

ABUNDANCE AND SCARCITY:

THE STORY OF WATER IN THE ORANGE-SENQU RIVER BASIN





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FOREWORD

The Orange–Senqu River basin is one of the largest in southern Africa. From the Orange–Senqu’s headwaters in the highlands of Lesotho the river is joined by numerous tributaries on its westward journey, draining significant areas of Botswana, Namibia and South Africa. More temperate in the east, the climate of the basin becomes increasingly arid towards the west. Rainfall is variable, both in time and space, subjecting the basin to droughts and floods. Nevertheless, the Orange–Senqu provides the water required to drive the most economically active region in southern Africa, supports large-scale irrigation and meets the domestic needs of several million inhabitants.

Water supply required to meet the various demands has been assured through the construction of numerous dams and a series of transfer schemes that store and move water to areas and at times when it would otherwise not be available. In western areas, much of the rural and urban water requirements are met by tapping the basin’s groundwater resources.

Whilst important for economic development, this remarkable operation of the basin’s water resources comes at a price. Extensive water abstraction for urban, industrial and agricultural purposes has significantly altered the natural flow of the river system. The frequency, size and duration of floods are also affected. These changes adversely affect the health of the river, the resources and ecosystems it supports and the services they provide. To maintain these important ecological functions and secure resources in the long term, it is essential that the Orange–Senqu is managed effectively, efficiently and sustainably. ORASECOM promotes such an integrated approach to water management.

To help the four basin nations plan on how to manage the river basin sustainably and equitably, we require a thorough understanding of the priority problems, their underlying causes and the impacts they have. Such an analytical study was recently carried out by the Orange–Senqu Strategic Action Programme, through the assistance of our international cooperating partners, UNDP–GEF. The study – or transboundary diagnostic analysis, as it is known – provides the technical and analytical basis on which strategic plans have been developed to address the problems.

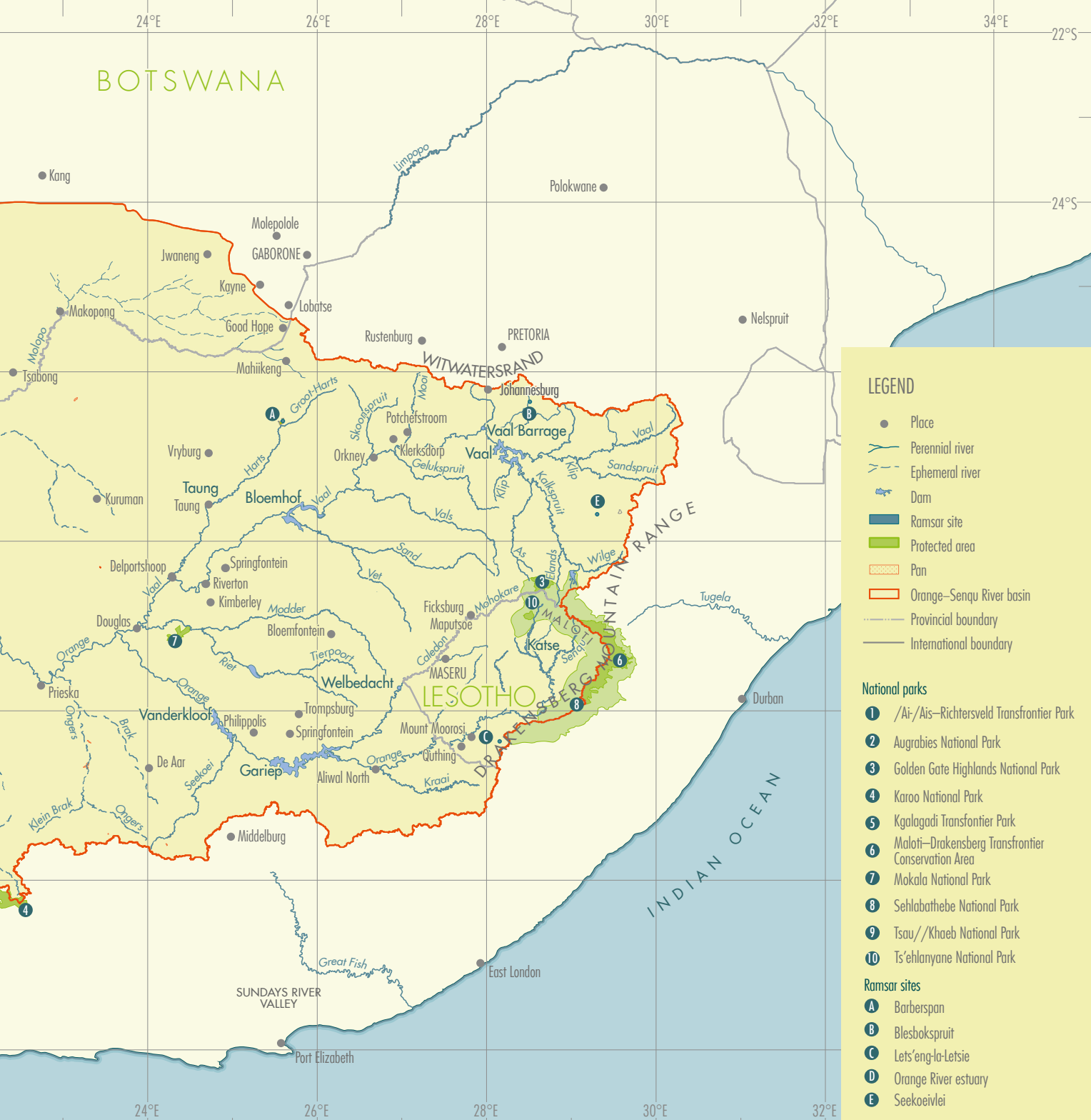
Based on findings of the *Orange–Senqu Transboundary Diagnostic Analysis*, this publication provides a rich description of the river basin – its resources, the people and economies it supports, and its problems. Greg and Leonie Marinovich’s powerful photographs capture the very essence of the Orange–Senqu, and Greg’s writing offers an engaging and thought-provoking read for a wide audience. This photographic essay is intended to create awareness of the importance of this river basin, its vital water resources and the challenges in managing them. Furthermore, it provides an insight into the diversity of the basin and the importance of a common understanding of pertinent management challenges to the nations which share the river basin and collaborate to address them. I trust you will find the insights inspiring. We look forward to your contribution towards improved basin cooperation and sustainable development.

Lenka Thamae
Executive Secretary
ORASECOM Secretariat

This publication was produced by the Orange–Senqu Strategic Action Programme on behalf of ORASECOM. It is based on the findings of a study that prioritises and analyses problems and challenges related to the management of the Orange–Senqu River basin. Drawing on the *Orange–Senqu River Basin Transboundary Diagnostic Analysis* and a number of other relevant sources, it is told through the pen of Greg Marinovich, a South African Pulitzer Prize winning photojournalist and author, and seen through the camera lenses of Greg and Leonie Marinovich. This book takes the reader on an illustrative journey through the basin from source to sea, highlighting the benefits drawn from this river system and the challenges facing those living there and those managing these vital water resources.

The Orange–Senqu River and its tributaries drain almost a million square kilometres from the temperate highlands of Lesotho and eastern South Africa to the increasingly arid lands that predominate in Botswana, Namibia and South Africa in the west.





INTRODUCTION

Lesotho's soaring mountain ranges are the high land that separates the well-watered coastal belt along the Indian Ocean and the dry vastness of the great plains that stretch westwards to the cold Atlantic Ocean.

The peaks of the Maloti Mountains and the Central Range encourage the massive storms of the summer months to release their rain. In winter, the snow-capped highlands hold additional water. It is here that southern Africa's mightiest river, the Orange–Senqu, is born. Lesotho is the entire headwaters of the Orange–Senqu, and the rugged topography forces the waters to run west, the long way, across 2,300 kilometres to empty into the Atlantic Ocean.

Without this fortunate coincidence of geography and climate, life would barely exist in a major part of southern Africa's hinterland. Certainly agriculture, industry and mining would be a dry and desperate business.

The very mountains seem to glint and dance to the eye as the sunlight reflects off a myriad of springs and seeps. The water trickles over basalt and sandstone, joining to form streams and rivulets that rush headlong down rugged gullies. These eventually combine into the rivers that carve out the valleys from the rock.

Lesotho is mostly well watered, yet the steep terrain and highly erodible soils combine to provide meagre agricultural potential for the majority of the country.

Lesotho's water and soils flow inexorably down its steep slopes, and already in the great valley of the Senqu River – the largest of the Orange River's tributaries – the water is

opaque and a distinct orange-brown colour. Despite the widely held belief that the river was named for its colour, it was in fact called the Orange River in 1779 to honour William V of Orange, when the Cape was under the control of the Dutch East India Company.

It was this colonial appropriation that has stuck worldwide, despite earlier Dutch settlers referring to it as the Great River. Yet long before the first Europeans came to the southernmost part of Africa, the river existed, and people lived by its bounty. The Nama and Korana (part of the Khoi peoples) for thousands of years knew it as the *!Gariep*, meaning simply Our River or The River. It is perhaps fitting that a river that is so important to so many people should be blessed with a richness of names.

The life-giving properties of the river are abundantly clear, and beyond the vast catchment area of the Orange–Senqu and Vaal rivers, 19 million derive their daily living from it, play on it and go to it to replenish their spiritual reservoirs. We mine along it, irrigate with it, use it to cool our molten iron as well as our sun-baked bodies. Without water, there is no life.

A traveller wandering along its banks, would find it less apparent that the river, while powerful, is vulnerable. The intensity of human use, exploitation and disregard is shrinking it to a shadow of its former greatness. Our dependence on the river is its greatest threat.

This book looks at the Great River from a contemporary viewpoint, from a humanistic and environmental point of view. It is a journey of exploration. ■



THE HIGH MOUNTAINS

In the high eastern mountains that crown the Kingdom of Lesotho, along the watershed separating the waters that run east to the Indian Ocean and those that flow west, there are secluded valleys high above the tree line. The mountains appear stark and unforgiving as clouds scud over, yet there is a wealth of rare and rugged plant and animal life here, an ecosystem unlike any other. Patches of land are cupped within the barren rock peaks, each like a delicate creature in a working-man's hand. These shielded locations are the bogs and wetlands that act as sponges, slowing and collecting the violent runoff from the summer storms, allowing the precipitation to filter through before seeping out further down the mountain.

This unique network of interlinked sponges is unlike anywhere else in the world. One such site is at Lets'eng-la-Letsie, where the Mohlakeng River eventually feeds into the Orange–Senqu. The flat valley floor has a gentle, clear stream that meanders through fields of verdant mountain grasses. A shoulder-high stone wall contains the fledgling river to create a shallow dam just as it begins its steep descent. A rough track skirts the edge of the sponge for a few kilometres eastwards. Here, jagged peaks mark both the watershed and the border with South Africa.

Herdsmen move their flock of sheep in the rain-soaked rangelands of rural Lesotho.





Lets'eng-la-Letsie is a sensitive ecological site and internationally recognised as an important wetland, being a declared Ramsar site. Yet for years, Lesotho authorities have struggled to keep local villagers from grazing their livestock on the wetland.

This is an idyllic place. As police inspector Mohlapiso Mohlapiso bounces along in his official, four-wheel-drive vehicle, he and his fellow detectives eye the cows, horses, sheep and goats peacefully grazing on the wetland grasses. "They are not meant to be here. This is a protected area, but we can't stop the villagers bringing their livestock here."

Inspector Mohlapiso had received a call that vital fencing had been stolen from a long-term experiment that examines how grazing affects the wetland grasses. The growth in a small patch of grass protected by high mesh fencing is remarkably more abundant than that in the surrounding land.

The impact of the horses, cows, sheep, goats and antelope is clearly evident. Scientists say that the overgrazing and the trampling effect of hundreds of animals on this fragile ecosystem has compacted the soil, reducing its ability to absorb water, making it less of a sponge.

The further impact of human activity has seen an obliteration of natural predators, and this has allowed the indigenous ice rat (*Otomys sloggetti robertsi*) to proliferate. The natural balance has been affected, perhaps forever. As Inspector Mohlapiso and his men examine the damage to years of scientific endeavour, he laments the fact that an area he loves to visit for its pristine natural beauty is being degraded, possibly beyond retrieval.

The policeman's concern for the fragile natural world of this rare Afro-alpine region is well founded. The degradation of Lesotho's natural heritage extends down the steep slopes as well. The traditional use of medicinal plants has helped the mountain people to overcome illness and injury, yet the increasing pressure on these plants has seen a decline in their range and frequency. Many of the rangelands that once allowed the Basotho people to graze their livestock comfortably have been denuded and overgrazed. This is especially true in southern Lesotho, where the mighty Maloti Mountains' rain shadow ensures the area is less verdant.

The high-altitude wetland of Lets'eng-la-Letsie and Lesotho's only Ramsar site is also a popular grazing site. Having open access, the site suffers from overgrazing and overexploitation of its diverse natural resources.





In the Mount Moorosi area, aloes and other drought-resistant plants cling determinedly to the steep slopes overlooking the wide curves of the Senqu River. Along the precipitous slopes, villagers have built low artisanal rock walls as part of a volunteer project to combat soil erosion. One such villager is 48-year-old Mamasako Lesotsa, who volunteers three days a week to build and maintain the walls, as well as clear invasive bushes and plant nutritious and hardy grasses onto rangelands that have been degraded.

The pressure from an increasing population has seen more marginal lands put to the plough and grazing. This, with sloping lands whose structure is weakened by human exploitation, means that more and more soil is lost to erosion. Mamasako's time spent trying to regain the fertility of common lands shared with her fellow villagers is part of a programme to recover the 20 per cent of Lesotho's land that is defined as eroded.

Away from the river, Mamasako and others replant the rangelands with the tenacious yet palatable *Eragrostis curvula*, a grass with spreading roots that holds the soil and also provides decent grazing. For her labours a local non-governmental organisation, the Serumula Development Association, has assisted her with developing a vegetable garden in her yard. The simple, raised stone-walled garden is keyhole shaped for easy access and is watered through a central compost aperture filled with manure, ash and vegetable kitchen waste.

To help rehabilitate their rangelands, community volunteers have built stone walls to stop the erosion of soils into the Senqu River below.

Top: Mamasako Lesotsa (48) with her 18-month-old daughter, Bohlokoa.

Bottom: Mamasako Lesotsa grows vegetables for her family and chicks in the keyhole garden outside her home. The garden uses minimal water and reuses kitchen waste.



The project, supported by UNDP–GEF’s Orange–Senqu Strategic Action Programme, also gave Mamasako a busy quintet of bright yellow chicks that will one day provide eggs and meat, both for family use and to raise cash by selling any surplus eggs. Like the majority of rural families, this one subsists on cultivating a little common land and keeps 20 sheep, a pig and a cow. Self-sufficiency is an important strategy, as Lesotho is a net importer of food, mainly from South Africa. The battle for them to rehabilitate Lesotho’s fragile biosphere is a survival necessity, as only ten per cent of land is classified as arable, and 70 per cent as grazing rangeland.

Access to these rangelands is traditionally controlled by tribal chiefs, and the livestock are herded by young men. Yet as Lesotho increasingly becomes a cash-based – as opposed to subsistence – economy, many villagers no longer pay close heed to the chiefs’ rulings. The pressures of a modern society encourage families – especially those who do not have an external source of cash, such as a business or expatriate earnings – to keep as many cattle on the land as possible. The damage to the rangelands and the loss of topsoil is dramatic. The impact of Lesotho’s high rainfall and extreme gradients that have always resulted in massive runoff carrying valuable soil, is exacerbated. As these social changes impact on the environment, the environmental modifications force changes on society.

Most of Lesotho’s population lives in the narrow belt of fertile lowlands along the Caledon River that borders South Africa’s Free State Province. The competition for the limited land is intense, and soil erosion is widespread.

Variability of rainfall makes the precarious nature of subsistence farming even trickier. Much of Lesotho is not food self-sufficient and the country relies on maize imports from South Africa. Crop production is mostly rain fed, and therefore periodic droughts and excessive rainfall events result in fluctuations in vegetable and maize production. The frequency of prolonged drought, combined with the persistent problem of land degradation, has led to very poor agricultural production, making subsistence farming an insufficient and unreliable main source of livelihood.

Many of the naturally occurring woody shrubs such as *ouhout* (*Leucosidea sericea*) have been over-harvested for fuel, and have been replaced by stands of water-thirsty aliens such as gum trees (*Eucalyptus* species).

Adding to the competition for resources is a textile industry that is encouraged with tax breaks and other benefits by the state. While these factories provide much needed revenue and employment, they are also the most thirsty of all economic sectors in Lesotho, including mining, domestic and agriculture. They are also a major source of water pollution, with weak regulation and enforcement of standards.

Maputsoe is a busy border town north of the capital, Maseru. In the factory zone, dozens of companies manufacture or finish clothing for the export market. These factories are vital, as they employ a good number of people and also earn foreign exchange for the country. Lesotho has become the largest exporter of clothing and textiles in sub-Saharan Africa.

Yet this boom in garment manufacturing has brought increased pressure to bear on Lesotho’s local water infrastructure. For at least a third of the day, the factories’ water supply runs dry. At one factory in Maputsoe, potable washing and drinking water has to be brought in, using large drums. The variability of water supply to designated industrial areas has limited Lesotho’s economic potential.





While the factories that merely cut, sew and press are quite light polluters, some of the more intensive manufacturing sites have a history of heavy pollution. In the industrial zone to the west of Maseru, a local stream was for years known as the ‘Blue River’ because clothing manufacturers, especially of fashionable stone-washed jeans, had allowed untreated effluent to flow into it.

Despite the highly variable and sporadic nature of Lesotho’s rainfall, its abundance of water resources means that it supplies almost half of the basin’s runoff from just three per cent of the basin’s landmass. As neighbouring South Africa’s need for water in its economic hinterland outgrew its supply, a massive water transfer scheme was mooted – the Lesotho Highlands Water Project. A vast network of dams and water transfer tunnels sees millions of cubic metres of water sold to South Africa. The first year of delivery in 1998 saw 439 million cubic metres of water transferred to South Africa; this gradually increased to 781 million by 2012. The royalties from the export of water and electricity earned Lesotho 438 million Loti in 2011 (USD62 million at the 2011 rate) – approximately 2.5 per cent of Lesotho’s gross domestic product.

The water from Lesotho is vital to South Africa. Without it, the region’s economic powerhouse – the province of Gauteng – would have run out of usable water long ago. ■

The Ace Apparel clothing factory in the industrial zone of Maputsoe, where the owners say they only have water about two thirds of the time. They have to get potable water in drums for staff to drink and for washing, as well as for steaming the clothes that are all for the South African market. The water for the toilets is collected by bucket from a trough of dam water. This particular factory employs 900 people.



MOVING WATERS

Botswana, Namibia and South Africa – the other three countries in the Orange–Senqu basin – are the driest countries in Africa south of the Sahara. South Africa, in particular, has needed a massive investment in infrastructure – from dams to canals and tunnels – to enable it to capture the rainfall and runoff of the short rainy months. Large-scale infrastructure along the Orange has been the only way to utilise this river that has been described as the Nile of southern Africa. Near its source, the Lesotho Highlands Water Project is one of the world’s largest water infrastructure schemes, delivering water to the heavily populated and water-scarce Johannesburg area. In addition, there are various transfer schemes that bring water from the well-watered eastern side of the central catchment divide (such as the Thukela and Usuthu rivers) and also feed the thirsty economic heartland. Yet the Orange River basin exports water too – to Rustenburg and Pretoria in the north and the Sundays and Fish river valleys of the Eastern Cape.

The Orange and Vaal rivers themselves, include massive storage capacities that have been built over the course of a century and have enabled the megalopolis of Johannesburg and its surrounds to exist, and allowed the industrialisation of the region.

Some of the infrastructure, such as the Vanderkloof, Gariep, Bloemhof and Vaal dams, are massive structures that are of huge social and economic value to the country and the associated communities. Yet these vital structures also have major effects on the river system itself, that living organism, a fluid entity. The flow of the river at its mouth is now reduced to 37 per cent of what it would be under natural conditions. The over-control of the flooding that defined the Great River, while allowing people to live more easily, has affected its very nature. ■

Top: Near Quthing in Lesotho, erosion in a streambed that leads to the nearby Senqu River, which eventually feeds into the Orange River. The Welbedacht Dam (right) is situated on the Caledon River near Wepener in the Free State Province, South Africa. It was built in 1973 to provide water for Bloemfontein via a 115-kilometre-long pipeline, but the massive amounts of sediment carried by the Caledon River have seen the dam lose capacity at an astonishing rate.

Bottom: Water from the Katse Dam on the Malibamatso River in Lesotho is transferred to the Vaal River to augment South Africa’s water supply.



THE INSATIABLE CITIES

Johannesburg's leafy suburbs have, with the characteristically brazen immoderation of this city of gold-seekers, long been proclaimed as the world's largest man-made forest. From the great white quartzite ridge that divides the city into urbane north and proletarian south, the view towards the northern Limpopo catchment area seems to support this. Sadly, gardens do not a true forest make, but indeed, millions of trees dominate the gentle hills that lead to the horizon. Looking south from the watershed, however, one's gaze is met by the tall buildings of downtown and, beyond the city, by glimpses of yellow-green veld.

From the unimposing rise of this rock that divides Johannesburg's southern, previously working-class suburbs and commercial centre from northern middle-class suburbia, it seems unlikely that it also divides the great river basins of southern Africa. Of the rain that falls to the northern side, a few drops will eventually make their way to the great Limpopo River and the Indian Ocean, while water falling south of the Witwatersrand – the Ridge of White Waters – will make its way to the Vaal and Orange rivers, and finally into the cold Atlantic.

From that unlikely watershed, to the south, the occasional light yellow mound catches the light. The goldmine dumps are a reminder of the metal that created Johannesburg and the rest of the 'Reef' towns. The Reef is a fantastically rich vein of gold running from east to west, rising close to the surface where the ore body bucks, and then dipping deep underground again as it heads towards the setting sun.

Water flows from broken pipes on the outside of the Wolhuter Native Men's Hostel, established in 1932 in Johannesburg's gritty Jeppestown area. The hostel is home to thousands of Zulu men who pay rent of ZAR27 (USD2.70) per month for a bed in a shared room. Grey water and effluent, mixed with litter and garbage, flow directly into flood runoff drains.

To encourage local authorities to improve their services in supplying safe drinking water and adequate sanitation services, South Africa's Department of Water Affairs has introduced a certification programme – the Blue Drop for water quality and the Green Drop for sanitation services. Gaining certification indicates that the responsible service provider has achieved the highest possible standards in minimising risk to public health and the environment.





For 130 years, men and women seeking their fortune have made their way to this once rough mining settlement. Initially, Black peasants were coerced into working on the labour-hungry mines through a series of hut taxes. Later, under apartheid and its unnamed union predecessors, laws were enacted to control the influx of these same rural Africans into the 'White' cities. By the late 1980s and 1990s the crumbling of apartheid led to a massive wave of migrants to the Reef fleeing the poverty that prevailed in the ethnic Bantustans.

In 2001, the population of greater Johannesburg exceeded seven million souls. Jo'burg, as it is fondly called, is the only metropolis in the world not built on a river or harbour. The city long ago outgrew the ability of its streams and small rivers to provide potable water. Even as far back as 1890s, when the rough mining town was home to about 100,000 people, water shortages were a constant headache for the city authorities.

The drought of 1895 spurred Johannesburg to find a source of good quality groundwater, and water was piped from Zuurbekom in the west. This too soon proved insufficient as the city grew, and by 1923 the Vaal River was dammed with a series of gates to form the Vaal Barrage. This was followed by the Vaal Dam 15 years later. The Vaal Dam's wall has been raised twice to meet the ever-growing burden of demand. Despite the Vaal's tawny colour and erratic flow – the Basotho called the river the *iliGwa*, for its unpredictability – it proved to be the saving of Johannesburg and its amalgam of towns.

Yet the very urban growth and heavy industrialisation that the Vaal encouraged has led to its deterioration. Today, the Vaal's water, captured in abundance in its reservoirs, is no longer of a quality suitable for human use, and it has to be diluted with various sources of clean water.

In 2011, Johannesburg recorded the second highest water use of all African cities, with citizens using an average of 349 litres per day – the African city average is 187 litres. South Africa's goal is to reduce water use by 15 per cent by 2030.

Within that average figure are the hidden dichotomies between rich and poor. In South Africa, domestic water use is 12 per cent of total water use, and of this, the poor use 1.2 per cent. The constitutionally mandated 25 litres of free water per person per day has been estimated as a rounded-off figure of 6,000 litres per household a month. In the poor, mostly Black areas, though, a household may have ten people living in it, as opposed to smaller numbers in upper-income homes. Civic organisations such as the Orange Farm Water Crisis Committee say this is a form of neo-apartheid, with the wealthy benefiting proportionately more than the poor, as each poor person gets fewer litres a day under this system.

In the upper-income areas of Johannesburg, water use is much higher than that of poor families; the large gardens and lawns are watered year-round to keep them green, and large-capacity baths, swimming pools and hot-water showers encourage more extravagant use of water. But there is a much lower percentage of water lost to leaks, and revenue from water is relatively high, as a much larger percentage of water consumption is billed for.



The ArcelorMittal steel manufacturing plant in Vanderbijlpark, Sedibeng Municipality, is one of biggest employers in the Vaal sub-basin and key to South Africa's national industry and economy. The manufacturing sector contributed 16 per cent to the gross domestic product in 2012. Manufacturing is, however, very water intensive.

Environmental experts say groundwater near the plant is contaminated with toxins that cause disease and birth defects, and residents have reported tea that foamed when milk was added.

The success of the supply of water to one of Africa's largest urban areas has led to an uncontrollable flow of effluent, pollution, salts, pesticides and other contaminants into the river system. The heavy industries in the southern extension of Gauteng Province's central conurbation include the massive steel producer ArcelorMittal (formerly Iscor), a myriad of associated industries and a rich swathe of coalfields along the Klip River where it feeds into the Vaal.

Johannesburg and its satellite towns form the economic powerhouse of the region, even of Africa, and as such attract tens of thousands of new migrants every year. The demand for water in cities is increasing exponentially. Africa is the world's fastest urbanising continent, and by 2035 half of all Africans are expected to live in cities. The demand for water rises with every new business park, every townhouse complex, every new person sharing an inner-city room and every new shack that springs up. The infrastructure to distribute potable water is ever under pressure with its constant extension, and as aging pipes in older settlements corrode. Johannesburg loses between 25 and 40 per cent of its treated water to leakage.

The flow of water-borne effluent from millions of humans is a struggle for the various authorities to keep up with. Seen from the air, the meandering route of the Klip River through the southern reaches of Johannesburg reveals small and large industries allowing a variety of effluents to disgorge into the Klip's meagre flow: the frothy effervescence of a chemical factory, the off-white salt from heavier industry, the algal-green effluent running untrammelled from small treatment plants into the river.

The very gold mines that once gave so bountifully are now a source of fear. The incredible human achievement of burrowing under the earth for kilometres has dwindled as the veins of the valuable metal closest to the centre of Johannesburg have been exhausted. For over 100 years, the mines maintained an intricate balance between removing tonnes of rock and keeping at bay the torrent of underground water that constantly threatened to flood the stopes and tunnels.



A girl pushes a container of water for her home across a streambed in Bekkersdal township, west of Johannesburg.

As the mines have been shuttered, acidified groundwater has reclaimed the subterranean passages. The most common cause of this acidification is when oxygen (mostly in air, but also in flowing water) reacts with iron-sulphide (fool's gold or pyrite) to form sulphuric acid. Sulphuric acid is highly corrosive, the stuff of acid rain. Usually, this iron-sulphide is enclosed in other rock and earth, and very little is exposed to water and oxygen; the oxidation process is low and the levels of acid are negligible. But in mining, the fool's gold becomes exposed by fine crushing during the extraction of the gold.

The crushed ore is brought to the surface in sludge ponds where it quickly acidifies vast amounts of water. Even deep under the surface, where tunnelling has allowed air and water to reach the previously locked-away iron-sulphide ores, millions of litres of acid water are created underground. The water, now essentially sulphuric acid, further leaches toxic heavy metals such as lead, uranium and arsenic into the water, which contaminate the rivers they flow into. The uranium may expose the environment and people to radiological risks.

In abandoned mines, where pumping has ceased, groundwater is gradually filling every underground tunnel and shaft. In 2010, the groundwater level in the Central Basin that Johannesburg sits upon was estimated to have risen to 600 metres below the surface, and rising at between 0.6 and 0.9 metres a day. By February of 2013, the level was 256 metres below the surface and was predicted to start breaching the critical level and contaminating surface water and aquifers by October if left unchecked.

The Department of Water Affairs in South Africa has, since 2012, been very active in trying to stem the tide with a variety of large-scale projects, such as a USD25-million pumping project to divert acid water from the city's water sources, and to treat and neutralise the contaminated water. The longer term requires more research to find a sustainable solution – the feasibility of a levy, updating monitoring and the removal of the salts are all being examined. Acid mine drainage is a worldwide problem – Roman mines that closed 2,000 years ago are today still producing acid mine drainage. The modern gold mines of the Witwatersrand, however, dwarf any ancient mines; and the ore is crushed far more finely, allowing the chemical reactions with oxygen and water to happen much more swiftly. Treatment can never cease, and will never entirely overcome the problems for the affected rivers and ecosystems. ■



Miners spray a membranous cement mixture to stabilise rock walls near to where AngloGold Ashanti broke the record and reached deeper into the earth than any other mine previously, with the Mponeng gold mine descending to 3,778 metres below the surface in 2009. South Africa has, since the 1880s, been reliant on its abundant goldfields for economic growth, but there is a price to pay. The Klip River that runs through the most heavily industrialised and mined areas in South Africa, as well as dense human populations, is heavily polluted. The pressure on the Klip, as well as on the Vaal River that it feeds into, is likely to increase as applications for new mines in the area spike with commodity booms. Acidification of the water due to mining has a knock-on effect downstream, with the Vaalharts Irrigation Scheme being affected.



Wastewater treatment works along the Klip River discharge partially treated sewage directly into the river. One of the immediate causes of excess nutrients and microbial contamination is human waste in runoff, and some of the underlying causes of this are the lack of sewerage infrastructure in informal settlements and sewage plants that are poorly operated and maintained. Such issues have been prioritised by the South African Government, with attempts to force wastewater discharge compliance from municipal treatment plants.



Mining is a major contributor to South Africa's economy, generating between 8.8 and ten per cent of the gross domestic product. It also sustains some one million jobs and a third of the market capitalisation of the stock exchange. Yet mining activity has a major impact on water quality, historically and currently, with seepage from mine dumps and tailings resulting in the mobilisation of salts and heavy metals into groundwater and rivers. Here, Gold One's surface uranium reclamation and retreatment of the historic and current slimes dam is a large operation that yields grades that are three to four times the district average in the mining regions west of Johannesburg.

Gold One merged some operations with Sibanye Gold to create a massive slimes dam in the area. Protests by local farmers and community members initially stalled the plan to create a pair of giant five-by-five-kilometre tailings dams, fearing it would turn a fertile farming area into a 'super dump' of concentrated toxic material. The mining company contended that super dumps would be more environmentally friendly than a multitude of smaller ones.







FARMING WITH THE LAND

The eastern Free State is one of South Africa's farming hotspots, with a variety of agriculture. Yet here, with a view of the mighty Maloti Mountains of Lesotho across the Caledon River, the rainfall is variable and irrigation is rare. Many farmers have been cautious about adopting new methods, especially that of minimum tillage. In these often conservative societies, the dominant pattern is for farmers to follow the traditions of their forebears. Meanwhile, the inevitable trend has been towards an increasingly globalised and industrialised agrobusiness environment, and small farmers have been forced to sell out, or opt out of competitive commercial farming. This has had massive repercussions for national food security and sovereignty, as well as employment. There are around 8.5 million people dependent on agriculture for income; it contributes seven per cent of formal employment, and is ever decreasing.

In the Ficksburg area to the west of the Maloti Mountains, as many smaller farmers' operations folded, a group of farmers realised that the economics of working together were far better than working alone. They formed the MD Foundation Cooperative that decided to adhere to sustainable farming practices in terms of the land as well as the farming community. They have a policy of using as much labour as possible, and retaining as many people who want to remain within the community.

In 2012, as a storm threatened, the farmers raced to harvest a good crop of rain-fed wheat that had managed to ripen with only ten millimetres of rainfall throughout its growing season. These fields have been minimum-tilled for several years and have allowed the natural resilience of the soil to recover, retaining the moisture.

The risk of cultivating without irrigation in an area with poor and erratic rainfall, like most of the Orange–Senqu River basin, is high. Agriculture uses more water than any other economic sector within the basin, with irrigation accounting for more than 60 per cent of the basin's demand on water resources, and wastage and losses are estimated between 35 and 45 per cent.





Above and right: Massive machines and men hurry to harvest the wheat crop ahead of the storm, eastern Free State Province, South Africa.

Irrigation evens the odds with capricious nature, but there are other ways to farm too – more environmentally sound ways that are also financially beneficial in the long run. Lands that have been ploughed for generations have a highly compacted layer at the bottom of the plough's reach or furrow. Water and nutrients cannot pass through this layer; it is so impervious that even roots cannot penetrate. This hard layer has to be broken before one can switch to minimum tilling. The turning of the soil through ploughing also moves the anaerobic microbes that inhabit the deeper soil up to the surface, where, in the presence of air, they die, decreasing the nitrogen-capturing capacity of the soil. Minimum tilling produces less runoff, which conserves the soil and increases the penetration of water into the ground below.



Ploughing has been used ever since humans first began to plant 10,000 years ago. The advantages of ploughing are that the weeds are killed, as are many of the crop-eating bugs. Yet it is energy intensive, either when hand-ploughing or fuelling the massive tractors of today.

These farmers use drought-resistant cultivars, which they claim are much less detrimental to the soil and water than the full range of pesticides, herbicides and fertilisers, from which trace metals, nitrogen and phosphorus can be leached, contaminating the groundwater and river system. Yet they still have to rely on the herbicide RoundUp® to facilitate the low tillage of conservation agriculture, despite their ethos of protecting the earth and its inhabitants. ■



SCHEMES FROM DREAMS

In his informative book *The Orange River* (1946), JH Moolman wrote of the erratic nature of the basin's rainfall: "The Orange may dry up completely in an exceptionally dry season, as in the spring of 1933, when during October and November not a drop of water passed over the gauges of the Orange for 38 days... in a 29-year period, 1906–1935, [the Vaal] stopped completely in at least 16 winters... but in 1917–1918 the volume of water that rushed over the weir of the waterworks was more than 37 times the normal."

When the Kimberley diamond fields brought tens of thousands to the dry hinterland, the shrewd Cecil John Rhodes bought up all the smaller operations and created a monopoly over diamond mining. He had another grand vision, and that was to bring water to the desiccated Harts valley that runs alongside the Vaal just before its confluence with the Orange River.

Despite Rhodes' influence, the Cape government was unable to raise the estimated £130,000 needed for the scheme in the 1880s. Eventually, by 1934, the Union government began work on the irrigation scheme. But by then, the project was about more than just water – it was also a vehicle to provide work for the so-called poor Whites. Large numbers of rural Afrikaners had left the land for the towns and cities in the wake of the destruction of their farms by the British during the Anglo–Boer war, but they found work hard to come by. The Nationalist government reacted by reserving categories of work for them at the expense of competing Black workers. The government also implemented vast public works, which were explicitly reserved for White labour.

Large numbers of poor Whites were offered work digging the canals and constructing the weirs, and plots of land to farm once the scheme was in operation. Initially many failed, as the plots were too small to be economically sustainable, but eventually a successful farming community was established.

Rhodes' grandiose dream to green the desert finally came to fruition in the largest irrigation scheme in southern Africa – extending over some 32,000 hectares.

A section of the Vaalharts Irrigation Scheme, which irrigates a vast area in the Northern Cape and North West Provinces of South Africa.





Above and right: Ipeleng Morgan Bonmamye and other small-scale farmers have access to the pumping station so they can irrigate their allotments.

As racially tainted as the Vaalharts Irrigation Scheme was, it would prove to be an invaluable part of the Orange–Senqu River basin infrastructure. Its massive scale and the amount of water that is stored, transferred and released or held, continues to play a role in altering the hydrological regime of the river systems and the natural flow of the Orange.

Almost a century after the Vaalharts Scheme began to divert water, its benefits are increasingly being enjoyed by wider populations groups. The small-scale Black farmers of Taung also pump water from those grand old canals.

Ipeleng Morgan Bonmamye (46) is a small-scale farmer who grows barley and maize on his ten-hectare allotment from the tribal authority in the former Bantustan of apartheid-era Bophuthatswana.



Ten hectares is at the bottom end of what is commercially viable, even with heavily irrigated lands such as these, and it limits him and the other farmers allocated these plots from building competitive farming enterprises. Yet it is enough for him to enter the middle class, with the opportunity to gradually build a decent house in Taung and educate his children. More opportunities will arise as the state progresses with plans to upgrade the entire system of canals of the Vaalharts Irrigation Scheme.

One of the infrastructure projects meant to augment the scheme, the Taung Dam, turned out to be an exercise in futility. The dam, in the former Bophuthatswana homeland, has not been used at all in the decades since its construction. In fact, it was never even physically connected to the scheme. It is now to be used to supply water to the villages around Taung that suffer from the illnesses and decline in economic activities that accompany severe water shortages. ■



KALAHARI WATER

Thousands of years ago, the Molopo River flowed strongly through the southern Kalahari, carving its way through the undulating red dunes and the bedrock below. Yet by the time that modern humans started to seize control of the land in a political way, using the Molopo to divide South Africa from Botswana, the river was but a trickle of its former self. It still ran strongly enough though, for the explorer Andrew Bain to refer to it as ‘a fine young stream’ in 1826, while the adventurer Major William Cornwallis-Harris reported ‘an abundance of hippo’ in a deep stream as late as 1852.

A century-and-a-half later, the Molopo flows infrequently; the last major flow was in 1988, and even then it only reached just beyond Makopong. A hundred kilometres further downstream, the river has not flowed in generations.

One would think that a small community of people dependent on their livestock having access to water would choose to be near a river, even one as grudging as the Molopo, but the tiny Botswana village of Tsabong is 26 kilometres from the riverbed, nudging against the mighty waves of red dunes.

The Nama or Khoikhoi who settled around the San water pits (*putte*) that had been dug into the saltpan found them to be a reliable source of water for them and their livestock. Once borehole technology increased the number and depth of the boreholes, the livestock increased. With the concomitant decrease in wildlife, the heavy grazing near the *putte* denuded the vegetation that stabilises the dunes. In times gone by, the difficulty in getting to the water table ensured lower numbers of livestock, and there was a balance between man and nature. Today, that balance has been shifted towards humans, much to their own detriment.

Tsabong and other small communities that trace the route of the Molopo precisely illustrate the difficulties faced by people and animals in the Molopo sub-basin – rainfall is rare and parsimonious, and because of the sparse vegetation and extreme temperatures and aridity of the Kalahari, just one per cent of the rain that falls recharges the groundwater. Thus the groundwater is extremely vulnerable to overuse, as the many defunct *putte* and boreholes that trace the course of the Molopo attest to.

Vaalhoek is a tiny community surviving on the lip of the Molopo, and a variety of inventive ways of getting to the underground water are evident. The older residents all have stories of their favourite sources of sweet water that can be found amongst the many brackish ones. On a clear, blazingly hot morning in December, three men, Titus Bok (50), Johan Vissagie (35) and Andries Olyn (26) gathered around a defunct well and reminisced about drinking its sweet, cold water. “This water was the best. The water we now get is sometimes salty; sometimes more, sometimes less,” said Mr Bok. That *put* belonged to the Hendriks family, but it is now no longer used.

Paul Kamboer (14) and Johanna Kamboer and Oscar Coetzee (both 11) carry firewood they have gathered to their home at Vaalhoek. While the ephemeral rivers that cross the Kalahari do not carry much water, they support trees, which provide a valuable source of fuel and fodder.



The exploitation of the underground water resources increases its salinity, making some of the water undrinkable, even though a state water scheme was developed in the early 1990s.

The state water scheme has replaced many of the Nama's dependence on the *putte*, but they miss the water of the smaller wells that they grew up with, and several families maintain their original *putte* as a fallback in a land of uncertainty.

In a tiny two-roomed, brick house in the high dunes off the river, the Kamboer-Vissagie family home has been rigged with soft-drink plastic-bottle funnels, PVC pipes and a drum to harvest as much rainwater as is offered by the sky. A metre-square vegetable garden, fenced off from both domestic and wild animals and protected from the sun by shade cloth, boasts a handful of tiny spinach plants and carrots. As meagre as this garden seems, it is a vital source of nutrition, and helps keep the family healthy. It is not only the climate that brings hardship. Despite the only income for the family of seven being their police-officer mother's salary and grandfather Paul's pension, the family has adopted two orphans, Sana and Oscar. In this home, water has to be used with care.

Counter-intuitively, it is the generous nature of these desert folk, as well as their ability to endure the toughest of climates, that has allowed them to survive where others might not. Modern medicine combined with borehole technology has helped human life to exist here – and with them, livestock, pushing out wildlife from areas around the pans and *putte*. Once held in place by vegetation, overgrazed dunes, pushed by the wind, have gone on the march again.

Various efforts have been put in place to ameliorate this effect over the years, from limiting livestock numbers to enforcing rotations. These were unpopular and proved to be unsuccessful. However, close to Tsaabong, the tiny village of Khawa has a project that is starting to pay off – the community monitors the rehabilitation of the rangeland. Fences have been installed to stop the dune encroachment, and trees and shrubs are planted to stabilise the sands. The rotation of the use of waterholes is also controlled by the community, and the livestock are kraaled at night, which lessens the damage to vegetation around the water points and decreases losses to predators. There is also a holistic plan to decrease dependency on traditional livestock, the most promising part of which is the introduction of karakul sheep farming from Namibia. This will broaden the economic possibilities – and allow for wildlife to be reintroduced for tourism. The usual conflict between wildlife and livestock has been worked around in an interesting way in Khawa, which borders a national park. Here, guard dogs have been introduced as well as more careful herding and kraaling of cattle to reduce stock losses to predators – all this with the help of the Botswana Cheetah Foundation – an intriguing co-operation. ■

Top: A Nama woman carries water from a tap supplied by a state water scheme that was established in about 1992 near the settlement of Vaalhoek. Her bed is outside her home, as with the heat, it is preferable to sleep outdoors in summer.

Bottom left: In some pan water points, rainwater is harvested in large cisterns, and this has extended the ability to water livestock for a further two to three months in the dry season.

Bottom right: A well belonging to the Bok family pumps water with a diesel Lister pump.



Johanna Delie's granddaughter, Blonique, inspects the family's water tank.

FAR FROM THE RIVER

Groot Mier (big ant) is nominally called a town, but it has just 450 inhabitants, hardly making it a village in most parts of the world. Its neighbouring settlement is called Klein Mier (small ant), even though it has more inhabitants. A little over 600 people cluster here in a hollow sheltering from the vast, arid savannah. But Mier is not most parts of the world – the Mier municipal area, including the vast farms, is larger than the entire Free State Province, yet has a population of just 6,000 people. The constraint to human habitation here is the lack of water, both for drinking and for goats and sheep. The low rainfall and searing heat ensure there is no surface water at all for the majority of the year, and precious little grazing.

Johanna Delie was born in Groot Mier in 1956, and she has never lived anywhere else. She shares her home with her daughter Lizette (27) and granddaughter Blonique. Their old mud and daub house has massive water tanks to retain any water that the heavens bless them with, and they look down onto the deep pan that was the centre of life in years gone by.

Yet now the pan is just a muddy hollow, with a few centimetres of water through which goats track to drink, leaving deep hoof prints in the slime.

Lizette's husband lives and works in Upington as there is no work in Mier, and he comes home when he can.

The Delie women live in circumstances that the state describes thus: "The groundwater resource is not adequate to meet the current and the projected water requirements for the Klein Mier Cluster. The quality of the groundwater resource is also deteriorating at an alarming rate rendering it unsuitable for sustained human use."

Johanna Delie and a grandchild in their home. The Delie family can expect that it will not be possible to meet the water needs of their isolated community by 2015. Already, the village is dependent on water tankers.



In the Delie home, the taps have water twice a week on average, and the rest of the time the family has to purchase water from a central municipal point.

The Department of Water Affairs has estimated that by 2015, Groot and Klein Mier will be unable to meet their residents' water needs. In spite of this, there are plans to build dozens more houses at Groot Mier to meet a shortfall of homes for people in the area. The solution to the water crisis is to extend a scheme from the dry lands further east, where the Kalahari East Water Supply Scheme pipes Orange River water hundreds of kilometres to sustain small stock-farming communities. Drawing on the generosity of the Great River to extend this to the greater Mier area would alleviate the situation here, but have consequences on the river. ■





FROM DESPERATION TO DESIRE

The riverside towns of Kakamas and Keimoes are part of the many critical irrigation schemes along the sections of the Orange above the Augrabies Falls. After the large town of Upington, the Orange enters an area of ancient granites, and this resistant rock forces the river to break up into several channels separated by islands that are large enough to be inhabited.

The river here is up to four kilometres wide, and some of the islands, like Kanoneiland and Paarden, are more than ten kilometres long. Many of the smaller channels run at a higher altitude than the main channels, and this allowed Khoikhoi pastoralists (who are now called the Nama) to settle and irrigate crops near present-day Upington.

The harsh drought of 1896 was also the year that the great rinderpest epidemic finally breached the natural barrier of the Zambezi River, and spread inexorably south. Wildlife and cattle died in enormous numbers, and by 1897 the disease had killed between 80 and 90 per cent of all cattle in southern Africa. Starvation stalked the land, and the Dutch Reformed Church initiated an irrigation scheme called ‘a church labour colony’ where poverty-stricken Whites dug diversion canals to create the first large-scale irrigation project on the lower Orange, and leading to the establishment of the town of Kakamas.

The cool and energising waters of the Orange River provide welcome reprieve from the heat for families at Keimoes, Northern Cape.





During the Great Depression that followed World War I, desperate families roamed the land trying to survive. In 1926, landless families invaded Kanoneiland, digging canals and irrigating the land. Today, Kanoneiland is one of the agricultural hotspots in South Africa, where export-quality grapes, raisins, melons and other fruits are cultivated from the desert, all watered from the bountiful Orange, creating employment in an otherwise economically sterile area.

Yet the generosity of the river has also seen the farming activity return high levels of pollutants to the water, with irrigation leaching nitrogen and phosphorus as well as pesticides and trace metals into the river. ■

Left and top right: Grape picking near Keimoes starts well before dawn and ceases shortly after sunrise, when the temperature rises. The grapes are crated and transported to the airport in Upington, destined for international markets.

Below right: Fruit such as melons are also sold locally, enabling the success of small-scale entrepreneurs, such as these in Kakamas.



CLIMATE CHANGE

From a number of studies on the effects of climate change, indications are that there could be less rain over much of the basin, except in the highlands of Lesotho where it could increase slightly. Without such an increase over this key runoff-producing area of the basin, it is likely that 12 to 15 per cent less water will reach the Orange–Senqu mouth by 2050. Temperatures are also likely to be higher, especially in the lower Orange River area of the basin, causing heat stress in cattle and crops to need more irrigation. The uncertainties of varying climate and the trends it will follow make long-term management difficult. There are, however, certain indicators that can help track climate trends in certain areas – one of which is the quiver tree (*Aloe dichotoma*).

Dotted through the dry western areas of the Orange–Senqu River basin, the striking, slow-growing quiver trees are more than just magnificent succulents. Scientists studying these trees can estimate when there have been die-offs or the trees have proliferated, giving them clues about the climate. Genetic evidence indicates that quiver trees in the cooler southern areas of the basin, especially on hills and mountains, are much younger than their northern cousins. This suggests that over time their range is moving southwards towards cooler latitudes. ■



A quiver tree at Keimoes, Northern Cape, South Africa. Scientists believe that the sensitivity of the slow-growing quiver tree, or *kokerboom*, to slightly higher temperatures is causing a shift in its distribution, making it an ideal indicator of climate change.



The Rehoboth Community Trust's commercial greenhouse venture is currently the largest supplier of cut Barberton daisies to florists in Namibia.

REHOBOTH BLOOMING

The town of Rehoboth in central Namibia is the cultural heart of the Baster people, and is sometimes still referred to as the 'Free Republic of Rehoboth' even though it no longer has any legal status as such.

It was founded in 1872 by mixed-race Afrikaans-speaking Calvinists who had over the centuries been deprived of their homes and civil rights in the Cape Colony. Originally their ranks had included land-owning Africans such as Khoi and people of mixed descent who spoke Dutch. Culturally and linguistically, they were very much within the mainstream of settlers who were to become known as Afrikaners, but were not absorbed due to racism.

As the number of Dutch, French and English settlers grew, the Basters were forced further out into the arid reaches of the colony, and were the first permanent inhabitants of the desert areas of the Orange. Eventually, many trekked with their ox wagons to Rehoboth, where their descendants remain to this day. Those who remained in present-day South Africa called themselves the Griqua.

Unemployment is a pressing problem in the urban areas of Namibia, and Rehoboth is no exception. In 2006, the Rehoboth Community Trust embarked on a greenhouse project. As opposed to many community-based projects that are ill conceived, unsustainable or fraught with fraud, this trust wanted to succeed in the long term.

Inspired by Israel's self-reliance in food, and drawing on their history of self-sufficiency, the Rehoboth Community Trust managed to purchase a plot on the outskirts of town. A Namibian engineering company was contracted to evaluate the feasibility of the project and engineer and supervise the construction of a fully automated greenhouse. The trust started off growing vegetables such as tomatoes, peppers and cucumbers, creating 54 skilled and unskilled jobs. It was run on a commercial basis, with produce being sold to a number of Namibian retailers, and it was able, even in the first year, to support several social projects, such as offering bursaries to Rehoboth children to study further, as well as funding the renovation of a local clinic.

As almost all commercial flowers were at the time imported into Namibia, the trust started growing Barberton daisies (*Gerbera jamesonii*). By the end of 2011 it was supplying about 2,000 cut flowers per week to florists in Windhoek and other towns around Namibia. ■





TREE FOR ALL SEASONS

The fear of desertification, and the growing pressure on marginal lands in the 1880s saw a variety of hardy tree species introduced to new environments across the globe.

In arid areas of Africa, the most popular choice was a useful and tough tree from the drier reaches of the Americas known as mesquite (*Prosopis* species). For many years it was a well-loved tree that stabilised the soil and provided shade, timber and fuel wood; its seed-pods provided protein and fibre for livestock. It should have been perfect.

Yet what did not accompany the tree was the knowledge of how to manage it, nor any of the multitude of its insect enemies that kept it in check in its native lands. And cross-breeding between two *Prosopis* species saw an even more vigorous hybrid emerge. By the 1960s, the dry regions of South Africa and southern Namibia had a major problem. *Prosopis* took over the water-courses, forcing out the most valuable local trees – the camel thorn (*Acacia erioloba*) and sweet-thorn (*Acacia karroo*) – and shrubs and grasses, lowering the water table and preventing any grazing wherever it established itself in dense thickets.

As this highly effective invader spread, governments attempted to stop it by cutting the trees down, then applying diesel to the stumps, and by applying herbicide by air and manually. All proved ineffective and extremely costly for low-value lands. By 1983, *Prosopis* was declared an invader species. Even the importation of its natural insect enemies from its native lands to eat the seeds proved unsuccessful.

In 1995, the Working for Water project of the South African government began a sustained effort to control undesirable alien species. By law, landowners are obliged to eradicate or reduce invader species on their lands. Major strides have been made, yet it is only a combination of eradication integrated with finding more suitable insect enemies of the tree and commercialisation of *Prosopis*' valuable properties that might see the scales tip back in favour of the environment.

In Namibia, the Nossob River – an important ephemeral watercourse in the Namibian and Botswana sections of the basin – has been hard hit by *Prosopis*, the river becoming choked with thick, impenetrable stands of the tree along its often-dry bed.

In the tiny rural settlement of Leonardville, Henk Kempen recognised that this pest could be turned into profit, and create much-needed employment. He put together a business plan to exploit the tree for its renowned timber – much akin to oak, and requiring little curing before being worked – and start a charcoal production business using the off-cuts. He would start to eradicate this tree that was outcompeting indigenous species. The business employed between 17 and 22 people in 2011, and was the main source of timber for the reconstruction of Swakopmund's historical jetty. Kempen has trained people in neighbouring communities on how to deal with their *Prosopis* problem too, clearing land for grazing again, while also providing valuable firewood.

Studies in other parts of Africa have shown that the *Prosopis* can provide even more. When the seeds are ground using small hammer mills, their high levels of protein are made available to livestock and fowl – animals fed the crushed seed show a remarkable gain in weight. The additional benefit of enabling domestic animals to absorb the nutritious seed content is that without viable intact seeds, *Prosopis* is unable to spread.

If *Prosopis* is managed properly, it may well fulfil the potential that many foresaw when they imported mesquite to arid zones across Africa. ■



Piles of hardy timber prepared under the shade of yet another thriving *Prosopis* hardly make a dent on the extensive invasion of this plant in the Nossob River.



WORKING SIDE BY SIDE

The villages of Vioolsdrift and Noordoewer straddle the Orange just as the river enters the Richtersveld region. The weir and canal system here was built in 1933 by the South African government as a poverty alleviation scheme for poor Whites. It served both settlements, as Namibia (then South West Africa) was under South African administration following Germany's defeat in World War I. After Namibia gained independence, the governance of the scheme has been jointly managed, and at a local level.

Over the subsequent years, there have been differences in governance of the 42 kilometres of canals that allow primarily for the flood irrigation of 283 hectares at Noordoewer and 600 hectares at Vioolsdrift. A South African Department of Water Affairs and Forestry study found that the Namibian side is better served in terms of government-provided services and improvement than the southern side of the river. Namibia has made Noordoewer a high-priority development region.

Currently, there are about 50 plots on both sides, owned by less than 20 farmers, who employ several hundred people. The numbers seem low, but in the sparsely populated area, with populations close to the poverty threshold and with fragile local economies, these jobs and businesses are vital – without them, the state would have to provide welfare for the community to survive *in situ*, or families would move to other centres to find work.

No provision was made for flow measurement in the canals built in the 1930s, but it is now realised that they are essential for managing water supply. Several measurement devices, such as this V-notch for measuring off-take, have recently been installed in the scheme to test various advanced irrigation methods.



Left: Export grapes on the irrigated farms at Noordoewer.

Right: Increased field sizes have allowed the use of centre-pivot irrigation. It is considered more water efficient than surface or furrow irrigation techniques.

Far right: Abe Olivier has managed to make a go of farming in Noordoewer by investing in suitable technology and growing high-value produce.



One of the farmers on the Namibian side is Abe Olivier, who farms grapes and vegetables. He started farming in 1985 as one of 13 farmers along the Orange River. By 2012, there were only two commercial farmers left on the Namibian side. Smaller farmers had been forced to sell their land as they were not able to reach the economies of scale needed to survive in today's corporatised agricultural business environment.

This transboundary water resource management is a test case for international cooperation and economic development at a local level. There are inherent tensions in any such enterprise as there are the institutions and laws of two different states involved, yet the operation of the Vioolsdrift–Noordoewer Joint Irrigation Scheme is a success.

Namibia has decided to significantly expand irrigation on their side of the river for five private enterprises – known as the Tandjieskoppe (Tooth Hills) Project. The dry, rocky land under the early morning shadow of Tandjieskoppe will soon be verdant, bringing employment and business to this remote corner of Namibia. Irrigation is not possible in vast areas of Namibia because it is so arid, with the only perennial rivers that the country has access to being the boundary rivers that mark the extreme northern and southern borders.

As the farms become more commercial, they also allow for more advanced methods of irrigation than flooding, including water-frugal drip irrigation and probes to monitor the soil moisture. A demonstration project testing such methods with the farmers in Vioolsdrift and Noordoewer is currently being carried out by UNDP–GEF's Orange–Senqu Strategic Action Programme on behalf of ORASECOM.

However, the old irrigation scheme – with careful maintenance and innovation – may offer many more decades of service to these remote communities. ■



MIRACLE IN THE DESERT

The miracle of the Namibian table grape industry is a narrow strip of rocky desert land irrigated from the Orange River on the great curve referred to in the German colonial name of Aussenkehr, or outer bend. It was a Yugoslav immigrant, Dusan Vasiljevic, who had a dream of using the extraordinarily hot temperatures of the area – combined with the plentiful waters of the Orange – to get table grapes to the European market up to five weeks before any other southern hemisphere growers.

After much trial and error, the government came in to assist and a new industry was born. In opportunity-starved southern Namibia, the grape farms employ 1,300 permanent workers and about 250 to 300 on a temporary basis during the growing season. Because so few people live permanently in the desert region, and due to the labour-intensive nature of grape farming, migrant workers from the much more densely populated far north of Namibia provide the extra hands that are needed.

During the harvest period, between 5,000 and 5,500 mostly migrant workers are taken on by the farms. Other hopefuls follow, providing a variety of services to the workers. It is estimated that there may be as many as 26,000 people living in the informal settlements in the desert at peak season.

While some work on the farms, many are entrepreneurs who make their way servicing the migrants. Others create a business out of drying the grapes left over after the export harvest and selling them in other parts of the country.

One of the largest of the migrant settlements – Number Five Location – is home to people from Kavango Region of northern Namibia. Here, their traditional Kavango huts rise incongruously like mushrooms in the hard rocky desert. Starkly delineated paths lead from hillock to hillock, the stones pushed aside by the passage of thousands of feet. Neither tree nor shrub disrupts the sun's torture of earth and man.

Thousands of migrant workers' reed huts overlook the extensive Aussenkehr vineyards, which are verdant against the stark contrast of the hyper-arid lower Orange River valley and Richtersveld beyond.





This woman, far from her home in Kavango Region, washes her clothes in water from the Orange River, collected from taps and carried by hand for more than a kilometre.

Yet the boon is not unmitigated by difficulties. Despite the value of the workers to the industry, the most basic amenities are absent. There is no piped water to the settlement, or decent sanitation. Sanitation-linked illnesses are common, and while some employers provide water tankers, most workers have to carry water to their homes up to a kilometre away. Most of the grape farms at Aussenkehr have been established with soft government loans, and should operate under the laws which ensure that both permanent and seasonal workers have accommodation, domestic water and sanitation. However, some circumvent these regulations (as well as those of the importing partners in the European Union) by providing sanitation facilities at the packing plants, but ignoring conditions where the workers and their families live.



The reed huts made in the style of migrant workers from Kavango in the far north of Namibia appear incongruent in the rock desert along the Orange River.

On a Sunday morning, a woman carries a drum of water from a distant tap up the steep inclines from the riverbank to a collection of several reed huts. She pauses at the door of the largest of them, where another woman helps her put the heavy drum onto the ground. Wiping the sweat from her brow, and slipping off her shoes, she hefts the water drum into the room. It is spacious, and has only a simple wood table covered with a white tablecloth and a central pole to obstruct the five-by-five-metre space within.

Here a tall, slender man dressed in a white robe, decorated with yellow trim, tilts the water into a red plastic basin; cupping the Orange River water in his hand he sprinkles it onto the earthen floor, raising puffs of dust.





The room houses the Crossing Healing Apostolic Church in Zion, a quasi-Christian sect. Gradually men and women enter, separating into gender-specific groups. The women kneel against the wall, shards of bright sunlight from the gaps between the reeds sparkling off their pristine uniforms; the men gather on the shadow side, readying their animal skin drums. After an impassioned sermon, the drums begin and the congregants begin to dance around the room, in a conga line, with the occasional person spinning gracefully on one foot, never losing the overall rhythm of the line.

The Sunday service allows for a few ecstatic hours of intense spirituality and a strengthening of the participants' close-knit fellowship, as the hardened soles of their feet stamp onto dust settled by the waters of the Orange. ■

At Aussenkehr, members of the Crossing Healing Apostolic Church in Zion, based in Rundu in the Kavango Region, conduct services on Sundays.



RICHTERSVELD RESCUE

The Orange's last great flourish is an extravagant northerly swing shortly after Vioolsdrift; the loop encompasses a great rocky desert known as the Richtersveld. The rocks of this surprisingly mountainous area absorb and reflect the African sun, baking everything to a seemingly sterile wasteland in temperatures that exceed 50° C in summer. Yet the Richtersveld is certainly not sterile, for this remote and harsh corner is home to a remarkable diversity of over 650 plants and the largest number of succulents in the world, as well as desert-adapted animals. It is the richest arid biodiversity hotspot on the planet.

This is also a remarkable human heritage site, with an ancient culture of people adapted to thrive in the harshest conditions imaginable. The Nama – the last surviving Khoikhoi clan – have kept sheep and goats for millennia, moving



their semi-circular, woven reed huts from site to site as their livestock follow the scarce grazing.

The Nama were joined in the Richtersveld in the 1940s by the descendants of Cape Dutch Boers and Khoikhoi – the Bosluis Basters – in an apartheid forced removal. Most of these latecomers settled in Eksteenfontein and Lekkersing.

As culturally adapted as the indigenous people are, without the lazy, winding Orange, or *!Gariep*, life would hardly be possible here. It is along a flat, sandy stretch of the southern bank of the great river that Joseph Obies has erected his shelter of sticks, cloth and plastic.

Joseph Obies with the goats and sheep he tends in the Richtersveld.



Top: Samuel Domdough with Optel.

Bottom left: A remote road through the mountains of the Richtersveld.

Bottom right: The skeleton of a Nama hut next to a *witgatboom* or shepherd's tree, a resilient tree that is an important source of fodder.

A gnarled kareeboom (*Rhus*) is where Obies has hung his enamel cups, water bottles, wood saw and the other appurtenances of a nomad's life, out of reach of the goats and his dogs. As he fills a fire-blackened pot with water drawn from the river, orphaned kids wander around his campsite, nibbling on objects both organic and inorganic.

Obies is a shepherd who continues a way of life that has existed for thousands of years along the northern and southern banks of the Orange, yet this culture is diluted, enriched and just plain changed in the modern world. Obies is an employee of a wealthier man, Samuel Domdough, and is paid ZAR500 (USD50) a month. His employer usually relieves him over the weekends, allowing Obies to go home to Khubus, a small Nama village. To walk that distance would take days, so Domdough usually arrives in a small Toyota Hilux pickup, making the journey in a matter of hours. Yet for two days, he has failed to show up. Obies is perturbed. It is the Christmas weekend, and his boss was due to relieve him for the festive season, allowing Obies the opportunity to catch up with family and friends for longer than usual. As the sun moves languidly across the desiccated sky, the loneliness that he usually keeps at bay begins to creep up on him.

Some 40 kilometres, but many rough hours of driving away from the river bank, Domdough and two friends sit at the side of the track beside their elderly *bakkie* (pick-up truck). They had run out of fuel the day before, on their way to relieve and collect Obies – the *bakkie's* fuel gauge no longer works, and Domdough has miscalculated. They have been stranded for 36 hours, and no other vehicle has come past – not unusual in this remote area. The water they brought with them is now exhausted, and they are hungry.

In the near distance, a ghostly shape flits between the rocks. It seems drawn to, yet nervous of the humans gathered in the middle of the desert. Domdough stands silently staring into the heat shimmer for a while. "It's the dog that was lost two weeks ago on a trek," he intones. The dog slinks closer and closer, and Domdough throws an old sheep bone toward it. The dog's back is curled from right to left like a dead centipede, its tail submissively between its legs. It wolfs down the bone, and sidles closer.

Domdough fastens a rope around its neck, and lifts it onto the back of the truck. "I'll call it 'Optel' (Pick-up)," he says with a smile. ■



FABLED SANDS

The mighty Orange, as if exhausted by the journey of 2,300 kilometres, slows as it snakes through the baked landscape, just a couple of hundred metres from where it will deliberately and inexorably discharge its orangish-brown load of sediment into the cold waters of the Atlantic Ocean.

Before humans walked the earth, the ancient river carried diamonds from the hidden kimberlitic pipes along its length, rolling and tumbling the gems until they peppered the ancient paths of the riverbed with pretty stones that would one day be lusted after by men and women. The older river courses that once ran through this changing terrain were altered and diverted by the massive tectonic forces at play in the earth's crust and sea-level changes. Once those then valueless stones were disgorged into the sea, the Atlantic Ocean's Benguela current swept them northwards, littering the beach with diamonds.

Today, the twin, closed, border towns of Alexander Bay and Oranjemund straddle the mouth of the Orange and are the gateways to what have been some of the wealthiest, high-quality gem diamond pickings in the world. As one drives along the river, the GPS goes blank, and even what is in plain sight becomes a sort of technical *terra incognita*.

On the north bank is the Sperrgebiet – the prohibited area – where legend has it that early prospectors and geologists like Hans Merensky could use shovels to simply collect the diamonds that lay thickly above the desert sands. Just how true that is, is difficult to ascertain, but that the earth has given this desert region an unrivalled bounty of gems is not.

It is here that adventurers have been drawn to the chance of sudden wealth, of a diamond to rival the fabled gems of history. It is here that workers once brought homing pigeons to work in the coastal segment with them, and released the remarkable carrier birds with *klippies* (stones) tied to them. The mine authorities took to arming their guards with shotguns to blast the poor creatures from the sky.

On the South African side, the diamond divers at Port Nolloth were legendary. They would wait for a calm day to head out into the ocean with specially equipped boats that could vacuum the diamondiferous gravel off the seabed.

The state-owned diamond mine Alexkor, at Alexander Bay, has entered into a deal with the Nama people of the Richtersveld that gives them the right to mine the diamonds on the land away from the shore, while the mining company mines the marine diamonds.





The divers were generally White ne'er-do-wells and adventurers from around the country who were attracted to this small town by the chance of riches and a lifestyle of drink and drugs. On land, in the hinterland, in the Nama settlements, the men who dealt in *klippies* drove fast cars, tuned to the peak of their performance to outrun the crack police of the Illegal Diamond Buying (IDB) Unit who were always on their heels.

Today, things have calmed down, though not entirely. After almost a century of mining, the onshore mines are mature and reserves depleted. Many small and completely legal diamond-mining operations can, however, still be found in both Namibia and South Africa, and they are an important source of economic activity in the area.

One of the most important socio-economic changes took place when the South African state-owned diamond mine Alexkor, which started way back in 1928, entered into a deal with the Nama people of the Richtersveld. The original inhabitants now have the right to mine the diamonds on the land away from the shore, while the mining company mines the marine diamonds. This was part of a land restitution deal following the dismantling of apartheid.

While the town of Alexander Bay feels the lash of the desert sun, a kilometre or two downstream the fog bank that shrouds the glorious beach does not deter a group of children from the town who have ventured out to enjoy a birthday excursion. The icy waters are cold enough to thrill, and the wild breakers on the steep shore are a fun place to play.



The icy Benguela Current of the southern Atlantic creates an almost permanent fog where the waters meet the hot, dry shore. The saltwater estuary – where the waters of the Orange and the tides have mixed to create a unique environment – is separated from this beach by dunes. This estuary is where flamingos, pelicans and other birds, fish and mammals find sanctuary. The balance between freshwater and tidal saltwater inflows have created a salt marsh that is a unique refuge for birdlife, of which 14 species are rare or endangered. However, years of disregard for the environment during the single-minded pursuit of diamonds, together with the effects of 2,300 kilometres of water-hungry, upstream activities have damaged this delicate site.

This delta, with its marshes and dunes, is regarded as the sixth most important wetland system in southern Africa. It was designated as a protected Ramsar site in South Africa in 1991 and Namibia in 1995. There have been concerted efforts to restore the site, and allow it once again become a dependable refuge for the flocks of migratory and resident birds that are the estuary's hallmark. ■

As the mighty Orange pours the last of its gift of water into the mighty Atlantic, there is hope that a sense of harmony between humankind and the great river can be reached, should we treat it wisely, and judiciously.



The Orange–Senqu River Commission (ORASECOM) was established in 2000 by the governments of Botswana, Lesotho, Namibia and South Africa, which share the water resources of the Orange–Senqu River Basin. The Commission provides a forum for consultation, sharing information and cooperation between the countries. For more information on ORASECOM, visit <http://www.orasecom.org/>

The Orange–Senqu Strategic Action Programme is a four-year project working in close collaboration with ORASECOM. It assists the basin states in identifying threats to the water resources of the Orange–Senqu and in developing a basin-wide plan to address these. The objective of implementing such initiatives contributes towards ORASECOM's programmes and the long-term goal of sustainable development of the Orange–Senqu River basin. The project is implementing a transboundary diagnostic analysis and strategic action programme process to meet this objective, while concurrently implementing a number of projects and activities to help strengthen ORASECOM, fill knowledge gaps, and raise awareness and encourage participation of the public.

The project is funded by the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP) and is executed by the United Nations Office for Project Services (UNOPS).

For more information on the project, visit <http://undp.orasecom.org/>



