

Connective Cities Workshop on Nature-based Solutions in Urban Areas

21-23 April 2026

Nairobi Kenya

What I hear, I forget. What I see, I remember. What I do, I understand. Kung Fu Tzu (Confucius)

BY Prof Johanes A. Belle

Associate Professor

UFS-DiMTEC

Tel: 051 401 9347

Email: Belleja@ufs.ac

T: +27(0)51 401 9111 | info@ufs.ac.za | www.ufs.ac.za

© Copyright reserved
Kopiereg voorbehou

UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



Content of the presentation

- ❖ Urbanisation in Africa and why it matters
- ❖ Cities Risk Profiles and challenges in addressing these challenges such as flooding, heat stress, fires and ecosystem degradation
- ❖ Understanding nature-based solutions in urban context
- ❖ Ecosystem services and their importance in building urban resilience

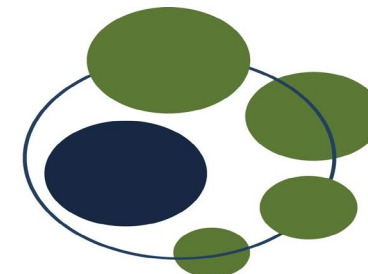
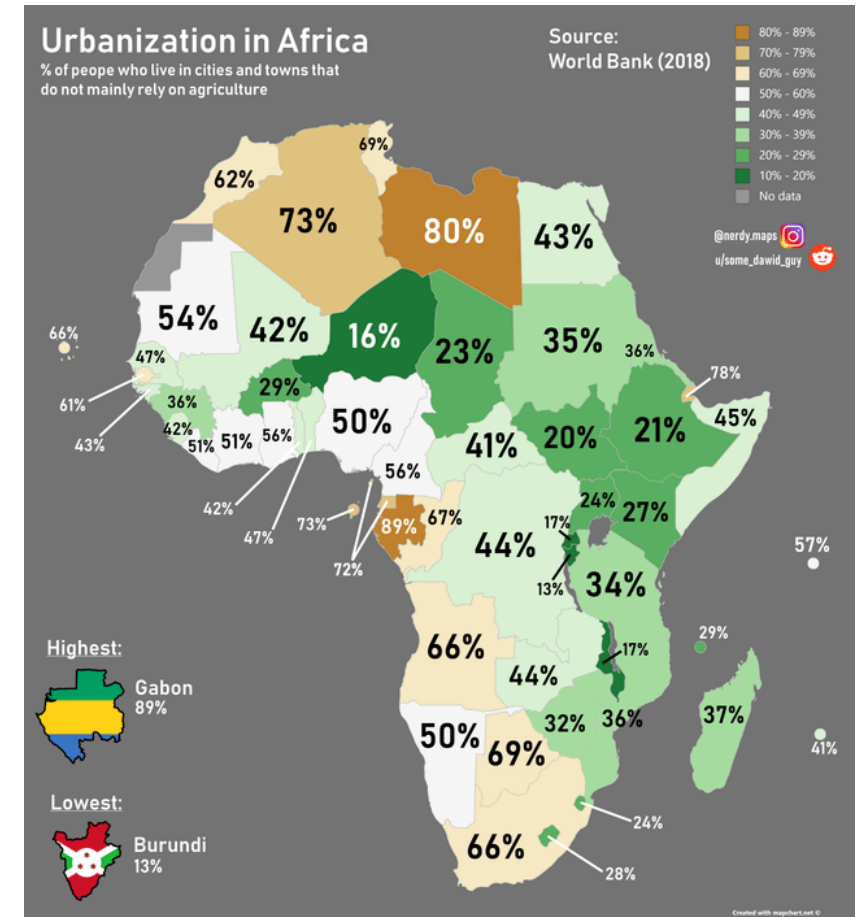


URBANISATION IN AFRICA

- ❑ Population of about 1.4 billion people (8 billion world), 45-50% live in cities (55% world).
- ❑ Fastest urbanising continent with 60% population in cities (68% world) by 2050

Factors fuelling Africa Rapid urbanisation

- Natural youthful population with high birth rates
- Economic opportunities in cities (jobs, businesses, industries etc)
- Better Services (health, education, housing, communication, roads etc)
- Climate Change induced factors including climate related extreme events
- Environmental degradation
- Conflicts and wars
- Rural-urban migration



TOP 10 CITIES IN AFRICA WITH POPULATION MORE THAN 6 MILLION PEOPLE (SOURCE: WORLD POPULATION REVIEW 2026)

A typical CBD of an our Cities



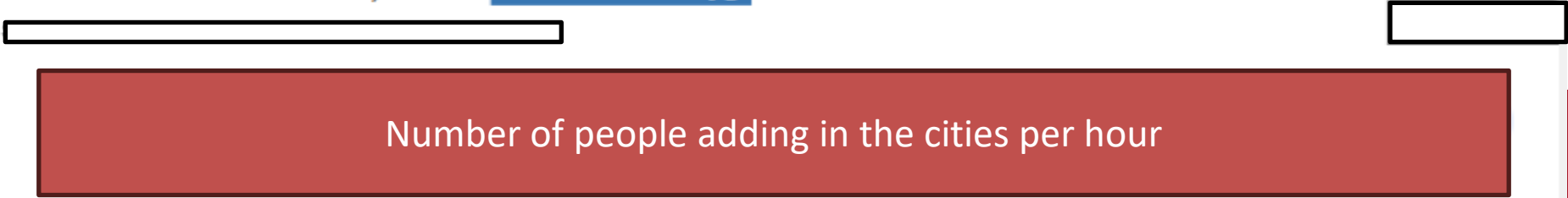
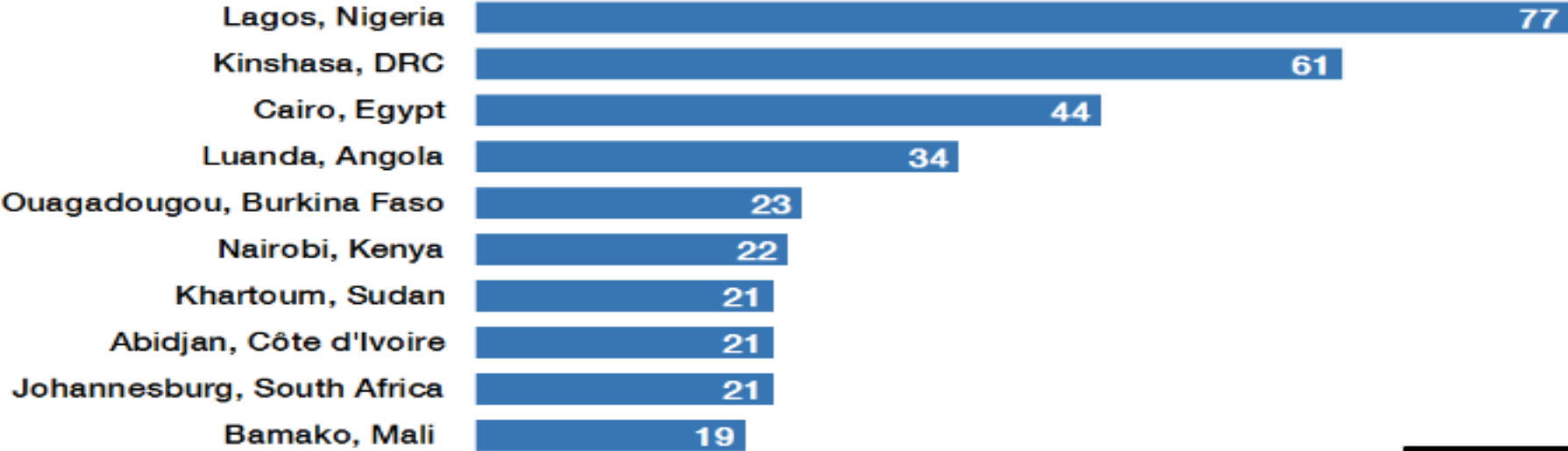
| No. | County | City | Population (in million) | World |
|-----|--------------|---------------|-------------------------|---------------------------|
| 1 | Egypt | Cairo | 23.55 | Japan (Tokyo) = 37 |
| 2 | DR Congo | Kinshasha | 18.55 | India (Delhi) = 33 |
| 3 | Nigeria | Lagos | 17.80 | Bangladesh (Daka) = 23 |
| 4 | Angola | Luanda | 10.42 | Brazil (Sao Polo) = 22 |
| 5 | Tanzania | Dar es Salaam | 8.97 | Mexico (Mexico City) = 22 |
| 6 | Sudan | Khartoum | 6.98 | |
| 7 | South Africa | Johannesburg | 6.55 | |
| 8 | Ivory Coast | Abidjan | 6.25 | |
| 9 | Ethiopia | Addis Ababa | 6.21 | |
| 10 | Kenya | Nairobi | 6,00 | |

T: 051 401 9111 info@ufs.ac.za www.ufs.ac.za

POPULATION GROWTH PER HOUR IN AFRICA FASTEST GROWING CITIES

These are Africa's fastest-growing cities

Population growth per hour, 2010-2030



T: 051 401 9111 info

© Copyright r
Kopiereg v

CONNECTIVE
ITIES



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



UFS
UV

MOST COMMON URBAN DISASTER RISK PROFILES

- **Flooding:** Most common disaster risk in urban areas, exacerbated by inadequate drainage, climate change, and settlement in high-risk zones.
- **Heatwaves/Extreme heat:** Creation of heat islands, increasing risks for urban poor lacking heat-resilient housing amidst rising temperatures.
- **Fire:** Widespread in informal settlements due to dense, flammable housing materials, lack of electricity, and use of open flames.
- **Water Scarcity & Drought:** Poor land use and land cover changes, Increase pressure on municipal water supplies, pollution and other degradation of water courses.
- **Epidemics:** High density and poor sanitation facilitate leading to spread of diseases.

T: 051 401 9111 info@ufs.ac.za www.ufs.ac.za

© Copyright r
Kopiereg v

CONNECTIVE
CITIES



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



NATURE BASED SOLUTIONS (NBS)

- ❑ Umbrella concept for various ecosystem-related approaches.
- ❑ Actions to **protect, sustainably manage, and restore** natural or modified ecosystems, that **address societal challenges effectively and adaptively**, simultaneously providing **human well-being and biodiversity benefits** (IUCN Congress, 2016; Resolution (WCC-2016-Res-069) .
- ❑ Cost effective strategies that use natural processes and ecosystems to address environmental, social, and economic challenges while generating social, economic and cultural co-benefits, and contribute to promote biodiversity.
- ❑ NbS are effective interventions to strengthening climate resilience, enhance ecosystem services and biodiversity, addressing infrastructure needs and other human needs.

T: 051 401 9111 info@ufs.ac.za www.ufs.ac.za

© Copyright r
Kopiereg v

CONNECTIVE
CITIES



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



TYPES OF NATURE BASED SOLUTIONS (NBS)

- Afforestation • Agrobiodiversity • Bioswales • Community forests • Community gardens • Floodplain restoration • Grassland revegetation • Green dykes • Green facades • Green roofs • Living weirs • Mangrove, salt marsh, wetland restoration • Permeable pavements • Rainwater harvesting • Reforestation • Removal of invasive species • River watershed management • Reef conservation/management/rehabilitation/restoration • River renaturation • Sand conservation/management/rehabilitation/restoration • Sustainable drainage systems • Sustainable grazing management • Sustainable management of fisheries • Stormwater management • Urban wetlands • Urban agriculture • Urban farming • Urban greening • Urban nature reserves

T: 051 401 9111 info@ufs.ac.za www.ufs.ac.za

© Copyright r
Kopiereg v

CONNECTIVE
ITIES



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



NATURE BASED SOLUTIONS (NBS) IN URBAN CONTEXT



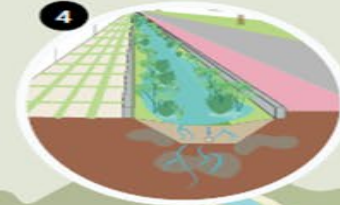
Wetland Restoration



Mangrove Restoration



Reviving Ecologically Important Regions



Bio-swales



Rain Water Harvesting

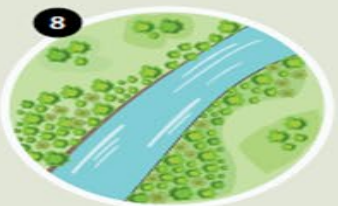


Green roofs and walls

NATURE-BASED SOLUTIONS



River / lake Restoration



Riparian Vegetation Restoration



Bioremediation of water bodies



Recharge wells



Restoring Natural Drainage Terrain



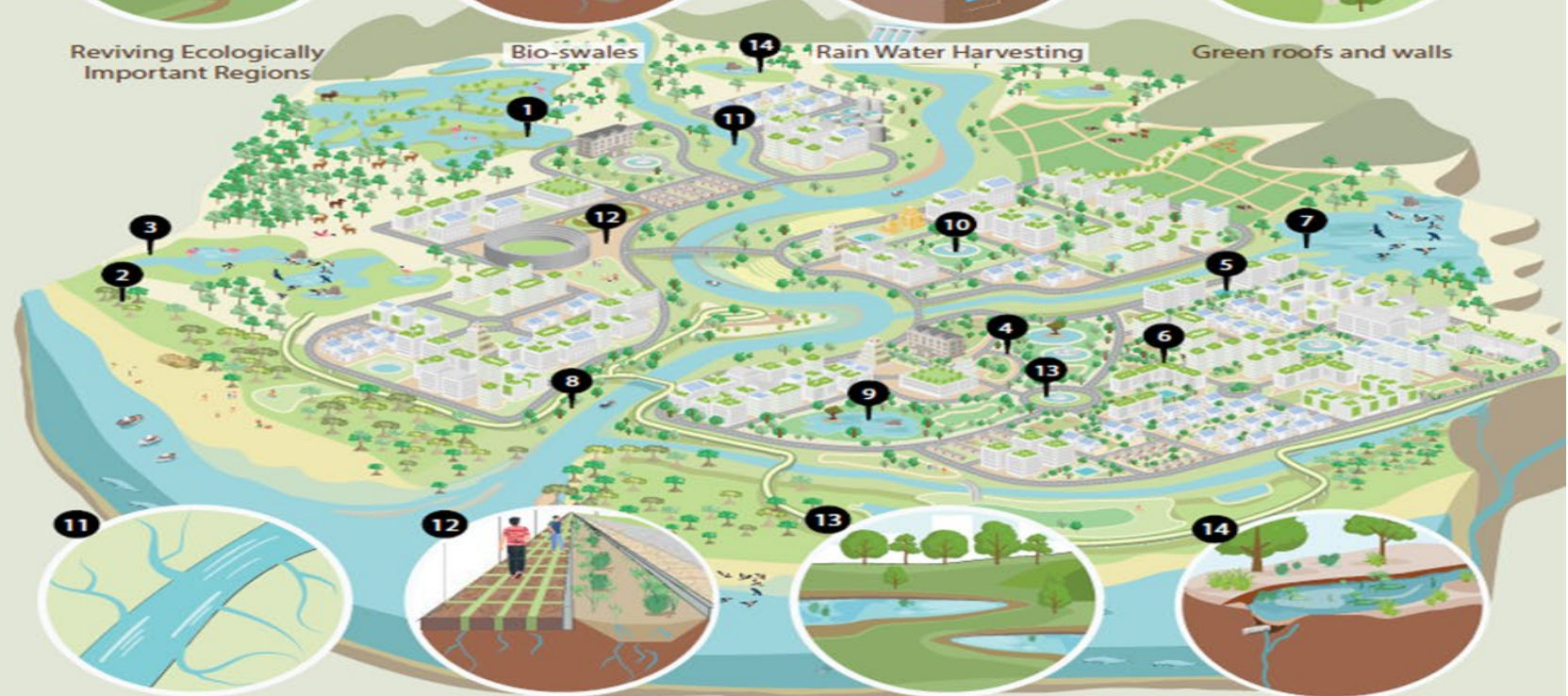
Permeable Ground Surfaces



Retention Ponds



Bioretention Systems



ECOSYSTEM SERVICES FROM OUR NATURAL ENVIRONMENT TO BUILD RESILIENCE

| PROVISIONING | These are harvestable goods |
|-----------------------|---|
| Food | Production of fish and fishshell, wild game and meat, wild fruits, aquaculture and grains. Example, the Mbongowane wetland in Eshowe-KZN cultivated (using conservation agriculture) for taro, sugar cane, cabbages, onion. Most of these crops are cultivated by women |
| Grazing land | For cattle grazing and wild game. Fodder especially during winter |
| | |
| Fibre and fuel | Timber, fire wood and manure, grasses for construction and artisanal craft, harvestable peat, |
| Biochemical | Extraction of medicinal and other materials from biota to cure or prevent diseases eg treat headache, urinary infection, ulcer, wounds, “Uklenya” is used for menstrual pain relieve or to expel the placenta after birth |
| Trade | Tourism, craft industries, sale of locally produced goods; all of which boost household income and contribute to the local GDP |
| | |

| REGULATING | Services responsible for maintaining natural processes and dynamics |
|---|---|
| Climate regulation | Source/sink for greenhouse gases, influence local and regional temperature, Precipitation, act as wind breaks and other climatic processes |
| Water regulation (Hydrological Flows) | Groundwater recharge/discharge; Flow regulation for flood control; River base flow regulation; Water storage capacity; Regulation of water balance; Sediment retention Prevention of saline groundwater intrusion; Prevention of saline surface-water intrusion |
| Water purification and waste treatment retention | Recovery, and removal of excess nutrients and other pollutants |
| Erosion regulation | Retention of soil and sediments, prevention of coastal erosion and wave dispersion eg coastal mangroves |
| Natural hazard regulation | Flood control; Storm water control; Protection against water erosion, Protection against wave action, act as wind breaks, act as wild fire breaks |
| Biodiversity regulation | Habitat for pollinators; maintenance of genetic, species and ecosystem composition; Maintenance of ecosystem structure; and suitability for nature conservation |

| | |
|------------------------------------|--|
| CULTURAL | These are services that provide a source of artistic, aesthetic, spiritual, religious, recreational or scientific enrichment, or non-material benefits |
| Spiritual and inspirational | Source of inspiration; many religions attach spiritual and religious values to aspects of wetland ecosystem. Wetlands pools used for baptism |
| Recreational | Opportunities for recreational activities such as boat racing, bird watching |
| Aesthetic | Beauty or aesthetic value of wetland ecosystems. Beautiful natural landscape, |
| Educational | Formal and informal education and training. Rich in biodiversity thus offering good research in plants and animals, education on conservation etc |
| SUPPORTING | Services necessary for the production of all other ecosystem services |
| Soil formation | Sediment retention and accumulation of organic matter. The formation of fertile soils |
| Nutrients cycling | Storage, recycling, processing, and acquisition of nutrients |

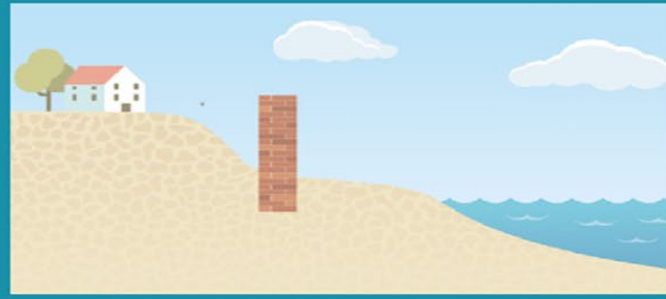
BLUE: GREEN: GRAY INFRASTRUCTURE FOR URBAN CLIMATE RELATED EVEN*

1



GRAY

Examples: Dikes, canals, pump stations, storm surge barriers, flood walls, seawalls



2



BLUE

Examples: Retention ponds, floodplain extension, underground water storage, water squares, bioswales



3



GREEN

Examples: Mangroves, salt marshes, green roofs, parks



T: 051 401 9

© Copyright r
Kopiereg v

CONNECTIVE
ITIES



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



GREEN VS GRAY SOLUTIONS/INFRASTRUCTURE-URBAN HAZARDS

| Green infrastructure eg Wetlands | Gray infrastructure eg sea walls/dykes |
|--|---|
| -Lower initial cost | -Higher initial cost |
| -Low maintenance cost & easily adaptable to changing conditions | -High maintenance cost & diff to adapt with changing conditions |
| - Matures with time | -Depreciate with time and eventually obsolete |
| -Provide wide variety of other services to the community e.g. creating jobs, boosting farm yields, increasing incomes, protecting biodiversity etc | - Provide only or limited other services to the community |
| -Bottom-up and community driven | -Top-bottom and government driven |
| Responds better to community needs especially poorer communities | - Respond more to government policies and research |
| -Can easily be managed by the community | -Managed by engineers |
| -New and very popular in recent time amongst international communities | -Old and elusive to poorer communities |
| -Win-win no regret approach | -Can cause other disaster if malfunctioning |

SOME EXAMPLES OF NBS

- **Water Management & Flooding:** Utilize urban wetlands, bioswales, and rain gardens to manage stormwater. In coastal cities, mangrove restoration, Coral reefs to protects against storm surges.
- **Urban Heat Reduction:** Implement urban green spaces and parks, green roofs, green walls, and tree planting to combat the urban heat island effect.
- **Infrastructure Hybridization:** Combine NBS with traditional gray infrastructure (e.g., permeable pavements with drains) for enhanced resilience.
- **Informal Settlement Upgrading:** Use small-scale, decentralized interventions such as rehabilitating local vegetation on slopes for landslide prevention and improving drainage through community-led projects.

T: 051 401 9111 info@ufs.ac.za www.ufs.ac.za



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



PLANNING AND IMPLEMENTING NATURE-BASED SOLUTIONS

- **Policy Integration:** Integrate NbS into local development, spatial plans, and climate adaptation strategies (NDCs).
- **Community Engagement:** Leverage local and indigenous knowledge systems and ensure community-led management for the operation and maintenance of NbS projects.
- **Technical Capacity & Design:** Focus on project preparation that incorporates local ecological knowledge and use ecological engineering that simplifies designs for easier maintenance.
- **Financing:** Seek funding that covers long-term maintenance, not just initial construction, use blended funding mechanisms like international funding (GCF), municipal funds, Multi-lateral funding agencies, Public-private partnerships (PPP) etc.

T: 051 401 9111 info@ufs.ac.za www.ufs.ac.za



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA





T: +27(0)51 401 9111 | info@ufs.ac.za | www.ufs.ac.za

© Copyright reserved
Kopiereg voorbehou



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA

