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

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

DOCTOR OF PHILOSOPHY

Faculty of Sciences,
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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

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LIST OF ABREVIATIONS

ACMAD	African Centre of Meteorological Applications for Development
ADRM	Agricultural Disaster Risk Management
AGCM	Atmospheric General Circulation Model
AMS	American Meteorological Society
ARC	Agricultural Research Council
ARDM	Agricultural Risk and Disaster Management
AU	African Union
CAgM	Commission on Agriculture Meteorology
CASP	Comprehensive Agricultural Support Programme
CLIPS	Climate Information and Prediction Service
CLIVAR	Climate Variability Analysis Research
DAFF	Department of Agriculture, Forestry and Fisheries
DCogTA	Department of Co-operative Governance and Traditional Affairs
DFID	Department for International Development
DMA	Disaster Management Act
DMC	Drought Monitoring Centre
DMISA	Disaster Management Institute of South Africa
DoA	Department of Agriculture
DPLG	Department of Local Government
DQRM	Departmental Quarterly Review Meeting
ENSO	EL Niño Southern Oscillation
EWC	Early Warning Committee
EWI	Early Warning Information
EWS	Early Warning System
FAO	Food and Agriculture Organisation
FARA	Forum for Agricultural Research in Africa

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

RHVP	Regional Hunger and Vulnerability Programme
SA	South Africa
SADC	Southern Africa Development Community
SARCOF	Southern Africa Regional Climate Outlook Forum
SAWS	South African Weather Service
SASAS	South African Society for Atmospheric Sciences
SCF	Seasonal Climate Forecast
SPSS	Special Package for the Social Sciences
SST	Sea Surface Temperature
TV	Television
UN	United Nations
UP	University of Pretoria
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Office for Disaster Risk Reduction
USDA	United States Department of Agriculture
USA	United States of America
VAC	Vulnerability Assessment Community
WCDR	World Conference on Disaster Reduction
WFP	World Food Program
WMO	World Meteorological Organisation
WSSD	World Summit on Sustainable Development