the Green Book
Place-based solutions for South African settlements

ISOCARP Congress, Bodø, Norway
1-5 Oct 2018

Willemien van Niekerk

Co-authored by:
Alize le Roux, Amy Pieterse, Kathryn Arnold & Chantel Ludick
Rationale for the Green Book project

Extreme weather events are becoming more frequent and intense with climate change.

Growing and urbanising population will continue to place pressure on infrastructure and service delivery.

Exacerbate vulnerabilities of communities, to put more people at risk of climate induced disasters.
The Green Book was commissioned with the aim to support municipal planning in developing climate-resilient cities and settlements through research in climate change adaptation.

The aim of this planning support tool is to propose a suite of climate change adaptation actions for every settlement in South Africa, based on their individual risk profiles.
Research design for the Green Book project

- Poorly Planned Development
- Poverty and environmental degradation
- Climate Change
- Natural Hazards
- Exposure
- Vulnerability
- Risk
- Poorly Planned Development
- Climate Change
- Natural Hazards
Results for the Green Book project

A likely 2050 future highlighting settlements projected to experience vast growth coupled with increases in natural weather related hazards

(*initial findings *low-mitigation scenario)
2050: The Projected Changes in South Africa’s Climate

Relative to the period 1961-1990

Legend
- Provinces
- Decrease in rainfall
- Increase in extreme rainfall events
- Significant increase in rainfall
- Increase in temperature > 3°C
- Increase in temperature 2.5°C-3°C
- Increase in temperature 2°C-2.5°C
- Increase in temperature < 2°C

CSIR

Green Book, 2018
Settlements most at risk of increasing population pressure

Taking into account the actual population numbers and the % change in population between 2011 and 2050
Settlements at risk to an increase in urban floods

Settlements most at risk of heat stress by 2050

Taking into account the increase in the number of very hot days and the increase in heat wave days by 2050
Settlements most at risk to increase in urban floods by 2050

Taking into account the flood hazard index and extreme rainfall by 2050
Settlements most at risk to increase in wildfire by 2050

Taking into account the increase in the number of fire danger days by 2050.
Groundwater dependent settlements at risk to decreasing groundwater supply and increasing population pressure by 2050

Taking into account the aquifer recharge potential combined with the population pressure by 2050
Settlements most exposed to coastal flooding by 2050
Settlements where agriculture GVA sector production is at risk
Settlements most at risk to the impacts of climate change
Settlements most at risk to the impacts of climate change

- Zeerust
- North West
- Limpopo
- Mankweng
## Current vulnerabilities

<table>
<thead>
<tr>
<th>Settlement</th>
<th>MUNICIPALITY</th>
<th>SEV</th>
<th>Trend</th>
<th>EVI</th>
<th>Trend</th>
<th>PV</th>
<th>Trend</th>
<th>EV</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burgersfort</td>
<td>Greater Tubatse/Fetakgomo</td>
<td>5.38</td>
<td>↓</td>
<td>9.44</td>
<td>↑</td>
<td>8.44</td>
<td>↑</td>
<td>7.41</td>
<td>No Trend</td>
</tr>
<tr>
<td>Swartruggens</td>
<td>Kgetlengrivier</td>
<td>4.45</td>
<td>↓</td>
<td>8.46</td>
<td>↑</td>
<td>6.57</td>
<td>↑</td>
<td>5.71</td>
<td>No Trend</td>
</tr>
<tr>
<td>Hermanus</td>
<td>Overstrand</td>
<td>1.54</td>
<td>↓</td>
<td>4.07</td>
<td>↑</td>
<td>6.39</td>
<td>↑</td>
<td>5.30</td>
<td>No Trend</td>
</tr>
<tr>
<td>Mankweng</td>
<td>Polokwane</td>
<td>3.19</td>
<td>↓</td>
<td>6.80</td>
<td>↑</td>
<td>7.22</td>
<td>↓</td>
<td>6.17</td>
<td>No Trend</td>
</tr>
<tr>
<td>Zeerust</td>
<td>Ramotshere Moiloa</td>
<td>5.75</td>
<td>↓</td>
<td>6.86</td>
<td>↑</td>
<td>6.74</td>
<td>↑</td>
<td>5.57</td>
<td>No Trend</td>
</tr>
<tr>
<td>Molote</td>
<td>Rustenburg</td>
<td>2.32</td>
<td>↓</td>
<td>8.49</td>
<td>↑</td>
<td>6.80</td>
<td>↓</td>
<td>6.19</td>
<td>No Trend</td>
</tr>
</tbody>
</table>

1. High % of households live under minimum living level
2. High % of Female and Child headed households

1. High inequality
2. Low GDP production & Low GDP per Capita

1. Road infrastructure (Low road density)
2. High density population covering large area

1. Ecological infrastructure (High amounts of conservation & protected areas)
2. Environmental governance (Encroachment on protected areas & Stressed catchments)

1. Low GDP growth
2. Low GDP production & Low GDP per Capita

1. High % of informal or subsidised housing
2. High % of population have low literacy level

1. Human influence (Urban encroachment)
2. Ecological infrastructure (High amounts of conservation & protected areas)
Implications for settlements

This decision-support tool identifies settlements most at risk that need to start thinking creatively about how to integrate adaptation actions into the planning and design of these settlements now in order to protect the lives of its occupants and ensure a sustainable resilient future.
Inland Flooding
Coastal Flooding
Increase d Wind Speed
Drought
Heat Stress
Wildfire

Adaptation Actions

Typology of adaptation actions

Environmental Planning
Engineering Services
Landscape & Urban Design

Spatial Planning
Land Use Management

Win-win
No regrets
Low regrets

Water
Storm water
Sanitation
Energy
Solid Waste
Mobility & Transport
Determine coastal management lines

**Spatial Planning**

Description
Identify coastal management lines for coastal settlements at risk of rising sea levels and coastal flooding. Coastal management lines are used as planning tools for coastal retreat and define the amount of open space between the shoreline and infrastructure (buildings, houses etc.). Management lines allow room for the average high water mark to naturally move inland by sea level rise throughout the economic lifetime of the property. Demarcation of coastal management lines should be informed by wave action, erosion, dune migration and the location of existing developments. The historic erosion rates or extreme weather levels need to be taken into account and should be specific to area implemented. Once coastal management lines have been determined, they need to be reviewed every five years. The coastal management should be included in the SDF.

Goals
To provide information in support of protecting coastal public and private property from risk, and protecting environmentally sensitive coastal areas from development.

Benefits
Once coastal management lines are identified and subsequently reviewed, every five years, it allows local government to better manage their coastal areas, protect infrastructure, and ensure public safety. They can also be used to complement other coastal adaptation options such as dune rehabilitation and wetland restoration.

Costs
Consultation services would be required to assess erosion rates and water levels, and to model coastline evolution. If an area is classified as a no-build zone, this could be problematic if the land has been privately purchased or there are existing structures in the area.

Example
Description
This involves the conservation and restoration of dunes by supporting the reestablishment of stabilizing vegetation. Plant species used for restoration should be native and adapted to the harsh conditions present in dune environments. Soft physical structures such as wooden fences or nets can be used to reduce wind speed across the sand surface and increase sand deposition to facilitate the establishment of a stable vegetation cover. Involve the community through local awareness raising campaigns to assist in protecting the dunes.

Goals
To prevent adjacent land, infrastructure and developments from inundation

Benefits
- Beach nourishment can complement hard protection measures such as seawalls and provide additional protection. This will reduce maintenance cost of any hard protection measures.
- Promote recreation and tourism through beach widening.
- Provide increased capacity for coping with coastal flooding.
- Natural dune systems are more aesthetically pleasing than hard defence measures and structures.

Costs
Reduced maintenance costs of hard infrastructure. Low resource option. Involves initial establishment (purchasing, planting and initial care) costs. Dunes require more space than conventional, 'hard' engineering structures. This can be problematic when in highly populated coastal areas, and conflicts of interest may arise, especially if coastal sand dune restoration takes place in areas primarily used for residential or tourism purposes.

Example
Management and rehabilitation plan for the Hout Bay Dunes (Cape Town):
Maintain & rehabilitate dunes

Description
Natural sand dunes provide effective defence against coastal flooding, wave surges, and erosion. They are, however, in decline due to developments and are at increased risk from erosion caused by sea level rise and more energetic wave climates and storm surges. Dune rehabilitation refers to the process of restoring or returning natural or artificial dunes that are degraded by active interventions to match, as closely as possible, pre-disturbance conditions and functions. Dune rehabilitation methods include building fences on the seaward side of an existing dune to trap sand and help to stabilise bare sand surfaces, planting vegetation to stabilise natural and artificial dunes, and construction of artificial dunes. This action also includes measures of beach nourishment, which refers to the practice of adding large quantities of sand or sediment to beaches to combat erosion and increase beach width. It can also be referred to as beach recharge, beach fill, replenishment, re-nourishment and beach feeding. Nourishment material should be compatible with the existing natural (or native) beach material.

Goals
Regular maintenance and rehabilitation of coastal dune systems will ensure the greatest coastal protection benefits, including storm protection and decreased erosion, for both infrastructure and settlements located along the coastal boundary.

Benefits
- Beach nourishment can complement hard protection measures such as seawalls and provide additional protection. This will reduce maintenance cost of any hard protection measures.
- Promote recreation and tourism through beach widening.
- Provide increased capacity for coping with coastal flooding.
- Natural dune systems are more aesthetically pleasing than hard defence measures and structures.

Costs
Compared to the construction of hard measures such as seawalls the costs of rehabilitation and maintenance are substantially lower. Costs include that of depositing the dredged material onshore and then the cost of reshaping with bulldozers. Additional costs could include dune grass or other plants, costs of fencing and notice boards, and costs of transporting beach material. Costs would be higher where more complex operations are required, detailed designs needed, and when more supervision or management is required during planning and implementation. Costs of continued monitoring and periodic re-nourishment to be done to maintain the effectiveness of the dune system need to be considered.

Example
Climate change is expected to amplify the extreme weather events in South Africa, particularly floods, droughts, wildfires and storms. High exposure and vulnerability of settlements will transform even small-scale and slow-onset events into disasters. Recurrent, small or medium-scale events affecting the same communities may have cumulative effects.

Given these risks, there is a great need for investment in adaptation actions in South African settlements. Local government is a critical role-player that can build climate resilience through “planning human settlements and urban development; the provision of municipal infrastructure and services; water and energy demand management; and local disaster response, amongst others” (NCCRP, 2011).

The Green Book project aims to provide local government with a decision support tool to prioritise the integration of climate change adaptation into their budgeting and planning instruments.
Thank you

Willemien van Niekerk
wvniedererk@csir.co.za