The contribution of seasonal climate forecasts to the management of agricultural disaster-risk in South Africa

Ikalafeng Ben Kgakatsi

A thesis submitted in fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Faculty of Sciences,
University of Witwatersrand, Johannesburg, South Africa

July 2014
DECLARATION

I declare that this thesis is my own, unaided work; unless specifically acknowledged, copied from other researchers; and that it is being submitted for the Degree of Doctor of Philosophy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Signed at Johannesburg -----------------day of------------------------------------------2014

__________________________________________
(Signature of candidature)
ABSTRACT

South Africa’s climate is highly variable, implying that the national agricultural sector should make provision to have early warning services in place in order to reduce the risks of disasters. More than 70% of natural disasters worldwide are caused by weather and climate or weather and climate related hazards. Reliable Seasonal Climate Forecasting (SCF) for South Africa would have the potential to be of great benefit to users in addressing disaster risk reduction. A disaster is a serious disruption of the functioning of a community or a society, causing widespread human, material, economic or environmental losses, which exceed the ability of the affected community or society to cope when using their own resources. The negative impacts on agricultural production in South Africa due to natural disasters including disasters due to increasing climate variability and climate change are critical to the sector.

The hypothesis assumed in the study is the improved early warning service and better SCF dissemination lead to more effective and better decision making for subsequent disaster risk reduction in the agricultural sector. The most important aspect of knowledge management in early warning operations is that of distributing the most useful service to the target group that needs it at the right time. This will not only ensure maximum performance of the entity responsible for issuing the early warnings, but will also ensure the maximum benefit to the target group.

South Africa is becoming increasingly vulnerable to natural disasters that are afflicted by localised incidents of seasonal droughts, floods and flash floods that have devastating impacts on agriculture and food security. Such disasters might affect agricultural production decisions, as well as agricultural productivity. Planting dates and plant selection are decisions that depend on reliable and accurate meteorological and climatological knowledge and services for agriculture. Early warning services that could be used to facilitate informed decision making includes advisories on
future soil moisture conditions in order to determine estimated planting times, on future grazing capacity, on future water availability and on forecasts of the following season’s weather and climate, whenever that is possible. The involvement of government structures, obviously, is also critical in immediate responses and long-term interventions.

The importance of creating awareness, of offering training workshops on climate knowledge and SCF, and of creating effective early warning services dissemination channels is realized by government. This is essential in order to put effective early warning services in place as a disaster-risk coping tool. Early warning services, however, can only be successful if the end-users are aware of what early warning systems, structures and technologies are in place, and if they are willing that those issuing the early warning services become involved in the decision-making process.

Integrated disaster-risk reduction initiatives in government programmes, effective dissemination structures, natural resource-management projects and community-participation programmes are only a few examples of actions that will contribute to the development of effective early warning services, and the subsequent response to and adoption of the advices/services strategies by the people most affected. The effective distribution of the most useful early warning services to the end-user, who needs it at the right time through the best governing structures, may significantly improve decision making in the agricultural, food security and other water-sensitive sectors. Developed disaster-risk policies for extension and farmers as well as other disaster prone sectors should encourage self-reliance and the sustainable use of natural resources, and will reduce the need for government intervention.

The SCF producers (e.g. the South African Weather Service (SAWS)) have issued new knowledge to intermediaries for some years now, and it is important to determine whether this knowledge has been used in services, and if so whether these services were applied effectively in coping with disaster-risks and in disaster
reduction initiatives and programmes. This study for that reason also intends to do an evaluation of the knowledge communication processes between forecasters, and intermediaries at national and provincial government levels. It therefore, aims to assess and evaluate the current knowledge communication structures within the national agricultural sector, seeking to improve disaster-risk reduction through effective early warning services. A boundary organisation is an organization which crosses the boundary between science, politics and end-users as they draw on the interests and knowledge of agencies on both sides to facilitate evidence base and socially beneficial policies and programmes.

Reducing uncertainty in SCF is potentially of enormous economic value especially to the rural communities. The potential for climate science to deliver reduction in total SCF uncertainty is associated entirely with the contributions from internal variability and model uncertainty. The understanding of the limitations of the SCFs as a result of uncertainties is very important for decision making and to end-users during planning. Disappointing, however, is that several studies have shown a fairly narrow group of potential users actually receive SCFs, with an even a smaller number that makes use of these forecasts

In meeting the objectives of the study the methodology to be followed is based on knowledge communication. For that reason two types of questionnaires were drafted. Open and closed questionnaires comprehensively review the knowledge, understanding, interpretation of SCFs and in early warning services distribution channels. These questionnaires were administered among the SCF producers and intermediaries and results analysed.

Lastly the availability of useful SCFs knowledge has important implications for agricultural production and food security. Reliable and accurate climate service, as one of the elements of early warning services, will be discussed since they may be used to improve agricultural practices such as crop diversification, time of planting
and changes in cultivation practices. It was clear from the conclusions of the study that critical elements of early warning services need to receive focused attention such as the SCF knowledge feedback programme should be improved by both seasonal climate producers and intermediaries, together with established structures through which reliable, accurate and timely early warning services can be disseminated. Also the relevant dissemination channels of SCFs are critical to the success of effective implementation of early warning services including the educating and training of farming communities.

The boundary organisation and early warning structures are important in effective implementation of risk reduction measures within the agricultural sector and thus need to be prioritised. Enhancing the understandability and interpretability of SCF knowledge by intermediaries will assist in improving action needed to respond to SCFs. Multiple media used by both SCF producers and intermediaries in disseminating of SCFs should be accessible by all users and end-users. The Government should ensure that farming communities are educated, trained and well equipped to respond to risks from natural hazards.
To my late mother, Mmanyana
and the Kgakatsi family
ACKNOWLEDGEMENTS

This dissertation deals with the implementation of an improved early warning system for disaster-risk management in the agricultural sector of South Africa. The study builds on the studies and research I have conducted over the past nine years at the Department of Agriculture in South Africa. Over the past years many people have offered me their support, either face-to-face or electronically. At the concluding stage of this thesis, that will form part of my doctoral degree, I would like to express my appreciation to all of those who have supported or have assisted me in my work.

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Secondly, I would like to thank the long-term seasonal climate studies research group of the South African Weather Service (SAWS), as my research topic was originally framed under their programme. Their contribution in assisting emerging farmers and farming communities, in general, to understand and correctly interpret the SCF information and to incorporate this into their decision-making is greatly appreciated.

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# TABLE OF CONTENTS

## CONTENTS

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>--ii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>vii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>viii</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>--x</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiv</td>
</tr>
<tr>
<td>LIST OF APPENDIXES</td>
<td>xviii</td>
</tr>
<tr>
<td>LIST OF ABREVIATIONS</td>
<td>ix</td>
</tr>
</tbody>
</table>

## CHAPTER 1 INTRODUCTION

1.1 Background--------------------------------------- --1
1.2 Seasonality of the South African Climate-------- --6
1.3 Climate change and the agricultural sector------ --7
1.4 Atmospheric modelling and seasonal forecasting-- --10
1.5 Seasonal agro-meteorological forecasts---------- --12
1.6 The importance of SCF implementation----------- --15
   1.6.1 Application of SCF information------------ --17
   1.6.2 End-to-end forecast assessment------------ --19
1.7 Uncertainty in SCFs----------------------------- --20
1.8 Disaster-risk management------------------------- --21
   1.8.1 Historical perspective on natural hazards in agriculture -- --24
   1.8.2 Engagement of stakeholders at all levels ---- --27
      1.8.2.1 International involvement---------- --28
      1.8.2.2 A regional approach------------------ --29
      1.8.2.3 National approach------------------- --30
1.9 Food security

1.10 Early warning information

1.10.1 Interaction between government and end-users

1.11 Problem statement

1.12 Aim and objectives

1.13 Approach of the study

1.14 Thesis outline

**CHAPTER 2 RESEARCH METHODOLOGY**

2.1 Introduction

2.2 The communication of knowledge model

2.3 The multi-method approach

2.4 Questionnaires

2.5 Respondents and sampling

2.6 Data and information captured from producers and intermediaries

2.7 Statistical analysis

2.8 Summary

**CHAPTER 3 ROLES, FUNCTIONS AND INFORMATION DISSEMINATION BY SEASONAL CLIMATE FORECAST PRODUCERS**

3.1 Introduction

3.2 Responsibilities of and requirements from SCF producers

3.2.1 Confidence in SCF products

3.2.2 Obtaining SCF feedback from users

3.2.3 Strategies to obtain SCF feedback from users

3.2.4 The value of SCFs

3.2.5 Importance of a boundary organisation

3.2.6 Summary
LIST OF FIGURES

Figure 1.1: The interactions of the Agricultural Disaster-Risk Management (ADRM) advisory information dissemination structures in South Africa. Acronyms: Department of Agriculture, Forestry and Fisheries (DAFF), Provincial Department of Agriculture (PDA), National Agro-meteorological Committee (NAC), Agricultural Research Council (ARC), National Disaster-Risk Management Committee (NDRMCO), Early Warning Committee (EWC) and South African Weather Service (SAWS). 24

Figure 1.2: Diagram showing the key role-players involved in the development, distribution and application of Seasonal Climate Forecasts (SCFs). This study addresses the sectors indicated by shaded boxes (A2, B1, B2 and B3). 40

Figure 2.1: Map of South Africa, which is the study area, with its nine provinces. Annual average rainfall calculated from 1920-2000 is also presented. Source: ARC–ISCW, (2008); see www.arc.agric.za. 51

Figure 3.1: The distribution of the number of respondents in the five occupation sub-groups from SCF producer community. The total number of respondents was N=24, of which 15 were male (N_m=15), and 9 were female (N_f=9). 57

Figure 3.2: Percentage distribution of feedback on the confidence level in SCFs amongst the five occupation sub-groups of respondents from the SCF producer community (N=24 from which N_m=7, N_r=6, N_cf=8, N_dr=1 and N_o=2). 59

Figure 3.3: Percentage distribution of feedback on the SCFs received amongst the five occupation sub-groups of respondents from the SCF producer community (N=24 of which N_m=7, N_r=6, N_cf=8, N_dr=1 and N_o=2). 60

Figure 3.4: Percentage distribution of feedback on the methods used to obtain SCF feedback amongst the five occupation sub-groups of respondents from the SCF producer community (N=24 of which N_m=7, N_r=6, N_cf=8, N_dr=1 and N_o=2). 62

Figure 3.5: Percentage distribution of feedback on the value of SCFs amongst the five occupation sub-groups of respondents from the SCF producer community (N=24 of which N_m=7, N_r=6, N_cf=8, N_dr=1 and N_o=2). 63
Figure 3.6: Percentage distribution of feedback indicating the recommendation for a boundary organization (B.o.) amongst the five occupational sub-groups of respondents from the SCF producer community (N=24 of which N_m=7, N_r=6, N_cf=8, N_dr=1 and N_o=2).

Figure 3.7: Percentage distribution of feedback from all occupation groups in the SCF producers community on the most preferred media channels currently used for communicating SCF knowledge to users (note: each of the respondents had multiple choices, hence the total percentage is more than 100%, N=24 of which N_m=7, N_r=6, N_cf=8, N_dr=1 and N_o=2).

Figure 3.8: Percentage distribution of feedback from all occupation groups in the SCF producers community on the most preferred receiving audience of SCF knowledge (note: each of the respondents had multiple choices, hence the total percentage is more than 100, N=24 of which N_m=7, N_r=6, N_cf=8, N_dr=1 and N_o=2).

Figure 3.9: Percentage distribution of feedback from all occupation groups in the SCF producers community on the content of knowledge to be communicated to users (note: each of the respondents had multiple choices, hence the total percentage is more than 100, N=24 of which N_m=7, N_r=6, N Cf=8, N_dr=1 and N_o=2).

Figure 3.10: Percentage distribution of feedback from all occupation groups in the SCF producers community on the methods used to avoid knowledge distortion (note: each of the respondents had multiple choices, hence the total percentage is more than 100, N=24 of which N_m=7, N_r=6, N Cf=8, N_dr=1 and N_o=2).

Figure 4.1: Total distribution of the number of respondents in the five occupation sub-groups from intermediary community. Total number of respondents were N=110, of which 56 were male (N_m=56), and 46 were female (N_f=46).

Figure 4.2: Percentage distribution of feedback on SCF accuracy amongst the four occupation sub-groups of respondents from the intermediary community (N=110 of which N_m=56, N_r=24, N Cf=17, N_dr=10 and N_o=3).

Figure 4.3: Percentage distribution of feedback on efforts to obtain feedback from end-users amongst the four occupation sub-groups of respondents from the...
intermediary community (N=110 of which Nₘ=56, Nᵣ=24, Nₑᵦ=17, Nᵣₜ=10 and Nₒ=3) 84

Figure 4.4: Percentage distribution of feedback on the value assigned to SCFs amongst the four occupation sub-groups of respondents from the intermediary community (N=110 of which Nₘ=56, Nᵣ=24, Nₑᵦ=17, Nᵣₜ=10 and Nₒ=3) 86

Figure 4.5: Percentage distribution of feedback on the importance of disaster-risk policies amongst the four occupation sub-groups of respondents from the intermediary community (N=110 of which Nₘ=56, Nᵣ=24, Nₑᵦ=17, Nᵣₜ=10 and Nₒ=3) 87

Figure 4.6: Percentage distribution of feedback on the importance of a boundary organization (B.o.) amongst the four occupation sub-groups of respondents from the intermediary community (N=110 of which Nₘ=56, Nᵣ=24, Nₑᵦ=17, Nᵣₜ=10 and Nₒ=3) 89

Figure 4.7: Percentage distribution of feedback on the frequency of discussing the climate Advisory (c.A.) amongst the four occupation sub-groups of respondents from the intermediary community (N=110 of which Nₘ=56, Nᵣ=24, Nₑᵦ=17, Nᵣₜ=10 and Nₒ=3) 92

Figure 4.8: Percentage distribution of feedback from all occupation groups in the intermediary community on the most preferred media channels currently used for communication of SCF knowledge to users (note: each of the respondents had multiple choices, hence the total percentage is more than 100, N=110 of which Nₘ=56, Nᵣ=24, Nₑᵦ=17, Nᵣₜ=10 and Nₒ=3) 95

Figure 4.9: Percentage distribution of feedback from all occupation groups in the intermediary community on the content of knowledge communicated to end-users (note: each of the respondents had multiple choices, hence the total percentage is more than 100, N=110 of which Nₘ=56, Nᵣ=24, Nₑᵦ=17, Nᵣₜ=10 and Nₒ=3) 96

Figure 4.10: Percentage distribution of feedback from all occupation groups in the intermediary community on methods used to ensure credibility and correct knowledge distribution to end-users (note: each of the respondents had multiple
choices, hence the total percentage is more than 100, N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 98

Figure 4.11: Percentage distribution of feedback from all occupation groups in the intermediary community on the importance of awareness and training programmes (Aatps) (N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 100

Figure 4.12: Percentage distribution of feedback from all occupation groups in the intermediary community on the improvement of the understanding and interpretation (Iui) of SCF knowledge after awareness and training programmes (atps) (N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 102

Figure 4.13: Percentage distribution of feedback from all occupation groups in the intermediary community on SCF dissemination improvement (d.i.) following training on the understanding and interpretation (tui) of SCF knowledge (N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 104

Figure 4.14: Percentage distribution of feedback from all occupation groups in the intermediary community on the use of SCFs during planning (note: each of the respondents had multiple choices, hence the total percentage is more than 100, N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 105

Figure 4.15: Percentage distribution of feedback from all occupation groups in the intermediary community on actions taken after a hazardous SCF (N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 107

Figure 4.16: Percentage distribution of feedback from all occupation groups in the intermediary community on efforts taken to obtain early warning feedback from end-users (N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 108

Figure 4.17: Percentage distribution of feedback from all occupation groups in the intermediary community on the level of understanding of climate change (Ucc) (N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 110

Figure 4.18: Percentage distribution of feedback from all occupation groups in the intermediary community on the importance of early warning structures (ewss) (N=110 of which N_m=56, N_r=24, N_es=17, N_dr=10 and N_o=3) 112
LIST OF APPENDIXES

APPENDICES

A QUESTIONNAIRE ON COMMUNICATION OF WEATHER/CLIMATE FORECAST---------------------------170
B QUESTIONNAIRE ON COMMUNICATION OF WEATHER/CLIMATE FORECAST---------------------------174
C STRATEGIES THAT COULD BE FOLLOWED DURING DROUGHT-------------------------------------179
D EXTREME WEATHER WARNING-----------------------------191
E National Agro-meteorological Committee (NAC) Advisory on the 2010/11 summer season------------------------194

Appendixes
# LIST OF ABREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACMAD</td>
<td>African Centre of Meteorological Applications for Development</td>
</tr>
<tr>
<td>ADRM</td>
<td>Agricultural Disaster Risk Management</td>
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<tr>
<td>AGCM</td>
<td>Atmospheric General Circulation Model</td>
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<td>AMS</td>
<td>American Meteorological Society</td>
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<tr>
<td>ARC</td>
<td>Agricultural Research Council</td>
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<td>ARDM</td>
<td>Agricultural Risk and Disaster Management</td>
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<td>AU</td>
<td>African Union</td>
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<tr>
<td>CAgM</td>
<td>Commission on Agriculture Meteorology</td>
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<td>CASP</td>
<td>Comprehensive Agricultural Support Programme</td>
</tr>
<tr>
<td>CLIPS</td>
<td>Climate Information and Prediction Service</td>
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<td>CLIVAR</td>
<td>Climate Variability Analysis Research</td>
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<tr>
<td>DAFF</td>
<td>Department of Agriculture, Forestry and Fisheries</td>
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<tr>
<td>DCogTA</td>
<td>Department of Co-operative Governance and Traditional Affairs</td>
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<tr>
<td>DFID</td>
<td>Department for International Development</td>
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<tr>
<td>DMA</td>
<td>Disaster Management Act</td>
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<td>DMC</td>
<td>Drought Monitoring Centre</td>
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<td>DMISA</td>
<td>Disaster Management Institute of South Africa</td>
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<tr>
<td>DoA</td>
<td>Department of Agriculture</td>
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<tr>
<td>DPLG</td>
<td>Department of Local Government</td>
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<tr>
<td>DQRM</td>
<td>Departmental Quarterly Review Meeting</td>
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<tr>
<td>ENSO</td>
<td>EL Niño Southern Oscillation</td>
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<td>EWC</td>
<td>Early Warning Committee</td>
</tr>
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<td>EWI</td>
<td>Early Warning Information</td>
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<td>EWS</td>
<td>Early Warning System</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation</td>
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<td>FARA</td>
<td>Forum for Agricultural Research in Africa</td>
</tr>
</tbody>
</table>
FEWS  Famine Early Warning System
FMD  Foot and Mouth Disease
GCM  General Circulation Model
GDP  Growth and Development Programme
GHG  Greenhouse Gas
ICPAC  IGAD Climate Prediction and Applications Centre
IDMC  Intergovernmental Disaster Management Committee
IFRC  International Federation of the Red Cross / Red Crescent
IGAD  Intergovernmental Authority for Development
IPCC  Intergovernmental Panel on Climate Change
IRI  International Research Institute
ISCW  Institute for Soil Climate and Water
ISDR  International Strategy for Disaster Reduction
ITCA  Inter-department Committee of Agriculture
NAC  National Agro-meteorological Committee
NACOF  National Climate Outlook Forum
NAFU  National African Farmers Union
NARDMC  National Agricultural Risk and Disaster Management Committee
NDoA  National Department of Agriculture
NDMAF  National Disaster Management Advisory Forum
NDMC  National Disaster Management Center
NEPAD  New Partnership for Africa’s Development
NGO  Non-governmental Organisation
NMS  National Meteorological Service
NRC  National Research Council
OECD  Organisation for Economic Co-operation and Development
PDAs  Provincial Departments of Agriculture
PDMC  Provincial Disaster Management Center
PNAC  Provincial National Agro-meteorological Committee
MINMEC  Minister and Members of Executive Council
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHVP</td>
<td>Regional Hunger and Vulnerability Programme</td>
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<td>SA</td>
<td>South Africa</td>
</tr>
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<td>SADC</td>
<td>Southern Africa Development Community</td>
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<tr>
<td>SARCOF</td>
<td>Southern Africa Regional Climate Outlook Forum</td>
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<td>SAWS</td>
<td>South African Weather Service</td>
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<tr>
<td>SASAS</td>
<td>South African Society for Atmospheric Sciences</td>
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<tr>
<td>SCF</td>
<td>Seasonal Climate Forecast</td>
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<td>SPSS</td>
<td>Special Package for the Social Sciences</td>
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<td>SST</td>
<td>Sea Surface Temperature</td>
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<td>TV</td>
<td>Television</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<tr>
<td>UP</td>
<td>University of Pretoria</td>
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<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<tr>
<td>UNISDR</td>
<td>United Office for Disaster Risk Reduction</td>
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<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
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<tr>
<td>USA</td>
<td>United States of America</td>
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<tr>
<td>VAC</td>
<td>Vulnerability Assessment Community</td>
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<tr>
<td>WCDR</td>
<td>World Conference on Disaster Reduction</td>
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<tr>
<td>WFP</td>
<td>World Food Program</td>
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<tr>
<td>WMO</td>
<td>World Meteorological Organisation</td>
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<tr>
<td>WSSD</td>
<td>World Summit on Sustainable Development</td>
</tr>
</tbody>
</table>