



Promoting Green Urban Development in African Cities

ETHEKWINI, SOUTH AFRICA

Urban Environmental Profile





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EXECUTIVE SUMMARY

The municipality of eThekweni (also known as Durban), South Africa has undergone a period of rapid urbanization that has contributed to the degradation of the city's natural environment. The arrival of thousands of in-migrants year after year has overwhelmed the city's ability to deliver adequate public services, housing and jobs. Unplanned, densely populated informal settlements that lack basic water, sewer, and waste services now cover much of the city's land area. At the same time, climate change is placing further strains on the city's ability to manage the urban environment. Increasing levels of rainfall from climate change contribute to storm runoff levels that exceed the capacity of the city's infrastructure, causing flooding and the spread of pollution. Such conditions have degraded the quality of the city's environmental assets and the vital ecosystem services that they provide.

eThekweni Municipality (EMA) has considerable institutional capacity and has been a leader in conservation planning, developing an inventory of greenhouse gas emissions, and resiliency planning for climate change adaptation. There are numerous environmental programs and projects in place to improve the quality of EMA's environmental assets. Yet the municipality is challenged by the lack of jurisdiction over traditional authority areas where many key environmental assets are located.

The Urban Environmental Profile for eThekweni has been prepared as the first component of the assignment "Promoting Green Urban Development in Africa: Enhancing the Relationship Between Urbanization, Environmental Assets and Ecosystem Services," a project being conducted under the leadership of the World Bank. The Urban Environmental Profile summarizes the existing quality of the city's environmental assets, identifies the drivers of environmental vulnerability, and describes the institutional challenges and constraining factors that limit the city's ability to address the environmental management challenges. By consolidating, into one document, eThekweni's drivers and challenges in environmental management, this document can inform and empower municipal officials, non-governmental entities and other advocates to more effectively promote sustainable and inclusive development.

Urbanization and Climate Change

Although eThekweni is experiencing relatively moderate growth in the context of Sub-Saharan Africa, the municipality has been challenged by a fragmented pattern of growth that has contributed to the decline of the region's environmental assets. Between 2001 and 2011, the population within the municipality grew at an average rate of 1.13% per annum. By contrast, the cities of Dar es Salaam, Tanzania and Kampala, Uganda grew at near 5% and 4% per year, respectively, over the past three decades, with significant environmental degradation. Though more modest in comparison, the environmental impacts of eThekweni's growth have been significant and threaten the city's long-term sustainability.

The city has developed in a fragmented pattern with higher growth in peri-urban areas that have encroached into natural habitats and conservation areas. Key drivers of the low density pattern of development have included: the legacy of Apartheid-based segregation that pushed the poor to informal settlement areas in the periphery, the trend of single-dwelling/plots that has been supported by national housing policy subsidies, and, more recently, the outward push of development by the private sector. The proportion of eThekweni households in informal settlements is increasing with inadequate provision of formal affordable housing. Informal settlements are often located within the Trust Lands that are not subject to either municipal development or environmental regulations. The lack of planning and compliance with municipal environmental and conservation objectives has led to the destabilization of land and vegetation in critical catchment areas and resulted in the degradation of the water quality downstream. The decline in water quality has been compounded by the lack of sanitation infrastructure in approximately 67% or 209,847 households within informal settlements which directly and indirectly discharge effluent into the municipality's rivers.

eThekweni has already experienced the impacts of climate change that threaten coastal wetland and dune ecosystems. Projected changes in climate include: a 1.5 to 2.5° C increase in mean annual temperature by 2065 with a 3 to 5° C increase in mean annual temperature by 2100; an increase in aggregate rainfall by 2065 with an increase of up to 30% by 2100; and an increase in coastal storms, storm surges, and flooding due to an increase in sea level rise of 2.7 +/- 0.05 mm/yr. The changes could result in an increase in droughts and water shortages that will exacerbate existing water stress.

Environmental Assets and the Drivers of Environmental Vulnerability

eThekwini is located in the middle of a global biodiversity and therefore requires careful consideration and balance between nature conservation and urban development.

The region supports a high proportion of endemic plant and animal species and includes savanna, forest, and grassland terrestrial biomes that support over 2,000 plant species. Over the past decades, the degradation of upland natural habitat of flora and fauna, the invasion of alien species, and a general decline in biodiversity has been observed. Land development in the upland areas has resulted in the increase in compacted and impervious land surfaces and the excessive extraction of natural resources such as sand has stripped soil and vegetation cover with significant erosion and sedimentation. These practices have exacerbated stormwater runoff and flooding, causing further disturbance in water catchment areas and the decline of water quality and availability.

The vegetated ecosystems of EMA are highly fragmented.

While 26% of EMA land area is vegetated with natural and semi natural habitats, the majority of the vegetated areas are not large. Contiguous vegetated areas are generally in the range of 50 ha or less while the majority are significantly smaller. Habitat fragmentation impacts different species in different ways and could greatly threaten the municipality's biodiversity. While the vegetated areas need not be particularly large to contain significant ecosystems, inter-connectedness of vegetated areas can compound their ecological value.

eThekwini's rivers have become heavily polluted by human activities and continue to degrade. There are 16 main rivers and estuaries, a number of which have headwaters and catchments that begin outside the EMA. In a 2010 sampling of 61 river sites, 40% were rated in poor condition and only 3% rated in good to intermediate condition. All but three of the estuaries were rated with generally good condition in 2009. The causes of degradation of the aquatic assets are numerous and include: effluent spills and illegal discharge, sporadic short term waste water treatment challenges during high rainfall events, solid waste dumping, realignment and canalization of water channels, flow reductions (dams), and the sedimentation that has resulted from land conversion, removal of vegetation (particularly within the riparian corridors), and sand mining. In general, the conditions of the rivers worsen as they flow through EMA toward the coast.

There is significant and increasing competition for water with growing water requirements as the city and region develop.

The city's water is predominantly from Umgeni Water Supply Scheme, which is managed as an integrated system for greater regional supply. Water is becoming increasingly more expensive as local resources are fully developed and depleted, requiring more water to be imported inter-basin transfers. Disposal of treated effluent into estuaries is beginning to decrease available high quality water and may increase treatment costs. Uncertainty about the impacts of climate change on water resources further challenges EMA planning.

The unchecked release of untreated or inadequately treated sewage and effluent is a contributing factor to the poor water quality of the city's rivers and degrades estuarine health.

Approximately 209,000 households within EMA lack sanitation services, resulting in untreated sewage and effluent discharging directly and indirectly into the rivers and streams. Furthermore, a number of wastewater treatment plants are approaching designed capacity and will need to be upgraded (eThekwini Municipality, 2011). Waste water treatment is hindered by illegal storm water drainage ingress that is introduced into the sewer system, resulting in an unintended "combined" sewer system effect. The excessive storm water flow during peak events results in temporary overwhelming of the capacity of waste water treatment works. The anticipated increase in the intensity of storm events from climate change will cause more frequent occurrences of overflow from combined runoff and exacerbate its impacts.

The average rate and volume of storm water runoff in the EMA has increased due to the increase in the proportion of impervious surface area.

The EMA lacks a city-wide drainage system to slow the velocity and volume of storm water runoff. Flooding has been increasing with sea level rise and intensity of storm events. Compounding the problem is the degraded quality of the storm water runoff received from informal settlement areas that lack infrastructure as the runoff carries untreated sewage into the systems.

eThekwini's wetlands are significantly degraded, with limited support for biodiversity and biological productivity. Twenty-four percent of the original wetlands of the EMA have been permanently lost. Most of the damage to the wetlands was driven by historical agriculture uses although land use conversions, encroachment, the construction of dams, and irrigation have reduced flows and contributed to the pollution of inflows to the wetlands. In 2014, 6,200 ha of wetlands remain, although 90% of the wetlands are rated degraded and only 10% are rated in good or intermediate condition.

The coastal ecology has been heavily impacted by development. The originally healthy mangrove forests along the coast have nearly disappeared and eThekwini's renowned beaches are eroding and becoming increasingly polluted. The degradation of mangroves occurred predominantly in the 1960-1970s due to modernization of the port and coastal development. The remaining significant mangrove forest areas include 15 ha at Durban Bay, 44 ha at the mouth of the Umgeni River, and 12.5 ha at Isipingo River. The beaches, an important economic asset to the city, are declining in quality and quantity from increased erosion due to more frequent and intense storms and the interruption of natural sand deposits due to shoreline construction. There has also been an increasingly poor level of water quality at the beaches in the first 24 hours after a storm event due to the volume and quality of runoff. Beach erosion also threatens the habitat of plants and animals and the biodiversity of the aquatic ecosystems, which projected sea level rise will exacerbate.

eThekwini has implemented air quality regulations that have resulted in lowering of the concentration of major air pollutants below international thresholds. It has become a leader among African cities in understanding the municipality's contribution to climate change, having initiated the inventory of greenhouse gas emissions more than a decade ago. Intervention by EMA has reduced the historically high levels of SO₂ from industrial activities, the impact of agricultural activities such as sugar cane crop burning, and required capture of landfill methane gas onsite. However, vehicular emissions from the transport sector are a growing source of air pollution. eThekwini began to document an inventory of GHG emissions in 2002 and has improved data collection with the most recent reporting in 2012, which identified an increase from 20 MtCO₂e to approximately 29 MtCO₂e over the prior ten year period. Durban's 45% increase in emissions between 2002 and 2012 is roughly equivalent to the 46% increase in emissions among a portfolio of large developing countries including South Africa, India, Brazil and Mexico (Olivier, Jos G.J. et al., 2013).

Key Findings

eThekwini has experienced urbanization over periods of development; economic, social, and political drivers have shaped the spatial arrangement and the environmental quality of the city. Much of the environmental degradation is the result of longer term activities due to the development and expansion of the port and the growth of a multi-nodal city. While the rate of population growth is relatively low, the pace of land conversion for development suggests relocation of households (resident and commercial flight from the central business district) and the decompression of households. The conversion of large inland and upstream areas– for formal and informal development– is a source of degradation to water catchments, compromising essential environmental assets and services of the city as a whole.

eThekwini is challenged by the fragmented capacity to implement and enforce environmental regulation. There are multiple layers of government involved in the regulation of the environment with limited authority at local levels and a lack of integration between planning and environmental processes. As of 2012, only 12% of the Durban Metropolitan Open Space System (D'MOSS), the primary tool for conservation of the municipality's environmental assets, of the municipality's environmental assets, is formally protected via land acquisition, nature reserve proclamation and non-user conservation servitudes.

Institutionally, the most difficult issue to address is the EMA's lack of authority over land under traditional authority and consequent inability to promote their development and conservation. The lack of operational coherence between the municipality and land under traditional authority has had significant impact on the environmental assets. Land under traditional tenure systems is informally regulated and not aligned with municipal planning or environmental goals, resulting in de facto land development and degradation of upland catchment areas. While eThekwini has developed numerous programs to address environmental degradation, it has been limited by the lack of authority over some of the most critical conservation lands.

eThekwini is further challenged by the absence of an effective platform or mechanisms for integrated and cross-sectoral dialogue and decision making. Strategic and financial planning across the sectors lacks integration and there are misalignment of goals, schedules, and reporting requirements. This has resulted in institutional fragmentation that has failed to provide an effective framework to protect and conserve the municipality's environmental assets.

I. INTRODUCTION

The city of eThekweni or Durban has undergone a period of rapid urbanization that has contributed to the degradation of the city's natural environment. The arrival of thousands of in-migrants year after year has overwhelmed the city's ability to deliver adequate public services, housing, and jobs. Unplanned, densely populated informal settlements that lack basic water, sewer, and waste services now cover much of the city's land area.

Climate change is placing further strains on the city's ability to manage the urban environment. Increasing levels of rainfall from climate change contribute to storm runoff levels that exceed the capacity of the city's infrastructure, causing flooding and the spread of pollution. Such conditions have degraded the quality of the city's natural environment and the vital ecosystem services that it provides.

The Urban Environmental Profile of eThekweni has been prepared as the first component of the assignment "Promoting Green Urban Development in Africa: Enhancing the Relationship Between Urbanization, Environmental Assets and Ecosystem Services," a project being conducted under the leadership of the World Bank. An overall objective of this project is to link the study of urban environmental issues with the advancement of more sustainable urban growth. The Profile summarizes the existing quality of the terrestrial and other aquatic environmental assets, identifies the key drivers that are the cause of their vulnerability, and describes the key institutional challenges and constraining factors that limit the city's ability to address environmental management challenges. By consolidating, into one document, eThekweni's drivers and challenges in environmental management, this document can inform and empower municipal officials, non-governmental entities and other advocates to more effectively promote sustainable and inclusive development.

A. Methodology

The Urban Environmental Profile was developed based on the collection of data using the Rapid Urban Environmental Assessment (RUEA) tool developed jointly by the United Nations Development Programme, United Nations Centre for Human Settlements (UNCHS – Habitat), and the World Bank (Leitmann, 1994). The purpose of the RUEA is to document available data and identify gaps in knowledge. A questionnaire was developed to guide the collection of data and to generate a baseline of environmental information.

The RUEA questionnaire includes numerous charts to be populated with specific data on sanitation, solid waste, energy, and other urban systems and services. While the questionnaire was used as a starting point for data collection, the team found that for the most part the information was not available in this format and that the focus of the questionnaire was more narrow than that of the study. However, while the questionnaire often could not be answered directly within the format or specific units requested, it did guide the team towards the intended data, provided that the team considered the purpose or intention of each question.

Identification of the key environmental assets and key drivers of environmental degradation within the city required a more comprehensive review of reports on urban planning and infrastructure services. The required information was too complex to fit into the RUEA questionnaire format. Therefore, the process evolved to the definition and annotation of an outline for the profile that was then developed into this document.

Consultation with key stakeholders informed the drafting of the profile. A kick-off workshop held in eThekweni in September 2014 introduced relevant municipal officials and stakeholders to the objectives and intentions of the study. Participants provided overall direction on relevant secondary sources of environmental data, such as municipal development plans and strategic planning documents and reports prepared by national-level ministries, the World Bank, and United Nations (UN). Information was also gathered from interviews with municipal officials.

A PowerPoint presentation summarizing the intermediate findings was presented during a second workshop in November 2014. During the event, key stakeholders provided preliminary comments and feedback that guided the refinement of the Profile.

B. Summary of Report

The Urban Environmental Profile is organized as follows:

Section II: eThekweni Context sets the background and context of the study of Durban, providing an overview of the impacts of urbanization and climate change and drawing the link to the urban environment.

Section III: Quality of the Environmental Assets of eThekweni describes the state of the key environmental assets of eThekweni: the terrestrial assets, aquatic assets, coastal assets, and the air, and attempts to infer the associated historic and current trends.

Section IV: Drivers of Environmental Vulnerability and Degradation describes the key issues that are driving degradation, the impacts caused, and the reason for these challenges. Drivers include informal settlements; effluent from residential, industrial and municipal sources; extraction of natural resources; development of the Port of Durban; and solid waste.

Section V: Institutional Issues and Challenges describes the key factors that constrain the eThekweni's ability to effectively address environmental management challenges.

Section VI: Key Findings provides a synthesis of key findings of the study.

II. ETHEKWINI CONTEXT

A. Geophysical and Economic Context

eThekwini or Durban is located on the southeastern coast of South Africa in the province of KwaZulu-Natal (KZN) (see Figure 1). eThekwini is 229,193 hectares (2297 km²) and is bounded by uTongati River in the north, the aMahlomgwa River to the south, and the Indian Ocean to the east (EPCPD, 2013c). The eThekwini Municipal Area (EMA) is characterized by diverse topography, from steep escarpments in the west to a relatively flat coastal plain in the east.

Between 2001 and 2011, the population of Durban grew from 3.09 million to 3.45 million at an average annual growth rate of 1.13%, as shown in Table 1 (eThekwini Municipality, 2014a). This growth rate is relatively slower than other rapidly urbanizing African cities, such as Dar es Salaam (at an average growth rate of 4 to 5%) (URT 2002, 2012).

Durban’s population is projected to grow at a steady rate over the next couple of decades. By 2035, the population is projected to be between 4.1 and 4.5 million as shown in Figure 2, and under low and high growth scenarios respectively (eThekwini Housing Sector Unit, 2012, eThekwini Municipality, 2014a).

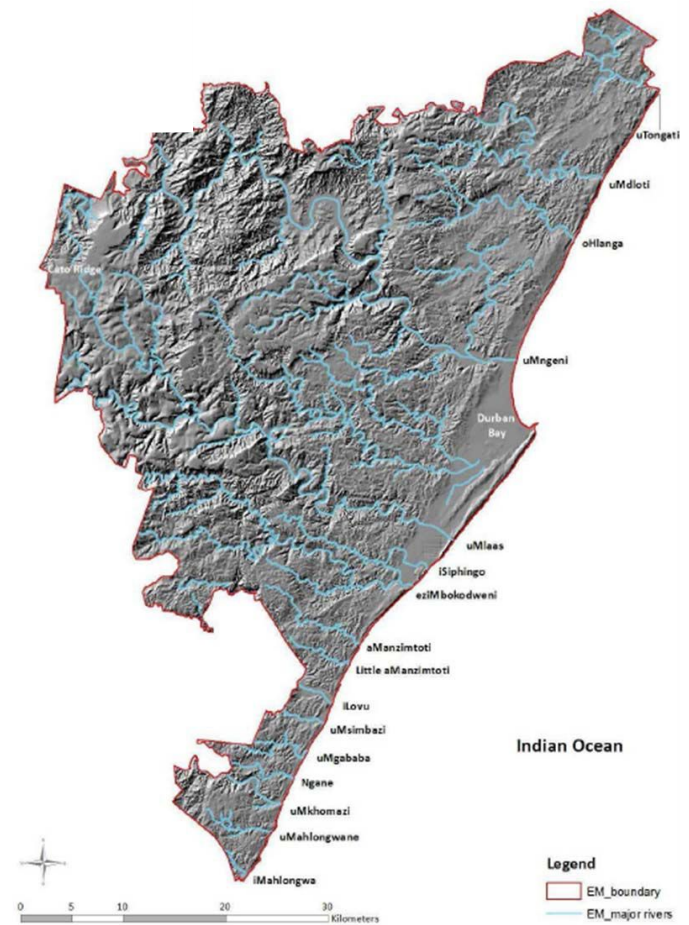


Figure 1 Topographical Map of eThekwini Showing Major Rivers
Source: Govender N, 2013

Table 1 eThekwini Historic Population and Population Projections

Year	Population	Annual Growth Rate*
2001	3,090,000	
2011	3,442,361	Average Annual growth of 1.13% (2001-2011)
2012	3,446,447	0.12%
2013	3,480,726	0.98%
2014	3,517,157	1.04%
2015	3,555,868	1.09%
2016	3,596,543	1.13%
2017	3,638,918	1.16%
2018	3,682,524	1.18%
2019	3,727,032	1.19%
2020	3,772,097	1.19%
2021	3,818,499	1.22%
2035*	>4,000,000	

* Note: Best published estimate, though numbers are not considered accurate with projected growth to be far in excess of the amount reported. Source: eThekwini Municipality, 2014a; *eThekwini Housing Unit, 2012

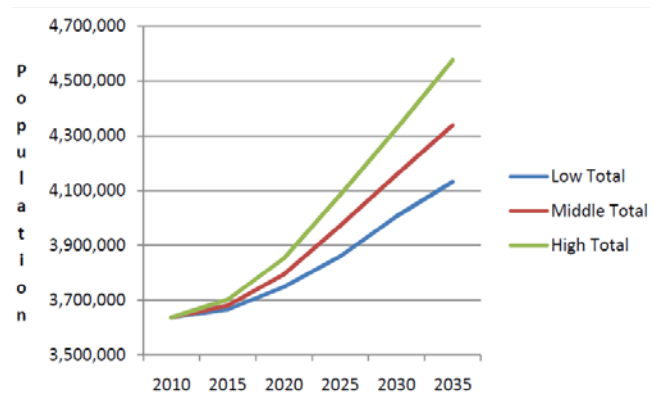


Figure 2 High and Low Growth Scenarios Metro Population
Source: eThekwini Municipality, 2012

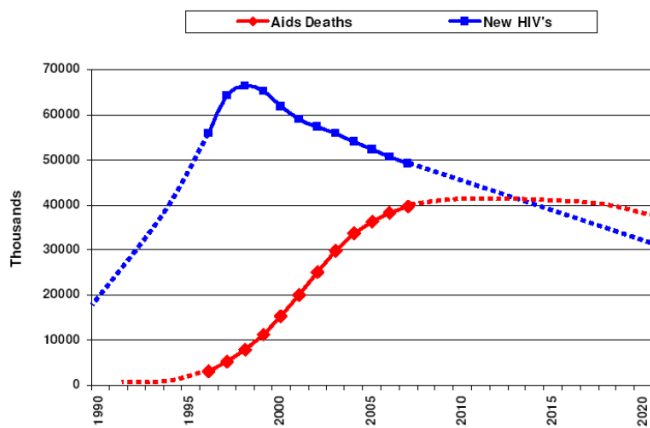


Figure 3 eThekweni AIDS Progression
 Source: eThekweni Housing Unit, 2012

eThekweni’s mortality rates, inflated by AIDS deaths, may be masking the rate of in-migration population growth rates. In 2007, 40,000 deaths were attributed to AIDS (eThekweni Housing Unit, 2012). Figure 3 depicts the number of deaths caused by AIDS and the number of new HIV cases annually.

In-migration is a key contributor to eThekweni’s population growth. According to Census 2011, the province that provided most migrants to eThekweni was KwaZulu-Natal, followed by migrants from Eastern Cape and Gauteng. 15% of eThekweni’s newcomers reside in informal settlements, (IDP, 2014).

GDP growth in the eThekweni Municipal region increased by 3.5% between 2011 and 2012, while KwaZulu-Natal and South Africa grew by 2.5% and 3.0% respectively (eThekweni Municipality, 2014a). This GDP growth has been steady, growing from 2009 at 3.3% (eThekweni), 3.2% (KZN), and 3.1% (SA) (eThekweni Housing Unit, 2012). In 2012, the two largest economic sectors (in terms of percentage contribution to GDP) in eThekweni were finance (22%) and manufacturing (22%), as shown in Figure 4. The manufacturing sector includes food and beverage production, as well as petroleum, fuel, chemical, and rubber production (eThekweni Municipality, 2014a).

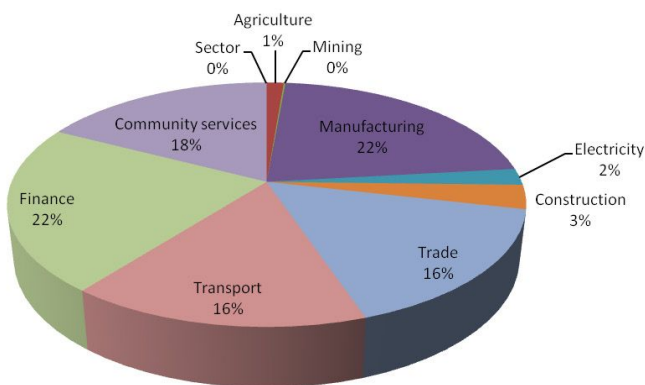


Figure 4 Percentage Contribution to GDP in 2012
 Source: eThekweni Municipality, 2014a

The Port of Durban is a critical economic asset for the city.

The Port of Durban is the largest port on the east coast of Africa and on average, handles 31.4 M tons of cargo valued at R 50 billion annually (Environmental Resources Management et al, 2011). Port activity is anticipated to increase over the next several years as there are plans to expand Durban’s shipping capacity with the construction of a dig-out port in South Durban. Plans call for tripling or quadrupling the capacity of current port operations. After completion, the Port of Durban will be the biggest port in the southern hemisphere (Steyn, 2013).

South Durban is home to several heavy industrial activities including one of the two largest oil refineries in South Africa, which refines 60% of South Africa’s petroleum. A paper mill, airport, landfills, incinerators, manufacturers, and rail facilities are also located in South Durban (eThekweni Municipality, n.d. b).

Although the unemployment rate is generally high, eThekweni has shown significant improvement, decreasing from 31.4% in 2006 to 20.4% in 2011. When compared to the other metro municipalities in 2011, only the City of Tshwane performed better achieving a 13.2% unemployment rate. Despite the decrease in unemployment, a more representative figure is the percentage of people employed from 2006 to 2011 as it includes the effect of workers who left the workforce. eThekweni still outperformed the other metros with an employment increase percentage of 3.8% during the five year period. These gains are essentially not as great as the reduction of unemployment rates portray (eThekweni Municipality, 2014a).

A much higher unemployment rate is observed in informal settlements. Informal settlements exhibit a much higher average unemployment rate of 43% (The Housing Development Agency, 2013). The gap between the rich and the poor is high, with the 2012 Gini coefficient¹ for eThekweni Municipality standing at 0.63, which is the national average (eThekweni Municipality, 2014a).

Historically, the city has developed in a fragmented pattern, with higher growth in peri-urban areas. eThekweni has a multi-nodal spatial development form. In addition to the central business district (and nearby inner western suburbs), two other large residential zones of medium-high density can be observed – to the north (KwaMashu, Inanda and Lusaka) and south-west (around Umlazi) (see Figure 5). On average the density is 4 dwelling units per hectare (eThekweni Housing Unit, 2012). This development pattern is partially due to legacy Apartheid segregation policies, a development and cultural trend of developing one unit per plot, and development by the private sector in outer areas where land is more readily available.

¹The Gini coefficient is a measure of income inequality where a Gini coefficient of 0 represents complete equality and a coefficient of 1 represents complete inequality (World Bank, n.d.).

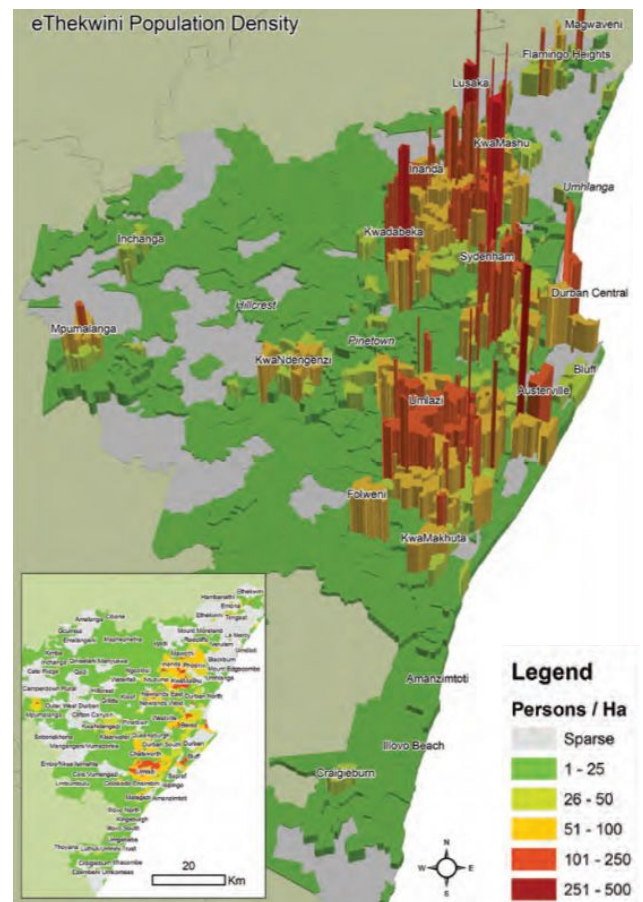


Figure 5 eThekweni Population Density
Source: State of the City Report 2011

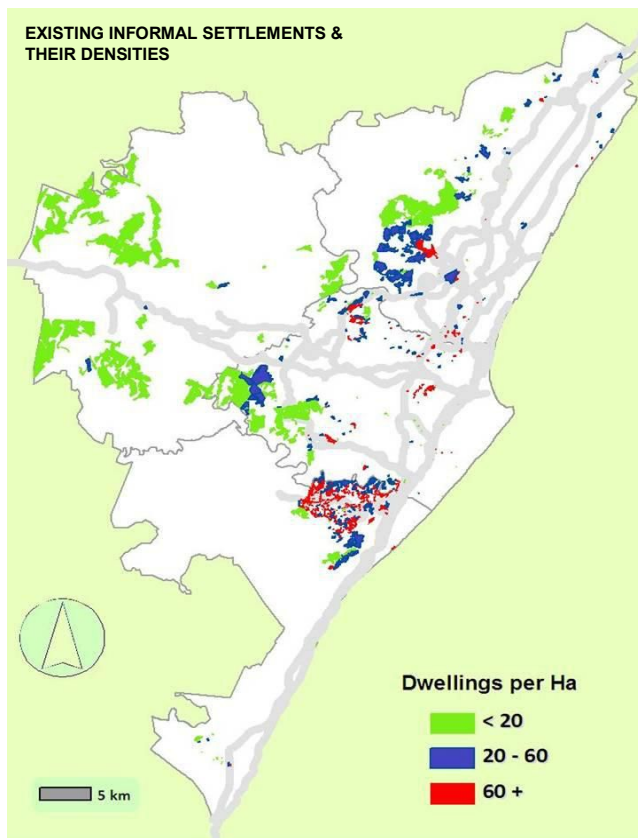


Figure 6 Existing Informal Settlements
 Source: eThekweni Municipality, 2013b

New development that is transforming land is largely taking place along the urban periphery. The percentage of eThekweni land area that is transformed increased from 49 to 53 percent from 2008 to 2011 (EPCPD, 2011/2012). Transformed land describes land that is used for agriculture, recreation, human settlements, and utilities. While the growth rate of developed land is comparable to that of population, new developments are largely taking place along the periphery of the urban boundary, which has led to:

- Greater encroachment into natural habitats and reduction in biodiversity;
- Increasing reliance on travel by motorized vehicles, which contributes to an increase in air pollution;
- Higher costs and capacity challenges to provide infrastructure services to areas not yet served.

The proportion of eThekweni households in informal settlements is increasing due to inadequate provision or availability of affordable housing. Informal settlements were home to 24.9% of eThekweni's households in 2001 and 27.2% in 2011. As shown in Figure 6, these settlements are located on the edge of the urban core and spread into the urban periphery. The settlements are predominantly medium density, with less than 20-40 dwelling units per hectare. In addition, there are pockets of informal settlements throughout the city with over 40 dwelling units per hectare (eThekweni Housing Unit, 2012).

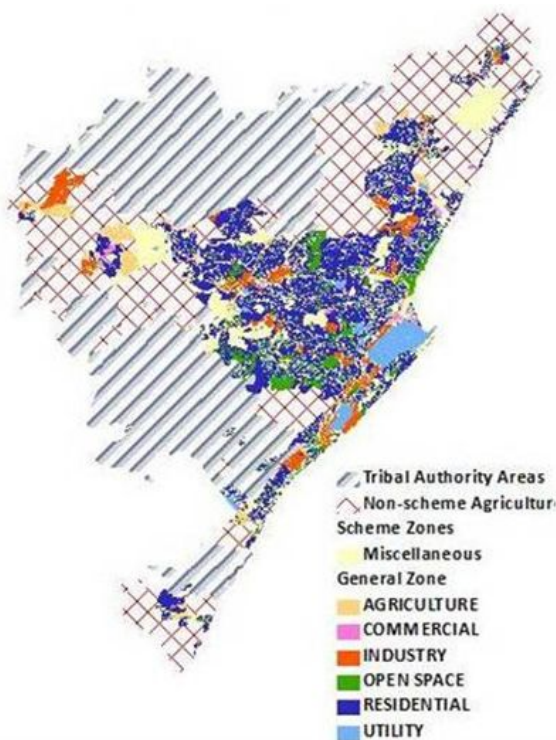


Figure 7 Land Use Regulatory Framework
 Source: eThekweni Municipality, 2013b

Informal settlements in the periphery have extended the reach of development into natural habitats and conservation areas. Informal settlements are predominantly located in the urban periphery in undeveloped areas. When comparing Figure 6 and Figure 7, informal settlements predominate in areas not administered by the eThekweni Municipality. The encroachment into natural habitats and conservation areas destabilizes the land and vegetation of critical catchment areas. This, coupled with the fact that approximately 67% (209,847 out of 313,958 households) of informal settlement and rural traditional households lack sanitation infrastructure results in the degradation of water quality downstream (eThekweni Municipality, 2012a). Informal settlements are located at the urban edge for three primary reasons. First, historic Apartheid-era planning did not allocate land for low-income housing in the urban core, thereby pushing informal settlements to the urban fringe (Marx et al, 2003). Second, the combination of a high demand and high price premium for well-located land within the urban core means that there is limited space for low-income settlements. Third, land use regulations within Ingonyama Trust lands are lenient, thereby encouraging informal settlements to occur. Areas formally administered by the eThekweni Municipality occupy approximately 36% of the EMA, while the remainder of the EMA is composed of traditional authority (approximately 37%) and non-scheme agriculture zones (approximately 27%) (EPCPD, 2013e; eThekweni Municipality, 2013b).

B. Climate Change Impacts and Challenges

eThekwini is already experiencing the impacts of climate change, with a documented annual sea level rise of 2.7 mm that threatens coastal wetland and dune ecosystems.

Climate change has been identified globally as one of the key challenges of the 21st Century (IPCC, 2014a). The impact of climate change is likely to fall disproportionately on cities of the global south, such as eThekwini, which are already facing developmental and other challenges. It is widely acknowledged that despite Africa's minimal contribution to global greenhouse gas emissions, the continent is likely to experience severe consequences from climate change, such as amplified water-stress and food insecurity. Climate change is likely to undermine development efforts in the region and exacerbate poverty. Africa is particularly vulnerable because it lacks the capacity to cope with climate change impacts due to its socio-economic status, political constraints, and limited access to technology (IPCC, 2014c). eThekwini has already experienced climate change effects, with a documented annual sea level rise of 2.7 mm (EPCPD, 2014a). It is anticipated that the following challenges will arise as a result of climate change:

- ***Increase in annual mean temperature*** Projections show a 1.5 to 2.5° C increase in mean annual temperature by 2065 and a 3 to 5° C increase in mean annual temperature by 2100, along with an increasing number of heat waves (EPCPD, 2014a). As Durban becomes warmer and wetter, the population may experience higher incidences of heat-related, vector-borne diseases, such as malaria, and water-borne diseases, including cholera. Residents living in damp conditions may develop respiratory illnesses. As a result of increased temperatures, food will spoil quicker, and the risk of food-borne diseases will increase (Golder Associates, 2011). The poor, the elderly, and the sick will be most vulnerable, which may place a strain on available medical resources (Ebi, et al., 2006). An increase in temperature may lead to increased evaporation rates, thereby influencing water availability (AECOM, 2014).
- ***Rise in sea level*** As a coastal municipality with 98 km of highly developed coastline, eThekwini is particularly vulnerable to sea level rise. Future sea level rise is expected to rise at a rate of 2.5 cm per decade (EPCPD, 2010a). The areas particularly vulnerable to sea-level rise are coastal wetland and dune ecosystems. Shoreline Management Plans are being prepared to determine what adaptation interventions, if any, are required or will be required into the future (EPCPD, 2014a).

- ***Increased and varied rainfall may impact potable water collection, lead to flooding, overburden waste-water treatment plants thereby impacting water quality, and lead to an increase in water-borne diseases. Increased frequency of large storms will erode the shoreline.*** eThekwini is projected to experience increasing and more varied rainfall. Rain events are expected to increase in intensity, with a potential increase in aggregate rainfall by 2065 of up to 500 mm by 2100. The northern parts of the EMA are expected to experience increases of up to 20% in long duration (1 day and longer) rainfall. The outer west areas are predicted to experience increases in short duration rainfall which may lead to localized increases of up to 30% in short-term flooding (EPCPD, 2014a).

The efficacy of dams to capture and store water will be impacted, as will the amount of water available for human consumption and industrial use (eThekwini Municipality, 2013c). At a high governmental level the KwaZulu-Natal (KZN) reconciliation Strategy by the National Department of Water and Sanitation is considering potential climate change impacts on water resources (AECOM, 2014). Increased rainfall may cause flooding damage to buildings and infrastructure below the 100 year flood line. Also, increased rainfall has the potential to overload waste-water treatment plants and impact water quality by causing untreated sewage to overflow in waterways, potentially increasing the risk of water-borne infectious diseases (Golder Associates Africa, 2011).

Recent work by Rouault (2009) predicts storm events and wave heights, further exacerbating the effects of local sea level rise. The effect will be an increase in the frequency and magnitude of storms (Corbella and Stretch, 2012), which is likely to erode the shoreline, particularly in low-lying areas and areas weakened by previous erosion (Theron, 2007).

The urban heat island effect describes the condition where the mean air temperature of built-up areas is hotter than nearby rural areas leading to increased peak energy and water demand, increases in greenhouse gas emissions and reduced water quality (U.S. EPA, 2015). The urban heat island effect was identified within Durban as early as 1968 (Whyte, 1970) and island effect is anticipated to intensify within Durban (eThekwini Municipality, n.d.a). The EMA's Municipal Climate Protection Programme has already initiated programs to mitigate urban heat island impacts such as the green roof program which rely on vegetated surfaces to reduce urban temperatures (eThekwini Municipality, n.d.a).

III. QUALITY OF THE ENVIRONMENTAL ASSETS

Being a global biodiversity hotspot, eThekweni's rich environmental assets are threatened by growth, economic development and climate change. According to the Endangered Wildlife Trust, South Africa is the third most biodiverse country in the world. eThekweni is situated in the middle of the Maputaland-Pondoland-Albany Region (shown in Figure 8), an area described by Conservation International as one of 35 "Biodiversity Hotspots" in the world. Biodiversity hotspots cover only 2.3% of the globe, but they support a high proportion of endemic plant and animal species (Conservation International, n.d.). eThekweni's subtropical climate, with warm, humid summers and mild winters, creates a natural environment for many endemic plant and animal species to thrive.

The development of natural habitats and conservation land threatens to permanently change Durban's environmental landscape and severely reduce the ecosystem services that sustain human civilization. As of 2010/2011, only 26% of eThekweni's land area was natural and non-degraded (EPCPD, 2011c). The degradation of natural habitats reduces the land area for endemic species to live and flourish. Disruption of upland habitats impacts water quality and availability of water.

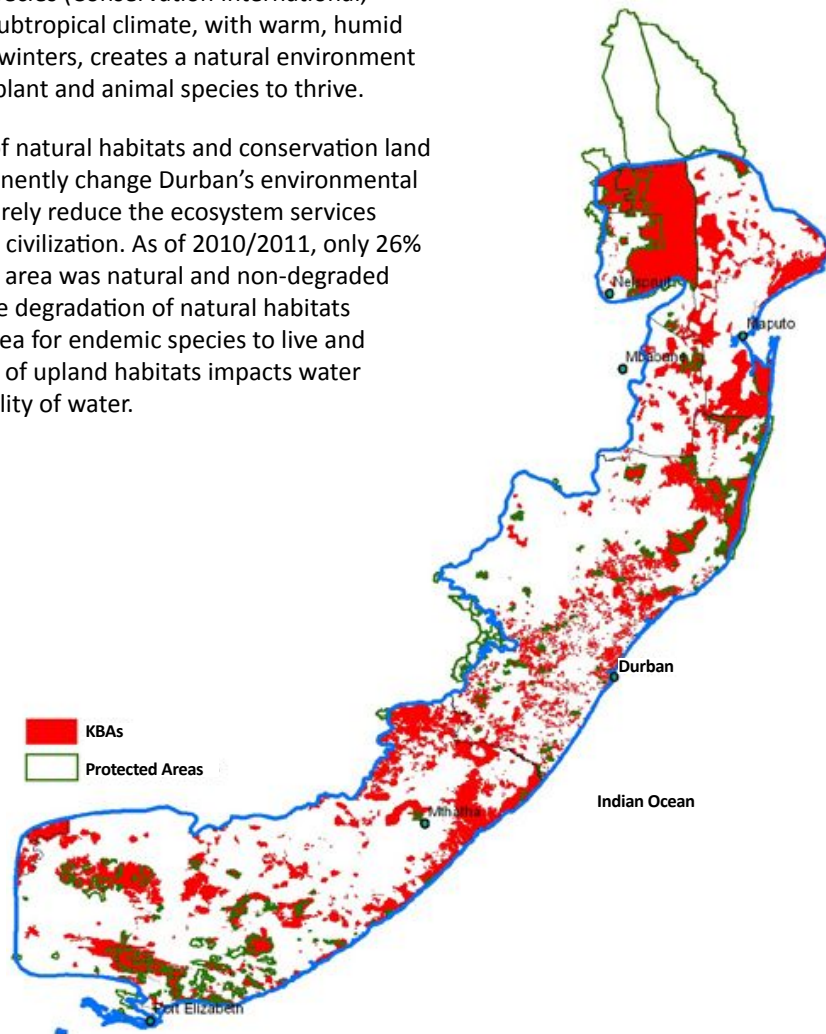


Figure 8 Key Biodiversity Areas (KBA) in the Maputaland-Pondoland-Albany Hotspot

*Notes: * The key biodiversity areas (noted in red) were compiled from underlying conservation plans. In addition, priorities within missing areas (especially the coastal sections of Mozambique, minor areas of the Northern Cape, Western Cape, and Limpopo) were filled in using compatible systematic planning methods and/or inclusion of conservation priorities from national-level conservation plans. * The hotspot boundary is in blue. The protected areas outlined in green extending to the north of the hotspot are parts of South Africa and Mozambique's Kruger and Limpopo National Parks that fall outside the hotspot. The outline of these parks is shown on this and other maps in this document because of the parks' importance within the context of the two countries' protected area systems.*

Source: Conservation International Southern African Hotspots Programme et al, 2010.

A. Terrestrial Assets

The extent of essential vegetation assets has been significantly reduced and they are in danger of eradication. Terrestrial assets in the EMA include forests, grasslands, thickets, and woodlands, which account for 25% of EMA’s total land area (EPCPD, 2013c). There are several nature reserves in eThekweni, including Paradise Valley, Burman Bush, Kenneth Stainbank Reserve, and the Giba Gorge; however these nature reserves account for only a small percentage of EMA’s total land area. Figure 11 depicts the location of the vegetation types in eThekweni, and the inset map shows the estimated original extent of each vegetation type.

In 2012, only 26% of eThekweni’s land area was in a natural, non-degraded state. Every three years the EMA tabulates the total hectares of transformed land (see Figure 12), which is defined as land used for agriculture, recreation, human settlements, and utilities. In 2008/2009, 49% of EMA was defined as transformed and by 2010/2011, the proportion rose to 53%. In the 2012/2013 State of Biodiversity report, EPCPD noted that the percentage of transformed land is actually higher than 53% because an additional 23% of eThekweni has been partially transformed, meaning that its natural state has been impacted, but not completely changed. Therefore, only 26% of eThekweni’s land is in a natural, non-degraded state. Future State of Biodiversity reports will include figures for the amount of land partially transformed. As the proportion of transformed land in Durban continues to increase, the amount of land available for naturally occurring ecosystems to thrive is diminished, thereby decreasing the ecosystems services available from terrestrial assets for supporting human development, such as groundwater supply recharge, water purification, carbon dioxide sequestration, pollination, etc. (EPCPD, 2013a).

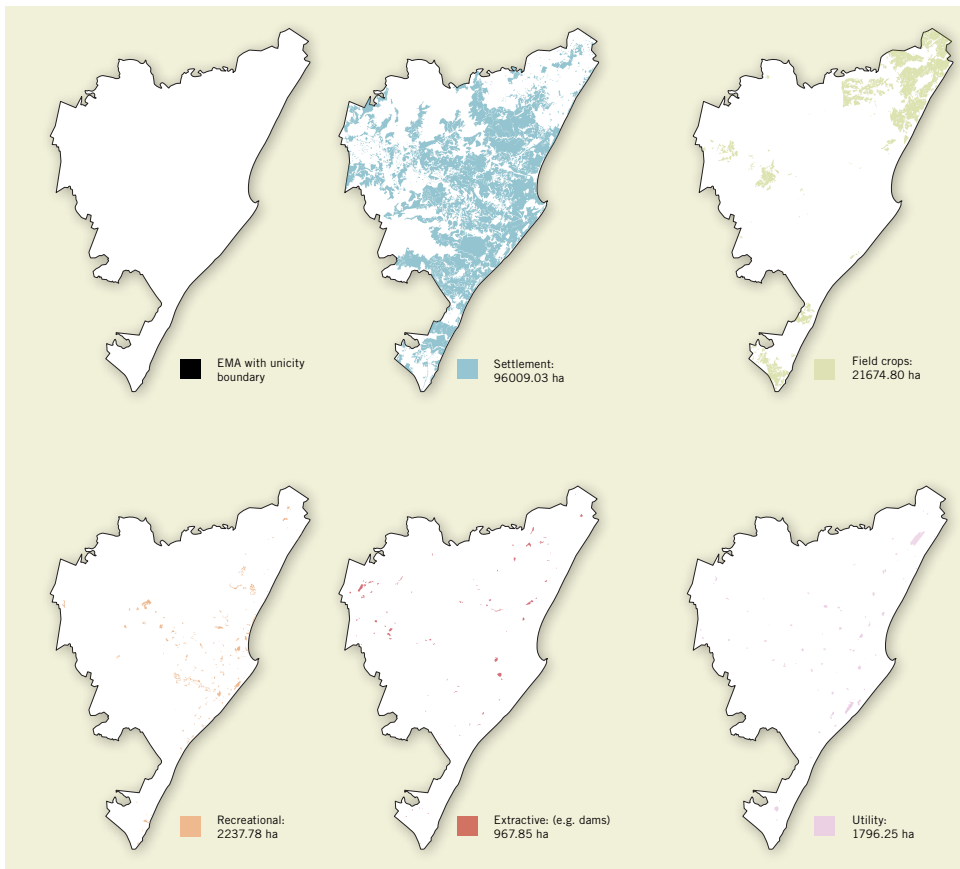


Figure 12 Transformed Land in eThekweni
Source: EPCPD, 2012b

eThekweni monitors the size of critical vegetation assets and sets targets for permanent conservation. For example, the KwaZulu-Natal Sandstone Sourveld (KZNSS), classified as endangered by the South African National Biodiversity Institute (SANBI), is a significant vegetation asset that once covered 6% of the eThekweni Municipality Area (EMA), but approximately 73% has been converted to urban settlement and agricultural land uses. As of 2009/2010, only 0.2% of the surviving KZNSS is conserved (EPCPD, 2010b). Figure 13 shows the original land area that KZNSS once covered as compared with the amount that was remaining in 2009.

Table 2 lists all the major vegetation types in eThekweni and documents the amount of hectares of each type currently in eThekweni and the land area that would be ideally allocated for each type. The figure highlights three vegetation assets that are not going to rebound to original land coverage rates and another six that are unlikely to rebound. While the chart may suggest that there is considerable vegetated land available to meet many of the targets, in practice the statutory protection for many of these areas is limited.

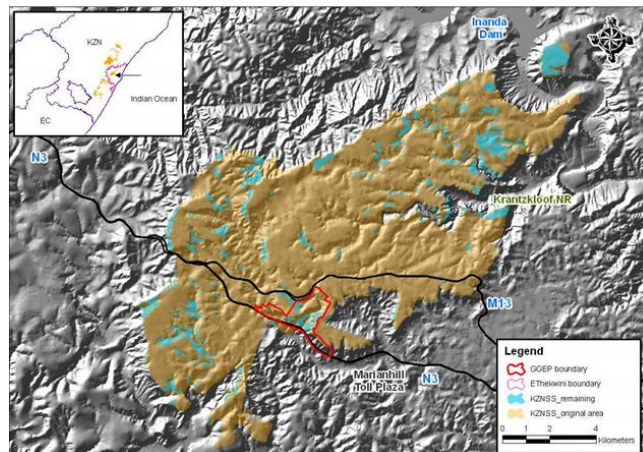


Figure 13 Relief Map of Original and Remaining KwaZulu-Natal Sandstone Sourveld

Source: McInnes, 2009

Table 2 Vegetation Targets and Deficiencies by Vegetation Type

Vegetation Type (KZN Classification)	Area Available in the EMA*	Target for Conservation (ha)	Protected Statutorily in the EMA ⁴ (ha)	Deficit/excess (ha)
Dry Ngongoni Veld	7,863	4,527	0	3,336
Moist Ngongoni Veld	3,871	3,099	0	772
Eastern Valley Bushveld	11,182	5,020	0	6,162
KZN Hinterland Bushveld	3,664	1,706	0	1,958
KZN Sandstone Sourveld	3,259	3,920	116	-545
North Coast Bushland	9,246	8,189	11	1,067
South Coast Bushland	765	488	0	277
North Coast Grassland	9,022	29,150	218	-19,910
South Coast Grassland	2,551	6,046	0	-3,495
Southern Coastal Scarp Forest	8,817	5,470	531	3,878
KZN Coastal Forest	2,075	1,572	34	537
KZN Dune Forest	1,285	888	26	423
Mangrove Forest	65	65	47	0
Swamp Forest	55	55	0	0

Vegetation types for which conservation targets can no longer be met.

Source: EPCPD, 2012b

Vegetation types where further significant loss of habitat is likely to result in targets not being met.

Elimination of land area and changes in climate have multiple impacts on terrestrial assets by creating new habitat for invasive species, threatening the livelihood of endemic species, reducing carbon sequestration capacity, increasing greenhouse gas levels, reducing aquifer recharge rates, and fragmenting habitats. When vegetation is cleared to allow for development, the natural habitat of endemic species is destroyed. Climate change impacts, such as increased rainfall, increase in temperatures, and severe storms, change an endemic species' natural environment by creating the opportunity for alien species to thrive and by creating conditions that make it difficult for native species to live. For example, two species of frogs are threatened in eThekweni. One frog, *Amietia vertebralis*, is found in higher altitudes where increased UV radiation (caused by climate change) causes embryo mortality and increased temperature creates optimal conditions for diseases that affect the *Amietia vertebralis*. The habitat of another endemic frog, the Long-Toed Tree Frog, *Leptopelis xenodactylus*, is reducing due to deforestation and agriculture practices and the climate-change induced drying of wetlands. Frogs play a very important role in the food chain and are critical to maintaining a high level of biodiversity. These two endemic frogs face an uncertain future as their habitats are eliminated by a combination of agricultural, development, and climate change trends (Tarrant, 2009).

The destruction of vegetated landscapes not only eliminates natural habitats for flora and fauna to thrive, it also results in the loss of carbon sequestration. Wetlands and forests sequester the most amount of carbon per hectare, but brush and thicket landscapes also sequester carbon and should also be protected. Elimination of these carbon sinks reduces sequestration capacity and can increase Durban's overall greenhouse gas levels.

The replacement of natural habitats with more impermeable surfaces, results in less water reaching aquifers. An increase in developed land and corresponding decrease in natural land means that more water runs off properties and into streams and rivers. Vegetated landscapes capture rainfall and allow it to percolate to subterranean aquifers. While the vast majority of Durban's water supply (90%) comes from surface water, subterranean aquifers are essential water resources for natural habitats and can be secondary water supply sources for humans (Ground Truth, 2006).

Habitat fragmentation caused by leap-frog development threatens biodiversity. Leap-frog development is the practice of developing non-contiguous parcels of land, leaving patches of undeveloped land in between. The EPCPD analyzed the vegetated land patches within eThekweni. Figure 14 shows that even though 25% of EMA's total land area is covered by vegetated ecosystems, the parcels are not very large and are fragmented. Habitat fragmentation impacts different species in different ways depending on mating, foraging and migration patterns for maintaining healthy species dynamics and populations. Nonetheless, habitat fragmentation greatly threatens biodiversity (EPCPD, 2013c).

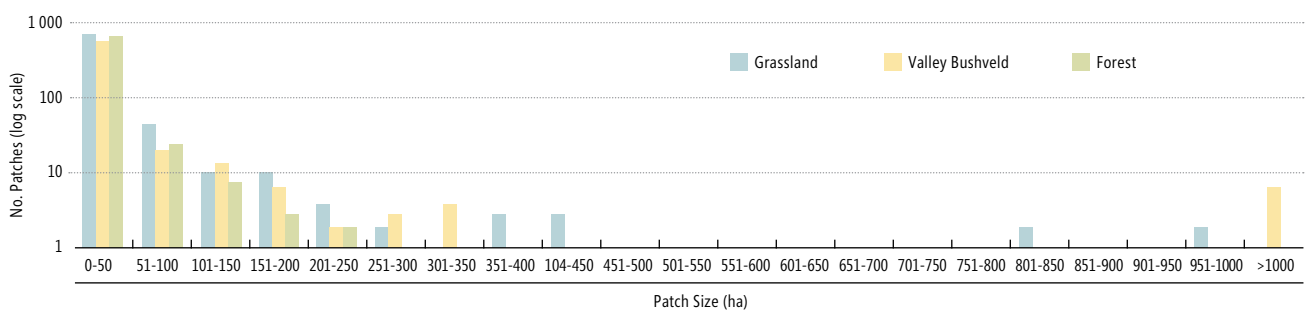


Figure 14 Vegetated Patches by Vegetation Type and Size
 Source: EPCPD, 2013c

Invasive Alien Species

Invasive alien species threaten the biodiversity and ecosystem services of eThekweni. Invasive alien species are causing the decline or elimination of indigenous species through competition, predation, or transmission of pathogens, and through the disruption of local ecosystems and ecosystem functions. eThekweni's warm, moist temperate climate, which is home to many endemic species, also provides ideal conditions for many invasive alien species. Invasive alien plant and animal species are not faced with the natural predators or competition found in their home land; therefore they rapidly reproduce and proliferate. Some of the ways invasive alien species transform ecosystems are by excessive use of resources (e.g. water, light, oxygen), enhancing or suppressing wildfires, increasing or decreasing soil erosion and siltation, and changing soil composition (EPCPD, 2013a). There are numerous invasive alien species degrading Durban's environmental assets. Below are examples of a few species and how they are degrading Durban's environment.

Invasive Alien Plant Species Approximately 8% or 100,000 km² of South Africa's total land area is invaded by invasive alien plant species. eThekweni documented 130 different invasive alien plant species that need to be eradicated in the metro area. eThekweni also identified the most commonly occurring 12 invasive alien plants and seven invasive alien weeds that are targeted for elimination efforts. A survey of invasive alien plants revealed that 30% of survey areas had a medium density of invasive alien plant and 8% had a high density of invasive alien plants (eThekweni Municipality, 2014a). A few examples of invasive alien plants are:

- *Epipremnum aureum*, a recently introduced climber species native to southeast Asia and New Guinea, is a recently identified invasive alien. In Sri Lanka and Florida this invasive alien plant has been found to completely overgrow the forest floor as well as the trunks of trees, causing severe ecological disruption. In Durban, this species has been planted in gardens and plants for many years, but it has now been recognized as a potential invader. Areas of the south coast are particularly at risk of invasion (EPCPD, 2011c). Invasive alien plant species such as the *Epipremnum aureum* threaten native vegetation such as the Coastal Lowland and Scarp Forests, Sourveld Grasslands and Valley Bushveld, which are in danger of complete elimination (see previous section for details) (EPCPD, 2013a).

- *Campuloclinium macrocephalum* (Pompom) is an invasive weed known to severely transform grasslands, savannas, and wetlands. eThekweni identified the Pompom as a high priority weed to eradicate (EPCPD, 2013d).
- *Eichhornia crassipes* (water hyacinth) is an aquatic invasive alien plant species that grows rampantly in high-nutrient load conditions. Its growth crowds out and kills endemic plant and animal species. Most of the sites surveyed for the 2006 State of the Rivers Report were highly infested with invasive weeds in aquatic and terrestrial ecosystems. While invasive aquatic plant species are generally controllable with biocontrol agents, they are difficult to control when rivers become polluted with high nutrient loads. Therefore, the expansive problem of untreated effluent entering rivers exacerbates the alien invasive species problem (Ground Truth, 2006).

Invasive Alien Animal Species Invasive alien animal species have varied impacts ranging from minor nuisance to significant impacts on indigenous populations. Invasive alien animal species have been documented at all levels of the food chain, from tiny invertebrates to mammals. The 2007 Invasive Alien Species Strategy, for example, cited more than 100 species of invasive alien aphids and more than 100 invasive alien scale insects in South Africa, many of which occur in eThekweni (Environmental Management Department, 2007). A 2008 study of invasive species in the Port of Durban found that the total number of confirmed introduced species in South African waters was 28, which is considered low by international standards (Angel et al, 2008). A few examples of invasive alien animal species in eThekweni include:

- The Argentine Ant and the Lepisiota incise ant are invasive alien ant species that are found in eThekweni. These small invasive ants displace endemic ants. Endemic ant species are critical to the livelihood of endemic plant species, which rely on the ants for seed dispersal (Environmental Management Department, 2007).

- The house crow is an invasive animal species that has impacted endemic bird species due to their highly competitive behavior (EPCPD, 2013a). In 1989 the total population was estimated at 1,600 birds, and the city effectively reduced the house crow population to 100 to 200 birds over a four year period. However, a lack of funding and staffing capacity in 1994 led to an increase in the bird population. The house crow threatens wildlife by killing or displacing endemic animal species (Environmental Management Department, 2007).
- The Nile Tilapia is an invasive alien fish species that is spreading rapidly throughout southern Africa and is threatening the possible extinction of the endemic Mozambique Tilapia through intense competition (Ground Truth, 2006; Environmental Management Department, 2007).

eThekwini is aggressively targeting invasive alien species. Every year the EPCPD allocates funding to control invasive alien plant species through programs like Working on Fire and Working for Ecosystems. In addition to these, there are several other programs to control the proliferation of invasive alien species. These programs are described in the Appendix.

Overview of Terrestrial Asset Trends

eThekwini's terrestrial assets make it among the world's most biodiverse cities. Furthermore, the municipality's data collection, assessment and monitoring programs have generated some of the most comprehensive understanding of its terrestrial assets among cities worldwide.

While eThekwini's vegetation asset trends are degrading, this decline could also contribute to a decline in the amount and diversity of the region's birdlife. However, data sets such as a baseline of vegetation types and other informants of the D'MOSS system provide eThekwini with conservation priorities and priority locations that can slow trends of transformation.

Invasive alien species are a serious threat to the overall health of eThekwini's urban ecosystems. The municipality documents invasives and eliminates them through engaging local communities. This is a key strategy for strengthening the city's overall resilience to the invasive threats. Building on successes of community-based ecosystem management by up-scaling these pilot programs can enable the municipality to expand its coverage for restoring ecosystems across more geographic areas of the municipality. Furthermore, growing the number of community members engaged and trained in community based ecosystem management could both enable eThekwini's terrestrial assets to overcome the constant pressure of invasive alien species as well as to expand ecosystem regeneration and restoration efforts more broadly.

B. Aquatic Assets

Rivers

eThekweni's rivers have become heavily polluted by human activities and are continuing to degrade. The eThekweni Municipal Area has 16 main rivers, which in addition to serving as a natural habitat for Durban's diverse species, also supply 90% of the region's water, serve as recreational areas for canoeing and other activities, and serve as sites for spiritual and cultural rituals (Ground Truth, 2006). There are 12 dams on eThekweni's rivers, which create freshwater reservoirs (CSIR, 2008) that supply water to eThekweni. The primary use and condition of notable rivers in eThekweni is listed in Table 5.

The degradation of eThekweni's rivers is increasing. In 2006, 34% of eThekweni's rivers were rated in poor condition, and by 2010 that proportion increased to 40%. Generally, river condition worsens as a river approaches the ocean and travels through more developed areas. The 2006 State of the Rivers Report, which includes data samples for 61 sites on 33 different river systems in the EMA, found a range of water quality and river health issues. Of the 61 sites monitored, 34% were rated in poor condition and an additional 27% were rated fair (see Table 3) (Ground Truth, 2006). A 2010 survey of monitoring sites found that conditions at 40% of the sites were poor and only 3% of the sites were near natural condition (eThekweni Municipality, 2014a). This data indicates that water quality is continuing to decline over time in eThekweni.

eThekweni posts a map once a month documenting the quality of the water of its rivers. Figure 15 shows the river water quality for October 2014. Although the actual E.coli counts for each river depicted in Figure 15 is not disclosed, Table 4 shows the thresholds for the river quality rating scale. For reference, the U.S. Environmental Protection Agency (EPA) recommends a maximum E. coli concentration of 410 cfu/100mL as the recreation water quality standard (U.S. EPA, 2012); therefore all rivers in Figure 15 that rated poor (yellow designation) or critical (red designation) are well above EPA's recommended thresholds.

Table 3 Ecstatus for all Sites Monitored in the 2006 River Survey

	Natural	Good	Fair	Poor	Dry
# of Sites	3	20	17	21	0

Source: Ground Truth, 2006

Table 4 River Quality Rating Scale

	E. coli (cfu/100mL)	PV4 (mgO ₂ /L)
Ideal	0 – 400	0 – 2
Acceptable	400 – 2000	2 – 5
Poor	2000 – 10,000	5 – 8
Critical	> 10,000	> 8

Source: eThekweni Municipality, 2012a

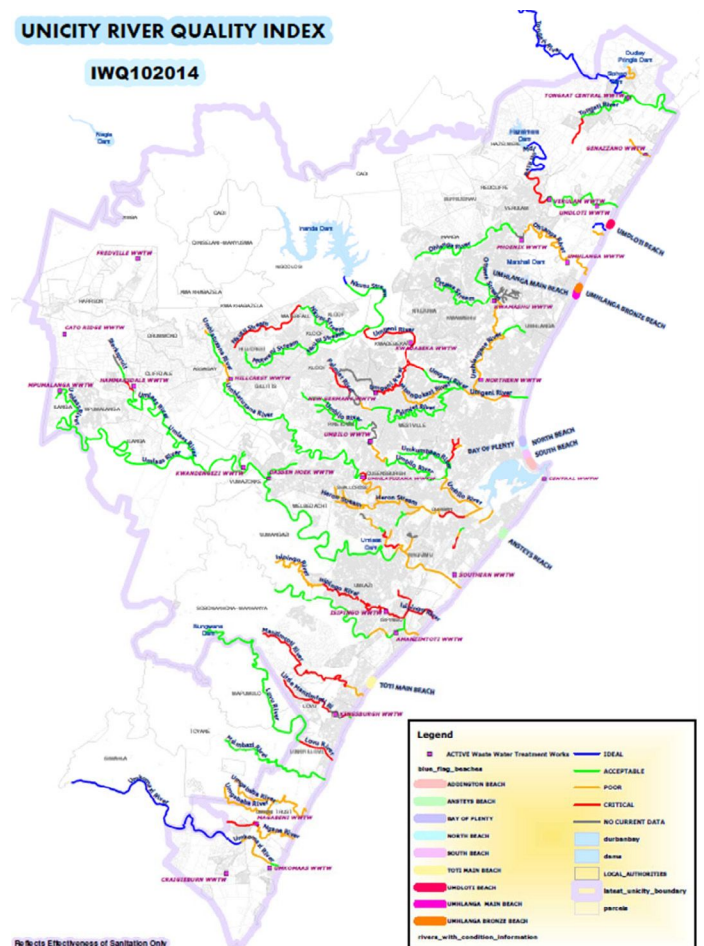


Figure 15 eThekweni River Water Quality (E.coli counts), October 2014

Red lines indicate critical water quality; Blue is ideal water quality; Green is acceptable water quality; Orange is poor water quality.

Source: Wallace, 2014

Table 5 Condition of Notable eThekweni Rivers

River	Primary Use	Condition
uMngeni River	The largest and most economically important river is the uMngeni River. Four large dams on the uMngeni and a water transfer from the neighboring Mooi River are a major water source for eThekweni, supplying 820 ML/d of the 920 ML/d consumed by the urban region (DWA, 2009).	The uMngeni is heavily polluted by effluent return flows that it receives from sewage treatment plants. There have been extensive water hyacinth infestations in the lower uMngeni (Ground Truth, 2006). The water hyacinth is an invasive plant species that proliferates when nutrient loads are high.
uMkhomazi River	The largest river from a catchment and flow perspective, the uMkhomazi River is not a water source; however there are plans to draw drinking water from the uMkhomazi (uMngeni Water Infrastructure Master Plan, 2012). The proposed infrastructure includes the construction of a dam and a tunnel, which is anticipated to be completed in 2023 (DWS, 2014).	The dominant ecological status in the lower uMkomazi is average to good with the main impacts being dams, forestry, overgrazing, and agriculture (DWA,2013).
Lovu River	The Lovu River provides 20 ML/d of water to eThekweni (uMngeni Water Infrastructure Master Plan, 2012).	The upper Lovu catchment is situated in areas mainly covered with plantation forestry (C and B/C PES). Sugar cane, rural development (towns/townships), and dams have increased impacts on these rivers, especially the water quality (C/D PES). The deeper valleys of the Lovu and Nungwane limit the extent of impact on the rivers but water quality impacts prevail. All the coastal rivers in the Lovu catchment are in a C PES, and the sources of impacts are very similar for all these rivers: rural settlement with extensive high density townships, with associated activities (informal agriculture and some sugar cane) (DWA, 2013).
Mdloti River	The Mdloti provides 45 ML/d of water to northern eThekweni and Ilembe (source #9). It is the second most important river from a water supply perspective.	The Mdloti River upstream of Hazelmere Dam is in a B/C and D PES. The impacts are non-flow related activities (informal settlements with related subsistence agriculture and grazing). The river downstream of Hazelmere Dam is in a D PES. The tributary is in a B/C PES.
uMlazi River	The uMlazi is a large river, but it does not supply water. The Shongweni Dam on the uMlazi River is used for recreation and serves as a flood attenuation measure (source to be confirmed)	Upstream of the Shongweni Dam, predominant impacts are both flow (in stream dams and irrigation) and non-flow related (forestry, agricultural activities, alien invasive vegetation, and water quality). The uMlazi is noted for wetlands of moderate and low importance. The Sterkspruit (U60C-04556) is noted for wetlands of moderate importance. The Lower uMlazi is in a poor ecological state and impacts are degraded water quality and riparian vegetation removal (wood harvesting and grazing) (DWA, 2013).
Piesang River	Drainage for development	The Piesang River was extensively re-aligned to drain wetlands for housing development and road construction (Ground Truth, 2006).
Tongaat River	Catchment drainage	The Tongaat River is relatively healthy until it nears the coast where rapid development along its banks and effluent return flows have heavily polluted the river.
Umbilo and Mhlatazana Rivers	Wastewater discharge	The Umbilo and Mhlatazana were altered by canalization and flow into the Durban Bay. High nutrient loads and dyes in treated water have been documented in the Umbilo River. The high nutrient loads have been attributed to poorly treated effluent discharged by a waste water treatment plant on the Umbilo. Additionally, a serious incident involving the intentional discharge of untreated, toxic substances into the river by an entity was documented on the Umbilo River. (Ground Truth, 2006).
<p><i>(PES is an acronym for the present ecological status of the river as expressed by classifications (Kleynhans et al., 2007; DWA South Africa, 2013); B/C = Natural with some modifications and loss of natural habitat C = Moderately modified but basic functions still unchanged C/D = Boundary between moderately and largely modified D = Largely modified with loss of natural habitat.)</i></p>		

Eutrophication, poor riverbed light penetration, erosion, inhibited river flow, and invasive species promulgation are the primary environmental problems facing eThekweni's rivers. Eutrophication creates an aquatic environment where few plants and animals can survive. Many of eThekweni's rivers have high chemical and nutrient levels, which upset the natural balance of the aquatic ecosystem. These high levels can be attributed to many sources including illegal dumping of solid and liquid waste, untreated or improperly treated effluent, untreated toxic industrial discharge, agricultural run off, and the use of detergents for cleaning in the river. Poor riverine water quality adversely impacts flora and fauna in the aquatic ecosystems, and also increases the cost of treating water for potable consumption (Ground Truth, 2006). Deteriorating water quality is also a concern for recreational users of water resources, such as the Duzi Canoe Marathon event on the uMngeni river, with Marathon organizers publicizing weekly water quality test results.

Poor Riverbed Light Penetration Colorants and dyes used in manufacturing processes are discharged into rivers and discolor the water, which makes it difficult for natural light to penetrate the riverbed. Dark riverbed environments in rivers like the Umbilo, where this pollution has been documented, can kill species (Ground Truth 2006).

Erosion Riverbanks in parts of eThekweni are eroded into channels, which accelerate water flows during rainstorms, reduce the ability for natural riverine vegetation to flourish, and increase flooding events. Described in greater detail in the next section, legal and illegal sand mining in eThekweni strips riverine vegetation, leaving the riverbank exposed and vulnerable to erosion. Also described more in the next section, with 52% of eThekweni's land area transformed (EPCPD, 2012b) there is a high proportion of impervious surfaces, which increases stormwater runoff and accelerates the erosion of riverbanks. Farming practices such as improper sugar cane planting methods and livestock over-grazing have created steeply sloped riverbanks (Department of Environmental Affairs and Tourism, 2014).

Inhibited Flow By inhibiting the natural flow of rivers, dams can have major impacts on native species by creating barriers to natural migration patterns and can impact the morphology of downstream riverine environments by trapping sedimentation. However, when dams are operating effectively, issues such as these can be mitigated. For example, one year, water was allowed to spill over the Nagle Dam in a controlled release. The simulated natural flow of the river resulted in a positive impact to aquatic invertebrates downstream of the dam (Ground Truth, 2006).

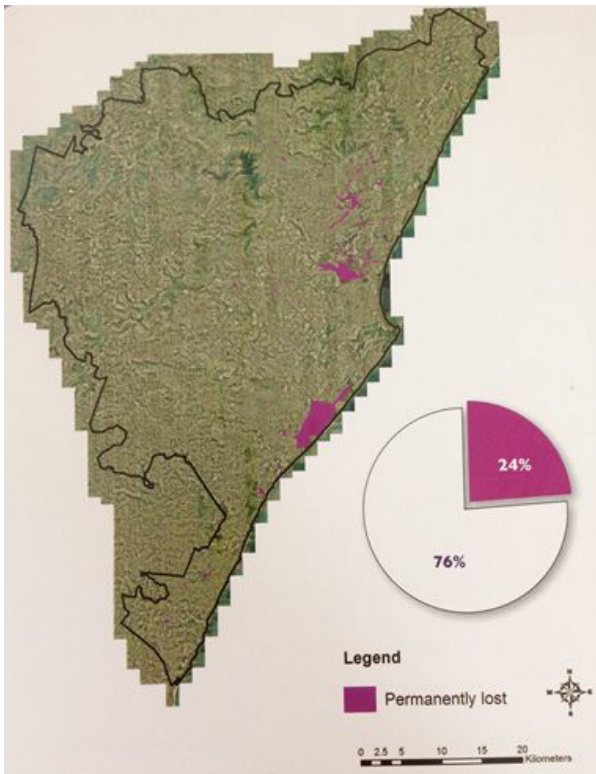


Figure 16 Wetlands Permanently Lost
 Source: EPCPD (2014), *State of the Wetlands of eThekweni Municipality*

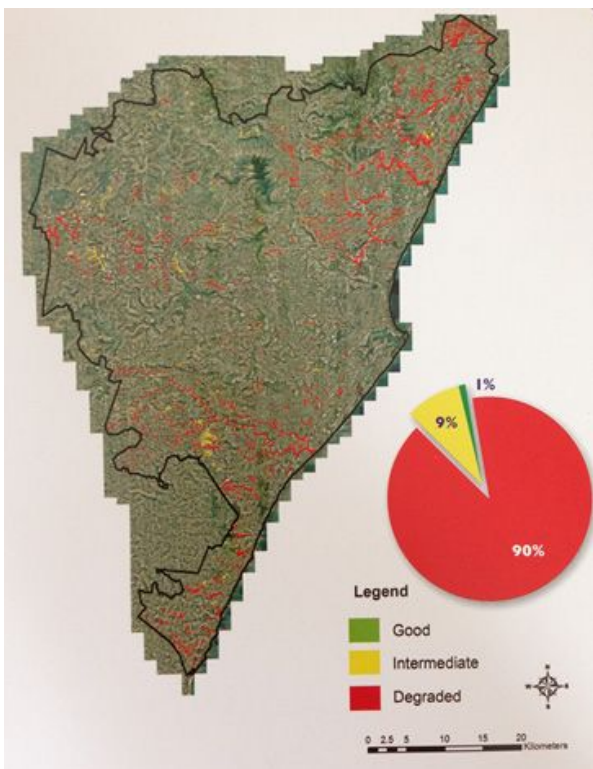


Figure 17 Wetland Condition
 Source: EPCPD (2014), *State of the Wetlands of eThekweni Municipality*

Wetlands

eThekweni's wetlands are significantly degraded, unable to support appropriate levels of biodiversity and biological productivity. Wetland assessments revealed that 24% of the historical wetlands within eThekweni have been permanently and irrevocably lost (see Figure 16). As of 2014, there were 6,200 hectares of wetlands in eThekweni, representing 3% of the municipality's total land area. The municipality's wetland assessment process revealed that 90% of eThekweni's wetlands are degraded and only 10% are in good (1%) or intermediate (9%) condition. The majority of the existing wetlands are located in the peri-urban area immediately adjacent to the urban core (see Figure 17) (EPCPD, 2014c).

The widespread land use conversion and encroachment of land use within wetlands is evidenced by the current Present Ecological Status of Durban's river systems as noted in Table 5 and Table 7. At the catchment scale, dams, irrigated agriculture, and afforestation have reduced inflows to wetlands. Urban and industrial areas, and to a lesser extent agriculture, have negatively affected water quality entering wetlands. Within the wetlands themselves, encroachment of agriculture and forestry into the wetland areas has caused degradation of wetlands across much of the catchment. Drainage of wetlands associated with these land use changes, as well as erosion by dongas, has reduced wet areas and flood condition durations within wetlands, causing further degradation. Good buffers from forestry and agriculture, however, can help prevent wetland loss (DWA South Africa, 2013).

Groundwater

While only a small percentage of the municipality sources water from boreholes, the potential for pollution of aquifers is heightened by activities such as waste disposal sites, pit latrines, septic tanks, and developments lacking sewage infrastructure (WSDP, 1999). Limited data substantiating the use of aquifers and observations from the Water and Sanitation Unit suggest that groundwater is a resource that is not well-documented, used or in demand, with boreholes mainly in the Umbumbulu district (eThekweni, 2014c; personal communications Chris Fennemore, 2015). Poor groundwater quality can impact plants, animals, and humans, via high nutrient and chemical levels.

Overview of Aquatic Asset Trends

The degradation of eThekweni's rivers over the past decade is likely to continue due to an increase in invasive species and other related trends noted in the section on terrestrial assets. Continued transformation of the catchment areas through habitat fragmentation and loss of vegetation will contribute to continued river quality and groundwater degradation due to erosion, sedimentation and effluent inputs. The overall degradation of the majority of the municipality's wetland assets is also likely to continue unless institutional challenges related to wetland conservation and enforcement are effectively addressed.

However, the comprehensive documentation of river quality and threats provides a strong starting point for identifying measures to slow or even reverse degradation of these assets. Furthermore, current (2014) GIS-based mapping of wetland locations and conditions updates provides the essential information needed for informing conservation and restoration efforts. The future outlook for aquatic asset trends could yield slowed or reversed degradation if fiscal, private and/or community-based resources can promote restoration, such as by growing the municipality's successful community-based ecosystem restoration programs.

C. Coastal Assets

Estuaries

All but three of Durban's bays are significantly degraded.

Durban has 98 kilometers of coastline featuring 16 estuaries, mangroves, beaches, and rocky shores as shown in Figure 18. The most notable estuary is Durban Bay, where the Port of Durban is located. In a 2009 survey of Durban's 16 estuaries, only three estuaries were classified as in good condition. No estuaries were classified as excellent condition, as shown in Table 6. Seven estuaries, which represent 58% of Durban's estuarine communities, were classified as highly degraded (Forbes et al, 2008; DWA South Africa, 2013). When compared with G.W. Begg's review of Durban's estuaries in 1978, many of the estuary's conditions were found not to have changed or to have further degraded (Forbes et al, 2008). The low quality of Durban's estuaries has potential major implications for communities dependent on water from these systems and undermines tourist opportunities (eThekweni Municipality, 2014a).

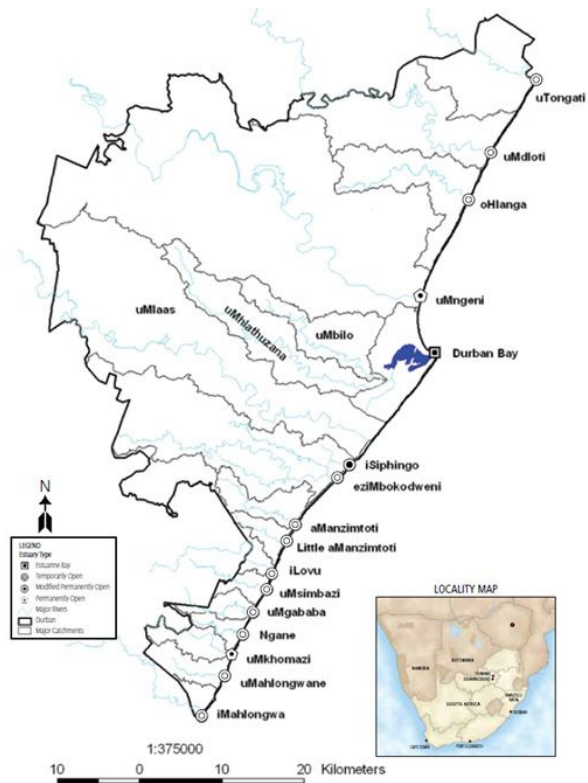


Figure 18 Durban's Bays and Estuaries

Source: Forbes et al, 2009

Durban's most impacted estuaries are located downstream of the majority of Durban's population. The estuaries rated as highly degraded or poor are primarily located on the northern and central coastline, while estuaries in fair or good condition are located along the southern coastline. The most degraded estuaries correlate with higher concentrations of population. Upstream agriculture, in particular sugarcane is also a key contributor to estuarine degradation, derived from non-point source pollution in the form of pesticides used by the plantations (DWA South Africa, 2013).

The natural habitats of Durban Bay have been considerably modified and full estuarine functions have been irrevocably lost to accommodate Port activity.

Durban Bay was heavily altered through canalization of rivers entering the estuary as well as by the construction of many wharfs, ship docking areas, and support functions. The Port also dredged to maintain channel depth for large

ships. There are only a handful of natural to semi-natural areas remaining (e.g. central sand backs). The natural morphology of Durban Bay makes it an excellent habitat from an ecological perspective for invertebrates and a variety of crabs to thrive. The bay is large and relatively sheltered from storm events and winds, and it features extensive shallow tidal areas. These features allowed mangroves to develop and provide a major invertebrate habitat; however, the development of the bay into a bustling port has destroyed these habitats (Environmental Resources Management and Marine et al, 2011). The 2009 Durban Estuaries Report found that "a very large proportion of the original Bay environment has been irretrievably lost and with it an arguably disproportionate level of regional estuarine function which, it can also be strongly argued, is on a trajectory of further degradation" (Forbes et al, 2008).

Table 6 Durban Estuarine Health

	Size (ha)	% of Total	Health rating	Anthropogenic threats to estuarine environments								
				Habitat Loss	Eutrophication	Freshwater diversions	Sewage	Chemical contamination	Litter/debris	Introduced species	Sea-level rise	Overexploitation
uTongati	95	4%	Highly Degraded	H	H	L	M	H	M	-	M	L
The uTongati Estuary is highly degraded with significant anthropogenic impacts to its natural habitats. The estuary, which has been modified so significantly that its functionality has essentially been nullified, has experienced shortening and shallowing that has reduced the original habitat by as much as 70%. Bridge construction, upstream dam construction, informal settlements, and sugar farming have reduced estuarine environments. Elevated levels of pathogens and high levels of nutrients suggest ineffective treatment or lacking sewage infrastructure.												
uMdloti	140	6%	Poor	H	H	H	M	M	L	-	M	L
In 1978 the uMdloti was described as "degraded in various ways," and the estuary has been further degraded since then. The estuarine habitat has been significantly reduced in size and function due to roads bisecting the floodplain, sugarcane plantings along the mid and upper estuary, and sedimentation. Hazelmere Dam, which is upstream of the uMdloti Estuary, has reduced the quantity of water reaching the estuary and significantly changed estuarine habitats. Increased residential land uses upstream correlate with an increase in nutrient levels in the estuary, which indicates improper effluent treatment and/or a lack of sewerage infrastructure.												
oHlanga	125	6%	Poor	M	H	H	M/H	L	L	-	M	L
The oHlanga Estuary's fish community, which was described as highly diverse in 1978, is now significantly reduced due to poor water quality stemming from poorly treated effluent from sewage works upstream. While the overall size of the estuarine habitat has not changed significantly, the poor water quality creates a hostile environment for native flora and fauna.												
uMngeni	230	10%	Highly Degraded	H	M	H	H	H	H	-	M	M
The uMngeni Estuary's size has decreased significantly due to extensive filling and canalization. The estuary suffers from poor water quality attributed to sewage spills, leaks and poorly treated effluent from sewage treatment facilities, and water discharges from the industrial basin which is immediately adjacent to the upper estuary. Four upstream dams have significantly reduced the quantity of freshwater reaching the estuary. The estuary is also over-fished.												

	Size (ha)	% of Total	Health rating	Anthropogenic threats to estuarine environments								
				Habitat Loss	Eutrophication	Freshwater diversions	Sewage	Chemical contamination	Litter/debris	Introduced species	Sea-level rise	Overexploitation
Durban Bay	910	40%	Highly Degraded	H	H	L	H	H	H	M	M	M
Discussed in further detail in a later part of this section, Durban Bay was significantly altered to develop the Port of Durban. Extensive infilling and canalization has reduced the habitat and altered the flows of freshwater into the estuary. The bay has poor water quality due to sewage spills, untreated and poorly treated effluent, and the adjacency of the industrial basin. Alien species have been recorded in the bay and endemic species have completely disappeared from the bay.												
iSiphingo	40	2%	Highly Degraded	H	H	H	H	H	H	-	M	L
This estuary's functions are severely compromised due to significant infilling and canalization due to industrial and residential development, high levels of nutrients, reduced freshwater, and chemical contaminations. Low dissolved oxygen levels and regular fish kills suggest significant nutrient loads due to improperly or untreated effluent discharges. System is average biodiversity importance.												
eziMbokodweni	12	1%	Highly Degraded	H	H	H	H	H	H	-	M	L
The eziMbokodweni Estuary is highly degraded due to a major loss of habitat area and nutrient and chemical contamination. Major industrialization in the catchment, infilling, and canalization have led to a loss in the size of the lagoon's mouth area. Low dissolved oxygen levels and regular fish kills suggest significant nutrient loads due to improperly or untreated effluent discharges and chemical contamination from the industrial basin. The estuary accumulates litter and debris during flash flood conditions.												
aManzimtoti	15	1%	Highly Degraded	H	H	M	H	H	H	M/H	M	L
The aManzimtoti Estuary is highly degraded. The estuary's mid and lower estuarine floodplains are reduced in size due to infilling and canalization. Freshwater levels are low due to extraction for irrigation upstream. Water quality in the estuary is poor due to discharges from drains that terminate in the estuary and high nutrient loads from improperly or untreated effluent that has led to regular fish kills. The invasive plant <i>Tarebia granifera</i> , which can negatively impact benthic communities, has been documented in the estuary.												
Little aManzimtoti	9	0%	Highly Degraded	M	H	M	H	L	M	-	M	-
The Little aManzimtoti Estuary is highly degraded due to a loss of flood plain areas. The estuary is possibly receive an excess of freshwater via discharged treated waste water. Water quality is poor due to high nutrient loads from improperly or untreated effluent that has led to regular fish kills.												
iLovu	225	10%	Fair	H	L	L	M	L	L	M/H	M	L
The iLovu Estuary is in fair condition with the loss of floodplain areas. The estuary experiences nutrient inputs from agriculture and upstream untreated effluent. It is under moderate pollution and habitat loss pressure. Freshwater extracted upstream for irrigation has reduced freshwater levels in the estuary. The invasive plant <i>Tarebia granifera</i> has been documented in the estuary.												

	Size (ha)	% of Total	Health rating	Anthropogenic threats to estuarine environments								
				Habitat Loss	Eutrophication	Freshwater diversions	Sewage	Chemical contamination	Litter/debris	Introduced species	Sea-level rise	Overexploitation
uMsimbazi	95	4%	Good	L	-	L	L	-	L	-	L	-
The uMsimbazi Estuary is in good condition because the estuary and its surroundings have not been developed at the same level as other estuaries; therefore its habitat diversity, water quality, and aesthetics remain good.												
uMgababa	112	5%	Good	M	L	M	L	L	L	-	L	L
In the 1970s, the uMgababa Estuary received a lot of attention to address heavy metal pollution. The uMgababa lagoon is "one of the most important on the Natal south coast, and has considerable conservation potential." However, increasing population density upstream has encroached the floodplain and the uMnini Dam diverts freshwater from reaching the estuary.												
Ngane	11	0.5%	Fair	M	-	-	M	-	L	-	L	L
The Ngane Estuary is in fair condition. Raised bacteria levels have been recorded in the past.												
uMkhomazi	139	6%	Fair	M	M	M	M	L	L	-	M	L
This estuary is in fair conditions. However, incursions into the floodplain by the construction of bridges and sand mining have been documented. Raised bacteria levels from untreated or poorly treated sewage have been consistently documented over the past several years. The increasing presence of dive boats in the estuary may increase gas and oil levels in the water.												
uMahlongwane	24	1%	Good	M	M	L	M	L	-	-	L	L
While the status of the uMahlongwane Estuary is Good, increasing threats indicate that this estuary is on a declining trajectory. The estuary's floodplains have been filled and drained for sugar plantations. The upper estuary is impacted by a waste water treatment plant and increased nutrient loads are rising. Freshwater is diverted upstream for irrigating sugar cane. The 2009 Durban Estuary Report suspects that there is chemical contamination from agricultural pesticides and herbicides.												
iMahlongwa	85	4%	Fair	M	M	L	M	L	L	-	L	L
While currently classified as in fair condition, the iMahlongwa Estuary is beginning to show the impacts from increasing urban development - habitat loss, poor water quality, less freshwater, and higher bacterial levels.												

Health Rating Scale

Excellent = Estuaries with high level of habitat integrity, good water quality, high diversity and high provisioning levels of goods and service

Good = Estuaries with most of the core estuarine habitat and estuarine support habitats still present, good water quality, diversity of habitat and species and estuarine processes in place

Fair = Estuaries with core estuarine habitat intact, some estuarine support habitats, impacted water quality and some loss of diversity and estuarine process in place

Poor = Estuaries with impacted core estuarine habitat. Substantially reduced or no estuarine support habitats, polluted water, substantial loss of diversity and/or abundance and key estuarine processes impaired

Highly Degraded = Estuaries which have had major impacts on core estuarine habitats through infilling, canalization and pollution, substantially reduced or no estuarine support habitats and major loss of key estuarine processes

Anthropogenic Rating Scale

H = High; M = Medium; L = Low; - = None

Source: Table created by AECOM with data from Forbes et al, 2008; DWA South Africa, 2013

The 2011 Bay of Natal Estuarine Management Plan gave Durban Bay an overall estuarine health score of E (30 out of 100), the lowest possible score. The bay scored 48 out of 100 for its habitat health score and a 13 out of 100 for its biotic health score as shown in Table 7. These low scores reflect the compromised state of Durban Bay. The Estuarine Management Plan states that given the major physical changes made to the bay to make it into a functioning port, the highest possible score the bay could achieve is a D. Therefore, the creation of the Port of Durban has had permanent, irreversible impacts on the health of the bay (Environmental Resources Management and Marine et al, 2011).

Degradation of Durban Bay directly correlates with the disappearance of waterbirds. While the Port of Durban is the major economic engine for the City of Durban, the creation of the port, its piers, and its support functions has resulted in the complete destruction of habitats that supported many plants and animals. The city does not have data on the impact of port activities on fish and plants, but the extensive data documenting the decline of bird populations in Durban Bay provides evidence of the port's impact on species. Between 1965 and 1999, the population of water birds in Durban Bay declined by 70%, 5 bird species were completely eliminated, 6 bird species saw major reductions, and 12 bird species saw minor reductions, as shown in Figure 19 (EPCPD, 2013c). During the same time period, the water bird populations

in other parts of South Africa did not see a similar decline. Allan, Sinclair & Rossouw (1999) in their studies of Durban Bay water birds estimated that the original area of the Bay has been reduced by about 57% and that only 14% of the original tidal flats, 3% of the mangroves, and 4% of the natural shoreline habitat remain (Environmental Resources Management and Marine et al, 2011). This indicates that the changes in the bay's natural environment led to the decline in species.

Mangroves

Mangrove habitats have significantly decreased in land area. For example, Durban Bay's mangrove habitat is just 3% of its original size. Mangroves, less than one percent of the total EMA land area, are critical ecosystems that are rich in biodiversity, act as a buffer from storm events, and play a pivotal role in cycling and detoxifying water. Mangroves are classified as critically endangered by the South African National Biodiversity Institute (SANBI). Mangroves exist in a few of the estuaries along the coast: Beachwood Mangroves Nature Estuary (uMngeni River Estuary) 44 ha; Bayhead Natural Heritage Site (Durban Bay) 15 ha; and Isipingo River Estuary 12.5 ha, as shown in Figure 20. The size of mangroves habitats has not changed much since 1982 because most of the mangrove loss occurred in the 1960s and 1970s (Steinke, T.D., n.d.).

Table 7 Provisional Present Ecological Health Status for Durban Bay

Estuarine Process or Biotic Component	Weight	Score	Weighted Score
Hydrology	25	60	15
Hydrodynamics and mouth condition	25	90	23
Water quality	25	20	5
Physical habitat alteration	25	20	5
Habitat Health Score			48
Final micro algae	20	20	4
Macrophytes	20	5	1
Final invertebrates	20	20	4
Fish	20	10	2
Birds	20	10	2
Biotic Health Score			13
Estuarine Health Score (average of habitat & biotic scores)			30
Provisional Present Ecological Category			E

(100 is excellent; 0-30 extremely poor quality)

Source: Environmental Resources Management and Marine et al., 2011

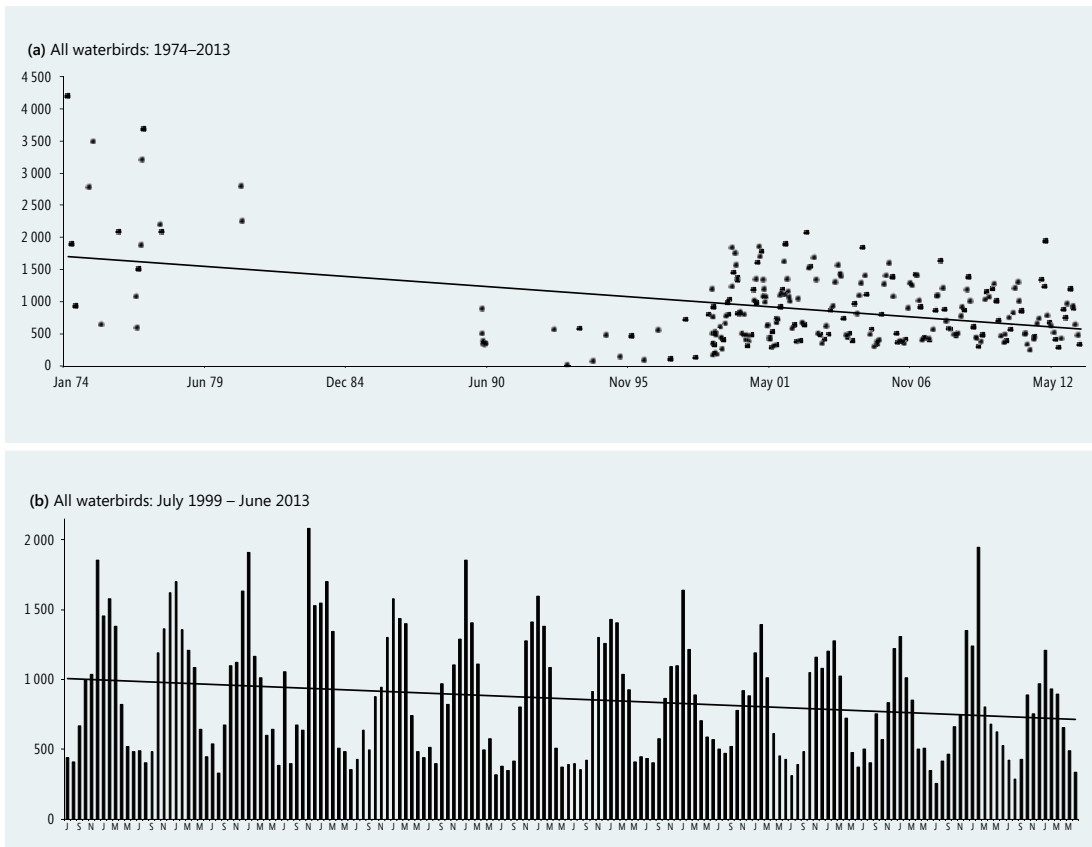


Figure 19 Decline in Water Bird Population from 1974 to 1999

Source: EPCPD, 2013c



Figure 20 Durban's Three Protected Mangrove Habitats

Source: Google Earth, 2014; AECOM

One example of the significant loss of mangrove habitats in eThekweni is Durban Bay, where the mangrove habitat declined from an estimated 438 hectares in the 1800s to 250 hectares in the 1950s and just 15 hectares today (EPCPD, 2011c; Environmental Resources Management et al, 2011). The surviving 15 hectares of mangroves are a protected natural heritage site.

Beaches

A popular tourist destination and a critical buffer against storms, Durban's beaches are eroding and increasingly polluted. With its subtropical climate and 98 miles of coastline that feature numerous beaches, Durban attracts 3.8 million visitors annually, who contribute R5.7 billion to the Durban economy (eThekweni Municipality, 2013a). In addition to being recreational and tourist attractions, Durban's beaches provide a storm buffer between terrestrial and marine ecosystems.

Beach erosion threatens plant and animal species, as well as human developments. When beaches erode, the natural buffer from storms disappears, leaving human settlements vulnerable. Beach erosion also eliminates the natural habitats of plant and animal species. The erosion can be attributed to heavy and more frequent storms, as well as the reduction in sedimentation flows from rivers. The development of Durban harbor as well as construction of the Lower Marine Parade contributed to the interruption of sand deposition on Durban's main beaches, driving an average total loss of 280,000 cubic meters of sand per year from the main beach front area (eThekweni Municipality, n.d. a). The city's Sand Pumping Scheme actively nourishes or replaces approximately 280,000 cubic meters of sand each year, dredged from the harbor's breakwaters.

Heavy nutrient loads in coastal waters adversely impact plant and animal species and can result in fish kills, algal blooms, and the destruction of native plant life. Surveys of the level of meiofauna present at La Lucia and Umdloti Beaches showed that meiofauna levels were drastically reduced near stormwater outfalls, highlighting how extremely sensitive these organisms are to disturbances in their environment. Meiofauna are very good indicators of the health of an ecosystem because they are sensitive to pollution and disappear in heavily polluted ecosystems (Govender, 2009).

While the water quality of Durban's beaches showed a trend toward increasingly poor quality from 2003 to 2008, a lack of consistent data is available to assess trends through 2014. The City of Durban regularly monitors the water quality of beaches and makes this information available through the City website. A 2014 survey of the city's 13 beach monitoring sites showed that only North Beach's water quality tested at a moderate level for the presence of E. coli bacteria, which can indicate the presence of human fecal matter from wastewater (see Figure 21). While the tracking of beach closings due to poor water quality does not appear to be currently maintained, numbers from 2003 to 2008 show an increasing trend of non-swim days each year due to poor water quality, as shown in Table 8 (eThekweni Municipality, 2008).

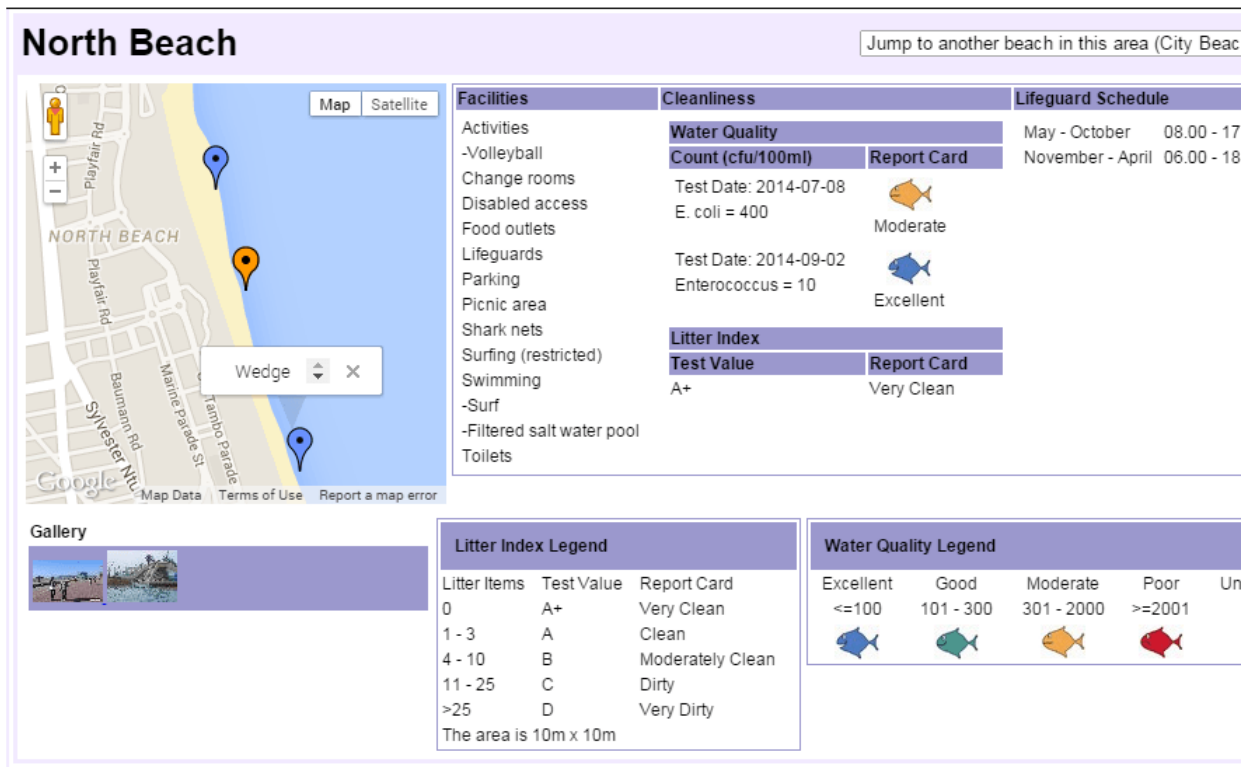


Figure 21 North Beach Quality Monitor

Source: Durban City Beach Water Quality Website http://www.durban.gov.za/Online_Tools/Pages/Beach_Water_Quality.aspx

Table 8 Beach Closing Due to Poor Water Quality

Indicator	Beach	2003-04	2004-05	2005-06	2006-07	2007-08	Trend	Sector Response
Number of non-swimming days at Durban's beaches due to poor water quality per annum.	Bay of Plenty	1 Day	4 Days	3 Days	9 Days	10 Days	↑	Number of swimming beaches monitored: 2003-2004: 2 2004-2005: 11 2005-2006: 12 2006-2007: 12 2007-2008: 12 Figures reflect exceedance from the Blue flag standard. From 2010 the water quality standards will be in accordance with Durban Beach monitoring program standards.
	Battery Beach	2 Days	6 Days	5 Days	11 Days	11 Days		
	South Beach	-	3 Days	3 Days	11 Days	10 Days		
	Country Club	-	5 Days	5 Days	8 Days	12 Days		
	Ansteys	-	2 Days	2 Days	8 Days	6 Days		
	Addington	-	2 Days	2 Days	6 Days	17 Days		
	Umhlanga Main	-	5 Days	-	-	-		
	Bronze Beach	-	3 Days	-	4 Days	10 Days		
	Westbrook	-	-	3 Days	6 Days	16 Days		
	Umhloti	-	-	4 Days	4 Days	4 Days		
	North Beach	-	-	2 Days	7 Days	10 Days		
	Umhlanga Rocks	-	-	-	5 Days	7 Days		
	Amanzimtoti	-	-	-	5 Days	15 Days		
Total Days		3	30	29	84	134		

Source: eThwKwini Municipality, 2008

Overview of Coastal Asset Trends

eThekweni's coastal assets, particularly its estuaries and bays, are in poor condition after decades of decline in quality and function. The overall decline of estuarine health has also contributed to and is a symptom of decline of mangrove forests, waterbirds and beach quality. While not all estuaries are in poor condition, those that remain in good condition face significant threats that could lead to future deterioration of ecological health such as the continued delivery of high nutrient loads from the municipality's rivers.

However, the improvement in beach quality over the past decade suggests that focused environmental management can reverse degradation. Furthermore, eThekweni's comprehensive baseline inventories and periodic monitoring of coastal assets such as estuaries and beaches will enable future management efforts to be focused on highest priority conservation and restoration activities.

D. Air

Air pollution can degrade ecosystems and lead to a number of health concerns. In eThekweni, the primary sources of air pollution are:

- **Industrial Activity** Durban's industrial activity is concentrated in the South Durban Industrial Basin, where industries such as Engen, Sappi, Tongaat-Hulett, and Mondi contribute significantly towards eThekweni's air pollution levels. The high levels of SO₂ have been the main contributor towards the decline of eThekweni's air quality over the past few years (Bruce Dale, Pollution Control, 2014). However, there have been interventions over the past 10 years that resulted in improvements in air quality during that time. Some of the air quality improvement interventions have included Air Quality Management Plans, the Annual Air Quality Governance Lekgotla and Air Quality monitoring systems in the affected areas. The industries mentioned above are regulated by an Air Emissions License or a Scheduled Trade. Quarries for stone and sand, located throughout eThekweni, can be sources of particulate matter but are less consistently regulated than other industries.
- **Vehicular Transportation** The road transport sector is considered to be a growing source of air pollution in the city. eThekweni has documented an increase in private motor vehicles as a transport mode. The municipality has documented high numbers of old passenger motor vehicles and heavy-duty trucks on the road, which contribute to high levels of air pollution and fuel consumption. Engineering solutions have typically been adopted to manage congestion, with little regard to the consequences for air pollution (eThekweni Municipality, 2014b).
- **Landfills** Landfill sites are major sources of gases such as methane (CH₄) and carbon dioxide (CO₂) which are greenhouse gases that contribute to climate change if not mitigated. eThekweni has facilities at its Bisasar Road and Mariannahill landfills that capture methane gas generated by the landfills and convert the gas to energy, thereby reducing the amount of CH₄ that enters the atmosphere (source: Strachan et al, n.d.).

- Agricultural Activity** Although agricultural activity such as sugar cane burning visibly affects the environment, it did not have a major impact on the air quality indicators such as PM10 and Sulphur Dioxide. The sugar cane industry burns 90% of its crop at harvest, while 10% is harvested green (Dept. of Env Affairs, 2013). Preliminary findings from the Air Quality Management Plan Update 2015 show that biomass burning (e.g. sugar cane) accounts for only 1% of PM10 emissions and less than 1% of NOx emissions (eThekweni Municipality, 2015) while accounting for less than 1% of SO2 emissions (eThekweni Municipality, 2013d).
- Durban has implemented air regulations that have lowered the concentration of major air pollutants below international thresholds; however vehicular transportation is a growing source of air pollution.** The Health Unit has been monitoring the concentration of benzene, sulphur dioxide (SO₂), indoor air pollution, particulate matter (PM₁₀), ozone (O₃), nitrogen dioxide (NO₂), carbon monoxide (CO), and odors around the eThekweni area for decades. The monitoring stations, extending from Isipingo in the south to Tongaat in the north and Pinetown in the west, are distributed throughout eThekweni to gather air pollution from the following sources: heavy industries, small to medium industries, traffic, and residential areas. The majority of the stations are located in the South Durban Industrial Basin, which is a hot spot for various pollutants (Dept. of Env. Affairs, 2013). Major pollutants and their concentrations are described here:
- Benzene and VOC** In 2004 and 2005, the benzene levels were below the WHO's threshold value of 10 µg/m³, but above the WHO's 2010 target of 5 µg/m³ (see Figure 22). The WHO states that no level of benzene exposure is safe but has placed target limits to help encourage reductions in benzene (eThekweni Health et al, 2007). Typical benzene sources are industries and vehicles that refine or burn oil. The primary source of VOC emissions in eThekweni in 2004 was from vehicles burning gasoline fuel.

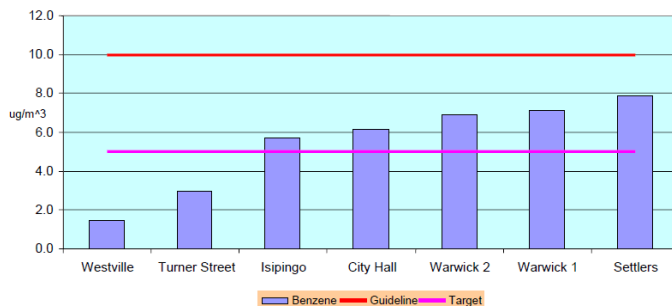


Figure 22 Annual Benzene Average, 2005
 Source: eThekweni Health et al, 2007

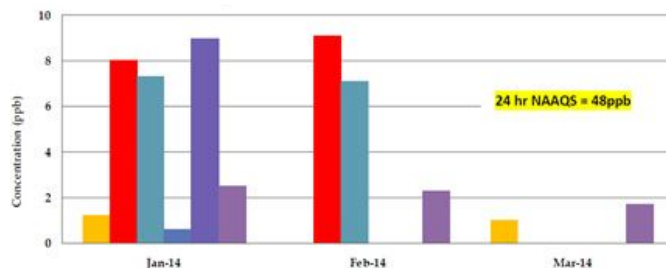


Figure 23 SO₂ Monthly Averages (24hr Averages), 2014 Q1
 Source: eThekweni Municipality, 2014b (Note: Data shown in Figure 23 reflects six monitoring station in eThekweni.)

- Sulphur Dioxide (SO₂)** Industrial activities in South Durban accounted for more than 96% of SO₂ emissions in 2005. The amount of SO₂ emissions decreased by 45% from 1997 to 2006. Over this period, major polluters installed scrubbers on smoke stacks to reduce SO₂ emissions. In 2005, the overall picture of SO₂ exceedances improved, with a 54% reduction in the number of 10-minute exceedances and a 56% reduction in the number of daily exceedances between 2004 and 2005 (eThekweni Health et al, 2007). This positive trend has continued as the 2014 Quarter 1 Air Quality Report found no exceedances during the first three months of the year; however no data was collected at Wentworth monitoring station due to faulty data analyzers. Wentworth (shown in light blue in Figure 23) is a site that has historically reported high levels of SO₂. The data collected from the Southern Works monitoring station showed levels of SO₂ below the 24-hour standard (eThekweni Municipality, 2014b).

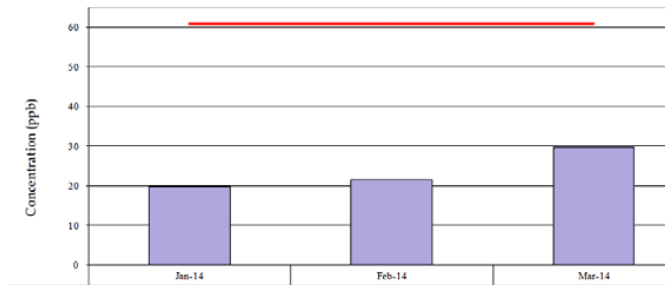


Figure 26 O₃ Monthly Averages (8-hour), 2014 Q1
 Source: eThekweni Municipality, 2014b (Note: Concentrations are below 8hr NAAQS standard of 61.)

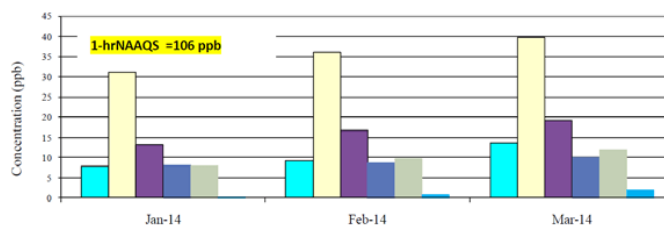


Figure 27 NO₂ Monthly Averages (24hrs), 2014 Q1
 Source: eThekweni Municipality, 2014b (Note: Concentrations were measured at five locations in eThekweni.)

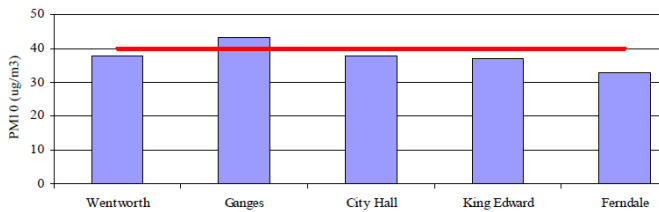


Figure 24 PM₁₀ Annual Average Concentration for 2005 at Various Stations
 Source: eThekweni Health et al, 2007

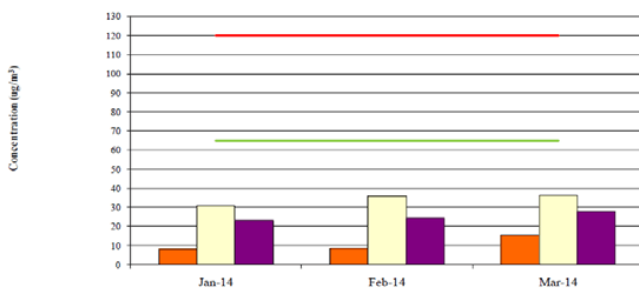


Figure 25 PM₁₀ and PM_{2.5} Monthly Averages, 2014 Q1
 Source: eThekweni Municipality, 2014b (Note: Concentrations from three monitoring locations are reported in Figure. The PM_{2.5} (24hrs NAAQS Limit Value) is at 65 while the PM₁₀ (24hr NAAQS Limit Value) is at 120.)

- Particulate Matter (PM₁₀)** Concentrations of particulate matter (PM₁₀) have decreased over the past decade. In 2005, the average annual PM₁₀ concentrations measured at four of the five monitoring stations was just below the allowable threshold and the fifth exceeded the threshold, and there were several daily exceedances documented at the five stations, as shown in Figure 24 (eThekweni Health et al, 2007). In Quarter 1 of 2014, the average 24 hour concentrations of PM₁₀ were below thresholds, and there were no exceedances, as shown in Figure 25 (eThekweni Municipality, Air Quality, 2014).
- Ozone (O₃)** In Q1 2014, Ozone (O₃) concentrations were below the 8 hour standard of 61 ppb, and there were no exceedances during this period, as shown in Figure 26 (eThekweni Municipality, 2014b).
- Nitrogen Dioxide (NO₂)** In Q1 2014, the average 1 hour concentrations for Nitrogen Dioxide (NO₂) were below the 1 hour standard of 106 ppb, and there were no exceedances during this period, as shown in Figure 27 (eThekweni Municipality, 2014b).

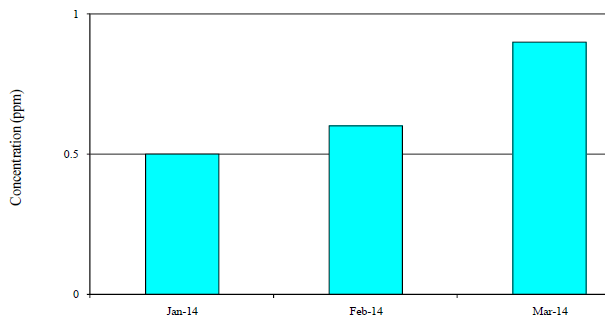


Figure 28 CO Monthly Averages, 2014 Q1
 Source: eThekweni Municipality, 2014b (Note: Concentrations are well below 1-hr NAAQS standard of 26.)

- Carbon Monoxide (CO)** CO levels are measured only at the Warwick traffic station. In Q1 2014, the average 1 hour concentrations for Carbon Monoxide (CO) were below the 1 hour standard of 26 ppm, and there were no exceedances during this period, as shown in Figure 28 (eThekweni Municipality, 2014b).

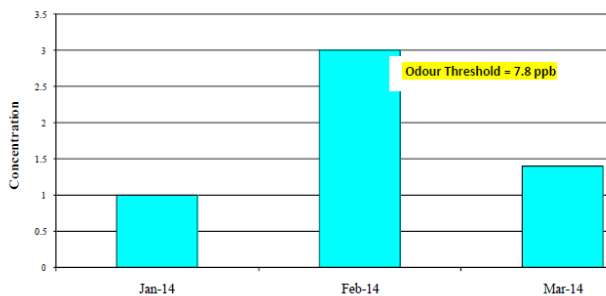


Figure 29 TRS Monthly Averages (30 min), 2014 Q1
 Source: eThekweni Municipality, 2014b (Note: Concentrations are below threshold of 7.8.)

- Odors and Total Reduced Sulphur (TRS)** While odor is a subjective pollutant, monitors are able to assess the levels of some chemicals that cause odors. Odor sources in eThekweni are from landfills, the paper mill, waste-water treatment facilities, oil refineries, and sewage pumping stations (eThekweni Health et al, 2007). In Q1 2014, the Total Reduced Sulphur (TRS) concentrations are below the odor threshold of 7.8 ppb, as shown in Figure 29 (eThekweni Municipality, 2014b).

Greenhouse Gas (GHG) Emissions

eThekweni has been a leader among African cities for tracking GHG emissions with transportation emissions accounting for 37% of the city's GHG contributions.

Transportation and industrial processes account for the most significant sources of GHG emissions, based on a community-wide inventory of emissions from the land area of Durban (see Figure 30, GHG emissions by sector). The findings of significant transportation emissions correlate with Durban's sprawling development footprint, partly reflected by the considerable amount of fuel consumed by vehicles for moving throughout the city.

While eThekweni has been a leader among cities in Africa in terms of establishing (in 2002) and regularly updating a greenhouse gas inventory, analyses of GHG trends for Durban are not conclusive, as the methodology for collecting and reporting data was not clearly defined until the 2010 GHG Inventory conducted in year 2011. However, looking towards the future, eThekweni is now well-positioned to evaluate its contributions and savings in GHG emissions through future inventories. From a general review of the city's GHG inventories, there is a continued and steady increase in emissions. It should be noted that this trend is partly the result of improved data collection methodologies, but also results from increased uses of energy- and carbon-intensive processes such as transportation, industry, and power generation.

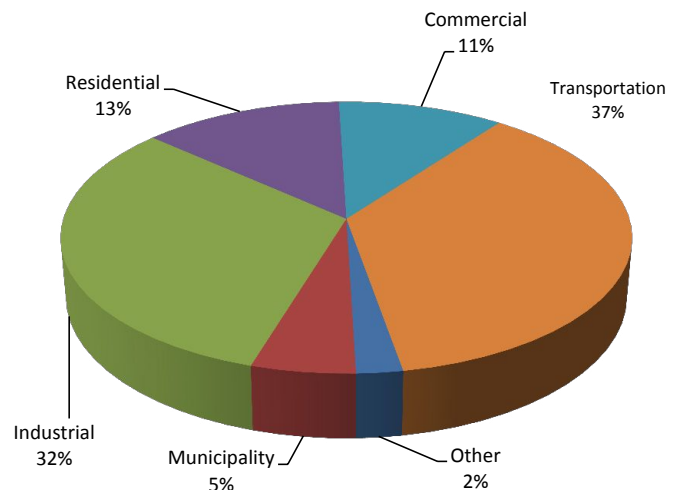


Figure 30 GHG Emissions by Sector
 Source: Energy Office, 2012

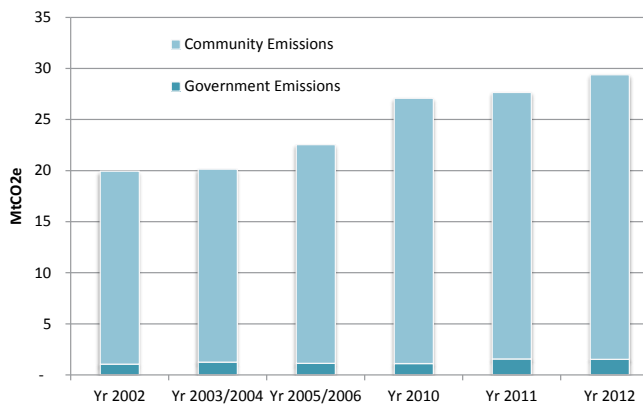


Figure 31 Historic Emissions Data for the eThekweni Municipality (tCO₂e)
 Source: Energy Office, 2012

Overview of Air Quality Trends

eThekweni’s air quality has shown considerable improvement over the past decade with regard to parameters such as SO₂ and PM₁₀. Consistent monitoring of locations throughout the municipality has provided a strong understanding of hot spots requiring particular management for air quality improvements, such as south Durban. This monitoring combined with community advocacy and awareness-raising of air quality decline has contributed to reversing degradation trends.

While some local air quality parameters related to industrial pollution have declined, air quality indicators such as Benzene have registered higher readings. Additionally, eThekweni’s greenhouse gas emissions have increased suggesting that growth in vehicle use and fuel consumption will contribute to future increases in related parameters such as Benzene, VOCs and GHGs. eThekweni’s leadership among cities globally, in tracking greenhouse gas emissions, should help raise awareness in the future of which urban sectors are driving GHG emission inventory changes. Similar to the municipality’s success in management SO₂ and PM₁₀, regular GHG inventory updates and continued monitoring of other local air quality parameters will enable prioritization of actions for reversing air quality degradation.

IV. DIRECT DRIVERS AND CAUSES OF ENVIRONMENTAL VULNERABILITY AND DEGRADATION

As described in Section III, Durban's environmental assets have been significantly degraded by anthropogenic actions. While ancillary drivers certainly exist, this section of the Urban Environmental Profile documents the direct drivers of environmental vulnerability and degradation.

A. Informal Settlements

The proportion of eThekweni households in informal settlements is increasing. EMA is unable to keep pace with the increasing demand for low-income and affordable housing. An array of political and social factors has pushed low-income residents to settle in environmentally vulnerable locations. Over a ten-year period the proportion of eThekweni households living in informal settlements has increased despite aggressive municipal efforts to upgrade settlements during that timeframe. In 2001, 24.9% (204,812) eThekweni households lived in informal settlements and in 2011, 27.4% (262,000) of households lived in informal settlements (The Housing Development Agency, 2012, 2013).

According to the 2011 Census, a higher proportion of the population lives in informal settlements in the EMA than in the rest of KwaZulu-Natal (KZN) province. An estimated 75% of households living in informal settlements in KZN live in the eThekweni Metro Area, whereas EMA is home to only 38% of KZN's population (The Housing Development Agency, 2013).²

²*It is important to note that the 2011 Census estimates there 111,000 households in informal settlements in eThekweni; however, the eThekweni Municipality estimated that there were 262,000 households in informal settlements in 2011. The extreme discrepancy may be due to the differences in the definitions of an informal settlement (KZN Informal settlements status, 2013).*

The increase in eThekweni population living in informal settlements can be attributed to the continued urbanization of the region and the slow pace of low-income housing supply in Durban. There is a significant demand for low-income housing (housing that serves the most poor) as well as affordable housing (housing that serves the next level up from low-income). The eThekweni Municipality has developed thousands of homes to address the low-income housing shortage; however the high backlog of demand, lack of well-located land, and limited funding have made it difficult to meet the extreme demand; therefore low-income households are creating their own housing on land that is far from the central business district and located on environmentally vulnerable land (eThekweni Municipality, 2014a).

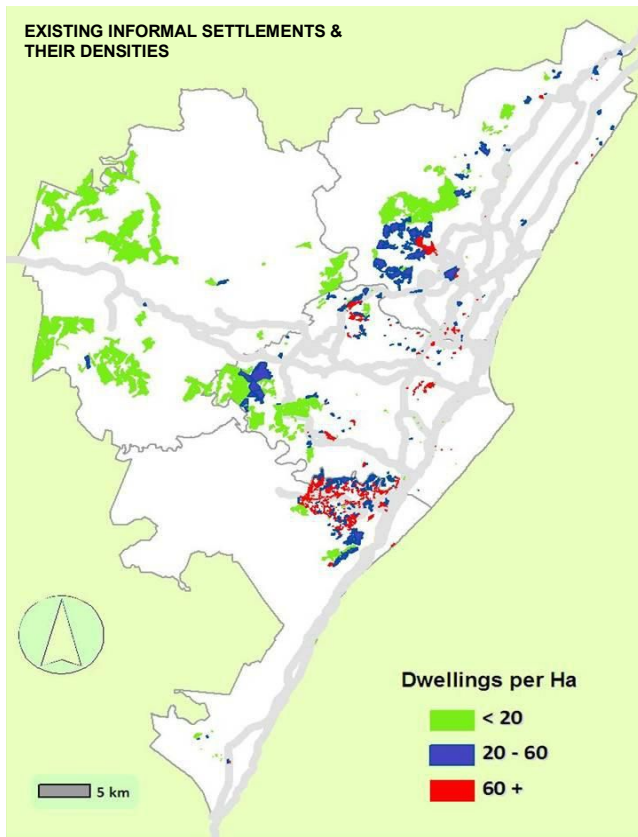


Figure 32 Existing Informal Settlement
 Source: eThekweni Municipality, 2013b

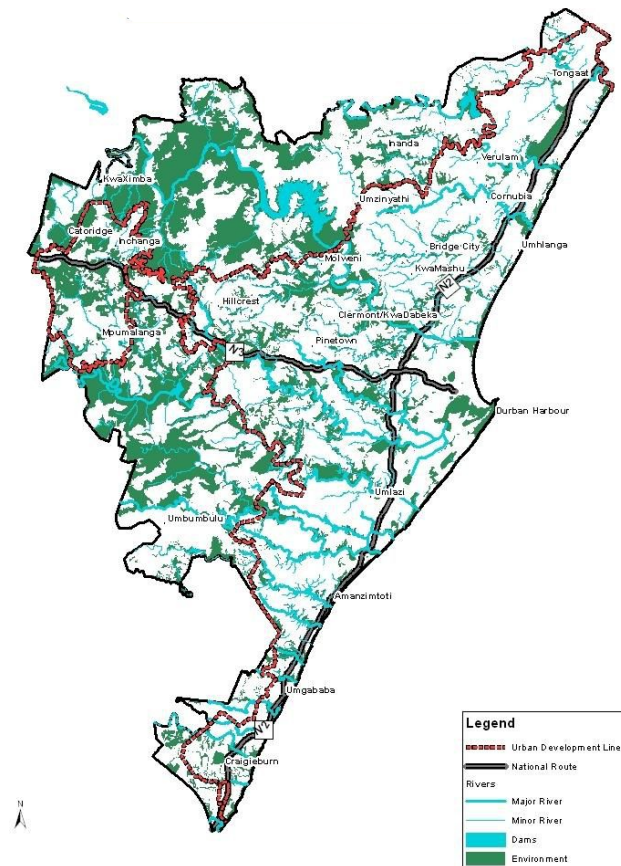


Figure 33 Environmental Map
 Source: eThekweni Municipality, 2013b

Informal settlements, predominantly located at the urban periphery and upstream of the rest of Durban, are displacing Durban’s existing environmental assets and negatively impacting the entire catchment. By locating on greenfields, the informal settlements replace the natural vegetated landscape with human development, greatly reducing or eliminating the ecosystem services the vegetated landscape provides. Viewing Figure 32 and Figure 33 side-by-side shows how the location of informal settlements correlates with the location of eThekweni’s remaining terrestrial assets. Furthermore, these growing informal settlements are located upstream of the rest of eThekweni. Since approximately 67% or 209,847 households within informal and rural settlements lack sewage infrastructure, the human waste generated by these settlements flows into the river system and impacts the entire catchment (The Housing Development Agency, 2012; 2013; Thola, 2015). For example, a detailed study of the condition of catchments in the Outer West Corridor found that the natural habitat was significantly degraded by rural settlements, as well as by agriculture and sand mining practices. The study found that nutrient loading from untreated effluent generated by informal settlements lacking sewage infrastructure was degrading river water quality and leading to massive infestations of alien aquatic weeds, such as the water hyacinth (Graham Muller Associates Consortium et al, n.d.).

B. Effluent

The loading of nutrients by inadequate household sanitation infrastructure and industrial processes drives poor water quality of the city's rivers, degrades estuarine health, and increases raw water treatment costs. High nutrient concentrations found in the lower Umngeni river catchment, Durban's primary river catchment, indicate release of upstream effluent contributions from multiple sewage-related sources. Nutrient-rich effluent such as sewage and industrial wastes are causing significant degradation of water quality, impairing health of flora and fauna, and contributing to a proliferation of alien invasive species. About 23% of estuaries within the broader water management area that serves Durban are under significant pressure from discharges from waste water treatment facilities, stormwater runoff, and discharges from industry (eThekweni Municipality, 2011; DWA South Africa, 2013). Impacts to the municipality can include an increase in raw water treatment costs (WSDP, 1999) as well as reduction in tourist and recreational offerings, as most of Durban's estuaries are unfit for full-contact recreational use (eThekweni Municipality, 2011).

Lack of sewage infrastructure in informal settlements contributes to the degradation of water bodies. According to the Census from 2001 to 2011, there was a 50% increase in the number of households with toilets connected to sewage infrastructure; however, that represents only 15% of the total households in informal settlements in 2011 (see Table 9). In 2011, approximately 67% (209,847 out of 313,958 households) of informal settlement and rural traditional households lacked sanitation infrastructure (eThekweni Municipality, 2012a). This means that the human waste from those households was disposed directly into natural systems, without prior treatment in a waste-water facility (Thola, 2015). The 1999 Waster Services Development Plan notes that a number of rivers in the Durban Metropolitan Area are of inferior quality mainly due to the overland runoff from informal and infill settlements, where there are inadequate water services (WSDP, 1999). Human waste contains nitrate and phosphorus, two nutrients that occur naturally in water bodies, but when found in high levels, these nutrients disrupt the balance of aquatic ecosystems and cause the proliferation of alien invasive plant species and the loss of native flora and fauna species.

Table 9 Access to Sanitation Facilities: eThekweni Households in Informal Settlements

Access to Sanitation Facilities	2001	2011	% change between 2001 and 2011
Higher level of access (Flush toilet connected to sewerage system)	10%	15%	50%
Basic access (Flush toilet with septic tank / pit latrine with VIP)	16%	12%	-25%
No access	75%	72%	-4%

Source: The Housing Development Agency, 2012, 2013

Note: It is important to note that the data shown in Table 9 is for eThekweni households in informal settlements as defined by the Census; however, the Census defines informal dwellings more strictly than the eThekweni Municipality. Therefore, the figures in this table may not truly represent the access informal dwellings have to infrastructure services. The Water Services Development Plan 2012, conducted aerial counts of informal housing structures and notes that there are 313,958 informal settlement and rural housing structures of which 67% or 209,847 lack access to basic sanitation (eThekweni Municipality, 2012a).

eThekwini's present sewage treatment infrastructure presents a significant risk to the city's environmental assets. Durban's waste-water treatment infrastructure consists of approximately 27 waste-water treatment works, approximately 280 sewage pump stations and 7,500 km of main trunk sewer lines (Thola, 2015). The system treats waste from approximately 500,000 households, 34,000 ablution blocks (multiple unit communal sanitation facilities connected to the main sewage system) and 956 permitted industries (eThekwini Municipality, 2011).

Inadequate treatment, inadequate operations and maintenance, improper disposal, vandalism, blockages throughout the main trunk lines, instances of pump breakdown, uncollected solid waste and spills and overflows due to storm events are ways that raw sewage directly pollutes groundwater and surface waters (Thola, 2015; Gordon, 2015). Anticipated impacts from climate change such as increased intensity of coastal storms and sea level rise could also exacerbate the occurrence of effluent releases as there are many sewage pumping stations located in vulnerable areas (eThekwini Municipality, 2011). eThekwini has implemented a pilot program to detect potential sewage spills by installing telemetry devices on approximately 50 sewage pumps, that alert maintenance crews when a pump fails (Fennemore, 2015).

Testing of river water downstream of select waste-water treatment works has confirmed high levels of nutrients that indicate inadequate levels of waste-water treatment (Ground Truth, 2006). While the rivers have some capacity to assimilate these pollutant loads, excess nutrients can contribute to ecological damage, such as those described above (DWA South Africa, 2013).

Nutrient loading of rivers from waste-water treatment effluent has been transported directly into Durban's estuaries, serving as one of the threats to estuarine health (Ground Truth, 2006). Sludge, the nutrient-rich byproduct generated from waste-water treatment, is disposed through re-use as fertilizer and compost, but a sizeable portion of Durban's sludge is also discharged directly into a 4km long sea outfall by the Central and Southern Waste-water Treatment Works.

Monitoring by CSIR shows that the most significant impacts from the outfall include enriched organic matter deposits within 300 m of the diffuser at the end of the outfall.

Table 10 Wastewater Treatment Works Loading & Capacity – Status Quo, 2030 Scenario and Ultimate Scenario

Wastewater Treatment Catchment	Wastewater Treatment Works	2010 Status Quo (MI/day)		2030 Scenario (Anticipated MI/day)		Ultimate Scenario (Anticipated MI/day)	
		Capacity	Load	Load	Additional Capacity Required	Load	Additional Capacity Required (over Status Quo)
Tongati	Tongaat Central	11	7	28	17	81	70
Mdloti	Verulam	12	6	24	12	66	66
	Umdloti (Existing)	2.3	1.6				
	Genazzano	1.7	1.3				
	New Mdloti (Regional)	0	0				
	All	16	9				
Ohlogna	Phoenix	25	23	57	25	81	56
	Umhlanga	7					
	All	32					
Umngeni	KwaMashu	59	67	84	25	100	41
	Northern	58	54	66	8	99	41
	All	117	121				

Source: eThekwini Municipality (2011)

While this impact is not considered to pose an immediate ecological threat, the expansion of the enrichment is a cause for concern that requires additional management consideration (CSIR, 2012). Depending on the ocean currents and amount of sludge discharged into the sea, this nutrient-rich material can also contribute to estuarine and beach habitat environmental impacts, though the CSIR monitoring report does not note any substantive impacts to these environmental assets.

Stormwater runoff and diffuse pollution from household sanitation systems that are not connected to the municipal sewage system flow untreated into Durban's rivers. Increased impervious surface from development has increased stormwater runoff during rain events, which can overwhelm existing waste-water treatment facilities, causing facilities to release untreated or minimally treated raw sewage into the environment. The lack of adequate city-wide drainage systems that slow velocities and volumes of stormwater while promoting infiltration exacerbates transport of household sanitation effluent and raw sewage releases. Moreover, the lack of sewage systems for a large percentage of the population, as previously described, makes sanitation waste easily available for transport by stormwater.

C. Extraction of Natural Resources

Sand Mining

Sand mining practices not only degrade terrestrial assets, but the practice has rippling impacts on aquatic and coastal assets as well. Sand mining operations strip a terrestrial ecosystem of all vegetation in order to access the natural sand deposits underneath. While sand is an essential raw material that is in high demand by the building industry, the proliferation of legal and illegal sand mining operations has a ripple effect of degradation on terrestrial ecosystems and aquatic and coastal ecosystems. Current sand mining practices are largely unregulated, and compliance monitoring by the national Department of Minerals appears to be absent (Ground Truth, 2006).



Photo: Sanding mining strips away all vegetation, wildlife habitat, and surficial soils, exposing sub surface soils and sands that can rapidly erode and cause sedimentation of streams, rivers and estuaries.

Source: AECOM

The 16 rivers within EMA jurisdiction, supply sediment (an ecosystem service) to the coastal zone, which is important in replenishing sand lost from beaches and coastal dunes through coastal erosion processes. Over the years, sediment flows to beaches have increased due to poor land management practices, but overall supply to the coastline has decreased by two-thirds of “natural” yields due to sand mining and the 12 large dams that have been constructed on Durban's rivers, which act as sediment traps (eThekweni Municipality, 2014a). Legal and illegal sand mining operations remove one third of all sediment from rivers, which in turn reduces the flow of sediment to beaches and contributes to beach erosion (EPCPD, 2011b). As described previously, beach erosion is a major problem according to a recent study by the Council for Scientific and Industrial Research in South Africa (CSIR). The CSIR found that roughly R 2.565 billion, in 2008 dollars, would be lost if sand mining operations resulted in the denudation of Durban's beaches (CSIR, 2008). Given that discharge of sediment from rivers dominates sand supply, it is predicted that the reduction in sand supply could result in mean coastal erosion of > 1 m/yr (eThekweni Municipality, 2014a).

In addition to contributing to the reduction of sediment flow, sand mining also negatively impacts the environment in the following ways:

- Vegetation removal, which kills indigenous species, destroys or fragments their habitat, and reduces the sequestration of carbon dioxide.
- Removal of soil, which destroys native habitats and exposes the disturbed area to colonization by invasive species (Ground Truth, 2006; EPCPD, 2011b).
- Sedimentation removal, which adversely alters the geochemistry downstream by increasing metal concentrations and decreasing nutrients (Pillay et al, 2014).
- Leakage and spills, including oil and diesel fuel (Ground Truth, 2006).

Water Extraction

The extraction of potable water to support settlements negatively impacts all environmental assets by removing water from the system and by reducing and eliminating natural flows of water down rivers. Potable water in Durban is supplied by 12 dams, which provide 90% of potable water to Durban's citizens. While necessary to extract water for human consumption, dams create major disruptions to natural aquatic habitats by inhibiting the natural migration of aquatic species and trapping sedimentation. As previously discussed, the fragmentation of habitats negatively impacts endemic species and reduces biodiversity, which can alter natural flow of sediments, impacting the health of beaches downstream. Additionally, dams divert freshwater from rivers, which impacts riverine habitats as well as estuarine habitats, which rely on a mix of freshwater and seawater. The 2009 Durban Estuaries Report found that 15 of the 16 estuaries are experiencing reduced freshwater flows – while freshwater diversion is cited as a significant threat to 5 estuaries (Forbes et al, 2008).

Durban is facing a major water shortage problem and has avoided major droughts only because there has been adequate rainfall (AECOM, 2014). Currently, water is primarily supplied to Durban via the uMngeni catchment. However, the Department of Water and Sanitation anticipates that demand will soon outstrip supply, and eThekweni will need to import water from neighboring catchments. However, existing and proposed land developments that lack adequate watershed protections within the broader catchments outside of the EMA boundaries, pose a significant threat to the quality of Durban's present and future water supply (personal communications Fennemore, 2015).

D. Development of the Port of Durban

While the Port of Durban is a critical economic engine, the development of the Port has affected the ecology of the bay. Entire taxonomic animal groups have disappeared from the bay. The bay's mangrove habitat has decreased to 3% of its original land area, and water bird populations have declined by 70%. The Port of Durban is a significant economic driver for the City of Durban and a critical asset for South Africa. In 2008, approximately 6,000 people were directly employed by the Port, and another 30,000 people were dependent on port activities. South Africa relies on the Port of Durban for almost all of its import/export of vehicles, a large amount of its tanker cargo, and the majority of its general products arriving by shipping containers (Angel et al, 2008).

Prior to the port's development, the bay was characterized by large mangrove areas and shallow sandbars, and a mix of freshwater and marine water. The development of the port involved dredging and the construction of pier facilities, which changed the bay into a marine water estuary with little freshwater (Angel et al, 2008). Figure 34 depicts the evolution of the Bay into the Port of Durban, which resulted in a loss of 57% of the original marine habitat.

A comparison of the results of comprehensive biological surveys conducted in 1950/1952 (Day & Morgan, 1956 as noted in Angel et al., 2008) and 1991/1992 (Hay et al., 1995 as noted in Angel et al., 2008) in Durban Bay revealed the entire absence of entire taxonomic animal groups, which indicated that habitat requirements were no longer being met (Angel et al, 2008). As stated in the previous section, the mangrove habitat in Durban Bay decreased dramatically, and the waterfowl populations have also declined.

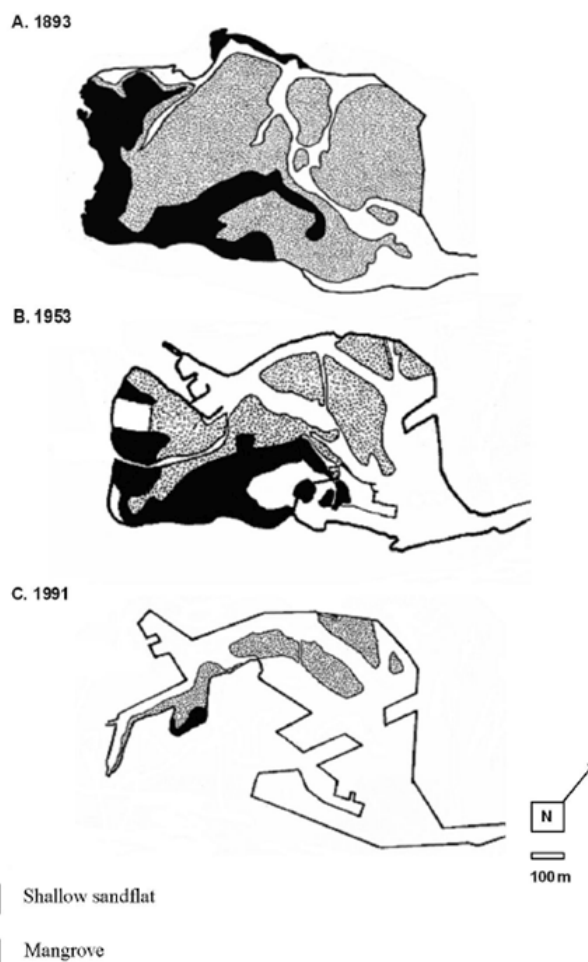


Figure 34 Durban Bay Habitat Distribution, 1893-1991
Source: A. Diagram of Durban Bay before harbor development. B. The bay at the time when Day and Morgan conducted the first comprehensive survey. C. Diagram of what the bay looked like in the early 1990's and close to what it looks like today. Straight lines represent harbor development. Source: Angel et al, 2008

As the Port of Durban continues to develop, air pollution is likely to increase. The expansion of the Port of Durban's capacity will place an increased demand on land-based transport of cargo. Only a small proportion of freight transported into and out of Durban is carried by rail, while a majority of cargo is carried by trucks. Trucks are a significant contributor to greenhouse gas emissions and can degrade air quality (EPCPD, 2014a).

E. Solid Waste

While eThekweni's rate of solid waste collection is much higher than other African cities, 9.6% of waste remains uncollected and contributes to environmental degradation (eThekweni Municipality, 2004). Uncollected waste from settlements can clog drainages causing floods that further erode catchments, contribute sediments to eThekweni's rivers and block sewer infrastructure causing sewer back-ups and overflows (DWA South Africa, 2013; eThekweni Municipality, 2014d; Gordon, 2015). Approximately 75% of waste remains uncollected from informal areas, contributing to clogging of drainages and streams (eThekweni Municipality, 2013d).

Although inadequately managed electronic waste is generally acknowledged as one of the many contributors to runoff contamination in South Africa's cities, there is limited, current, data available substantiating e-waste and potential impacts to eThekweni's environmental assets (EWASA, 2008). Furthermore, illegal dumping of waste outside of regulated collection and disposal means is a contributor to environmental degradation, costing the City R180 million for enforcing and addressing the problem, as this waste remains uncollected and available for transport into the city's rivers, drainage channels and estuaries (eThekweni Municipality, 2015e).

Solid waste collected in eThekweni's landfills also drives a portion of the city's air pollution. Landfill processing and decomposition of waste releases methane which contributes to the approximately 1% of Durban's greenhouse gas emissions that are derived from methane (eThekweni Municipality, 2013d). However, the municipality has established a landfill gas to electricity project at Marianhill and Biasar Road landfills to capture and process methane, a high global warming potential gas, into electricity generation. These efforts have prevented approximately 1,549,030 tons of carbon dioxide equivalent from being released into the atmosphere since the project's inception or about 20,000 tons of carbon dioxide equivalent each month or approximately 240,000 tons of CO₂e per year (eThekweni Municipality, 2013d; eThekweni Municipality, 2013e). This landfill methane processing removes the equivalent of half of the amount of methane emitted from the City's waste facilities each year (534,498 tons of CO₂e released according to the 2011 GHG Inventory) (eThekweni Municipality, 2013d, eThekweni Municipality, 2013e).

While leachate from the Mariannhill Landfill contains high levels of ammoniacal-nitrogen which is toxic to plants, animals and fish, a prototype on-site treatment facility is demonstrating an ability to cleanse effluent-rich leachate using reed-beds to polish the treated water (eThekweni Municipality, 2013e; Strachan, 2010). Furthermore, eThekweni's Mariannhill and Buffelsdraai Landfills are being closely managed and monitored for environmental impacts while also containing extensive buffers with environmental management plans for protecting vegetation, wildlife and groundwater resources (Moody et al., 2011). The establishment of the Mariannhill Landfill Conservancy, perhaps among the first landfill conservancies in Africa, is helping to protect local aquatic and terrestrial assets while also informing environmental management concepts for use at the city's other landfill sites (Strachan, n.d.a).

V. INSTITUTIONAL CHALLENGES

A. Overview

In discussing the key drivers and causes of environmental vulnerability and the promotion, or lack thereof, of green urban development in eThekweni, the threads converge onto governance and institutional issues. This section, therefore, seeks to: (i) characterize the prevailing institutional landscape around promoting green urban development in eThekweni, thereby highlighting key institutional factors or challenges that may foster or hinder green urban development, and (ii) offer possible suggestions for improvement. To provide tangible examples we focused on the environmental assets of land and water and on the issues of planning, management and implementation of the Durban Metropolitan Open Space System (D'MOSS). These are discussed within a broader context of urban planning and development.

The first half of the section will present an overview of the prevailing institutional landscape through a rapid institutional mapping organized around four main areas: (i) institutional structure, (ii) relevant regulatory environment, (iii) typical processes and interactions and (iv) capacity and resources (see Figure below). The selected key agencies or institutions involved in the planning, execution and management related to the environmental assets of land and water are introduced.

With the overall understanding established in the first part, the second half of the section explores the key institutional challenges and issues related to these four areas. Finally, the section concludes by offering some suggestions and recommendations for improvements to policy and decision makers and practitioners.

The methodology undertaken comprised mainly: (i) data collection through desk-research on the background of the selected agencies/institutions for the institutional mapping and conducting face-to-face interviews with senior technical staff in some of the agencies/institutions; and (ii) institutional context analysis using information mainly drawn from the interviews and any supplementary documents or data collected.

The discussion does not seek to be comprehensive and does not cover all relevant stakeholders. Instead, through the qualitative and anecdotal evidence, it serves to highlight and reveal some of the main institutional obstacles, to candidly surface issues being faced and reflect honest opinions, in the hopes of feeding into larger ongoing debates and assisting with tackling the challenges of achieving green urban development.

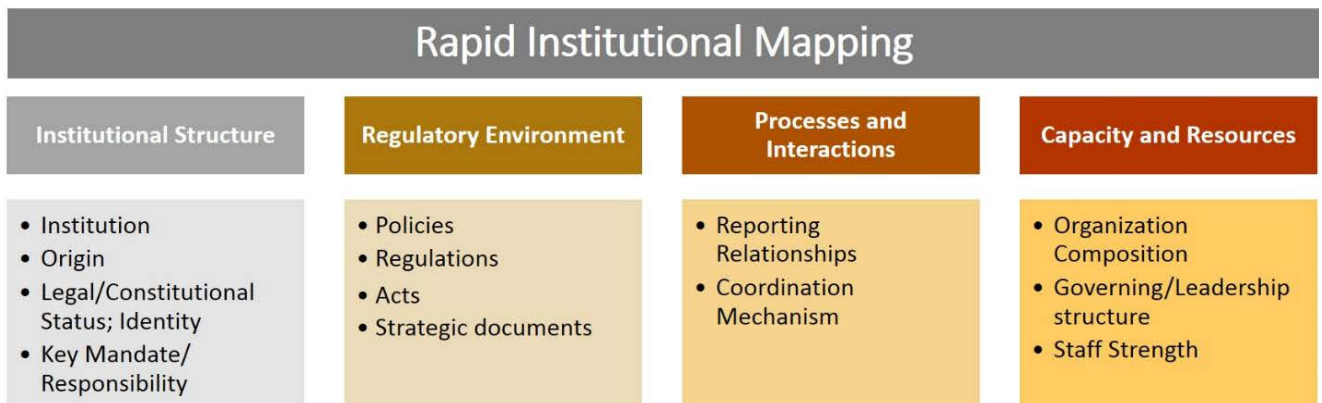


Figure 35 Scope of Rapid Institutional Mapping

B. Prevailing Institutional Landscape

Institutional Structure, Capacity and Resources

Relationship between municipal, provincial and national administrations

In general, the principle of co-operative governance is practiced in South Africa. The three levels of government, national, provincial and local, are regarded not as hierarchical tiers but as “distinctive, interdependent and interrelated”. All three levels of government have certain roles to play in environmental management, including environmental compliance and enforcement, and to some degree overlap in their responsibilities and competencies.

There are several national level entities (foremost the Department of Environmental Affairs (DEA), as well as the other Departments - Mineral Resources, Rural Development and Land Reform, Water and Sanitation, Human Settlements etc.) and provincial level entities (eg. the Department of Economic Development, Tourism and Environmental Affairs) with influence on the development of the city and certain authority over the management of specific environmental resources and matters. For example, the competent authority for determining whether there is a need to undertake an environmental assessment is either the National Department of Environmental Affairs and Tourism, or the KwaZulu-Natal Provincial Department of Economic Development, Tourism and Environmental Affairs. In addition, the municipality (EPCPD) will provide opinion or direction if such an environmental assessment is required. During the EIA process, the EPCPD will have to be consulted as both an organ of state as well as an interested and affected party should the proposed development occur within the municipal boundary. The EPCPD may also provide direction regarding the specific requirements of the assessment i.e., the need for a vegetation assessment or wetland delineations, etc.

As prescribed by the Constitution, the local governments generally have the right to govern their local affairs, subject to national and provincial legislation. In the case of eThekweni, the division of roles and responsibilities are generally clear. Functional duplication and vertical institutional fragmentation do not appear to be a serious issue in this case.

eThekweni Municipality

The city administration is led by the City Manager, supported by an Executive Management Team of Deputy City Managers, each heading an Administrative Cluster, in addition to the Chief Strategy Officer, Chief Operations Officer and a Chief Audit Executive. The Administrative Clusters are chiefly responsible for the City’s services and infrastructure delivery. Each Cluster is responsible for its own planning and budget in accordance with the City’s overall Integrated Development Plan and Service Delivery and Budget Implementation Plan. Under the Clusters are the Units, and under the Units are Departments. (See eThekweni Municipal Organogram below for details.) In addition, the City is governed by a 205-member city council, which elects the Mayor, Deputy Mayor and Speaker.

The work and responsibilities of many units and associated departments have direct relevance to the planning, utilization and/or management of key environmental assets such as land and water. The major players and their key mandates are highlighted here:

- a. Development Planning, Environment and Management Unit: assists the City to focus on problem solving on a manageable scale so as to uplift and sustain development within the City as a whole; supports a wide range of economic development programs that enable City-wide growth and sustainable development.
- i. Environmental Planning and Climate Protection Department (EPCPD): main mandate is to conserve biodiversity and the ecosystem goods and services it provides for the benefit of present and future generations; and plan for adaptation to the impacts of climate change. It is primarily responsible for biodiversity conservation planning, assessing potential impacts of development applications on key biodiversity resources, commenting on Environmental Impact Assessments lodged with national or provincial departments and the implementation of certain conservation projects. The department is the focal and contact point for climate change adaptation

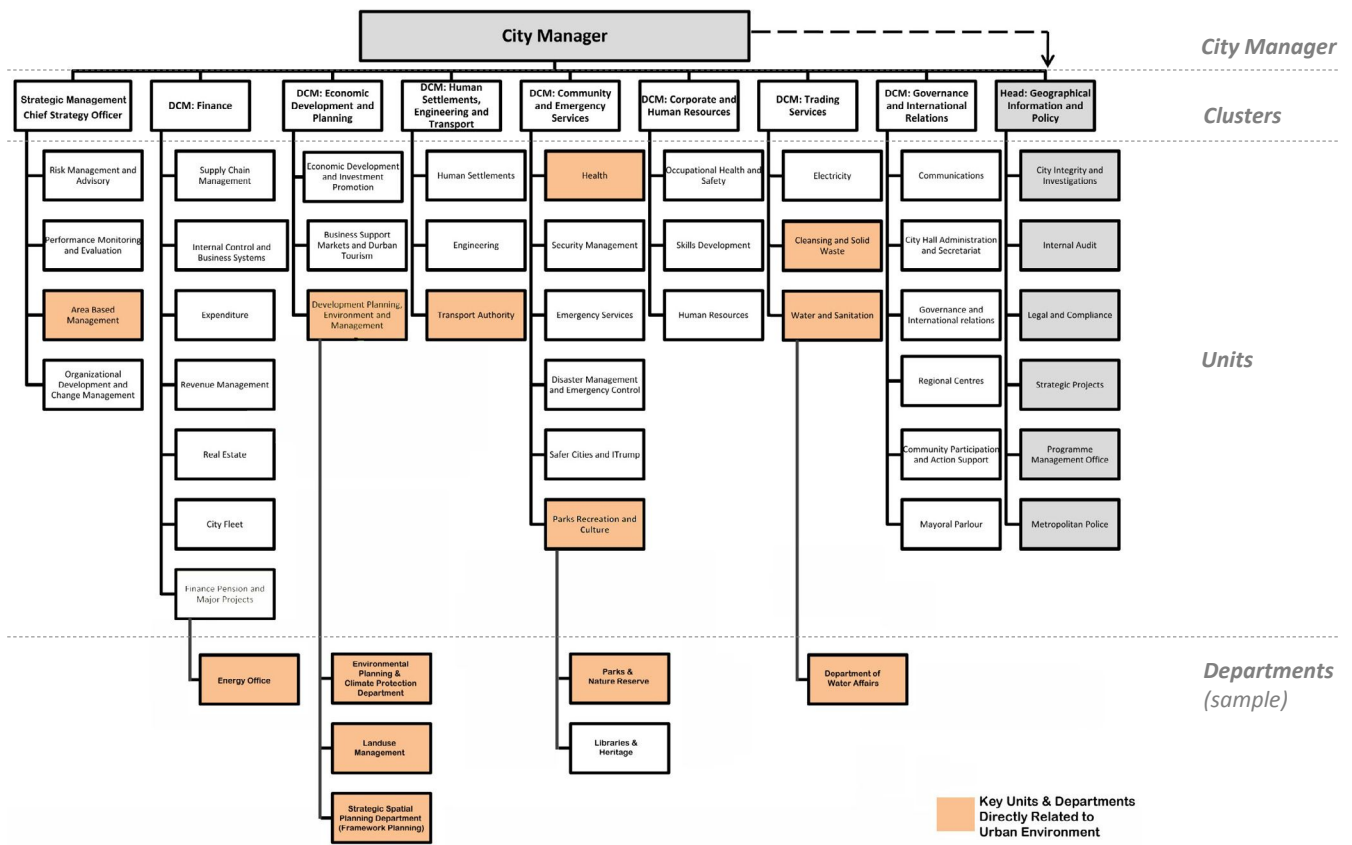


Figure 36 eThekweni Municipality Organogram

Source: Adapted from eThekweni Municipality website by World Bank staff (Note: During the time of report preparation, changes have been made to the organizational structure of the eThekweni Municipality and thus, the organogram may not be accurate but serves as an illustration to demonstrate multiple agency involvement.

in the Municipality and is key to providing relevant climate change information and expertise. This includes research into local level risks and impacts (environmental, social, and economic) and providing oversight and guidance in the implementation of the prioritized Municipal Adaptation Plans and the Durban Climate Change Strategy. The EPCPD provides the secretariat for the implementation of the Durban Adaptation Charter, and provides support to the Mayor of Durban in his role as a global leader in climate change adaptation.

Notably, the environmental management function of the municipality was established in 1994 and the role of the original entity known as “Environmental Management Branch” has changed over the years. In 2002, the overall sustainable environment and development mandate of the department was mainstreamed to become a core consideration in every municipal department. At the same time, the EMD refocused and became more specialized in the planning and protection of the city’s biodiversity resources (and later also addressing the issue of climate change). Finally in 2009, the department name

was changed to “Environmental Planning and Climate Protection Department”. Since its establishment in 1994, the department’s capacity has increased in terms of both budget and staff, from a single employee to around 43 staff in the full organogram in 2014. However, the department’s jurisdictional purview expanded as well when the municipal area grew from 300 sq. km to 2290 sq. km during the same time period.

- ii. Strategic Spatial Planning Department (or Framework Planning): manages future development, growth and change in the city through strategic and longer-term planning. It oversees the preparation and updating of the Spatial Development Framework (SDF) and Spatial Development Plans (SDPs), in addition to preparing other local area and strategic plans. It is also required to comment on the more significant or major development applications received with a view to ensuring that they broadly comply with the intent and vision of the various upstream or higher level plans of a strategic nature. It is a relatively small department with around 12 staff, ten of whom are professionals.

- iii. Landuse Management Department: develops policies for regulating the use and development of land in support of the City's Integrated Development Plans (IDPs) and Vision; develops and updates landuse schemes in line with the IDP, SDF and SDPs; processes town planning development applications; and monitors and enforces development in compliance with statutory procedures. It has around 300 staff (including around 80–90 planners), operating through a main central Durban office and five regional offices.
- iv. Enforcement and Prosecution Department: responsible for monitoring compliance with legislation in the interest of maintaining a safe and healthy environment of the residents of Durban. The enforcement and prosecution actions pertain to development control (e.g. illegal erection of buildings or of unauthorized alterations and additions). (There are also two enforcement officers under EPCPD who focus specifically on issues under EPCPD's purview, whilst some other Department members are trained and appointed as Environmental Management Inspectors in terms of national legislation.) The department has 25 staff, and all have been trained by national agencies and are "peace officers" accredited. They operate from both a central Durban office as well as through regional branches.
- b. Parks, Recreation and Culture Unit, Natural Resources Management Division: responsible for the establishment, development, maintenance and administration of the park and open space system of Durban; caring for street trees, maintains undeveloped verges in the municipality and enforces clearance of overgrowth on undeveloped land in private ownership;
- c. Water and Sanitation Unit: Responsible for the provision of water and sanitation services to all customers in the municipality. The unit aims to be a world class water and sanitation provider of affordable and efficient services. It also treats wastewater from approximately 1,000 industries and actively regulates discharge of wastewater to sewers.
- d. Engineering Unit: Coastal Engineering, Stormwater and Catchment Management Department: responsible for managing flood risks to houses, industrial and commercial properties; improving water quality in the city's rivers, wetlands and receiving coastal waters by managing and monitoring developments; protecting and enhancing urban river corridors and wetlands as important natural features within the urban landscape; promoting multi-functional, sustainable use of river corridors and drainage systems; and maintaining a suitable beach width.

Traditional Authorities

Areas formally administered by the eThekweni Municipality occupy only 36% of the eThekweni Metropolitan Area (EMA) as part of its (town planning) schemes. Another 27% of the EMA falls under non-scheme agriculture areas, administered jointly by local and provincial government. The remainder of the EMA (37%) is jointly administered by eThekweni Municipality and the traditional authority - Ingonyama Trust Board, with primary responsibilities falling under the latter (eThekweni Municipality, 2013b; EPCPD, 2013e).

The Ingonyama Trust Board is an entity responsible for administration of the Trust and the Ingonyama Trust land (which is about 2.8 million hectares in extent spread throughout the province of KwaZulu-Natal). It is a public entity reporting to the National Minister for Rural Development and Land Reform. The main mandate of the Trust Board is "optimal land management for the material benefit and social wellbeing of the communities living on Ingonyama Trust land." This mandate is derived from the Constitution, and refers to the property clause (Section 25 - the framework for granting of tenure rights on land), and the healthcare, food, water and social security clause (Section 27 - the framework for the provision of support to rural communities residing under Ingonyama Trust land). By the KwaZulu-Natal Ingonyama Trust Act, the Ingonyama Trust Board with consent of the Traditional Council has the authority to issue tenure rights and lease of Trust land.

The Trust Board constitutes nine members including the King, who is also the sole trustee, and a Chairperson and Vice Chairperson. The members of the Board are appointed by the responsible Minister and in consultation with His Majesty the King, the Premier of the KwaZulu-Natal province and the chairperson of the House of Traditional Leaders in KwaZulu-Natal. The Board members have a term of four years, but are eligible for further appointment. The statutory functions of the Board are:

- the formulation and implementation of policy;
- the provision of effective land administration and real estate management systems;
- the creation of a climate to encourage development;
- the extension of security of tenure in accordance with both customary and statutory law always subject to the Constitution Act (Act 108 of 1996).

In addition, the Board is supported by a Secretariat, the administrative arm of the Board. There are currently 27 approved posts within the secretariat, and an additional 30 contract posts. The secretariat falls under four main units: the Office of the Chief Executive Officer, Real Estate Management, Financial Administration and General Administration.

Large portions of rural eThekweni fall within the Ingonyama Trust Land and are known as traditional settlement areas (see figure below). There is no private tenure within these areas, and much resource utilization takes place on a communal basis. Each traditional area is under the authority of a local inkosi. Most areas under the Trust are of high biodiversity value (indigenous forests, wetlands, rivers, grasslands and sand dunes) as they are still largely rural.

Regulatory Environment

Overall

Generally, there is a strong regulatory environment around urban and urban environment management to support the mandates of the relevant eThekweni Units and Departments – in terms of the presence of acts, regulations, as well as policies, guidelines and strategies. These occur at the national, provincial and local levels and can be perceived under two main inter-related areas: urban development and land use planning; and environmental planning and management.

Environmental Regulations

At the national level, the National Environment Management Act (NEMA) is the main Act that provides the strong legal backing and guidance on environmental management and the overarching framework for a number of other environmental laws. NEMA is supplemented by other Acts protecting certain focused aspects of environment, such as on Biodiversity, Protected Areas, Integrated Coastal Management, Waste and Air Quality Acts and the related Acts on National Forestry, National Heritage Resources, National Water. In addition, there are complementary regulations, guidelines and policies such as the National Biodiversity Strategy and Action Plan, Mining and Biodiversity Guideline, Environmental Impact Assessment Regulations, Alien and Invasive Species Regulations, and environmental management plans and environmental implementation plans required by various statutes. Other relevant national level laws include the earlier Environment Conservation Act, National Water Act, National Forests Act, Marine Living Resources Act, Mineral and Petroleum Resources Development Act, etc.

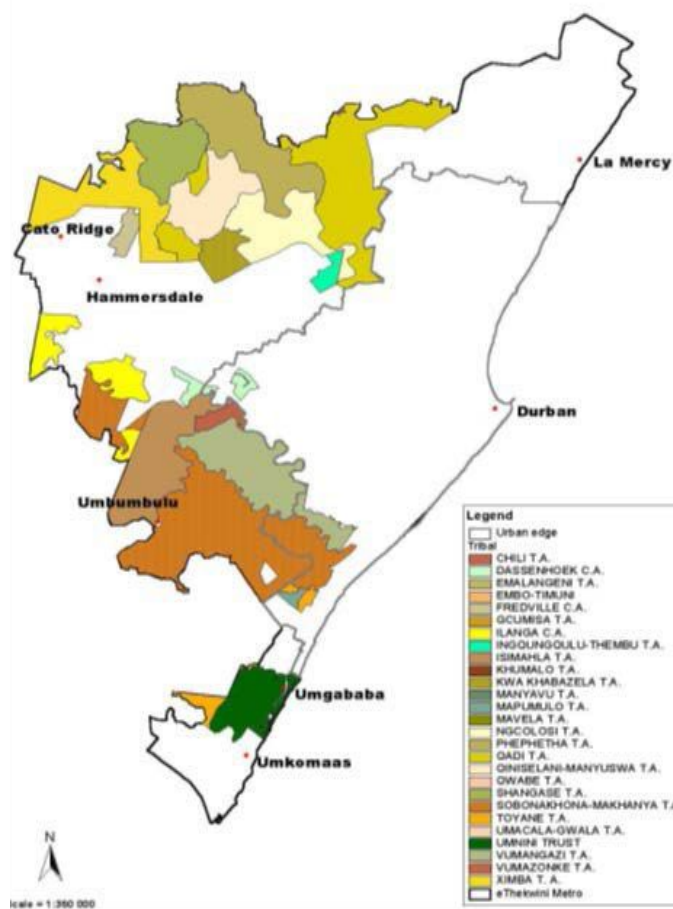


Figure 37 Traditional Authority Areas within eThekweni Municipality's Jurisdiction
Source: Corporate GIS, eThekweni Municipality

At the provincial level, the main department responsible for environmental matters is the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs. The main tools and mechanisms available at this level are the Provincial Environmental Implementation and Management Plan (EIMP), the environmental legislation compendium and integrated environmental plans for municipalities, and provincial Environmental Management Frameworks Program. In addition, there is a Provincial Committee for Environmental Coordination (established under the terms of the Intergovernmental Relations Framework Act) to promote cooperative environmental governance within the Province. Trainings for municipalities and joint enforcement inspections with both national and municipal level agencies are conducted.

At the local level, the municipality has the powers to pass by-laws and adopt guidelines to regulate affairs within the local jurisdiction. Some relevant by-laws for environmental management are: Buildings, Water Supply, Water and Waste Tariffs, Public Health, Seashore Regulations, Sewerage Disposal, Denudation of Vegetation, Municipal Parks and Recreation Grounds etc. For example, the Municipal Parks and Recreation Grounds by-law provides for the “control, preservation and maintenance of municipal parks and recreational grounds as well as the use and enjoyment thereof by members of the public...” and specify regulatory details on public access, tree preservation, enforcement and others.

Location/nature of the proposed site or activity	Legislation requirements	Competent authority/ department
Within Durban Metropolitan Open Space System (D'MOSS).	EThekweni Municipality's Environmental Planning and Climate Protection Department approval is required.	EThekweni Municipality: Environmental Planning and Climate Protection Department.
Within 32 metres of a watercourse (river, wetland, stream etc).	An environmental authorisation in terms of the Environmental Management Act.	The Provincial Department of Agriculture and Environmental Affairs.
	A water use licence in terms of the National Water Act.	The National Department of Water Affairs.
In an Indigenous forest.	A license in terms of the National Forests Act.	The National Department of Agriculture Forestry and Fisheries.
Within 100 metres of a coastal environment (sand dunes, beach).	An environmental authorisation in terms of the National Environmental Management Act.	Department of Agriculture and Environmental Affairs.
Diversion, impounding or infilling of a watercourse?	A water use license in terms of the National Water Act.	Department of Water Affairs.
Clearance of more than 300 m ² of indigenous vegetation.	An environmental authorisation in terms of the Environmental Management Act.	The Provincial Department of Agriculture and Environmental Affairs.

Figure 38 Example of Relevant Legislation and Authorities on Developments of Environmentally Sensitive Areas
Source: EPCPD, 2013b

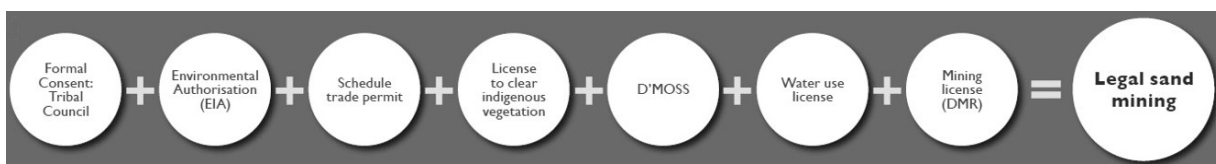


Figure 39 Graphic Illustrating Key Steps and Processes to be Completed for Sanctioning a Legal Sand Mining Activity
Source: EPCPD, 2013b

Table 11 Example of Process, Relevant Authorization and Authorities on Sand Mining

Source: Adapted and updated from Land use and the environment in tribal communities of the eThekweni Municipality: Guideline document for tribal authorities, EThekweni Municipality 2013

Authorization	Issuing Department
Mining license	The National Department of Mineral Resources
Water use license (for alteration of river banks)	The National Department of Water and Sanitation (DWS)
Environmental Authorization (for excavating within a watercourse)	The Provincial Department of Agriculture and Environmental Affairs
Planning Permission	eThekweni Municipality's Town Planning Department
License (to cut, disturb or destroy a natural forest or protected tree)	The National Department of Agriculture, Forestry and Fisheries
EPCPD Approval (for mining within D'MOSS)	eThekweni Municipality's Environmental Planning and Climate Protection Department
Schedule Trade Permit	eThekweni Municipality's Environmental Health Department

In addition, the Municipal Council adopts local-specific policies to guide various aspects such as the Water Policy, Land Affairs Policy, Policies and Practices for Water Sanitation, etc. There are also numerous projects and programs contributing to the cause of environmental conservation, such as the EThekweni Environmental Services Management Plan, Acquisition Program to acquire environmentally sensitive land, Durban Climate Change Partnership, uMngeni Ecological Infrastructure Program, Municipal Adaptation Plans, Community Reforestation Projects, Integrated Assessment Tool, Biodiversity Stewardship Program, Working for Ecosystems, Coastal Management Plans and Estuary Management Plans, etc.

Urban Development and Land Use Regulations

In the area of urban development and land use planning, the Constitution assigned the responsibility of municipal planning to municipalities. In addition, the Municipal Systems Act set out the requirement for municipal councils to prepare and adopt an Integrated Development Plan (IDP) which also includes a Spatial Development Framework (SDF), providing the basic guidelines for the land use system in the municipality. Further relevant legislations include the Spatial Planning and Land Use Management Act 2013, Spatial Data Infrastructure Act 2003, Planning Professions Act 2002, Housing Act 1997, Physical Planning Act 1991, National Building Regulation Act 1977, etc. At the Provincial level, the KwaZulu-Natal Planning and Development Act is the main planning legislation in effect, in addition to Town Planning Ordinance and the KwaZulu Land Affairs Act.

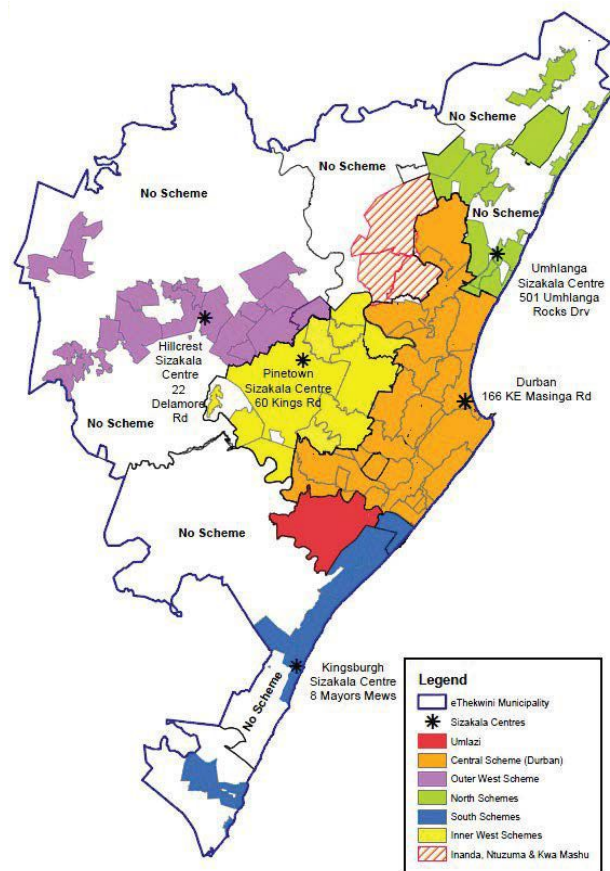


Figure 40 Map Showing the eThekweni Schemes Coverage
Source: eThekweni Municipality, 2013f

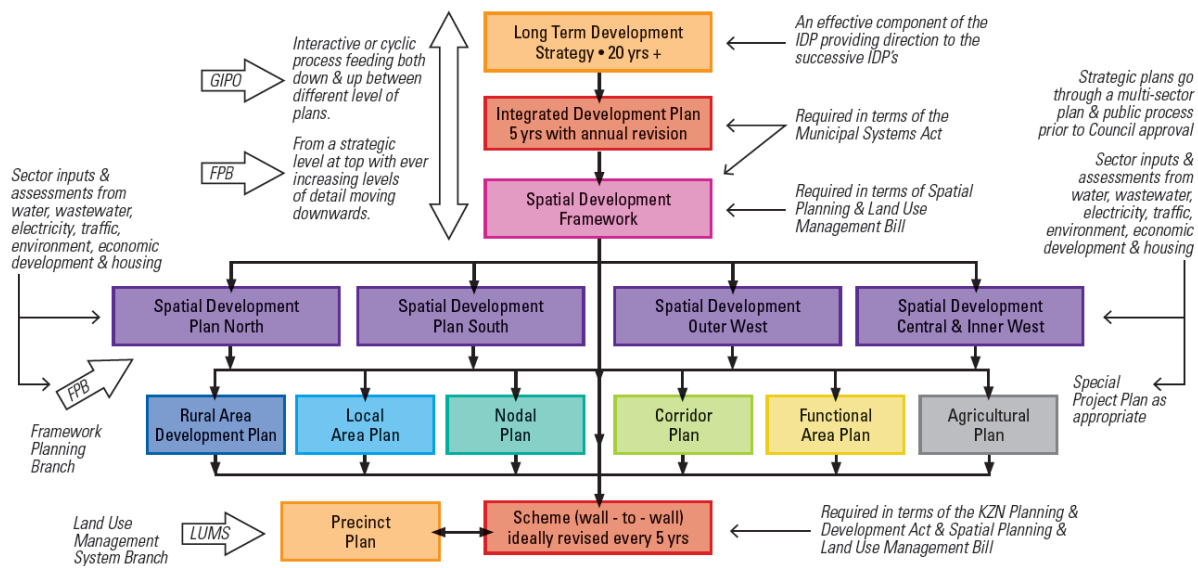


Figure 41 Schematic Hierarchy of Plans
 Source: eThekweni Municipality, 2013f

At the local level, the town planning schemes including zoning maps and controls, and conceived as part of the Land Use Management System, are the main day-to-day tool for development administration within the municipality. They are statutory and akin to a by-law. In eThekweni, there were originally 54 planning schemes which were consolidated into five Regional Schemes (North, South, Inner West, Outer West and Central) in 2012. Currently, only around 60% of the EMA has land use Schemes (largely corresponding to land administration responsibilities – Ingonyama Trust land areas generally do not have land use schemes).

Specific zoning provisions in these local land use schemes allows the municipality to reserve or protect land related to environmental functions. For example, an Environmental Conservation Reserve or Conservation Zone allows dedicated protection and management of “natural areas of land and/or water for the ecosystem goods and services that the areas provide and the biodiversity which they support”. Other relevant zones include Public Open Space, River Reserve, Beach, etc.

Durban Metropolitan Open Space System (D'MOSS)

D'MOSS is short for the Durban Metropolitan Open Space System, which was also previously known as the eThekweni Environmental Services Management Plan (EESMP). D'MOSS identifies conservation-worthy areas and ecosystems (such as sensitive grasslands, rivers and forests) which provide ecosystem services. Essentially, it is a network of open spaces and incorporates areas of high biodiversity value. Currently, around 75,000 hectares of land and water or around 33% of the total eThekweni municipal land area are identified as part of the D'MOSS layer.

In its initial years, D'MOSS existed purely as a Municipal Council policy directive and its status and relation with land use planning zoning and schemes was unclear. Following its formal adoption by the Municipal Council on 9 December 2010, D'MOSS has since been integrated into all eThekweni Municipality planning schemes, as a control area or overlay.

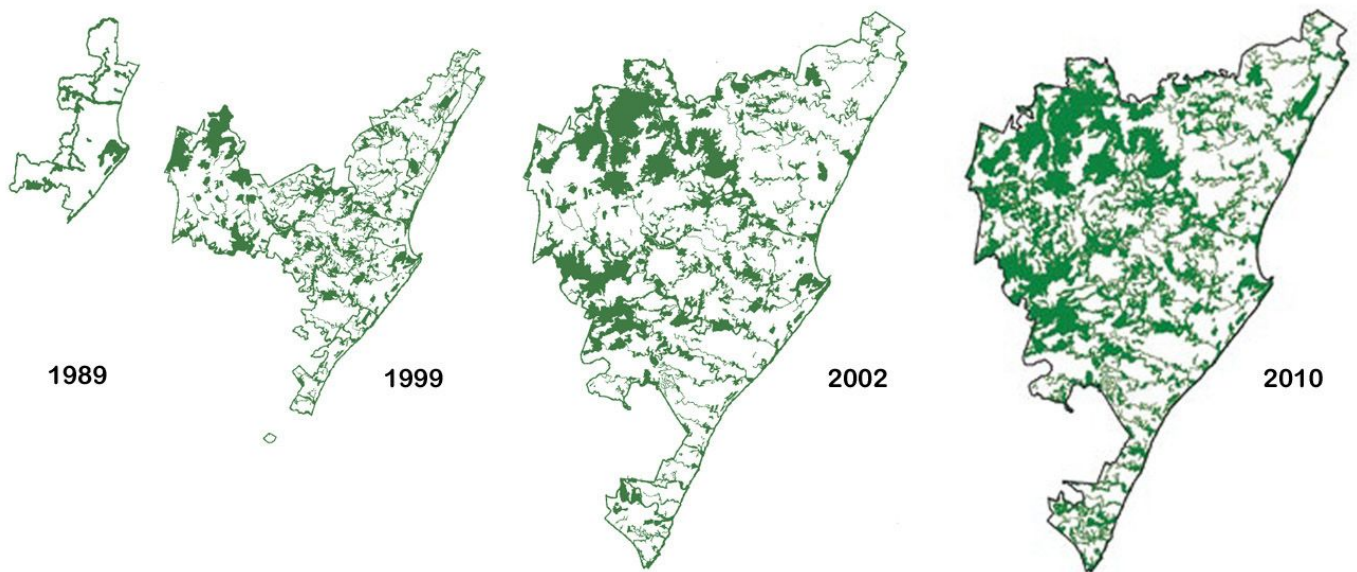


Figure 42 Changing Municipal Boundary and Open Space Footprint
 Source: Durban Environmental Services Management Plan, eThekweni Municipality 2002

Essentially, any development which is proposed within or adjacent to a D'MOSS area is subjected to review by EPCPD, to assess the potential impacts of the development on biodiversity and ecosystem goods and services. EPCPD will advise on specific limitations or guidance to develop in such areas. These could include whether there are any development restrictions, allowable type of uses and density, necessary set-backs or buffers around environmentally sensitive areas, and measures to manage such areas etc.

The version of D'MOSS that is currently in preparation has been developed using the international best practice techniques of systematic conservation assessment, thus the results are more scientific and defensible. The outcomes of the assessment process will be communicated by various means. The EPCPD's assessment team has set targets for completing assessments and periodically produces guideline documents (such as the Development Assessment Guidelines (2010)), which explain how the Department will assess applications for various circumstances.

Traditional Authorities

As mentioned earlier, around 37% of the EMA falls within traditional authority areas administered primarily by the Ingonyama Trust Board (Ethekewini Municipality, 2013e). The Ingonyama Trust was established in 1994 by the KwaZulu Ingonyama Trust Act to hold the land in title for "the benefit, material welfare and social well-being of the members of the tribes and communities" living on the land. The Act was subsequently amended in 1997 and given the status of a National Act, as it is administered by the Minister for Rural Development and Land Reform (previously the Minister for Agriculture and Land Affairs). In addition to the Trust Act, there is a set of administrative regulations and financial regulations for the governance of the Trust Lands.

The Trust Board has the authority to decide on affairs regarding land lease, alienation or other disposal of any Trust land. However, this does not exempt the Ingonyama Trust Board and Traditional Council or rural residents from adhering to requirements of National, Provincial legislation or Local Authority By-laws. In the case of the environmental regulations, the formal framework still regulates the use of the environment and natural resources on Trust Land.

Process and Interaction

Overall

For general day-to-day municipality functions, overall there is a well-established hierarchical system of reporting mechanisms and performance evaluation to monitor and track performance. Departments will report upwards to the Unit, and in turn to the Cluster and City Manager. There are regular meetings and forums held at each level for the various sectors.

Integrated Development Plan (IDP)

As mentioned, the IDP is the municipality's principal strategic planning instrument to guide and inform all planning and development and related decisions in the municipality. It is also a key tool for coordination within the municipality. The IDP essentially provides an overall framework for development, coordinating across sectors and across levels of government. It should take account of the existing conditions and resources available for development and should incorporate social, economic and environmental dimensions. It is also a budgeting and planning tool - all municipal planning and projects should happen in terms of the IDP and the annual council budget should be based on the IDP. The IDP has a lifespan of five years, but is reviewed every year.

In eThekweni Municipality, the IDP compiles all the plans and projects by all eight Clusters of the city. Regular IDP forums (or working groups) are held and the working group includes representatives from the eight cluster plans, and supported by an IDP secretariat (of around four staff), under the City Manager's Strategic Management Office. Community participation is also included as part of the process, and the IDP is drawn up in consultation with forums and stakeholders. The final IDP and annual reviews are approved by the Municipal Council.

D'MOSS

Due to factors such as land ownership (90% of D'MOSS is individually or communally owned), only around 1.5% of D'MOSS (June 2015) is formally protected in terms of the Protected Areas Act and 2% is managed by the municipality. In particular, due to the inherent nature of D'MOSS – land with high biodiversity value the largest concentration of the D'MOSS area falls within rural land under the joint administration of the ITB and the Municipality.

As mentioned earlier, the D'MOSS is reflected as a layer in the land use planning schemes. Therefore in the process of development planning approvals, a land use management planning official is alerted of the potential limitations in uses whenever an application involves an area with D'MOSS. The planning official in turn consults the EPCPD on such applications for specific limitations or guidance. While there are explicit external service standards in terms of the processing timeframe of planning applications (an enquiry should be addressed within seven days, whereas planning submissions range from 10 to 18 days depending on the type of submission), the internal consultation timeframe between departments varies depending on the nature of the development application. The standard of seven days for responding to enquiries regarding D'MOSS is not always possible due to the individual nature of the applications received - high biodiversity, CAPMON EIA (municipal capital infrastructure projects) and CAPMON Housing takes 21 to 30 days; incomplete applications or information gaps sometimes exist; other cases merit further engagement with applicants in order to facilitate outcomes that achieve the targets of the EPCPD while not stifling growth. These different conditions add to increased time for decisions.

Traditional Authorities

The traditional authorities and municipality operate two entirely different and separate administrative regimes and their planning and implementation systems are not aligned. The link to the formal administration occurs at the central level where the Ingonyama Trust Board reports to the National Minister for Rural Development and Land Reform. At the local level, the Trust Board essentially makes decisions on how to govern and manage activities within its lands. Ingonyama Trust authorities are required to inform and seek counsel from the municipality on land use decisions within the Trust Lands. However, such coordination does not occur consistently.

C. Institutional Key Findings

Institutional Challenges

- 1. Horizontal institutional fragmentation at metropolitan level** - formal municipality and Ingonyama trust constitute two governing institutional structures and systems especially on land matters. Areas formally administered by the eThekweni Municipality occupy only 36% of the eThekweni Metropolitan Area (EMA) while around 37% of the area is under joint administration with the Ingonyama Trust Board, the traditional authority. Effectively, there are two separate and parallel institutional structures and systems governing the EMA. In terms of environmental conservation and protection, the challenges are particularly pronounced as a larger concentration of the D'MOSS area falls within rural land under traditional authority where there are as yet no town planning schemes; and the formal protection and regulation of D'MOSS areas are largely through the development application and EIA processes as directed by the schemes. While the traditional authorities are required to inform and seek counsel from the municipality on land use decisions and also adhere to requirements of National, Provincial legislation and Local Authority By-laws, in reality, as its main governance is over land-related decisions, private developers could leverage such a situation. In addition, coupled with the large absence of formal planning schemes for Trust Land areas and a lack in corresponding regulatory and enforcement mechanisms, it is much more difficult to enforce similar standards and conditions to development and environmental protection as in formally planned areas.
- 2. Enhanced coordination and synergies in managing natural resources.** The interests, roles and responsibilities of the EPCPD and the Parks, Recreation and Cultural Department (Parks Department) have good intersections and synergies. The EPCPD is responsible for biodiversity planning and research aimed at developing an evidence-based understanding of existing and future ecological processes, and identifying the possibilities and challenges associated with the development of novel ecosystems and a restoration economy. With regard to biodiversity research, EPCPD manages areas that have been acquired through the land acquisition program and its ecosystem management functions are directed towards providing an outdoor laboratory for an evolving local biodiversity knowledge network involving partnerships with local tertiary institutions and implementation partners. On the other hand, the Natural Resources Management Division of the Parks Department is responsible for the establishment, development, maintenance and administration of the park and open space system of Durban for the purposes of traditional public amenity and use. As the geographic realm of interest for both agencies intersect with mutually-reinforcing short and long-term objectives, enhanced coordination between both departments could yield even larger benefits for the municipality as a whole. In addition, currently both departments have enforcement staff. The enforcement officers within EPCPD are meant to focus on monitoring of specific areas linked to the development assessment process of the Biodiversity Assessment Branch. The Parks Department would look at broader enforcement issues. It is however, sometimes difficult to determine when to engage EPCPD enforcement officers as any environmental violation or potential ones may also have an impact on biodiversity management.
- 3. Relatively weak provincial level administration on environmental management.** Currently, provincial level support and inputs on environmental management for the EMA play a relatively minor role. While there are formal forums and tools in place (e.g. Provincial Environmental Implementation and Management Plan (PEIMP)), and some trainings and joint enforcement inspections with both national and municipal level agencies also take place, provincial level administration on environmental management issues is relatively weak. For example, it still faces challenges on coordinating inputs for the PEIMP. Provincial level support could be further enhanced and leveraged especially to act as an intermediary and provide greater support to the municipality. It would also serve an important function on the 27% of EMA non-scheme agriculture areas, which are administered jointly by the local and provincial government (eThekweni Municipality, 2013b). In addition, at the local level, Environmental Management Systems across the municipal sectors are lacking. Few, if any, of the municipal sectors or departments have formal ISO certified Environmental Management Systems in place. Some local policies and legislation (bylaws) are also outdated and are sometimes poorly enforced. For example, there are few policies specifying municipal environmental norms and standards.

4. **Absence of wall-to-wall town planning schemes.** As discussed in the environmental profile, urbanization and in particular, a fragmented growth pattern of the EMA with more rapid developments in the peri-urban areas and informal settlements, has been a continuous challenge contributing to the decline of environmental assets. Such growth is in part due to a lack of sufficient guidance for urban development. It is worth noting that since the introduction of the Spatial Planning and Land Use Management Act (SPLUMA), future desired land uses could be indicated and regulated through the Spatial Development Framework (SDF). This also provides the legal planning framework in the absence of schemes. However, schemes are still important in order to provide more detailed development guidance. They also serve a critical role in protecting D'MOSS and environmentally sensitive areas. Specific zoning provisions in these local land use schemes demarcate the Environmental Conservation Reserve or Conservation Zone, Public Open Space, River Reserve, Beach etc., together with associated development restrictions and management provisions. Currently, the town planning schemes do not cover the entire EMA, but only around 60% of its area (and this largely corresponds with land administration responsibilities; i.e. traditional authority areas generally do not have land use schemes). The absence of local planning schemes for the entire EMA results in developments which could only be regulated through the less granular SDF, other more general policy directives and through ad-hoc planning applications. This may give rise to developments which are not aligned with municipal strategic planning, especially on privately owned land and land under traditional authorities.
5. **Better understanding of the review process and implementation of D'MOSS requirements for urban development.** At the local level D'MOSS remains one of the key regulatory tools for protecting the urban environment. D'MOSS is currently reflected as a control overlay in the town planning schemes and serves as a very useful municipal-scale flagging tool for environmentally sensitive areas. Even though it is much more accurate than equivalent national or provincial layers, it does not attempt to rigidly define development opportunities on specific properties due to a number of constraints.¹

Given these constraints, any planning applications which may impact environmentally significant features, must be assessed 'manually' to ensure that impacts on the environment have been avoided or minimized. Aspects of this decision-making assessment may be subjective, although based on significant experience, and professional expertise, while other planning applications are guided by environmental law, regulations, policy and guidelines. In addition, to ensure necessary and quality evaluation of applications, at times, trade-offs need to be made between meeting the standard response time and facilitating outcomes that achieve the targets of EPCPD while not stifling development growth and needs.² From brief interviews conducted during this institutional analysis, there is a general lack of appreciation concerning D'MOSS, of the constraints involved and technical evaluation process and time required to achieve balanced outcomes. Continuous efforts towards any potential improvement and streamlining of the D'MOSS review process (such as for cases of simple development applications) would be useful. In addition, a better understanding and buy-in from both internal and external stakeholders on the D'MOSS review process and evaluations required will help manage expectations and mitigate negative perceptions of the D'MOSS.

6. **Overall ineffectiveness of the IDP as a meaningful integration and coordination tool.** Tackling environmental degradation issues involve multiple sectors and an integrated approach to development. The IDP is designed as an important integration and coordination tool to guide development in EMA. Thus far, it has been prepared, updated and implemented in eThekweni according to national guidance. While the IDP has been prepared in earnest in eThekweni, its effectiveness to integrate and coordinate across sectors is questionable. Many interviewees regarded the IDP with cynicism and as a bureaucratic process, overburdened by excessive reporting; they viewed it as a document which merely compiles the sector plans and projects, but without real ownership by the departments nor an added dimension of true integration to make the document the municipality's effective development blueprint. One contributing reason could be a lack of understanding of the purpose and functions of the IDP, by each unit and department.

¹ The EMA is too large and comprised of too many properties to accurately survey environmental assets with the resources available. Even if this was possible, the information generated would be outdated before it could be published and used. Environmental data available for planning (e.g. the distribution of the occurrence of threatened species) is inadequate for prescribing what development is possible at the level of the land parcel. The type of development proposed (which is largely unknown when mapping occurs) can also be significant in deciding what development can be permitted in a particular context.

² Timeframes vary depending on the nature of the development application. An enquiry should be addressed within 7 days, whereas planning submissions range from 10 to 18 days depending on the type of submission. High biodiversity, CAPMON EIA (municipal capital infrastructure projects) and CAPMON Housing are 21 to 30 days.

7. **Better resource allocation, upgrading in skill sets in line with evolving needs and functions.** eThekweni generally has the basic level of staff, capacity and resources available. However, as the municipality evolves, there needs to be a complementary strategic planning in terms of resources and staff to meet the priorities and needs set out by the city. In addition, this involves more upgrading in skill sets and more efficient resource allocation and consolidation where necessary. Therefore, the main challenge here is not just in providing the number of staff but whether they are of sufficient caliber, equipped with the necessary skills and resources to perform their required functions. In particular, if there are new needs that develop, such as dealing with environmental issues which extend beyond the municipality's jurisdictional boundaries, there is little spare capacity and resources for cross-jurisdictional collaboration.
3. **Continued improvements in D'MOSS, its implementation and enforcement process and regulatory mechanisms.** To streamline and improve effectiveness in implementing and enforcing D'MOSS, a few potential areas of improvement could be considered: (i) accurate mapping and verification of the D'MOSS boundaries; (ii) outline and communicate the methodology behind determining why and what falls within the D'MOSS; (iii) in relation, whether there are different categories of sensitivities of D'MOSS areas and how this could relate to the necessary degree of control (to streamline review process); (iv) if so, for the different categories, what should be the associated protocols or standard procedures and roles to be played by various departments when it comes to development in such areas; (v) transparent and clear guidance on the specific limitations related to developing in D'MOSS areas, according to particular traits or criteria; and (vi) improve both internal and external understanding with regards to standard response time – such as how these may be defined (for example, it could be defined as time between receipt of enquiry and first response, even though it could be an interim response with issues not fully resolved and that the planning application should be defined as receipt of complete application, without missing information required).

Suggestions and Recommendations

1. **Consolidate functions and align institutional mandates in managing natural resources and associated enforcement.** For more effective management and better use of resources, potentially the function of managing natural resources could be consolidated under one department and further equip the department with the necessary enforcement capacity and resources. In addition, clarifications and better alignment of regulations, policies and mandates both at the local level, as well as from national to provincial to local level would assist with better accountability and enforcement responsibilities.
2. **Realize wall-to-wall town planning schemes.** While this has been a target and a development agenda in eThekweni for a long time, it has not been effectively realized. Notably, the SDF provides useful framework guidance on desired land uses and is the guiding legal planning framework in the absence of Schemes. However, it has been well proven and cited that for areas with formal town planning schemes, they are being managed and controlled much more effectively, thus proving their merits. While this is not an easy task, and will involve, overcoming stigmas and long-standing issues (such as management of Ingonyama Trust-owned land), completing the town planning scheme for the entire EMA would be a first step in providing clear development guidance for the entire municipality. In addition, the formulation of the town planning schemes should carefully and pragmatically consider environmental factors, especially in determining land use and zoning.

Notably, it is understood that various efforts have been completed or are already ongoing towards these ends. For example, EPCPD recently concluded a Systematic Conservation Assessment (SCA) for Durban. A SCA is a collaborative process which includes the cooperation of a broad spectrum of stakeholders. Its preparation involves the use of existing biodiversity information, including surrogate information, as well as information on the ecological processes that sustain this biodiversity and the 'costs and opportunities' that potentially threaten or support its existence. Based on this information, areas are prioritized according to explicit goals or targets. Information coming from this assessment process may then be used to identify priority areas for environmental action. The technical document detailing the process of mapping is also in its final stages of completion and will be available to any interested and affected parties. In addition, a series of meetings and workshops are being conducted with various municipal departments to explain the methodology and the uses of the SCA. Further a set of Development Assessment Guidelines have been published, which explain in detail what requirements and restriction apply to different habitat types etc. These are available electronically (from the municipal website) and in hardcopy from the departmental offices.

4. **Improvements to IDP processes and enhanced sector integration.** As discussed, the IDP is meant to be an integration and coordination tool across sectors of the city. However, this role has not been effectively achieved thus far through the IDP. One complementary coordination tool is the SDF, which could reflect the vision and plans of various sectors spatially. Cross-sectoral integration and collaboration could also be enhanced by strengthening and emphasizing the role of the current IDP working groups. For example, perhaps an “integration exercise” could be conducted at the preliminary stage of the IDP process. This exercise could attempt to align any inconsistencies or overlapping work programs and identify synergies or opportunities for collaboration amongst sectors. These could then be carried into the alignments of budgets and work plans for each sector. In addition, further expanding or promoting current trainings on IDPs could increase awareness and improve understanding of the functions of the IDP.
5. **Align staff and resource management with strategic objectives, priorities and action plans of each department.** Potentially using the IDP, or other unit/departmental strategic plans, a review of existing staff and resource inventory could be conducted. This could help to identify any potential gaps/mismatch in skills or resources. Opportunities for improving staff and resource efficiency could also be identified. Thereafter, a phased action plan could be drawn up to improve the overall management of staff and resources.

VI. KEY FINDINGS

eThekwini has experienced waves of development; economic, social, and political drivers have shaped the spatial arrangement and the environmental quality of the city. Historically, environmental degradation had been the result of longer term activities due to the development and expansion of the Port of Durban. In more recent times, eThekwini has experienced the growth of a multi-nodal city along with the expansion of suburbs and peri-urban areas.

The rate of population growth of the EMA has remained relatively low when viewed in comparison to the rate of growth in other cities in South Africa and across Sub-Saharan Africa. However, the pace of land conversion from open and agricultural land to urban development is slightly higher, suggesting at least two phenomena at play. In the formal areas, there has been ongoing relocation of household in the form of resident and commercial flight from the Central Business District. In the informal settlement areas, there has been a decompression of households as multi-family and multi-generational households disperse into additional housing.

The conversion of large inland and upstream areas for both formal and informal development, that are within and adjacent to targeted conservation areas, has been an increasing source of degradation to water catchments. Land destabilization and erosion, loss of vegetative cover, sedimentation in the rivers and streams, the discharge of sewage and effluents, and other drivers of environmental degradation have led to the compromise of essential environmental assets and services that have negative impacts on the city as a whole.

While eThekwini has considerable institutional capacity and has been a leader in conservation planning; the inventory of greenhouse gas emissions to baseline climate change mitigation strategies; and resiliency planning for climate change adaptation; EMA environmental objectives are severely compromised by the limited capacity to implement and enforce environmental regulation. There are numerous environmental programs and projects in place to improve and protect the quality of EMA's environmental assets (see section V). But there are multiple layers of government involved in the regulation of the environment that result in limited statutory authority at the local level. For example, only 12% of the Durban Metropolitan Open Space System (D'MOSS) was under formal protection in 2012 despite the role of D'MOSS as the primary tool for conservation of the municipality's environmental assets. Only a small portion of critical vegetation habitats are statutorily protected as Special Ratings Areas. D'MOSS is ineffective in preventing or directing the development activities that impact targeted conservation areas within the land under traditional authority and tenure.

Institutionally, the most difficult issue to address is the lack of authority to direct development and conservation in the lands under traditional authority and tenure. The lack of operational coherence between the municipality and lands under traditional authority has had significant impact on the environmental assets. Land under traditional authority is informally regulated and not aligned with municipal planning or environmental goals, resulting in de facto land development. The most significant impact has been degradation of the upland water catchment areas. While it is noted that eThekwini has developed numerous programs to address environmental degradation, EMA has been very limited in its ability to act on these programs due to the lack of authority over land under traditional tenure systems that include some of the most critical areas in need of conservation.

eThekwini is further challenged by the absence of an effective means for an integrated and cross-sectoral dialogue. Strategic and financial planning across the sectors lacks integration and the alignment of goals, schedules, and reporting requirements. There is also lack of integration between spatial planning and the environmental conservation and regulation processes. For example, the Integrated Development Plan is the product of very little cross-sectoral dialogue and coordination; the plan is integrated in name only. These gaps limit the ability of either the sector or the municipality as a whole to pursue more environmentally sustainable development plans and policies. The end result has been a degree of institution fragmentation that has failed to provide an effective framework to protect and conserve the municipality's environmental assets.

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VIII. APPENDIX

Appendix A: Summary of Institutional Analysis

	Prevailing Institutional Landscape	Institutional Challenges	Suggestions and Recommendations
<p>Institutional Structure</p>	<ul style="list-style-type: none"> Co-operative governance; three levels of government; national, provincial and local, are regarded not as hierarchical tiers but as “distinctive, interdependent and interrelated”. In formal administration of eThekweni, the division of roles and responsibilities are generally clear amongst the three levels. Areas formally administered by the eThekweni Municipality occupy only 36% of the eThekweni Metropolitan Area (EMA). Another 27% of the EMA are non-scheme agriculture areas, administered jointly by local and provincial government. The remainder of the EMA is comprised of traditional authority areas administered by the Ingonyama Trust Board (37%). 	<ul style="list-style-type: none"> Horizontal institutional fragmentation at Metropolitan Level - formal municipality and Ingonyama Trust Board constitute two governing institutional structure and systems especially on land matters. Enhanced coordination and synergies in managing natural resources 	<ul style="list-style-type: none"> Consolidate functions and align institutional mandates in managing natural resources and associated enforcement
<p>Regulatory Environment</p>	<ul style="list-style-type: none"> Generally strong regulatory environment around urban and urban environment management, at the national, provincial and local levels. Only around 60% of the EMA has land use Schemes. D/MOSS represents a network of open spaces and is depicted as overlays over the zoning on planning schemes. The Ingonyama Trust Act and its related set of administrative regulations and financial regulations governed the Trust Lands. 	<ul style="list-style-type: none"> Relatively weak provincial level administration on environmental management. Absence of wall-to-wall town planning scheme 	<ul style="list-style-type: none"> Realize wall-to-wall town planning schemes

<p>Processes and Interactions</p>	<ul style="list-style-type: none"> • For general day-to-day municipality functions, overall there is a well-established hierarchical system of reporting mechanisms and performance evaluation. • IDP is the municipality's principal strategic planning instrument, coordinating across sectors and across levels of government. • D'MOSS is reflected as a control overlay in the landuse planning schemes. • The traditional authorities and municipality operate two entirely different and separate administrative regimes and their planning and implementation systems are not aligned 	<ul style="list-style-type: none"> • Better understanding of the review process and implementation of D'MOSS requirements for urban development. • Overall ineffectiveness of IDP as a meaningful integration and coordination tool. 	<ul style="list-style-type: none"> • Continued improvements in D'MOSS, its implementation and enforcement process and regulatory mechanism • Improvements to IDP process and enhanced sector integration
<p>Capacity and Resources</p>	<ul style="list-style-type: none"> • Generally have the basic level of staff and resources for each department. However, better match and upgrade in necessary skills should be the task at this stage. 	<ul style="list-style-type: none"> • Better resource allocation, upgrading in skill sets in line with evolving needs and functions. 	<ul style="list-style-type: none"> • Align staff and resource management with strategic objectives, priorities and action plans of each department.

Appendix B: Municipal Capacity for Environmental Programs

Municipal Capacity for Environmental Programs

eThekwini increased the capacity of its Environmental Planning and Climate Protection Department (EPCPD), which implements many programs and projects to improve Durban's natural assets and combat climate change. The Durban Environmental Planning and Climate Protection Department (EPCPD) is the institutional entity with the legislative authority to monitor and improve Durban's physical environment. Since it was established in 1994, the EPCPD's capacity increased dramatically in both budget and staff. The EPCPD began with a single employee and now employs 30 staff members. Additionally, the department's jurisdictional purview expanded as the municipal area grew from 300 km² to 2,290 km² (EPCPD website, 2014). Some of the programs and projects developed and managed by EPCPD and its partners include:

- **Durban Climate Change Partnership** The DCCP was established in 2009 to foster continuous dialogue between municipal and private sector stakeholders to discuss climate change adaptation and mitigation issues. The seed funding the support the DCCP has expired and the partnership is on hiatus until a new funding stream is determined. http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Municipal_Climate_Protection/Pages/Durban-Climate-Change-Partnership.aspx
- **Durban Climate Change Strategy** Completed in September 2014, the DCCS outlines goals, objectives, and recommendations for Durban to pursue to reduce the impacts climate change in sectors include water, sea level rise, biodiversity, transportation, and others. <http://www.dccs.org.za/>
- **uMngeni Ecological Infrastructure Program** In order to address water quality and ecological concerns within the uMngeni catchment, the EPCPD, the Department of Water and Sanitation, the KZN office of the Department of Water Affairs (DEA), Mgeni Water, the South African National Biodiversity Institute (SANBI) and a host of other stakeholder organizations signed a Memorandum of Understanding in 2013 "to safeguard, rehabilitate and manage the ecological infrastructure within the uMngeni catchment." The program has initiated three pilot projects to improve the catchment. One project is the Palmiet Rehabilitation Project which calls for constructing a series of wetlands and tracking water quality indicators to assess the impact of the new wetlands. http://www.durban.gov.za/City_Services/

[development_planning_management/environmental_planning_climate_protection/Projects/Pages/Investment-in-Ecosystem-Services.aspx](http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/Investment-in-Ecosystem-Services.aspx)

- **Municipal Adaptation Plans** In 2010, eThekwini developed three Municipal Adaptation Plans (MAP) focused on health, water, and disaster management. Each MAP outlines strategies for the three sectors to implement to adapt for anticipated climate change impacts. http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/Municipal-Adaptation-Plans.aspx
- **Community Reforestation Projects** In partnership with Wildlands Conservation Trust, the EPCPD initiated the Buffelsdraai Community Reforestation Project near the Buffelsdraai landfill to offset carbon emissions generated by the 2010 FIFA World Cup which was hosted in South Africa. Initiated in 2008, by 2012 the project had planted trees on approximately 284 hectares and created 374 jobs for members of the surrounding community. Given the success of this project, eThekwini initiated a similar project at Inanda Mountain to rebuild a 250 hectare coastal scarp forest. http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/Buffelsdraai-Community-Reforestation-Project.aspx
- **Durban Invasives Website** This website is a crowd-sourced invasive alien plant species tracking tool established to promote the early detection of invasive species and a rapid response to control these invasive species. Interested individuals can sign up to log sighting of ten targeted invasive alien plants. <http://www.durbaninvasives.org.za/>
- **Integrated Assessment Tool** This computer-based tool allows municipal stakeholders to evaluate development plans and policies with a climate change lens. An initial version of has been developed and is still being finalized. http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/Integrated-Assessment-Tool.aspx
- **Biodiversity Stewardship Program** The Biodiversity Stewardship Program is comprised for EPCPD staff and volunteers to oversee the development of policies and programs that conserve biodiversity in eThekwini. The group is currently developing an eThekwini Biodiversity Stewardship Policy and establishing partnership with Traditional Councils to explain the importance of biodiversity and encourage environmental protection and conservation. <http://>

www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/eThekwini-Biodiversity-Stewardship-Programme.aspx

- **Working for Ecosystems** Since 2006, this program has employed local individuals to remove invasive alien plants from the environment. In the 2013/2014 fiscal year, the program worked on controlling invasive alien plants on 188.83 hectares of new land and conducting follow-up control on another 855.4 hectares. http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/Working-for-Ecosystems.aspx
- **Working on Fire** Established in 2009, Working on Fire employs 48 individuals to control invasive alien plants by using fire application. In the 2013/2014 fiscal year, Working on Fire conducted invasive alien plant control on 6.4 new hectares of land and conducted follow-up control on another 86.6 hectares. http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/Working-on-Fire.aspx
- **Coastal Management Plans and Estuary Management Plans** eThekwini has developed management plans to improve its coasts and estuaries. These plans document the current conditions of these assets and provide recommendations to improve conditions.
- **D'MOSS:** The Durban Metropolitan Open Space System (D'MOSS) is an ecosystem management program managed by the eThekwini Municipality's Environmental Planning and Climate Protection Department (EPCPD). D'MOSS describes a series of green open spaces in the Durban metro region that provide critical ecosystem services and are characterized by high rates of biodiversity. As of 2012/2013 nearly 75,000 hectares of land are included in D'MOSS, which is 33% of the total eThekwini municipal land area (EPCPD, 2012/2013). As of 2012/2013, only 12% of D'MOSS was formally protected and 2% of D'MOSS was managed. The EPCPD uses various tools to conserve the land within D'MOSS, 90% of which is individually or communally owned, and spends approximately R2 million annually to acquire land within D'MOSS.
- **Giba Gorge** The Giba Gorge is one of several permanently protected environmental assets in eThekwini. The Giba Gorge and its environs, encompass a variety of important habitats, plants, and animals as well as sites of archaeological significance. The government and private sector joined forces to protect this environmental asset through the establishment of a Special Rating Area, which is an assessment area where landowners contribute levies toward maintenance. The Giba Gorge Environmental Precinct (GGEP) is a cooperative project between private landowners and the municipality to manage a common natural asset for conservation purpose. Giba Gorge. The funds that are collected are used for alien invasive plant control, trails construction, soil erosion control, river health monitoring, and administrative functions (EPCPD, State of Biodiversity, 2008/2009).
- **Rockefeller Foundation Resilient City** In 2013, Durban was selected from over 350 cities to be one of 33 cities in the Rockefeller Foundation's Resilient Cities program. By participating in this program, Durban is engaging with a broad section of urban experts from across the globe in developing strategies to make Durban more resilient to physical, social, and economic challenges. http://www.durban.gov.za/City_Services/development_planning_management/environmental_planning_climate_protection/Projects/Pages/Durban-and-the-Rockefeller-Foundation%E2%80%99s-100-Resilient-Cities-%28100RC%29-Programme.aspx

