Climate Information and Early Warning Systems for Supporting the Disaster Risk Reduction and Management Sector in South Africa under Future Climates

CSIR – NRE and BE Team
January 2014
Overview of TOR2

• **Sub-component 1: Early Warning Systems**
  
  o Describe current capacity with regards to:-
    
    o climate information and
    
    o early warning systems for floods, fires, droughts and storm surges,
    
    o decision support tools available cross sectorally

• Describe mandates, capacity and links between national, provincial, municipal and local community levels with regards to:-
  
  o early warning systems, including
  
  o the production, interpretation, packaging and dissemination of weather and climate forecasts and related information across relevant sectors.
Overview of TOR2

- Outline policy recommendations for strengthening climate information and early warning systems for building climate resilience under the LTAS four climate futures for the thematic areas of food and water security linked to human settlements.

- Identify and describe case studies of good practice at:
  - local, provincial and national levels
- including climate information
- early warning systems for flood, storm surges, fires and droughts.
- Relevant local and international examples of good practice
Overview of TOR2

- **Sub-component 2: Analysis of Past Extreme Events**

  Based on existing research and work and in consultation with relevant experts working in the field,
  - determine the socio-economic impacts of past extreme weather events in South Africa
  - a summary where feasible of the approximate costs of disaster risk reduction and rehabilitation/recovery in terms of government and private infrastructure such as roads, bridges and dams at provincial, and municipal level for past events.
Introduction

- The National Climate Change Response Paper (NCCRP) and the Second Communication to the UNFCCC, highlight disaster management as a key area of development, for the country
  - Likely increase in extreme climatic events, heat waves, drought, wild fires, floods and storm surges
- Disaster management, required to support areas in immediate crisis and long term recovery,
- A response strategy for disaster reduction noted in the NCCRP highlight the expansion and enhancement of early warning systems for severe weather events.
- Includes communication of information to the potentially affected populations
Introduction

- development of risk and vulnerability science centres at academic institutions to support local municipalities,
- maintaining, updating and improving the South Africa Risk and Vulnerability Atlas (SARVA) as a tool to advice local government on climate change adaptation.
- increased use of climate seasonal forecasts, for the agriculture and water sector,
- development of micro-insurance to assist the poor recover from the effects of disasters,
- region wide collaboration on early warning systems, and collaboration with community organisations, NGOS, women’s and farmer organisations
- detailed *ex-post* studies of severe storms and related flood events to be conducted to provide critical awareness on risk factors for purposive adjustments and useful potential adaptive strategies (LTAS, 2013).
Methodology

• Desktop review
  – Journal papers
  – National and provincial government reports – NDMC, COGTA, SALGA etc
  – Newspaper Articles

• Telephonic interviews with informants from key departments such as NDMC, SAWS
Natural hazards naturally occurring rapid or slow onset events

- **geophysical** (earthquakes, landslides, tsunamis, volcanic activity),
- **hydrological** (avalanches and floods), climatological (extreme temperatures, drought, wildfires),
- **meteorological** (cyclones and storms/wave surges)
- **biological** (disease epidemics and insect/animal plagues)

In South Africa the disasters between 1980 and 2010 have gone up in frequency and dramatically more in costs of damage.

Figure 3.1 provides information on the frequency of previous disasters events for South Africa from 1980 to 2010

source: EM_DAT 2014
Past extreme weather events - Costs

A very rough cost indication over time (1981 - 2013)

Costs extracted from internet search: Emdat, PreventionWeb, News Articles, Research Reports & Government Annual Reports

Years

Costs

www.csir.co.za
### Past extreme weather events

#### Socio-Economic Impacts after Floods

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health</strong></td>
<td>Destruction of sewers systems, water pollution diseases such as typhoid, Cholera, Malaria, Gastroenteritis, conjunctivitis cases, in urban, rural and informal settlements, Trauma, displacement</td>
<td>After the Juksei River flooded in Johannesburg’s Alexandra township in 1999 resulted in cholera outbreak. Residents were moved to sanitary conditions. (UNEP 2000)</td>
</tr>
<tr>
<td><strong>Mortality</strong></td>
<td>Recovery and identification of bodies, Mortuary capacity over exceeded sometimes resulting in mass burials of unidentified people resulting in distress for families due to traditional ceremonies not being performed.</td>
<td>The The Laingsburg flood disaster of January, 1981 resulted in 104 losses of life. In 1987 the Kwazulu-Natal Flooding left 388 people dead, some buried under collapsed mud</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>Water and sewerage, roads, bridges washed away, drainage systems blocked, dams, hospitals, schools, community centres, housing and property damage, electricity supply. Compensation, resettlement and reconstruction cost escalate, running out of flood relief funding.</td>
<td>In 1987 the Kwazulu-Natal Flooding. Caused severe damages to thousands of kilometres of roads, 14 bridges washed away, all entrance routes to Durban closed. 68 000 people were left homeless. People left homeless after the Laingsburg flood disaster of January, 1981, caused by a cut-off low weather system</td>
</tr>
<tr>
<td><strong>Agriculture</strong></td>
<td>Loss or damage to agricultural infrastructure, loss and damage of crops and livestock, Loss of livelihoods, loss of income to subsistence families</td>
<td>Successive floods of 1983, 1984 and 1985 resulted in food being imported for the domestic market, loss of livestock due to reduced grazing.</td>
</tr>
<tr>
<td><strong>Tourism</strong></td>
<td>Infrastructure including lodges washed away, road damage and road closures, Loss of livelihood, including loss of employment</td>
<td>Flooding in KwaZulu-Natal in September 1987 resulted in all entrances to Durban being closed. (Grobler 2001) The Cape Mountain Pass Meiringspoort closed for 4 years after a serious flood in November 1996 (Ross 2001). 32 hikers had to be rescued after being trapped by heavy rain on the Whale Trail near Bredasdorp. (Al Jazeera 2012)</td>
</tr>
</tbody>
</table>
Socio-Economic Impacts of Disasters
A floods examples: Infrastructure

Laingsburg Part of the N1 through Laingsburg was closed after flooding. January 2014

uMngeni River dam

Laingsburg flood of 25 January 1981

This flood-damaged bridge in the Kruger National Park

uMngeni River catchment is subject to wide fluctuations in flow, ranging from crippling droughts to raging floods over the space of a few years. January 2011

I don’t want to die' in South Africa floods. November 2011 - November 2013 - Vergelegen Medi Clinic in Somerset West

www.csir.co.za
A severe storm hit the Cape Winelands district over the past weekend causing major damage throughout the Western Cape.

Socio-Economic Impacts of Disasters
A floods examples: Tourism

The floods of 2006 irreparably damaged the historical Outeniqua Tannoo cheese cheddar. The Augrabies Falls in the Upington area are spectacular with 3 million litres of water a second making its way over the waterfall.
Socio-Economic Impacts of Disasters
A floods examples: Agriculture

No handouts for farmers after floods - South Africa. Crops and houses have been submerged in muddy water since the disastrous floods that struck in Upington in the Northern Cape. The government says it will not compensate farmers who suffered crop damage during the storms.
Socio-Economic Impacts of Disasters

A floods examples: Health

Displaced South African families living in camps

Cholera threat after flooding

Alex residents busy cleaning up Jukskei River

Flooding in KwaMamSuthu (Quarry Road), 28 November

Flooding in KwaMamSuthu (Quarry Road), 28 November
Socio-Economic Impacts of Disasters

A floods examples: Mortality
Overview of Disaster Risk Reduction and Management systems

- **Disaster Risk Reduction**, is a complex and multi-disciplinary element that aims to **decrease mortality, livelihoods and property damage**, including environmental, economic and social obstructions caused by disasters.

- DRR’s objectives are to **strengthen resilience against natural disasters** and are aligned to development initiatives so as not to increase vulnerability to hazards (NDMC,

- Vulnerability is exacerbated by inadequate comprehensive planning, implementation and insurance cover for disaster losses e.g for the poor.

- Thus, for South Africa, **DRR is topical issue, needing urgent attention**, especially for the poor (UNEP, 2004).

- DDR requires various of activities and actors, beyond government and sub-government institutions, to include **private sector and communities**
  - E.g. **some activities of DRR require technical expertise** and other skills which may not be found in government, e.g. vulnerability risk assessment, capacity building, setting early warning systems.
Overview of DRR and Management Systems

- Intergovernmental structures
- The mandate for disaster risk management in South Africa is the responsibility of the National Disaster Management Centre (NDMC),
  - whose objective is to coordinate and promote and integrated disaster management at all levels of government, national, provincial and local municipalities as well other role players.
  - building and enhancing capacity as well as accountability of provincial and local municipalities in preventing and responding to disasters.
  - to improve to the general resilience of the communities and infrastructure to reduce risk (NDMC, 2006).
- A technical forum, the National Disaster Management Advisory Forum (NDMAF) which includes all the players from government to communities involved in disaster management (NDMC, 2006) was established in 2007
- Other DRR structures established at different levels of government
Overview of DRR

• Legislation and Policy Environment
• Two main instruments guiding DRR in South Africa providing a transition from a reactive to a proactive approach
  – Disaster Management Act (2002)

• Objective of the DMA
  – to integrate and coordinate disaster management,
  – mainly preventing and reducing the risks of disasters,
  – alleviate the severity, emergency preparedness, timely and effective response and post disaster recovery
  – establishment of disaster management centres across the country, at provincial and municipal levels
Overview of DRR

• National Disaster Management Framework (2005)
  – assists in the interpretation of the DMA,
  – comprises of a myriad of guidelines and recommendations to assist in effective disaster prevention, mitigation and preparedness
  – essential planning tool for disaster management, aiming expansively influence the management of most disasters,

The Drought Management Plan (2005),

• Other legal Instruments
  – Agricultural Disaster Risk and Management Plan
  – sector specific framework to address disaster risk management in the agriculture, forestry and fisheries sectors, with a focus on CC
  – Still under Development
  – Agricultural Flood Management Plan,
  – Agricultural Cold Spells Management Plan and the
  – Agricultural Veld Fire Management
Challenges of DRR

- Lack clarity in the Act about the roles and responsibility of local government in DRR
- A lack of or inadequate financial resources, for both start-up and operations
- A lack of clarity in the Act on funding options thus lack of knowledge by the municipalities on how to access these resources
- DRR does not get much attention getting minimum allocation of the municipal budgets – in competition with service delivery etc..
  
  (DMA under review – some of the issues maybe addressed)

- The placing on the NDMC in the Department of Cooperative Governance (COGTA) has been cited as a possible contributing factor to poor implementation,
- including the placing of the other centres at sub-national level in sectors with not enough political authority.
- This means that the NDMC cannot enforce the corrective measures (van Nierkerk, 2011).
South Africa moved from reactive crisis management to proactive risk management approaches

- In 2008 - 48% of the country’s population lived below the poverty line (National Planning Commission)

- “Disasters seek out the poor and ensure they stay poor” (Didier Cherpitel, IFRC)

- For development to be sustainable it should reduce climate change disaster risk

- “The more governments, UN agencies, organizations, business and civil society understand about risk and vulnerability, the better equipped they will be to mitigate disasters when they strike and save more lives (UN General Secretary)
Proactive Approach

- South Africa has adopted the Multi hazard Early Warning System and other government and private sector funded projects to get a better understanding of climate change and disaster risk reduction.
- Legislative developments from the late 90’s
  - 1998 - Green Paper on Disaster Management – 1st integrated policy document on disaster mgt
  - 1999 - white Paper on Disaster Management - describes the primary responsibility of the Gvt in relation to disaster mgt, as laid down in section 41(1) (b).
  - 2002 - Disaster Management Act – promotes an integrated and coordinated disaster mgt; decentralisation of DRR at various levels of gvt
  - 2005 Disaster Management Policy Framework - guides the development and implementation of disaster risk mgt as envisaged in the Disaster Mgt Act
Structures and responsibilities of disaster management across all spheres of governance

- **National**
  - Interministerial Disaster Management Committee (IDMC)
  - National Disaster Management Center (NDMC)

- **Provincial**
  - 9 Provincial Disaster Management Centers (PDMC)

- **Local**
  - Municipal Disaster Management Centers (MDMC)

Policy, national disasters
- Advisory forum: NDMAF

Coordination of provincial support and disasters
- PDMAF

Management of local disasters, risk reduction activities
- MDMAF
  - Traffic, police, Other structures
Production of weather forecasts and climate forecasts

- **South African Weather Services** – *daily weather forecasts, long term forecasts and early warning system for floods, fires, storm surges*

- **CSIR Meraka institute- Wide Monitoring Information System** - *provides real time monitoring of natural events such as fires, floods and droughts in Southern Africa*

- **CSIR Meraka Institute- Advanced Fire Information System** - *used to locate fires in near real time over Southern Africa*
Interpretation and packaging

- South African Weather Services
- CSIR Meraka- Advanced Fire information System
- Wide Area Monitoring Information System
- South African Risk and Vulnerability Atlas
- Climate Systems Analysis Group- UCT
Dissemination

- South African Weather Services - internet, email, sms, radio, TV and word of mouth
- Department of Agriculture forestry and fisheries - National Agro-Meteorological Committee
- SARVA - newsletters, spatial portal
- AFIS – SABC tv, email, Twitter, sms
Community Response

- National Disaster Mgt Centre, PMDC & MDMC as stipulated in Sec 15 of DMgt Act
- Various gvt departments
  - The extended Public Works Programme Working on fire
  - Department of Agriculture, Forestry and Fisheries
  - City of Tshwane Metropolitan
  - Disaster Mitigation for Sustainable Livelihoods
A warning map for South Africa for the different hazards is updated daily and is available on the SAWS website (See [http://www.weathersa.co.za/web/index.php/warnings](http://www.weathersa.co.za/web/index.php/warnings)).

<table>
<thead>
<tr>
<th>No Alert</th>
<th>Advisory</th>
<th>Watch</th>
<th>Warning</th>
</tr>
</thead>
<tbody>
<tr>
<td>No hazardous weather expected in next few days</td>
<td>Early warning of potential hazardous weather</td>
<td>Weather conditions are likely to deteriorate to hazardous levels</td>
<td>Hazard is already occurring somewhere or is about to occur with a very high confidence</td>
</tr>
<tr>
<td>No hazardous weather expected in next few days</td>
<td>Early warning of potential hazardous weather</td>
<td>Weather conditions are likely to deteriorate to hazardous levels</td>
<td>Hazard is already occurring somewhere or is about to occur with a very high confidence</td>
</tr>
<tr>
<td>2 to 6 days period</td>
<td>1 to 3 day period</td>
<td>Next 24 hours, 3 hrs for FF, TS</td>
<td>Next 24 hours, 3 hrs for FF, TS</td>
</tr>
</tbody>
</table>
Early warning systems (2)

- Examples of early warning systems and decision-support system for the four most common disasters

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Early warning system</th>
<th>Decision-support systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floods</td>
<td>• Severe Weather Forecasts Demonstration project</td>
<td>• The South African Flash Flood Guidance System (SAFFG)</td>
</tr>
<tr>
<td></td>
<td>• South Africa River Flow Flood Forecasting System</td>
<td>• Seasonal forecasts</td>
</tr>
<tr>
<td>Fires</td>
<td>• National Fire Danger Rating System</td>
<td>• AFIS (Advanced Fire Information System)</td>
</tr>
<tr>
<td>Droughts</td>
<td>• Umlindi</td>
<td>• Drought Monitoring Desk at South African Weather Services</td>
</tr>
<tr>
<td></td>
<td>• National Storm Surge Early Warning System</td>
<td>• Seasonal forecasts</td>
</tr>
<tr>
<td>Storm surges</td>
<td>• National Storm Surge Early Warning System</td>
<td>• South African Navy Hydrographic Office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CSIR for the National Ports Authority</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Marine Office of the SAWS</td>
</tr>
</tbody>
</table>
EWS used during past events

- Case Study: Flooding in Gauteng (December 2010)
  - SAWS using their flash flood guidance systems issued warnings to the National Disaster Management Centre, including a hourly breakdown

Snapshot of basins where flooding was expected

Hourly breakdown issues by SAWS for the floods

<table>
<thead>
<tr>
<th>District</th>
<th>Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedibeng</td>
<td>16</td>
</tr>
<tr>
<td>West Rand</td>
<td>5</td>
</tr>
<tr>
<td>Ekurhuleni</td>
<td>13</td>
</tr>
<tr>
<td>City of Johannesburg</td>
<td>7</td>
</tr>
<tr>
<td>City of Tshwane</td>
<td>10</td>
</tr>
</tbody>
</table>

(source: SAWS)
Seasonal Forecasts

- Useful tool for reducing risk of floods and droughts for the coming season
- Forecasts are usually issued for a period of six months and suggest the total amount of rainfall expected over that period

Challenges:
- Large uncertainties in the predictions
- Delivery and uptake of information is limited
- Need for the development of tools that can translate this information to end-users
Gaps in current EWS

- Despite the existence of DMA the uptake of EWS remains slow
  - **Provincial offices of DAFF remain incapacitated and constrained** because of the lack of structure and defined roles for individuals (NDMC Annual Report 2010-2011)
  - Disaster management function is **not seen as a funded mandate** by local municipalities (NDMC Annual Report 2010-2011)
- Botha et al. (2011) found that in 50% of local municipalities in South Africa **lacked the disaster management structures**, while 68% of local and 25% of district municipalities did not have the disaster management advisory forums
  - Disaster management roles were often assigned to civil defense structures (fire and police services)
Gaps in current EWS

-decentralisation has faced various challenges, provinces at different stages of development (figure 3.1)
Gaps in current EWS

- **Lack of funding** or limited institutional knowledge on how to secure funds
  - Municipalities do not budget for DRR programmes
- **Lack of communication between government departments** involved with disaster management
- **Dissemination of warnings** to all levels of society remains a challenge (SAWS, 2011)
  - e.g. limited role of extension services
- **Lack of awareness** in communities
- **Poor participation of communities** and other key stakeholders in disaster management
  - e.g. Fire Protection Associations
Policy recommendations for enhancing climate information and early warning systems for building climate resilience

5.1. Considering the LTAS scenarios in the context of DRR

• Under LTAS Phase 1, analysis of climate trends and scenarios indicate under high emissions scenarios, a high likelihood of drying and significant warming scenarios (at least by the end of this century).

• The four ‘narrative climate scenarios’ developed for South Africa by 2050 and beyond all indicate higher temperatures (two warmer, and two hotter); while all assume a certain (if varying) increase in frequency of extreme rainfall events.

• Such scenarios clearly have implications for a changing environment for disaster risk reduction in the country, even as we note current challenges in responding to existing events (section 4.3).
5.2. Recommendations for the early warning system

- Have taken the approach here of considering priority recommendations in the field of EWS and DRR; particularly taking a changing environment of vulnerability and external environmental changes into account.

- Policy recommendations for policy, operational and strategic operation based on gaps and opportunities identified e.g. NDMC’s own reporting, and analyses, and SAWS’s mandate and functioning).

- Future planned feedback, as a part of LTAS process, will contribute to refinement of listing and priorities.

- Support must be provided to:
  - the inclusion of risk assessments,
  - mapping of vulnerable areas,
  - measures to adapt to climate change and development of early warning mechanisms (see further, section above) into the DM framework and enactment of the amendment bill.
5.2. Recommendations for early warning system

- R&D support for forecasting and tailored forecasting has declined
  - recommend R&D support for initiatives in these areas be substantively increased, to address some (if not all) of the technical issues identified in section 4.3.

  - recommend that a specific audit the areas of Research and Development be undertaken, by an independent stakeholder; including a comprehensive updated user needs assessment.

  - Linked to recommendation 2; we recommend that additional actors be enabled to join both R&D and operational prediction/forecasting, in addition to those who currently have mandate.

Figure 5.1: Meteorological station, Northern Cape (part of community based climate risk adaptation and response capacity building initiatives in the area)
5.3. Institutional and process recommendations

- Firstly and most importantly, the challenge of funding in the implementation of the NDM Framework needs to be addressed.

- Support must be provided to the “-”
  - inclusion of **risk assessments**,  
  - mapping of **vulnerable areas**,  
  - measures to **adapt to climate change** and **development of early warning mechanisms** (see further, section above) into the DM framework and enactment of the amendment bill.

- Linked to recommendation above, findings of risk assessments and vulnerability levels need to be integrated into programme and project design e.g province level.
Policy Recommendations

• Standardized guidelines and operational procedures are essential.

• Beyond a focus on design and operational implementation, **capacity building** of the relevant stakeholders requires critical attention – national, provincial, municipal, community level.

• Attention needs to be paid to the difficulty in obtaining verified assessment reports in cost damages - not simply a capacity issue; but links further to the challenge of the perception of **funded versus non-funded mandates** described above.

• Partnerships: **SARVA** and **RAVSCs**, in terms of response capacity and capacity development (including communication and dissemination)

• Opportunities to extend the Cape Town metropolitan area’s disaster risk information system for the whole country be examined
Institutional and process recommendations

- Capacitation of DAFF at the provincial level needs priority attention, in particularly vulnerable provinces

- There are, however, existing initiatives in this regard – care should be taken to avoid duplication, and to align and support existing efforts (for example, initiatives in Limpopo Province around prediction and response in the agricultural sector,
Case studies

• Severe weather is a reality, thus CC needs to be taken seriously and early warning systems are being developed and implemented, though poorly documented.

• Examples of good practice include: City of Cape Town and Nelson Mandela Bay; Eden District Municipality; and Western Cape Province.
Case studies – Nelson Mandela Bay

• Biggest natural risks in NMB are floods, fire, storm surges, drought.

• NMB has implemented CCTV at remote sites to monitor potential high-risk flooding areas. Some are linked to automatic weather stations of the SAWS.

• Automatic rain stations monitor for flash floods.

• A few river crossings have alarms to warn of flooding.

• All weather, rain and water levels are monitored at Joint Operations Centre and alerts are sent out to affected communities.
Case studies – Eden District

• Biggest natural risks in Eden District are floods and droughts.
• Area has been declared disaster area a number of times.
• All weather alerts are received from the SAWS, automatic rain stations, and dam level monitors.
• Alerts are sent out via an LED early warning display system, SMSs to disaster management advisory forums and ward councillors.
Case studies – Western Cape Province

• Biggest natural risks in Eden District are floods, wildfires and droughts.
• These risks will increase as the climate changes.
• Provincial losses already amounts to billions of Rands.
• Based on information from the SAWS, flash floods and fire early warning systems, Western Cape Disaster Management Centre alerts relevant stakeholders via email or SMS of any potential risks.
• Alerts are disseminated to public where applicable to prepare and act accordingly.
Conclusion

- Impacts on climate variability and extreme weather events has been acknowledged internationally and locally.
- Climate change information and early warning systems play a key role in supporting DRR and management in South Africa.
- South Africa has adopted proactive legislation, statutory instruments and infrastructure however there challenges that deter the realisation of the benefits of these frameworks for DRR and climate change adaptation.
- The escalation in damage costs from disasters is an indication that DRR will continue to be a key development issue in South Africa.
- LTAS process is a crucial instrument to address some of the issues on DRR.