LivingLands.

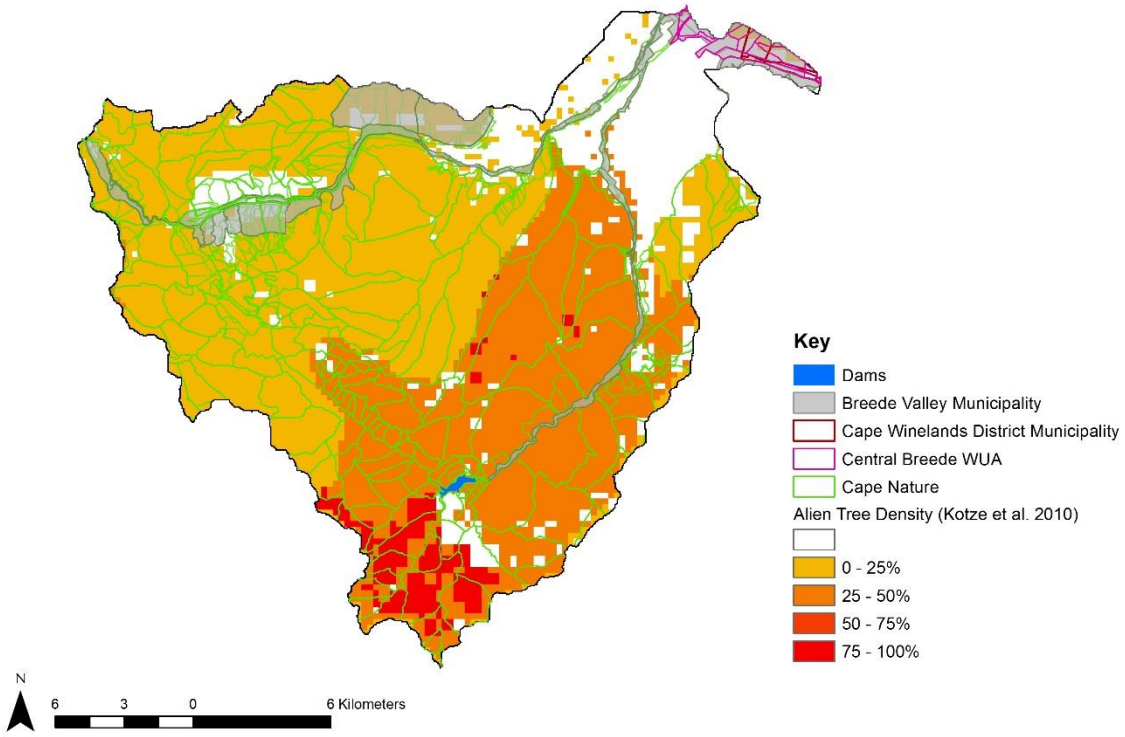

Figure 1.d. Working for Water funded alien clearing in the Upper Breede overlain on the Kotzé et al. (2010) alien tree density map. WUA: Water Users Association.

Figure 1.e. Alien invasion (Black Wattle) in the upper parts of the Holsloot subcatchment (just below the Stettynskloof Dam). The picture to the right shows the highest property on this tributary, which grows grapes, fruit and is also a trout farm.

Site 2: Upper Berg

Plate 2. The Dwarsrivier subcatchmen, in the headwaters of the Berg River Catchment. Left: The river flowing through Boschendal Wine Farm, Right: Simonsberg Mountains with alien pine invasion in the background, and areas recently cleared of alien trees pictured with the SEBEI team in the foreground.

The Upper Berg subcatchment is divided into two smaller subcatchments: the first is the mountainous area above the Berg River Dam, and the second is the Dwarsrivier (Figure 2.a). The steep and rugged mountains are predominantly sandstone, reaching up to over 1500 m above sea level (Simonsberg is at 1399 m), whereas the wide valleys are highly arable, dominated by decomposed granite and shale soils with good drainage (Forsyth et al. 2016b; Forsyth et al. 2016a). The Dwarsrivier valley is an important agricultural area, predominantly for viticulture and fruit farming, forming part of the renowned Cape Winelands (Figure 2.b).

About half of the land in the Upper Berg subcatchment is privately owned (mainly farmers), whereas the other half, especially mountainous areas, is managed by Cape Nature. There is a large portion of state owned land above the Berg River Dam (Department of Public Works, previously South African Forestry Corporation) for which ownership is still being determined. Some will be allocated to nature areas (e.g. under CapeNature management) (Forsyth et al. 2016b). Many of the farmers in the area are part of the Simonsberg Conservancy, which is the implementor for a lot of the alien clearing using Working for Water funding (NRM, DEA), and some landowners are WWF Champion Farmers.

The mountain peaks above the Berg River Dam are estimated to receive over 3000 mm of rainfall per annum, making it a strategic water source area (Forsyth et al. 2016b) (Figure 2.c). The Berg River Dam, commissioned in 2009, is one of the main water storage dams for the city of Cape Town (Rossouw and Grobbler 2008). It was designed to supply up to 80 million m^3 of water per year to the City of Cape Town, as well as to supply irrigators downstream, and honour the ecological reserve (Forsyth et al. 2016b). There are many small towns in the Dwarsrivier valley, including Pniel, Kylemore, Johannesdal, and Lanquedoc. (Forsyth et al. 2016b; Forsyth et al. 2016a).

The City of Cape Town is the main water-user in the Upper Berg, receiving 300 million m^3 from the Western Cape Water Supply System (WCWSS), which includes transfers from the

Theewaterskloof and Steenbras Dams. Stellenbosch also gets its water from the WCWSS, whereas Franschhoek gets its water from springs and the Wemmershoek Dam (just outside of this subcatchment) (Forsyth et al. 2016b). Downstream users of the Berg River include the towns of Paarl and Wellington, and various irrigation boards (Forsyth et al. 2016a). The Upper Berg Major Irrigation Board, servicing farmers in the area, uses about 66 million m^3 each year, half extracted from the river, and the other half from farm dams (Forsyth et al. 2016b). This irrigation board (formed in 1986) is earmarked to become a Water User Association under the Berg-Olifants Catchment Management Agency (Forsyth et al. 2016b).

In the high-lying areas, Pines are the major invasives (*Pinus pinaster* and *P. radiata*), in the middle slopes Eucalyptus species are dominant, and *Acacia's* are the major issue lower in the catchments, forming dense stands. Other riparian invaders include Oaks, Poplars and Elms (Figure 2.e) (Forsyth et al. 2016b; Forsyth et al. 2016a). Failing infrastructure is also an issue, leading to sewage flowing into the rivers (Figure 2.e). Besides water security, invasive alien trees are a major fire risk, through increased fuel loads. Fires are most common in this subcatchment in summer, between December and March (Forsyth et al. 2016b). Four major fires are of importance for the Upper Berg subcatchment. Two, in January 2000 and January 2015 respectively, burned the Simonsberg mountain, and the other two, in December 2005 and March 2006, burned the mountains around the Berg River Dam. As a result, the vegetation around the Berg River Dam is currently around 13 years old, whereas that on the Simonsberg is around 2 years old (Forsyth et al. 2016b; Forsyth et al. 2016a). These fires perpetuated the invasive alien tree problem through stimulating the germination of large numbers of Pine and Acacia seedlings (Forsyth et al. 2016b; Forsyth et al. 2016a)

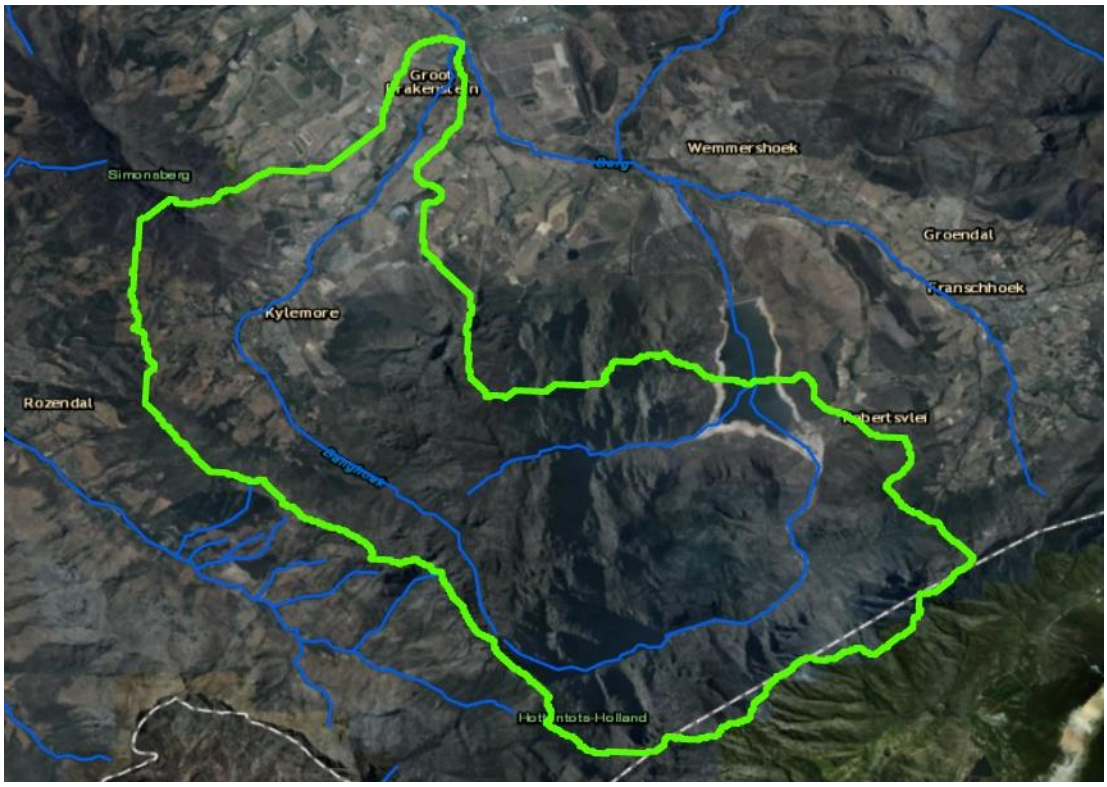

Figure 2.a. Terrain, rivers and towns in the Upper Berg subcatchment

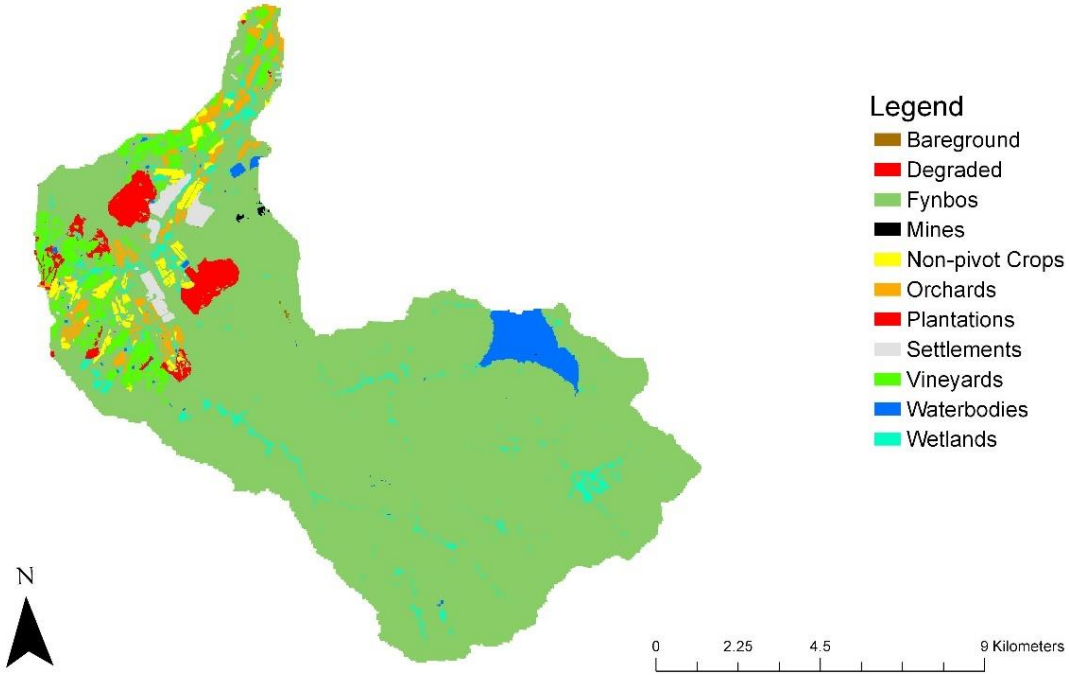

Figure 2.b. Land cover in the Upper Berg subcatchment

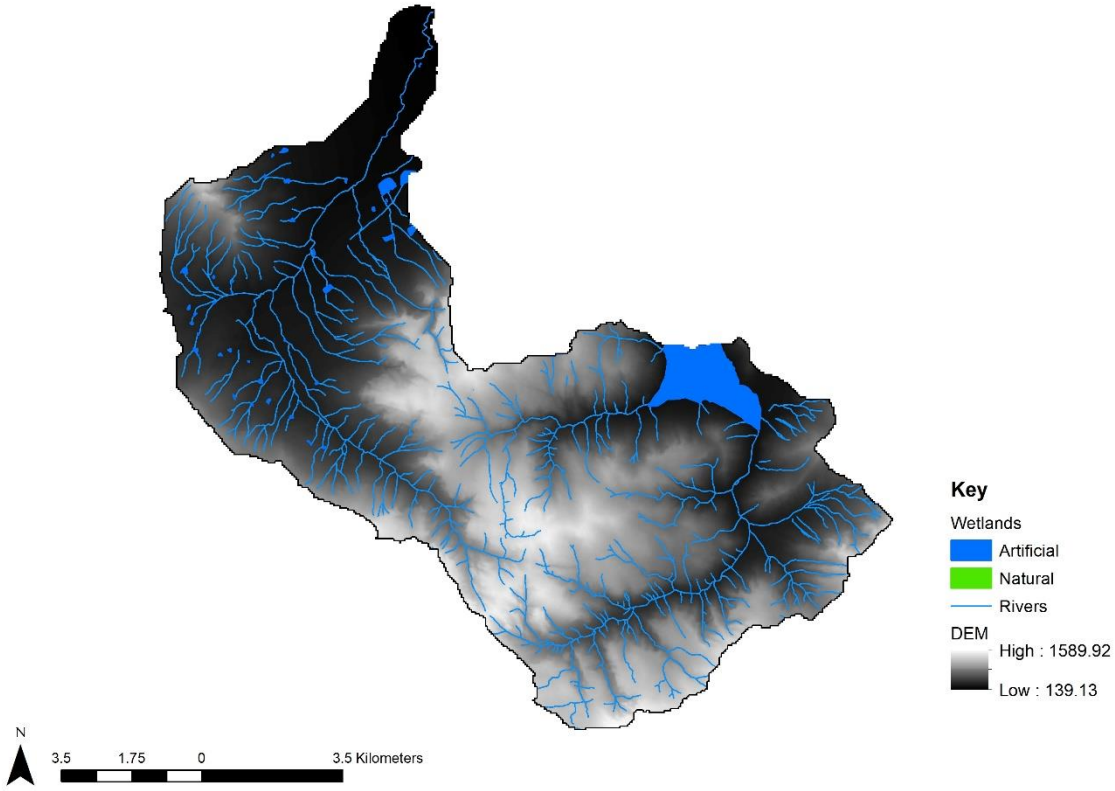

Figure 2.c. Wetlands and detailed river systems in the Upper Berg overlain on a digital elevation model.

Major Ecological Infrastructure Interventions

There are many Ecological Infrastructure (EI) initiatives taking place in the Upper Berg, including alien clearing, wetland rehabilitation and wetland revegetation, as well as social upliftment programmes. Organisations involved in most of the alien clearing include CapeNature in the mountains, Working on Fire in the steep/high altitude areas, the Simonsberg Conservancy, and the Wildlands/Ranyaka (Wild Trust) along the Dwarsrivier itself. The Cape Winelands District Municipality have also been clearing above the Berg River Dam area (Forsyth et al. 2016b). DEADP (Western Cape Government) have done some small patches of river revegetation along the banks of the Dawrsrivier, and Working for Wetlands has done some wetland rehabilitation above the Berg River Dam (Figure 2.d).

Other organisations active in the area include the Upper Berg River Irrigation Board, the Berg-Olifants CMA. The Champion Farmer Initiative (WWF) is active in the area, and many private landowners (notably Boschendal Wine Farm Ltd) are actively funding their own alien clearing efforts, supported with herbicide from Working for Water. Organizations involved in social upliftment include the Banhoek Conservancy, the Dwarsrivier Community Development Trust, and DroomStroom, According to Forsyth et al. (2016b), land-user incentives are initiatives (not yet active here) where groups of landowners can partner together to apply for funding for alien clearing and biomass control operations (e.g. firewood, other products).

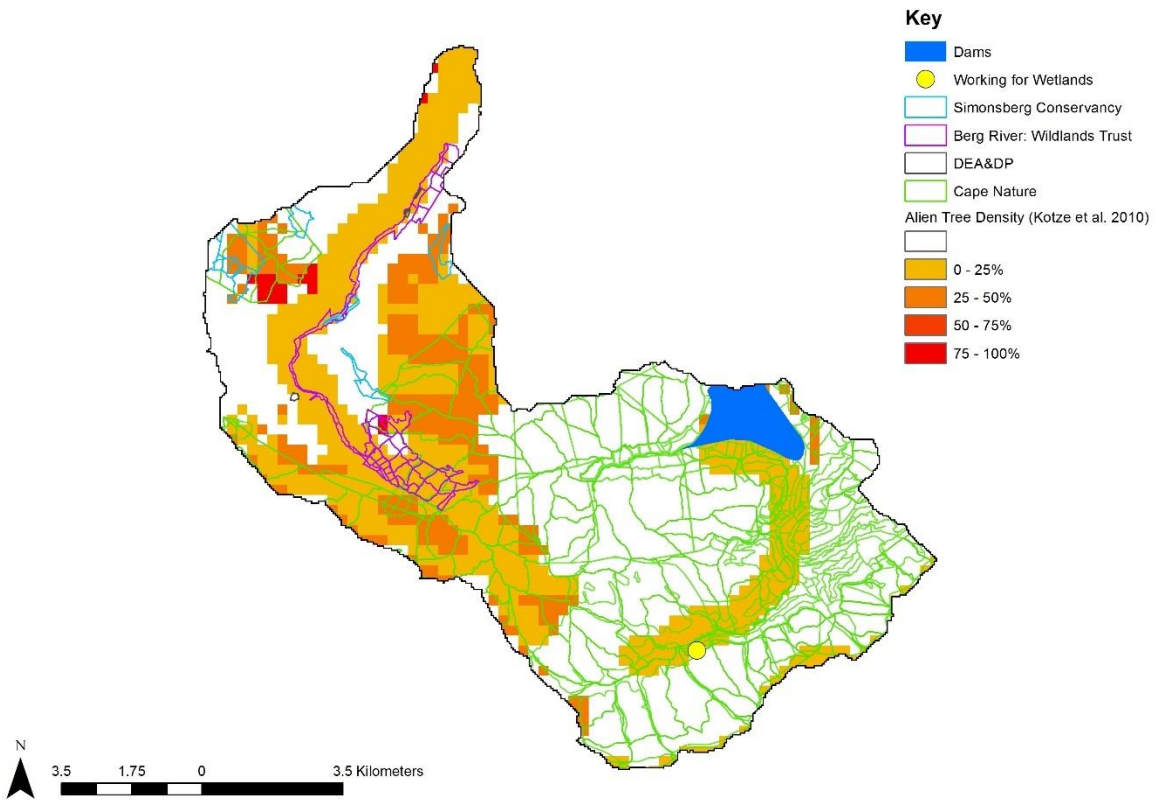

Figure 2.d. Working for Water funded alien clearing, as well as some riparian revegetation in the Upper Berg overlain on the Kotzé et al. (2010) alien tree density map. DEA&DP: Department of Environmental Affairs and Development Planning (Western Cape Province).

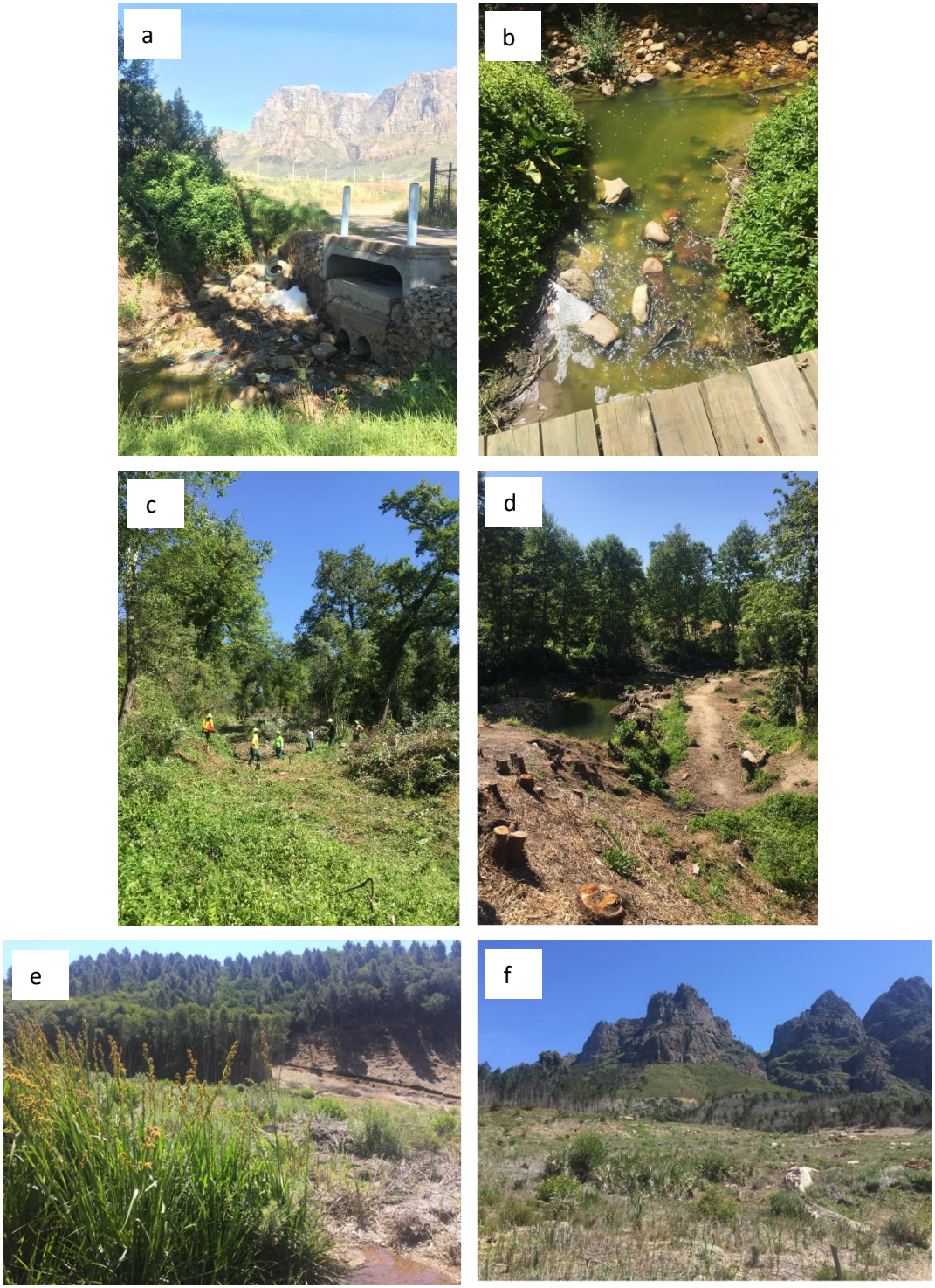

Figure 2.e. Photos of the Upper Berg subcatchment, (a & b) sewage flowing into the Dwarsrivier near Pniel, (c & d) the Wild Trust (Wildlands) clearing alien trees (Poplar, Elm & Oak) along the Dwarsrivier, and (e & f) Boschendal Wine Farm Ltd clearing alien *Acacias* and *Eucalypts* on the slopes of the Simonsberg Mountains.

Site 3: Riviersonderend

Plate 3. The Riviersonderend valley, below the Theewaterskloof Dam.

The Riviersonderend subcatchment is the largest of our six study subcatchments. Similar in geology and soils to the Upper Berg and Breede in its northern, fynbos-dominated mountainous region, in the south-eastern part of the subcatchment the vegetation transitions to critically endangered renosterveld, with richer soils (Figure 3.a). The Riviersonderend river flows through a long, unchanneled valley-bottom palmiet wetland which is highly threatened by invasive alien trees, mainly *Acacia* and *Eucalyptus* (Rebelo et al. 2017) (Figure 3.c,e). Agriculture changes with the vegetation transitions, with fruit farming (predominantly apples and vineyards) in the north-west of the subcatchment, and predominantly winter wheat, with some canola, in the south-east (Figure 3.b).

The Theewaterskloof Dam is connected to the WCWSS via a two-way tunnel to the Berg River Dam, thereby supplying some of the City of Cape Town's water, however the majority of the water is used for agricultural irrigation, industry and municipalities (Theewaterskloof Local and Overberg District Municipalities). The Theewaterskloof Dam was built in 1980 and has a capacity of about 480 million m^3 water per annum (Nitsche et al. 2006). Presently the City of Cape Town and Department of Water and Sanitation are exploring alternative means to secure water security, and using drought funding, have been sinking hundreds of deep boreholes into the Table Mountain Group Aquifer, predominantly in the mountains surrounding the Theewaterskloof Dam. Towns that are important for sources of labour for EI interventions in this subcatchment include Villiersdorp, Genadendal and Berea (Figure 3.a).

There are two RAMSAR wetland sites that the Riviersonderend flows into, and these are the De Hoop Vlei and the Heuningnes Estuary (Robinson 2017). Major problems in the subcatchment include invasive alien trees (mainly *Eucalyptus* and *Acacia*), draining of the wetlands for agricultural development, encroachment into wetland buffer zones, poor agricultural practices (overgrazing and deep ploughing) as well as water quality issues (chemical, sewage and stormwater) (Robinson 2017).

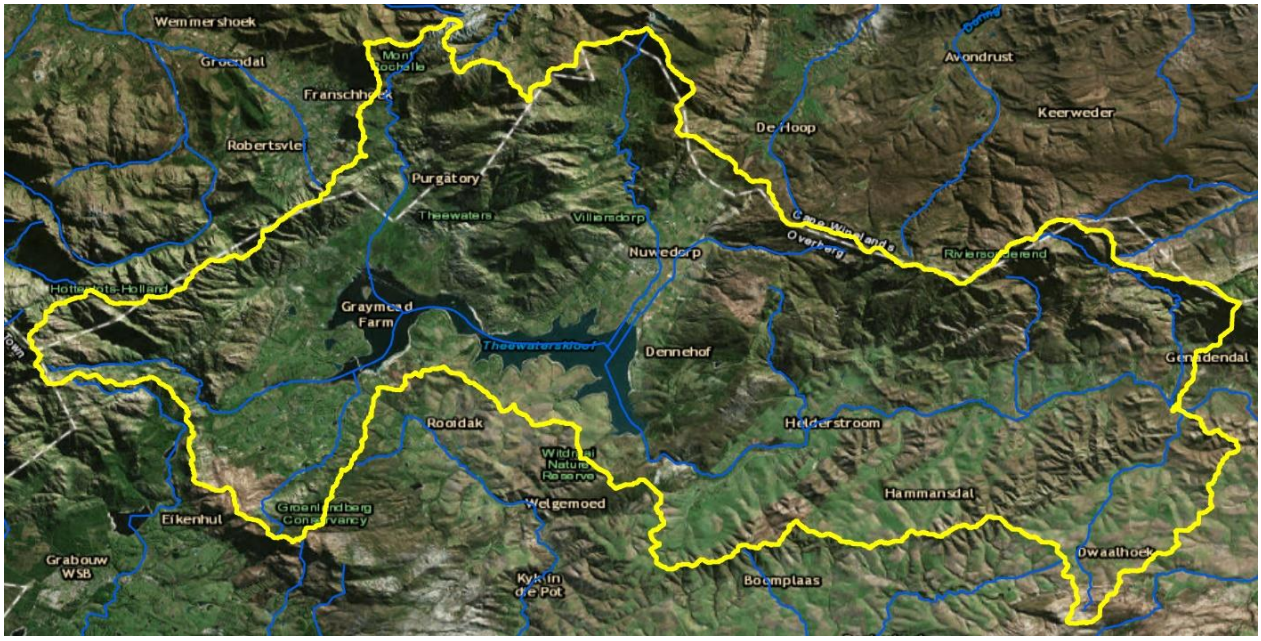

Figure 3.a. Terrain, rivers and towns in the Riviersonderend subcatchment

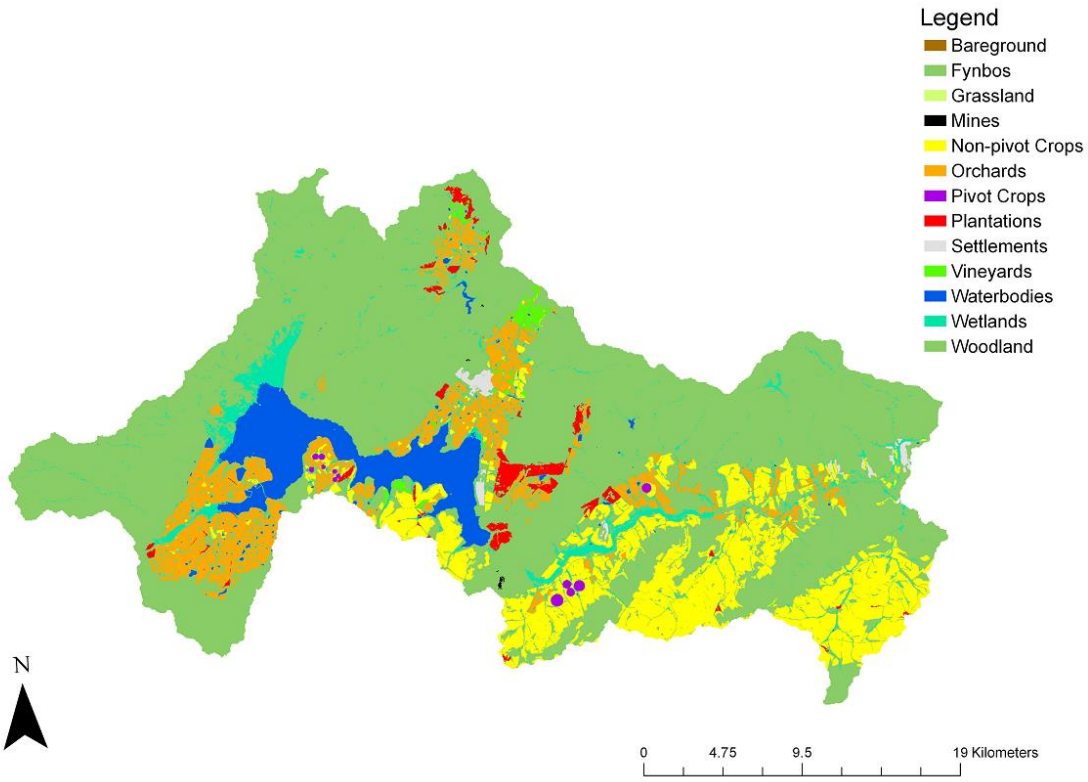

Figure 3.b. Land cover in the Riviersonderend subcatchment

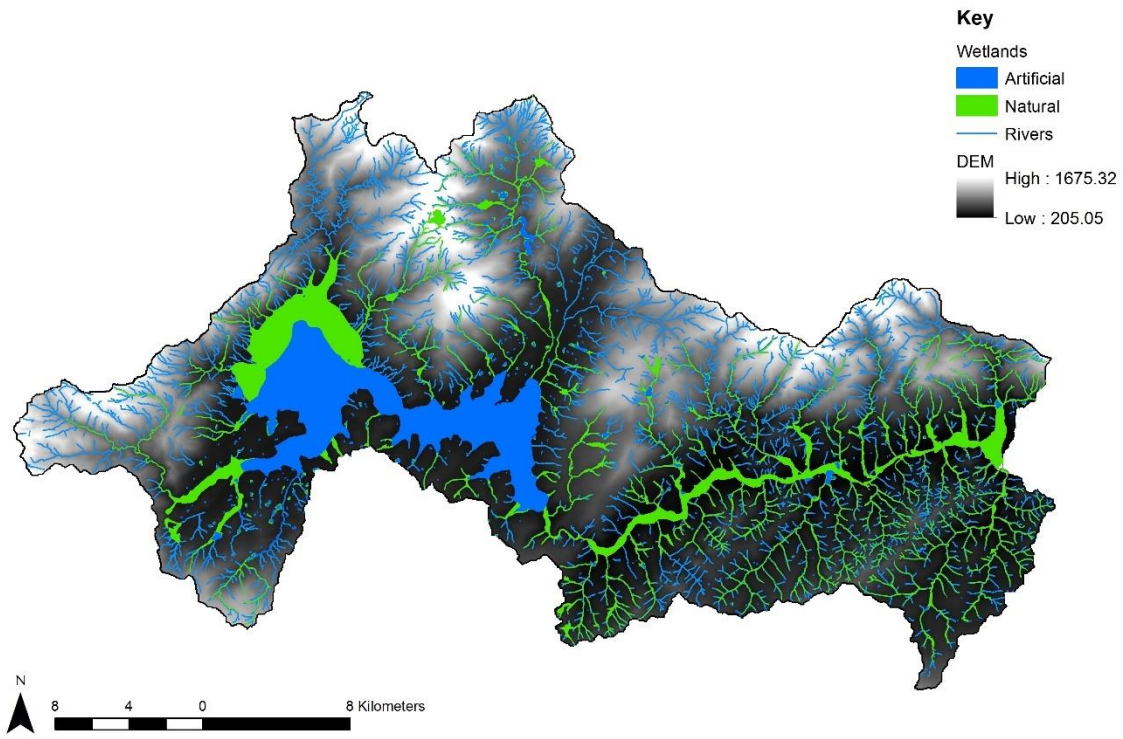

Figure 3.c. Wetlands and detailed river systems in the Riviersonderend overlain on a digital elevation model.

Major Ecological Infrastructure Interventions

The major presence in this subcatchment in terms of EI interventions is the Zonderend Water Users Association (ZWUA) (Figure 3.d). Initiated by the landowners, and funded through Working for Wetlands, the ZWUA, managing about 14 teams, is implementing alien clearing, ecological burns and riparian revegetation in the subcatchment. WWF has also done some alien clearing in the upper parts of the system, also using the same funding source (Robinson 2017). Cape Nature is involved in alien clearing on the mountains above the Theewaterskloof Dam, as is the Stellenbosch Local Municipality (a land owner at Purgatory) which is also an area of interest for the future local Water Fund (The Nature Conservancy). Working on Fire is also involved with clearing high altitude/steep slope alien trees, as well as assisting the ZWUA with ecological burns in the valley-bottom wetlands.

There is also a local nursery on the commonage near the town of Genadendal where the plants for the rehabilitation are grown (Figure 3.e). This nursery is used by both Landcare (Department of Agriculture) and ZWUA for riparian revegetation. Other organisations involved in the area include: the Breede-Gouritz Catchment Management Agency, the Breede Water Users Association, the Overberg District Municipality (Department of Environmental Management), the Theewaterskloof Local Municipality, the Riviersonderend – Groenlandberg Conservancy, and LivingLands. Not EI interventions, but important recent hydrological alterations, include some of the tributaries of the Riviersonderend being straightened and reinforced with groins, by the Landcare (King 2014).

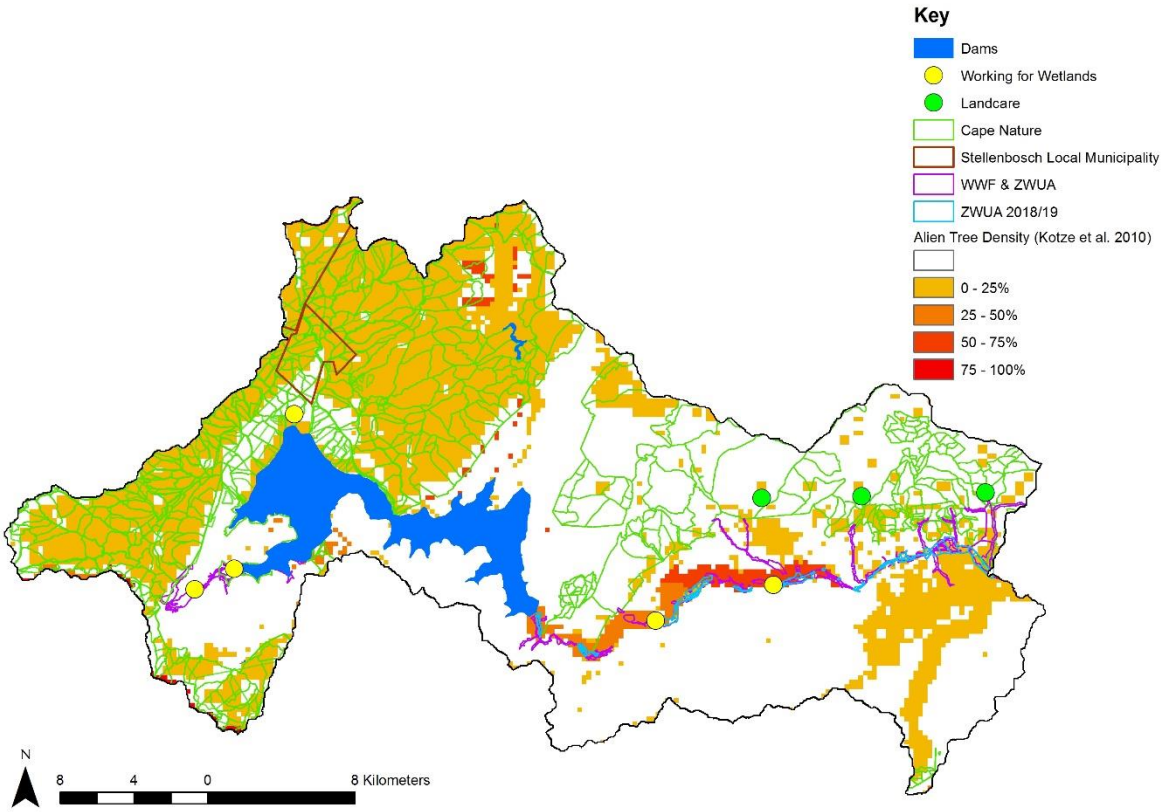

Figure 3.d. Alien clearing and wetland rehabilitation in the Riviersonderend overlain on the Kotzé et al. (2010) alien tree density map. The light blue (ZWUA 2018/19) is work planned for the near future. ZWUA: Zonderend Water Users association.

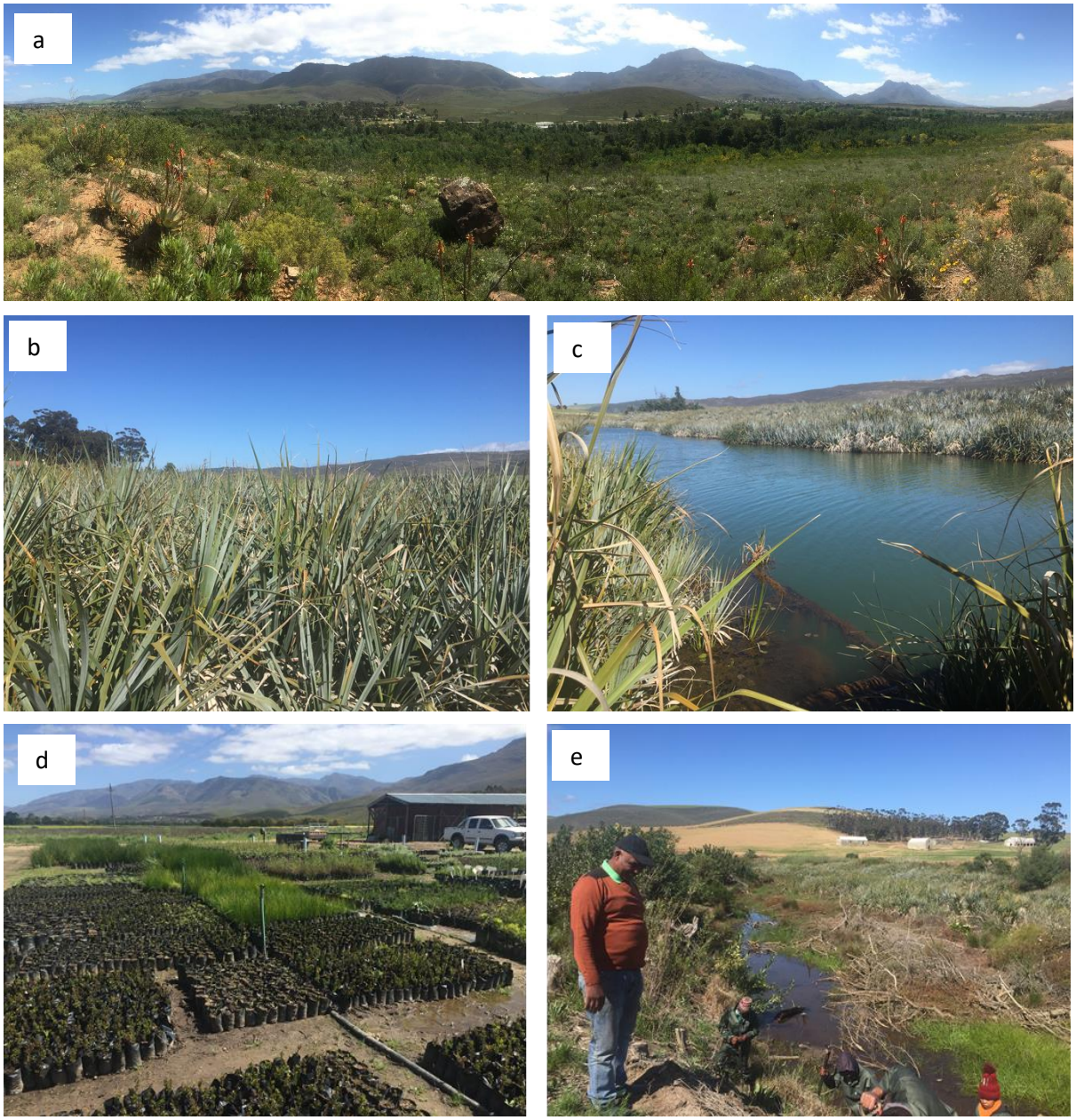

Figure 3.e. Photos of the Upper Riviersonderend subcatchment, (a) an intact palmiet valley-bottom wetland emerges after alien clearing, (b) healthy Palmiet (*Prionium serattum*) in the wetland, (c) a channel through the palmiet wetland, (d) the nursery near Genadendal (on the commonage) used by the Zonderend Water Users Association (ZWUA) and Landcare for riparian revegetation, and (e) a ZWUA contractor and his team, working on riparian revegetation.

Site 4: Mthinzima

Plate 4. The Mthinzima tributary of the uMngeni River flows from its relatively pristine headwaters in a grassland matrix to the Midmar Dam.

The Mthinzima subcatchment is located in the headwaters of the uMngeni (mountain peaks at ±1760 m above sea level) and is made up of three major tributaries: the Mthinzima, Gqishi and Khayalisha (Figure 4.a). The climate in the Midlands is temperate, with summer rainfall and the geology is primarily Volksrust Shale with some Beaufort Mudstone and Karoo Dolerite outcroppings. The three main tributaries flow into the Midmar Dam and are critical in providing water security to the cities of Pietermaritzberg and Durban (eThekwini, uMgungundlovu and Msunduzi municipalities) (Meier 2015).

The Mthinzima tributary flows through predominantly tribal lands comprised of a 6000-unit settlement called Mpopomeni, developed in the 1960s (Van Deventer 2012). There is an ageing wastewater treatment plant below Mpopomeni, built to treat domestic wastewater. However this wastewater treatment plant is dysfunctional, and raw sewage is being discharged into the Midmar Dam via the Mthinzima tributary (Van Deventer 2012) (Figure 4.e). There are plans for the wastewater treatment plant to be upgraded, and for the wetland adjacent to this plant, and above the Midmar Dam to be rehabilitated in the future. The Khayalisha tributary flows through mainly natural landcover (51%) and cultivated lands (23%), however is ear-marked for a social housing projected comprising 1500 units (Van Deventer 2012) (Figure 4.b). The Gqishi subcatchment is dominated by forestry in its upper reaches, and mixed agriculture and livestock production in its lower reaches.

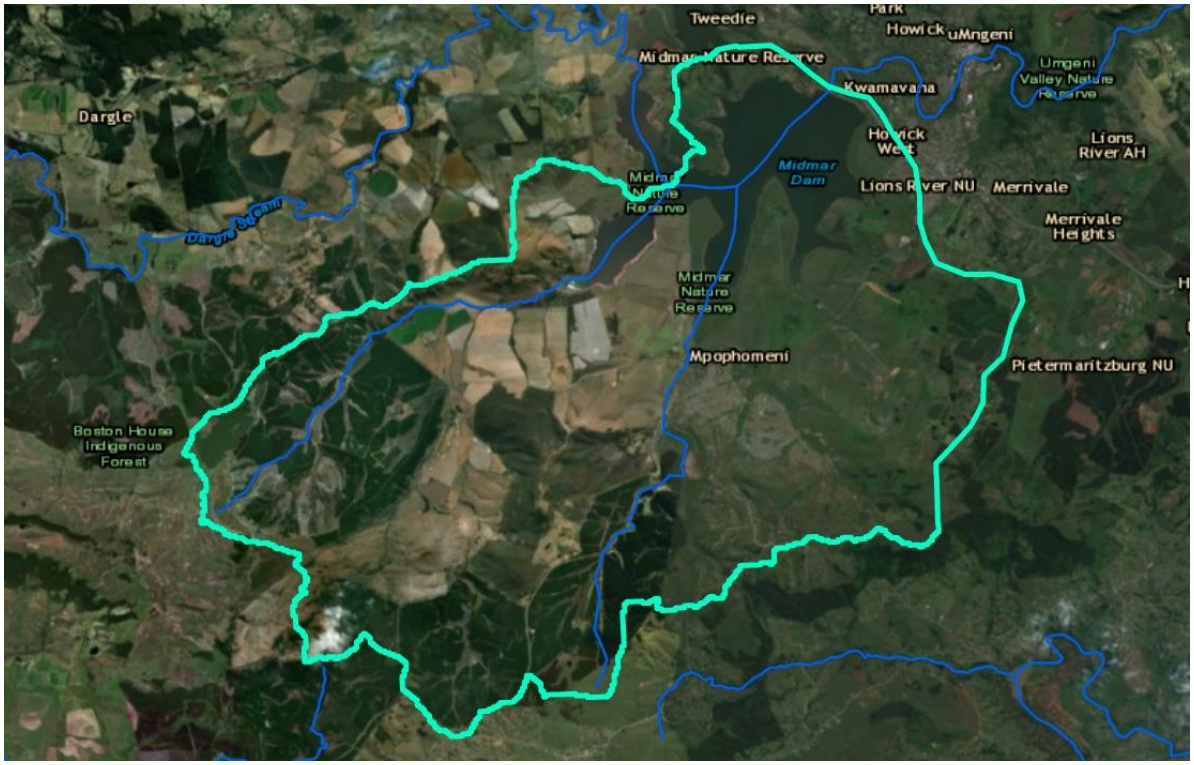

Figure 4.a. Terrain, rivers and towns in the Mthinzima subcatchment

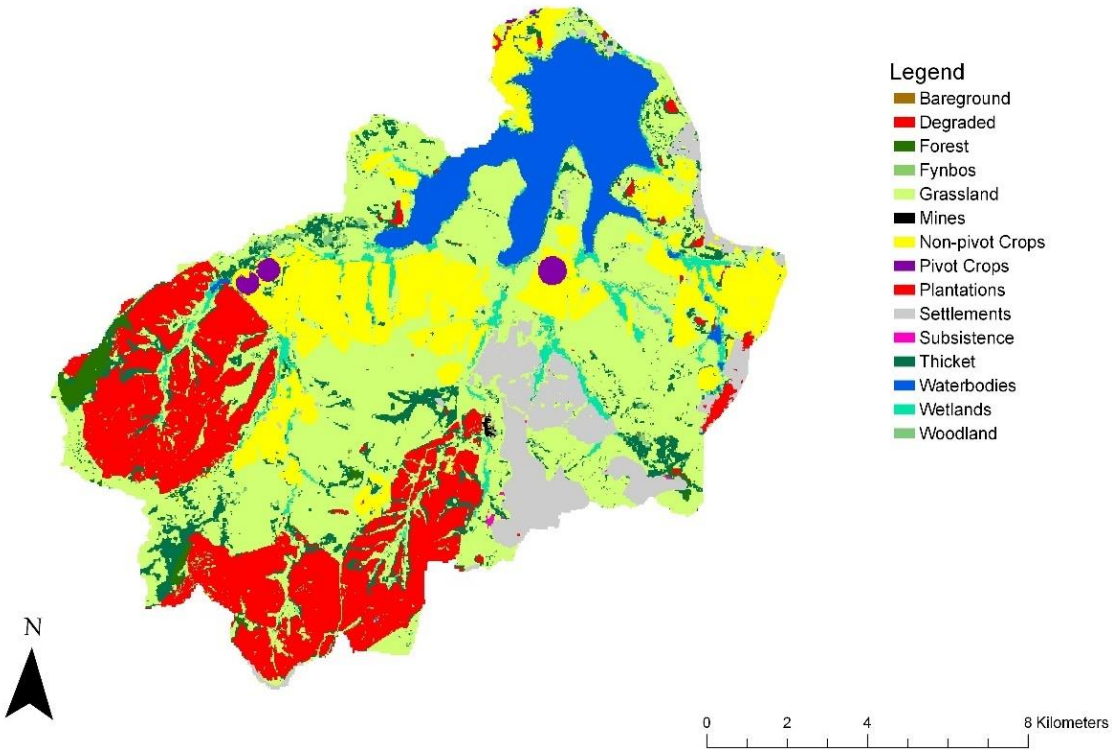

Figure 4.b. Land cover in the Mthinzima subcatchment

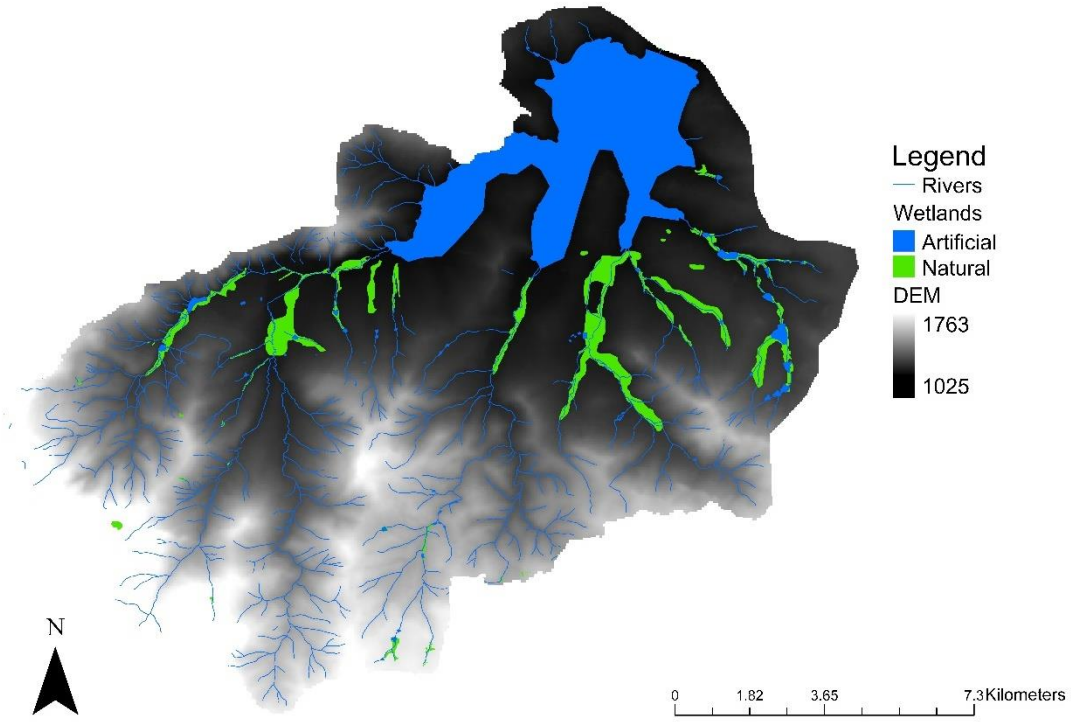

Figure 4.c. Wetlands and detailed river systems in the Mthinzima subcatchment overlain on a digital elevation model.

Major Ecological Infrastructure Interventions

The major EI programme in the Mthinzima subcatchment is the Working for Water Programme. There are currently three funded WfWater projects running: the Midmar, Midmar Qgishi and the Elandskop projects (Figure 4.d). We are currently attempting to source information about the contractors/implementing agents. There may have been work done by Working for Wetlands and some wetlands specialists (pro-bono) as specially requested by the Mpopomeni community, in the upper part of the Mthinzima subcatchment, however we are waiting for confirmation of this by Aurecon. Other key stakeholders include: the uMngeni Ecological Infrastructure Partnership (UEIP), GroundTruth, The Duzi uMngeni Conservation Trust (DUCT), WWF, WESSA, and the Wildlands Conservation Trust. Key projects include the Capacity for Catchments uMngeni Ecological Infrastructure project, the uMngeni Resilience Project, the River Care Project, the Save the Midmar Dam Project, and WESSA Share-net (see Appendix 1 for details about these projects).

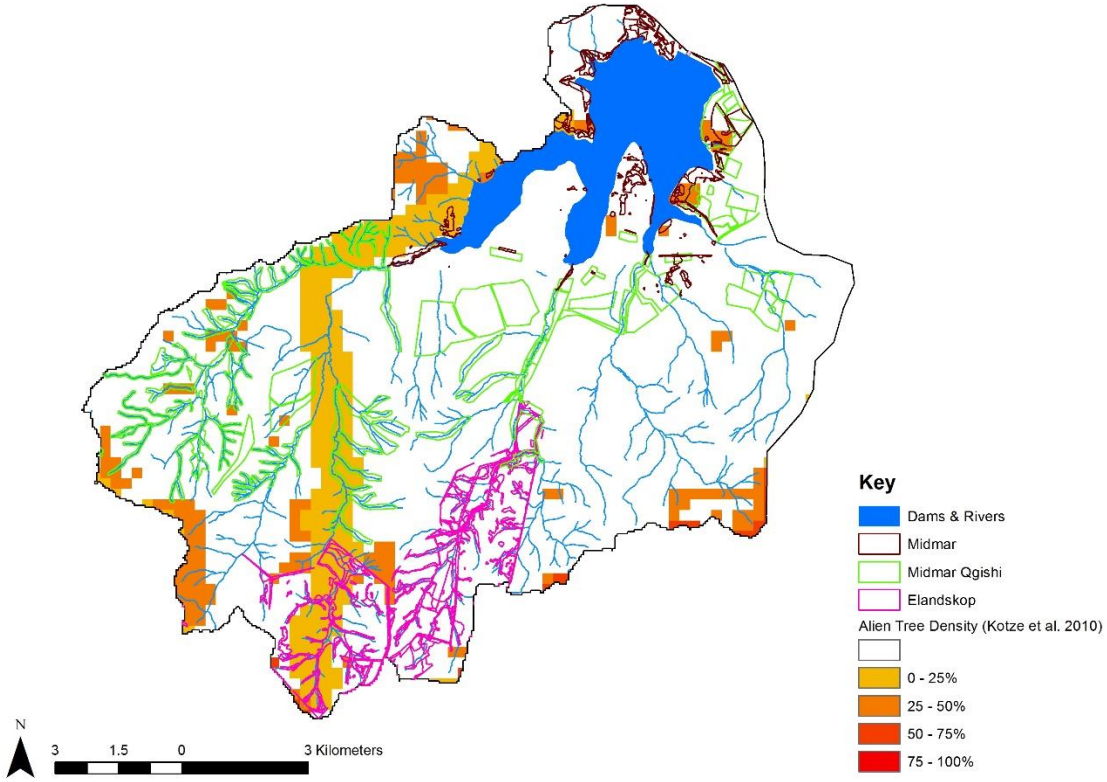

Figure 4.d. Working for Water funded alien clearing in the Mthinzima subcatchment overlain on the Kotzé et al. (2010) alien tree density map.

Figure 4.e. Photos of the Mthinzima subcatchment, (a & b) some degradation near Mpopomeni in the upper part of the subcatchment, (c) a burst manhole in Mpopomeni, (d) the Mthinzima inflow into the Midmar Dam.

Site 5: Baynespruit

Plate 5. The Baynespruit River flowing through Pietermaritzberg, showing the banks under cultivation, some remaining wetland with informal settlements of Sobantu (right bank) and Madiba (left bank).

The Baynespruit river is approximately 9 km long, with its headwaters (±990 m above sea level) in Northdale (Peitermaritzberg), merging with the Msunduzi River near Sobantu (Ramburran 2014) (Figure 5.a,c). The Msunduzi river is one of the main tributaries that flows into Inanda Dam, the city of Durban's primary water supply. The geology is predominantly Pietermaritzberg Shale with Dwyka Tillite dykes and sills. The Baynespruit subcatchment is heavily transformed and polluted by industry (Figure 5.b), and there is a large issue of failing waste water and sewerage infrastructure. It is one of the top six most polluted rivers in South Africa (Ramburran 2014). There are many informal settlements along this river who are affected by this poor water quality (e.g. Sobantu and Madiba). Wetlands have declined significantly, and there are now 13 remaining wetlands in the Baynespruit subcatchment (Figure 5.c), amounting collectively to an area of 13.24 ha (Ramburran 2014). There are 56 species of animals, 20 species of plant and over 50 endemic species in the Baynespruit (Ramburran 2014).

Figure 5.a. Terrain, rivers and towns in the Baynespruit subcatchment

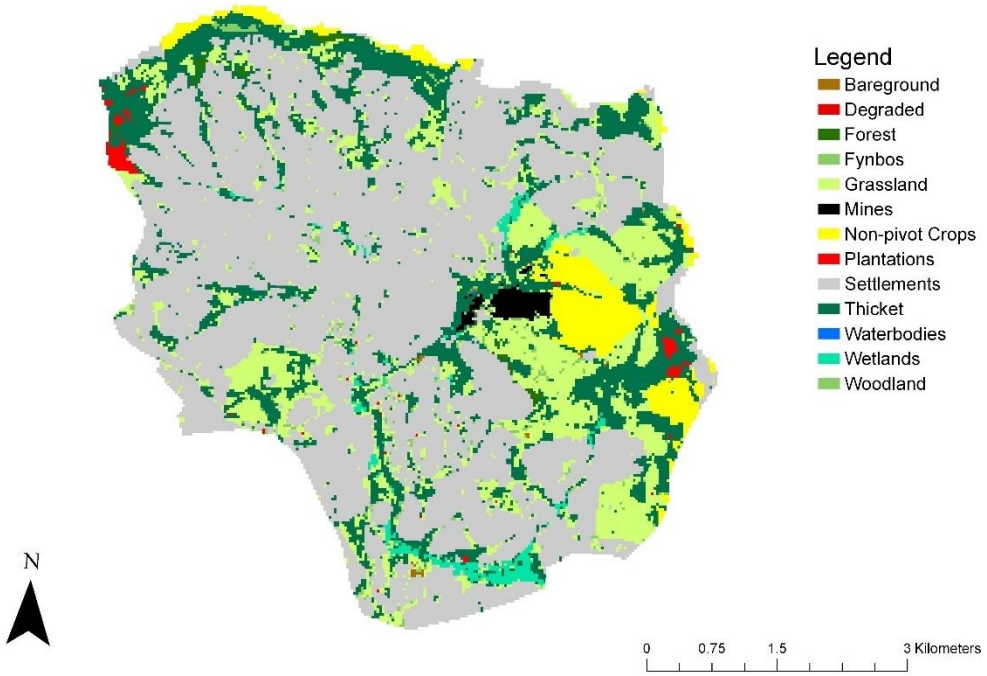

Figure 5.b. Land cover in the Baynespruit subcatchment

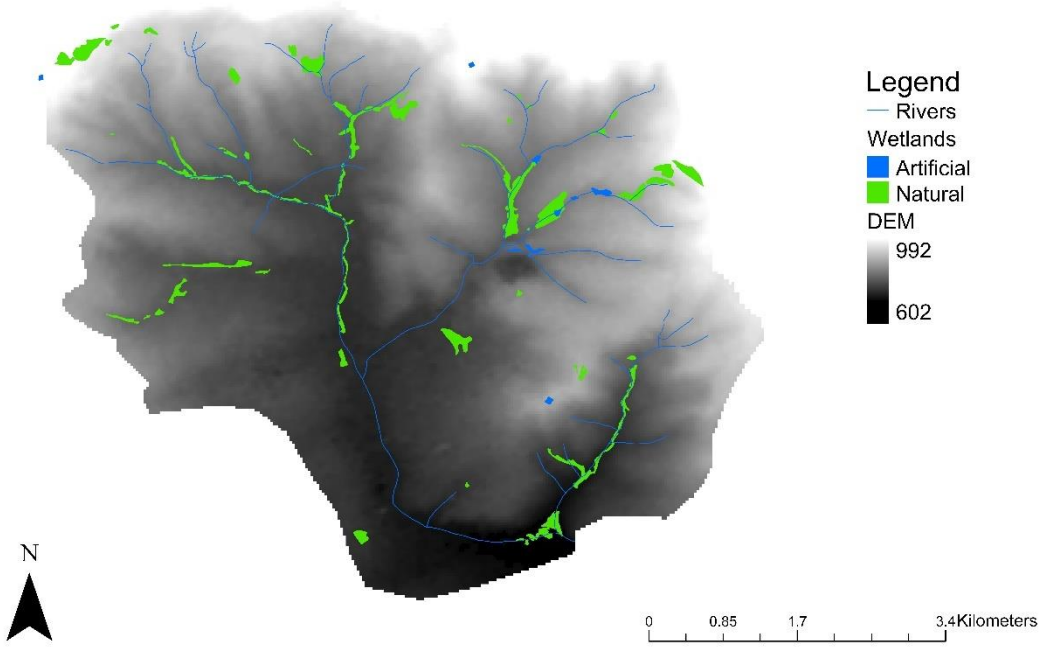

Figure 5.c. Wetlands and detailed river systems in the Baynespruit subcatchment overlain on a digital elevation model

Major Ecological Infrastructure Interventions

There are two artificial floating wetlands in the Baynespruit River commissioned by the Msunduzi Local Municipality (Figure 5.e). This is part of the Baynespruit Rehabilitation Project coordinated by the Msunduzi Municipality (Ramburran 2014). The uMngeni

Ecological Infrastructure Partnership (UEIP) and the Duzi Umngeni Conservation Trust (DUCT) are also active in coordinating measures in the system. These include wetland rehabilitation, alien plant clearing/control (Figure 5.d) and revegetation of the cascades wetland and Townbush Stream in Pietermaritzburg. The Kingfisher Lake at the SANBI Botanical Gardens in Pietermaritzburg (on the Dorpspruit) has undergone habitat restoration (reinstating the lake). There has also been some rehabilitation of the Edendale Mall wetland, which is just off from the mainstem of the uMsunduzi River.

Other programmes include champion/waste minimization clubs, river clean-ups (including the trash boom installed by DUCT), public awareness and education, as well as information campaigns. Some other key stakeholders in the Baynespruit include: the Sobantu Farmers Association, Departments within Msunduzi Municipality, KwaZulu-Natal Department of Agriculture and Environmental Affairs (DAEA), Wildlands Conservation Trust, Msunduzi Catchment Management Forum, Duzi Umgeni Conservation Trust, Umgeni Water, WESSA Eco-Schools,WESSA Share-net, Pietermaritzburg Chamber of Business (PCB), and Groundtruth.

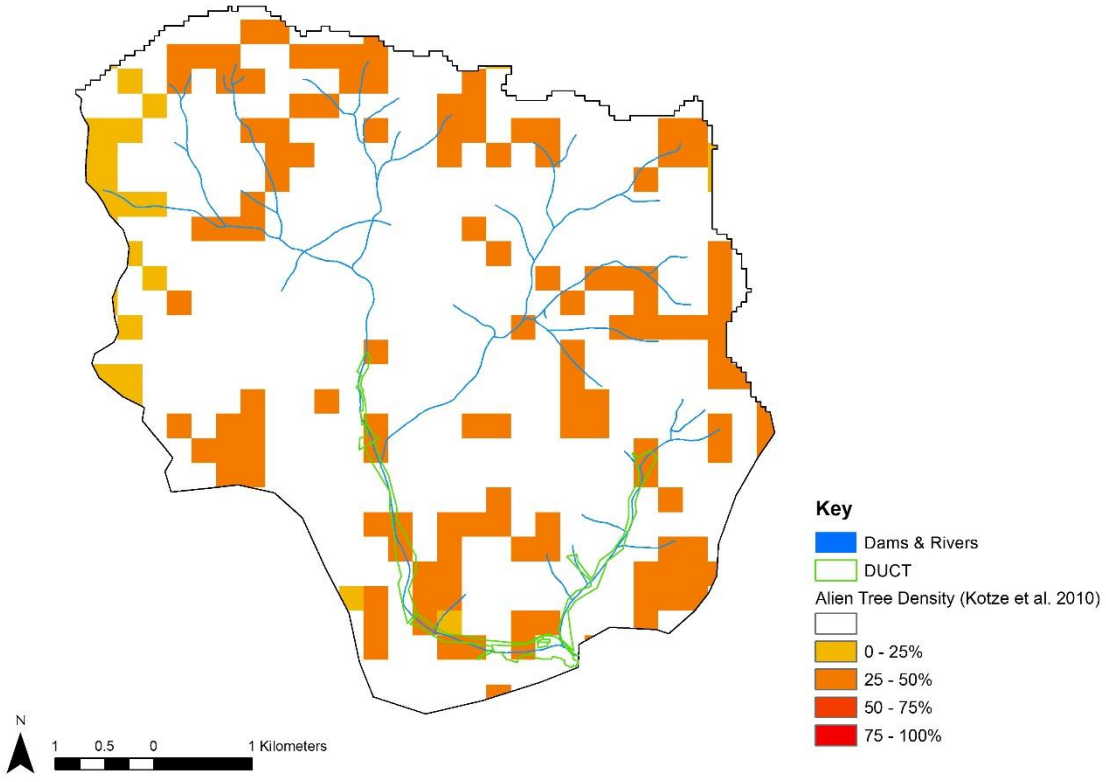

Figure 5.d. Working for Water is not funding any alien clearing in the Baynespruit subcatchment. This map shows the Kotzé et al. (2010) alien tree density map.

Figure 5.e. Photos of the Baynespruit subcatchment, (a) a floating wetland implemented by the Msunduzi Local Municipality, (b) a trash boom, with the aim to reduce solid waste, implemented and maintained by DUCT, (c) a wetland in the Baynespruit, currently and rapidly being cultivated by the local residents of Madiba and Sobantu, (d) agriculture in the floodplain.

Site 6: Palmiet

Plate 6. The Palmiet River flowing through the Palmiet Nature Reserve.

The Palmiet River is approximately 23 km long, with 6 km passing through the rugged terrain of Kloof and the Palmiet Nature Reserve (±550 m above sea level) and the lower, flatter reaches bordered by industry (Pinetown/New Germany industrial area), as well as both formal and informal settlements (Naidoo 2016) (Figures 6.a,b,c,e). The most notable informal settlement is the Quarry Road Settlement which is located in the river floodplain nearby its confluence with the uMngeni River. The geology of the Palmiet subcatchment is predominantly sedimentary rocks (Sandstone) with some Dwyka Tillite dykes and sills and Pietermaritzberg Shale.

The Palmiet subcatchment is degraded, with river channel modifications (hard infrastructure) and impervious surfaces (impacts on infiltration in the subcatchment) resulting in the channeling of the river water during flood events, leading to flood damage downstream (Naidoo 2016). Another major challenge related to high flow events, is the numerous stormwater outlets and obstructions to these. Naidoo (2016) found that as a result of this degradation, the riverflow of the Palmiet catchment had been significantly modified, resulting in scouring of the riverbed and banks. Industrial pollution is the third major challenge in the Palmiet subcatchment. Other minor challenges have been identified as: alien vegetation, illegal waste dumping, illegal sand mining, habitat destruction, and loss of wildlife and biodiversity.

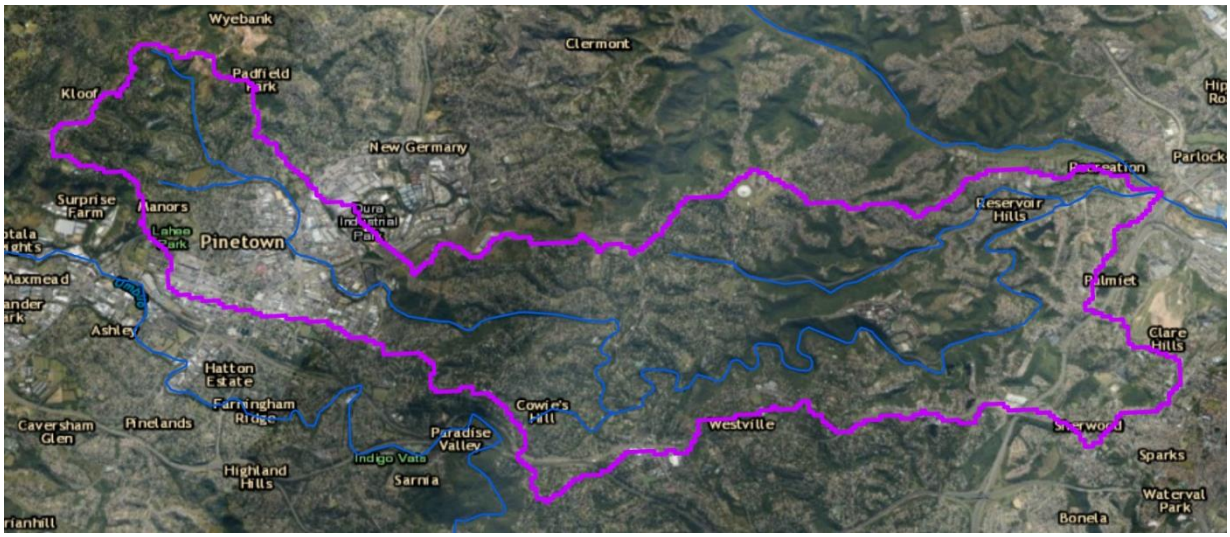

Figure 6.a. Terrain, rivers and towns in the Palmiet subcatchment

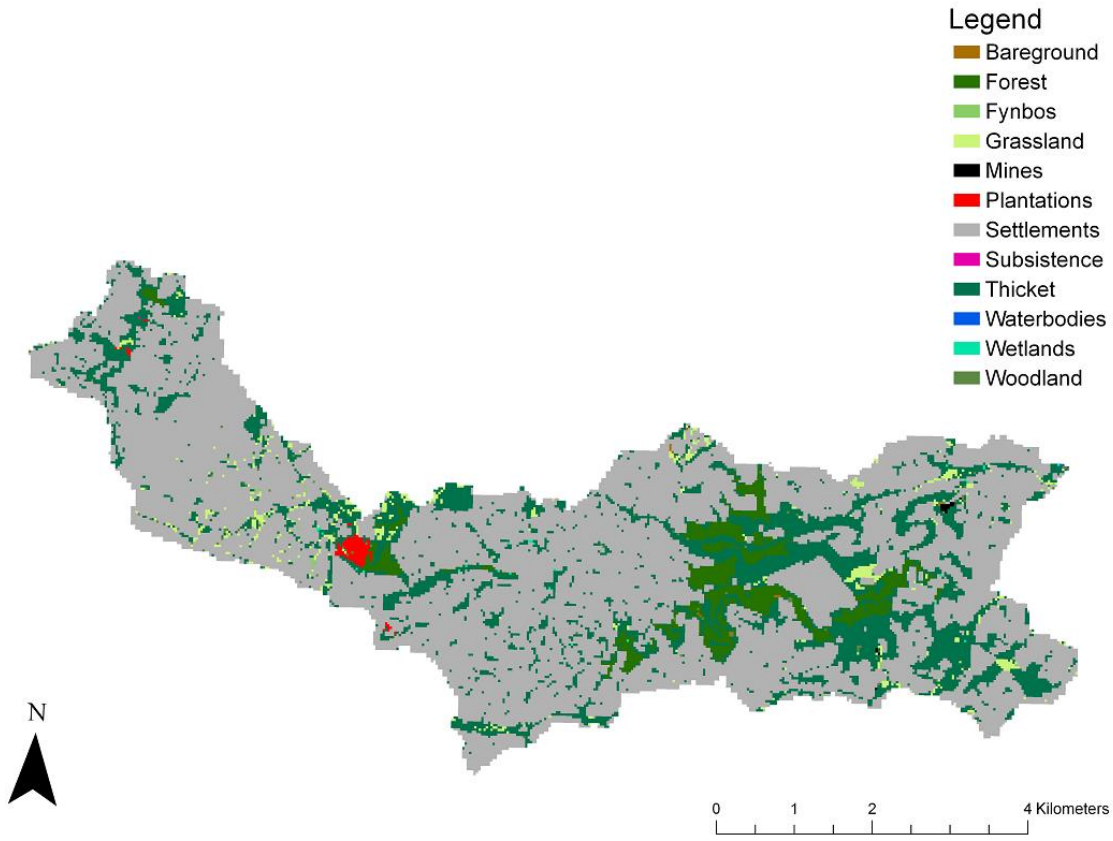

Figure 6.b. Land cover in the Palmiet subcatchment

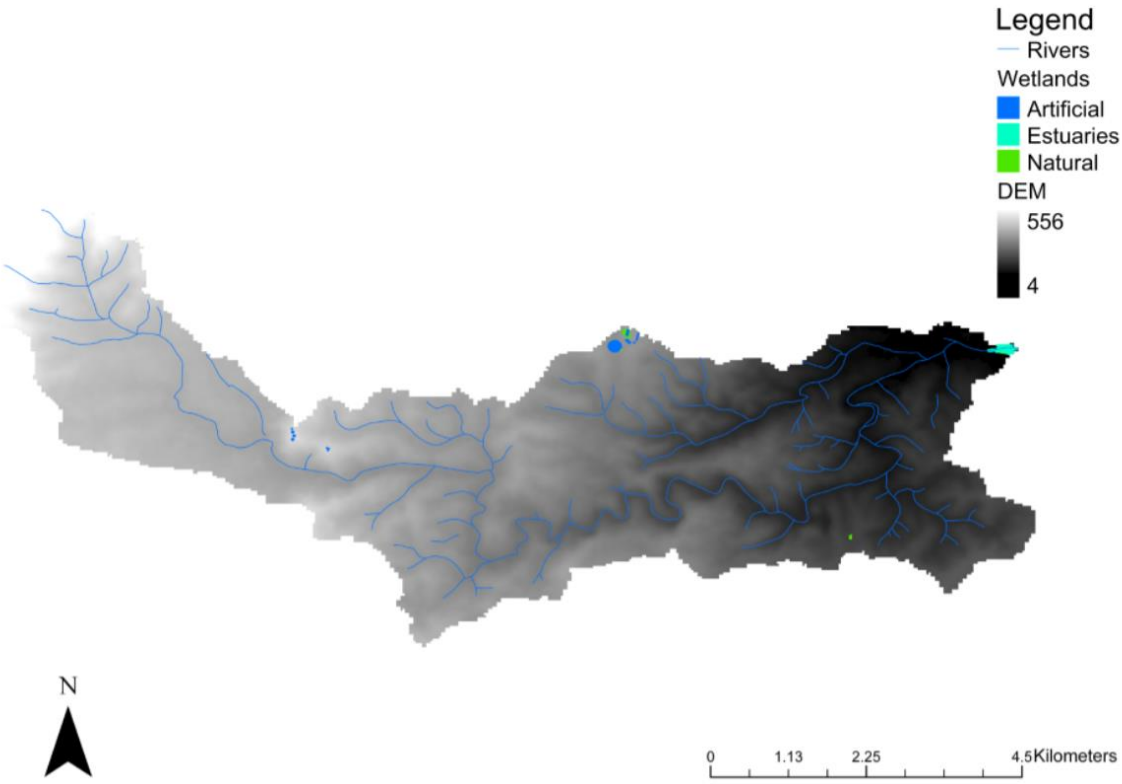

Figure 6.c. Wetlands and detailed river systems in the Palmiet subcatchment overlain on a digital elevation model

Major Ecological Infrastructure Interventions

The major stakeholders involved in EI in the Palmiet subcatchment are the uMngeni Ecological Infrastructure Partnership (UEIP) and the eThekwini Metropolitan Municipality (Climate Protection Branch, Water & Sanitation: Pollution & Environment), which jointly coordinate the Palmiet Rehabilitation Project (PRP). The PRP developed an action plan to improve the effectiveness of ecological infrastructure and build community resilience through a process of stakeholder engagement. They established a Community of Innovation to oversee the implementation of this action plan. One example of a project through the PRP was on waste management. The Wildlands Conservation Trust was engaged by the PRP to assist with solid waste issues as well as poverty alleviation and job creation. These issues were addressed through interaction with the community to stop littering and polluting the Palmiet River and in addition waste services were provided by the municipality and a recycling project was implemented in 2016. Other key stakeholders in the Palmiet subcatchment include NGO's (Palmiet River Watch, eThekwini Conservancies Forum, uThekwane Conservancy, and Durban Green Corridor), the Quarry Road West Informal Settlement Committee and the UKZN School of Development Studies. The Duzi Umngeni Conservation Trust (DUCT) has also been involved in the lower reaches of the Palmiet subcatchment with some alien clearing, and removal of water weeds (Figure 6.d).

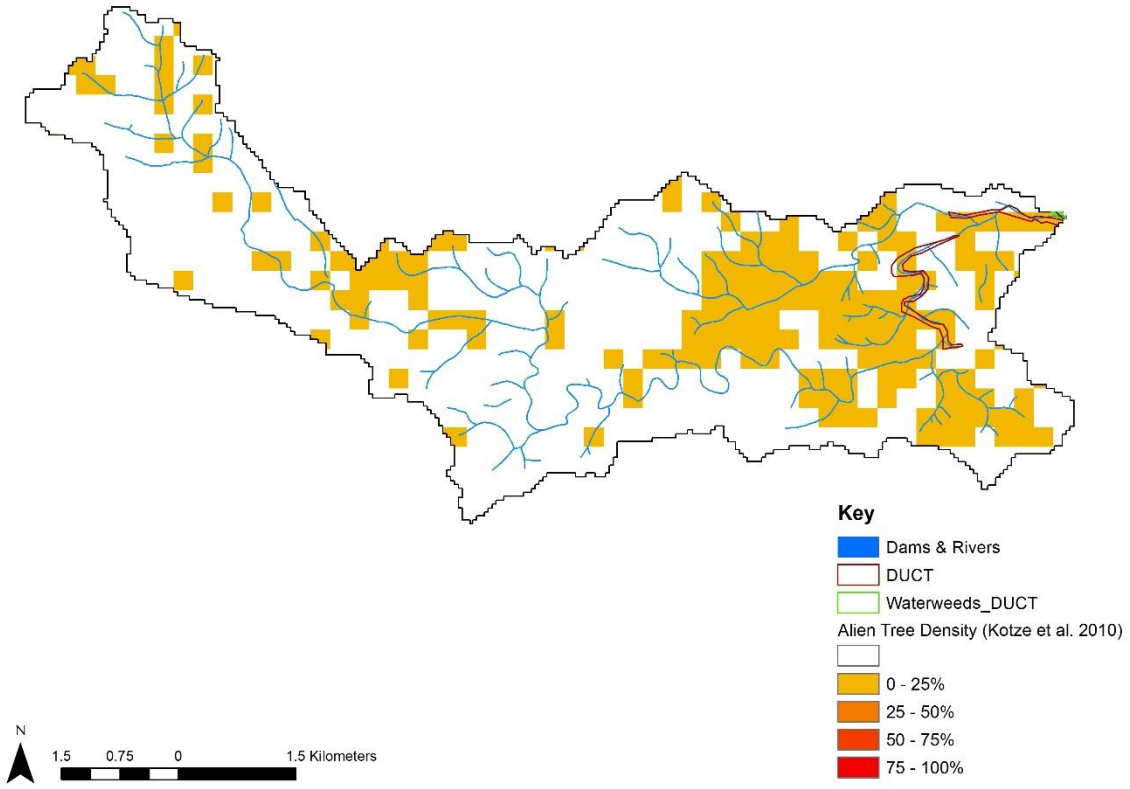

Figure 6.d. Working for Water funded alien clearing in the Palmiet subcatchment (waterweed clearing from the uMngeni estuary) overlain on the Kotzé et al. (2010) alien tree density map.

Figure 6.e. Photos of the Palmiet subcatchment, (a) the Palmiet Nature Reserve, (b) industry in the lower part of the catchment, (c) meeting Cathy and some of her team at the Quarry Road Settlement, and (d) the Palmiet Nature Reserve.

Alternative site selection for the uMngeni

Since sites 5 and 6 have very little potential for EI investment (the subcatchments are 64% and 73% transformed respectively, with the major issues being failing built infrastructure), there is the option to select sites higher up in the uMngeni catchment, where there has been significant investment into ecological infrastructure by organisations such as Working for Water and Working for Wetlands (**Figure 7**). Working for Water have 12 projects in the uMngeni, Working for Energy is also active, and Working for Wetlands has 2 projects, one at Ivanhoe Farm, and the other a project for the future, rehabilitating the wetlands above the Midmar Dam (site 4). There are also other organisations involved in the area: most notably the WWF farmer stewardship initiative. One suggestion from WP3 is that site 6 is retained as a site, as it may have interesting opportunities to model flood risk, through reduction in impervious areas higher in the catchment. However, this is still under discussion, as there is little opportunity for WP4 to work at this site. The alternative is to select two new sites higher up in the uMngeni catchment.

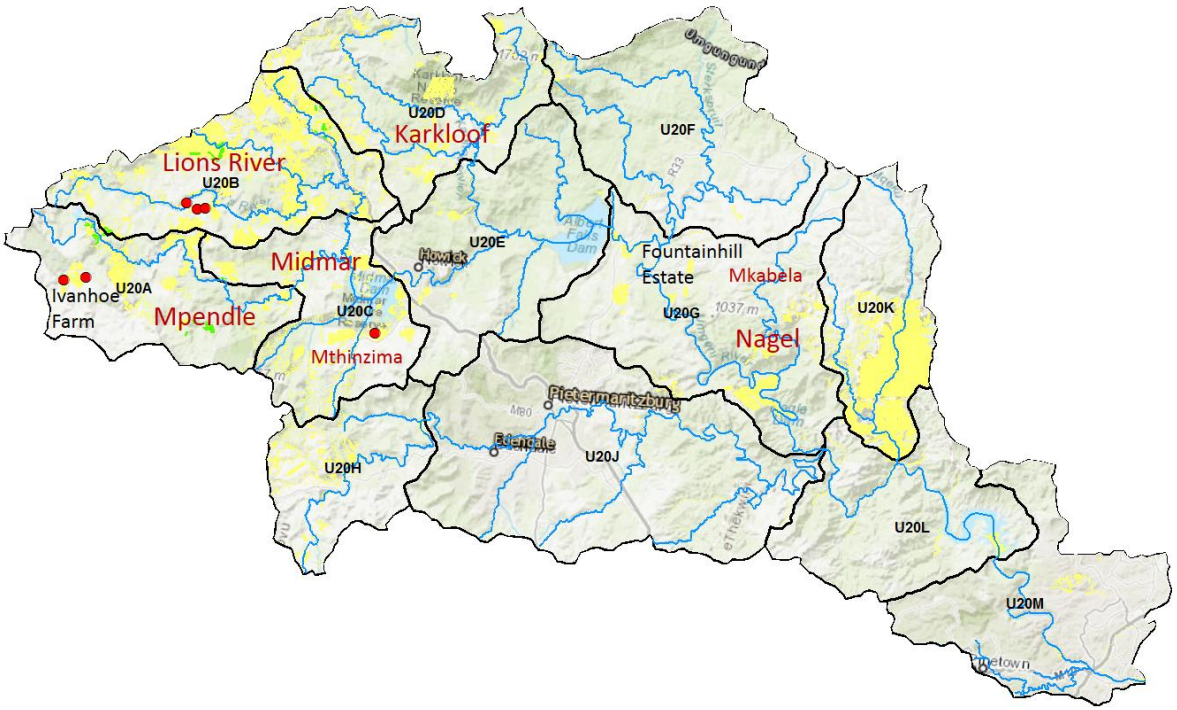

Figure 7. Current EI interventions in the uMngeni secondary catchment are shown on a labelled topographic base-map. Quaternary catchments are indicated in black, key ones are labelled with dark red large text. Subcatchments of interest are labelled in smaller red text. Rivers are shown in blue. Working for Water alien clearing is mapped in yellow, and Working on Energy activity in green. Working for Wetlands sites are indicated with red points, though at this stage it seems that they have only been active at Ivanhoe Farm. Two farms of interest are labelled in black.

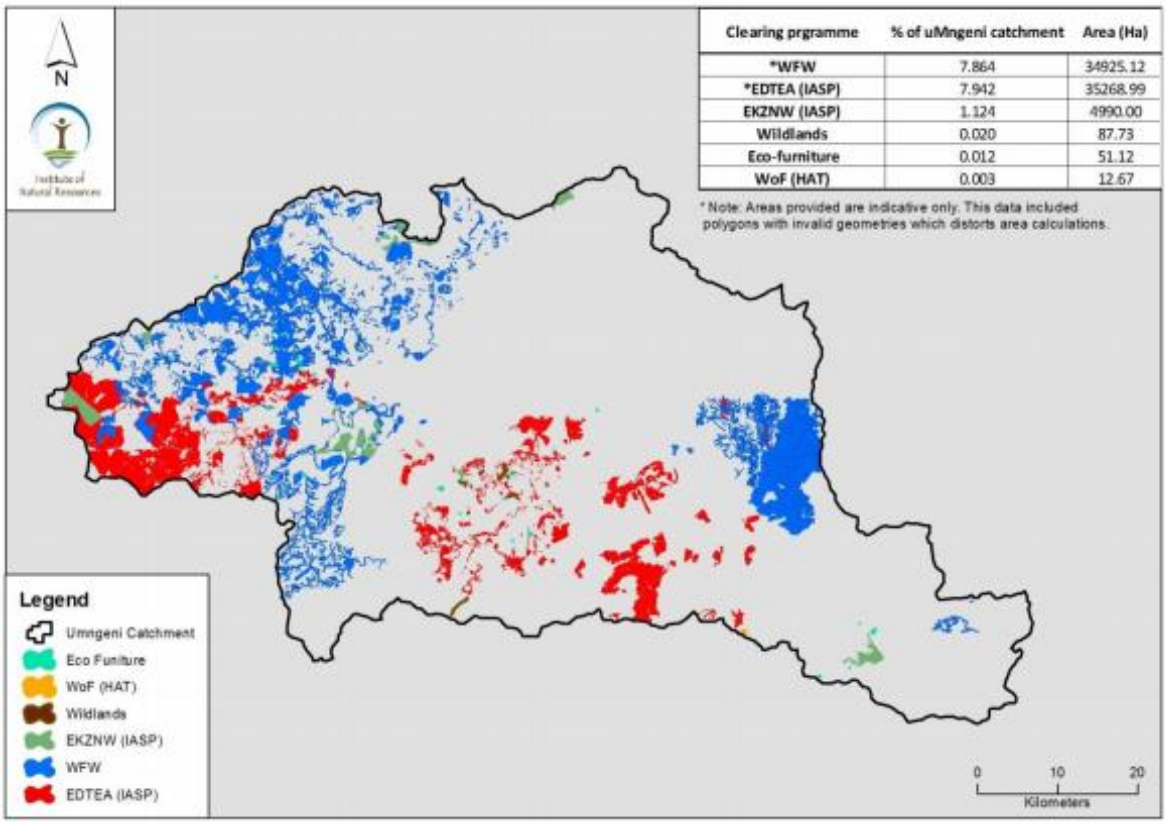

Figure 8. Alien plant clearing by six projects in the uMngeni catchment -taken from Pringle et al. (2016). Abbreviations are: WoF: Working on Fire, EKZNW: Ezemvelo KZNWild, WFW: Working for Water, EDTEA: KZN Economic Development & Tourism.

Ivanhoe wetland system

This wetland was selected by Working for Wetlands for two reasons (1) it is a site with a history of rehabilitation efforts, and (2) it is part of the greater uMngeni wetland complex, a priority in terms of ecosystem service provision downstream (Aurecon 2015). It is located about 570 m south of the Umgeni Vlei Nature Reserve, and flows into the perennial uMngeni River. The Ivanhoe wetland, approximately 113 ha in size, is classified as a seep and is divided into three wetland units: Runnymeade: U20A-01, Heatherdon: U20A-02, and Fold: U20A-03. It is classified as least threatened, but poorly protected (Nel and Driver 2012). However, the Ivanhoe wetland system occurs within an area demarcated as Drakensberg Foothill Wattled Crane (*Bugeranus carunculatus*) Habitat, which is classified as vulnerable (Aurecon 2015). Wattled Cranes are listed as critically endangered in South Africa. The wetland complex also includes an area which has been flagged as the last site to be conserved to meet targets of the KwaZulu-Natal Systematic Conservation Terrestrial Plan (Aurecon 2015). The dominant vegetation type is Foothill Moist Grassland (Mucina and Rutherford 2006).

The local municipality is called Impendle and the primary land-use is agriculture (including grazing). There are pine plantations 2.5 km north of the wetland (Aurecon 2015). Major impacts to the wetland include: impoundments (dams) upstream impacting flow regimes, road

crossings, alien invasive species and “central drain” from wetland areas upstream (Aurecon 2015).

Upper Lions wetland system

This wetland was selected by Working for Wetlands for two reasons (1) the wetlands of the Upper Lions catchment have historically been extensively drained for agriculture, (2) there are several breeding and nesting sites for the Wattled Crane (Aurecon 2015; Aurecon 2017). The Upper Lions wetland system is about 110 ha in size and is also divided into three wetland units: Upper Lions River Floodplain: U20B- 01, Upper Lions Stubbs Dam 1: U20B-02, and Upper Lions Stubbs Dam 2: U20B-03. The first two units are classified as channelled valley-bottom wetlands, and the third was originally a seep, however this wetland unit is now classified as an ‘artificial wetland’ (Nel et al. 2011). The main river is the perennial Lions River, which is moderately modified and considered a National Freshwater Ecosystem Priority Area (Nel et al. 2011). The dominant vegetation type is Sub-Escarpment Grassland (endangered and poorly protected), but it is bounded to the north by a small patch of indigenous Eastern Mistbelt Forest. The “upper south” wetland system occurs in Fort Nottingham Lowland Grasslands which are classified as threatened, and Drakensberg Foothill Moist Grassland which are classified as least threatened (Mucina and Rutherford 2006; Aurecon 2015). This wetland complex also includes an area which has been flagged as the last site to be conserved to meet targets of the KwaZulu-Natal Systematic Conservation Terrestrial Plan (Aurecon 2015).

The local municipality is called uMngeni, and the dominant land use in the catchment is also agriculture (including grazing) (Figure 10). Main impacts to the wetland include: extensive historical drainage of the wetland system for agricultural purposes, dams within the wetland that alter flow regimes and upstream plantations.

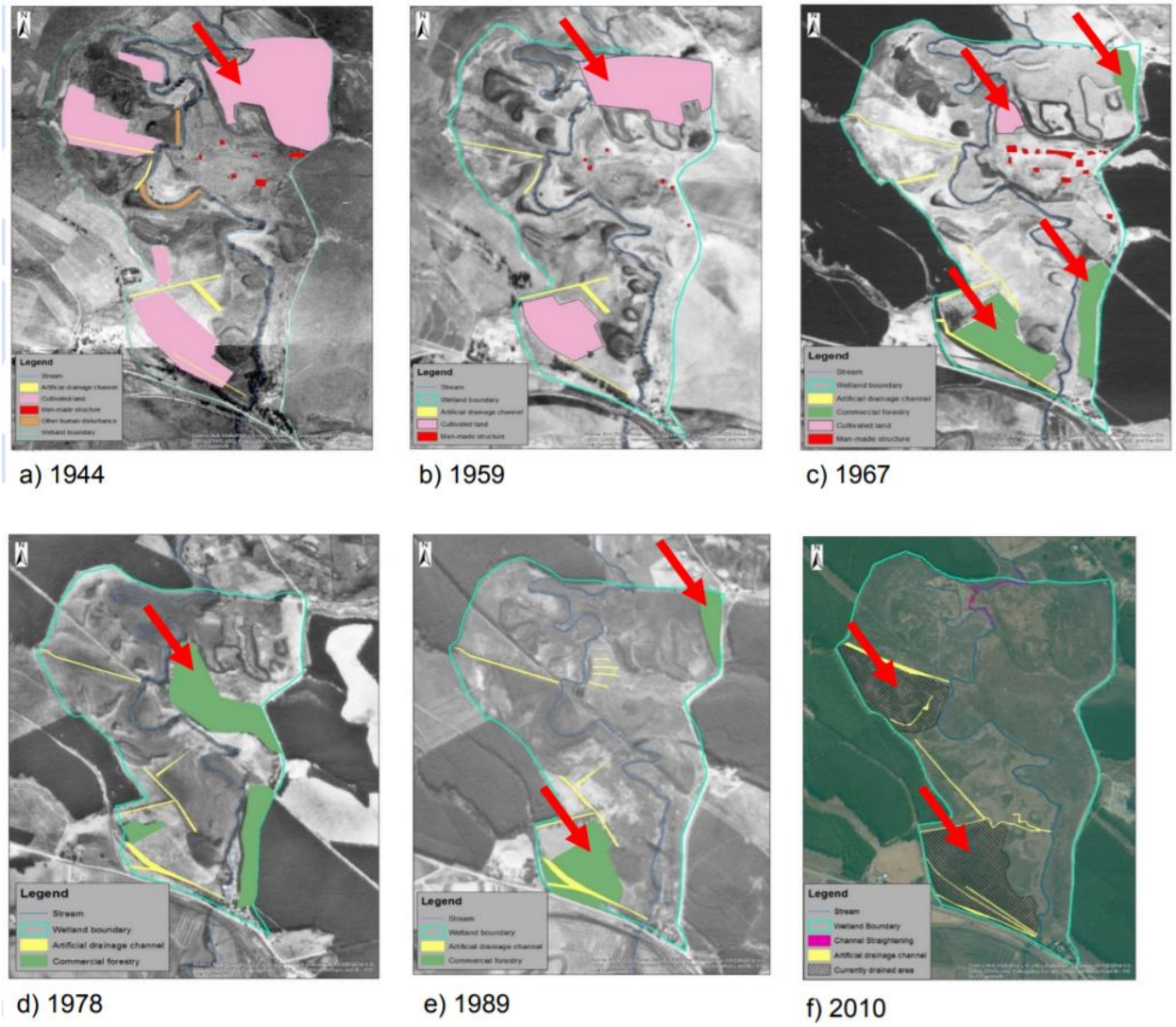

Figure 10. This is change in land-use in the Lions River Wetland (blue outline: wetland border; pink: cultivation; green: forestry) (Taken from Ndlovu 2015).

Mpophomeni wetland system

The Mpophomeni wetland system covers about 98 ha and is located 6 km south west of Howick, bounded to the north by the Midmar Nature Reserve (Aurecon 2015). The wetland is located above the perennial Nguklu River (classified as moderately modified) and is a channeled valley-bottom wetland (Nel et al. 2011). The Midmar Valley in which the wetland is located is classified as threatened and considered vulnerable (Aurecon 2015). This wetland complex also includes an area which has been flagged as the last site to be conserved to meet targets of the KwaZulu-Natal Systematic Conservation Terrestrial Plan (Aurecon 2015). The main vegetation type is Southern KwaZulu-Natal Moist Grassland which is classified as vulnerable (Mucina and Rutherford 2006).

The local municipality is the uMngeni. The main impacts to the wetlands include: polluted water entering the wetland, livestock grazing in the wetland, alteration to the flow regime,

erosion in the catchment and the wetland itself, invasion of alien vegetation and excavation of artificial drainage channels (Aurecon 2015).

Rehabilitation activities (EI implementation):
Rehabilitation activities are listed in the report for all three sites together (Activities 12, 14, 15, 17, 23, 48, 49, 52):

Activities 12, 14, 23, 48, 49:
In order to achieve the objectives of wetland rehabilitation, changes must be made to artificial drainage lines or eroding water channels if the wetland systems are to be returned to their original statuses. For example:

- The construction of (or expansion of existing) concrete or gabion weirs within watercourses/wetlands;
- The formalization of stream crossings to ensure that the integrity of wetland systems downstream and upstream of the crossings are protected from further degradation; and
- The construction of bird hides and walkways in public wetlands to limit human impact, and to form part of the educational component of the project (many of the target wetlands located near a protected area).

Alternative sites: Major implementors

Site 7: Lions
Working for Water
Working for Wetlands
Working for Energy
WWF Stewardships (Water Balance Programme)
Working on Fire
KZN Economic Development & Tourism
Ezemvelo KZNWild
MONDI & SAPPI?

Site 8: Karkloof
Working for Water
MONDI & SAPPI

Site 9: Ivanhoe
Working for Wetlands
Working for Water

Socio-Economic Indicators

We extracted eight socio-economic variables from the 2011 South African National Census and combined six of them into two indices to investigate (a) social vulnerability (employment, income level) and (b) dependence on natural resources (water source, use of wood for heating or cooking, traditional dwellings) for the six study subcatchments. We give an overview of averages for each subcatchment in Table 3, and display spatial variation in these indices for each subcatchment in Figures 11a-h. All statistics for the variables are reported as a percent of the number of households per census small area (also referred to as SAL)[1] except for unemployment which is expressed as a percentage of household heads. The statistics for the Poverty and Dependency on natural resources indices are means across the relevant variables listed in brackets above.

Table 3: Socio-economic indices: information from the 2011 South African census statistics. These values are expressed as percentages and are means across "small areas". 'hh': households, 'hhh': household heads.

SA census data (2011)	**Site 1 Upper Breede**	**Site 2 Upper Berg**	**Site 3 Riviersonderend**	**Site 4 Mthinzima**	**Site 5 Baynespruit**	**Site 6 Palmiet**
Total number of households	*2633*	*3976*	*9507*	*12663*	*35154*	*26697*
Mean households per small area	*214.1*	*153.7*	*214.8*	*180.9*	*186.0*	*193.5*
Poverty index	15.6	22.1	20.8	40.5	32.9	23.7
Unemployment (%hhh)	22.5	32.4	30.0	52.8	44.3	30.9
Low Income (%hh)	8.7	11.8	11.5	28.2	21.5	16.4
Dependency on natural resources	9.2	5.3	5.5	7.0	2.9	0.8
Water source - river/stream (%hh)	6.7	3.3	2.9	2.4	0.4	0.1
Wood for heating (%hh)	25.0	13.3	15.0	10.8	5.7	2.2
Wood for cooking (%hh)	3.7	3.1	2.1	5.2	1.3	0.3
Traditional dwellings (%hh)	1.2	1.7	2.0	9.6	4.2	0.6
Other						
Minimum income (%hh)	0.9	4.2	2.0	5.6	9.6	4.1
No/limited piped water (%hh)	37.8	27.4	45.0	40.0	30.9	17.5

[1] An enumeration area (EA) is the smallest geographical unit (piece of land) into which the country is divided for census or survey purposes. EAs typically contain between 100 and 250 households. Each EA is expected to have clearly defined boundaries. The small area layer (SAL) was created by combining all EAs with a population of less than 500 with adjacent EAs within the same sub-place. Subplace is the second (lowest) level of the place name category, namely a suburb, section or zone of a township, smallholdings, village, sub-village, ward or informal settlement.

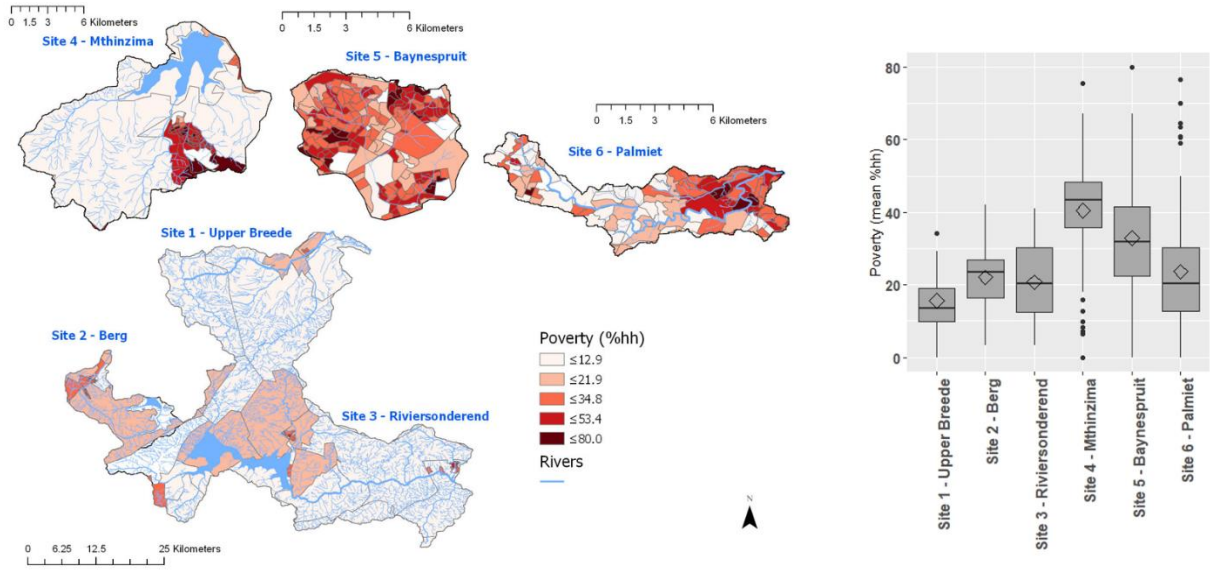

Figure 11a. Poverty Index: mean percentage of household heads unemployed and with no income or a combined income of <R9600 per annum.

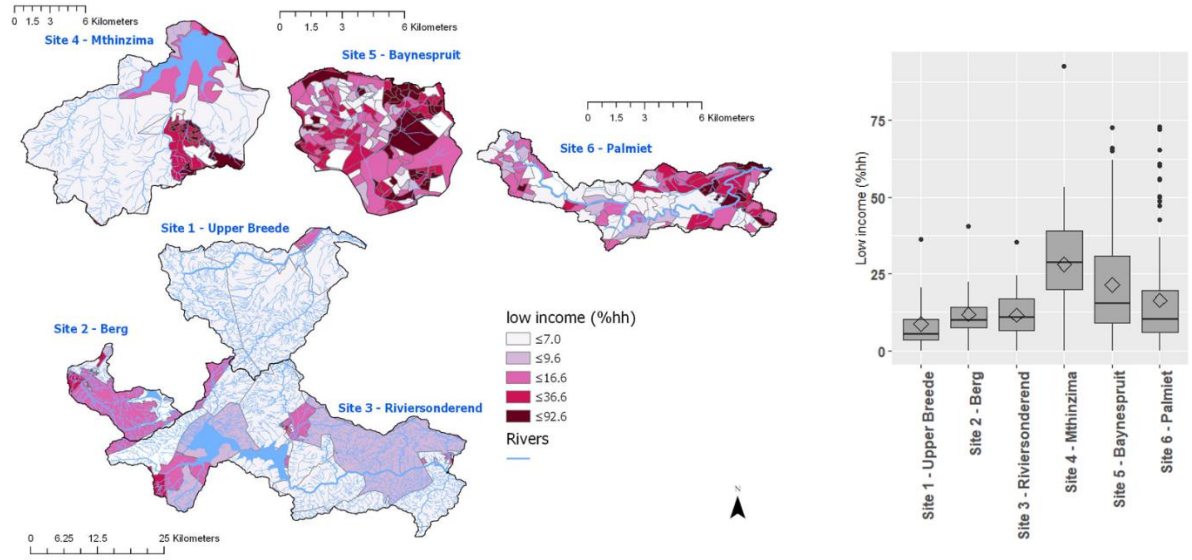

Figure 11b. Low income: percentage of households with no income or a combined income of <R9600 per annum.

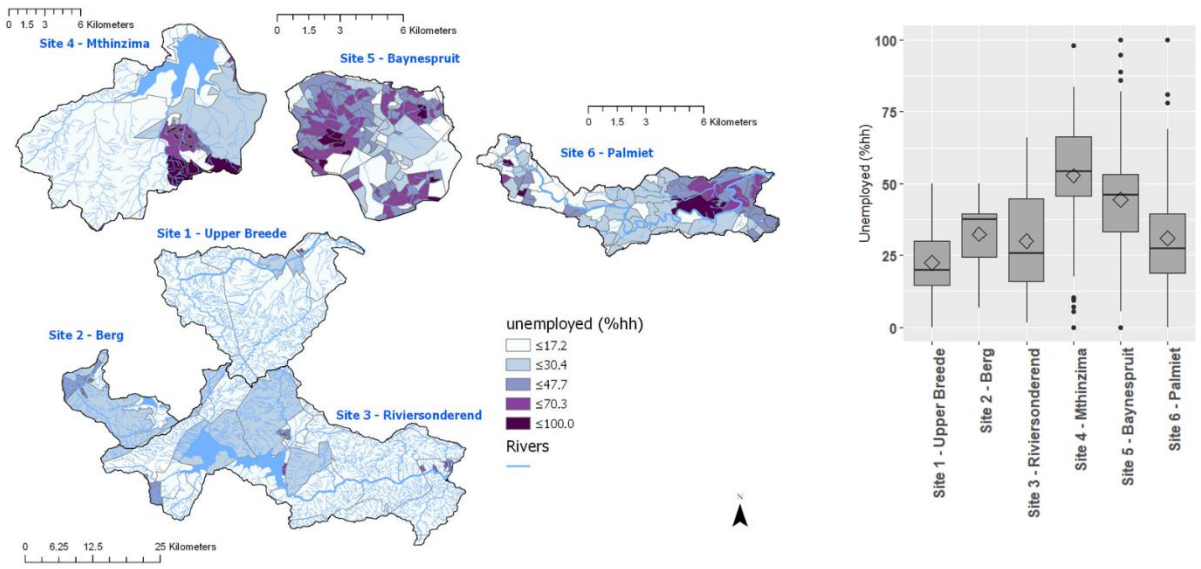

Figure 11c. Unemployment: percentage of household heads who are unemployed, discouraged work seekers, not economically active or under 15 years of age.

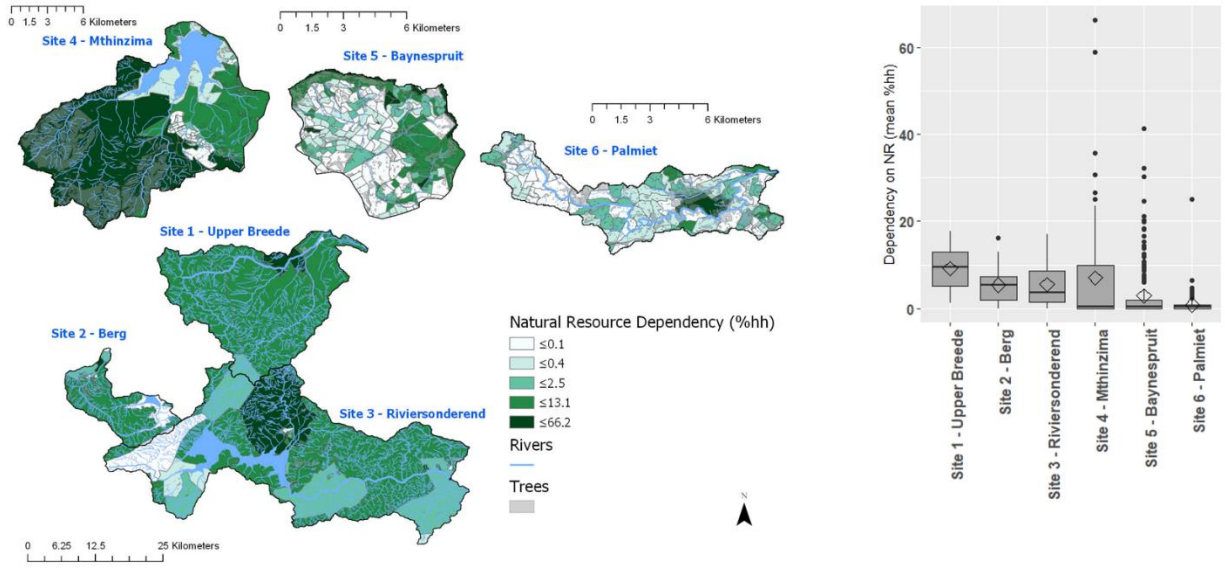

Figure 11d. Natural Resource Dependency Index: mean percentage of households that rely on (i) rivers as a source of water, (ii) wood for cooking, (iii) wood for heating, and (iv) traditional dwellings.

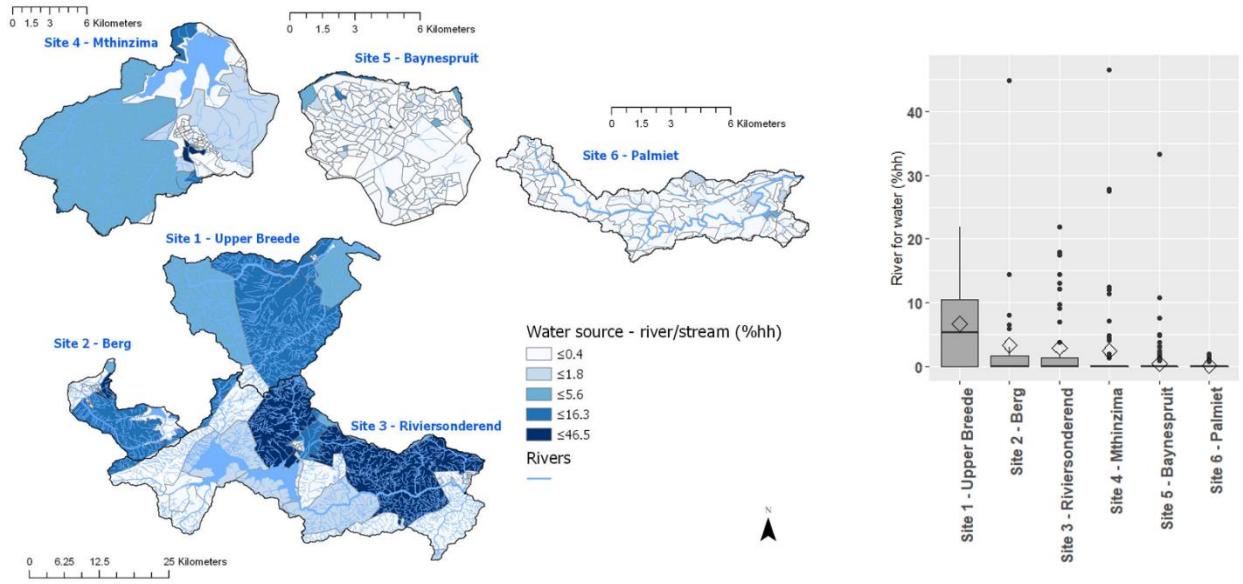

Figure 11e. The percentage of households that use a river as a source of water.

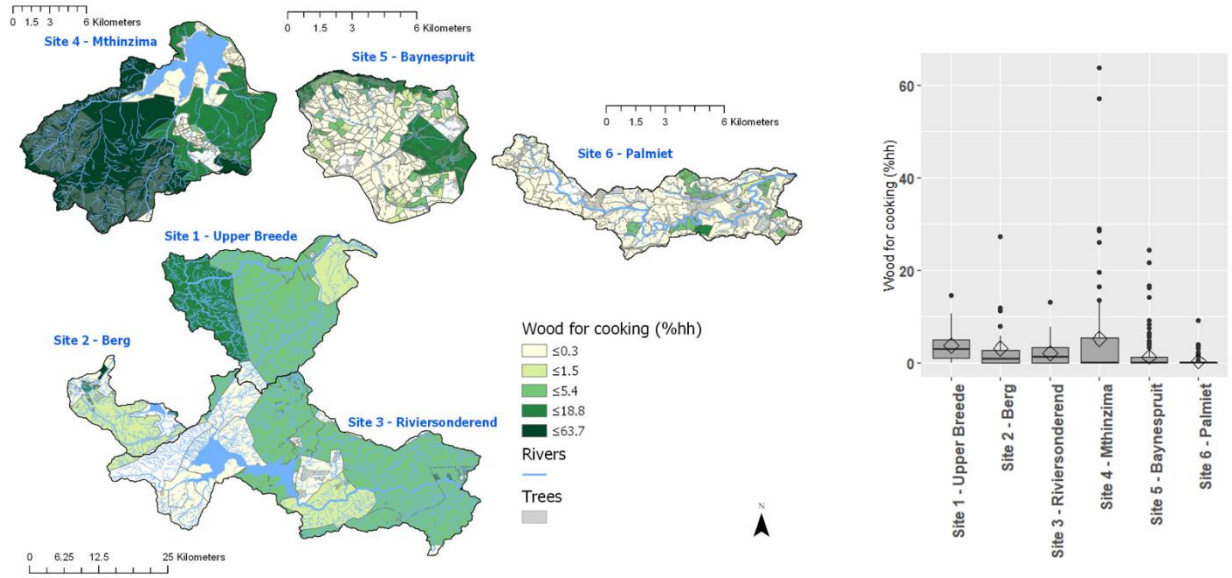

Figure 11f. The percentage of households that are dependent on wood for cooking.

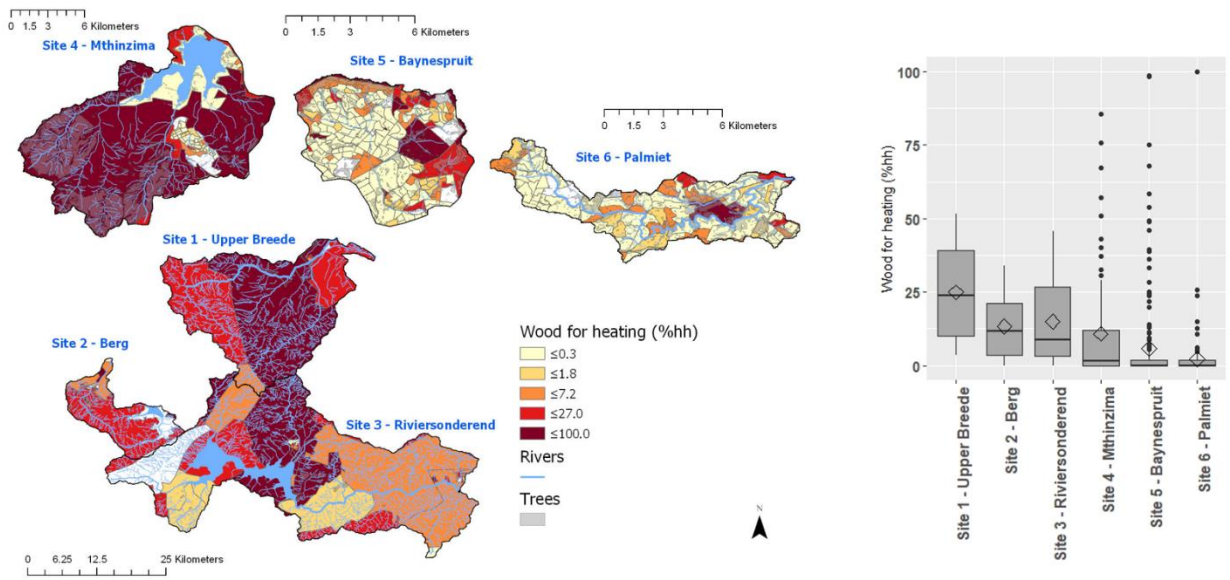

Figure 11g. The percentage of households that are dependent on wood for heating.

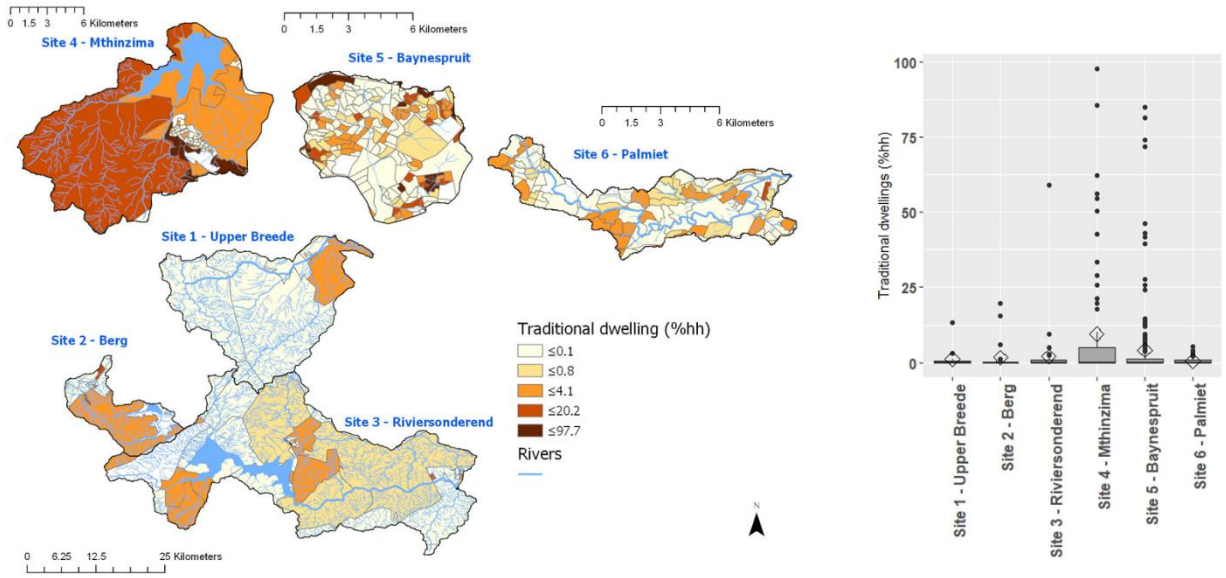

Figure 11h. The percentage of households that live in traditional dwellings.

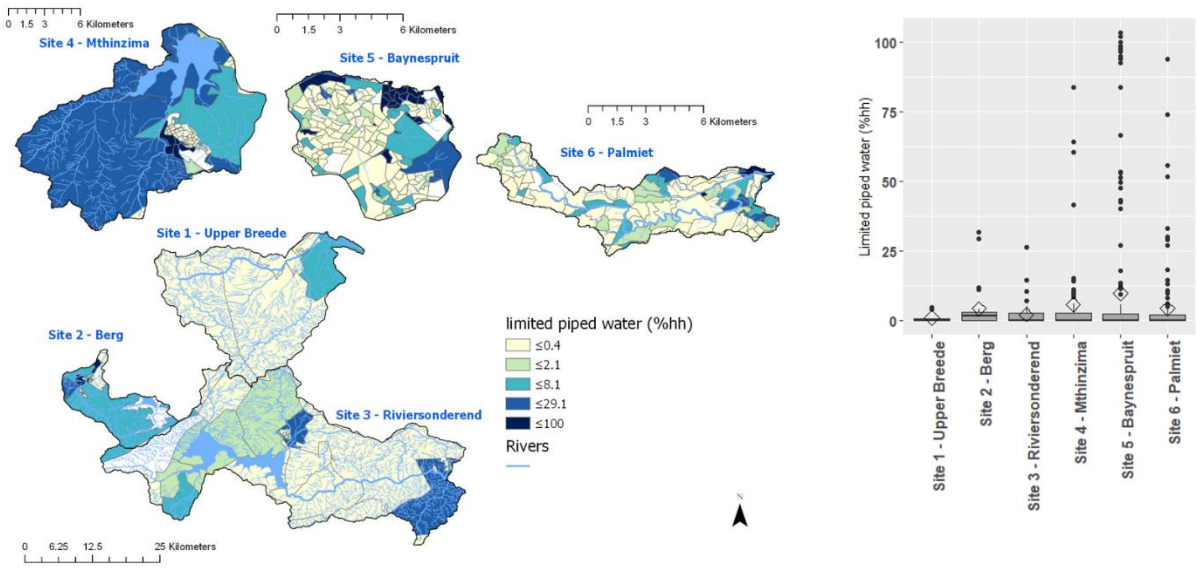

Figure 11i. The percentage of households that have limited or no access to a direct supply of piped water (i.e. have to travel more than 200 m to access piped water).

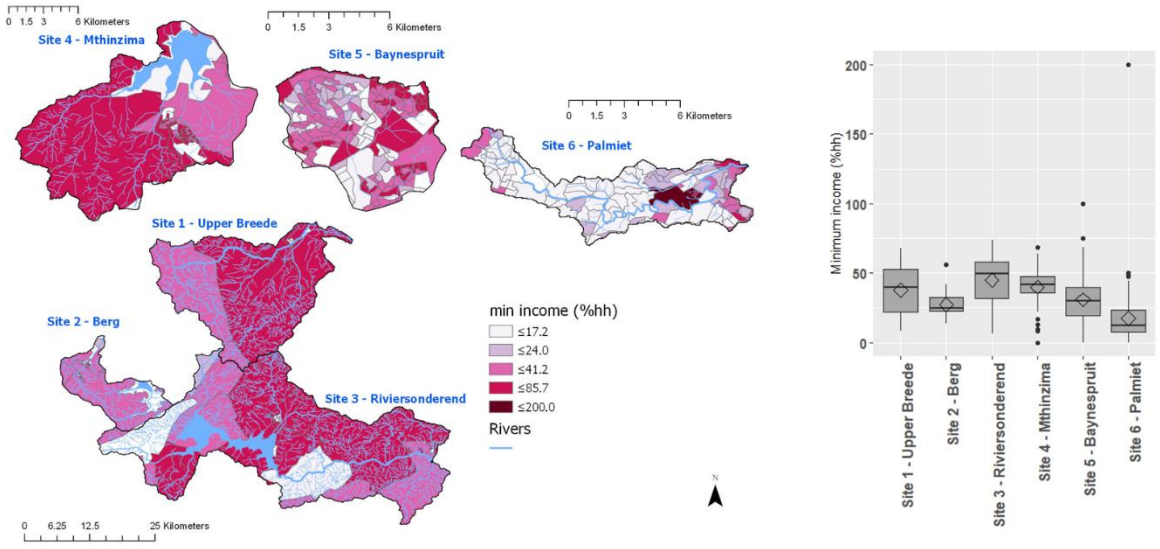

Figure 11j. Minimal income: the percentage of households with income between R9601 and R38200 per year.

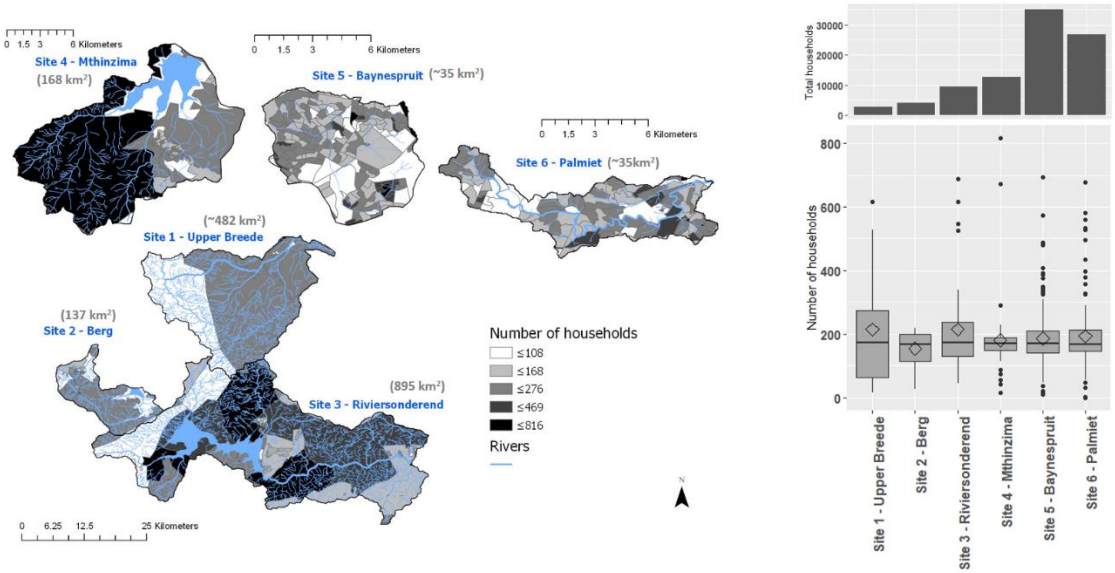

Figure 11k. The number of households per subcatchment.

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Appendix 1: Related Projects

There are several other large research/policy projects also working in these subcatchments, and we outline these briefly in Table 3.

Table A1: Key related projects involved in the Berg/Breede & uMngeni Catchments

Lead Organization	Duration	Project	Main Aim
SANBI	2015-2019	GEF5: Biodiversity & Land-use	The Biodiversity and Land Use Project was initiated to support municipalities in effectively regulating land use to ensure that biodiversity continues to provide essential ecosystem services to municipal residents.
SANBI (Jenifer Zungu)	2017-2022	GEF6: EI for Water Security	Unlocking biodiversity benefits through development finance in critical catchments; This project aims to integrate biodiversity and ecosystem services into development and finance planning. This will be achieved through policy and capacity development incentives for mainstreaming biodiversity and ecosystem values into national, regional and local development policy and finance in the water sector.
DEADP Western Cape Government & CSIR (David le Maitre & Marlene le Ros)	2018-?	EI Investment Framework	An Ecological Infrastructure Investment Framework for the Western Cape.
The Nature Conservancy (Louise Stafford)	Launch 2018	The Water Fund	The Business Case puts forward ecological infrastructure restoration as a critical component of efforts to enhance water security for all users of the Western Cape Water Supply System.
DEADP Western Cape Government (Annabel Horn)	Start 2018	Resource Economic Valuation of Wetlands	Assess economic value of ecosystem services provided by wetlands in the Breede catchment; model flow; assess wetland condition.
CSIR (Dr Jeanne Nel)	2010 - 2015	Project on Ecosystem Services (ProEcoServ) funded by GEF & UNEP	The project addressed the importance of ecological infrastructure as an integral part of the answer to future development in South Africa. This work was a collaborative effort between Chile, South Africa, Trinidad and Tobago, and Vietnam, which aimed to advance the potential of ecosystem service assessments and their influence on decision making, and distil lessons across the countries for global-scale use and replication.
DEA&DP (Jason Mingo)	2017 - onward	The Freshwater Forum	Collaborative platform on EI related matters
CSIR (Greg Forsyth)	2016	MUCP's: Management Unit Control Plan	This document sets out a plan for clearing alien plant invasions. It details (amongst others) (a) Current state of the catchment including key aspects of the environment, land-use and land ownership (b) A summary of the current state of alien plant invasions (c) The goal of IAP control in the catchment developed with stakeholders (d) The criteria used to the prioritise control operations (e) The budgets and resources, and the partnerships that will be needed to achieve those goals over 20 years.

WWF-SA (Janine Titus)	2018 - onward	CatchX	A global hydro-climate platform-on the Breede Catchment, South Africa
SAEON (Dr Julia Glenday)	2018 - onward	WRC: Hydrological Model Comparison	Aims: 1) Explore the performance of hydrological modelling tools widely used in South Africa (WRSM-Pitman, ACRU) and elsewhere (SWAT, MIKE-SHE, FLEX-Topo) under different climatic, geologic, land-use settings when applied to practical catchment management questions, and assess their relevant process representation capabilities, levels of uncertainty, and usefulness to users. 2. Produce a set of guidelines to assist in the selection and use of hydrological modelling tools and model structures for applied different settings which is accessible to general model output users. 3. Increase understanding of the capabilities of different hydrological modelling tools in assessing key catchment management questions at relevant spatial and temporal scales.
SANBI (Dr Pearl Gola)	2013-2023 (10 years)	uMngeni Ecological Infrastructure Partnership (UEIP)	A partnership that was formally established in November 2013 upon signing of an MoU by key organisations that are committed to finding ways of integrating ecological infrastructure solutions to support built infrastructure investments in addressing challenges of water security in the uMngeni catchment.
WESSA & WWF (Tembeka Dambuza)	2011 onward	The Maas Maasen Fund: The Capacity for Catchments uMngeni Ecological Infrastructure project	The project focuses on securing ecological infrastructure within the Umngeni catchment in KwaZulu-Natal through capacity building of the key role players (especially local authorities) to become responsible custodians of the uMngeni freshwater ecological infrastructure.
German Ministry of Research and Education (Claudia Pahl-Wostl)	2017-2020	STEER: Increasing good governance for achieving the objectives of integrated water resources management	The goal of STEER is to find innovative ways to increase good governance to solve complex water resources problems. New forms of coordination and cooperation are at the project's centre of interest. STEER examines the influence of the governance and management system on solving complex water resource problems. The project also investigates the impact of societal and environmental conditions to find out under which conditions elements of effective governance systems can be transferred. On the basis of these analyses, STEER will develop solution strategies for current conflicts of use around water resources. (https://www.steer.uni-osnabrueck.de/case-studies/umgeni/)
UKZN (Prof Graham Jewitt)	2014-2020	WRC Project 2354: Demonstration of how healthy ecological infrastructure can be utilized to secure water for the benefit of society and the green economy	With a focus on the case study catchments identified by the UEIP, i.e. the Midmar Dam catchment, the Baynesspruit and the Palmiet, within a broader integrative framework for the uMngeni as a whole, the overall objective is to develop and test an adaptable multidisciplinary and multi-sectoral socio-ecological water resource governance framework in selected catchments or basin(s) through action

		through a programmatic research approach based on selected landscapes.	research for inclusive and participatory catchment management. This research is aimed at responding to the green economy, water for growth and development, and government strategies/ priorities as reflected in the National Development Plan and other strategies, such as the WRC Green Village lighthouse and knowledge tree.
SANBI (Gigi Laidler) & uMgungundlovu District Municipality (UMDM)	2015-2020	uMngeni Resilience Project Adaptation Fund: Building Resilience in the Greater uMngeni Catchment	The overall objective of the uMngeni Resilience project is to reduce the vulnerability of these communities and small-scale farmers in the UMDM to the impacts of climate change. This is to be achieved by increasing climate resilience and adaptive capacity by combining traditional and scientific knowledge in an integrated approach to adaptation
DUCT (Dave Still)	2005 - onward	DUCT: The Duzi uMngeni Conservation Trust	Duct has eight strategic focus areas. These are: • Minimization of faecal waste in the rivers • Reduction of solid waste in the rivers (trash boom in PMB) • Reduction of industrial pollution in the rivers • Control and eradication of invasive alien plant vegetation on the river banks and in the rivers (Landcare Project) • Improvement of land care and reduction of soil erosion in the catchments • Reduction of water borne diseases in the rivers • Improvement of management of mining operations in the Valley • Implementation of an environmental flow schedule below the major dams, as provided for in the National Water Act of 1998
DUCT (Sithembiso Sangweni)	2010 - onward	River Care Project (National Lotteries Board)	The project employs 10 teams of 10 to 15 employees each, to remove solid waste, as well as alien invasive plant species, from the Msundusi and uMgeni Rivers. These teams also monitor the rivers for sewerage spills and industrial waste dumping, as well as illegal sandmining activities.
DUCT & eThekweni Municipality	2016 - onward	Durban Green Corridor Project	Durban Green Corridors, a NPO, addresses three pressing needs: youth development, economic upliftment and environmental stewardship. It will achieve this through tourism and environmental rehabilitation projects from Inanda to Blue Lagoon.
DUCT (Richard Clacey)	2015	Msunduzi Green Corridor PilotProject	To restore and maintain freshwater ecological infrastructure, ecosystems and water security in the upper Msunduzi River.
uMgungundlovu District Municipality (Riaz Jogiat)	2014-2017	Save the Midmar Dam	This EI project aims to restore and maintain degraded wetlands, riparian zones and grasslands, creating and maintaining water resource buffer zones and educating water users on the importance of conserving critical ecological infrastructure within the Mthinzima River, the Lions River, the upper uMngeni catchment, and the Mooi River.
DUCT (Penny Rees)	?	Msunduzi Catchment Management Forum	?

WESSA (Jim Taylor)	?	WESSA Share-net	Share-Net is a South African-based informal networking project that supports environmental education and development in the SADC region. Share-Net is coordinated from the Wildlife and Environment Society of South Africa (WESSA) in the Umgeni Valley Nature Reserve, KwaZulu-Natal. The office operates alongside the SADC Regional EE Centre to provide stronger support to environmental education initiatives in the southern African region.
WESSA (Jim Taylor)	1976	Umgeni Valley Project	WESSA launched the Umgeni Valley Project in 1976 and established its then national headquarters at the Umgeni Valley Nature Reserve. This was in response to the world-wide appeal for increased knowledge and awareness of our total environment and a more caring attitude to it.
Msunduzi Local Municipality (Rodney Bartholemew)	2014	Baynespruit Rehabilitation Project	This project attempts to enhance water quality in the Baynespruit stream by implementing projects to improve ecological infrastructure. The Msunduzi municipality is a signatory to the Memorandum of Understanding arising from a regional initiative called the Umgeni Ecological Infrastructure Partnership and the Baynespruit project is the contribution of this Municipality to improving water quality and quantity within the Umgeni Catchment area.
UEIP (Zama Khuzwayo)	2016	Palmiet Rehabilitation Project	A shared-governance climate change adaptation-oriented project to improve efficacy of ecological infrastructure & build community resilience.
WWF (Christine Colvin)	2015	Journey of Water	Radio personalities, celebrities, government and environmental specialists visit Midmar dam and Mpophomeni township just outside Howick to witness firsthand the raw sewage spilling into Midmar's tributaries. https://www.news24.com/SouthAfrica/News/Midmar-sewage-pollution-concern-20150513
WWF (Sue Viljoen)	2012 - 2014	Water Balance Programme (Nedbank & Woolworths)	The WWF-SA Water Balance Programme is an innovative initiative that allows private companies to balance their operational water use by investing in the clearing of invasive alien plants that consume large amounts of water. The programme chose to focus on biodiversity stewardship areas, where alien plant clearing would form an incentive to landowners and ensure that the alien clearing was part of a long-term conservation approach. This is an example of Biodiversity Agreements, a flexible type of biodiversity stewardship based on an agreed management plan. The programme helped to establish three new Biodiversity Agreements on land with high biodiversity value in the uMngeni catchment. In the uMngeni, case studies include EI interventions on Ivanhoe and Bigadoon Farm.
Natal Fly Fishers Club (Andrew Fowler)	1996 - onward	The Blue Ribbon Umgeni Initiative	Restoring the Umgeni as a trout stream (Trout are invasive alien fish in South Africa).

Table A2: Ecological Infrastructure implementation projects in the Berg/Breede Catchments (taken from DWS 2014). There may be some overlap with Table A1.

Project Name	SIP Priority Area	Principle Implementing Agency	Value	Duration
Real time monitoring of water quality in urban hotspots in Berg River, Paarl		University of Cape Town	R680 000	18 months
River Environmental Management Plan		Drakenstein Municipality	R 11.0 Million	3 years
Cape Critical Rivers Project (CCR)		EWT	R 900 000	3 years
Alien Vegetation Clearance & Firebreaks		Drakenstein Municipality	R 5 000 000	5 years
Securing South Africa's Water Source Areas		WWF	R 240 000	3 years for phase 1
WWF-SA Water Balance Programme		WWF	R 3 277 601	5 years
20 Working for Water projects		DEA's Branch: Environmental Programmes	R 32 515 441	Various
1 Working for Wetlands project		SANBI	R 1 858 154	Various
1 Working for Land project		DEA's Branch: Environmental	R 1 359 267	Various
The Berg River Improvement Plan (BRIP)	Phase II Priority Area	Western Cape Provincial Government	R300 million	10 years

Table A3: Ecological Infrastructure implementation projects in the uMngeni Catchment (taken from DWS 2014). There may be some overlap with Table A1.

Project Name	SIP Priority Area	Principle Implementing Agency	Value	Duration
uMngeni Ecological Infrastructure Partnership (UEIP)	Phase I Priority Area	South African National Biodiversity Institute (SANBI)	Approximately R500 million	10 years ending in 2023
Benefits of Ecological Infrastructure		Water Research Commission	R5 million	5 years ending in 2020
Rehabilitation of alien invaded riparian zones and catchments using indigenous trees: An assessment of indigenous tree water-use		Water Research Commission	R5 million	5 years ending in 2020
Investing in ecological infrastructure to enhance water security in the uMngeni River catchment		South African National Biodiversity Institute (SANBI)	R4,900,000	18 months ending in 2015
Upper uMngeni Resilient Landscape Approach		WWF-SA (through the Mondi Wetlands Programme)	R9.94 million	3 years
Enhancing ecological infrastructure in the uMngeni catchment through collective private sector action: The role of private finance and markets		WWF-South Africa	R 2 500 000	18 months
Working for Ecosystems		WESSA, on behalf of eThekwini Municipality	R15 554 521	2 years
uMngeni River Basin Water Security Case-study		Monash South Africa	About R 2.5 million	5 years
Durban Green Corridor Project		Duzi Umgeni Conservation Trust (DUCT) and the Ethethwini Metropolitan Municipality	R10 million annual average	On-going
DUCT River Care Teams (RCTs)		Duzi Umgeni Conservation Trust (DUCT)	R60 million	6 years
Expose-a-Sewer Campaign		Duzi Umgeni Conservation Trust (DUCT)	R120 000	3 years
National Lotteries KZN		WESSA	R3 866 899.00	2 years
WESSA/WWF Capacity for Catchments Project		WESSA and WWF	R3 million	3 years
Msinsi Alien Plant Programme		Msinsi Holdings (Pty) Ltd	R664 million	20 years
Threatened grassland species conservation project		EWT	R 6 900 887	5 years
Drakensberg Crane and Wetland Conservation Project		EWT	R 6 933 000	66 months
Securing South Africa's Water Source Areas		WWF	R 240 000	3 years for phase 1
WWF-SA Water Balance Programme		WWF	R 3 277 601	5 years
Maloti Drakensberg Park WHS – Catchment Rehabilitation		Ezemvelo KZN Wildlife	R 35 000 000	3 years
9 Working for Water projects		DEA's Branch: Environmental Programmes	R 6 154 047	Various
1 Working for Wetlands project		SANBI	R 1 944 000	Various
1 Working for Land project		DEA's Branch: Environmental Programmes	R 1 165 720	Various
The Berg River Improvement Plan (BRIP)	Phase II Priority Area	Western Cape Provincial Government	R300 million	10 years