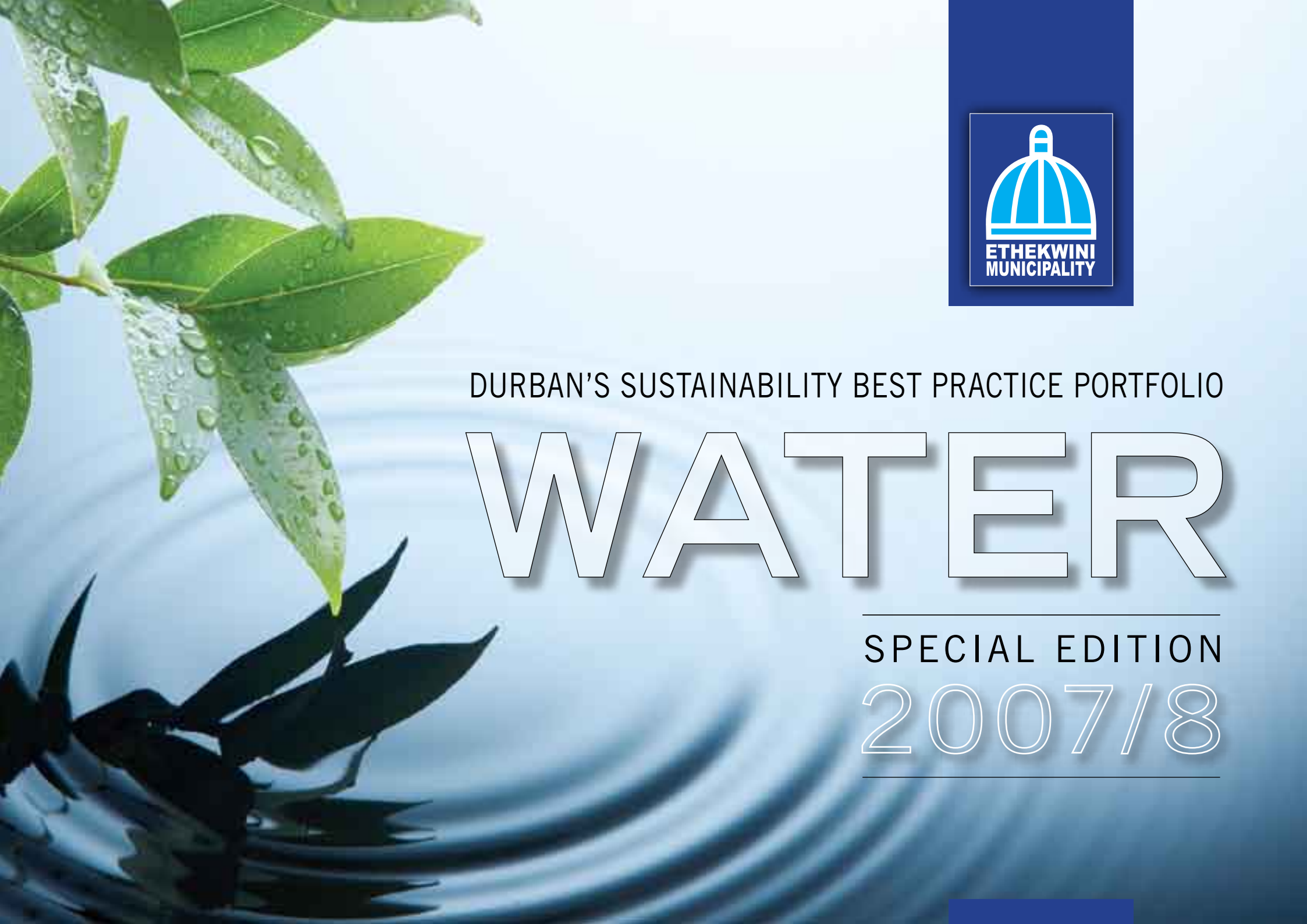


ETHEKWINI MUNICIPALITY

DURBAN'S SUSTAINABILITY BEST PRACTICE PORTFOLIO

WATER

SPECIAL EDITION

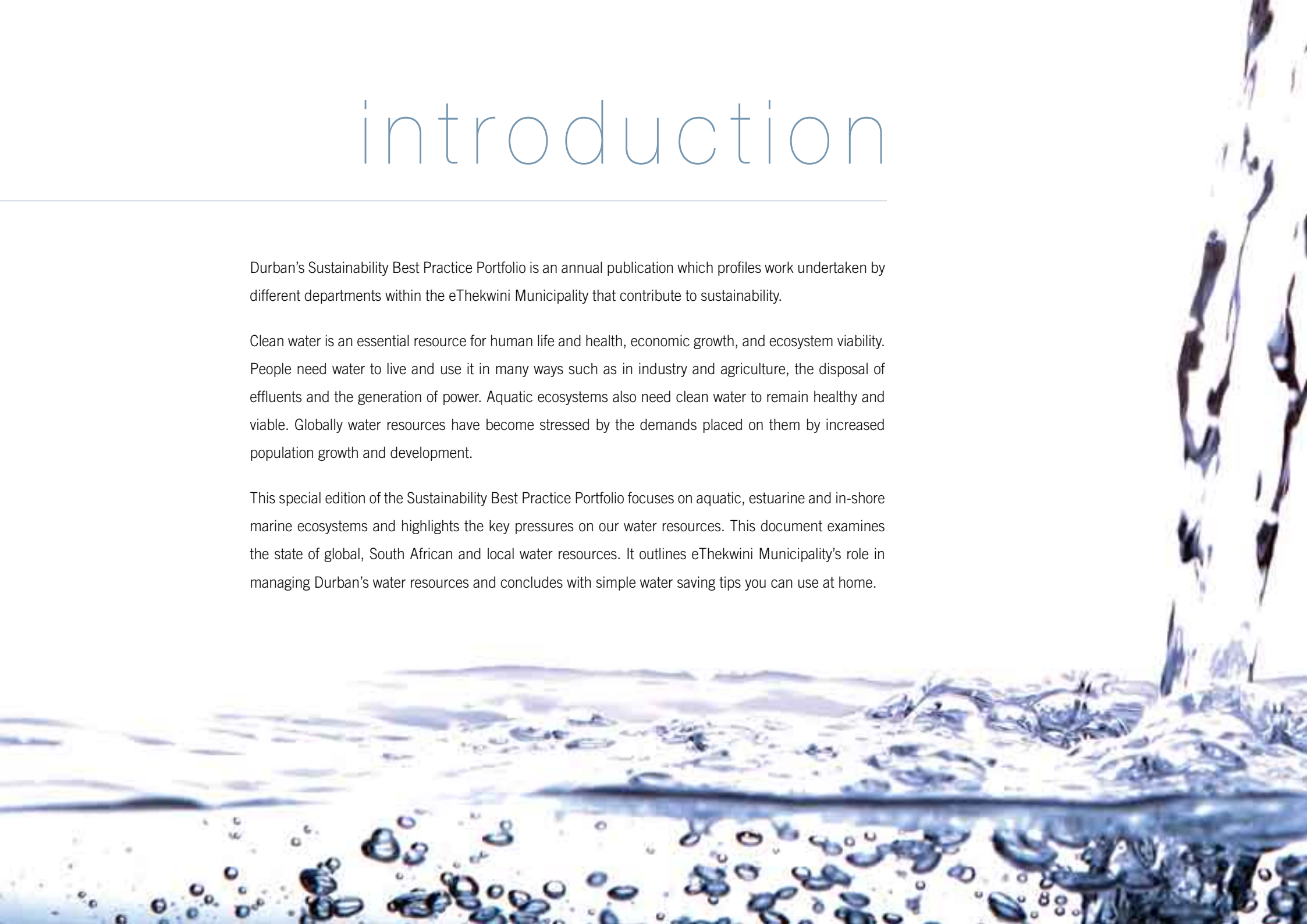
2007/8

introduction

Durban's Sustainability Best Practice Portfolio is an annual publication which profiles work undertaken by different departments within the eThekwini Municipality that contribute to sustainability.

Clean water is an essential resource for human life and health, economic growth, and ecosystem viability. People need water to live and use it in many ways such as in industry and agriculture, the disposal of effluents and the generation of power. Aquatic ecosystems also need clean water to remain healthy and viable. Globally water resources have become stressed by the demands placed on them by increased population growth and development.

This special edition of the Sustainability Best Practice Portfolio focuses on aquatic, estuarine and in-shore marine ecosystems and highlights the key pressures on our water resources. This document examines the state of global, South African and local water resources. It outlines eThekwini Municipality's role in managing Durban's water resources and concludes with simple water saving tips you can use at home.



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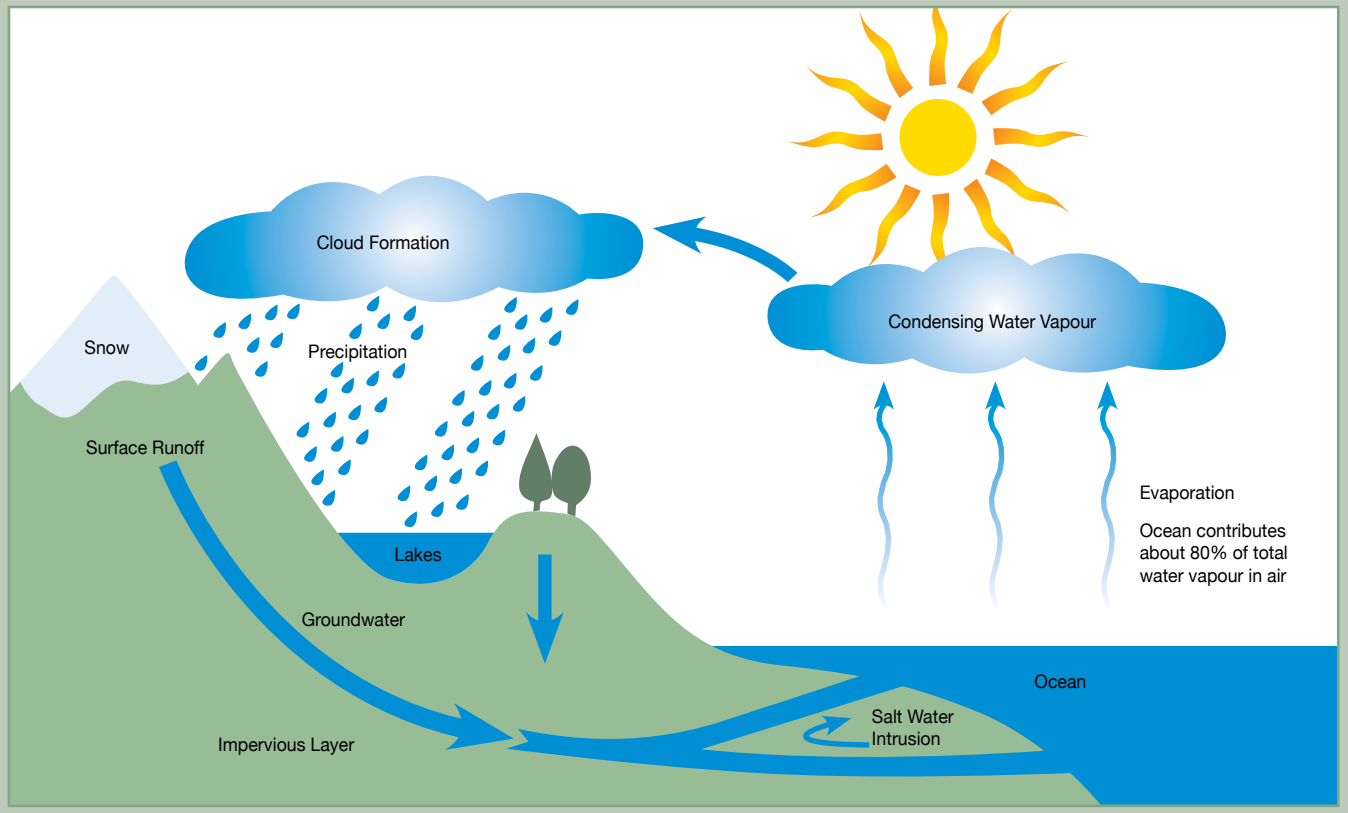


Figure 1: The Water Cycle[a]

THE water CYCLE

The water cycle begins when heat from the sun causes water from the ocean to evaporate and water from plant material through transpiration to be released into the atmosphere. Water reaches the earth from the atmosphere as precipitation in the form of rain, hail and snow. Some of this precipitation falls directly into the ocean, but some of it falls on land. Here it runs along the surface, into streams and rivers, eventually reaching the ocean or percolating through the soil becoming groundwater before flowing slowly back to the ocean. Water then returns to the atmosphere through evaporation and transpiration, where it cools, forming clouds before producing precipitation to complete the cycle.

[a] www.sawater.com 2008.

the state of the GLOBAL WATER RESOURCE

There are about **1.4 trillion cubic kilometers of water on the earth**. Water covers **71%** of the earth's surface **but only about 1% of this is available as fresh water that humans and other organisms can use**. United Nations statistics indicate that about **1.2 billion people** now live in water stressed areas and this figure is expected to reach **3 billion by 2025**[1].

[1] Global Environmental Outlook Report, 2007.

the value of the GLOBAL WATER RESOURCE

Water resources contribute significantly to the functioning of the global ecosystem. About 63% of the value of global ecosystem goods and services is contributed by **marine systems (US$20.9 trillion per annum)**[2]. Most of this comes from **coastal systems (US$12.6 trillion per annum)**. About 38% of the estimated value comes from terrestrial systems, mainly from **forests (US$4.7 trillion per annum)** and **wetlands (US$4.9 trillion per annum)**[2]. Natural and undisturbed ecosystems (including freshwater, estuarine and marine ecosystems) provide the most valuable goods and services.

[2] Costanza et al, 1997. The value of the world's ecosystem services and natural capital. Nature, Volume 387.
[3] Average Rand/US Dollar exchange rate in 1997 was R 4.6 to US $1. Economymagic.com: Economic Times Series.

Table 1: Summary of Average Global Value per Annum of Freshwater and Marine Ecosystem Goods and Services[2] (1997)[3]

Ecosystem	Total value per hectare ($ hectares per annum)	Total global flow value ($ trillion per annum)
Marine	577	20, 949
Open ocean	252	8,381
Coastal	4,052	12,568
Estuaries	22, 832	4,110
Seagrass/ algae beds	19,004	3,801
Coral reefs	6,075	375
Shell	1,610	4,283
Wetlands	14,785	4,879
Tidal marsh/mangroves	9,990	1,648
Swamps/floodplains	19,580	3,231
Lakes/ rivers	8,498	1,700

key services that water provides

Clean water is essential for all living organisms. 50-60 % of our body weight is made up of water and we would die after a few days without fresh water to drink.

THE FOLLOWING LIST OUTLINES SOME OF THE KEY SERVICES PROVIDED BY WATER RESOURCES:

- **SPIRITUALITY:** Aquatic ecosystems (fresh, estuarine and marine) provide key elements in the spiritual practice of many belief systems;
- **WASHING & WASTE REMOVAL:** People use water to clean themselves and their living spaces and prevent the spread of disease. Water dilutes effluent and reduces the effects of pollution;
- **ENABLING LIVELIHOODS**: Water is used directly in fishing, farming, forestry, building and craftwork;
- **FOOD & AGRICULTURE:** Water ensures food security and agricultural production is limited by water availability. Good water quality and soil resources ensure our food supply;
- **TRANSPORTATION & RECREATION:** Fresh and marine water systems allow boats and other water craft to move people and goods for transport and leisure activities;
- **POWER GENERATION & INDUSTRY:** Water is used for cooling in many industries and the energy in running water can be converted to electricity;
- **SEDIMENT MOVEMENT:** Surface water moves sediments by erosion and deposition. This sculpts the land into valleys and floodplains and provides sand to the coastal zone creating and maintaining beaches;
- **NUTRIENT DISTRIBUTION:** Water transports salts and nutrients into floodplains increasing their productivity, and into estuaries, bays, and oceans, supporting marine life;
- **ECOSYSTEMS:** Aquatic habitats support all aquatic life. Aquatic flora and fauna need a supply of good quality and quantity of water which is either fresh, saline or a mix of both in order to survive;
- **STORAGE:** Water bodies such as rivers, lakes, wetlands, groundwater, and human-made reservoirs store fresh-water allowing us to survive through dry seasons or in areas with low rainfall. Glaciers, especially those at mid-latitudes, provide water storage and summer water supply for both rural and urban areas around the world;
- **GLOBAL WEATHER SYSTEMS:** Water is a component of the Earth's climate system. Water influences the intensity of climate variability and change, it is the key feature of extreme weather events such as drought and floods. The required quantity and timely delivery of precipitation are critical for meeting social, economic and ecological demands;
- **CLIMATE CONTROL:** The oceans are the world's primary source of water vapor, the source of precipitation. Atmospheric water vapor is a greenhouse gas which, together with carbon dioxide, is responsible for keeping the Earth's surface temperature well above freezing. In water's frozen form, sea ice and snow cover tend to cool the planet by reflecting the Sun's incoming solar radiation, thus creating a balance in the Earth's temperature.

GLOBAL pressures on freshwater, esturine and in-shore marine ECOSYSTEMS

21st CENTURY CHALLENGES

FRESH WATER ECOSYSTEMS

Water use has, as a result of a growing population and resultant increase in agriculture and industry, **increased six fold during the 21st century**[3]. At the same time, the availability of freshwater is declining, partly because of excessive withdrawals of surface and groundwater and partly because of decreased water runoff from land, that can be attributed to climate change. Freshwater ecosystems are disappearing faster than those of other ecosystems. Approximately half the world's wetlands have been lost, and more than **20% of the world's 10,000 known freshwater species have become extinct**, **threatened or endangered** as a result of unsustainable fishing practices and habitat degradation[4].

Freshwater is often considered a 'renewable resource' because water resources can be replenished by rain, but we are using freshwater faster than it can be renewed. Up to **30% of potable water is lost due to leakage from pipes in developed countries**. Changes in water quality are being exacerbated by pollutants from land-based sources, such as municipal wastewater treatment works and urban runoff[3]. This reduces the availability of clean water for human use and ecosystem functioning. Contaminated water remains the greatest cause of human illness and death; **every week an estimated 42,000 people die** from water-related diseases such as **diarrhea and malaria**, which are ranked as the 3rd and 4th highest causes of death amongst children under the age of 5 worldwide[4].

[3] Global Environmental Outlook Report 4, Fact Sheet 6: Water, 2007.
[4] United Nations, Water for Life, 2005.

ESTUARINE AND IN-SHORE MARINE ECOSYSTEMS

The greatest threat to coastal and marine ecosystems is human development. Many areas of the coast are degraded or altered and people are facing increasing coastal erosion, flooding, declining water quality and increased health risks[5]. **Coastal areas have a human population three times that of inland areas**. This increases the pressures on marine resources[5]. As a result marine ecosystems are being threatened by effluent and sewage disposal, pesticides and fertilizers, habitat loss, over exploitation, invasive species infestation and climate change[6]. 58% of the world's major reefs, 64% of all mangrove forests and 62% of all major estuaries occur within 50 kilometers of major urban centers of 100 000 people or more. **35% of the world's mangroves have disappeared over the past two decades**[5].

Dredging, engineering works and unsustainable fishing practices are responsible for the destruction of estuarine and in-shore marine ecosystems. Human activities have increased sediment flows in rivers by 20% but reservoirs, dams and water diversions prevent about 30% of the sediment load from reaching the oceans. This results in an overall reduction of sediment delivery to coastal areas[5].

An increase in nitrogen from agricultural or human development into an aquatic ecosystem can lead to eutrophication. Eutrophication is an excessive growth in plant material which then decays and affects water quality, fish and other species populations. Nitrogen loads have almost doubled, chemically altering estuaries and in-shore marine habitats, resulting in irreversible changes to these ecosystems[5].

[5] Millennium Ecosystem Assessment: Coastal Systems, 2005.
[6] European Environment Agency, Biodiversity and marine resources, 2008.

THE IMPACT OF GLOBAL CLIMATE CHANGE ON GLOBAL WATER RESOURCES

Global Climate Change is the increase in the average temperature of the earth's atmosphere, which causes changes in local climate patterns and sea level rise worldwide. **This century's rate of warming has been faster than any global temperature changes estimated for the past 10 000 years**[7]. This rapid warming has been caused by human actions such as fossil fuel burning and land cover change which produce greenhouse gases such as carbon dioxide that trap heat in the Earth's atmosphere. It is predicted that if these activities continue, there will be a **1.8^0 – 4^{0}C average temperature increase in the next century**[7]. Climate change is likely to alter rainfall patterns which causing more extreme floods and droughts. Glaciers and snow will melt which will reduce the storage capacity of freshwater on land, and an increase in sea level will result in flooding, habitat loss, and cause groundwater and other water resources to be salinized (made salty). In-shore marine, estuarine and freshwater habitats will be degraded, thus reducing their capacity to generate the goods and services they currently provide.

GLOBAL ACCESS TO WATER

Despite the six-fold increase in water use this century, there are currently 1.1 billion people who lack access to safe drinking water and 2.6 billion people who lack access to basic sanitation worldwide[4]. In September 2000, at the United Nations Millennium Summit, world leaders agreed to a set of timebound and measurable goals and targets for combating poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women. These goals are referred to as the **Millennium Development Goals**. The Summit's Millennium Declaration also outlined a wide range of commitments in terms of human rights, good governance and democracy.[8] The Millennium Development Goal for water is to "**halve by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation**."[9] The number of people with access to drinking water from safe sources has improved in the developing world, which means that the 2015 target is likely to be reached[10]. While growing populations and access to safe drinking water for rural populations pose significant challenges, access to water resources in urban areas is increasingly identified as the greater challenge[10].

Inter-regional differences indicate that **Africa has the lowest proportion of urban households with access to piped water (38.3%)**, while Latin America and the Caribbean has the highest (89.3%). Over 25% of the developing world's urban population or 560 million residents, lack adequate sanitation[10]. Without clean water, sanitation and basic services, **urban areas are amongst the most life threatening environments to human beings**.

All signs suggest that the quantity and quality of global water resources are declining and that they will continue to do so, unless immediate corrective action is taken. Water requires careful management and protection by all individuals, societies, and governments on the planet.

[7] Intergovernmental Panel on Climate Change, 2007.
[8] United Nations, Implementing the Millennium Declaration, Fact Sheet, 2000.
[9] United Nations Millennium Development Goals Report, 2006.
[10] United Nations Human Settlements Programme- UN HABITAT, 2006.

WATER

supply, management and use in SOUTH AFRICA

South Africa is regarded as an arid to semi-arid country, with an average rainfall of approximately 450 millimeters per annum[11]. The geographical distribution of rainfall, and availability of water supply is highly variable, with the eastern and southern parts of the country receiving significantly more rain than the northern and western regions[11]. In the provinces receiving more rain, water is accessed from local surface water resources such as rivers and dams, while the drier areas rely on local groundwater and surface water diverted or pumped from elsewhere in the country.

South Africa is classified as a '**water stressed**' country because only about **1.1 million litres of water are available per person per annum**. It is estimated that the average adult needs about 30 litres of water per day for drinking, cooking, washing and sanitation including more than 1.8 litres per day for food production. **Each South African needs roughly 1 million litres of water per annum to maintain their current lifestyle**[12].

In order to manage South Africa's water resources the country has been divided into **19 water management areas** (See Figure 2). Due to the uneven distribution of water, a significant amount of water transfer takes place between the water management areas. Rivers and dams provide for most of South Africa's water requirements. South Africa's total mean annual runoff (rainwater that

is not evaporated) is about **49 000 cubic meters per annum**[11]. This includes about 4 800 million cubic meters per annum draining from Lesotho into South Africa and a further 500 million cubic meters per annum draining from Swaziland[11]. Roughly 66% of this run-off goes into the country's 320 major dams which have a total capacity of more than **32 400 million cubic meters**[11]. A portion of this runoff, typically about 20%, needs to remain in rivers and estuaries to support ecological systems, but the total run-off yield is constrained by pollution, such as irrigation return flows, urban drainage, and industrial and mining activities[11].

Agricultural irrigation accounts for about **62%** of South Africa's total water use, with urban demand being about **23%**. The remaining **15%** is shared by the rural, mining and industrial sectors[11].

Water quality in South Africa is variable and has generally deteriorated due to the lack of adequate pollution control. Poor land practices have also resulted in water resources being degraded. In general, we now have less water available than in the past and what is available is of a poorer quality[11].

Population, economic growth and climate change are regarded as the primary determinants of future water requirements and availability. In **2025**, it is predicted that South Africa will have a short fall of water resources of approximately **2 044 million cubic meters per annum**[11]. It will be a '**water scarce**' country with less than 1 million litres per person per annum available.

[11] South African Environmental Outlook, 2006.
[12] Population Action International. "People and Water". *People in the Balance: Population and Natural Resources at the Turn of the Millennium.* Update 2002.
[b] www.dwaf.gov.za.

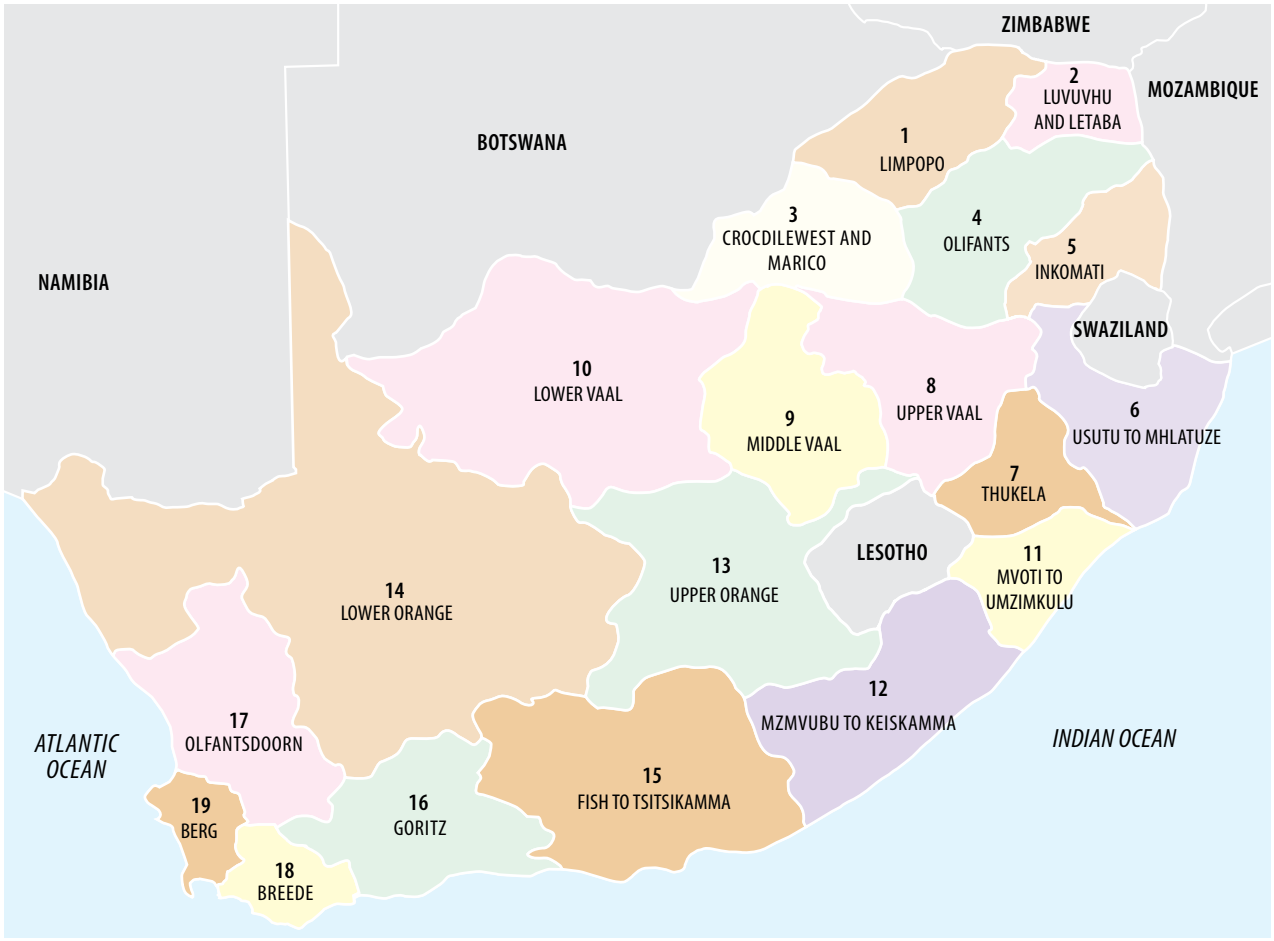


Figure 2: 19 Water Management Areas In South Africa 2008[b]

the state of FRESHWATER, ESTUARINE & IN-SHORE MARINE ecosystems in SOUTH AFRICA

The health of aquatic ecosystems is declining in South Africa. The health of river ecosystems is generally good in their upper reaches. However, as water passes through urban and agricultural areas, the quantity and quality of the water resource decreases due to extraction and pollution. This results in cumulative impacts in the estuarine environment before the water reaches the in-shore marine environment[11].

Wetlands, vital for storing water and nutrients and for filtering water, are also vulnerable to drainage, land use change, human pollution and over-exploitation. In much of the country, groundwater is the only source of water for many ecosystems, including wetlands, during drier months. Over-abstraction of groundwater has lowered the water table (the level of the ground water) to the detriment of human and natural systems[11].

South Africa relies heavily on its rich in-shore marine resources for food, recreation, tourism, and transport. Under increasing human pressure this ecosystem has altered its functioning and structure. Uncontrolled and mismanaged use has led to over-exploitation, degradation, and resource loss impacting on estuaries which are reliant on the in-shore marine ecosystem for its own functioning[11]. Continued pressure on our aquatic ecosystems will result in their further decline and loss of the goods and services they provide.

As one of the responses to the deterioration of water resources, the National Department of Water Affairs and Forestry has made provision within the National Water Act (No 36 of 1998) for the '**water reserve**', which accords water rights to both people and ecosystems[13]. The water reserve consists of the **Basic Human Needs Reserve** and the **Ecological Reserve**[13]. The Basic Human Needs Reserve is the water allocated for human consumption before other uses[13]. It ensures that water is provided to people for drinking, food preparation and personal hygiene[13]. The Ecological Reserve ensures the provision of water for aquatic eco-systems served by the water resource[13]. The quality and quantity of the water reserve is determined at the discretion of the Minister of Water Affairs and Forestry[13].

[13] Ecological Reserve: Keeping SA's Lifeblood Pumping. www.wrc.org.za.

the impact of CLIMATE CHANGE on water resources in SOUTH AFRICA

Climate change is expected to alter hydrological systems and water resources and reduce the availability of water[14]. Rising temperatures and increasing variability of rainfall will affect surface waters, increasing drought in some regions and causing floods in others, as well as influencing groundwater recharge. There is likely to be a general decrease of **5% – 10% of present rainfall**, with longer periods of dry spells in the interior and northeastern areas of the country coupled with frequent and severe flood events. Recent models indicate that the eastern half of the country is expected to be wetter and the western areas to be drier.[14]

Parts of South Africa could experience **reductions in runoff and/or stream flow of up to 10% which could be evident in the western parts of the country as soon as 2015[14]. The decrease in runoff will move progressively from west to east, and could be expected to reach the east coast in 2060[11]. Should the warmer conditions prevail, current human and ecosystem water requirements will not be met in the future.**

[14] Mukheiber. P and Sparks, D Water resource management and climate change in South Africa: Visions, driving factors and sustainable development indicators. 2003.

Figure 3: Map of South Africa and its provinces.

WATER CATCHMENT ILLUSTRATION

ILLUSTRATION of a water catchment

ECOSYSTEM KEY

FRESHWATER ECOSYSTEMS

- Working 4 Ecosystems - pg 24
- Non-revenue Water Management Interventions in Durban - pg 28
- State of River Health in Durban - pg 33

ESTUARINE ECOSYSTEMS

- Chlorination of Rivers and Estuaries in Durban - pg 33
- Durban's Estuarine Assesment - pg 34
- Waterbird Counts in Durban Bay/Harbour - pg 36

IN-SHORE & MARINE ECOSYSTEMS

- Blue Flag Beaches - pg 38

THE STATE OF DURBAN'S water resource

EThekwini Municipality is the local government responsible for planning and managing Durban. The municipal area is 2297 square kilometers in size and it is home to approximately 3.13 million people or 7% of the total South African population, making Durban the second most populated area in the country[15]. Durban contains three of the countries eight biomes, seven broad vegetation types and over 2000 plant species. Seventeen major river catchments that reach the sea via 16 estuaries, 4000 kilometers of river and 97 kilometers of coastline are all within the municipal area.

Topographically Durban is very diverse, including steep escarpments caused by weathering of ancient sandstone deposits, in the west, to a narrow and flat coastal plain consisting of relatively recent tertiary deposits, in the east. Durban's climate is subtropical, with humid, warm summers, and mild winters. Moving west into the interior, conditions become more temperate towards the mist belt region. Durban experiences relatively high rainfall, usually above 1000 millimeters per annum, falling mostly during the summer months.

Figure 4: Relief map of Durban.

Durban plays a major role in the South African economy as the third largest economic center which accounts for 10% of South Africa's economic output. Durban's economy has grown at an average annual rate of 3.65% between1995-2005[15]. Durban's economic growth is consistent with that of Cape Town's (3.52%) and the City of Tshwane (3.23%)[15]. Durban is the economic hub of KwaZulu-Natal, generating R135 billion in Gross Domestic Product in 2005[15] even though the city occupies only 1.4% of the provincial land area. Durban's economy is centered around tourism, transport, logistics activities of the Port and manufacturing industries such as the petroleum and chemical, food and beverage, tobacco, transport equipment (including automotive) and metal industries. Water is a central component for these activities. The demand for water is expected to increase in order to accommodate future growth in Durban's economy and population.

FRESHWATER ECOSYSTEMS

Durban is situated in the southeastern Coastal Hinterland. KwaZulu-Natal has the highest river length in South Africa, constituting approximately 20% of the river length of all major rivers in South Africa[16]. This is seen in Durban where 17 major river catchments and an abundance of perennial and non-perennial rivers are found[16].Two of these catchments, the uMngeni and the uMkhomazi have their origins a considerable distance inland of the city's boundary, originating in the Pietermaritzburg Midlands region and the Drakensberg respectively[16]. Both of the major rivers in these catchments are classified as endangered where less than 10% of their length is intact[16]. The catchments of uMhlathuzana, uMbilo, Ngane and the oHlanga are contained entirely within Durban.

[15] eThekwini Municipality Economic Review, 2006/2007.
[16] Durban's Biodiversity Report, 2007.

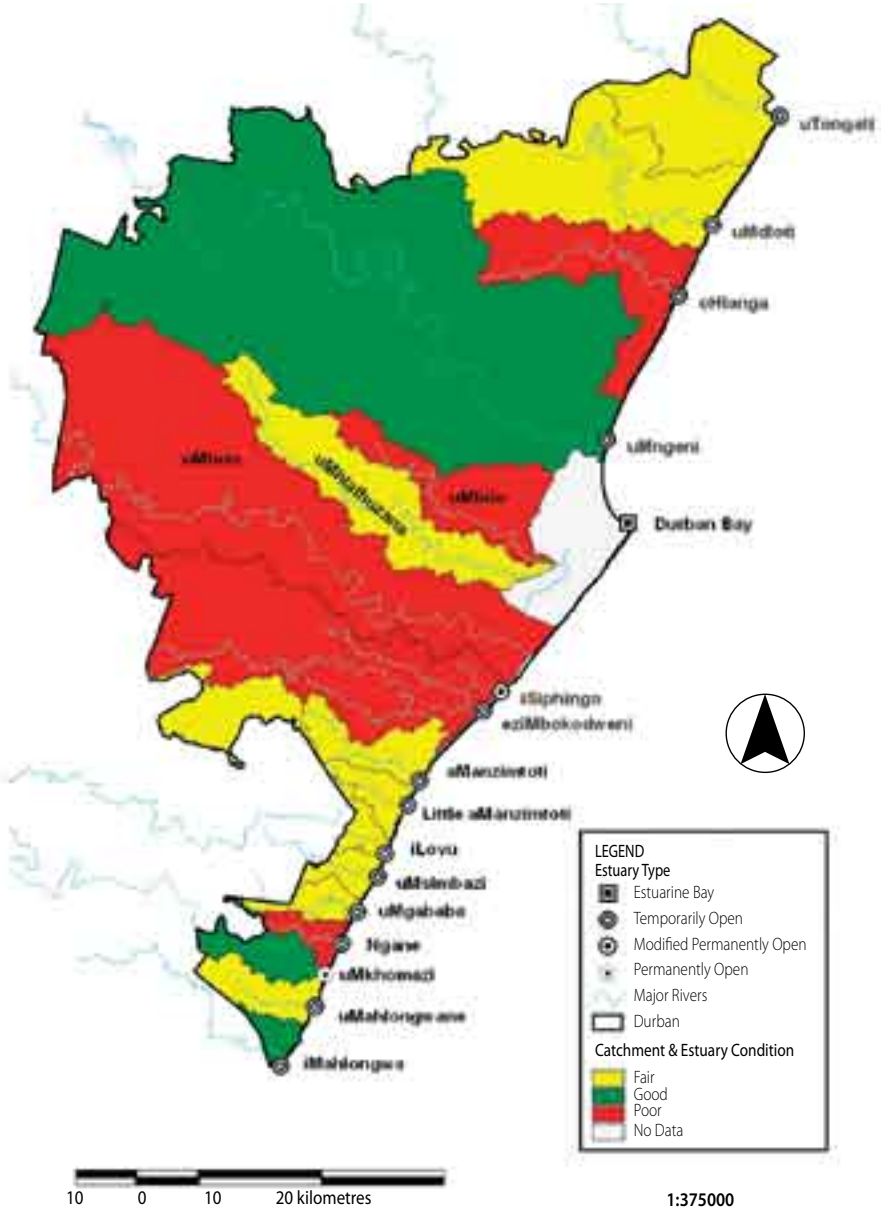


Figure 5: Extent and health status of the 17 river catchments and 16 estuaries in Durban, including estuary classification types. Note that the uMbilo and uMhlathuzana Rivers end at Durban Bay and the uMlaas estuary is totally modified.

ESTUARINE ECOSYSTEMS

There are 16 estuaries in Durban which fall into 3 types:

Temporarily open estuaries are closed for most of the year due to low river flow and longshore movement often forming sand bars at the mouths[16]. Mouth opening is usually by flooding and hypersaline conditions that occur during drought years[16]. The majority of the city's estuaries belong to this group and the number of these estuaries that occur within the municipal boundary hold regional significance for the organisms that reside in these systems[16]. In general, the health of these estuaries improves along Durban's southern section and in the north of the city. The only two estuaries that have statutory protection belong to this group. The uMgeni estuary is only partly conserved at the Beachwood Mangroves Nature Reserve while the oHlanga estuary has a large portion of its estuarine area formally protected via the Umhlanga Lagoon[16].

Permanently open estuaries are typically open throughout the year with varying degrees of salinity gradients, and have temperatures that are influenced by the sea during normal conditions[16]. Organisms in these systems are typically of marine and estuarine origin[16]. The uMkhomazi is the only estuary of this type in Durban[16]. The iShipingo estuary, historically a 'temporarily open' estuary, has been classified as 'modified permanently open'[16]. This is a result of a pipeline being laid under the sandbar at the mouth that enables tidal and freshwater exchange.

The Durban Bay is an estuarine bay and is the only estuary of this type in Durban[16]. It is linked to the sea and therefore has similar salinities and temperatures to the sea. It is dominated by marine and estuarine organisms and has extensive wetlands and mangrove swamps[16]. It constitutes 68% of the total estuary surface area in the city and has been ranked as the 11th most important estuary, out of 256 estuaries, in South Africa[16]. Regionally, Durban Bay is significant in terms of the nursery function it provides to various marine organisms, especially fish and prawn species[16]. The future integrity of this system remains uncertain due to increased pressures to expand port operations.

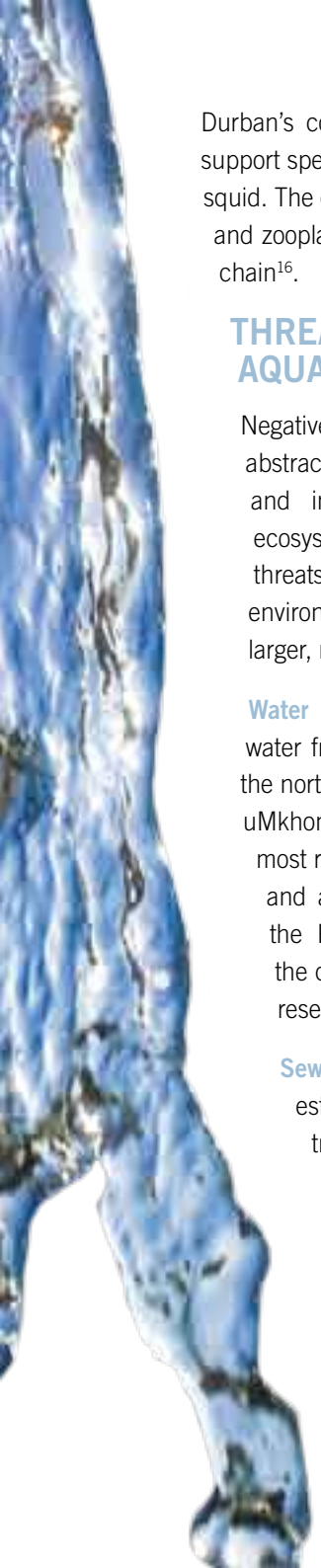
IN-SHORE MARINE ECOSYSTEMS

Durban's in-shore marine environment is made up of three different zones:

The coastal zone between the marine and terrestrial environments extends inland from the high water mark and includes the dunes and their associated flora and fauna. The Beachwood Mangroves is a proclaimed Nature Reserve, which abuts the seashore. It is the only biozone in the city listed as 'endangered' with the biggest threat to this environment being coastal development[16].

The intertidal zone extends from mean spring high to mean spring low levels. In Durban, this biozone includes sandy beaches and rocky shores. Sandy beaches in the city are affected by strong wave action and an unstable ocean floor which makes them species-poor. Rocky shores in Durban support species which are strongly influenced by their location relative to tidal patterns[16].

The third zone includes rocky reef, soft sandy ocean floor and open water habitats. Rocky reefs are characteristically species-rich habitats that include many organisms, including algae, sponges and hard and soft corals[16]. An excellent example of this habitat is found in the Aliwal Shoal Marine Protected Area offshore of Umkomaas[16]. Durban's ocean floor habitats can be found throughout



Durban's coastline where rocky reefs are absent and support species such as small crustaceans, prawns and squid. The open water habitats are dominated by phyto- and zooplanktons that form the foundation of the food chain[16].

THREATS TO DURBAN'S AQUATIC ECOSYSTEMS

Negative impacts such as pollution and sediment abstraction, both influence the freshwater, estuarine and in-shore marine environments. As these ecosystems are linked, it is important to understand threats to the one as threats to the whole aquatic environment. The following are key threats to the larger, more complex aquatic system:

Water abstraction relates to the abstraction of water from the major river systems: the uMdloti in the north, the uMngeni in the central region and the uMkhomazi in the south. Of these, the uMngeni is the most regulated, with a series of large water storage and abstraction areas for the settlements along the Pietermaritzburg/Durban axis. As a result, the current flow regime of the river has very little resemblance to that of a natural river[16];

Sewage and effluent return flows to rivers, estuaries and the ocean from wastewater treatment works often alter the natural flow and water quality (such as nutrient loading) in the receiving aquatic systems. Nitrates and phosphates from sewage works act as plant nutrients and enhance algal blooms which can lead to deterioration in water quality including oxygen depletion and fish kills, as experienced in the Durban Bay in 2007[16];

Pollution threats arise from point sources such as effluent outfalls, as well as a number of stormwater drains emptying into the harbour and sea. General catchment runoff and litter is drawn from urban centers, suburbs, industrial areas and informal settlements, all of which contribute to a cocktail of soluble substances with varying degrees of toxicity. The effects are sometimes seen in rivers as discolored or malodorous water or as fish kills, and in the harbour where there are additional industrial risks such as oil spills[16];

Alien species such as alien invasive vegetation congest many of the lower reaches of rivers particularly Water hyacinth (*Eichhornia crassipes*), Water lettuce (*Pistia stratiotes*) and Kariba weed (*Salvinia molesta*). Areas of the lower uMngeni River are often 100% covered by Water hyacinth. Regulated flows from upstream dams and nutrient-enriched waters exacerbate this problem. Rivers congested with invasive aquatic vegetation have major impacts on natural biodiversity, local water quality and have a reduced amenity value. There has been a limited amount of aquatic weed clearing in Durban. Chemical control in particular can have negative side effects as rotting plant material leads to oxygen depletion and fish kills. The introduction of alien marine species, through shipping and the release of ballast water into local coastal waters has the potential to impact on local biodiversity. As of 2004, alien species in the marine and estuarine environments were not known to pose a threat to any indigenous species[16], however, there has been a change in the zooplankton in Durban Bay and the broader impact on this community is unknown;

Disruption to sediment balances and flow dynamics in estuarine and beach environments through agriculture, sandmining, dam construction and structures such as harbour breakwaters, and water abstraction or addition

from sewerage works has changed patterns of sediment movement and mouth breaching in estuaries[16];

Shark netting is an activity directed at protecting bathers. While the nets are a highly successful method of trapping sharks, they also catch a large variety of other marine species such as dolphins, large fish, rays and turtles. There are currently approximately 12.5 kilometers of shark nets off Durban's coastline. Due to the negative impacts that this system has on non-target species, the Natal Sharks Board has begun a process of replacing shark nets with drumlines. This system uses baited hooks that are attached to large, anchored floats and reduces but does not remove, the impacts of shark control[16];

Expolitation of marine and estuarine re-sources is an acknowledged but largely under researched pressure exerted on estuarine and in-shore marine biodiversity. Numerous recreational and commercial boat fishers, shore anglers, spear fishers, seine-netters and invertebrate collectors harvest Durban's aquatic resources. Over-fishing can cause marine stocks to shrink and create the potential for extinction of some species[16];

Global climate change could have a significant impact in Durban. Durban is likely to experience a decrease in water availability, changes in rainfall patterns, increases in the frequency and intensity of floods and droughts and can increase in erosion of coastal areas[17]. The predicted changes to rainfall patterns may lead to impacts on water availability, agricultural productivity and food security[17]. In addition, infrastructural damage is likely to increase along the coast due to extreme weather events.

[16] Durban's Biodiversity Report, 2007.
[17] Climatic Future for Durban report, 2006/2007.

THE DURBAN WATER PERSPECTIVE: CASE STUDY ASSESSMENT

The following section focuses on activities undertaken by eThekwini Municipality in managing its local aquatic ecosystems as demonstrated through case studies. These case studies outline four programmes which were or are being implemented and three research initiatives. Each of these have been assessed for their impacts on the ecological, social, economic and institutional sustainability of Durban's water resources and accorded a positive or negative status according to this impact.

Several criteria were used in the assessment of the case studies against these sustainability principles, which include the following:

ECOLOGICAL SUSTAINABILITY

the conservation of biodiversity and maintenance of ecological integrity

- Addressing climate change;
- Sustaining biodiversity;
- Maintaining water quality;
- Providing valuable ecosystem management information.

SOCIAL SUSTAINABILITY

social justice and equity

- Meeting basic needs;
- Providing education and training;
- Reducing crime and violence;
- Protecting vulnerable groups.

ECONOMIC SUSTAINABILITY

economic viability and integrity

- Job creation;
- Skills development;
- Promoting ecotourism;
- Reducing service cost to ratepayers;
- Maximizing natural resource productivity.

INSTITUTIONAL SUSTAINABILITY

good governance management and partnerships

- Promoting transparency and democracy;
- Cooperative governance;
- Empowering local communities;
- Public-private partnerships;
- Catchment management;
- Local action;
- International action.

It is important to note that it was not the findings of the case studies that were assessed but rather the impact which the programme or research initiative had on the aquatic ecosystem. The assessment process is not intended to rank the case studies, but to highlight how different activities undertaken by the eThekwini Municipality contribute, or not, to the health of Durban's aquatic ecosystems.

the aquatic ecosystem & DURBAN'S metropolitan open place system

In order to sustain Durban's natural environment, both the terrestrial and aquatic environments need to be planned and managed as critical ecological and socio-economic assets. The Durban Metropolitan Open Space System (DMOSS) has a footprint of approximately 64 000 hectares (or 27% of the city). This includes key terrestrial and aquatic ecosystems within the city

The value of DMOSS comes from the ecosystem goods and services that are provided by the biodiversity contained in the different habitat or ecosystem types included in the system (see Figure 6). Natural or undisturbed open spaces and water bodies are the most functional ecosystems. Of particular importance are large, coastal, and upper catchment areas and the surrounds of strategic water resources.

The benefits provided by ecosystem goods and service can be categorized as follows:

- **Direct benefits** - Direct consumption or use of resources such as water for drinking and plants for fuel, food and construction materials;
- **Indirect benefits** - Indirect or non consumptive use of resources to provide a cost saving or benefit to urban residents, such as wetlands to reduce flooding and trees to provide shelter and erosion prevention;
- **Option benefits** - Resources that can be protected for the future, such as an attractive coastline that can be used to ensure tourism growth in the future; and
- **Existence benefits** - Unspoilt landscapes that give people a feeling of wellbeing, identity, sense of place and improve overall quality of life[16].

An estimate undertaken in 2002 of the value of the ecosystem goods and services supplied by these natural areas included in DMOSS, suggested that they were worth in excess of R 3.1 billion per annum. Of this, freshwater, estuarine and marine ecosystems deliver an estimated R1.6 billion per annum (excluding the tourism sector)[18].

Although the spatial component of DMOSS has been included in the Municipality's Spatial Development Plan as a base layer in an attempt to ensure that the city develops in a sustainable manner, much of DMOSS is zoned for development and is in private ownership. If all of this land were to be developed, the open space system would cease to function and its ability to provide a sustained supply of environmental goods and services would be undermined. As a result, the Environmental Management Department has, over time, established a number of development assessment guidelines that are applied when assessing development proposed on or adjacent to DMOSS. The summary below highlights those guidelines applicable to the water sector.

[18] Ethekwini Environmental Services Management Plan, 2003.

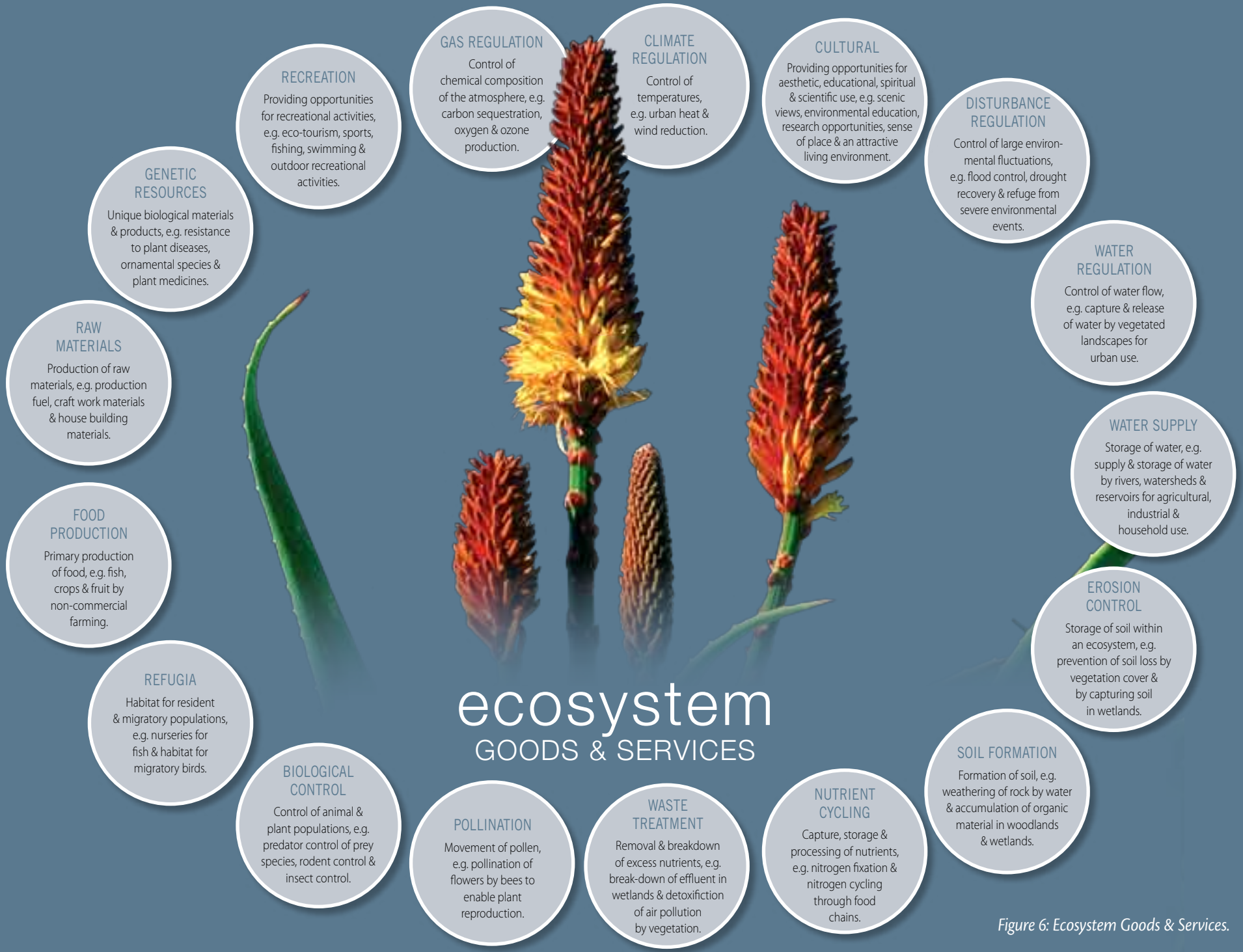


Figure 6: Ecosystem Goods & Services.

DEVELOPMENT ASSESSMENT GUIDELINES

WATERCOURSES (rivers, streams and drainage lines)

The Environmental Management Department has for many years applied a policy of no development within the 100 year floodline and a minimum setback of 10 meters from the edge of drainage lines where floodlines cannot be calculated. This figure is based on the need to manage these areas for ecosystem goods and services provision and to provide for limited flood protection.

Over time and with increased availability of information, it has become evident that a buffer beyond the 100 year floodline is required to establish ecological resilience. Rivers need a riparian area beyond floodlines that act as a source of species to re-colonise the areas disturbed by floods. In addition the validity of the 10 meter setback was being challenged in the absence of scientific consensus, especially within the upper catchment areas of the City.

Recently, given the potential impacts of climate change and the need to protect water resources against these impacts, the Environmental Management Department has initiated a study to investigate and evaluate this policy. The current setbacks will be interrogated and assessed in terms of flood protection, biodiversity conservation and climate change resilience. A more detailed guideline will be developed to ensure adequate protection of watercourses in the future.

WETLANDS

Wetlands require Environmental Impact Assessments before any development, which may impact on them is permitted. Both the National Department of Water Affairs and Forestry and the Provincial Department of Agriculture and Environmental Affairs have policies to protect wetlands.

The Environmental Management Department has, with increased understanding of the importance of wetland systems, recently begun applying more extensive buffers than those stipulated in provincial and national policy. A minimum of 30 meters is applied, especially within the upper catchment areas and for wetlands that have a high level of functionality. This is an attempt to ensure the long-term sustainability of wetland systems and the water availability downstream.

As our demand for freshwater increases, it is likely that the amount of water available for various ecosystems such as wetlands and rivers will be reduced. This will reduce their ability to provide ecosystem goods and services, and ultimately impact on human health and well-being. Ecosystems such as grasslands, forests, wetlands, floodplains, estuaries and some coastal areas not only rely on freshwater resources, they also perform important regulatory functions within their ecosystems. The conservation and management of all ecosystems included in DMOSS is the only way to ensure the continued supply of the ecosystem goods and services they provide.

case study working 4 ecosystems

The 'Working 4 Ecosystems' programme is a poverty relief programme initiated in Giba Gorge and Ntshongweni, sponsored by the National Department of Environmental Affairs and Tourism and eThekwini Municipality's Environmental Management Department. The programme aims to create jobs and alleviate poverty while managing DMOSS. The Environmental Management Department successfully applied to the Department of Environmental Affairs and Tourism for programme funding amounting to R2.5 million in 2006. A further R1 million was granted to the programme as a result of the eThekwini Municipality winning the 'Cleanest City Award' in 2006.

As municipalities cannot receive poverty alleviation funding directly, an implementing agent, in the form of the Wildlife and Environment Society of South Africa: KZN Region, was appointed to run the programme. The Wildlife and Environment Society of South Africa is an established non-profit organization that undertakes a number of environmental activities including environmental education.

The programme provided much needed employment, training, and social upliftment in the selected disadvantaged communities. The programme was also precedent setting in encouraging and fostering community involvement in the management and protection of open space resources.

Community members were employed according to the National Department of Environmental Affairs and Tourism guidelines which specify a minimum number of women, youth and disabled people. Training was provided in order to develop skills which related to needs identified by the community. Fieldwork in the two selected areas ceased at the beginning of April 2008 when funding came to end.

This programme has achieved the following results:

- The clearing of invasive alien plants in an area of 200 hectares;
- The planting of 7,000 indigenous trees in areas such as road verges, schools and residential areas;
- The construction of 6 small domestic nurseries on privately owned residential sites in Ntshongweni;
- The clearing of litter in various river courses over an approximate length of 24 kilometers;
- The cutting of 12 kilometers of hiking trails through pristine areas of Ntshongweni;
- At its height, the programme generated employment for 130 people from the Ntshongweni and Giba Gorge areas;

- The conducting of basic environmental education courses for 3,600 learners in both target areas;
- The training of 12 trail guides up to NQF level 2 standard in nature conservation;
- The training of 53 people in basic first-aid through the St. John's Ambulance Organisation;
- The conducting of a basic course in fire fighting by the Pinetown Fire Brigade;
- The design and erection of appropriate directional signage in the two target areas;
- Raising environmental awareness amongst 3,600 learners from various local schools.

Following the termination of funding, the Wildlife and Environment Society of South Africa: KZN Region will offer 6 months of further training in their own Nature Reserves to four nature guides and four field rangers.

WORKING 4 ECOSYSTEM'S IMPACT ON THE WATER RESOURCE AND ECOSYSTEM		
PRINCIPLE	CRITERIA	STATUS
ECOLOGICAL	**Sustaining biodiversity:** Clearing of alien vegetation and litter.	☺
	Addressing climate change: Planting of indigenous trees.	☺
	Maintaining water quality: Clearing of litter in river courses.	☺
SOCIAL	**Empowering local communities:** Training and skills development related to needs identified by the community.	☺
	Meeting basic needs: Development of domestic nurseries, skills development, job creation.	☺
	Protecting vulnerable groups: Employment guidelines specified a minimum number of women, youth and disabled participants.	☺
	Provision of education and training: Training for trail guides in nature conservation, in basic fire fighting, in first-aid, in tree planting and in environmental awareness for 3 600 learners from local schools; developing domestic nurseries; additional 6 months further training to 4 nature guides and four field rangers.	☺
ECONOMIC	**Job creation:** 130 temporary jobs.	☺
	Skills development: Skills development allows for either entrepreneurial or entry into existing employment opportunities.	☺
	Promoting Ecotourism: Provision of 12 kilometers of hiking trails, signage and trained local nature conservation guides and field rangers.	☺
INSTITUTIONAL	**Financial sustainability:** Ongoing programme funding is uncertain.	☹
	Public-private partnership: eThekwini Municipality and Wildlife and Environment Society for South Africa: KZN Region public private partnership.	☺
	Local action: Local protection of the environmental asset encourages sustainability of that action.	☺

DURBAN'S fresh water ecosystems

Durban's 17 catchments function as the arteries and veins of the landscape. The quality and quantity of the water resource within the catchments impact on the estuarine and in-shore marine environments into which they flow.

By way of contrast, Durban's bulk water supply system is made up of an extensive network of water pipelines and aqueducts which transfer water from the main storage reservoirs at Midmar, Albert Falls, Nagle and Inanda Dams all on the uMngeni River System and Hazelmere Dam on the Mdloti River to local water users. In addition, the Mooi-Mngeni Transfer Scheme adds to the supply of water from the upper uMngeni River (Midmar Dam). Under normal operating conditions, 72% of Durban's water is supplied from Albert Falls Dam via Nagle Dam and 28% from Inanda Dam. The focus of this system is on the human end user.

WATER SUPPLY AND DELIVERY

Water supply for human consumption is a municipal responsibility undertaken by the eThekwini Water and Sanitation Unit. The eThekwini Water and Sanitation Unit is responsible for the distribution of potable water, the provision of affordable and acceptable services for the disposal of sewage and industrial effluent, the control of water pollution, and the provision of ancillary services.

Umgeni Water[19] operates the Durban Heights and Wiggins treatment works, where water is treated before it is distributed to water users by the eThekwini Water and Sanitation Unit. The eThekwini Water and Sanitation Unit purchases **832 Megalitres of treated water per day** from Umgeni Water for distribution in Durban[20]. In addition, some of the westernmost areas of Durban are supplied directly by Umgeni Water. The quality of water supply is tested against levels set by **Standards South Africa**. These health standards have been developed to ensure consumer health and safety and environmental protection and more than **99% of piped water complies with these health standards**.

WASTE WATER MANAGEMENT AND PLANNING

The eThekwini Water and Sanitation Unit also manages the city's sewers and wastewater treatment plants, collecting sewage effluent and treating it before discharging treated wastewater to rivers and the sea. It is estimated that **240 Megalitres per day of treated wastewater** is discharged to sea, which is **95% compliant** with the marine discharge permit and **221 Megalitres per day** of treated waste water is discharged to rivers,

which is **80% compliant** with the river discharge permit[20]. In 2006/07, the eThekwini Water and Sanitation Unit issued **561 notices and prosecutions** for non compliant discharges to its sewers[20].

Planning for the provision of wastewater services, both for low-income and informal settlements, as well as the increasing densification of middle and higher income areas, is a key challenge in Durban. While average domestic consumption of water in Durban is estimated at 160 litres per person per day[21], approximately **152 880 households are without access to sanitation facilities and approximately 32 228 households in Durban are without access to piped water**[20].

The eThekwini Municipality has been a leader in the application of a sliding scale of tariffs to manage water consumption. This includes a penalty tariff for luxury consumption of water by domestic households, and the initiation of a life-line service whereby the first 6 kilolitres of water per month are provided free of charge. This ensures that all residents have access to sufficient water for basic health and hygiene purposes. Based on the eThekwini Municipality's success, the National Department of Water Affairs and Forestry made free basic water a national policy in 2001.

Wastewater forecasting requires authorities to plan for future urban growth, while at the same time meeting the current requirements to alleviate the environmental pressures associated with poor sanitation, lack of access to piped water, and increasing residential and industrial development. The demand for water in Durban is increasing and the future supply and demand is unknown. As part of a National study, the Department of Water Affairs and Forestry has initiated a Water Reconciliation Strategy Study, to determine water requirements, establish water availability, and prioritise water supply interventions for each region. The study for KwaZulu-Natal has been initiated and is expected to be completed in 2008. This study will be used by the eThekwini Water and Sanitation Unit to address the impacts of future urban growth on the quantity and quality of freshwater supply.

[19] Umgeni Water is the largest bulk water supplier in the province of KwaZulu-Natal and it supplies clean, safe drinking water to almost 4.8 million people annually.
[20] State of Environment Report: Headline Indicators Report; 2006/07.
[21] State of Environment Report, 2003/04.

case study

non-revenue water management interventions in durban

Non-revenue water refers to water that is lost through the distribution network of water pipelines via leaks, before it reaches the consumer. The Non-Revenue Water Branch within the eThekwini Water and Sanitation Unit is responsible for managing water loss. The main mechanisms used to reduce water loss include; water pressure management, active water leak control, water speed management and repairs, and infrastructure management.

Since 2006, the Non-Revenue Water Branch has detected approximately 14 660 leaks, repaired 9 044 kilometers of water main and identified that approximately every third dwelling in informal settlements is illegally connected. Despite the number of management interventions, water loss has remained high at 31% in 2006/07. To address water loss in Durban on a larger scale, the Branch has embarked on a Non-Revenue Water Reduction Programme. This programme aims to achieve a 20% reduction in annual water loss through the replacement of aging asbestos cement water mains throughout the water network and reducing water loss at reservoirs. These initiatives are currently underway and will be completed in 2008. As a result of these water loss management interventions, the eThekwini Municipality has saved approximately R40 million per annum in operating and capital costs in 2007/08. This has resulted in lower tariff increases for existing consumers and faster expansion of the water reticulation network into previously unserviced areas.

NON-REVENUE WATER MANAGEMENT IMPACT ON THE WATER RESOURCE AND ECOSYSTEM		
PRINCIPLE	CRITERIA	STATUS
ECOLOGICAL	**Sustaining biodiversity:** Reducing water abstraction through reduction in water loss leaves more water in the natural system.	☺
	Maintaining water quality: Reducing water abstraction through reduction in water loss reduces the amount of water going through our wastewater treatment systems and returning to our natural water systems.	☺
SOCIAL	**Meeting basic needs:** Savings through water loss management has meant more rapid expansion of water reticulation network into unserviced areas.	☺
ECONOMIC	**Reducing service cost:** Savings through water loss management has meant lower tariff increases for existing consumers.	☺
INSTITUTIONAL	**Operating and capital savings on infrastructure:** EThekwini Municipality has saved approximately R40 million per annum in operating and capital costs in 2007/08 through water loss management.	☺
	Local Action: Local protection of the environmental asset encourages sustainability of that action.	☺

case study state of river health in durban

To better understand the state of Durban's rivers, the Environmental Management Department initiated a river health study and produced a State of Rivers report in 2005-2006 and 2006-2007. Indicators were used to check for signs of degradation or distress in the river systems. 33 rivers and streams in Durban were sampled at 60 sampling sites in 2006 and 59 sampling sites in 2007. River sites were sampled as per the South African River Health Programme indicators to establish the ecostatus at each sampling site. The South African River Health Programme indicators include an Instream Habitat Index and a Riparian Habitat Index. In addition, the South African Scoring System for invertebrates (SASS) and Diatom[22] sampling were used to establish the ecostatus of river health in the municipal area.

TABLE 2: RIVER HEALTH ECOSTATUS

RIVER HEALTH ECOSTATUS	ECOLOGICAL INTERPRETATION	MANAGEMENT INTERPRETATION
Natural	No or negligible modification of in-stream and riparian habitats and biota.	Protected rivers; relatively untouched by human disturbance; no discharges or impoundments allowed.
Good	Ecosystems essentially intact, biodiversity largely intact.	Some human-related disturbance but mostly of low impact potential.
Fair	A few sensitive species may be lost; lower abundance of biological populations may occur.	Zones of competing uses; development pressures are a dominant feature.
Poor	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (e.g. biota can no longer breed or alien species have invaded the ecosystem).	Often characterised by high human densities or extensive resource exploitation. Management intervention is needed to improve river health – e.g. to restore flow patterns, river habitats or water quality.

[22] Diatom sampling was used as an overall health indicator similar to SASS, but the scoring is based on the different types of micro-organisms (diatoms) found surviving in the river according to their resistance to the disturbance as compared to what micro-organisms would be expected in natural conditions.

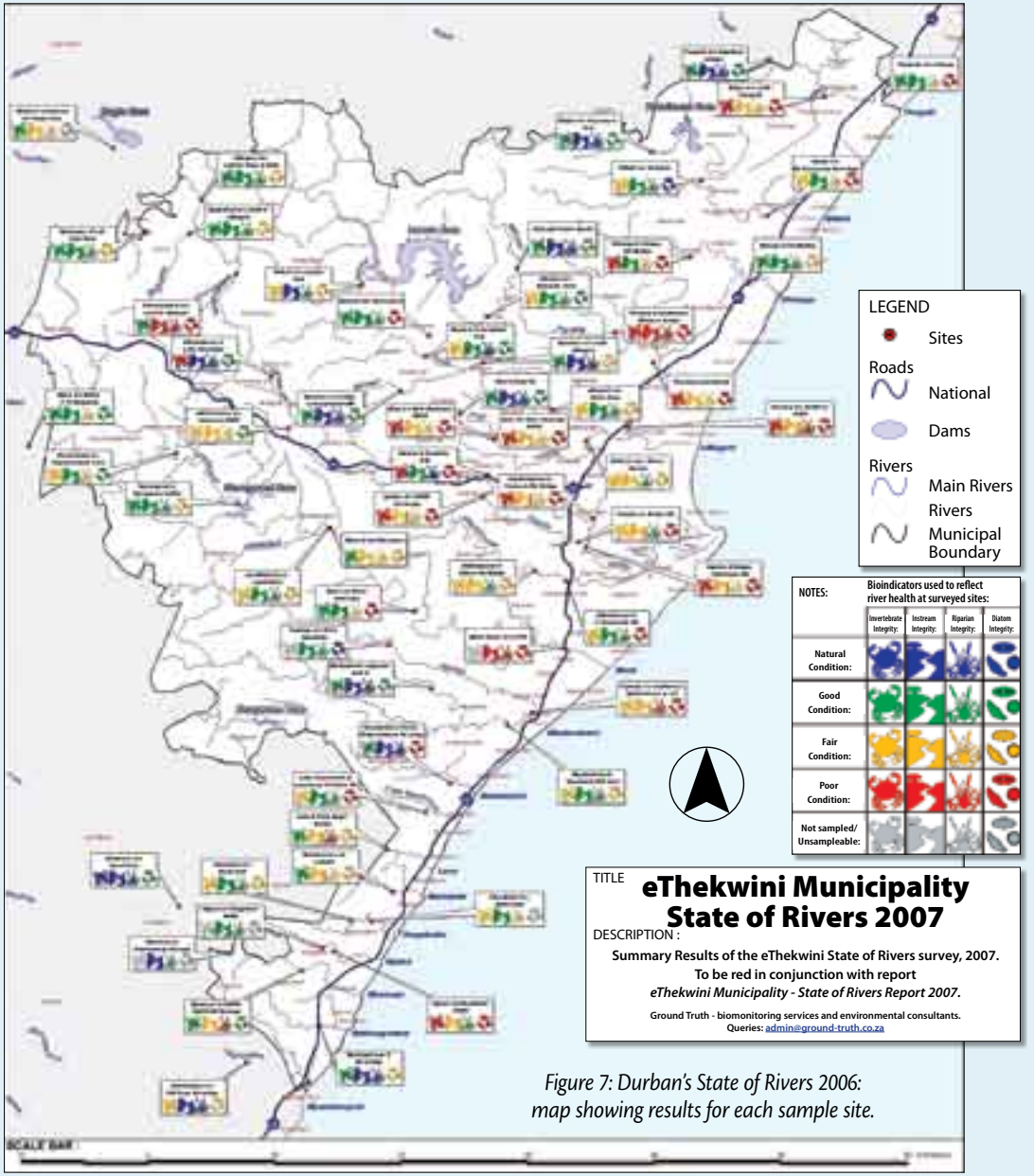


Figure 7: Durban's State of Rivers 2006: map showing results for each sample site.

The State of Rivers reports revealed that the health of rivers was generally better in the upper catchment areas and, on the less urbanized edges of Durban. River quality declined as rivers ran through more developed areas toward the sea. **Only 4% of river sites sampled were in a 'Natural' condition and 32% of river sites sampled were in a 'Poor' condition taken as an average over the two sampling years.**

TABLE 3. SUMMARISED ECOSTATUS FOR ALL SITES MONITORED FOR RIVERS DURING THE 2006 AND 2007 DURBAN'S STATE OF RIVERS (SOR) SURVEY[23]

	Ecostatus					
	Natural	Good	Fair	Poor	Dry	Not sampled
2006 SoR Survey	3	20	17	21	0	0
2007 SoR Survey	2	19	21	17	0	2

*(*Note: The Mkomaas at Goodenough Barrage site (in a Natural state in 2006) and the Ngane upstream of the Magabeni WWW site (in a Poor state in 2006) were not sampled in 2007).*

STATE OF RIVER HEALTH IN DURBAN CURRENT IMPACTS ON THE WATER RESOURCE AND ECOSYSTEM		
PRINCIPLE	CRITERIA	STATUS
ECOLOGICAL	**Provides valuable information for catchment management:** Management interventions can be made in order of priority based on known level of impact.	☺
SOCIAL		
ECONOMIC		
INSTITUTIONAL	**Cooperative governance:** The Environmental Management Department began the River Health Programme and eThekwini Water and Sanitation Unit has committed to continue ongoing river health monitoring.	☺
	Promoting transparency and democracy: Provision of this information to the public promotes greater awareness of aquatic issues and the lobbying of decision makers to improve the quality of our aquatic environment.	☺

The study indicated that the key pressures on rivers came from direct pollution (spills, leaks, illegal discharge from industries and waste water treatment works), solid waste dumping (domestic and industrial waste, construction rubble), indirect pollution (chemicals, excess nutrients and solid waste picked up by stormwater as it runs over developed or agricultural land), river channel re-alignment and modification of flow, erosion, illegal sandmining and alien species (riparian and aquatic vegetation, snails, fish).

All of these impacts degrade the habitat for aquatic species and decrease the ability of the river to deliver ecosystem goods and services. In addition:

- Degraded river banks and channels cannot prevent soil erosion in storms;
- Damaged or drained wetlands cannot filter stormwater or slow down run-off to prevent downstream floods;
- Polluted rivers pose a health hazard to those who drink, wash, or swim in the water;
- Rivers contaminated with bacteria from sewage can cause gastro-intestinal disease in those who come into contact with it;
- Excessive amounts of nutrients and/or other chemical pollution in river water have already led to fish kill incidents in rivers and estuaries such as the iSipingo, uMbilo, uMdloti, and Durban Bay.

As a result of these reports the eThekwini Water and Sanitation Unit has committed to undertaking the ongoing management of river health in Durban and is considering the initiation of a biomonitoring programme for the city's rivers.

[23] EThekwini Municipality's 2007 State of Rivers report.

DURBAN'S estuarine ecosystems

There are **16 estuaries in Durban**. Estuaries are transition zones at the mouth of rivers where riverine and marine ecosystems meet[24]. The health of an estuary is thus dependent on the quality of both estuarine and marine ecosystems. Estuaries are among the most biologically productive ecosystems in the world. They are nurseries of the sea because they contain large amounts of food and provide shelter for juvenile fish and other fauna[25]. More than two thirds of fish and shellfish spend some part of their lives in estuaries[24]. Estuaries act as filters for aquatic and terrestrial pollutants, provide protection from flooding, and provide tourism opportunities.

All activities that take place within catchments will impact on the estuary. Rivers carry pesticides, herbicides and excess nutrient loads which make their way into estuaries. Poor land practices can result in erosion, which increases the silt load of rivers, deposited in estuaries, smothering estuarine life. Silt also reduces light penetration affecting plant growth which can interfere with the month dynamics. Damming of rivers and the use of water for irrigation or industry can lead to freshwater starvation of an estuary. This alters the ratio of freshwater to seawater, which disrupts the ecosystem dynamics.

[24] Millennium Ecosystem Assessment: Coastal Systems, 2005.
[25] South African Environmental Outlook, 2006.

case study

Vandalism and blockages in Durban's sewage system coupled with ageing municipal infrastructure have resulted in hundreds of sewers overflowing directly into rivers. The sewage spills and overflow contaminate the water and spread disease that lead to environmental degradation. In order to address sewage spills and overflows, the eThekwini Water and Sanitation Unit currently uses chlorine as a biocide to remove pathogens from river systems as a short-term management intervention.

Chlorine is a well-established and proven disinfectant; particularly for fresh water. Chlorine is effective against most viruses and bacteria; however, its behavior in seawater, especially the potential reaction with other disinfectants is not well understood[26]. Biocidal products

the challenge of meeting human and environmental needs: chlorination of rivers and estuaries in durban

such as chlorine can pose a significant risk to human health and welfare. The consequence of introducing chlorine to an aquatic ecosystem is its complete sterilization, resulting in the death of most, if not all, of its biodiversity. As a result of this action, riverine and estuarine ecosystem functioning and their ability to provide goods and services is compromised.

The current focus of the eThekwini Water and Sanitation Unit is on improving the quality of water for human use and consumption. Little attention or consideration is given to the state of health of river ecosystems or the biodiversity that supports it. Due to the connection between freshwater, estuarine and marine ecosystems, attempts to improve water quality upstream using chemicals, impacts negatively on the biodiversity as well as human health throughout the ecosystem, with unknown impacts in saline conditions.

Negotiations with the eThekwini Water and Sanitation Unit are currently underway to explore alternatives to chlorine treatment which could address human health concerns without negatively impacting on ecosystems. Interdepartmental cooperation is key to identifying environmental threats and finding sustainable management solutions.

CHRLORINATION OF RIVERS' AND ESTUARIES' IMPACT ON THE WATER RESOURSE AND ECOSYSTEM		
PRINCIPLE	CRITERIA	STATUS
ECOLOGICAL	**Sustaining biodiversity:** The consequence of chlorine in an aquatic ecosystem is its complete sterilization and death of most if not all biodiversity, ecosystem functioning and ability to provide goods and services is compromised.	☹
SOCIAL	**Meeting basic needs:** Biocidal products such as chlorine can pose a significant risk to human health and welfare.	☹
ECONOMIC		
INSTITUTIONAL	**Cooperative governance:** Negotiations between the Environmental Management Department and the eThekwini Water and Sanitation Unit are underway to explore alternatives to chlorine treatment which address human health concerns without negatively impacting on ecosystems.	☺
	Promoting transparency and democracy: Provision of this information to the public promotes greater awareness of aquatic issues and the lobbying of decision makers to improve the quality of our aquatic environment.	☺
	Local action: Local protection of the environmental asset encourages sustainability of that action, in this case through a negotiated solution to chlorination of our estuaries.	☺

[26] Ballast Water Treatment Methods Fact Sheet 11 Chemical Biocides Organic Acids And Other Disinfectants, 2005.

case study durban's estuarine assessment

In the absence of data, an urgent need was identified to better understand out estuarine ecosystems so as to inform strategic planning and decision-making. The eThekwini Municipality commissioned an assessment of Durban's estuaries which is the first regional scale assessment of estuarine abiotic and biotic parameters conducted in South Africa since the 1980s and will provide a much needed update of the current ecological status and threats to these systems.

A historical review has been undertaken using available litreature as well as aerial photographs dating back to 1937. This was done to assess changes in each estuarine system. Each system was also sampled in July/August 2007 (winter) and January/February 2008 (summer).

Physiochemical and biological conditions in all systems were assessed on the basis of:

- Salinity, temperature, turbidity and dissolved oxygen;
- Nutrient status;
- Bacterial contamination;
- Riparian, floodplain and aquatic vegetation;
- Phytoplankton;
- Macrobenthic invertebrates;
- Fish-seine and gill nets; and
- Water associated bird counts.

Figure 8: Extent and health status of the 17 river catchments and 16 estuaries in Durban, including estuary classification types.

Although the study has not been finalized, the following findings have emerged:

- Despite harbour development and massive habitat loss, Durban Bay retains its status as the prime estuarine habitat along Durban's of coastline;
- Significant habitat loss has occurred in all systems through infilling of flood plains and causeway construction for road and rail bridges;
- Summer rains and dry winters result in seasonally very different river flows and consequent changes in the extent of saline penetration. This has significant management and legal implications in terms of the definition of estuarine boundaries;
- During periods of closure, tidal effects are lost and the salinity drops virtually to zero due to sustained but low levels of river flow. Back flooding during closure expands the estuarine habitat significantly;
- Flow in smaller systems is enhanced by the addition of wastewater originating from different catchments. This disrupts natural breaching patterns and increases the nutrient levels in these systems;
- Macrobenthic biodiversity is reduced by the loss of intertidal habitats. Low salinities mean tolerant species increase significantly under the relatively stable conditions and the greater habitat area generated by back flooding;
- Marine migrant fish species using the estuaries as nursery grounds appear capable of tolerating low winter salinities;
- The use of open or closed systems by waterbirds, particularly piscivores, depends on the water depths and the fishing methods, i.e. wading, underwater swimming or plunge diving;
- Twelve of the 16 systems (those that are urbanized and semi-urbanised) showed evidence of nitrification and bacterial contamination.

A number of direct pressures are impacting on estuaries in Durban. These include:

- habitat loss as a result of bridges, sugar cultivation and urban development;
- changes in mouth dynamics resulting from the manipulation of mouths to maintain constant water levels or prevent flooding;
- sandmining which disrupts benthic habitats and riparian zones and reduces water quality;
- sedimentation of estuaries due to bad catchment or mouth management;
- pollution from chemical, industrial and domestic sources.

In addition freshwater supplies into the estuary are under pressure from:

- Reductions in freshwater inputs due to upstream abstraction and afforestation;

- Increase in freshwater inputs due to agricultural irrigation and sewage return flows;
- Reductions in water quality, including turbidity, due to bad catchment management, polluted return flows and effluent disposal.

The data and understanding gathered during this study will provide a baseline to facilitate regular regional reporting with appropriately selected parameters and input into strategic planning and decision-making.

DURBAN'S ESTARINE ASSESSMENT'S IMPACT ON THE WATER RESOURCE AND ECOSYSTEM

PRINCIPLE	CRITERIA	STATUS
ECOLOGICAL	**Provides valuable information for estuarine management:** Management interventions can be made in order of priority based on known level of impact.	☺
SOCIAL		
ECONOMIC		
INSTITUTIONAL	**Promotes transparency and democracy:** Provision of this information to the public promotes greater awareness of aquatic issues and the lobbying of decision makers to improve the quality of our aquatic environment.	☺

case study

waterbird counts in the durban bay/harbour

This programme was initiated by the ornithology department of the eThekwini Municipality's Natural Science Museum in 1999. The objective of this programme is to understand the spatial and temporal trends of an abundant diversity of water birds in Durban Bay. Monitoring takes place monthly and the results provide a useful indicator of the health of the bay.

Durban Bay has undergone extensive modification in the past century through commercial harbour activities. These changes have included the displacement of 426 hectares of mangroves and 1078 hectares of intertidal habitat. Historical records of waterbird numbers and diversity in Durban Bay indicate an exceptionally rich estuarine avifaunal community. Despite the substantial reduction in habitat extent, Durban Bay is still rated as one of the four most important estuarine systems for waterbirds in KwaZulu-Natal, especially for Palearctic wader species that occupy the intertidal sand and mudflats. Growing pressure for further alterations to Durban Bay to accommodate harbour expansion has necessitated a thorough understanding of which areas are crucial for waterbirds.

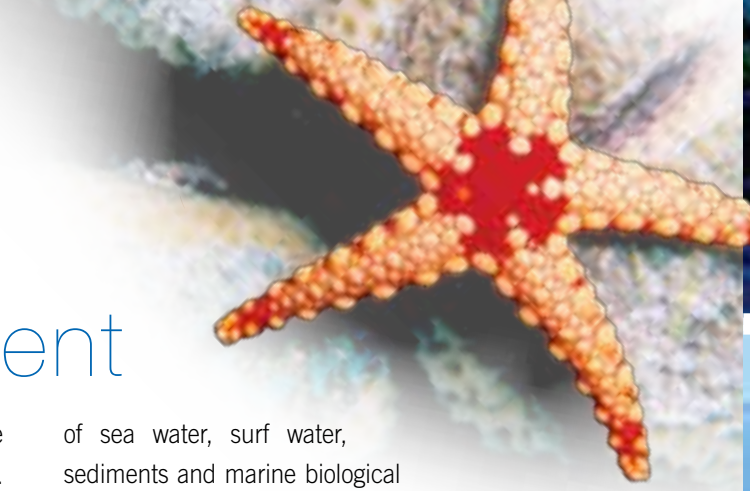
To date, a total of 108 counts have taken place since 1999 and key findings show that:

- Since 1965, the abundance of waterbirds has decreased by 70% and five species have become locally extinct;
- Central Bank and Bayhead intertidal habitats are key areas for waterbird conservation in Durban Bay;
- Central Bank is identified as important to roosting gulls and terns;
- Two distinct species assemblages can be identified at Bayhead and Central Bank respectively;
- Modified and 'sterile' areas of the Bay are the least attractive sites for waterbird diversity and abundance.

The results of the waterbird counts have been used in past and current Durban harbour planning exercises. Given the importance of the Durban Bay to waterbirds, it is important that development and operations of the Port do not further impact on this ecosystem.

WATERBIRD COUNTS IN THE DURBAN BAY/HARBOUR IMPACT ON THE WATER RESOURCE AND ECOSYSTEM		
PRINCIPLE	CRITERIA	STATUS
ECOLOGICAL	**Provides valuable information for estuarine management:** Management interventions can be made in order of priority based on known level of impact.	☺
SOCIAL		
ECONOMIC	**Maximising natural resource productivity:** Durban Bay planning been informed by long term monitoring data to the benefit of the ecological asset in ensuring provision of environmental goods and services.	☺
INSTITUTIONAL	**Promoting transparency and democracy:** Provision of this information to the public promotes greater awareness of aquatic issues and the lobbying of decision makers to improve the quality of our aquatic environment.	☺

DURBAN'S in-shore marine environment



Durban's coastline is 97 km long and stretches from the uTongati River in the north to the iMahlongwa in the south. The marine environment spans the dunes and beach habitats out to sea to a depth of approximately 30 meters below sea level[16]. Habitats in this zone include sandy beaches, rocky shores, rocky reefs, soft substrate sandy ocean floor and open water habitats[16]. The warm coastal waters of Durban are strongly influenced by the southward-flowing Agulhas current[28]. This has resulted in the Durban's coastline hosting numerous tropical and sub-tropical flora and fauna. There is also a large number of endemic species. Most of the fish and invertebrate species targeted by recreational and commercial fishers are either fully or overexploited[16].

Durban has the largest and busiest port on Africa's east coast[29]. Durban is also a popular tourist destination. There are increasing pressures on our coastal areas for transport, waste disposal and recreational activities. The eThekwini Municipality is concerned with seawater quality as Durban's coast is extensively used for recreational activities, both in summer and winter. Declining water quality places both human health and ecosystem health at risk. The eThekwini Water and Sanitation Unit regularly monitors the quality of treated effluent discharged from marine outfalls. Bacteriological, biological and chemical monitoring surveys of sea water, surf water, sediments and marine biological tissue samples are carried out in the vicinity of the marine outfalls as an audit function in terms of discharge standards which are issued by the National Department of Water Affairs and Forestry.

Discharge released to rivers has an impact on the quality of water in the in-shore marine environment. 72% of discharge released to rivers was compliant with standards from sewage outfalls to rivers in 2006/07. However **84 non-swimming days** were recorded across Durban's beaches due to poor water quality in 2006/07 year[20].

The greatest threat faced by the coastal system is ongoing development and infrastructure expansion. Increased development within coastal areas destroys coastal vegetation and increases the occurance of coastal erosion. In addition, an increase in severe storm events is eroding the coastline. The Coastal Policy Unit and the Coastal, Stormwater and Catchment Management Department have established a development setback line, which is designed to protect the natural environment from development that could impact on coastal biodiversity and accelerate erosion. The development setback line also protects beachfront developments from the effects of storms and erosion.

[16] Durban's Biodiversity Report, 2007.
[20] State of the Environment Report: Headline Indicator Report, 2006/2007.
[28] State of the Environment Report, Marine resources, 2008.

case study

blue flag beach programme

The Blue Flag Beach programme was first developed in Europe in 1985. The aim is to establish a quality standard for beaches based on sound environmental practice, safety, cleanliness and visible security, whilst at the same time promoting tourism and positively influencing local economies. South Africa was the first country in the southern hemisphere to apply for and achieve Blue Flag status for its beaches. Durban has played a significant role in bringing the Blue Flag programme to South Africa. In 1994, a working group was established by the Durban Chamber of Commerce Beachfront Business Committee to establish Durban as a Blue Flag destination.

The Blue Flag process starts with an application to carry out a pilot phase for a year. Once permission has been granted, the national co-coordinator of Blue Flag South Africa, under the agency of the Wildlife and Environment Society of South Africa carry out unannounced periodic inspections to evaluate the beach against 27 criteria, which include:

- *Water quality;*
- *Adequacy of lifeguard services;*
- *Continual visibility of law enforcement officers on the beach;*
- *Clean ablution facilities;*
- *An operational environmental education programme.*

In the 2004/05 season Umhlanga Main Beach and South Beach were awarded Blue Flag status. Subsequently in the 2005/06 and 2006/07 seasons, the Umhlanga Main Beach, Bay of Plenty Beach, North Beach, South Beach, Addington Beach and Anstey's Beach were awarded full Blue Flag status. Several Blue Flag beaches were unable to retain their status due to infrastructure damage caused during the severe storm event in March 2007. As part of the Blue Flag programme, periodic inspections were conducted in 2008. These revealed poor water quality at Westbrook and the Bay of Plenty beaches. Similar inspections conducted at North Beach, South Beach and Addington, revealed poor water quality and poor management of beach facilities. As a result Westbrook Beach, Bay of Plenty, North Beach, South Beach and Addington lost their Blue Flag status. The Umhlanga Main Beach is the only remaining Blue Flag beach in Durban.

The Municipality has elected not to participate in the Blue Flag programme next season and to develop its own criteria for managing Durban's n-shore marine environment. The poor water quality and lack of appropriate management at these beaches remains unresolved and a key concern.

BLUE FLAG BEACH PROGRAMME'S IMPACT ON THE WATER RESOURCE AND ECOSYSTEM		
CRITERIA	ASSESSMENT	STATUS
ECOLOGICAL	**Maintaining water quality**: Blue Flag programme criteria supports good water quality.	☺
SOCIAL	**Provision of education and training:** Blue Flag programme criteria supports education and training.	☺
	Reduces crime and violence: Blue Flag programme criteria supports reduction in crime and violence.	☺
ECONOMIC	**Promoting ecotourism:** Blue Flag programme criteria supports tourism and ecotourism.	☺
INSTITUTIONAL	**Public-private partnership:** EThekwini Municipality and Wildlife and Environment Society for South Africa: KZN Region public-private partnership.	☺
	Local action: Local protection of the environmental asset encourages sustainability of that action.	☺
	International action: Blue Flag programme highlights importance of coastal marine ecosystem at the international level.	☺
	Catchment management: Durban's exit from the Blue Flag programme and decision to develop its own criteria is a potential risk to the in-shore marine environment given existing poor water quality and lack of appropriate management at existing beaches.	☺

how to SAVE WATER at home!

Given the pressures on our water resources, it is important that each resident of Durban plays a role on improving the quantity and quality of limited resource.

KITCHEN

- Only fill a kettle with the amount of water that you need. It will help to cut down on water and electricity bills.
- Store drinking water in a bottle in the refrigerator instead of getting water from the tap.

BATHROOMS:

- Don't leave taps dripping. Fix leaks immediately and replace leaking washers. A slow dripping tap can waste up to 30 litres of water a day. A new washer can be bought for less than R1.
- Check toilets regularly for leaks. A simple toilet leak can waste up to 200 litres of water each day. To check for a leak put a few drops of food colorant in your Cistern and wait for 30 minutes. If the water in the bowl changes colour, you have a leak.
- Put a water saving device into the toilet cistern. With each flush the toilet uses 10-12 litres of water. More than 25% of all water used in a household is flushed down the toilet.
- Invest in a dual flush toilet.
- Install toilets that have cisterns with a maximum flush capacity of nine litres.
- Only put toilet paper paper down the toilet. Don't use your toilet as an ashtray or wastepaper basket.
- Don't leave the tap running when you brush your teeth, shave or wash your hands. This can waste more than 5 litres of water every minute. Turning the tap off or putting the plug in the sink will reduce water usage.
- Use a glass of water to rinse when brushing your teeth.
- It is far better to shower than to run a bath. A bath uses about 200 litres of water while a shower cuts down on water usage by 66%.
- Install washbasin taps with aerator outlets. The aerator mixes air with the water, resulting in a lower flow rate (five to 10 litres per minute, which splashes less and feels quite pleasant on the skin).
- Shorten your shower by one minute. One person taking a five-minute shower every day will use more than 20 000 litres of water per year.
- If you wash dishes by hand, rinse the dishes off in a sink partially filled with water instead of running water.

GARDENS

- Using a watering can instead of a hose will reduce water demand. A water sprinkler in the garden uses almost as much water in an hour as a family of four will in a day.
- Wash your car on the grass. This will water your lawn at the same time. Wash pets outdoors in an area in need of water.
- Most plants die from over-watering than from under-watering. Only water your plants when necessary.
- Ensure that you only plant indigenous plants. Indigenous plants tend to need less water than other plants.

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