Climate change adaptation options, policies & projects

A review at global, national & the Olifants Catchment levels

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USAID: RESILIENCE IN THE LIMPOPO BASIN PROGRAM (RESILIM) – OLIFANTS

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Contents

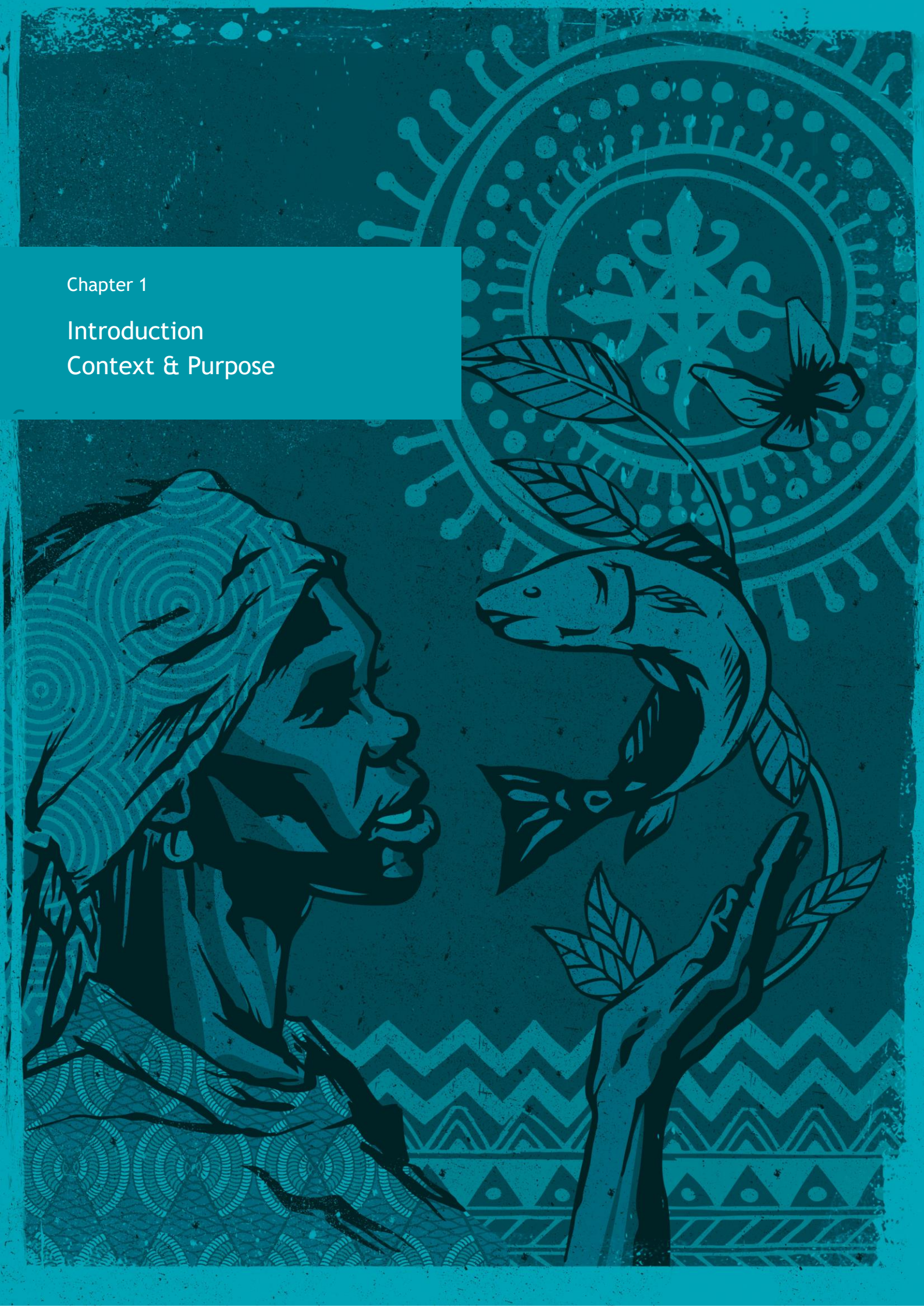
List of abbreviations

AF	Adaptation Fund
ARC	Agricultural Research Council (South Africa)
AR5	Fifth Assessment
BCRP	Bureau for Crisis Prevention and Recovery
Bik-F	Senckenberg Biodiversity and Climate Research Centre
CCAS	Climate change adaptation strategy
COGTA	Department of Cooperative Governance and Traditional Affairs
COP	Conference of the Parties
CSA	Climate Smart Agriculture
CSIR	Council for Scientific and Industrial Research (South Africa)
CSP	Climate Support Programme
DAFF	Department of Agriculture, Forestry and Fisheries (South Africa)
DARDLA	Department of Agriculture and Rural Development and Land Administration
DBSA	Development Bank of South Africa
DEA	Department of Environmental Affairs
DIRCO	Department of International Relations and Cooperation
DM	District municipality
DMAF	Disaster Management Advisory Forum
DRR	Disaster Risk Reduction
DWS	Department of Water Affairs and Sanitation
EbA	Ecosystem-base Adaptation
EIT	Economies in Transition
EWT	Endangered Wildlife Trust
FAO	Food and Agriculture Organization
GCF	Green Climate Fund
GEF	Global Environment Fund
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICI	International Climate Initiative
INAM	National Meteorology Institute (Mozambique)
INGC	National Disaster Management Institute (Mozambique)
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least Developed Countries
LDCF	Least Development Countries Fund
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LTAS	Long Term Adaptation Scenarios
LM	Local municipality
MDGF	Millennium Development Goals Achievement Fund
MICOA	Ministry for Coordination of Environmental Affairs (Mozambique)

MINAG	Ministry of Agriculture (Mozambique)
MM	Metropolitan municipality
NAPA	National Adaptation Programmes of Action
NC	National communication
NCA	Norwegian Church Aid
NCCAS	National Climate Change Adaptation Strategy
NCCRP	National Climate Change Response Policy
OECD	Organization for Economic Co-operation and Development
OLCMA	Olifants Letaba Catchment Management Authority
PCCAS	Provincial climate change adaptation strategy
PTJ	Projektträger Jülich Forschungszentrum Jülich
SALGA	South African Local Government Association
SAFCEI	Southern African Faith Communities' Environment Institute
SANBI	South African National Biodiversity Institute
SCCF	Special Climate Change Fund
SPACES	Science Partnerships for the Assessment of Complex Earth System Processes
TFCAs	Trans-frontier Conservation Areas
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHABITAT	United Nations Human Settlements Programme
UNIDO	United Nations Industrial Development Organization
WB	World Bank
WCC	World Climate Conference
WESSA	Wildlife and Environment Society of South Africa
WFP	World Food Programme
WWF	World Wide Fund for Nature

Chapter 1

Introduction
Context & Purpose



A need for climate change adaptations

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) confirmed that climate changes are observed in all geographical regions and are unequivocal (IPCC 2014). Moreover, global surface temperature change for the end of the 21st century is likely to exceed 1.5°C relative to 1850 to 1900[1]. Rising temperatures are linked to a number of climate-related threats. For example, increasing surface temperatures lead to higher ocean temperatures, which cause ocean expansion and sea level rise. Warmer temperatures also accelerate the rates at which land ice melts, further elevating average sea levels. A warmer atmosphere makes extreme precipitation more likely, which is expected to make wet regions even wetter but could also make dry regions even drier.

In Africa, there are already observed impacts to snow and ice, rivers and lakes, floods and drought, terrestrial and marine ecosystems, coastal erosion, food production and livelihoods attributed to climate change. Figure 1 summarizes these observed impacts as reported in the AR5 by Working Group 2. The observed climate change impacts on snow, ice and rivers all work to reduce water budget in a continent where majority of the land is classified as drylands and water scarcity is a major challenge. Recurrent drought is a feature of drylands and contributes to water scarcity. It is anticipated that drought will be a key risk for Africa because there will be a greater drought-stress in areas that are prone to recurrent drought (*Figure 2*) .Majority of the land in South Africa including the Olifants Catchment is vulnerable to drought. Another key risk for Africa is reduced crop productivity, which is linked to heat and drought stress and has knock-on effects on regional, national and household livelihood and food security (*Figure 2*). In addition, price volatility for agricultural commodities is projected to increase and the management of food insecurity is predicted to become a greater challenge. Indeed, climate-related threats pose risks on virtually every aspect of human and natural systems, though the extent and nature of the effects will vary from system to system.

The recognition of climate change as a global challenge can be traced back to the first World Climate Conference (WCC) in 1979 and the subsequent establishment of the IPCC in 1988. Two years later, IPCC released its first assessment report and urged the United Nations General Assembly to negotiate a global treaty on climate change with the second WCC. In the following year, an Intergovernmental Negotiating Committee (INC) was convened to conduct these negotiations. The outcome of these negotiations was the drafting of the United Nations Framework Convention on Climate Change (UNFCCC). It was an international treaty to enable countries to cooperatively consider what they could do to limit average global temperature increases and mitigate the impacts of climate change. In 1994, the UNFCCC enters into force after receiving the requisite 50 ratifications. There are now 195 countries (referred to as *Parties*) that have ratified the UNFCCC. The *Parties* meet annually at what is called the Conference of the Parties (COP).

[1] This projection is for all Representative Concentration Pathway (RCP) scenarios except RCP2.6 (a low emission scenario). RCP is the latest generation of scenarios that provide input to climate models. Global surface temperature is likely to exceed 2°C for RCP6.0 (intermediate emissions) and RCP8.5 (high emissions), and more likely than not to exceed 2°C for RCP4.5 (intermediate emissions).

Africa	
Snow & Ice, Rivers & Lakes, Floods & Drought	• Retreat of tropical highland glaciers in East Africa (*high confidence*, major contribution from climate change) • Reduced discharge in West African rivers (*low confidence*, major contribution from climate change) • Lake surface warming and water column stratification increases in the Great Lakes and Lake Kariba (*high confidence*, major contribution from climate change) • Increased soil moisture drought in the Sahel since 1970, partially wetter conditions since 1990 (*medium confidence*, major contribution from climate change) [22.2-3, Tables 18-5, 18-6, and 22-3]
Terrestrial Ecosystems	• Tree density decreases in western Sahel and semi-arid Morocco, beyond changes due to land use (*medium confidence*, major contribution from climate change) • Range shifts of several southern plants and animals, beyond changes due to land use (*medium confidence*, major contribution from climate change) • Increases in wildfires on Mt. Kilimanjaro (*low confidence*, major contribution from climate change) [22.3, Tables 18-7 and 22-3]
Coastal Erosion & Marine Ecosystems	• Decline in coral reefs in tropical African waters, beyond decline due to human impacts (*high confidence*, major contribution from climate change) [Table 18-8]
Food Production & Livelihoods	• Adaptive responses to changing rainfall by South African farmers, beyond changes due to economic conditions (*very low confidence*, major contribution from climate change) • Decline in fruit-bearing trees in Sahel (*low confidence*, major contribution from climate change) • Malaria increases in Kenyan highlands, beyond changes due to vaccination, drug resistance, demography, and livelihoods (*low confidence*, minor contribution from climate change) • Reduced fisheries productivity of Great Lakes and Lake Kariba, beyond changes due to fisheries management and land use (*low confidence*, minor contribution from climate change) [7.2, 11.5, 13.2, 22.3, Table 18-9]

Figure 1: Observed impacts attributed to climate change with very low, low, medium, or high confidence level for natural and human systems over the past few decades. (Adopt from IPCC 2014, Table SPM.A1, p 30)

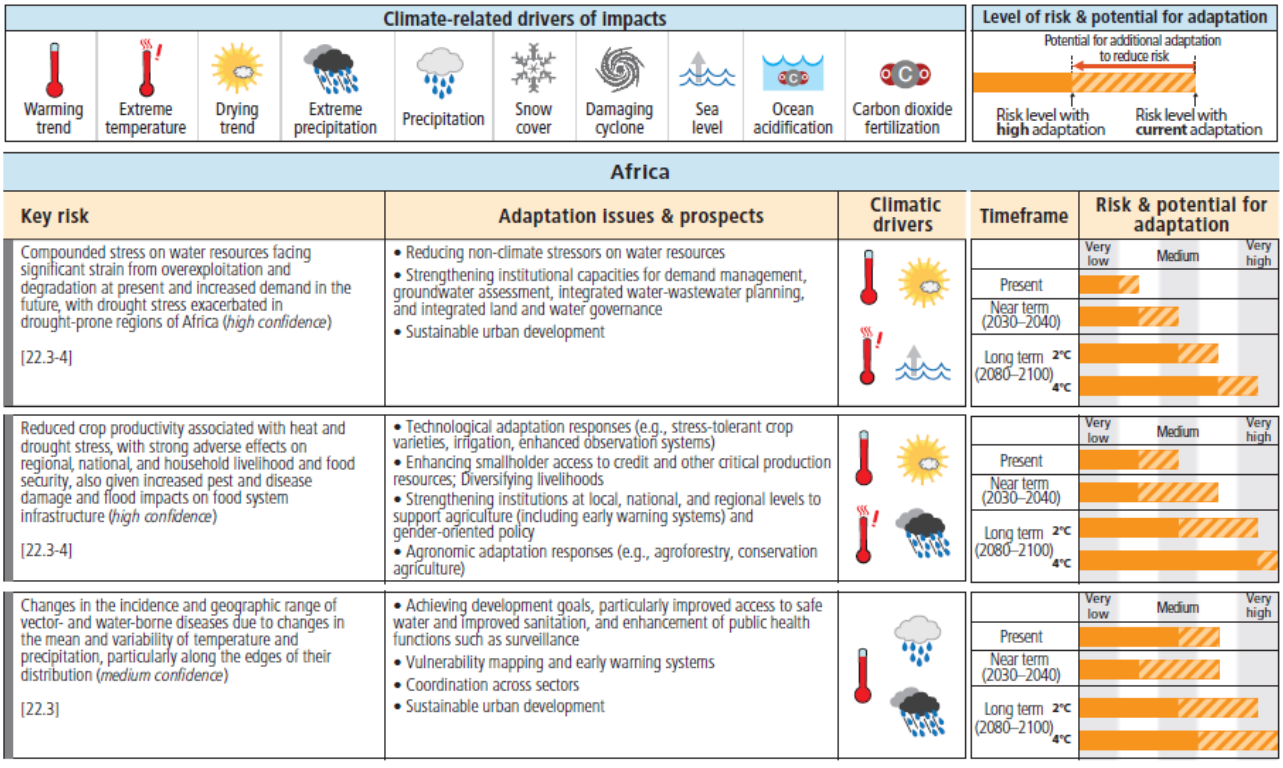


Figure 2: Key regional risks from climate change and the potential for reducing risks through adaptation and mitigation. Each key risk is characterized as very low to very high for three timeframes: the present, near term (here, assessed over 2030–2040), and longer term (here, assessed over 2080–2100). For the longer term, risk levels are presented for two scenarios of global mean temperature increase (2°C and 4°C above preindustrial levels). Climate-related drivers of impacts areindicated by icons. (Adopted from IPCC 2014, SPM.2, Table 1, p 21.)

It is at these COPs where important global agreements are negotiated to influence the world's capacity to abate the rate of climate change and to adapt. In 2001, the UNFCCC approved the preparation of National Adaptation Programmes of Action (NAPA) for the Least Developed Countries (LDCs). It is generally agreed that less developed countries are disproportionately affected by climate-related threats (WB 2010). This is because these countries have less resources and capacity to adapt and their economies also tend to rely more on natural resources. The NAPAs provide a process for the LDCs to identify priority activities that respond to their urgent and immediate needs to adapt to climate change. The priority adaptation needs refer to those for which further delay could increase vulnerability or lead to increased costs of adapting at a later stage. The main content of NAPAs is a list of ranked priority adaptation needs and options, and a short profile for each option to facilitate the development of project proposals to implement the NAPAs. To date, 50 LDCs have submitted their NAPAs to the UNFCCC.

Regardless of whether a country qualifies as a LDC, all *Parties* to the UNFCCC must submit National Communications (NCs) to the COP though the required contents of the NCs and timetable for their submission [2] are different for Annex I and non-Annex I *Parties*. Annex I *Parties* include the industrialized countries that were members of the Organization for Economic Co-operation and Development (OECD) and countries with economies in transition (EIT), whereas non-Annex I *Parties* are mostly developing countries. The Annex I *Parties* are required to provide information on emissions and removals of greenhouse gases (GHGs), national circumstances, policies and measures, vulnerability assessment, financial resources and transfer of technology, education, training and public awareness in their NCs. The non-Annex I *Parties* have to include GHG inventories, measures to mitigate and to facilitate adequate adaptation to climate change. All *Parties* have to provide any other details of the activities they have undertaken to implement the UNFCCC in their NCs. To date, 153 *Parties* have been included in the UNFCCC online database.

In addition to the differences in report contents and timetable, Annex II *Parties* are required to provide financial resources to enable Non-Annex I *Parties* to undertake emissions reduction and adaptation. Annex II *Parties* consist of the OECD members of Annex I, but not the EIT Parties. Funding provided by Annex II *Parties* is channelled mostly through four financial mechanisms[3] established by the UNFCCC for climate change. In addition, Annex II *Parties* have to "take all practicable steps" to promote the development and transfer of environmentally friendly technologies to EIT *Parties* and Non-Annex I *Parties*.

[2] *Annex I Parties have to submit the NCs more frequently, whereas the non-Annex I Parties are required to submit their first NCs within three years of becoming a UNFCCC Party, and every four years thereafter.*

[3] *These financial mechanisms are: i) Special Climate Change Fund (SCCF); ii) Least Development Countries Fund (LDCF); iii) Adaptation Fund (AF); and iv) Green Climate Fund (GCF). The SCCF finances adaptation activities, especially projects on water resouces management, land management, agriculture, health, infrastructure development and fragile ecosystems. The LDCF is only available to LDCs to finance same activities as the SFCC. The AF is financed through a 2% share of the profits from Clean Development Mechanism (CDM) and finances adaptation in developing countries that are signatories of the Kyoto Protocol. The GCF commits donor nations to mobilize US$100 billion a year – in new and additional resources – for climate change mitigation and adaptation by 2020. These donor funds comprise a combination of public and private sources beyond the traditional fund source from bilateral and multilateral aid commitments by the developed countries (UNFCCC 2011).*

Some important definitions

With an increasing number of development programs aiming at addressing the effects of climate change, considerable research has been invested into characterizing what constitutes climate change adaptation and how to facilitate it. As a result, many definitions and classification of climate change adaptation have been developed. Similarly, there is an explosion of literature on a conceptual framework for adaptation and related terms such as coping and transformation.

For the purpose of this report, we will used the IPCC definition for adaptation, coping and transformation because this is the definition adopted by the *Parties* of the UNFCCC.

The IPCC definition is also applied in the NAPAs and NCs.

- **Adaptation** is the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects. (IPCC 2014, p.1)
- **Coping mechanism** is the use of available skills, resources and opportunities to address, manage and overcome adverse conditions, with the aim of achieving basic functioning of people, institutions, organizations and systems in the short to medium term. (IPCC 2014, p. 8)
- **Transformation** is a change in the fundamental attributes of a system, often based on altered paradigms, goals, or values. Transformations can occur in technological or biological systems, financial structures, and regulatory, legislative, or administrative regimes. (IPCC 2014, p. 27)

The IPCC classifies adaptation into three categories: structural/physical, social and institutional. Structural/physical type of adaptations rely on engineering-, technology-, or ecosystem-based solutions. Additionally, this type of adaptations include services such as social safety nets, food banks, vaccination programs, and water and sanitation services. Social adaptations are educational, informational or behavioural in nature. Institutional interventions operate at the level of economic incentives and mechanisms, laws, regulations, and government policies and programs. *Table 1* lists examples adaptation options under each of these three categories and their sub-categories.

The different ways in which adaptation is conceptualized is linked to whether vulnerability is viewed from an end-point or starting-point perspective (O'Brien *et al*. 2007). When viewed as an end-point condition, vulnerability is captured as a residual of climate change impacts minus adaptation (Kelly and Adger 2000). On the other hand, vulnerability is understood as a characteristic or state generated by multiple political, environmental and social processes, but exacerbated by climate change when it is viewed as a starting-point condition. The end-point interpretation of vulnerability sees science playing the central role in identifying and explaining climate risks and defining adaptation. When vulnerability is viewed as a starting-point condition, the type of adaptation that emerges tend to be social and institutional (Kelly and Adger 2000). However, neither end-point nor starting-point perspective can say much about what the effects of climate change mean for what people value, for example, their cultural identity and way of life, their sense of place, their visions for their future and their human security (O'Brien 2011).

Contrary to adaptation, **maladaptation** refers to adaptation options that, in addressing specific development objectives, inadvertently end up increasing the vulnerability or reducing the resilience of a human or ecological system. An example of maladaptation is an adaptation that supports the monoculture of a high-value crop, with the objectives of maximizing the efficiency of irrigation systems, water productivity, yields and income generation. However, a monoculture could potentially lower the adaptive capacity of farmers by making their income stream more sensitive to changing climate conditions and pest outbreaks. Consequently, the adaptation option of enabling farmers to improve productivity using a monoculture crop could inadvertently increase their vulnerability to climate risks.

TABLE 1: CATEGORIES AND EXAMPLES OF ADAPTATION OPTIONS. (ADAPTED FROM NOBLE ET AL. 2014, IPCC WG2 AR5 - CHAPTER 14, TABLE 14-1, P 845.)

Structural/ physical	Engineered and built environment	Sea walls and coastal protection structures (5.5.2 and 24.4.3.5; Figure 5-5); flood levees and culverts (26.3.3); water storage and pump storage (Section 23.3.4); sewage works (3.5.2.3); improved drainage (24.4.5.5); beach nourishment (5.4.2.1); flood and cyclone shelters (11.7); building codes (Section 8.1.5); storm and waste water management (8.2.4.1); transport and road infrastructure adaptation (8.3.3.6); floating houses (8.3.3.4); adjusting power plants and electricity grids (10.2.2; Table 10-2)
	Technological	New crop and animal varieties (7.5.1.1.1, 7.5.1.1.3, 7.5.1.3; Box 9-3; Table 9-7); genetic techniques (27.3.4.2); traditional technologies and methods (7.5.2, 27.3.4.2, 28.2.6.1, and 29.6.2.1); efficient irrigation (10.3.6 and 22.4.5.7; Box 20-4); water saving technologies (24.4.1.5 and 26.3.3) including rainwater harvesting (8.3.3.4); conservation agriculture (9.4.3.1 and 22.4.5.7); food storage and preservation facilities (22.4.5.7); hazard mapping and monitoring technology (15.3.2.3 and 28.4.1); early warning systems (7.5.1.1, 8.1.4.2, 8.3.3.3, 11.7.3, 15.4.3.2, 18.6.4, 22.2.2.1, 22.3.5.3, and 22.4.5.2); building insulation (8.3.3.3); mechanical and passive cooling (8.3.3.3); renewable energy technologies (29.7.2); second-generation biofuels (27.3.6.2)
	Ecosystem-based[a]	Cross Chapter Box CC-EA, Ecological restoration (5.5.2, 5.5.7, 9.4.3.3, and 27.3.2.2; Box 15-1) including wetland and floodplain conservation and restoration; increasing biological diversity (26.4.3); afforestation and reforestation (Box 22-2); conservation and replanting mangrove forest (15.3.4 and 29.7.2); bushfire reduction and prescribed fire (Section 24.4.2.5; Box 26-2); green infrastructure (e.g., shade trees, green roofs) (8.2.4.5, 8.3.3, 11.7.4, and 23.7.4); controlling overfishing (28.2.5.1 and 30.6.1); fisheries co-management (9.4.3.4 and 27.3.3.1); assisted migration or managed translocation (4.4.2.4, 24.4.2.5, 24.4.3.5, and 25.6.2.3); ecological corridors (4.4.2.4); ex situ conservation and seed banks (4.4.2.5); community-based natural resource management (CBNRM) (22.4.5.6); adaptive land use management (Section 23.6.2)
	Services	Social safety nets and social protection (Box 13-2; 8.3, 17.5.1, and 22.4.5.2); food banks and distribution of food surplus (29.6.2.1); municipal services including water and sanitation (3.5.2.3 and 8.3.3.4); vaccination programs (11.7.1), essential public health services (11.7.2) including reproductive health services (11.9.2) and enhanced emergency medical services (8.3.3.8); international trade (9.3, 9.4, and 23.9.2)
Social	Educational	Awareness raising and integrating into education (11.7, 15.2, and 22.4.5.5); gender equity in education (Box 9-2); extension services (9.4.4); sharing local and traditional knowledge (12.3.4 and 28.4.1) including integrating into adaptation planning (29.6.2.1); participatory action research and social learning (22.4.5.3); community surveys (Section 8.4.2.2); knowledge-sharing and learning platforms (8.3.2.2, 8.4.2.4, 15.2.4.2, and 22.4.5.4); international conferences and research networks (8.4.2.5); communication through media (22.4.5.5)
	Informational	Hazard and vulnerability mapping (11.7.2, 8.4.1.5); early warning and response systems (15.4.2.3 and 22.4.5.2) including health early warning systems (11.7.3, 23.5.1, 24.4.6.5, and 26.6.3); systematic monitoring and remote sensing (15.4.2.1 and 28.6); climate services (2.3.3) including improved forecasts (27.3.4.2); downscaling climate scenarios (8.4.1.5); longitudinal data sets (26.6.2); integrating indigenous climate observations (22.4.5.4, 25.8.2.1, and 28.2.6.1); community-based adaptation plans (5.5.1.4 and 24.4.6.5) including community-driven slum upgrading (8.3.2.2) and participatory scenario development (22.4.4.5)
	Behavioral	Accommodation (5.5.2); household preparation and evacuation planning (23.7.3); retreat (5.5.2) and migration (29.6.2.4), which has its own implications for human health (11.7.4) and human security (12.4.2); soil and water conservation (23.6.2 and 27.3.4.2); livelihood diversification (7.5.1.1, 7.5.2, and 22.4.5.2); changing livestock and aquaculture practices (7.5.1.1); crop-switching (22.3.4.1); changing cropping practices, patterns, and planting dates (7.5.1.1.1, 23.4.1, 26.5.4, and 27.3.4.2; Table 24-2); silvicultural options (25.7.1.2); reliance on social networks (Section 29.6.2.2)
Institutional	Economic	Financial incentives including taxes and subsidies (Box 8-4; 8.4.3 and 17.5.6); insurance (8.4.2.3, 13.3.2.2, 15.2.4.6, 17.5.1, 26.7.4.3, and 29.6.2.2; Box 25-7) including index-based weather insurance schemes (9.4.2 and 22.4.5.2); catastrophe bonds (8.4.2.3 and 10.7.5.1); revolving funds (8.4.3.1); payments for ecosystem services (9.4.3.3 and 27.6.2; Table 27-7); water tariffs (8.3.3.4.1 and 17.5.3); savings groups (8.4.2.3 and 11.7.4; Box 9-4); microfinance (Box 8-3; 22.4.5.2); disaster contingency funds (22.4.5.2 and 26.7.4.3); cash transfers (Box 13-2)
	Laws and regulations	Land zoning laws (22.4.4.2 and 23.7.4); building standards (8.3.2.2, 10.7.5, and 22.4.5.7); easements (27.3.3.2); water regulations and agreements (26.3.4 and 27.3.1.2); laws to support disaster risk reduction (8.3.2.2); laws to encourage insurance purchasing (10.7.6.2); defining property rights and land tenure security (22.4.6 and 24.4.6.5); protected areas (4.4.2.2); marine protected areas (Box CC-CR Chapter 6; 23.6.5 and 27.3.3.2); fishing quotas (23.9.2); patent pools and technology transfer (15.4.3 and 17.5.5)
	Government policies and programs	National and regional adaptation plans (15.2 and 22.4.4.2; Box 23-3) including mainstreaming climate change; sub-national and local adaptation plans (15.2.1.3 and 22.4.4.4; Box 23-3); urban upgrading programs (8.3.2.2); municipal water management programs (8.3.3.4; Box 25-2); disaster planning and preparedness (11.7); city-level plans (8.3.3.3 and 27.3.5.2; Boxes 26-3 and 27-1), district-level plans (26.3.3), sector plans (26.5.4), which may include integrated water resource management (3.6.1 and 23.7.2), landscape and watershed management (4.4.2.3), integrated coastal zone management (2.4.3, 5.5.4.1, and 23.7.1), adaptive management (2.2.1.3 and 5.5.1.4; Box 5-2), ecosystem-based management (6.4.2.1), sustainable forest management (2.3.4), fisheries management (7.5.1.1.3 and 30.6.2.1), and community-based adaptation (5.5.4.1, 8.4, 15.2.2, 21.3.2, 22.4.4.5, 24.5.2, 29.6.2.2, and 29.6.2.3; Tables 5-4 and 8-4; FAQ 15.1)

Institutional framework for South Africa's climate change adaptation

South Africa is an Annex I *Party* to the UNFCCC and a signatory of other major international agreements on climate change including the Kyoto Protocol, Copenhagen Accord and Cancun Agreements (UNFCCC 2014). These agreements bind the South African government to commit to working with other *Parties* to limit average global temperature increases and address the impacts of climate change. Consequently, South Africa has included adaptation as an important element in its institutional framework on climate change because it recognizes the needs for addressing climate change impacts. In fact, the National Development Plan 2030 incorporates climate change as a major challenge to the country's development goals (National Planning Commission of South Africa 2012).

In recognition of the importance of climate change adaptation, the South African government participated in the Climate Support Programme (CSP) to develop and implement an institutional framework for climate change adaptation (GIZ 2015). The CSP (2009 to 2016) is part of the International Climate Initiative (ICI) and is funded by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The lead executing agency is the Department of Environmental Affairs (DEA).

These efforts have resulted in the following documents that support South Africa's development of an institutional framework for climate change adaptation.

- The National Climate Change Response Policy (NCCRP) was a White Paper gazetted in 2011. It frames the objectives, responsibilities and approach for climate change adaption in the country.
- The Let's Respond Toolkit was published in 2012. It is a guideline for municipalities to address climate change adaptation and mitigation as part of the constitutional and legislative obligations of local government;
- The Long Term Adaptation Scenarios (LTAS) research reports were published in 2014. They document the projected impacts of climate change on South Africa's major sectors as based on extensive scientific research and modelling. The LTAS assessments are used as a basis for framing and strategizing climate change adaptation in South Africa.
- A National Climate Change Adaptation Strategy (NCCAS) and Provincial Climate Change Adaptation Strategies (PCCAS) are currently being developed and finalised. Three pilot provinces have been selected to implement their CCAS in early 2016. (More details to follow at the end of this section.)

The NCCRP[4] is a central document that describes the South African government's responsibilities to address climate change. It is framed by a vision to transition the country to a lower carbon economy and climate resilient society.

The vision is to be materialized through two objectives:

i. To manage inevitable climate change impacts
ii. To contribute to the global effort to stabilise GHG concentrations in the atmosphere.

[4] *Available at http://www.gov.za/documents/national-climate-change-response-white-paper Accessed on 9 December 2015.*

These objectives will be achieved through a strategic approach that will be:

i. Developmental
ii. Transformational and participatory
iii. Needs driven and customized
iv. Dynamic and evidence based
v. Supportive of informed decision-making
vi. Balanced approach to both climate change mitigation and adaptation responses in terms of cost-effectiveness
vii. Supportive of sectorial integration and alignment.

Even though cross-sectorial collaboration and participation from local government were emphasized in the NCCRP, the policy has not yet been integrated vertically and laterally into the full institutional structure and practices of government (Ziervogel *et al*. 2014).

According to a recent study, institutional barriers to South Africa's implementation of an integrated climate change adaptation include:

- Limited capacity for the necessary personnel resources and expertise;
- High turnover of staff within government departments;
- Limited understanding of and expertise in tackling climate-related issues;
- The positioning of climate change as an environmental issue rather than as a development issue;
- Conservative financial management practices; and
- Poor communication and coordination between departments and between different levels of government, especially from national and provincial to the local level (Ziervogel *et al*. 2014).

To address the challenge of effective integration of climate change adaptation into the South African institutional framework, a recent review examined the extent to which climate change adaptation has been integrated into existing sectoral policy instruments (GIZ 2013). This review was intended to inform various technical task teams that are trying to mainstream and align climate change adaptation in South Africa's policy instruments. The review included the following sectors: water, health, biodiversity, human settlements, and disaster management. For this report, the results of the review were summarised according to the degree to which the policy instruments address the adaptation objectives of the NCCRP as well as what adaptation factors are addressed (

Table 2). A detailed listing of the aligned adaptation elements for each policy is included in *Appendix A*.

The review indicated notable gaps in existing South African policy to address climate change. Policies for the disaster management sector were relatively the best aligned with NCCRP. However, policies for agriculture, health and biodiversity were only moderately aligned, while policies for water and human settlement were poorly aligned with the NCCRP.

After the review by GIZ, additional policies have been developed for the biodiversity sector to explicitly address climate change adaptation, particularly ecosystem-based adaptation (EbA), and therefore could be highly aligned with the NCCRP. Namely, these are Biodiversity Sector Climate Change Response Strategy and Climate Change Adaptation Plans for South African Biomes. However, these plans are still being finalised and are not yet available in the public sphere. Consequently, they were not reviewed in depth for this report.
The lack of alignment between the NCCRP and South African water policy is of particular concern. Only one out of the 10 policy instruments (i.e. National Water Resource Strategy 2012) aligned with the NCCRP. The remaining nine policy instruments either indirectly aligned or did not align at all with the NCCRP. Similarly, The Department of Water Affairs and Sanitation (DWS) conducted a National Water Policy Review at the end of 2013 (DWS 2013). The review identified the need to consider the impact of climate change on water resources as well as legal and policy instruments to address any existing or future vulnerability due to climate change. Critically, as stated by the GIZ review, the National Water Act 36 of 1998 — which has already been affected by a slow implementation process — does not meaningfully address climate change. The National Water Act may provide flexibility to develop regulations that could contribute to climate change adaptation. However, the Act needs to be reviewed to explicitly integrate measures for climate change resilience. The Drought Management Plan also did not address climate change adaptation. However, according to the GIZ review, this is of less concern because this instrument will likely be replaced by the water sector disaster management plan within the National Disaster Management Framework[5]. Overall, the policy instruments of the water sector fail to address disaster management from a preventive and reduction approach. This is of critical concern because South Africa is prone to prolonged periods of drought and consequently water security is a major climate risk (DEA 2013). South African water policy is in need of an extensive review and amendment to better align with the NCCRP.

These gaps in water policy implicate the agricultural sector because of the interconnectedness between water and food production. Although policies for the agricultural sector were moderately aligned with the NCCRP, their effectiveness could be hampered because of the lack of clear climate change adaptation measures in the water sector. Furthermore, the Integrated Food Security Strategy for South Africa is not aligned with the NCCRP. This is of concern, because without meaningful mitigation and adaptation measures, it is projected that South Africa's current vulnerability to food insecurity will increase by 26% in the 2050s and 37% in the 2080s (WFP 2015).

Policy instruments for human settlements were also poorly aligned with the NCCRP. Consequently, they fail to address disaster management from a preventive and reduction approach. Therefore, the

5 The National Disaster Management Framework was included in the review, but only in the disaster management sector and not the water sector. The National Disaster Management Framework does address climate change adaptation according to the review, however to what degree it directly includes the water sector is not clear.

impacts of disaster management policies (although well aligned with the NCCRP) are not far-reaching enough to be considered as risk reduction with regards to climate change.

To conclude, there are notable non-alignments between sectoral policies and the NCCRP as well as omissions of climate change adaptation in important legislation in South Africa. Furthermore, many of the policy instruments address climate change mitigation but have not meaningfully incorporated adaptation, or lack direct references to climate change adaptation. These limitations ultimately would hinder South Africa's institutional capacity to implement climate change adaptation options.

TABLE 2: LIST OF POLICY INSTRUMENTS REVIEWED THAT DO, DO NOT, INDIRECTLY OR WEAKLY ADDRESS ADAPTATION OBJECTIVES OF THE NCCRP.

	POLICY INSTRUMENT	ALIGNMENT WITH THE NCCRP?
WATER SECTOR	National Water Resource Strategy ("NWRS2") (2012; DWA)	Yes
	Groundwater Strategy ("GWS")(2010; DWA)	Indirectly
	Water for Growth and Development in South Africa ("WFGD") (2008; DWA)	Indirectly
	Irrigation Strategy for South Africa. (2010; DAFF)	[Requires copies from DAFF]
	The New Growth Path Framework ("NGP") (2nd ed), (2011; DED)	Indirectly
	National Development Plan 2030 ("NDP 2030") (2011; NPC)	Indirectly
	Integrated Resource Plan 2010-2030 ("IRP") (2011; DOE)	No
	South African National Infrastructural Plan ("Infrastructural Plan") (2012; PICC)	Indirectly
	Drought Management Plan (2005; DAFF)	No
	National Water Act 36 of 1998 (NWA) and regulations in terms thereof	No
DISASTER MANAGEMENT	National Disaster Management Framework of 2005 ("Disaster Framework")	Yes
	Disaster Management Act 57 of 2002 ("DMA")	Yes
	Agricultural Disaster Risk Management Plan ("ADRMP")	Yes
	Drought Management Plan (2005; DAFF)	Yes, but address drought from agriculture perspective and omits other critical secotrs e.g. water
AGRICULTURE, FORESTRY AND FISHERIES	National Development Plan Vision for 2030 ("NDP") (specifically chapter 6 – "An Integrated and Inclusive Rural Economy" and to some extent, chapter 5 - "Ensuring Environmental Sustainability and an Equitable Transition into a Low-Carbon Economy")	Yes
	Agriculture Forestry and Fisheries, Integrated Growth and Development Plan ("IGDP") (2012; DAFF) (replaces the Strategic Plan for South African Agriculture, named in the NCCRP.)	Yes
	Draft Climate Change Sector Plan (DAFF, 2013)	Yes
	Strategic Plan for the Department of Agriculture, Forestry and Fisheries 2011/12- 1014/15 (2011; DAFF).	Weakly
	Integrated Food Security Strategy for South Africa (2002) ("IFSS")	No

HEALTH	National Department Of Health ("DOH") Strategic Plan 2010/11-2012/13 ("NDHSP")	Indirectly
	National Development Plan("NDP") 2030 (2011; NPC)	No
	NEM: Air Quality Act 39 of 2004 ("NEMAQA") and the South African Air Quality Information System.	Yes
	National Ambient Air Quality Standards (GNR 1210 of 24 December 2009) (which includes the regulation of Particulate Matter (PM10))	Yes
	National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Micron Meters (PM2.5), GNR 486 of 29 June 2012 ("GNR 486")	Yes
	Draft National Dust Control Regulations published in Government Notice 1007 of 7 December 2012	Yes
HUMAN SETTLEMENTS	National Development Plan: Vision 2030, (NDP)	Indirectly
	The National Housing Code 2009, Department of Housing (including Breaking New Ground" A comprehensive Plan for the Development of Sustainable Human Settlements (2004; DoH)	Yes
	National Norms and Standards for the Construction of Stand Alone Residential Dwellings	Very weakly
	National Building Regulations and Building Standards Act 1997 and Regulations thereunder in terms of GNR.2378 of 12 October 1990.	Very weakly
	Spatial Planning and Land Use Management Bill 2012.	Very weakly
	Comprehensive Rural Development Programme ("CRDP") (2009 ; Department of Rural Development and Land Reform)	Indirectly, not comprehensively
	Global Change Grand Challenge: National Research Plan (June 2009; DST)	(Could inform/ contribute to)
	National Environmental Management Act 107 of 1998: Environmental Management Frameworks ("EMF")	No
	National Environmental Management: Integrated Coastal Management Act 24 of 2008 ("NEMICMA")	No
BIODIVERSITY	National Framework for Sustainable Development in South Africa, 2008 ("NSDF"") and the National Strategy for Sustainable Development and Action Plan ("NSSD1")	Yes
	National Biodiversity Strategy Action Plan ("NBSAP")	Weakly
	DEA (2005) and the National Biodiversity Assessment 2011 ("NBA 2011") (SANBI)	Weakly

Let's respond toolkit

The South African Local Government Association (SALGA) has collaborated with the GIZ to roll out the *Let's Respond Toolkit* in district (DM), metropolitan (MM) and local municipalities (LM). They first piloted the Toolkit in five municipalities: Amathole DM, Johannesburg MM, Nxuba LM, Emfuleni LM and Thulamela LM. SALGA learned that a lot of capacity development and technical support were needed to help these pilot municipalities to utilize the Toolkit to integrate climate change into their Integrated Development Plans (IDPs). Additionally, there were municipalities that succeed in developing IDPs with climate change integration, but could not implement the adaptations. SALGA recognized that there were greater challenges than getting a municipality to develop a climate change integrated IDP for a municipality to be able to implement adaptation. Presently, SALGA is conducting workshops to introduce non-pilot municipalities to the Toolkit. We have attended one such workshop for the Nkangala and Gert Sibande DMs.

Provincial climate change adaptation strategy

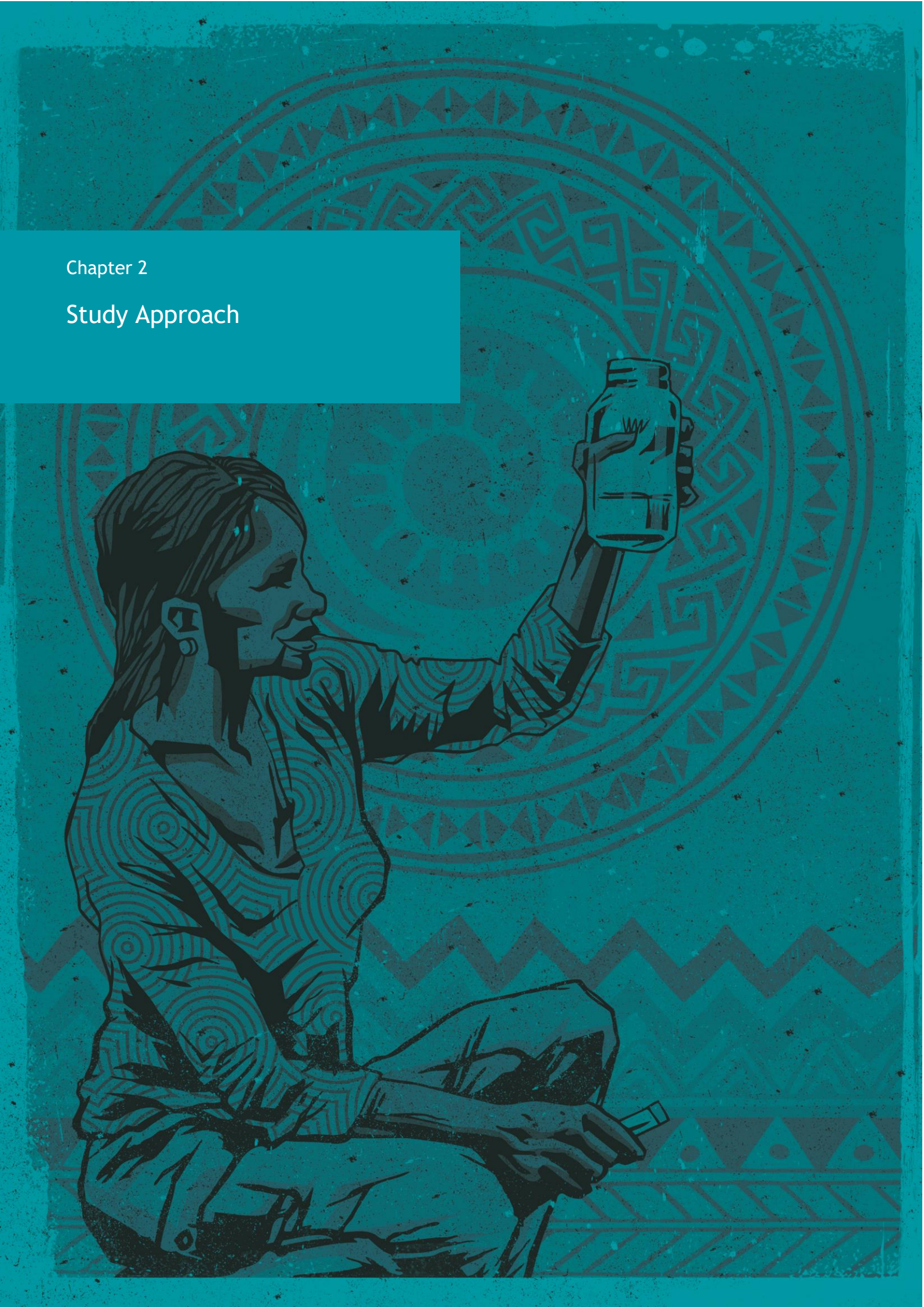
The PCCAS Project aims to develop and implement climate change strategies at the provincial level for South Africa. Initially, only three provinces have been selected for piloting the development and implementation of PCCASs. These provinces were selected because of their high vulnerability to climate change. These provinces are: Mpumalanga, Limpopo and North West. The ultimate outcome is to produce a CCAS for each of the selected provinces and then transfer lessons learned to other provinces to develop their own PCCAS. An important factor in this process is to contextualise each PCCAS to the specific context and adaptation needs of each province.

Purpose of this study

The purpose of this study is multi-fold. Firstly, we want to understand how different countries across the world, with particular attention on South Africa, frame its climate change adaptation on a global platform such as the UNFCCC. Secondly, we want to understand how climate change risks and adaptation have been framed at a provincial and local level within the boundary of the Olifants Catchment. Thirdly, we want to use this understanding to frame resilience plans for the Olifants Catchment. Fourthly, we want to draw ideas and lessons learned, and identify opportunities for collaboration from existing adaptation projects in the Olifants Catchment. Ultimately this study is to contribute to one of the seven main objectives of the RESILIM-O: to reduce vulnerability to climate change and other factors by supporting collective action, informed adaptation strategies and practices and tenable Institutional arrangements.

Chapter 2

Study Approach



Data sources

NAPAs & NC

For the analysis of the NAPAs and NCs, we downloaded the final reports catalogued in the UNFCCC database[6]. There were 50 countries that have submitted their NAPAs to date. We downloaded only those written in English, which totalled to 35. It should be noted that South Africa did not submit a NAPA because it is not classified as a LDC per the UNFCCC. There were 153 non-Annex I *Parties* listed in the database.

However, we only downloaded 109 NCs for analysis because of the following reasons.

- The NCs were in other languages, and an English-version was not available
- No NC was submitted even though these countries were listed in the database
- There were NCs listed in the database, but the links for the NCs were not working.

Provincial CCAS project

For the purpose of this report, we engaged only with the two pilot provinces that fall within the Olifants Catchment, namely, Limpopo and Mpumalanga. We were invited to participate in the stakeholder inputs for vulnerability assessment and review of the recommended adaptations in the draft PCCASs.

Through the process, we engaged with the agencies responsible for the implementation of the PCCASs:

- National DEA, who oversees the whole CCAS project
- Mpumalanga Department of Agriculture and Rural Development and Land Administration (DARDLA), who oversees Mpumalanga's CCAS development and implementation
- Limpopo Department of Economic Development, Environment and Tourism (LEDET), who oversees Limpopo's CCAS development and implementation.

Representatives from AWARD attended and participated in the workshops arranged by the implementing agencies. The first series of workshops were for vulnerability assessments and started in early 2015. The second series of workshops were for a review of the vulnerability assessment results and initial inputs on the adaptation strategies suggested by the implementing agencies. These workshops took place in mid 2015. The last series of workshops were second round of discussions aiming at a sectoral review of the proposed adaptation strategies for the respective province. These workshops took place at the end of 2015, and some are expected to continue in 2016 because of poor attendance. We collected information on the vulnerability assessment and recommended adaptations from these workshops and subsequent correspondences with the implementing agencies.

[6] The database is available online at http://unfccc.int/national_reports/items/1408.php.

Existing adaptation projects in the Olifants catchment

A desktop review was conducted in October and November 2015 to search for recent, active or planned climate change adaptation projects/programmes in the Olifants Catchment that could possibly align with or compliment RESILIM-O activities. This search included reviewing websites of relevant multi-lateral funding sources, international networks, NGOs, NPOs, civic societies, South African government departments (national and provincial), research institutions, and major businesses operating in the Olifants Catchment. In addition, major search engines were also used. Key search words included: “Olifants River Catchment”, “climate change”, “adaptation”, “projects”, “programmes”, “Limpopo”, “Mpumalanga” and “South Africa”.

Projects were only selected and listed if the aims, objectives and activities: i) explicitly address climate change adaptation; or ii) notably overlap or align with the aims, objectives and activities of RESILIM-O. Furthermore, active and planned projects were also chosen if there is potential for partnership with RESILIM-O. Past projects were selected if they ended in the last 3 years and provide lessons learned that could inform the activities of RESILIM-O. Preferably, projects’ sites should be in or include the Olifants Catchment. However, projects that operate within close proximity to the Catchment were also considered if their aims, objectives and activities extensively overlap or align with that of RESILIM-O.

Analytic framework

NAPAs & NCs

From each NAPA and NC, we extracted what each country proposed as its adaptation options. We categorized each adaptation option into one of the follow 14 sectors:

- Agriculture
- Biodiversity
- Cross-sectoral
- Coastal zones
- Disaster management
- Energy
- Fisheries
- Forestry
- Health
- Infrastructure
- Tourism
- Transportation
- Waste management
- Water resources

We then classified each of the adaptation option into one of the three categories as defined by the IPCC: structural/physical, social and institutional. Refer to *Chapter 1* how these categories were defined and example adaptation for each category. We developed rules for what adaptation options belong in each of the three categories based on the IPCC definition and characteristics of the examples provided in *Table 1*. For options that were not adaptation per the IPCC definition were labelled as "non-adaptation" and excluded from analysis. Once categorized, we counted the number of adaptation options under each sector and category as a way to analyse the frequency. We also examined the types of adaptations that were proposed frequently for the few sectors with the most adaptation under each category to determine whether there is any pattern in the nature of these adaptations.

Provincial CCASs

We engaged with and reviewed the Provincial CCAS process in Mpumalanga and Limpopo by reviewing produced documents (including provincial vulnerability assessments and draft PCCASs) and participating in the stakeholder consultation workshops.

The results of the Limpopo vulnerability assessment were summarised in a table. The assessment stated whether a sector's sensitivity, exposure, adaptive capacity (short-term and long-term) or overall vulnerability (short-term and long-term) to the impacts of climate change had a high, medium or low rating. If the report did not explicitly describe the rating of any of these aspects, then we interpreted the text qualitatively and assigned a rating.

To contextualise these ratings, we also reported on the following from the assessment:

- Most important factors regarding the increased risk to a sector induced by climate change
- Existing factors that contribute to the adaptive capacity of a sector (e.g. implemented sector plans that meaningfully incorporate climate change)
- Factors that are limiting adaptive capacity (e.g. the lack of sector plans that consider climate change).

For the PCCASs, we reviewed the draft documents and the feedback from stakeholders captured during the consultation workshops. We summarised the original adaptations recommended for the PCCASs in a table alongside the changes that stakeholders made to these recommendations (e.g. adding, rewording or removing recommendations). Furthermore, we also consolidated and reported back on comments and themes emphasised by stakeholders during the workshops. These comments included what kind of actions or activities stakeholders would want to be included under each recommendation, additional information that should be included in the final PCCASs, and feedback on the overall consultation and implementation process.

Adaptation projects in the Olifants catchment

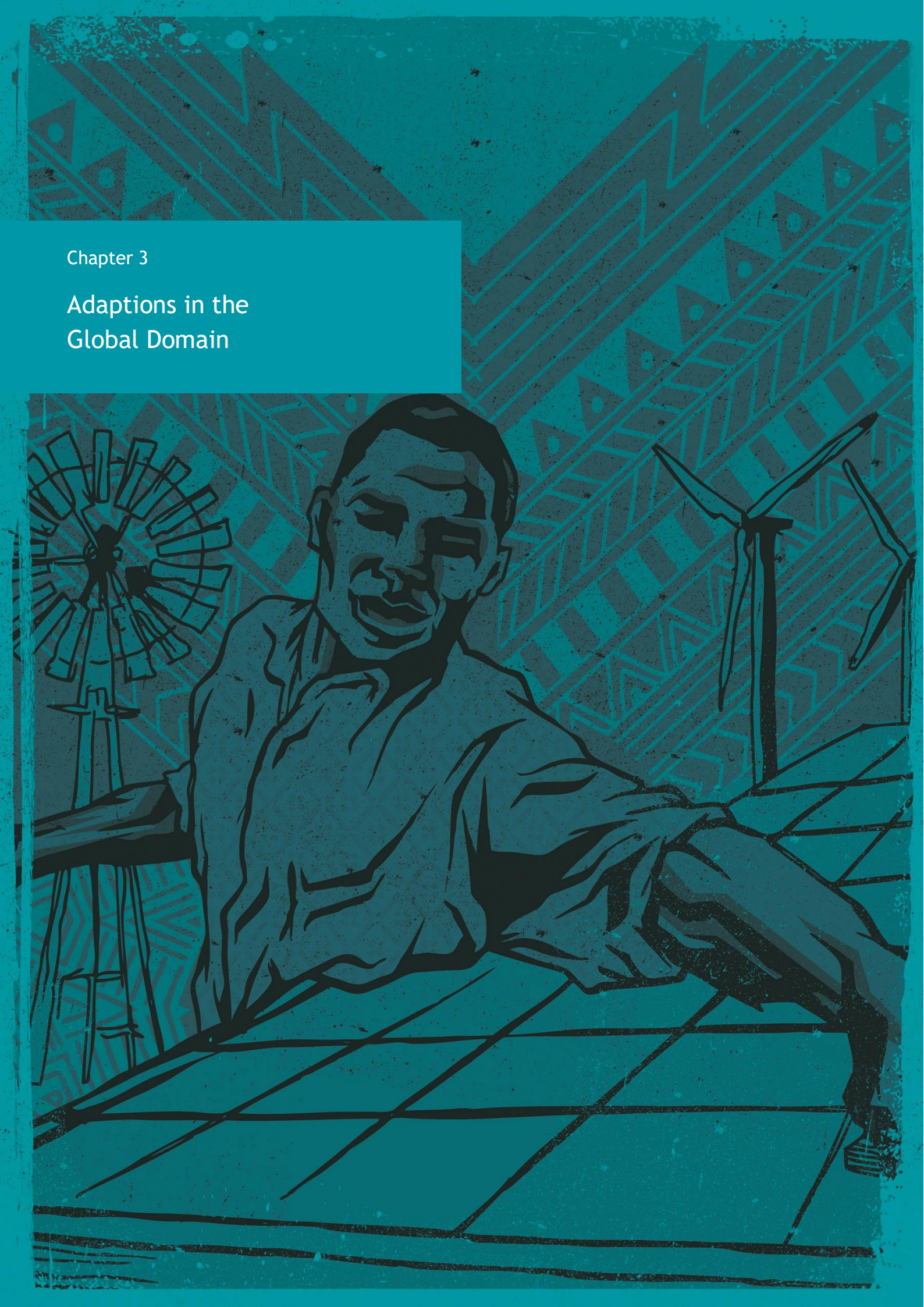
From the desktop review, 10 projects were identified as having potential for partnerships because they are particularly relevant to RESILIM-O and could be potential collaborators or could provide important lessons learned.

Each project was analysed according to its:

- Aim/objective that is relevant to RESILIM-O
- Project site
- Main funding agency
- Main implementing agencies
- Scale, in terms of being international, regional, national or localized
- The specific sector involved
- Adaptation characterizations
- Prioritisation for collaboration with RESILIM-O
- Kind of collaboration opportunity that may exist.

Chapter 3

Adaptions in the Global Domain



NAPAs

The adaptation options for climate change listed in the NAPAs covered 13 sectors, spanning from agriculture to water resources. For a full list of the sectors, refer to the legend in *Figure 3*. Among these sectors, agriculture, water resources, coastal zones, disaster management and biodiversity had the highest number of adaptation options and accounted for 72% of all adaptation listed. The three sectors with the lowest number of adaptation options were waste management, tourism and fisheries. These sectors accounted for only 2% of total adaptation options included in the NAPAs.

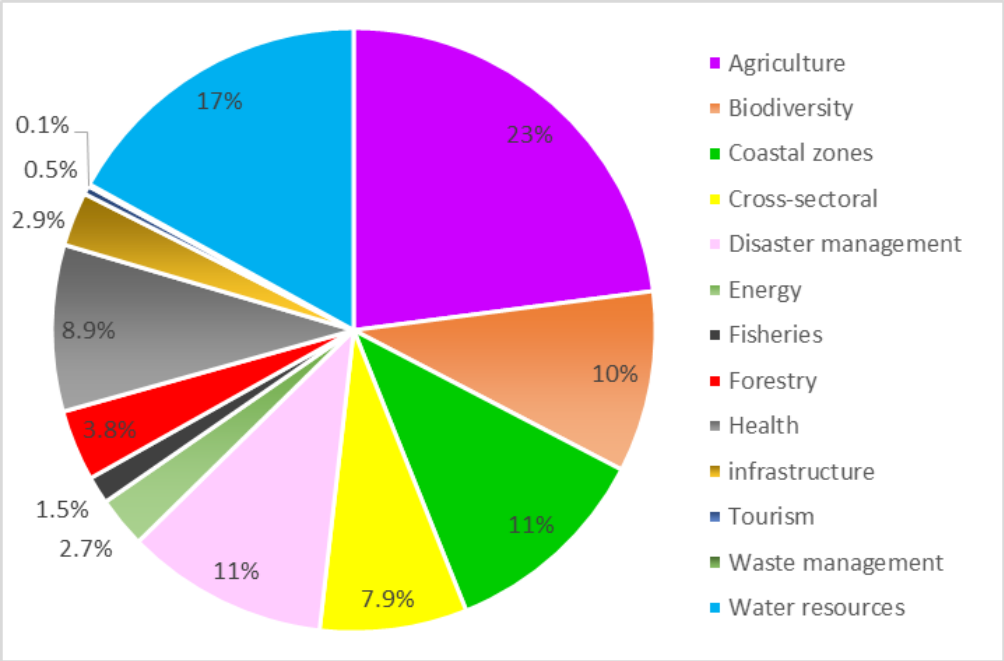


Figure 2: Distribution of adaptation options in the NAPAs by sector

Some of the options listed as adaptation for water resources in the NAPAs could have also been classified as agricultural adaptation. For examples, efficient irrigation system, water harvesting, protection of water bodies, improved management of water supply systems, and rehabilitation of wetlands, catchments and other water bodies cut across the water and agricultural sectors. Similarly, monitoring of water quality, and protecting and maintaining the infrastructure for potable and waste water were listed as adaptation options for the health sector in some NAPAs, but they could have been classified as adaptation for water resources. Unless a NAPA specified the sector for these adaptation options, which was usually the case, we classified these options under the water sector. Additionally, there were adaptation options that concern multiple sectors, and we classified these under cross-sectoral.

When examining the adaptation options by their characteristic categories, 51% of the options were social in nature, while structural/physical and institutional options accounted for 39% and 10%, respectively. Among the options listed in NAPAs, a small percentage (6%) either did not qualify as adaptation based on the definition that we outline in Chapter 1 or contained too little details in the NAPAs for us to determine whether they are adaptation. We categorized them as “non-adaptation”. There were also a few adaptation options that could fit into more than one category.

For examples, early warning systems and hazard mapping could be considered as technological interventions, which would be structural/physical, or as informational interventions, which would fall under the social category. Unless there were more details in the NAPAs to help us determine whether the options were referring to the technological or informational aspects, we classified options that involve installing or building software, hardware or physical structures as structural/physical adaptation. When a technological-informational intervention is more generic without specifying installation or construction of physical elements, we classified it as a social adaptation.

When we juxtaposed the three adaptation categories over the 13 sectors, social-type adaptation dominates in all but two sectors – energy and forestry *(Figure 3)*. However, there was only a small difference in the total number of options that fall under the social- vs. the structural- or physical-category for the agricultural, biodiversity, coastal zones and water resources. Institutional adaptation options were substantially fewer compared to the other two categories in all sectors.

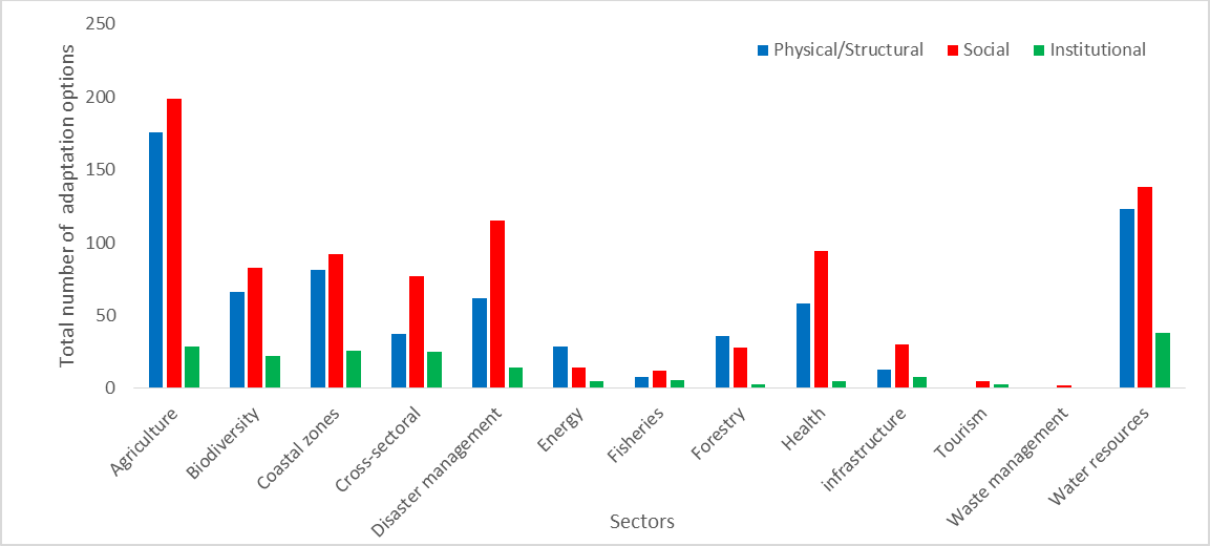


***Figure 3**: Distribution of adaptation options by sector and category in the NAPAs.*

Table 3 listed the common structural/physical, social and institutional adaptation options for the seven sectors that had the highest number of adaptation mentioned in the NAPAs. Under structural/Physical options, the majority of adaptation were related to engineering interventions, particularly for water resources and coastal zones (e.g. the maintenance and construction of infrastructure and protective structures such as sea walls, dams and dykes). To a lesser degree, the introduction or enhancement of technology was also important across sectors. These interventions were particularly relevant for the disaster management (e.g. upgrading or introducing monitoring and surveillance technology) and health sector (e.g. equipment for laboratories). Under social options, awareness raising and training were most common across sectors. Although, assessments, surveys and mapping exercises were also prominent for the biodiversity, coastal zones and water sectors. Under institutional options, the development and implementation of plans and policies to support adaptation were most prominent across all sectors. In addition, financial mechanisms and the establishment of committees/associations to promote implementation of adaptation were commonly mentioned for the agricultural sector, while financial mechanisms and the enforcement of regulations were commonly mentioned for the biodiversity sector.

TABLE 3: COMMON ADAPTATION OPTIONS FOR SEVEN SECTORS WITH THE HIGHEST NUMBER OF ADAPTATION IN THE NAPAS.

	Physical / Structural	Social	Institutional
Agriculture	Identification, development and experimentation of new crop and livestock varieties that are more resilient to climate change impacts and are economically beneficial. This included dissemination and encouraging the use of these new varieties**.	Introducing changes in agricultural practices. This included applying soil and water conservation techniques, crop diversification, changing crop rotation and planting, introducing aquaculture, running farming trials of new techniques, and establishing community associations to manage livestock grazing and health**.	Establishment of user and maintenance associations, including community based institutions, management boards and committees. Introducing financial mechanisms such as investment programmes, subsidies, microcredit schemes and overall making inputs more accessible to communities.
Water Resources	Construction and maintenance of infrastructure to support and control water supply as well as the physical protection of water resources. This included infrastructure for spillway channels, clean water conveyance systems, dredging, dikes, boreholes, pipes, groundwater recharge and protection against saline intrusion. The introduction of water use technology to support supply and protect water quality, including pumps, backup desalination systems, water recycling, and water purification.	Assessment, survey and/or mapping water vulnerability, resource use and condition (e.g. water use), groundwater resources, environmental impacts, flood-prone areas, and baseline conditions. Training relevant stakeholders in sustainable natural resource management, rainwater harvesting, maintenance of water infrastructure, water treatment, and mapping resources and vulnerability.	Review, development and implementation of plans and policies to manage watersheds, protect water infrastructure, manage droughts and water resource fluctuations. This included strengthening existing mandates of sectors and entities to refer to climate change and water management issues.
Coastal zones	Rehabilitate, reforest and/or restore ecosystems, including mangroves, wetlands, natural reefs, and foreshore green-belts. Design, evaluate, inspect, upgrade and/or construct protection coastal engineering infrastructure. This included seawalls, breakwaters, culverts, drains, revetments, floodgates, jetties, and dykes.	Mapping, surveying of land use practices, topography, bathymetrical features, vulnerability, degradation (e.g. erosion), hazards (e.g. the delineation of flood zones), risks of climate change impacts, and other environmental/socio-ecological aspects.	Enforcement and introduction of regulations, including the integration of climate change impacts in Environmental Impact Assessments (EIAs) as well as by-laws to support adaptation. Establish committees to support adaptation options. Revise, update and integrate policies, plans and strategies for managing climate change adaptation.

	Physical / Structural	Social	Institutional
Disaster Management	Establish, restore, rehabilitate and/or survey a network for automatic weather stations as well as national climate centres. Establish and/or enhance technology for data assimilation, processing and communication. This included hardware and software to support weather models, geographic information systems and early warning systems.	Train and skill development related to disaster preparedness, relief coordination, emergency assistance, rescue operations, data capture/processing, meteorological hydrological assessment, and overall disaster risk reduction. This was for the capacity development of technicians, farmers, extension workers, teachers and other professionals and community members.	Development and implementation of polices and plans to support integrated risk reduction and disaster preparedness. This included national disaster management strategies, national emergency medical service strategies, and including climate change impacts in national development plans.
Biodiversity	Rehabilitation, reforestation, restoration of ecosystems to address climate risk. This included national and pilot projects.	Assessment of baseline situation, adaptation needs, potential conservation areas, and the impact and cost-effectiveness of interventions. This included the mapping and surveying of degradation, protected areas and vulnerability.	Introduction of regulations to monitor and manage practices and resource use. This included certification and defining rules. Revise and update plans and policies for integrated planning of natural resource management at different levels of government as well as creating a platform for policy dialogue. Introduce financial mechanisms such as revolving funds, insurance schemes, microcredit, investment programmes and market-based incentives to support adaptation.
Cross-sectoral	Pilot, construct, upgrade, evaluate and/or promote infrastructure to support water supply, including rainwater harvesting, reservoirs, tanks and dams. (These could be adaptation for water resources, agriculture or disaster management. There was no clear indication in the NAPAs for the specific sector.)	Awareness raising and dissemination of information related to climate change, water conservation, and agricultural practices. This included radio programmes, television programmes, posters, education modules, knowledge centres, and public lectures and meetings. Train and skills development on climate change and water harvesting for extension workers, vets, technical staff in the health sector, government staff, NGO staff, teachers, artists, and the media.	Development and implementation of policy and plans for national bush fire management, disaster response, sustainable development, water use efficiency, health, food security. Furthermore, the development of climate change legislation aligning with international protocols.

	Physical / Structural	Social	Institutional
Health	Improve the preparation of healthcare services for extreme events. This included constructing and equipping facilities, initiating mosquito habitat clearance campaigns, setting up mobile ophthalmic surgery units and expanding medical team. Providing equipment, materials and technology for medical services. This included reviewing drug supplies, introducing improved ventilated pits, installing GIS, refurbishing laboratories, and distributing antimalarial nets, bio-pesticides and insecticides.	Awareness raising and public health education on "population strategies" (referring to family planning), malaria, HIV/AIDS, anti-stigmatisation programmes and nutrition. Providing training linked to climate change and disease incidence, biological pesticide production, health care management, maintenance of infrastructure, malaria surveillance, database management.	Develop and implement plans that integrate climate change into public health programmes for e.g. vector outbreak control.

*** Refers to the discussion below on the difficulty with categorizing certain adaptation options.*

It should be noted that some of the classification of adaptation options in the NAPAs and NCs into these three categories (i.e. structural/physical, social and institutional) were not definitive nor straightforward. Although some options can be clearly typified (e.g. the construction of sea walls as physical options), other options are more difficult to fit into one category. This occurs for two reasons: one has to do with the blurry boundary between the three categories and the other has to do with the ambivalent nature of some adaptation options. For example, community-based management can be classified as structural/physical (if related to community-based natural resource management as an EbA), social (if related to community-based adaptation plans as a change in practices) or institutional (if related to community-based institutional arrangement). To address this challenge, we developed and applied rules for classifying the adaptation options. However, we acknowledge that with different classification rules, certain adaptation options could be categorized differently. We also recognized that there are a lot of nuances involved in the classification of adaptation into any categorization scheme. Consequently, the results of this analysis should be considered in light of these nuances and challenges.

NCs

The adaptation options for climate change listed in the NCs of Annex I *Parties* covered 14 sectors (see legend in *Figure 5*). Among these sectors, agriculture, water resources, coastal zones and health had the highest number of adaptation options and accounted for 70% of all adaptation listed. The four sectors that accounted for less than 2% of adaptation options each were disaster management, tourism, transportation and waste management.

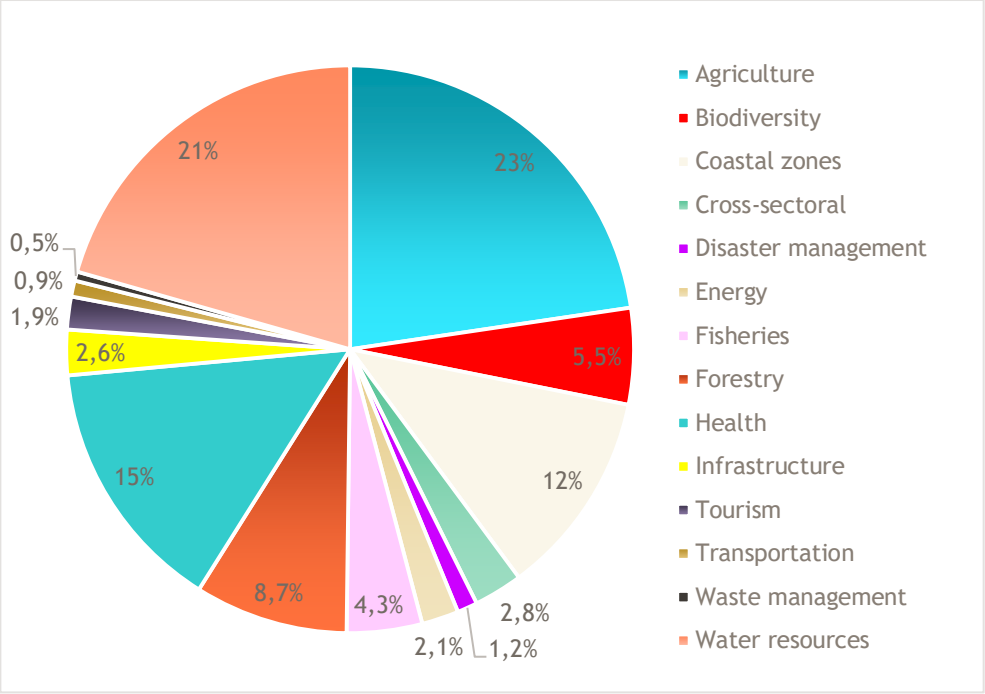


***Figure 4**: Distribution of adaptation options by sectors as proposed in the NCs of Annex I Parties.*

Five percent of all options listed in the NCs were classified as non-adaptation. Among those that qualified as adaptation, 48% were structural/physical options, while social and institutional adaptation accounted for 36% and 16%, respectively. This distribution was slightly different from that of the NAPAs, where social adaptation was most common. In both NAPAs and NCs, institutional-type options were least common. Perhaps, this type of adaptation is much harder to implement and requires a longer time-frame. It is also institutional-type of option that is more commonly associated with transformational adaptation.

For the water resources, coastal zones, forestry, biodiversity, energy and infrastructure sectors, countries listed substantially more structural- or physical-type of options than the other two categories of options *(Figure 6*). However, more social interventions were suggested for the agricultural, cross-sectoral, health and tourism sectors. There were relatively more variations in the distribution of the three categories of adaptation across the different sectors in the NCs than in the NAPAs.

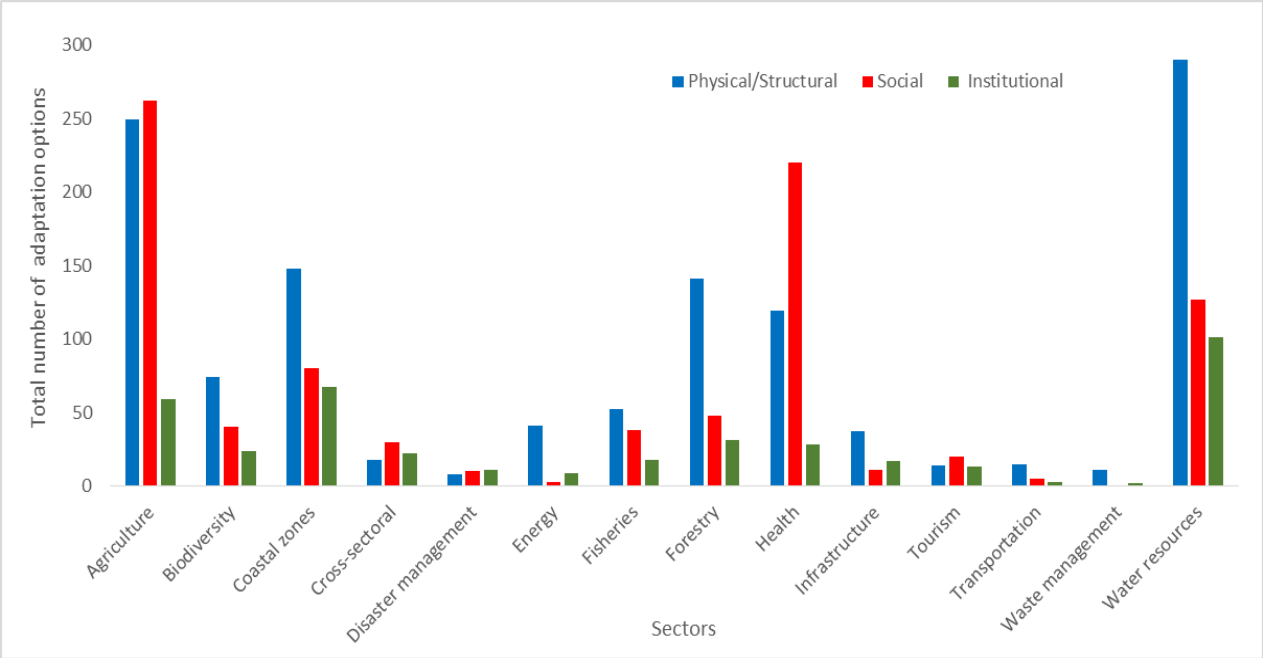


Figure 5: Distribution of adaptation options by sector and category in the NCs of Annex I Parties.

Table 4 listed the common structural/physical, social and institutional adaptation strategies for the six sectors that had the highest number of adaptation mentioned in the NCs. In the table, we have also listed the common adaptation for disaster management and cross-sectoral for ease of comparison with the analogous table for the NAPAs and the discussion on the South African NCs later in the chapter.

Among structural/physical options, engineering and built-environment type of adaptation was featured most prominently across sectors. Additionally, hard engineering structures to defend water resources and coastlines as well as revising building design to adapt to climate change impacts (i.e. green buildings) were common. The popularity of these structural/physical options were also observed in the NAPAs. It should also be noted that the introduction of infrastructure to collect and store water, and ecosystem-based adaptation (EbA) options were often mentioned. EbA options that were commonly mentioned include rehabilitation, reforestation and restoration of degraded ecosystems, and establishment enforcement of conservation and protected areas.

Among social adaptation, training was cited relatively few times across the sectors. The most common options were related to awareness raising and education campaigns on climate change impacts and the importance of natural resources. Additionally, informational adaptation options also featured prominently including monitoring, research, assessments, and establishing database and information networks. However, it should be noted that the agricultural and forestry sector was an outlier, in which behavioural adaptation options (i.e. changing of practices in farming and forestry) were most common.

Regarding the institutional adaptation, the development, introduction, review and revision of policies and plans were most predominant across the sectors. The introduction and enforcement of regulations also featured commonly, as well as financial mechanisms to support adaptation options (e.g. notably the introduction of insurance schemes for extreme events/disasters and the revision of subsidies related to the agricultural sector).

TABLE 4: COMMON ADAPTATION OPTIONS FOR SEVEN SECTORS WITH THE HIGHEST NUMBER OF ADAPTATION IN THE NCS FOR ANNEX I PARTIES.

*	Physical / Structural	Social	Institutional
Agriculture	The development, improvement, promotion and/or access to varieties of crops and livestock that are more resilient to the impacts of climate change. For example, crops that are xerophilic and exothermic, and livestock (including indigenous breeds and cross breeding) that are more suited and adapted to matching local environments. Relatedly, also the establishment of gene banks and seed banks to maintain diversity of agricultural species and support genetic engineering. Introduction or improvement of water irrigation to increase access to water and support water saving. For example, drip irrigation.	Changing existing practices for crop and livestock management. This included changing cropping patterns, fertilizing techniques, tillage, disease weed pest control, and grazing management. Introducing new practices such as integrating livestock and crop management, multi-cropping, diversification of crops, and agrotechnical measures for water and soil conservation.	Introduction of financial mechanisms to support adaptation. This included credit systems (e.g. credit unions and support to buy fertilizers), insurance schemes (e.g. crop insurance against extreme events and disasters), and subsidies that favour interventions. Development, implementation and enforcement of a policy framework for climate change. This included including climate change considerations in policies for integrated natural resource management, national land use and water use. In addition, existing policies for water investment and subsidies (e.g. favouring local produce over imports) were revised.
Biodiversity	Establishment, extension or strengthening of protected areas and conservation efforts including in situ and ex situ species conservation, buffer zones, and protecting important migration routes and ecological connectivity.	National campaigns for awareness raising and education initiatives for communities, professionals and visitors to conservation areas on the importance of biodiversity of flora and fauna. Assessments, surveys and maps of species distribution, migration routes and invasive alien plants. Monitoring and surveillance of species, ecosystem, and other ecological aspects. Researching the climate change impacts, adaptation responses, climatological projections, and local climate variability.	Reviewing and revising relevant legislation. This included introducing climate change adaptation into environmental protection policies, introducing integrated natural resource management, prioritizing biodiversity policy, developing climate change action plans (including regional plans), and designing integrated plans to link different sectors.
Water resources	Measures to support water supply, especially for drought-alleviation This included introducing technology and infrastructure for harvesting and storage, water recycling, desalination, reverse osmosis, extending or improving waste water treatment plants, and redistribution (e.g. inter/intra basin transfers). Maintenance and construction of infrastructure. This included flood-control measures (e.g. dams, gabions, weirs, dykes), addressing leakages, and upgrading sewage facilitates. Overall, modernizing efficiency of water infrastructure.	Monitoring and improving forecasting of e.g. sea levels, unregistered water use, soil water, water quality, and other biological and chemical factors.	Formulation, introduction and implementation of integrated watershed management and integrated water resource management plans at national and local scales that incorporate climate variability. Mainstreaming of climate change in policies and plans related to the water sector, including adopting new policies or reforming and updating existing legislation. For example, new legislation on water use, national programs to manage long-term demand, and contingency plans.

	Physical / Structural	Social	Institutional
Health	Improving access to safe drinking water and overall good sanitation standards. This includes water harvesting, storage and protection equipment, improved drainage systems and water treatment technology. Improvement of health servi22ces, including vaccination campaigns, extending treatment facilities increasing access and availability of equipment and infrastructure.	Awareness, sensitization and education of the public and health professionals on sanitation, hygienic amenity, and healthy diets and lifestyles.	Development and introduction of policies and plans that consider climate change impacts in long term development, urban planning, disaster preparedness, and sector plans. Introduction of regulations for air quality, construction standards, quarantine processes, and building design.
Coastal zones	Hard engineering infrastructure to fortify and defend coastal areas. These structures include seawalls, dykes, breakwater, drainage systems, and upgrading existing infrastructure. Rehabilitation and/or restoration of ecosystem features, including sandy beaches and coral reefs.	Assessing, mapping, and/or analyzing the feasibility of interventions, vulnerability, risk of hazards as well as establishing a baseline.	Review, revise and implement policies and plans including a national response plan for disaster management and to management tourism development in coastal zones.
Forestry	Protection and conservation measures including increasing the area of forests that are protected, reducing fragmentation of forests and supporting connectivity, protecting migration routes, and implementing specific measures to conserve/protect vulnerable ecosystems (e.g. wetlands) and indigenous species.	Changing existing practices and introducing new practices related to disease and pest control, soil conservation, agro-forestry, homestead forestry development, and the use of a wider range of timber species and multipurpose species. Assessing, mapping and/or modeling climate change impacts, changes in forest structures, and species assemblages.	Review, revise and implement policies and plans such as biodiversity management plans, biodiversity action plan, sectoral climate change plans, and forest protection plans. This includes integrating and reforming existing and new legislation.
Disaster Management	Implementation of fire management schemes, including establishing and maintain firebreaks. Developing, constructing and maintaining hard infrastructure (e.g. dams and levees) to address flood-risks. Additional infrastructure for disaster management included emergency structures and improving transportation facilities for extreme events, as well as agro-meteorological stations to support information systems. The rehabilitation, restoration and reforestation of ecosystems to support disaster preparedness.	Assess, survey, map and identify vulnerable areas. Uptake of early warning systems and forecasting. Training of technicians in the required skills.	Introducing financial mechanisms including incentives and insurance for disaster preparedness. Development and introduction of disaster management plans, including operation procedures and evacuation plans.
Cross Sectoral	Implementation of natural resource management, particularly for invasive alien plants. The establishment and enforcement of protected and conservation areas. The rehabilitation, restoration and/or reforestation of ecosystems. Construction and promotion of water saving technology including water harvesting and storage.	Awareness raising of climate change adaptation and related policies.	Development of integrated policies and plans that address climate change adaption. Particular, integrated plans for the agricultural and mining industry were mentioned as well as plans for “eco-city” management.

Sector

South Africa's NC & NCCRP

The 35 adaptation options listed in the South African NC's (2000 and 2011) span across six sectors: water resources; agriculture; forestry; biodiversity; disaster management; and cross-sectoral (Table 5). These options were mostly structural/physical (40%) and social (43%) in nature. Similar to the NCs of other Annex I Parties, South Africa put less focus on institutional-type of adaptation options. There were other similarities, but also differences in the adaptation options proposed in the South African NCs and those in the other NCs. For example, there were many similarities in the adaptation options for agriculture and biodiversity in the South African NCs and in the other NCs. These options include conserving soil and water, improving irrigation efficiency, identifying more climate-resilient cultivars, constructing water storage infrastructure, integrated planning, financing adaptation, expanding protected areas, establishment of seedbank, and monitoring species. On the other hands, South Africa also proposed adaptations that were different from the common ones in the other NCs. For examples, South Africa did not focus much on awareness raising and capacity development. Instead, it proposed changing water allocation rules during droughts, wetland conservation, consolidation of farmland, controlling alien species invasion in farmland, and considering climate change implications in land reform and land redistribution policy and practice.

Subsequent to the NCs, South Africa proposed another suite of adaptation options in its NCCRP (See Table 5). The 48 options in the NCCRP span more sectors than those in the NCs: water resources; agriculture; forestry; biodiversity; disaster management; health; and human settlements. Health and human settlements were new and previously not considered in the NCs. However, many of the adaptation for rural human settlements could be categorized under agriculture and those for coastal human settlements tend to limit to disaster related adaptation. Additionally, South Africa proposed more institutional-type of adaptation (33%) in the NCCRP and in the two NCs. The institutional adaptation options in the NCCRP were aiming at more far-reaching impacts in the way of effecting transformational change.

Examples of such type of adaptation include:

- Integrate agriculture and forestry into climate-resilient rural development planning;
- Develop food security and sound nutritional policies;
- Investigate how to leverage opportunities presented by urban densification to build climate-resilient urban infrastructure and promote behavioural change as part of urban planning and growth management; and
- Investment in water conservation and water demand management.

The NCCRP also included more awareness raising and research as social-type of adaptation across many sectors. Overall, the NCCRP was an improvement of the NCs.

TABLE 5: LIST OF ADAPTATION OPTIONS FOR SOUTH AFRICA AS INCLUDED IN ITS NC AND NCCRP.

	NC	TYPE	NCCRP	TYPE
WATER RESOURCES	Construction of more large and/or farm dams for irrigation, or making infrastructure modifications to dams to deal with future climate conditions.	S-P	Integrating climate change considerations in the short-, medium- and long-term water planning processes across relevant sectors.	I
	Wetlands conservation.	S-P	Sustaining state-of-the-art, water-related research and capacity development in all aspects of climate change.	S
	Sustainable groundwater use by considering altered recharge rates under climate change.	S-P	Implementing best catchment and water management practices, in particular, investment in water conservation and water demand management.	I
	Water conservation practices with a focus on water productivity by promoting water-use-efficiency-related technologies, and conservation tillage and water harvesting.	S	Exploring new and unused resources, particularly groundwater, re-use of effluent, and desalination.	S
	Flood and drought management such as changing allocation rules during droughts and protecting agricultural lands from flooding.	S	Providing human, legal, regulatory, institutional, governance and financial resources and capacity to deal with the long-term effects of climate change.	I
	The reduction of high salinity levels by more judicious management of soil and water by agriculture in future climates.	S	Undertaking focused monitoring and research in order to ensure the efficacy of water adaptation over the long-term.	S
BIODIVERSITY	To maintain the current vegetation.	S-P	Strengthen biodiversity management and research institutions.	I?
	Extension of the protected areas that are predicted to experience limited impact or extend protected areas to adjacent land with high topographical relief.	S-P	Expand the protected area network and manage threatened biomes, ecosystems, and species in ways that will minimise the risks of species extinction.	S-P
	Ex-situ conservation and seedbanks.	S-P	Conserve, rehabilitate and restore natural systems that improve resilience to climate change impacts or that reduce impacts.	S-P
	Establishment of a biodiversity monitoring network of areas at risk.	S	Prioritise impact assessments and adaptation planning that takes into account the full range of possible climate outcomes.	S
	Conservation planning is required to ensure that a 10% conservation requirement is implemented for each vegetation type.	I	Prioritise climate change research into marine and terrestrial biodiversity and ecosystem services, and institute effective monitoring to enhance the understanding and forecasting of critical future threats.	S
			Enhance existing programmes to combat the spread of terrestrial and marine alien and invasive species.	S-P
			Encourage partnerships for effective management of areas not under formal protection.	I
			Expand existing gene banks to conserve critically endangered species.	S-P

	NC	TYPE	NCCRP	TYPE
AGRICULTURE AND FORESTRY	Increasing the area under irrigation (subject to water and suitable soils being available, irrigation practices being efficient, and expansion not leading to negative repercussions downstream).		Integrate agriculture and forestry into climate-resilient rural development planning.	I
	Conversion to drip irrigation (from overhead or flood methods).	S-P	Identify climate-resilient land-uses. This will support the agricultural industry's proactive efforts to exploit new agricultural opportunities.	S
	Application of local and crop specific irrigation scheduling to avoid excessive water and fertiliser losses from irrigated lands.	S-P	Invest in research on water, nutrient and soil conservation technologies and techniques, as well as agricultural production, ownership, and financing models to promote Climate Smart Agriculture (CSA).	S
	Use of mulching/crop residue as a water saving mechanism.	S	Use early warning systems to give timely warnings of adverse weather and possibly related pests and disease occurrence.	S-P
	The overall promotion of best management practices (BMPs) with the principles of minimizing soil disturbance, permanent soil cover, multi-cropping, and integrated crop and livestock production.	S	Invest in education and awareness programmes in rural areas and link these to agricultural extension activities to enable both subsistence and commercial producers to understand, respond and adapt to the challenges of climate change.	S
	Consolidation of small plots of land.	S		
	Integrated water use planning.	I		
	Keeping alien invasive grass species to a minimum.	S-P		
	Factoring in animal health resulting from changes in rainfall and temperature.	S-P		
	Adapting livestock (and game) densities to changing grassland carrying capacities.	S		
	Minimising overgrazing to curb increased erosion through enhanced surface runoff.	S		
	Minimising weed infestations in grasslands.	S		
	Practising fodder storage for livestock.	S		
	Shifting of livestock to land with higher carrying capacity.	S		
	Select more temperature-tolerant tree cultivars for plantations.	S-P		
	Genetic engineering to develop more heat- and drought-resistant hybrids.	S-P		
CROSS-SECTORAL	Increasing policy awareness.	S		
	Expanding extension services to expedite adaptation.	S		
	The importance of integrated planning, especially with regard to agriculture and mining uses in relation to municipal needs.	I		
	Streamlining complex or cumbersome legislation to make adaptation to the additional stressor of climate change easier.	I		
	Finding means to finance and use current and new technology and practices.	I		
	Considering climate change implications in land reform and land redistribution policy and practice.	I		

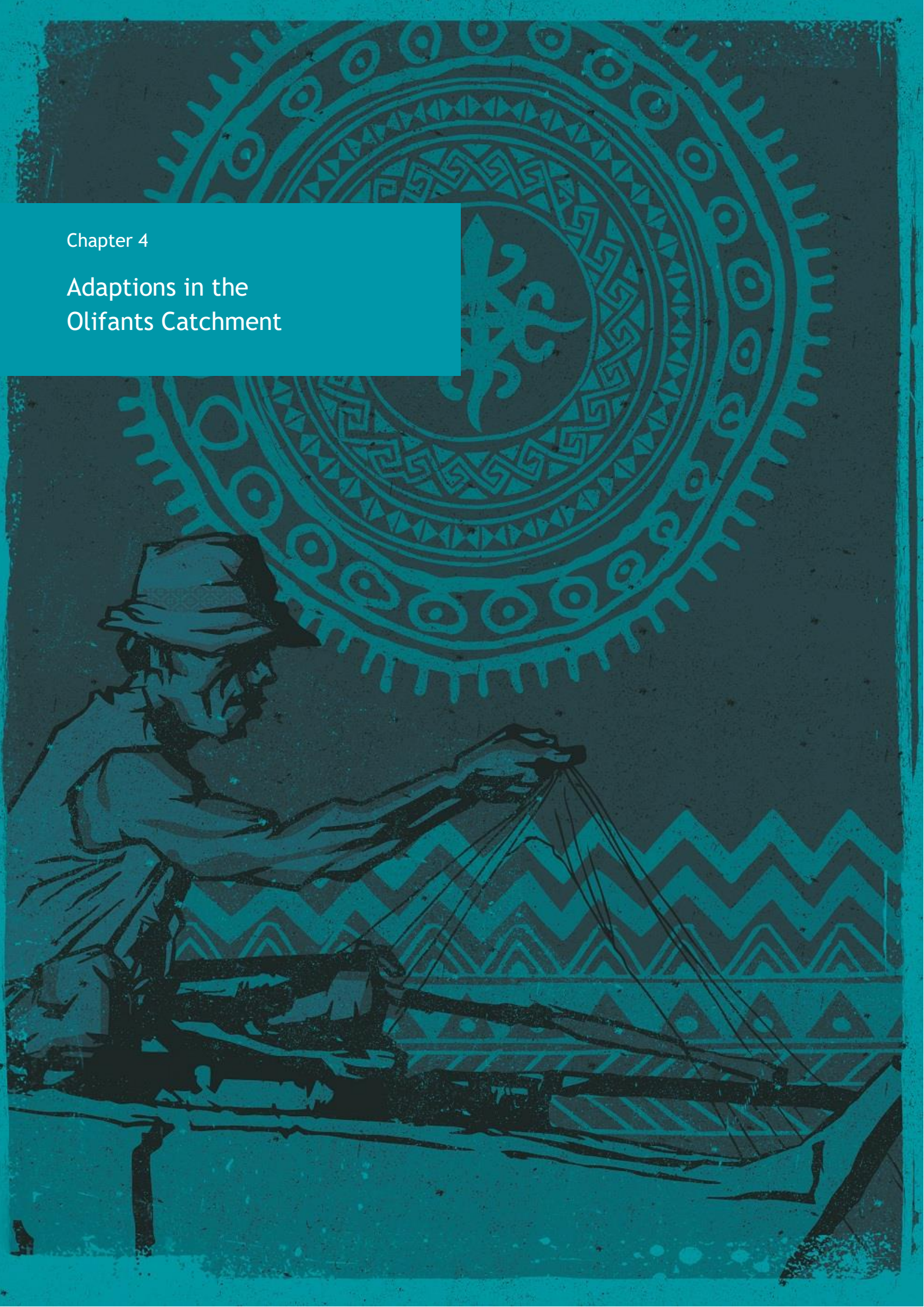
	NC	TYPE	NCCRP	TYPE
HUMAN SETTLEMENTS – CITY, RURAL AND COASTAL SETTLEMENTS			Investigate how to leverage opportunities presented by urban densification to build climate-resilient urban infrastructure and promote behavioural change as part of urban planning and growth management.	I
			In the implementation of low-cost housing, ensure access to affordable lower-carbon public transport systems, incorporate thermal efficiency into designs and use climate-resilient technologies.	S-P
			Develop effective information, monitoring and assessment tools to evaluate the resilience of our cities and towns to climate change.	S-P
			Encourage and develop water-sensitive urban design.	S-P
			Encourage and support the appropriate downscaling of climate models to provincial and where possible.	S-P
			Ensure that land-use zoning regulations are enforced and that urban land-use planning considers the impacts of climate change and the need to sustain ecosystem services when considering settlements and infrastructure development proposals.	I
			Educate subsistence and small-scale farmers on the potential risks of climate change, and support them to develop adaptation strategies with on-farm demonstration and experimentation.	S
			Design and implement economic and livelihood diversification programmes in rural areas.	I
			Prioritise technologies for climate change adaptation within rural areas, including low water-use irrigation systems, rainwater harvesting strategies, and drought resistant seed varieties.	S-P
			Ensure that national, provincial and municipal coastal management plans incorporate relevant climate information.	I
			Take account of the potential impact of sea-level rise and intense weather events on infrastructure development and investment in coastal areas.	I
			Protect and rehabilitate natural systems that act as important coastal defences.	S-P
			Develop Disaster Risk Management plans that take into account the potential consequences of climate change along the coast.	I
			Support ongoing research to determine the impacts of climate change on artisanal fishing communities and livelihoods in coastal areas.	S

	NC	TYPE	NCCRP	TYPE
DISASTER MANAGEMENT	Coping with more frequent/hotter fires and resultant loss of grazing and of other crops/plantations by making firebreaks and burning at the times dictated by law.	SP	Continue to develop and improve its early warning systems for weather, climate and pest infestation events, and to ensure that these warnings reach potentially affected populations timeously.	**S-P**
	Improving pest control to anticipated increases in pest and disease infestations.	S	Seek to collaborate with our neighbouring states to share early warning systems with regional applications and benefits.	S-P
			Continue to promote the development of Risk and Vulnerability Service Centres at universities.	S
			Facilitate increased use of seasonal climate forecasts among key stakeholders such as those in the water and agricultural sectors.	S
			Maintain, update and enhance the SARVA as a tool that provinces and municipalities may use to inform their climate change adaptation planning.	S-P
			Collaborate with social networks to help raise awareness and to transfer technology and build capacity.	S
			Develop mechanisms for the poor to recover after disasters, including micro-insurance.	I
HEALTH			Reducing ambient particulate matter, ozone, and sulphur dioxide concentrations by legislative and other measures to ensure full compliance with National Ambient Air Quality Standards by 2020.	I
			Develop food security and sound nutritional policies.	I
			Develop public awareness campaigns on the health risks of high temperatures and appropriate responses.	S
			Design and implement “Heat-Health” action plans.	I
			Research on the linkages between disease and climate change.	S
			Develop a health data-capturing system that records data at spatial and temporal scales.	S
			Improve the bio-safety of the current malaria control strategy.	S-P
			Strengthen the awareness programme on malaria and cholera outbreaks.	S

Note:
S-P refers to structural/physical adaptation;
S refers to social adaptation; and,
I refers to institutional adaptation.

Chapter 4

Adaptions in the Olifants Catchment



Adaptation planning at provincial level

The PCCAS project addresses a notable lack of strategies that are dedicated to climate change adaptation at a provincial level. Even though the Green Economy Plan[7] for Limpopo does contain elements of climate change adaptation, its focus is to pioneer a green economy, which tends to involve mostly mitigation actions (LEDET 2013). The key sectors for adaptation in the Limpopo Green Economy Plan are agriculture, water and biodiversity. Adaptation options for the water sector aim to improve water security. These interventions include alternative water storage, improving reticulation systems, recycling of water from sewage plants and water harvesting. Ecosystem-based adaptation include formalizing a Limpopo Biodiversity Conservation Plan, upscaling the EPWP and tree planting. Indeed, the Green Economy Plan was foundational to the development of the province's draft CCAS.

The PPCAS project includes three phases. During Phase 1, the project was incepted and a climate change coordinator for each province was selected. Relevant data was also collected. For Phase 2, a sectoral vulnerability assessment was conducted for the three provinces by an external service provider. This assessment identified the sectors that are most vulnerable to climate change in each province. Currently, the project is conducting Phase 3. For this phase, adaptation strategies are developed for the identified vulnerable sectors.

In early 2015, the service provider ran a series of workshops with stakeholders to solicit their inputs to assess the vulnerability of different sectors to risks resulting from climate change. The provincial vulnerability assessments were used to determine recommendations for sectoral adaptation strategies. These recommendations were captured in a draft CCAS for each province. An additional round of workshops are now active to get further feedback from stakeholders on the recommendations of the draft CCASs (see *Table 7* and *Table 8*).It is expected that the CCASs will be finalized, adopted, published and that implementation will start early in 2016.

The vulnerability assessments consider exposure, sensitivity and adaptive capacity collectively to determine vulnerability to climate change impacts of each sector in Mpumalanga (see ***Table 6***) and Limpopo. The most vulnerable sectors in each province are included in the draft CCAS. In Mpumalanga, seven sectors were prioritised because of their high vulnerability to climate change.
These are:

- Ecosystems (terrestrial and aquatic)
- Tourism
- Forestry
- Agriculture
- Water Supply
- Livelihoods and Settlements (Rural and Urban)
- Disaster Management.

[7] *LEDET, Provincial Government of Limpopo, "Limpopo Green Economy Plan: Including Provincial Climate Change Response," June 2013. https://www.environment.gov.za/sites/default/files/docs/limpopogreen_economyplan.pdf*

Human health and the extractive (mining) sector were also prioritized even though they were assessed as having medium level of vulnerability in the long-term. In addition, energy supply was added to the CCAS and workshop series following initial consultation with stakeholders who felt that the impact of this sector on the province's economy — along with mining — should not be excluded. Although the transport sector was also considered in the vulnerability assessment, it was not included in the draft CCAS nor in the workshop series because its vulnerability was assessed as low. Overall, the assessment flagged water shortages as a major climate risk which implicates all other sectors, and the absence of accounting for climate change in existing plans was raised as a factor limiting adaptive capacity in multiple sectors.

In Limpopo, the following sectors were prioritised because of their high vulnerability to climate change.

These were:

- Ecosystems (Terrestrial and Aquatic);
- Agriculture;
- Livelihoods and Settlements (Rural);
- Water Supply; and
- Human Health.

After initial stakeholder consultations, urban livelihoods and settlements were also added even though they were assessed to have a lower vulnerability than rural livelihoods and settlements. Furthermore, stakeholders strongly preferred disaster management to be addressed as a cross-cutting sector and not as a separate sector. Consequently, adaptation strategies were not described specifically for disaster management but were rather integrated as a collective in other sectors. Across all sectors, the vulnerability assessment highlighted water shortages as a major risk, and indicated that the existing governance mechanisms and water infrastructure have limited capacity to address water insecurity as impacted by climate change.

TABLE 6: SUMMARY OF CLIMATE CHANGE VULNERABILITY ASSESSMENT FOR MPUMALANGA BY SECTOR.

ECOSYSTEMS (TERRESTRIAL AND AQUATIC)					
Sensitivity	H	***Adaptive Capacity***		***Vulnerability***	
Exposure	H	Short term	L	Short term	M
Risk	H	Long term	M	Long term	H
Increased risk of: ■ Decreased dilution of pollutants in water bodies ■ Floods and flash floods ■ Decreased groundwater recharge ■ Further loss of grassland biome ■ Range contraction of endemic species		***Factors that increase adaptive capacity:*** ■ Mpumalanga has a Biodiversity Sector Plan that addresses climate change and supports biodiversity connectivity ■ Mpumalanga has a Wetlands Forum ■ Savanna biome is already reasonably well protected		***Factors that limit adaptive capacity:*** ■ Biodiversity Sector Plan will take a long to implement ■ Strategies for control of alien vegetation, wetland management and overall management integration on biodiversity need revision ■ Grassland biome is one of the most threatened and least protected biomes in Southern Africa	
TOURISM					
Sensitivity	H	***Adaptive Capacity***		***Vulnerability***	
Exposure	H	Short term	L-M	Short term	M
Risk	H	Long term	L-M	Long term	H
Increased risk of: ■ Detrimental impacts on fauna and flora, particularly endemic species ■ Invasion of alien species ■ Changes in ecosystems		***Factors that increase adaptive capacity:*** ■ Conservation agencies are mandated to meet biodiversity targets ■ Diversification of tourism products		***Factors that limit adaptive capacity:*** ■ Not assured that future planning of conservation agencies will include climate change mitigation or adaptation measures	
FORESTRY					
Sensitivity	H	***Adaptive Capacity***		***Vulnerability***	
Exposure	H	Short term	M	Short term	M
Risk	H	Long term	M	Long term	H
Increased risk of: ■ Decreased production ■ Increased water abstraction		***Factors that increase adaptive capacity:*** ■ Alternative forms of silviculture, such as mixed species forests, agroforestry, and the use of adapted indigenous tree species could yield more resilient forests		***Factors that limit adaptive capacity:*** ■ Shifts in local climates will impact the suitability of certain trees for commercial forestry ■ Expansion of forests of fast-growing plantation species does not address water use restrictions	

AGRICULTURE					
Sensitivity	H	*Adaptive Capacity*		*Vulnerability*	
Exposure	H	Short term	VL	Short term	M
Risk	H	Long term	VL	Long term	H
Increased risk of: ■ Water shortages and impaired production (dependence on very variable rainfall for crop production & intensive irrigation schemes) ■ Veld fires ■ Floods		*Factors that increase adaptive capacity:* ■ Land and water allocation is being reviewed		*Factors that limit adaptive capacity:* ■ Existing need for climate specific crops ■ Competition with the mining sector for arable land ■ Limited access to water resources ■ Limited amount of water with acceptable quality ■ Possibly increased demand for agricultural production	

DISASTER MANAGEMENT					
Sensitivity	H	*Adaptive Capacity*		*Vulnerability*	
Exposure	M	Short term	L	Short term	M
Risk	H	Long term	H	Long term	H
Increased risk of: ■ Veld fires ■ Floods ■ Drought ■ Discharge of pollutants and wastewater ■ Human displacements		*Factors that increase adaptive capacity:* ■ Provincial spatial development plan is being reviewed, to improve access to water, jobs and clinics, etc.		*Factors that limit adaptive capacity:* ■ Lack of long-term health data that can be linked to changes in the climate system	

WATER SUPPLY					
Sensitivity	H	*Adaptive Capacity*		*Vulnerability*	
Exposure	H	Short term	M	Short term	M
Risk	H	Long term	L	Long term	H
Increased risk of: ■ Water shortages ■ Soil erosion ■ Pollutants and sewage washing into water bodies ■ Floods		*Factors that increase adaptive capacity:* ■ Scale-up War on Leaks Programme ■ Steel reservoirs to increase bulk water storage ■ Upgrade Waste Water Treatment Works (WWTWs) ■ Construction of strategic dams ■ Boreholes to be drilled in needed communities ■ Development of comprehensive water management plan ■ Strong call to enforce compliance and monitoring of water use		*Factors that limit adaptive capacity:* ■ Reconciliation Study looked at increasing water availability primarily for domestic and industrial use, but did not consider impacts of climate change ■ Unclear if future plans/strategies will include mitigation and/or adaptation for climate change impacts	

<table>
<tr><th colspan="6">EXTRACTIVES (MINING)</th></tr>
<tr><td>Sensitivity</td><td>M</td><td colspan="2">Adaptive Capacity</td><td colspan="2">Vulnerability</td></tr>
<tr><td>Exposure</td><td>M</td><td>Short term</td><td>L</td><td>Short term</td><td>L</td></tr>
<tr><td>Risk</td><td>M</td><td>Long term</td><td>L</td><td>Long term</td><td>M</td></tr>
<tr><td colspan="2">Increased risk of:
■ Limited water availability
■ Poor quality coal
■ Increased AMD volumes
■ Poor water quality (e.g. decreased dilution effect of water bodies)
■ Floods, which increases risk of pollutants and hazardous waste washing into water bodies</td><td colspan="2">Factors that increase adaptive capacity:
■ Some studies currently addressing the future of mining and resource availability</td><td colspan="2">Factors that limit adaptive capacity:
■ Direct impact of climate change has not been considered in studies
■ No changes in mining practices have taken place</td></tr>
<tr><th colspan="6">LIVELIHOODS AND SETTLEMENTS (URBAN AND RURAL)</th></tr>
<tr><td>Sensitivity (rural)</td><td>H</td><td colspan="2" rowspan="4">Adaptive Capacity</td><td colspan="2" rowspan="4"></td></tr>
<tr><td>Sensitivity (urban)</td><td>L-M</td></tr>
<tr><td>Sensitivity (urban-informal)</td><td>H</td></tr>
<tr><td>Exposure (rural)</td><td>H</td></tr>
<tr><td>Exposure (urban)</td><td>M</td><td>Short term (rural)</td><td>VL</td><td colspan="2" rowspan="3">Vulnerability</td></tr>
<tr><td>Risk (rural)</td><td>H</td><td>Short term (urban)</td><td>L</td></tr>
<tr><td>Risk (urban)</td><td>M</td><td>Long term (rural)</td><td>VL</td><td>Short term</td><td>M</td></tr>
<tr><td colspan="2">Increased risk of:
■ Water-related disasters
■ Food insecurity
■ Damage by extreme climate impacts (e.g. floods, windstorm)
■ Wastewater discharges
■ Increased water demand and services such as sanitation and refuse removal</td><td colspan="2">Factors that increase adaptive capacity:
■ Implementation of Mpumalanga Human Settlements Master Plan, a roadmap for urban rejuvenation and rural development interventions up to the year 2030
■ Mpumalanga Economic Development Growth Path outlines improvement in services, increased job opportunities and improved spatial planning</td><td colspan="2">Factors that limit adaptive capacity (All referred to rural areas):
■ Limited infrastructure and access to services
■ Malnutrition and limited primary health care
■ Limited land ownership and household income
■ Lack of human capacity, both in government and society</td></tr>
<tr><td>Long term (urban)</td><td>L</td><td>Long term</td><td>H</td></tr>
<tr><th colspan="6">ENERGY SUPPLY</th></tr>
<tr><td>Sensitivity</td><td>M</td><td colspan="2">Adaptive Capacity</td><td colspan="2">Vulnerability</td></tr>
<tr><td>Exposure</td><td>M</td><td>Short term</td><td>M</td><td>Short term</td><td>L</td></tr>
<tr><td>Risk</td><td>M</td><td>Long term</td><td>M</td><td>Long term</td><td>M</td></tr>
<tr><td colspan="2">Increased risk of:
■ Power shortages (Energy supply of the province is at high risk, but due to a number of factors other than climate change. However, indirect impacts climate change can exacerbate this.)</td><td colspan="2">Factors that increase adaptive capacity:
■ Upgrading and maintenance of the coal haulage network
■ Potential green energy sub-sectors (e.g. biogas and biomass) is considered in province's energy plan</td><td colspan="2">Factors that limit adaptive capacity:
■ Impacts on water use and quality, especially during drought</td></tr>
</table>

HUMAN HEALTH					
Sensitivity	M	*Adaptive Capacity*		*Vulnerability*	
Exposure	H	Short term	L	Short term	M
Risk	H	Long term	L	Long term	M
Increased risk of: ■ Heat stress, morbidity and mortality rates ■ Non-communicable diseases (e.g. respiratory and cardiovascular diseases) ■ Spread and/or increase incidence of infectious, vector-borne, and water-borne diseases ■ Poor water and air quality ■ Food insecurity, hunger and malnutrition ■ Opportunistic infections (e.g. diarrhoeal)		***Factors that increase adaptive capacity:*** ■ Improving individual's socio-economic status: province's spatial development plan and economic plan to increase jobs ■ Existing plans to pilot National Health Insurance System, as well as to improve the financial and human resource management systems of Department of Health		***Factors that limit adaptive capacity:*** ■ Current plans not taking into account climatic change impacts	
TRANSPORT					
Sensitivity	L	*Adaptive Capacity*		*Vulnerability*	
Exposure	L	Short term	M	Short term	L
Risk	L	Long term	H	Long term	L
Increased risk of: ■ Water and temperature related damage ■ Water shortages for maintenance		***Factors that increase adaptive capacity:*** ■ Infrastructure Development Plan for the province aims at ensuring that by 2020, Mpumalanga's infrastructure is resilient coordinated and contributes to economic growth and increased quality of life ■ Implementation of solar traffic lights and ensure better synchronisation of the traffic lights to ease traffic congestion		***Factors that limit adaptive capacity:*** ■ Backlog of infrastructure maintenance	

Based on the vulnerability assessment for each pilot province, the service provider recommended three to four adaptation strategies for each priority sector. *Table 7* summarised the proposed recommendations and stakeholder feedback for each sector provided during the consultation workshop series for Mpumalanga. *Table* summarized the same for Limpopo.

The recommendations from the draft PCCASs and the feedback from stakeholders were considered collectively. For both Mpumalanga and Limpopo, more than half of recommendations can be categorized as social and/or institutional adaptation. Social adaptation options were particularly emphasised in the disaster management, human health, mining, and livelihoods and settlements sectors for both provinces. Whilst institutional adaptation was more common among the biodiversity, water and agricultural sectors. In Limpopo draft CCAS, structural/physical adaptation options were equally emphasised as institutional options for the agricultural sector.

Overall, capacity development featured prominently in the recommendations. For illustration, stakeholders during the Limpopo consultation workshop emphasised that before any CCAS is implemented, it is essential to develop the capacity of adaptation agents. Furthermore, the allocation of resources to support capacity development was also stressed. For example, at least 15 out of the 29 recommendations made for Mpumalanga referenced capacity development in some way, including six that specifically state that funding should be made available to initiatives that will increase knowledge, awareness, monitoring and relevant skills required for adaptation.
For Limpopo, at least 12 of the 20 recommendations made some reference to capacity building with three specifically addressing funding issue.

Stakeholders in the Mpumalanga workshop added numerous recommendations and provided substantial revisions to the proposed recommendations. This might be attributed to some of the proposed recommendations being too general to be actionable or adaptation specific.

For examples, the recommendations listed below are very general:

- "Redouble efforts to improve overall socio-economic security and wellbeing" (for livelihoods and settlement);
- "Expand protected areas and promote the protected area expansion strategy" (for biodiversity); and
- "Strengthen existing catchment management efforts" (for water sector).

These three recommendations were revised as follows, respectively, to be more adaptation specific and actionable by the stakeholders.

- "Encourage effective food production by promoting home gardens" (for livelihoods and settlement);
- "Incorporate climate change priorities within the protected area expansion strategy" (for biodiversity); and
- The following activities were added:

  i) Clear invasive alien plants and introduce indigenous plants

  ii) Strengthen enforcement of National Water Act including preventing illegal diversion of water and building of dams in rural area.

Furthermore, some of the proposed recommendations did not match the climate risks identified in the vulnerability assessment. For example, the proposed recommendations for the water sector do not explicitly address the key climate risk of water shortages and floods.

In addition to the sector-based feedback, stakeholders also made the following cross-sectoral recommendations for the Mpumalanga CCAS:

viii. Increase education and awareness on climate change and adaptation
ix. Provide funding resources for adaptation
x. Support capacity building to implement adaptation plans/actions
xi. Improve cooperative governance
xii. Promote more research on climate change impacts on the identified vulnerable sectors

These cross-sectoral recommendations will be worked into an additional chapter in the final Mpumalanga CCAS.
In Limpopo, stakeholders made the following cross-sectoral recommendation for their PCCAS.

- *Establish cross-sectoral climate task team:* LEDET is planning to form a provincial action team to engage on all issues related to climate change as well as implementing the PCCAS for Limpopo. This committee will include identified "climate change champions" in each municipality. It is expected that such a forum and network of "climate change champions" will facilitate cross-sectoral engagement and collaboration as well as integration of climate change awareness into relevant sectors. This would address the recognised lack of communication, awareness and coordination among sectors on climate change adaptation.
- *Include stakeholders from industrial and private sectors in the PCCAS:* Some of the attending stakeholders felt that the PCCAS does not adequately include nor address important stakeholders in industrial sectors (e.g. mining and electricity generation), particularly how these stakeholders should acknowledge responsibility for their impact on the environment and how they intend to reduce this impact. Therefore, stakeholders felt that the PCCAS should consider adaptation with the reduction of environmental impacts together instead of only focusing on adaptation. Relatedly, stakeholders felt that the private sector is hardly engaged with at a municipal level even though they are big role players. Therefore, private-public partnerships should be explicitly stated in the PCCAS.

Stakeholders from Limpopo also voiced the following challenges that could hinder the implementation of the CCAS.

- *Lack of socio-political and economic power*: Some stakeholders felt that they did not have enough power to engage with or impact the activities of important stakeholders in industry (e.g. Eskom) to comply with legislation.
- *Existing good plans and strategies are not enforced and/or delayed:* Stakeholders felt that there are already many "good" plans and strategies that address environmental concerns such as climate change, but they are not enforced and their implementation is delayed.
- *Lack of political will*: Stakeholders noted that there is a lack of political will to support the management and implementation of e.g. biodiversity plans. For example, one stakeholder expressed concern that the five biodiversity corridors that Limpopo already has, but is not properly maintaining. Thus, the stakeholder asked, "How can we implement [new] plans if we can't even manage what we have?"
- *Lack of funding at the local municipality level for meaningful action*: Stakeholders stated that the local municipal level is where national and provincial plans are implemented. However, people who work at this level normally do not receive the necessary funding to implement plans.

There were a lot of similarities in the recommendations for the draft Mpumalanga and Limpopo PCCAs. Indeed, some of the recommendations – take those for the water sector for an example – were exactly the same. One would have the impression that there was little contextualization in the recommended adaptation options for the two provinces. Granted that Mpumalanga and Limpopo do share some similar climate-induced risks such as water shortages, floods and livelihoods insecurity in rural areas. However, there are distinctive features that the two provinces do not share and consequently require different adaptation options. Among the concerns expressed by stakeholders, the one related to the lack of specificity raises the same issue that we have noted.

TABLE 7: RECOMMENDATIONS FOR EACH SECTOR AS LISTED IN THE DRAFT PCCAS FOR MPUMALANGA, AS WELL AS THE FEEDBACK FROM STAKEHOLDERS CAPTURED DURING CONSULTATION WORKSHOP SERIES.

	Recommendations in draft Climate Change Adaptation Strategy for Mpumalanga	Recommendations revised and/or added by stakeholders (indicated in red)
Agriculture	Recommendation 1: Formally establish and strengthen strategic long-term partnerships for Climate Smart Agriculture and foster collaboration with key organizations.	[workshop was not attended, consequently stakeholders' feedback was not captured]
	Recommendation 2: Secure, dedicate, and allocate substantial funding to carry out studies within the province regarding the impacts of climate change on the major food and cash crops of Mpumalanga, on livestock farming, on agricultural revenue, and to identify locally relevant Climate Smart Agriculture practices that would benefit farmers in Mpumalanga.	[workshop was not attended, consequently stakeholders' feedback was not captured]
	Recommendation 3: Fund and implement a comprehensive climate change awareness and skills-building programme within the farming communities of Mpumalanga province, with extensive coverage over a period of 3-5 years.	[workshop was not attended, consequently stakeholders' feedback was not captured]
Disaster Management	Recommendation 1: Secure, dedicate, and allocate funding for research on specific climate-related disaster risks for Mpumalanga, based on climate change scenarios, including identifying geographic hotspots for each major disaster type.	Stakeholders requested the following aspects to be added to the recommendations: ■ More research and innovation on the impacts of climate change and adaptation options.
	Recommendation 2: Develop and implement public awareness and training programmes based on this evidence base to educate people about climate change related disaster risks and responses.	Stakeholders requested the following aspects to be added to the recommendations: ■ Communication between stakeholders must be improved, e.g. communication between tribal authorities and municipalities on developments and land use must be strengthened. ■ Training programmes should include officials in all sectors as well as traditional leaders. ■ Traditional knowledge must also be valued and included.
	Recommendation 3: Strengthen overall disaster prevention, disaster management, and disaster response in the province through broad-based capacity building of first responders and relevant officials.	Stakeholders requested the following aspects to be added to the recommendations: ■ Climate change must be clearly incorporated into the Disaster Management Plans of sectors.

	Recommendations in draft Climate Change Adaptation Strategy for Mpumalanga	Recommendations revised and/or added by stakeholders (indicated in red)
Biodiversity	Recommendation 1: Develop a specialized climate change management programme to focus on protection of Mpumalanga's two main terrestrial ecosystems in the face of climate change	Develop a specialized climate change management programme to focus on protection of Mpumalanga's biodiversity in the face of climate change
	Recommendation 2: Identify and integrate specific climate-change related priorities and metrics when next revising the Mpumalanga Biodiversity Sector Plan (MBSP)	Stakeholders made no substantial revisions to this recommendation, but emphasized that the MBSP has been revised and now directly addresses climate change adaptation.
		Stakeholders added the following recommendation: Implement the MBSP and bioregional that would allow for the protection of climate-change related priorities
	Recommendation 3: Expand protected areas and promote the protected area expansion strategy	Incorporate climate change priorities within the protected area expansion strategy
	Recommendation 4: Enhance the use of ecological infrastructure to create natural buffers that create resilience against extreme weather events.	Stakeholders made no substantial revisions to this recommendation.
		Stakeholders added the following recommendation: Establish gene banks that contribute towards the *ex situ* conservation of species vulnerable to climate change
Water Resources	Sector: Water Supply	Stakeholders felt that this sector should be referred to as "Water Sector" and not "Water Supply".
	Recommendation 1: Establish a cross-sectoral, inter-departmental governance framework to help integrate and mainstream climate change adaptation into all water related operations.	Stakeholders made no substantial revisions to this recommendation, but did express that this recommendation does not provide them with any new information. They were disappointed that the Strategy did not already layout such a framework.
	Recommendation 2: Ensure that proposed water related infrastructure projects explicitly integrate climate change resilience into their planning and design stages.	Stakeholders made no substantial revisions to this recommendation. However, an additional recommendation was added to emphasise "non-infrastructure projects" (i.e. natural ecosystems and features that provide services, e.g. wetlands).
	Recommendation 3: Raise performance and efficiency of water service delivery for domestic use with aggressive quantitative targets.	Recommendation 4: Raise performance and efficiency of water service delivery for water use, with aggressive quantitative targets.

	Recommendations in draft Climate Change Adaptation Strategy for Mpumalanga	Recommendations revised and/or added by stakeholders (indicated in red)
Human Health	Recommendation 1: Formally join, participate in, and leverage capacity and information from global climate change health networks and knowledge-sharing platforms	Stakeholders requested that the following should be added to the recommendation: ■ Development of provincial Health Climate Change Adaptation Strategy in line with National Climate Change Adaptation Strategy ■ Mainstream Climate Change in existing forums such as MOSASWA and cross-border cooperation as well as provincial health forums.
	Recommendation 2: Secure, dedicate, and allocate substantial funding for better climate-related health surveillance and monitoring in the province and to carry out studies within Mpumalanga on health impacts of climate change.	Stakeholders made no substantial revisions to this recommendation.
	Recommendation 3: Fund and implement a comprehensive public health and climate change awareness and adaptive capacity building programme, with a particular focus on heat-health and vector-borne diseases, water-borne diseases, respiratory health, and with a special focus on vulnerable populations like children and the elderly.	Stakeholders removed this recommendation.
		Stakeholders added the following recommendation: Integrate climate change on public health surveillance and monitoring.
Urban and Rural Livelihoods and Waste Management	Recommendation 1: Devote resources to identifying and providing training on alternate sources of livelihood for different regions and communities within Mpumalanga.	Stakeholders requested that the recommendation should encourage the following: small scale farming in urban and semi-urban areas, local markets for crops produced within communities, "green" buildings, and "greening" (e.g. planting trees) in settlements. The recommendation should also address adaptation options for water, energy and waste management.
	Recommendation 2: Create and strengthen support business development mechanisms for smallholder farmers.	Recommendation 2: Create and strengthen support business development mechanisms for communities. Stakeholders requested that the establishment of co-operative models and Agri Parks (i.e. networks that support supply chains and skills development) to be added to the recommendations.
	Recommendation 3: Redouble efforts to improve overall socio-economic security and wellbeing.	Stakeholders removed this recommendation.

	Recommendations in draft Climate Change Adaptation Strategy for Mpumalanga	Recommendations revised and/or added by stakeholders (indicated in red)
Urban and Rural Livelihoods and Waste Management (continue)	Recommendations 4: Improve building practices and strengthen monitoring: after reviewing current practices and regulations, an effort should be made to improve building codes and regulations to encourage better building practices, for more resilient (or strong) structures, and to use higher quality construction methods and materials.	Recommendation 3: Improve development practices and strengthen monitoring to ensure climate resilient settlements.
	Recommendation 5: Leverage existing financial mechanisms.	Stakeholders removed this recommendation.
	Recommendation 6: Enhance disaster management and response	Stakeholders made no substantial revisions to this recommendation, except for adjusting the number of the recommendation.
	Recommendation 7: Improve information dissemination: Information sharing is key to assisting with Disaster Management	Stakeholders removed this recommendation.
	Recommendation 8: Make better use of SPLUMA.	Recommendation 5: Integration and alignment of Environmental and Planning tools i.e. MSDF, PSDF and land use schemes in terms of SPLUMA.
Mining		Stakeholders requested the following aspects to be added to the recommendations: ■ The development and use of technology to address impacts (e.g. very hot temperatures underground). ■ "Hands on" facilities on mining sites to respond immediately to problems ■ Employees should have access to medical treatments funded by mining companies ■ Health professionals must be capacitated to deal with climate change impacts (e.g. heat waves) ■ Ensure that all municipalities have Disaster Management Plans that include climate change. ■ Monitoring programmes should also monitor working conditions in mines. ■ Town planners must be engaged to build houses that are resilient to climate change.
	Recommendation 2: Organize an annual conference or symposium in the province focused on the mining industry's response to climate change.	Stakeholders commented that these conference only include management/managers who are not affected by the climate change impacts on the ground. Consequently, workshops should be arrange specifically for communities and mining employees.

	Recommendations in draft Climate Change Adaptation Strategy for Mpumalanga	Recommendations revised and/or added by stakeholders (indicated in red)
Mining (continue)	Recommendation 3: Fund a province-specific assessment of water related climate change risk to the mining industry in Mpumalanga.	Stakeholders added that mining infrastructure should be suitable and adaptable to current and future conditions. This includes checking overflows to address heavy rainfall in open cast mines, and on-site waste treatment plants to recycle water.
	On implementing agencies	Include SALGA and the Department of Justice as collaborators.
		■ The following additional points did not address a specific recommendation, but their importance was emphasized. ■ Mining impacts "beyond the fence" should be seriously considered. This includes establishing buffers between mining operations and communities, a committee through which communities can directly engage with the management of mining companies, and a forum to ensure accountability and enforcement of regulations and agreements with mining companies (e.g. rehabilitation following open cast mining). ■ Consider alternative land uses in conjunction with mining operations must be considered, including what other land uses can be applied during mining and after rehabilitation of mining sites. ■ The language used for climate change adaptation must be simplified to improve understanding and awareness.

TABLE 8: RECOMMENDATIONS FOR EACH SECTOR AS LISTED IN THE DRAFT PCCAS FOR LIMPOPO, AS WELL AS THE FEEDBACK FROM STAKEHOLDERS CAPTURED DURING CONSULTATION WORKSHOP SERIES.

Sect	Recommendations in draft Climate Change Adaptation Strategy for Limpopo	Recommendations revised and/or added by stakeholders (indicated in red)
Agriculture		Stakeholders added the following recommendation: Before any other strategy is implemented, there should be an emphasis on skill and capacity development for adaptation agents.
	Recommendation 1: reate a Climate Smart Agriculture programme to help develop or promote the use of specific seed or plant varieties in specific locations.	Recommendation 2: Create and implement a Climate Smart Agriculture programme to help develop or promote the use of specific seed or plant varieties in specific locations.
	Recommendation 2: Enhance ongoing efforts involving Conservation Agriculture.	Stakeholders added that the following activities should be emphasised by the recommendation: projects to preserve indigenous livestock and crops through breeding programmes and seed/gene banks, as well as to implement rainwater and greywater harvesting.
	Recommendation 3: Initiate a dedicated climate change adaptation programme for cattle ranching / livestock rearing in the province.	Stakeholders added that the following activities should be emphasised by the recommendation: Develop and implement a model for sustainability that could guide/inform effective responses to extreme events. Management strategies for the efficient use of rangelands (e.g. use specific livestock for specific areas to support efficient use of rangelands) ■ On cattle ranching, promote rotational grazing, reduction of livestock culling, and breeding and keeping indigenous livestock.
	Recommendation 4: Fund and implement a comprehensive climate change awareness and skills-building programme within the province.	Stakeholders added the following activities to the recommendations: ■ Develop a programme for capacity development and awareness raising. ■ Involve funders from NGO programmes to support awareness, farmer training, and extension training.

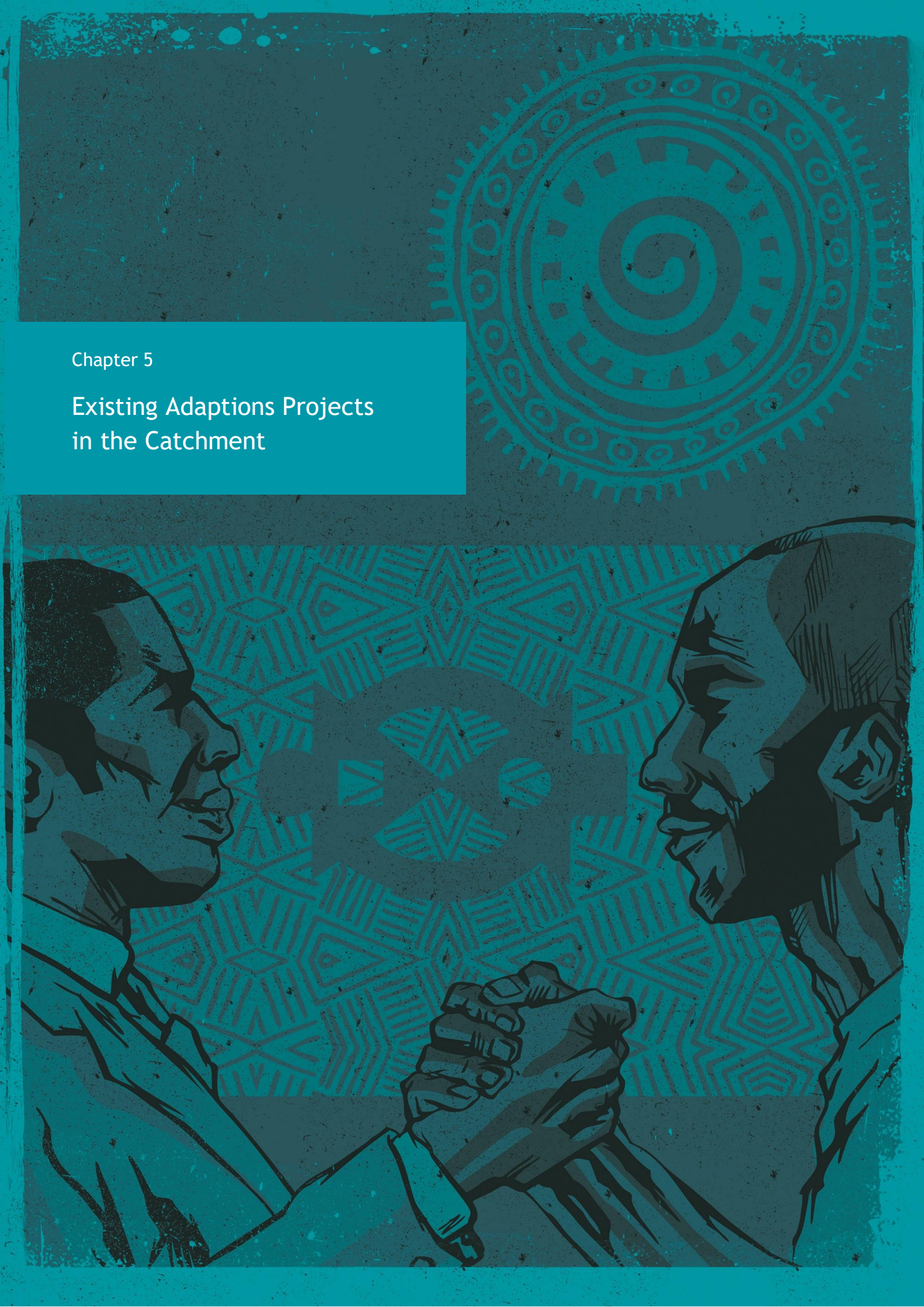
Sect	Recommendations in draft Climate Change Adaptation Strategy for Limpopo	Recommendations revised and/or added by stakeholders (indicated in red)
Ecosystems	Recommendation 1: Develop a specialized climate change management programme to focus on protection of Limpopo's two main terrestrial ecosystems in the face of climate change.	Stakeholders added the following activities to the recommendations: ■ Address issues and political principles regarding protected areas and mining interests. ■ Enhance provincial biodiversity management plans and corridors. ■ Implement the Limpopo Environmental Management Plan.
	Recommendation 2: Identify and integrate specific climate-change related priorities and metrics when next revising the Limpopo Biodiversity Conservation Plan.	Stakeholders made no substantial revisions to this recommendation.
	Recommendation 3: Formally establish and draw resources to a scientific research project to better understand the loss of bird species-richness in the South African Limpopo Basin.	Stakeholders made no substantial revisions to this recommendation.
	Recommendation 4: Develop a focused climate change adaptation response plan and implementation programme targeting the province's wetlands and water pans.	Stakeholders made no substantial revisions to this recommendation.
Water Supply	Recommendation 1: Establish a cross-sectoral, inter-departmental governance framework to help integrate and mainstream climate change adaptation into all water related operations.	Stakeholders commented that the recommendation should address the improvement of existing structures and engagement with existing forums in the Olifants and Letaba Catchments.
	Recommendation 2: Ensure that proposed water related infrastructure projects explicitly integrate climate change resilience into their planning and design stages.	Stakeholders added the following activities to the recommendations: ■ Alternatives to surface water must be considered, e.g. desalinization, conserving and managing demand, and improve leakages. ■ Reduce evaporation from dams and encourage the reuse of black water.
	Recommendation 3: Raise performance and efficiency of water service delivery for domestic use, with aggressive quantitative targets.	Recommendation 3: Raise performance and efficiency of water service delivery and allocation for domestic use, with aggressive quantitative targets. Stakeholders also added that water use per household must be limited and fines must be introduced for exceeded use.
	Recommendation 4: Strengthen existing Catchment Management efforts.	Stakeholders added the following activities to the recommendations: ■ Clear invasive alien plants and introduce indigenous plants. ■ Strengthen enforcement of Water Act including preventing illegal diversion of water and building of dams in rural area.

Sector	Recommendations in draft Climate Change Adaptation Strategy for Limpopo	Recommendations revised and/or added by stakeholders (indicated in red)
Livelihoods & Settlements – Rural & Urban	Recommendation 1: Devote resources to identifying and providing training on alternate sources of livelihood for different regions and communities within Limpopo.	Stakeholders added the following activities to the recommendations: ■ Allocate funds to provide this training ■ Identify key vulnerable areas and roll-out training in the key vulnerable areas identified
	Recommendation 2: Create and strengthen support business development mechanisms for smallholder farmers.	Stakeholders added the following activities to the recommendations: ■ There should be a charter to support small, medium and micro enterprises to become more resilient to climate change. Cooperatives must be supported. ■ Develop an innovative programme for opportunities and create markets. ■ For livestock, add a value chain so that farmers can benefit more. ■ Establish a mentoring programme to improve quality of agricultural produce.
	Recommendation 3: Redouble efforts to improve overall socio-economic security and wellbeing.	Stakeholders added the following activities to the recommendations: ■ Encourage effective food production by promoting home gardens.
	Recommendation 4: Enhance efforts to reduce flood risk to rural and urban communities.	Recommendation 4: Enhance efforts to reduce flood risk and drought risk to rural and urban communities. Stakeholders added the following activities to the recommendations: ■ Municipalities and South African Water Services should disseminate information on these risks. ■ Ensure that early warning systems inform people in time to respond. ■ Create awareness of the importance to restore the environment to prevent flooding. ■ Implement Disaster Management Plans.

Sector	Recommendations in draft Climate Change Adaptation Strategy for Limpopo	Recommendations revised and/or added by stakeholders (indicated in red)
HuHuman Health	Recommendation 1: Formally join, participate in, and leverage capacity and information from global climate change health networks and knowledge-sharing platforms.	Stakeholders made no substantial revisions or comments on these recommendations.
	Recommendation 2: Secure, dedicate, and allocate substantial funding for better climate-related health surveillance and monitoring in the province and to carry out studies within Limpopo on health impacts of climate change.	
	Recommendation 3: Fund and implement a comprehensive public health and climate change awareness and adaptive capacity building programme.	
	Recommendation 4: Redouble efforts to improve overall socio-economic status and health indices.	

Chapter 5

Existing Adaptions Projects in the Catchment



Existing adaptation projects in the catchment

Of all the existing adaptation projects that were found in the Olifants Catchment, 10 were selected for further analysis because they had the greatest potential for collaboration with RESILIM-O or provide lessons learned that could inform our projects.

The 10 projects represent a diversity of characteristics (see *Table 8)*. Five of the projects were related to multi-lateral funding sources, one was related to supporting an international network, another was a national government project, another mainly attributed to research institutions, and two were related to NGOs and civic society. Six projects were localised, three were national and one was international. Relatedly, six projects had sites specifically in South Africa, three in Mozambique, and one included both countries.

The majority of projects were related to the agricultural sector (four projects) and disaster management (four projects), of which three projects overlapped. This overlap is probably because droughts and floods are the two of the most common disasters and impact both sectors. These projects included structural/physical, social and institutional adaptation options. Furthermore, three projects were related to the biodiversity sector and were mostly social- and institutional-type of adaptation. Three projects also address the water sector, and were mostly social-type of adaptation. One project addressed waste management and another was cross-cutting. Overall, the majority of projects included social adaptation options (nine projects). For example, these options included capacity development for alternative livelihoods, learning networks and stakeholder collaboration to support adaptation, and development or support for early warning systems. By comparisons, seven projects included institutional adaptation options such as establishment of funding mechanisms. Only six projects had structural/physical adaptation such as rehabilitating ecosystems and improving or maintaining existing infrastructure.

Most of the projects (six) are still active, while four have ended. The projects that have ended could provide lessons learned to inform RESILIM-O. We have initiated a scoping process to explore potential collaboration with these projects (see *Table 9)*. Such collaboration could include learning from or partnering with initiatives that have experience in engaging with stakeholders on climate change adaptation by presenting and facilitating workshops and training modules on the subject (e.g. WESSA and SAFCEI). Collaboration could also be in the form of sharing results and findings with complimentary projects (e.g. SPACES: North Limpopo Living Landscapes). Furthermore, we have informed our partner, Verde Azul, about the three projects that were active in Mozambique so that they can incorporate lessons learned from these projects into their activities.

TABLE 8: SUMMARY OF EXISTING ADAPTATION PROJECTS IN THE CATCHMENT THAT ARE RELEVANT TO RESILIM-O.

Project name	Securing multiple ecosystems benefit through sustainable land management (SLM) in the productive but degraded landscapes of South Africa			Taking adaptation to the ground: A Small Grants Facility for enabling local level responses to climate change			Joint Programme on Environment Mainstreaming and Adaptation to Climate Change		
Relevant project objectives	Strengthen the enabling environment for the adoption of knowledge-based SLM models for land management and land/ecosystem rehabilitation in support of the green economy and resilient livelihoods through capacity building, improved governance and financial incentives			Incorporate climate adaptation response strategies into local practices to adapt to droughts, seasonal shifts and storm-related disaster events through small grant in two pilot district municipalities			Support the Government of Mozambique's efforts towards sustainable development through the implementation of two components: Environmental Mainstreaming and Adaptation to Climate Change		
Project scale	Localised			Localised			Localised		
Project sites[1]	Baviaanskloof (Eastern Cape), Machubeni (Eastern Cape), Olifants Catchment: **B52B quaternary, Greater Sekhukhune District**			Namakwa District Municipalities, **Mopani District Municipalities**			**Chicualacuala District** (Gaza Province, Mozambique)		
Project lifespan	2015-2021			2015-2019			2008-2010		
Funding[2]	GEF Trust Fund, UNDP, EWT, South African government			AF			Spanish Government through the MDG-F		
Implementing Agency*	DAFF, DEA, EWT, Rhodes University, CSIR, ARC, DBSA Drylands Fund; University of KwaZulu Natal			SANBI			FAO, UNEP, UNHABITAT, UNIDO, UNDP, WFP, MICOA, MINAG, INGC, INAM, Governments of the Gaza Province and Chicualacuala District		
Sectors	Agriculture, Biodiversity			Agricultural, Disaster Management, Water, Waste Management			Agriculture, Disaster Management		
Category of adaptation[3]	S/P	S	I	S/P	S	I	S/P	S	I

[1]Bold text refers to sites located within the Olifants Catchment.
[2] See Abbreviations list for the full name.
[3] The categories are: "S/P" indicates "structural/physical"; "S" indicates "social"; and, "I" indicates "institutional". The relevant categories for each project were shaded.

Project name	Coping with Drought and Climate Change (CwDCC) in Mozambique			Disaster Risk Resilient Livelihoods Recovery in Gaza Province			Climate Change Adaptation In SADC Trans-Frontier Conservation Areas Project		
Relevant project objectives	Enhance food security and capacity to adapt to climate change in agricultural and pastoral systems			Support disaster risk resilience and livelihoods recovery of flood-affected communities in Gaza province, Mozambique			Enhance knowledge, skills and agency among stakeholders in the important biodiversity zones of the TFCAs to build resilience in human livelihoods and ecosystems against climate change impacts as part of Transboundary Protection and Use of Natural Resources Programme		
Project scale	Localised			Localised			International		
Project sites[1]	Gaza Province: Mbala-vala, Nhanguenha, Nalazi and Chivonguene communities in **Guijá District** (Mozambique)			**Gaza Province** (Mozambique)			**Kruger National Park** (South Africa)		
Project lifespan	2009-2014			2013-2014			2013-2014		
Funding[2]	SCCF			UNDP/BCRP			SADC, SADC/GIZ, DIRCO		
Implementing Agency	Ministry of Environment, UNDP, GEF			UNDP, INGC, MICOA, INAM, Provincial Government			WESSA		
Sectors	Agriculture, Disaster Management			Disaster Management			Biodiversity		
Adaptation trait[3]	S/P	S	I	S/P	S	I	S/P	S	I

[1] *Bold text refers to sites located within the Olifants Catchment.*
[2] *See Abbreviations list for the full name.*
[3] *The categories are: "S/P" indicates "structural/physical"; "S" indicates "social"; and, "I" indicates "institutional". The relevant categories for each project were shaded.*

Project Name	War on Leaks Project			SPACES: North Limpopo Living Landscapes			Water Balance Programme			Eco-Congregation and Earth Keepers		
Relevant project objectives	Ensure that South Africa's Water and Sanitation Sector will be equipped with a competent arsenal of skills and capacity to minimise water losses in the country			Understand and predict the combined effects of land use and climate change processes on rangeland vegetation, unique biodiversity, and rural livelihoods			Facilitate and support private-sector investment in water security, and to encourage active water stewardship of stakeholders			Provide information, resources and a supportive network for faith congregations to support capacity development and advocacy on climate change and energy issues		
Project scale	National			Localised			National			National		
Project sites[1]	All provinces in South Africa			**Northern Limpopo**			Various catchments in South Africa			All provinces in South Africa)		
Project lifespan	2015-2020			2015-*unknown*			Ongoing			2006-ongoing		
Funding[2]	DWS			DLR Projektträger, PTJ			WWF			NCA, Christian Aid, Heinrich Böll Stiftung, WWF Nedbank Green Trust, Church of Sweden, Brot für die Welt, ICCO Cooperation, ACT Alliance Alliance, Kerk in ACT Alliance		
Implementing Agency	Rand Water			Bik-F, University of Göttingen, University of Bonn, University of Cologne, University of Limpopo, University of Witwatersrand, University of Venda			WWF			SAFCEI		
Sectors	Water			Agriculture, Biodiversity			Water			Cross-cutting		
Adaptation trait[3]	S/P	S	I	S/P	S	I	S/P	S	I	S/P	S	I

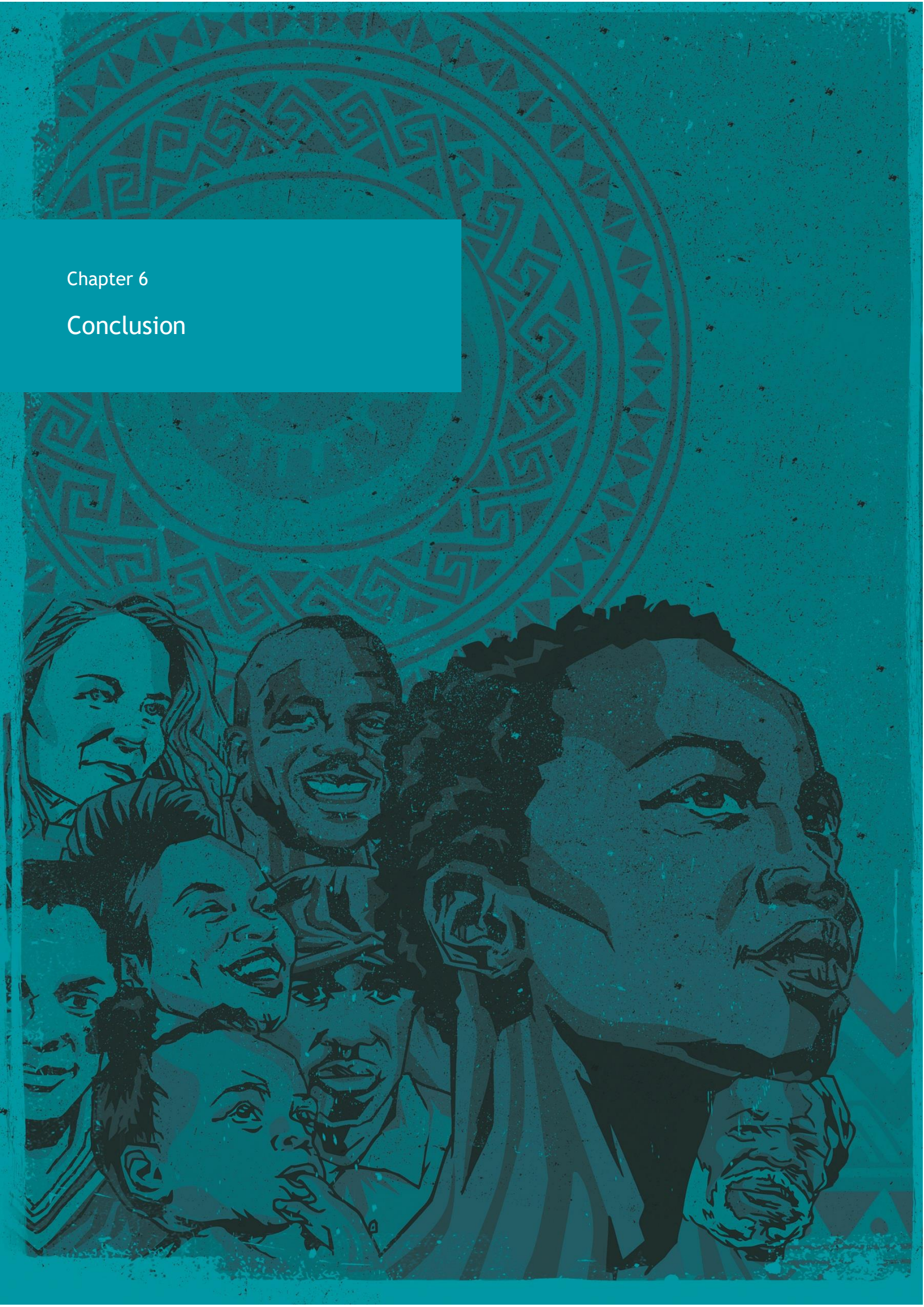
[1] *Bold text refers to sites located within the Olifants Catchment.*
[2] *See Abbreviations list for the full name.*
[3] *The categories are: "S/P" indicates "structural/physical"; "S" indicates "social"; and, "I" indicates "institutional". The relevant categories for each project were shaded.*

TABLE 9: SUMMARY OF NEXT STEPS FOR SCOPING POTENTIAL COLLABORATIONS WITH EXISTING ADAPTATION PROJECTS IN THE CATCHMENT THAT ARE RELEVANT TO RESILIM-O.

Project Name	Next Steps For Scoping Potential Collaborations
Securing multiple ecosystems benefit through sustainable land management (SLM) in the productive but degraded landscapes of South Africa	Initial contact is being established to scope for potential collaboration. The degree of collaboration will be dependent on the location and the type of activities being implemented by the project. Clarity is needed on the projects activities.
Taking adaptation to the ground: A Small Grants Facility for enabling local level responses to climate change	Initial contact is being established to scope for potential collaboration. RESILIM-O project activities can possible align with or compliment adaptation projects that are selected to receive the small grants.
Joint Programme on Environment Mainstreaming and Adaptation to Climate Change	Lessons learned were collected from an evaluation report and send to Mozambican partner (Verde Azul).
Coping with Drought and Climate Change (CwDCC) in Mozambique	Project documents were send to Mozambican partner (Verde Azul).
Disaster Risk Resilient Livelihoods Recovery in Gaza Province	Project information was send to Mozambican partner (Verde Azul).
Climate Change Adaptation In SADC Trans-Frontier Conservation Areas Project	We have contacted and interviewed a representative from WESSA, and are in the process of establishing potential collaboration or sharing lessons learned. This includes establishing which of the training modules used for developing capacity for climate change adaptation can be used for our purposes and/or would be appropriate for our stakeholders. WESSA could also be a source for additional facilitators if such a need emerges.
War on Leaks Project	Initial contact is being established to scope for potential collaboration. Collaboration could potentially include sending our stakeholders to participate in the skills development and training provided by the project to support alternative livelihoods as a livelihood diversification. This will require determining more detail on the project's objectives, activities and implementation.
SPACES: North Limpopo Living Landscapes	We have contacted representatives of the relevant research institutions and are in the process of arranging scoping interviews for potential collaboration. The potential benefit from such a relationship would be to share the results of the project with our stakeholders, including farmers and agricultural extension services.
Water Balance Programme	We have conducted a scoping telephonic interview. WWF is not interested to expand geographically with its Water Balance Programme. However, it is willing to share lessons learned with other institutions interested to set similar programme. We are their offer into consideration for the project activities on alien plant control and the Lower Olifants EcoPark.
Eco-Congregation and Earth Keepers	We have interviewed a SAFCEI representative. We are in the process of establishing potential collaboration or sharing lessons learned. This could include joint workshops and coordinating with the established SAFCEI social network to facilitate awareness raising activities.

Chapter 6

Conclusion



What does it mean for the RESILIM-O?

According to the latest Assessment Report by the IPCC, global surface temperature change for the end of the 21st century is likely to exceed 1.5°C relative to 1850 to 1900 (IPCC 2014)[8]. The warming of our atmosphere induces threats that pose risks on virtually every aspect of social ecosystem system (SES), though the extent and nature of the effects will vary from system to system. South Africa and its people are not sheltered from impacts of climate-induced threats. At a *Party* to the UNFCCC, South Africa has made a commitment to the Convention that it will contribute toward climate change mitigation and adaptation. It is within this context that South Africa formulates its adaptation needs and options to the international community in their NCs. This context also influences how South Africa frames its national policies for climate change response: NCCRP and sectoral legislature and strategies for climate change adaptation. In addition, the LTAS assessments are used as a basis for framing and strategizing climate change adaptation in South Africa, which is developing its NCCAS. At the provincial level, PCCASs are being developed in three pilot provinces namely, North West, Mpumalanga and Limpopo, and *Let's Respond Toolkit* is being rolled out in municipalities to assist them in integrating climate change adaptation into their IDPs.

These international communications and domestic policy instruments form the institutional framework for climate change adaptation within which the RESILIM-O operates. The South African institutional framework for climate change adaptation is relevant to RESILIM-O because one of its main objectives is to reduce vulnerability of the Olifants Catchment to climate change. Indeed, almost half of the RESILIM-O project activities for 2016 speak to this objective by supporting collective action, informed adaptation strategies practices and tenable institutional arrangements in the Olifants Catchment.

Table 10 lists the 15 RESILIM-O project activities that integrated climate change adaptation as a core element for the water, biodiversity, agriculture, disaster management and cross-sectoral sectors.

For these project activities to be successful in the Catchment, they must align with the greater climate change adaptation developments at the local, provincial and national levels. This study was undertaken to inform us of these developments and the discourse on climate change adaptation at the different levels.

Chapter 6 provided a review of the existing adaptation projects with project sites in the Olifants Catchment. At least six active projects related to climate change adaptation that are relevant to the Olifant Catchment have been identified. These projects mostly address social and institutional adaptation options, and are related to the agriculture and disaster management sectors. However, none of these projects are specifically aiming to support the transformation of practices in local government and the overall management of the water catchment area to be more systemic.

TABLE 10: A LIST OF RESILIM-O PROJECT ACTIVITIES THAT INTEGRATED

[8] *This projection is for all Representative Concentration Pathway (RCP) scenarios except RCP2.6 (a low emission scenario). RCP is the latest generation of scenarios that provide input to climate models. Global surface temperature is likely to exceed 2°C for RCP6.0 (intermediate emissions) and RCP8.5 (high emissions), and more likely than not to exceed 2°C for RCP4.5 (intermediate emissions).*

ADAPTATION PER THE IPCC CATEGORIZATION.

Resilim-O project activitives	Sector	S/P	S	I
Integration through a RESILIM-O flagship project				
Climate change modelling for planning (SDM and CRA)	Cross-sectoral		Info	
To enhance long-term water security and protection				
Olifants-Letaba CMA support for the Governance and Management of water resources of the Olifants River Catchment	Water		educ	gov
Support for a bi-lateral agreement to enhance basin-wide ecosystem integrity	Water			gov
Real-time compliance monitoring of river health	Water	tech		
Wastewater Treatment Works (WWTWs) compliance support initiative: Governance, management and skills enhancement	Water	serv	educ	
To conserve biodiversity and sustainably-managed high-priority ecosystem				
Blyde Ecosystem Restoration & NRMP support project	Biodiversity	EbA		
Legalameetse co-management support project	Biodiversity			gov
Blyde co-management & stewardship support management	Biodiversity			gov
To reduce vulnerability to climate change and other factors				
Integrating climate change (CC) into disaster risk	Disaster mgmt		educ, info	gov
Update and collate climate information for the Olifants	Cross-sectoral		info	
Embedding CC in RESILIM-O projects	Cross-sectoral		educ	gov
Support for climate adaptation to small-scale agriculture	Agriculture		educ, behr	
Support for climate adaptation to vegetable gardens	Agriculture		educ, behr	
WCDM for muncipalities	Water		info	

Note: S/P stands for structural/physical adaptation; S stands for social adaptation; and, I stands for institutional adaptation.

Chapter 5 provided a review of the PCCAS development in Limpopo and Mpumalanga. As a whole, RESILIM-O project activities will directly or indirectly address several of the recommendations of the PCCASs for Mpumalanga and Limpopo (see *Table* 11). Our overall contribution will be to introduce and facilitate systems thinking to support and enhance cross-sectoral planning for climate change adaptation. A key part of this will be to engage with the cross-sectoral climate task teams in Limpopo and Mpumalanga. We have already submitted the nomination of one AWARD staff member to be part of the Limpopo task team. Furthermore, we are currently in close engagement with the DEA, SALGA, LEDET and DARDLEA on exploring opportunities to align capacity development activities as these entities continue to finalise and implement the PCCASs, establish task teams or networks of "climate champions", and implement the *Let's Respond Toolkit* in local municipalities.

TABLE 11: RECOMMENDATIONS OF THE MPUMALANGA AND LIMPOPO CCAS THAT WILL BE ADDRESSED BY RESILIM-O PROJECTS AND INITIATIVES.

Sector and Province	Recommendation	RESILIM-O
Livelihoods and Settlements – Rural and Urban (MP, LP)*	Recommendation 3: Redouble efforts to improve overall socio-economic security and wellbeing. Stakeholders added to "encourage effective food production by promoting home gardens"	Initiatives like this are being considered under our CSA project.
Water (LP)	Recommendation 4: Strengthen existing Catchment Management efforts. Stakeholders added the following activities: i) Clear invasive alien plants and introduce indigenous plants; ii) Strengthen enforcement of National Water Act including preventing illegal diversion of water and building of dams in rural area.	We are building an application for and providing support for monitoring compliance of EWR and water quality. This includes the following projects: "Integrated Water Quality and Quantity Modelling in Support of the Integrated Water Resources Management System (IWRMS)", and "Real-time compliance monitoring of river health (quantity and quality) in support of IWRMS".
DM (MP)	Recommendation 2: Develop and implement public awareness and training programmes based on this evidence base to educate people about climate change related disaster risks and responses.	This recommendation will be addressed indirectly through our disaster risk reduction (DRR) project.
DM (MP)	Recommendation 3: Strengthen overall disaster prevention, disaster management, and disaster response in the province through broad-based capacity building of first responders and relevant officials.	Our DRR project will directly address this recommendation.
Human Health (MP, LP)	Recommendation 3: Fund and implement a comprehensive public health and climate change awareness and adaptive capacity building programme, with a particular focus on heat-health and vector-borne diseases, water-borne diseases, respiratory health, and with a special focus on vulnerable populations like children and the elderly.	We are currently conducting research to link water quality and human health which can inform addressing risk related water-borne diseases.
Agriculture (LP)	Recommendation 2: Enhance ongoing efforts involving Conservation Agriculture.	We are proposing soil and water conservation practices in the CSA project that will be implemented in the Upper Ga-Selati and Sekhunekhune.

Sector and Province	Recommendation	RESILIM-O
Biodiversity (MP, LP)	Recommendations overall address the integration/inclusion of climate change considerations into the planning and management of biodiversity resources and ecosystems.	The "Embedding climate change" project will support this effort at the level of the Olifants Catchment by working with RESILIM-O's projects related to "Biodiversity and Natural Resources Governance and Protection in the Catchment". These projects will support the rehabilitation and maintenance of ecological infrastructure which can then be used to support ecosystem-based adaptation.
Cross MP	Recommendation 1: Increase education and awareness on climate change and adaptation;	This will be addressed by our "Embedding climate change" project which will involve awareness raising and collective meaning-making approaches.
Cross MP	Recommendation 3: Provide funding resources for adaptation	The Blyde ecosystem restoration and NRMP support project will explore funding mechanism for EbA through private sector partnership.
Cross MP	Recommendation 4: Support capacity building to implement adaptation plans/actions	This will be addressed by our "Embedding climate change" project as part of the "Resilience Support Initiatives" to facilitate workplace support and capacity development.
Cross Limp	Establish cross-sectoral climate task team	LEDET has approached us to submit a nominee to be part of the task team. This has been done. We will approach the Mpumalanga task team as well.
**Mpumalanga Province (MP), Limpopo Province (LP)*		

At a national level, NCCRP is the quintessential policy instrument for South Africa's climate change adaptation. It was gazetted shortly after South Africa has developed its second NC, and was considered to be an enhancement of the later in terms of the scope and nature of adaptation options. Chapter 4 provided an analysis of the two South African NCs relative to NCCRP and to the NCs of other non-Annex I *Parties*. NCCRP covered more sectors than the second NC and focused more on social- and institutional-type adaptation options, whereas NC focused more on the structural/physical- and social-type of adaptation. Social and institutional adaptation options usually are designed to lead to transformational adaptation than the structural/physical options are.

There is much alignment between the NCCRP and the adaptation project activities to be implemented for RESILIM-O, which addresses four common sectors with the NCCRP: water resources, biodiversity, agriculture and disaster management. Similar to the NCCRP, most of the adaptation project activities in RESILIM-O fall under the social (50%) and institutional (33%) categories (Table 10). Among the social-type adaptation, much of the emphasis of the RESILIM-O project activities is on capacity

development (e.g. skilling municipalities, small-scale farmers and Olifants-Letaba CMA) and enhancing information by facilitating sharing and collation of relevant information.
All of the institutional-type adaptation that RESILIM-O is implementing aim to enhance governance through institutional arrangements.

Even though South Africa has been taking steps to establish an institutional framework for climate change through the Climate Support Programme, there exists significant institutional barriers to the implementation of an integrated climate change adaptation. These barriers include poor integration of adaptation vertically and laterally into the full institutional structure and practices of government (Ziervogel *et al*. 2014). The lack of alignment between the NCCRP and South African water policies is of particular concern. The policy instruments of the water sector fail to address disaster management from a preventive and reduction approach. This is of critical concern because South Africa is prone to prolonged periods of drought and consequently water security is a major climate risk (DEA 2013). These gaps in water policy implicate the agricultural sector and food security because of the interconnectedness between water and food production. Recognizing the importance of the water sector and these institutional gaps in the sector, RESILIM-O has a very strong focus on enhancing the governance and developing adaptive capacity of water resource management in the Olifants Catchment.

In addition to these institutional barriers, limited capacity and understanding of climate change, as well as poor communication and coordination between departments and between different levels of government were identified as other major barriers to building climate resilience of South Africa (Ziervogel *et al*. 2014). Similarly, stakeholders in the consultative workshops for the draft Limpopo and Mpumalanga CCASs emphasized the importance of capacity development and allocating resources to support capacity development at provincial and local levels. At least 15 out of the 29 recommendations and 12 of the 20 recommendations provided by the Mpumalanga and Limpopo stakeholders referenced capacity development, respectively. Taking these barriers and recommendations into consideration, majority of the adaptation project activities in RESILIM-O are social in nature with a very strong focus on capacity development at provincial and local levels.

Overall, this study has provided a basis for understanding the international, national and provincial discourse and development on South Africa's climate change adaptation. Additionally, the study has revealed significant institutional barriers for implementing adaptation and opportunities for collaboration with other adaptation projects in the Olifants Catchment. It is within this context that AWARD developed the adaptation project activities for RESILIM-O and is implementing these activities to build the climate resilience of the SES in the Olifants Catchment.

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Appendix A

SOUTH AFRICAN POLICY INSTRUMENT PERTAINING TO CLIMATE CHANGE ADAPTATION.

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Policy instruments related to the Water Sector		
National Water Resource Strategy (2012; DWA) ("NWRS2")	Yes	Addressing the impacts of climate change is articulated as a clear objective. Direct measures include: ■ building adaptive capacity into institutions; ■ recognising the uncertainty of current models on projected impacts on water in South Africa and for this reason this uncertainty should be built into climate change response strategies; ■ building co-operation and coordination within and the water sector and between sectors for climate change; ■ developing climate change awareness and communication campaigns; ■ supporting research and development on water specific climate change impacts and resilience building; ■ factoring climate change resilience for water infrastructure into the National Water Investment Framework; ■ decision making for water is to be tested against the climate change scenarios; ■ Water Services Authorities to develop climate response strategies in their development plans; ■ implement water conservation and water demand management and reduce levels of non-revenue water; ■ improve flood early warning systems in critical catchments; ■ all water institutions managing infrastructure are to address the issue of climate change impacts in their asset management plans; ■ monitoring and evaluation of water and climate data is to be prioritised under the coordination and leadership of the DWA; ■ standardised reporting protocols must be agreed on and implemented under the leadership of the DWA and Department of Environmental Affairs;

(continue) **National Water Resource Strategy (2012; DWA) ("NWRS2")**	Yes	■ improve climate change modelling and understanding of hydrological impacts; ■ the DWA is to conduct a vulnerability assessment for the country to assess the most critical areas for the implementation of water and climate change adaptation measures; ■ all catchment management strategies, Reconciliation Strategies and investment planning, water services development plans, Integrated Development Plans, and all programmes and strategies of all water sectors and water dependent entities, must address the issue of climate change adaptation and mitigation; ■ adapt tools for allocation of water to intra- and inter-annual changes in water availability; ■ implementation of water conservation and water demand management as a critical adaptation tool; ■ integrate potential impacts of water-related climate change into water quality management strategies and reserve determination processes, and the protection of aquatic ecosystems, as well as disaster management systems and processes and the enhancement thereof. Indirect measures include: ■ implementation of equity policy and allocative reform; ■ placing water at the centre of integrated strategic planning and decision making to achieve national development and sector goals; ■ better integration of water considerations generally into integrated development plans; ■ development of major water infrastructure, regional bulk infrastructure and municipal infrastructure; ■ decentralising management of water related impacts as envisioned by the NCCRP; ■ prioritizing the investigation and use of alternative water resources such a groundwater, rainwater harvesting, effluent re-use and other technologies; ■ the provision of resources and capacity building; ■ effective collation of data from a range of water institutions into an accessible information system and with a data sharing protocol; ■ monitoring infrastructure to be upgraded. Other objectives related to vulnerability and resilience development include various measures aimed at securing environmental integrity in aquatic ecosystems, such as the development of National Freshwater Ecosystem Priority Areas; the protection of riparian and wetland buffers and critical groundwater recharge areas, the rehabilitation of strategic water ecosystems; strategic water investments ; the monitoring of ecological health and reduction of pollution from waste water treatment works. Water conservation and water demand management as identified in the NCCRP, has a particularly high priority in the NWRS2.

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Groundwater Strategy ("GWS")(2010; DWA)	Indirectly	Groundwater is prioritised because it is a more resilient source of water in drought conditions and its integral relation to food security.
Water for Growth and Development in South Africa ("WFGD") (2008; DWA)	Indirectly	The instrument is not informed by adaptation considerations, instead it notes the gaps in knowledge and need for more detailed data to determine what impacts are anticipated.
DAFF. Irrigation Strategy for South Africa. (2010; DAFF)	[Requires copies from DAFF]	[Requires copies from DAFF]
The New Growth Path Framework ("NGP") (2nd ed), (2011; DED).	Indirectly	The instrument makes generic references to the need to address climate change, via "greening" the economy, though it is not the main goal of the NGP. Initiatives mostly focus on mitigation measures (e.g. investments in renewable energy and reduction in emissions) and not adaptation.
National Development Plan 2030 (2011; NPC) "NDP 2030".	Indirectly	The instrument addresses transition to a low carbon economy, but this is not integrated into all sectors. It mostly refers to mitigation, and not adaptation.
Integrated Resource Plan 2010-2030 (2011; DOE) ("IRP")	No	The IRP is more focused on mitigation and achieving carbon emission reductions as opposed to adaptation and thus does not address any of the adaptation concerns in the NCCRP for the water sector.
South African National Infrastructural Plan (2012; PICC). ("Infrastructural Plan")	Indirectly	It seeks to improve upon water and sanitation infrastructure, however it does not appear to be informed by adaptation considerations.
Drought Management Plan (2005; DAFF).	No	The instrument is not informed by or provide for adaptation considerations. It is presumed this plan will be replaced by the preparation and implementation of the water sector disaster management plan within the National Disaster Management Framework.
National Water Act 36 of 1998 (NWA) and regulations in terms thereof.	No	Needs review in the specific context of climate change.

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Policy instruments related to Disaster Management		
National Disaster Management Framework (2005; ("Disaster Framework") Disaster Management Act 57 of 2002 ("DMA")	Yes	Address issues related to adaptation and disaster management (e.g. early warning systems), but does not directly address climate change adaptation. The instrument focuses on the development and support of: ■ early warning systems and technologies ■ inter-state collaboration ■ creation of Risk and Vulnerability support structures (e.g., National Forecasting Centre and the Aviation Weather Centre) ■ establishment of the National Disaster Management Advisory Forum ■ enhance the National Disaster Management Information System (NDMIS) (e.g. Hazard Analysis, Vulnerability Assessment, Contingency Planning, Reporting Systems as well as Early Warning Systems) ■ Fire Danger Index providing near real-time live fire updates with continued improvements regarding performance and functionality ■ Ex post disaster analysis is provided for
Agricultural Disaster Risk Management Plan, ("ADRMP")	Yes but limited to agriculture sector	Specifically addresses impacts of climate change, but limited to agricultural sector. This includes the development of early warning systems, post-disaster recovery and rehabilitation, information and awareness management and dissemination.
Drought Management Plan (2005; DAFF)	Yes but limited to agriculture sector	Adaptation is address through the development of mechanisms for financial assistance, early warning systems, awareness and education, and institutional support at various levels of government.

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Policy instruments related to Agriculture, Forestry and Fisheries		
National Development Plan Vision for 2030 ("NDP") (specifically chapter 6 – "An Integrated and Inclusive Rural Economy" and to some extent, chapter 5 - "Ensuring Environmental Sustainability and an Equitable Transition into a Low-Carbon Economy")	Yes	Environmental sustainability and the equitable transition into a low-carbon economy is addressed. Adaptation factors for agriculture that are mentioned include: ■ public investment in new agricultural technologies and the development of resilient and environmentally sustainable strategies and support services for small-scale and rural farmers as well as the expansion of commercial agriculture ■ maintenance of ecosystem services such as those providing foods and clean water, regulating climate and disease, supporting crop pollination and nutrient cycles ■ application of practices that will reduce meat production, reduce the use of nitrogen fertilisers, and promote organic farming methods. For the sustainable expansion of forestry, the instrument addresses the establishment of natural plant cover in areas such as the thicket biome. Overall, the instrument recognizes that: ■ the rural poor are vulnerable to climate-change effects ■ climate change will affect what agriculture-specific investments will pay off best and where they should be made. ■ water and infrastructure development, sectoral development must be informed by the best available climate predictions and coordinated responses promoted through an effective national planning system ■ development of climate-adaptation strategies should avoid running parallel to broader national development strategies ■ climate change impacts must be considered in planning of the agricultural sector.
Draft Climate Change Sector Plan (DAFF, 2013)	Yes	The instrument calls for the identification of appropriate strategies for adaptation and provides examples of adaptation measures that could be adopted in each of the agriculture, fisheries and forestry sub-sectors, but itself does not identify any specific adaptation measures to be implemented. Examples of adaptation measures and activities mention include: response farming, crop selection and breeding, animal selection, rainfall use efficiency, and timing of agricultural activities. For the agricultural sector, prevention and mitigation strategies are emphasised (e.g. supporting risk management initiatives; research of large-scale epidemics and hazards).

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Agriculture Forestry and Fisheries, Integrated Growth and Development Plan ("IGDP") (2012; DAFF) (replaces the Strategic Plan for South African Agriculture, named in the NCCRP.)	Yes	Adaptation is addressed through the: ■ establishment of awareness and training programmes to encourage alternative livelihood practices to reduce pressure on natural resources ■ integration and alignment of early warning systems (e.g. pests, diseases, fire, drought) ■ implementation of risk mitigation and management systems as a basis for allocation of disaster management funds and interventions ■ Implementation and support of environmental awareness programmes ■ development of an integrated climate change strategy in collaboration with sector stakeholders, including guidelines to resource users on adaptation and mitigation measures. Furthermore, the IGDP requires that an Integrated Climate Change Strategy must be developed in collaboration with the sector stakeholders. This strategy is to include guidelines on adaptation and mitigation measures.
Strategic Plan for the Department of Agriculture, Forestry and Fisheries 2011/12-1014/15 (2011; DAFF).	Weakly	The anticipated adaptation impacts from the only reference made to adaptation is the ensuring of strategic goal 2 (sustained management of natural resources), specifically in the forestry sector.
Integrated Food Security Strategy for South Africa (2002) ("IFSS")	No	The IFSS is not informed by adaptation considerations at all. However, two of the policy interventions proposed for the improvement of household food production are relevant to adaptation in that the concept of adaptation can be used in the implementation of these policies. The two policies are: ■ promotion of small-scale irrigation and other rainwater harnessing technologies; ■ investment in productivity-enhancing, environmentally sustainable technologies for the agriculture and agro-processing sector, targeting small-scale producers.

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Policy instruments related to Health.		
National Department of Health ("DOH") Strategic Plan 2010/11- 2012/13 ("NDHSP")	Indirectly	The NDHSP is not directly informed by nor does it seek to plan for climate change impacts. However, it will help to reduce pre-existing health sector vulnerabilities to climate change by improving overall service delivery, access to medication, decreasing the burden of certain diseases and by focusing on better primary health care, disaster management and information systems.
NEM: Air Quality Act 39 of 2004 ("NEMAQA") and the South African Air Quality Information System. National Ambient Air Quality Standards (GNR 1210 of 24 December 2009) (which includes the regulation of Particulate Matter (PM10)) National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Micron Meters (PM2.5), GNR 486 of 29 June 2012 ("GNR 486") Draft National Dust Control Regulations published in Government Notice 1007 of 7 December 2012	Yes	NEMAQA and its regulations both current and draft are considered sufficient to address the air related impacts on public health in respect of climate change. Similarly SAAQIS has developed an ambient air quality monitoring data management system that allows all Government owned monitoring stations to feed their data into the SAAQIS. SAAQIS is currently in the second phase of the design, development, testing and implementation of the National Atmospheric Emission Inventory, including the Greenhouse Gases (GHG) emission inventory. Once finalised it will provide accurate, current and complete information on all significant sources of identified atmospheric emissions, including greenhouse gas emissions. This in turn will address many of the adaptation needs required in respect of this particular climate change impact.
National Development Plan("NDP") 2030 (2011; NPC)	No	Described measures will support the NDHSP and will alleviate climate change impacts to some degree, but they are not climate change specific or motivated. These measures include: ■ early warning systems for disease occurrence ■ education and awareness training, especially in schools, regarding health care and nutrition.

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Policy instruments related to Human Settlements.		
National Development Plan: Vision 2030, (NDP)	Indirectly	The NDP is informed by adaptation impacts but these are addressed separately under the context of the transitioning to a low carbon economy and not in an integrated fashion with other sectors. Aspects of required adaptation measures are included but not dealt with comprehensively under the sections addressing human settlements.
The National Housing Code 2009, Department of Housing (including Breaking New Ground" A comprehensive Plan for the Development of Sustainable Human Settlements (2004; DoH)	Yes	Climate change vulnerabilities and adaptation considerations are considered in programmes for improved housing design (e.g. address poor quality by including more professional input as well as traditional technologies and indigenous knowledge) and improved information management, monitoring and reporting.
National Norms and Standards for the Construction of Stand Alone Residential Dwellings National Building Regulations and Building Standards Act 1997 and Regulations thereunder in terms of GNR.2378 of 12 October 1990.	Very weakly	Associated manuals advice on norms and standards that could contribute to climate resilience
Spatial Planning and Land Use Management Bill 2012.	Very weakly	It is unknown whether the principle of spatial resilience, which is to guide the development of the Spatial Development Frameworks is sufficiently developed in the draft Bill to account for adaptation requirements.
Comprehensive Rural Development Programme ("CRDP") (2009 ; Department of Rural Development and Land Reform)	Indirectly, not comprehen-sively	Water harvesting and support for non-farming activities are addressed, but without specific consideration for climate change considerations. However, certain projects such as training rural communities with technical skills, combining them with indigenous knowledge to mitigate community vulnerability to climate change, soil erosion, adverse weather conditions and natural disasters, hunger and food insecurity will assist in addressing climate change impacts.

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Global Change Grand Challenge: National Research Plan (June 2009; DST)	(could inform/ contribute to)	The contents of these research focus areas could contribute to and inform climate change adaptation. Research focus areas include: ■ What are the factors that would determine urban resilience? ■ How does a city's physical form and infrastructure affect its resilience? ■ How can cities, their infrastructure, and the control and management systems that regulate their functions be designed so to improve the resilience of the conurbation? ■ What would be appropriate monitoring and assessment tools with which to evaluate a city's on-going resilience? ■ The coastal zone (especially the east and south coasts where most people live on). ■ Water-stressed ecosystems and regions, where freshwater resources are "over-allocated". ■ Where climate predictions suggest that rainfall will decrease. ■ Riparian and other low-lying areas that could be subject to flooding. ■ Areas of high fire danger, especially where climate predictions suggest that weather conditions conducive to the spread of veld fires will increase
National Environmental Management Act 107 of 1998: Environmental Management Frameworks ("EMF")	No	An EMF is not specifically intended to address climate change considerations with regards to human settlements in a particular geographic area, but could be used to do so. Specific EMFs could be used to manage areas particularly vulnerable to climate change.
National Environmental Management: Integrated Coastal Management Act 24 of 2008 ("NEMICMA")	No	Minor revision of this statute may be warranted to include greater climate change specificity with regards to the requirements of costal management plans and programmes including location specific climate change vulnerabilities. Its full implementation is however unrealised.

Policy Instrument	Addressing the adaptation objectives of the NCCRP?	What element of adaptation does the policy instrument address? Anticipated adaptation impacts
Policy instruments related to Biodiversity.		
National Framework for Sustainable Development in South Africa, 2008 ("NSDF"") and the National Strategy for Sustainable Development and Action Plan ("NSSD1")	Yes	The NSDF and NSSD1 is not primarily focused upon climate change but it is considerably informed thereby. It seeks to influence the manner in which development takes place by seeking to render it more sustainable. With regards to climate change objectives specifically it has the following objectives: ■ Have city-wide public transport systems in place by 2020; ■ Achieve energy efficiency target of at least 12% by 2015; ■ Roll out 1 000 000 solar water heaters by 2014; ■ Biofuel strategy aims to achieve a 2% penetration level of biofuels in the national liquid fuel supply; ■ Development of climate risk management systems for priority adaptation sectors; ■ Strengthen key sectors such as water, agriculture, health etc to be more resilient and also have the ability to adapt to climate variability and change; ■ Implement more than 50% of the National Protected Areas Expansion Strategy by 2020 to build ecosystem resilience and reduce risk of natural disasters.
National Biodiversity Strategy Action Plan ("NBSAP") DEA (2005) and the National Biodiversity Assessment 2011 ("NBA 2011") (SANBI)	Weakly	The plans lack clarity on how eco-based adaptation can be translated into practice. However, the NBA has a more climate focused agenda than the NBSAP. It identifies specific climate actions which serve as a useful outline of the development trajectory for this sector as focused upon spatial mapping. Vulnerability Spatial Mapping identifies geographic areas that are most important for climate change resilience which enables appropriate management and conservation of those areas to ensure continued integrity of ecological infrastructure, supporting the provision of ecosystem services. The focus is currently on terrestrial to be expanded towards aquatic ecosystems.

Appendix B

LIST OF WEBSITES OF RELEVANT ORGANISATIONS SEARCHED FOR CLIMATE CHANGE ADAPTATION PROJECTS IN THE OLIFANTS CATCHMENT.

(*The websites were accessed in October to November 2015.*)

Organisations	Website
Multi-lateral funding sources	
World Bank	www.worldbank.org/projects
Adaptation Fund (AF)	www.adaptation-fund.org/ www.uni-goettingen.de/en/478267.html
Global Environment Facility (GEF)	www.worldbank.org/
United Nations Development Programme (UNDP)	http://open.undp.org/#2015/filter/region-RBA
United Nations Environment Programme (UNEP)	www.unep.org/climatechange/
International Networks	
International Council for Local Environmental Initiatives (ICLEI)	www.iclei.org/activities/projects-initiatives.html http://africa.iclei.org/
GLTFCA Great Limpopo Transfrontier Park (GLTP)	www.greatlimpopo.org/ahead-gltfca-network-and-programme/
Organisation for Economic Co-operation and Development (OECD)	www.oecd.org/southafrica/
NGOs, NPOs, Civic Society	
Endangered Wildlife Trust (EWT)	www.ewt.org.za/#
Federation for a Sustainable Environment for the Olifants River	www.fse.org.za/
NGO Pulse	www.ngopulse.org/vacancies
South African Faith Communities' Environment Institute (SAFCEI)	http://safcei.org
Wildlife and Environment Society of South Africa (WESSA)	www.wessa.org.za/
World Wide Fund for Nature (WWF)	www.wwf.org.za/
Private Sector	
Anglo Platinum	www.angloamericanplatinum.com
Anglo America	http://southafrica.angloamerican.com/
Exxaro	www.exxaro.com
Komatiland	www.komatilandforests.co.za/
Sappi	www.sappi.com/regions/sa/Sustainability/Pages/Sustainability-in-Southern-Africa.aspx
Research Institution	
Council for Scientific and Industrial Research (CSIR)	www.csir.co.za/
Consultative Group for International Agricultural Research (CGIAR)	www.cgiar.org/
South African Environmental Observation Network (SAEON)	www.saeon.ac.za/
South African National Biodiversity Institute (SANBI)	www.sanbi.org/biodiversity-science/state-biodiversity/climate-change-and-bioadaptation-division/climate-change-ada
Water Research Commission (WRC)	www.wrc.org.za/
Government (National & Provincial)	
Department of Environmental Affairs (DEA)	www.environment.gov.za/
Department of Economic Development, Environment and Tourism (LEDET)	www.ledet.gov.za/
Department of Agriculture, Forestry and Fishing (DAFF)	www.daff.gov.za/
Mpumalanga Tourism and Parks Agency (MTPA)	www.mtpa.co.za/

The *Association for Water & Rural Development [AWARD]*

AWARD is a non-profit organisation specializing in participatory, research-based project implementation. Their work addresses issues of sustainability, inequity and poverty by building natural-resource management competence and supporting sustainable livelihoods. One of their current projects, supported by USAID, focuses on the Olifants River and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems to sustain livelihoods and resilient economic development in the catchment.

P O Box 1919, Hoedspruit 1380, Limpopo, South Africa
T 015-793 0503 Waward.org.za
Company Reg. No. 98/03011/08: Non-profit org.
Reg. No. 006 - 821

About USAID RESILIM-O

USAID: RESILIM-O focuses on the Olifants River Basin and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems that support livelihoods and resilient economic development in the catchment. The 5-year program, involving the South African and Mozambican portions of the Olifants catchment, is being implemented by the Association for Water and Rural Development (AWARD) and is funded by USAID Southern Africa.

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