Building resilience to climate change: costs and benefits of restoring natural capital in South African drylands

Christo Marais
Department of Environment Affairs
South Africa
Presentation Structure

• **Section 1**: Introduction to the case study (brief information about the scope of the initiative, the *Working for Programmes* context and sources of funding.

• **Section 2**: Evaluation of the initial situation

• **Section 3**: Objectives

• **Section 4**: Project measures aiming at participation, capacity development and appropriation by concerned stakeholders

• **Section 5**: Project measures aiming at good governance (policy and institutional issues)

• **Section 6**: Project measures to implement restoration in the field

• **Section 7**: Monitoring system to assess/improve restoration actions, stakeholders involved and roles

• **Section 8**: Cost-benefit analysis of the case study, Project results and impacts, sustainability

• **Section 9**: Conclusion and Lessons learnt.
Socio-Political Priorities in South Africa (and the rest of Africa)

• Health
• Education
• Crime
• Employment
• Rural Development
Department of Environmental Affairs

Expanded Public Works Programme – Environmental and Social Sector

Water Trading Account

Private Sector Investment through Carbon Market, Land User Resources, Corporate Social Investment

Environmental Programmes Branch

“Working for Water”

Working for Water

Working for Land

Working for Forest

Working on Fire

National Implementing Agents

Provincial/Regional Offices

Regional Programme Offices

Regional Implementing Agents of Programme Offices

Projects

Projects

Base Partners

Provincial and Regional Offices

Regional Implementing Agents of Programme Offices

Working for Land

Working for Forest

Base Partners
# Environmental Programmes Scope

<table>
<thead>
<tr>
<th>Programmes</th>
<th>Annual Investment 2012/13 in $'000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Protection &amp; Infrastructure</td>
<td>$100,653</td>
</tr>
<tr>
<td><strong>Working for Water (including Land &amp; Forests)</strong></td>
<td>$148,427</td>
</tr>
<tr>
<td>Water Trading Account</td>
<td>$3,867</td>
</tr>
<tr>
<td><strong>Working on Fire</strong></td>
<td>$51,138</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td>$304,086</td>
</tr>
</tbody>
</table>
## Overview of Geographical and Socio Economic Scale of Working for Programmes

<table>
<thead>
<tr>
<th></th>
<th>2011/12</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Working for Water Initial Hectares Treated</strong></td>
<td>160,965</td>
<td></td>
</tr>
<tr>
<td><strong>Working for Water Follow Up Hectares Treated</strong></td>
<td>557,160</td>
<td>6,111,474</td>
</tr>
<tr>
<td><strong>Working for Water Total Hectares Treated</strong></td>
<td><strong>718,125</strong></td>
<td><strong>8,421,767</strong></td>
</tr>
<tr>
<td><strong>Working for Land Initial Restoration</strong></td>
<td>1,337</td>
<td>3,650</td>
</tr>
<tr>
<td><strong>Working for Land Follow Up of Restored Area</strong></td>
<td>148</td>
<td>428</td>
</tr>
<tr>
<td><strong>Working for Land Total Hectares Treated</strong></td>
<td><strong>1,485</strong></td>
<td><strong>4,078</strong></td>
</tr>
<tr>
<td>Number of People Employed</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Full Time Equivalent (or Person Years of Employment)</strong></td>
<td>9,328</td>
<td></td>
</tr>
<tr>
<td><strong>Working on Fire</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hectares of Fire Controlled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of fires fought</td>
<td>2,208</td>
<td></td>
</tr>
<tr>
<td>Number of People Employed</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Full Time Equivalent (or Person Years of Employment)</strong></td>
<td>4,985</td>
<td></td>
</tr>
</tbody>
</table>
“Over simplified” Spectrum of Degradation

Desertification

Bush Encroachments & Invasives
National Invasive Alien Plant Survey

Hectares Invaded = 20 million
Condensed Hectares = 1.9 million
Wetlands in South Africa of which 40% is degraded.
And addressing most of these needs through restoration programmes can contribute to poverty alleviation!!
Focusing on Albany Thicket (Stunted Forest) Restoration
Why forest restoration actions are needed), including the identification of underlying causes

1. Most of the arid (250-350 mm yr⁻¹) thicket, where the succulent shrub Portulacaria afra (spekboom) is dominant, have been degraded by unsustainable pastoralism. This process reduces the unusually high carbon stocks in thicket (which exceed 200 t ha⁻¹ in some regions) by more than 50%.

2. Degradation also reduces the availability of wood, fruit and medicines for local communities, with a potential financial loss of approximately $150 per annum per household (Cocks & Wiersum, 2003).

3. Spontaneous recovery of populations of canopy species does not appear to occur in browsing –degraded Arid and Valley forms of subtropical thicket (Stuart-Hill & Danckwerts, 1988; Sigwela et al. 2009, 2005; Lechmere-Oertel et al., 2005a)

4. Browsing by goats initially destroys the canopy skirt on the edge of thicket clumps (Stuart-Hill, 1992), thereby altering the beneath-canopy microclimate and destroying the rich layer of organic mulch that accumulates there (Lechmere-Oertel et al., 2008)

5. Deprived of an organically enriched soil medium, and subject to browsing higher up on the canopy, plants eventually die, and the thicket clumps steadily dwindle (Lechmere-Oertel et al., 2005a)
The good - 300,000 ha
Semiarid solid thicket (characterized by a dense canopy of tall shrubs and a *Portulacaria afra* Jacq. component)
The bad - 600,000 ha
Moderately degraded by injudicious goat-farming
The ugly - 800,000 ha
Severely degraded by injudicious goat-farming
<table>
<thead>
<tr>
<th></th>
<th>Above ground</th>
<th>Litter</th>
<th>Roots</th>
<th>Soil</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>t C ha⁻¹</td>
<td>40 3</td>
<td>11 1</td>
<td>10.9 1.6</td>
<td>92.5 7.2</td>
<td>154.4 12.8</td>
</tr>
<tr>
<td></td>
<td>7 1</td>
<td>1 0.4</td>
<td>2.7 0.3</td>
<td>30.9 1.8</td>
<td>41.6 3.5</td>
</tr>
</tbody>
</table>

and falling?

Objectives

• The programme aims to **restore the composition, structure and function of degraded land, thereby enhancing ecosystem functioning, such as carbon sequestration, water regulation and purification**. In so doing, and by reducing environmental risks, it will improve the sustainability of livelihoods and productive potential of land, and promote economic empowerment in rural areas; improve natural species diversity and landscape and catchment stability and resilience, and promote the development of a market for ecosystem services.

• **Enhancing the financial capital of beneficiaries** by developing sustainable SMMEs providing decent job opportunities to beneficiaries.

• **Enhancing the Human Capital** of beneficiaries by supporting a safe and healthy work environment and providing skills and education programmes to beneficiaries.

• **Enhancing the social capital** of beneficiaries by supporting the establishment of accessible and effective governance and local support systems.
Key Challenges

To simultaneously:

• *Develop the ecological case for restoration* interventions and capacity for conducting restoration ecology,

• Conduct research in collaboration with key stakeholders ensuring – via effective learning organizations - *that research is interdisciplinary and that strategy is responsive to research feedbacks*.

• *Identify voluntary investments in ecosystem services*,

• *Develop ways to monitor changes in service delivery and linking payments to service delivery* for a broad range of services.

• Develop an *effective institutional framework* for the development of the market for ecosystem goods and services.
Project measures aiming at participation, capacity development and appropriation by concerned stakeholders and good governance (policy and institutional issues)

- The Programme is underpinned by good science, but it is also socially well engaged through active involvement of a wide range of stakeholders.
Environmental Programmes Branch

Expanded Public Works Programme – Environmental and Social Sector

Private Sector Investment through Carbon Market (Project Design Document Validated through VCS,)

Land User Resources, Corporate Social Investment

Working for Water

Working for Land

Working for Water
Regional Office Oversight

Gamtoos Irrigation Board (Implementing Agent)

Community Based Restoration Contractors

SANParks & Eastern Cape Parks & Tourism Authority (Provincial & National Conservation Agencies)

Scientific Oversight (Senior Staff and Students from Three Universities)

Individual Land Users

Community Consultation through the PRESENCE Network (Using data and information From Scientists and around 12 Post Graduate Students & a Team of 7 Field Technicians)
Monitoring system to assess/improve restoration actions, stakeholders involved and roles - Learning through implementation

Other members of scientific community e.g. CSIR, Wageningen, CAPE

DEA Funder

Eastern Cape Parksboard

Programme Management Committee

GIB

Interns

PRESENCE

Investments in Ecosystem Services

Community Contractors

Land Owners
Building the ecological case

• Unfortunately, *rapid restoration is not as simple as removing the goats.*

• Restoration, therefore, *requires active intervention to establish shrubs*

• A potentially cost-effective, practical restoration method is *planting cuttings of the succulent shrub Portulacaria afra (spekboom)*

• It *propagates vegetatively from branches ... and is able to switch between C3 and CAM photosynthetic pathways an unusual and useful adaptation to arid conditions.*

• CAM photosynthesis refers to *opening stomata at night, thereby reducing water loss. CO$_2$ is absorbed and stored in the form of an acid before being broken down and the CO$_2$ released for photosynthesis.*
Building the ecological case cont.

- Restoration *implies the return of ecological integrity and the full pattern of biological complexity and diversity*, together with the ecosystem processes that maintain this pattern.

- *Planting cuttings of P. afra and other succulent plant species will not restore the ecosystem in the short-term*.

- We hypothesize, however, that *P. afra in particular will improve the microclimate of the planting sites for plant growth, and will provide cover for seed-dispersing animals and birds, facilitating natural ecosystem recovery over a period of decades*. 
Building the ecological case cont.

- At present, many transformed thicket landscapes appear to have ** abiogenic barriers that restrict seedling establishment.** These barriers include **extreme soil surface temperatures (up to 50°C),** reduced soil water holding capacity and soil crusts.

- **Planting** *P. afra* and other succulents would **remove such barriers by shading soils and returning organic matter.** Remnant shrubs are likely to benefit from the effects of *P. afra* establishment, though seedlings do not establish readily under *P. afra* canopies.
Measures to implement restoration in the field

- **Thicket Wide Plots** (experimental planting nearly 400 plots)
- **Landscape scale planting of cuttings** harvested from spekboom shrubs
- The **restoration procedure is very labour intensive**, requiring workers to harvest stems from intact thicket, excavate the holes and then to plant the cuttings then planted in the degraded landscapes
- **Shrubs are able to grow without irrigation** – a major advantage in a region with low rainfall (although sometimes minimal watering is done.
- **Mechanical planting** (a skilled worker with a drill supported by a team of planters) is about **80% cheaper** than manual planting (using hand tools only).
- Where cattle or some games species are present (especially elephants & baboons) planted areas **must be protected for at least 5 – 15 years** depending on the site quality (soils and drainage).
Measures to implement restoration in the field – some further questions

• The various sites where farmers have successfully planted spekboom cuttings have demonstrated that this **method of restoration is indeed feasible**. Several **key questions** remain unanswered. These include:
  
  • **Where** in the Eastern Cape is **restoration feasible**?
  
  • **How do soil properties and climatic conditions influence survivorship** of cuttings and rates of carbon capture?
  
  • **What is the best technique of planting** spekboom cuttings?
  
  • **Should they be treated with rooting hormone** before planting, watered after planting, planted horizontally or vertically?
  
  • **How do these planting techniques affect survivorship** and growth?
Extent of Land Restored

Extent of Land Planted in Degraded Albany Thicket

- Working for Land Follow Up of Restored Area
- Working for Land Initial Restoration

<table>
<thead>
<tr>
<th>Hectares Planted</th>
<th>2011/12</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,500</td>
<td>4,500</td>
</tr>
<tr>
<td></td>
<td>3,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>27,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30,000</td>
<td></td>
</tr>
</tbody>
</table>
Cost-benefit analysis of the case study

- Steep slopes, very dry climate
- Gentle slopes, very dry climate

- ~35,000 person-days
- ~20,000 person-days
- ~4.5 mill person-days
- ~2.5 mill person-days
Cost-benefit analysis of the case study cont.
Added Benefits – Watershed Services

- Flows
  - Yield from water infrastructure
  - Ecological Reserve

- Water quality
  - Purification costs
  - Waterweed management costs
  - Health risks
Conclusions

- Establishing the platform for a carbon sequestration investments in South Africa is by no means an easy task. In comparison with other countries active in the carbon sequestration market South Africa has a very dry climate which makes it less competitive.

- Research has shown that there is the potential to sequester carbon in the order of 100 t C ha\(^{-1}\) and at rates of between 1.2 and 4.2 t C ha\(^{-1}\) yr\(^{-1}\). At the lower rates of sequestration, restoration may not be viable based on income from the carbon market alone. Other investment will have to be secured.

- From both a scientific and implementation/operational perspective our understanding of the value chain is improving constantly through interactions between senior scientists, managers, students, community contractors and land users.

- The biggest challenge though is not in getting the science right but rather the institutional model for the trading in ecosystem services.

- The relationship between the sellers and the buyers is key for the successful development of the market.
Thank You!!
Acknowledgements

- **FAO** for the funding of my participation in this workshop

- **The Department of Environmental Affairs** for funding the development and implementation of the restoration programme.

- **Gamtoos Irrigation Board** and its management team for the implementation of not only the restoration projects but also for their effort to accommodate the development work done by the team of scientists in the programme.

- **My colleagues** who are turning the programme into a reality, to many to mention.

- All photographs by Anthony Mills, Mike Powell and Christo Marais