Role of Information and Communication Technologies (ICTs) in Climate Change Awareness in Seke and Murewa Districts of Zimbabwe

African Technology Policy Studies Network
WORKING PAPER SERIES | No. 75

Role of Information and Communication Technologies (ICTs) in Climate Change Awareness in Seke and Murewa Districts of Zimbabwe

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This paper should be cited as:

African Technology Policy Studies Network, ATPS 2013: *Role of information and Communication Technologies (ICTs) in climate Change Awareness in Seke and Murewa Districts of Zimbabwe* [Shakespear Mudombi], ATPS WORKING PAPER No. 75

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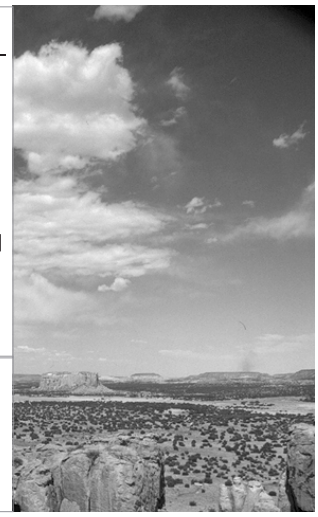

Published by the African Technology Policy Studies Network
P O Box 10081, 00100 GPO Nairobi Kenya

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ISBN: 978-9966-030-62-7

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Acknowledgement

This report was produced as part of the implementation of the African Technology Policy Studies Network (ATPS) Phase VI Strategic Plan, 2008 – 2012 funded by ATPS Donors including theMinisterie van Buitenlandse Zaken (DGIS) the Netherlands and the Rockefeller Foundation. The authors hereby thank the ATPS for the financial and technical support during the implementation of the program. The Authors specially thank Prof. Kevin Chika Urama, the ATPS Executive Director for his visionary leadership as Program Director; Prof. Atieno Ndede-Amadi, Program Coordinator; Dr. Nicholas Ozor, Senior Research Officer, ATPS; Mr. Ernest Nti Acheampong, ATPS Research Officer and the ATPS Team for the technical support during the research process.

Abstract

The paper examines the role of Information and Communication Technologies (ICTs) in contributing to climate change awareness in rural areas. It is based on a cross sectional study that was conducted in Seke and Murewa districts in Mashonaland East province of Zimbabwe. The findings indicate that the majority of respondents in the two districts are aware of climate change. Significant differences in the level of climate change awareness were observed between those who had access and those who did not have access to ICTs, with those who had access having a higher level of awareness than those who did not have access. However not all ICTs were found to significantly influence the likelihood of a respondent being aware of climate change. The following ICTs were found to have a significant positive influence on the likelihood of an individual being aware of climate change: reading farming/environmental magazines (really old ICTs); access to radio (old ICTs); access to mobile phone (new ICTs). An inverse relationship was observed between access to television and the likelihood of individual awareness of climate change. Access to television rather decreased the likelihood of respondents' awareness of climate change. These findings highlight not just an important aspect of ICTs as tools that facilitate information dissemination and communication, but how these technologies and their capabilities are utilised is dependent on the users.

1. Introduction

Climate is recognised as one of the biggest risk factors affecting the performance and management of agricultural systems, and its variability and change contribute to the vulnerability of individuals, businesses, communities and regions (Meinke, et al. 2006). The decline in rainfall and extreme weather patterns such as heavy rains, cyclones and droughts are becoming more frequent throughout the continent especially in Sub-Saharan Africa (IFAD, 2010). Agricultural production relies mainly on rainfall and will be severely compromised in many African countries, particularly for subsistence farmers; under climate change, with shorter growing seasons and lower yields, much agricultural land will be lost (UNFCCC, 2007).

Cooper et al., (2008) noted that whilst the exact nature and extent of the impacts of climate change on temperature and rainfall distribution patterns remain uncertain, it is the poor and vulnerable who will be the most susceptible to changes in climate.Though these farmers have developed several adaptation options to cope with current climate variability, such adaptations may not be sufficient for future changes of climate (Boko, et al., 2007). Because of rural households' vulnerability to climate change, there is need to devise strategies and coping mechanisms that enhance rural households' capacity to adapt to and also participate in the mitigation of climate change. In order to strengthen farmers' capacity to adapt to climate change, it will be necessary to implement adaptation strategies through educating farmers with tested and proven methods (Ngigi, 2009). Through sensitization of farmers and dissemination of climate change information, farmers' capacity to adapt to climate change can strengthen (ibid). Climate change awareness plays a critical role within decision-making processes and is the basis to mobilise action within and for rural agricultural communities (Ospina and Heeks, 2011).

There are various ways in which technologies both old and new can help in reducing the effects of climate change. ICTs can play an important role as a medium of information and communication in climate change awareness, adaptation and mitigation strategies. However the availability and adoption of ICTs is varied between areas: developed and developing countries; urban and rural areas and within rural areas themselves. Even when the ICTs are available, the information that is transmitted is also varied and its reception is varied.

Thioune (2003) noted that ICTs are known to transform communities, however the details of these transformations, the degree and pace of such changes are yet to be fully grasped, hence the link between development and use of ICTs are yet to be clearly established and supported by empirical results from Africa. Ospina and Heeks (2010) noted that, experiences from vulnerable communities in Asia, Africa, Latin America and the Caribbean point to the use of ICT applications as part of climate change responses, however, this constitutes a new field of enquiry where much remains to be explored. Hence the need for research that explore the level of climate change awareness and how ICTs contribute to climate change awareness amongst rural households.

This paper examines the role of Information and Communication Technologies (ICTs) in climate change awareness. The focus of the paper is at the local/community level in the rural areas of Seke and Murewa districts in Mashonaland East Province of Zimbabwe. It is based on a cross sectional survey that was conducted in the two districts from May to August 2010.

1.1 Objectives of the Research

The main objective of the study was to analyse the role/contribution of Information and Communication Technologies (ICTs) in climate change awareness in rural communities. The specific objectives include:

- Analyze the level of climate change awareness amongst rural people in Seke and Murewa districts of Zimbabwe.
- Assess if there is a positive difference in the level of climate change awareness between those who had access and who did not have access to information and communication technologies (ICTs).
- Establish if there is a positive relationship between access to information and communication technologies (ICTs) and climate change awareness.

2. Literature Review

Ospina and Heeks (2010) in the scoping study on the links between ICTs and climate change in developing countries noted that literature linking both the potential and challenges of ICTs in the climate change field began to emerge at the beginning of the 2000s; they identify three distinctive strands of research in the field. The first strand of research addresses broad issues concerning ICTs, sustainable development and the environment from a global perspective. The second strand is characterized by the emergence of more topic-specific and technical research covering aspects of climate change mitigation, and driven primarily by developed countries' priorities in the field. The third strand is characterized by an increasing acknowledgement of developing countries' needs and priorities in the climate change field. This strand is characterized by emerging evidence on the use of ICT applications in vulnerable contexts and adaptation strategies of developing countries (ibid). It is the third strand that is the focus of this paper.

2.1 Climate variability and change in Zimbabwe

Climate change leads to variations in the amount of rainfall received, with some regions experiencing too much rainfall which might result in floods while other areas receive less and inconsistent rainfall, which might result in droughts (Hulme et al, 2005). The Intergovernmental Panel on Climate Change (IPCC)'s regional scenarios for Africa for the next century indicate that East Africa could receive more rain while southern Africa will probably become drier, and desertification will remain a major threat in arid and semiarid regions (UNEP, 2003).

The factsheet on climate variability and change in Zimbabwe highlighted a number of issues on the country's climate. Zimbabwe is experiencing more hot and fewer cold days than before; with the country's annual mean surface temperature having warmed by 0.4oC between 1900 and 2000 (Coping with Drought & Climate Change (CwDCC) (b), n.d.). The period between 1980 and 2000 was the warmest and the driest; and the timing and amount of rainfall received has become increasingly uncertain. The last thirty years (from 1980) have seen a trend towards reduced rainfall or heavy rainfall and drought occuring in the same season. Mutekwa (2009) also concurred noting that Zimbabwe has of late been experiencing frequent droughts alternating with periods of very high rainfall, in some cases, floods and mid-season prolonged dry spells being experienced in the same season. Data from Zimbabwe on temperature trends 1933 to 1993, show a rise in maximum temperatures, a decrease in minimum temperatures and a substantial rise in the diurnal temperature range (Unganai, 1996; Balling, 2005).

2.1.1 Initiatives that were undertaken to enhance climate change awareness in Zimbabwe

In Zimbabwe, Ministry of Environment and Natural Resources Management, previously known as Ministry of Mines, Environment and Tourism is responsible for environmental and climate issues. The Ministry of Mines, Environment and Tourism (1998) noted that in 1987 the Government of Zimbabwe developed a policy document which was a blue-print for the conservation of the environment called "National Conservation Strategy". This document paved way for most environmental programmes in Zimbabwe, including the signing and ratification of the United Nations Framework Convention on Climate Change (UNFCCC) by

Zimbabwe in Rio de Janeiro. Climate change activities which followed the issuing of this document were part of environmental programmes based on this historic policy document. In an attempt to meet the obligation of Article 6 of the UNFCCC which requires Parties to the Convention to promote and facilitate the development and implementation of educational and public awareness programmes on climate change and its impact, Zimbabwe conducted climate change awareness workshops targeted at the grassroots community, industry, schools and universities, professional groups and policy makers (ibid).

The Zimbabwean government also took other initiatives to increase climate change awareness in the country, these initiatives include workshops such as the "Climate Change Roundtable" organised in 2009 by the Ministry of Environment and Natural Resources Management in conjunction with COMESA with financial support from the Norwegian Embassy (Ministry of Environment and Natural Resources Management, 2009). One of the aims of the workshop was to create awareness and initiate dialogue on climate change in the country with full participation of legislators, industry and insurance sectors, bankers, and other players. However the impact of all these inititiatives have not been documented.

2.2 Barriers to smallholder farmers' adaptation to climate change

Given the threats to livelihoods due to current climate variability and expected change there is need for rural households to adapt. Gbetibouo (2008) noted that the extent to which the adverse impacts of climate change are felt depend in large part on the extent of adaptation in response to climate change, without adaptation, climate change would be detrimental to the agricultural sector, but with adaptation, vulnerability can be significantly reduced.

The Coping with Drought and Climate Change (CwDCC) project in Zimbabwe identified some barriers to replication of successful adaptive strategies. These are: information; institutions; inclusion; and finance CwDCC. Information barriers were due to limited awareness among policy makers and development practionioners about the risks posed by climate change and how these relate to local development priorities. Institutional barriers contributed to weak coordination between those working on climate change, development and disaster risk reduction. Inclusion barriers occur because there are limited platforms to share and capture experiences from different stakeholders while financial barriers are there because the cost of adaptation is substantial.

2.3 The Link between information, knowledge and adaptation

For meaningful adaptation and mitigation, individuals, households, and communities should be aware and have the necessary knowledge on what should and should not be done in addressing the challenge of climate change. Rural households' access to information about climate change may enhance their awareness and adaptation capacity. Information can lead to knowledge which is a prerequisite for development (Mansell & When, 1998; Mansell, 1999; Ahmed, 2007). Farmers' ability to perceive climate change is a key precondition for their choice to adapt (Gbetibouo, 2008).

The African Climate Change Resilience Alliance (ACCRA) consortium identified five characteristics of adaptive capacity, and one of the characteristics is knowledge and Information. It highlights that successful adaptation requires information and understanding of future change, knowledge around adaptation options, whereby it is important to ensure that systems are in place to distribute relevant information at both national and regional scales e.g. early warning systems; meteorological data and forecasting; and climate impact data (ACCRA, 2010). Mutekwa (2009) studied climate change impacts and adaptation in the smallholder sector in Mazvihwa area of Zvishavane District in Zimbabwe, and the findings indicated that majority of the farmers (53%) were ignorant about climate change and its potential consequences, whilst 47% opined to a level of changes observed in recent years.

2.4 Applications of Information and Communication Technologies (ICTs)

The term Information and Communication Technologies (ICTs) is used to refer to hardware, software, networks and media for collection, storage, processing, transmission and presentation of information in the formats of voice, data, text and images (World Bank (n.d.); Nyirenda-Jere, 2010). ICTs are diverse ranging from fixed telephones, radios and TVs to more complex technologies such as internet technologies, mobile telephony, computers and databases (ibid). The primary purpose of ICTs is to provide an enabling environment for the generation of ideas, their dissemination and use. Through ICTs, the diffusion and sharing of knowledge is enabled through open access to information and better coordination of knowledge. ICTs have been and continue to be used to an ever increasing extent in education and learning through computer aided learning and distance learning (ITU, 2008). Likening the ICT revolution to the first machine-driven industrial revolution, Baskaran and Muchie (2006) noted that ICTs have generated fundamental changes in the socio-economic lives of people and nations across the world. The UN Millennium Project (2005) noted that ICT will become one of the main enablers in pursuit of poverty alleviation, as a facilitator of networking, processing, distribution and sharing of knowledge and information. There are many ICT applications in environmental issues which are categorised as: environmental observation; environmental analysis; environmental planning; environmental management and protection; impact and mitigating effects of ICTs utilization; and environmental capacity building (ITU, 2008). The role of ICTs in capacity building is of importance to climate change awareness and adaptation. Capacity building includes efforts to increase public awareness of environmental issues and priorities, the development of professionals involved either directly or indirectly in the environment, as well as integrating environmental content into formal education (ibid).

There are few studies that have been done that focus on the application of ICTs in different aspects of climate change. However, there are some initiatives that are being undertaken such as the Climate Change, Innovation and ICTs Project at Centre for Development Informatics at the University of Manchester which is at the forefront of doing research in this regard. It provides evidence through the various case studies on the application of ICTs on the different aspects of climate change. In one of the case studies, Saravanan (2011) on using ICTs to facilitate “ClimateSmart Agriculture” among farmers in North-East India highlighted the need to prioritise appropriate ICTs in rural areas especially those that are already in use such as the radio and TV for raising the general awareness and mobile phones for more individualised assistance.

2.5 Conceptual Framework

The role of ICTs in climate change awareness was conceptualised using the sustainable livelihoods (SL) framework. Other researchers who have used the SL framework include Duncombe (2006) who analysed the ICT applications for poverty reduction via micro-enterprise in Botswana. Sife, Kiondo, & Lyimo-Macha (2010) also employed the SL framework in studying the contribution of mobile phones to rural livelihoods in Morogoro region of Tanzania. Duncombe (2006) integrated the information chain proposed by Heeks (1999; 2005) to show the information and communication processes in the livelihoods framework. In this paper, climate variability and change aspects were added to the Duncombe and Heeks framework as shown in Figure 1.

Lack of livelihood assets in rural areas heightens their vulnerability to climatic impacts, and also undermines their capacity to respond to the challenges and to benefit from potential opportunities derived from climate change (Ospina & Heeks, 2012). Knowledge and information play a key role in overcoming the challenges and constraints that communities face, and are pivotal for building and strengthening the capacity of multiple stakeholders involved in adaptation strategies at the micro, meso (intermediate) and macro levels (Ospina & Heeks, 2011).

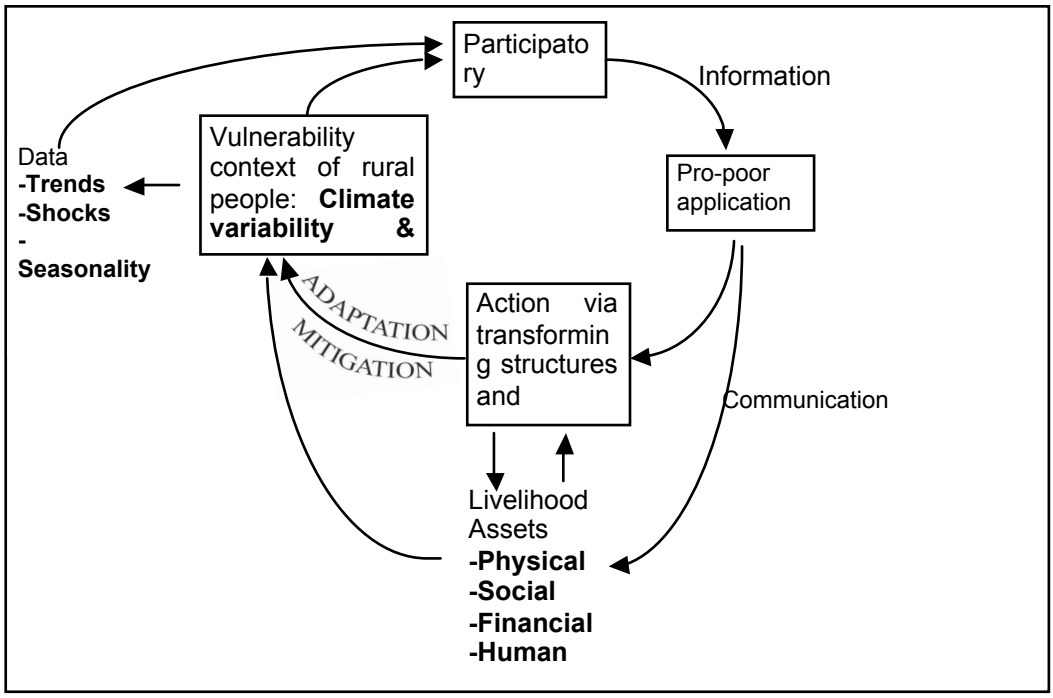


Figure 1: Climate change information and communication processes in the livelihoods framework. (Source: Adapted from Duncombe (2006) who adapted it from the information chain by Heeks, 1999)

ICTs can be used in a number of effective ways to enhance current livelihoods or to create new ones (Greenberg, 2005). From the conceptual framework, ICTs will contribute to sustainable livelihoods in rural areas when they are utilised for information generation, exchange and knowledge creation; when they facilitate communication amongst the people within and outside the rural areas; and when they reduce transaction costs. Climate change awareness is the basis of all other responses to climate change. Duncombe (2006) noted that information has both an analytical and a functional role within the SL framework. Of importance is, if climate variability and change data on trends, shocks, and seasonality is available and through participatory assessment is converted to information and communicated to the people, they are better able to adapt to and also participate in the mitigation of climate change.

The adaptation and mitigation actions that rural households and communities undertake in response to climate change is dependent on the availability and utilisation of livelihood assets within their reach and these adaptation and mitigation actions will in turn impact on the livelihood assets. Appropriate introduction and utilisation of ICTs in rural areas is likely to directly and indirectly enhance all the livelihood assets (physical; social; financial; human; and natural). However in terms of climate change awareness, ICTs are likely to enhance the human capital component of livelihood assets by availing information and facilitating communication which are essential in knowledge creation and its transfer. ICTs also play an important role by transmitting climate change information from the research field to the rural people and from rural people to researchers; however this information is important only if the rural people understand the information, which can contribute to knowledge.

3 Research Methodology

3.1 Population and Sampling

Zimbabwe has 10 provinces, and from the 10 provinces one province (Mashonaland East) was selected. According to the 2002 Census, Zimbabwe had a total population of about 11 634 663 people, and Mashonaland East province had a total population of about 1 127 413 people and 309 198 households. Most of the population in the province is rural while the urban population accounts for about 24 percent. Figure 2 below is the Mashonaland East map; it has 11 districts two of which were selected for the study namely Seke and Murewa

Figure 2: Mashonaland East Province map showing Seke and Murewa districts (in dark colour) Source: CSO (2004)

A multi-stage sampling approach was used. The sampling unit was a household[1] . Sample size of 300 households was used in the study, with 150 households coming from each of the two districts. One respondent, supposedly the household head was selected from each household, however if the household head was not available any other adult member of the household could respond on behalf of the household head. Data collection was conducted from May to August 2011. The information was entered and cleaned for analysis using SPSS and STATA.

1. Household constitutes a person or group of persons, irrespective of whether related or not, who normally live together in the same housing unit or group of housing units and have common cooking arrangements (Stork & Stork, 2008)

3.2 Measurement of variables

The study focused on two main issues namely: access to and use of Information and Communication Technologies (ICTs) and climate change awareness. Greenberg (2005) noted that ICTs are often categorized based on how long they have been in common use, and to some extent the technology used for the transmission and storage of information. Greenberg identified three categories namely: new; old; and really old ICTs.

- New ICTs are mainly based on digital technology, these include: computers, satellites, wireless one-on-one communications; mobile phones, the Internet, e-mail and multimedia.
- Old ICTs have been in reasonably common use throughout much of the world for many decades, these include: radio, television, land-line telephones and telegraph. They are mainly based on analogue technology though some are now migrating to digital technology.
- Really Old ICTs have been in common use for several hundred years, these include: newspapers, books and libraries.

This paper looks at both old and new ICTs namely: radio; television; video cassette recorder (VCR); digital video disc (DVD) player; fixed telephone; mobile phone; satellite decoder; computer; internet; and the traditional print media (newspapers; farming/environmental magazines; business magazines; entertainment magazines; church magazines; and posters). Though the term ICTs is generally used to refer to information and communication technologies that are electronically based, in this particular study it was deemed necessary to include even those in print format. Various questions were formulated to explore different aspects of access to and use of the ICTs.

Climate change awareness was also evaluated. In measuring climate change awareness, the aim of the study was not to solicit a scientific definition of climate change from respondents; the aim was to evaluate people's knowledge on various aspects of climate change. This was done by asking the respondents a yes/no question on climate change awareness and this was the initial question to separate those who were aware and those who were not aware of climate change. For the respondents who had indicated that they were aware of climate change, they were asked 11 questions/statements which had five point Likert scale (strongly agree; agree; undecided; disagree; strongly disagree) in which the respondent was expected to indicate his/her level of agreement with the statements. Whyte (2000) noted researchers can manipulate variables to create various types of scales, particularly ordinal and interval scales, which enable them to apply various types of statistical tests; whereby one can combine the initial variables to create indices, either by simply adding them or by some other means. The responses to the 11 questions were used to create a climate change awareness index. The index was calculated as follows: the scores from the 11 questions were summed up and the minimum and maximum total scores a respondent could get were -22 and 22 respectively. To get an index between -1 and 1, the total score that a respondent got was then divided by 22.

3.3 Data Analysis

3.3.1 Testing for differences using T-tests

T-tests were used to test for the differences on climate change awareness between those who had access and those who did not have access to ICTs. T-tests can be used to test whether a correlation coefficient is different from zero; to test whether a regression coefficient is different from zero; and test whether group means are different (Field, 2000). There are two different t-tests for measuring differences in means namely the independent-means and

dependent-means t-tests. Independent-means (Independent samples) t-test is used when there are two experimental conditions and different participants were assigned to each condition. Dependent-means (matched pairs/ paired samples) t-test is used when there are two experimental conditions and the same participants took part in both conditions. The independent t-test was used in this study since it tests differences between different people (those who have had access and those who did not have access to ICTs). The formula of the independent t-test is shown in equation (3.1).

(3.1) $$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{(\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2})}}$$

Where $\bar{x}_1$ and $\bar{x}_2$ are sample means of respective groups while and are population means for

respective groups and $\sqrt{(\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2})}$ is the estimate of the standard error. Instead of comparing differences b etween pairs of scores as for the dependent-means t-test, differences in overall means of the 2 samples are compared. Under the null hypothesis (where the hypothesis

is there are no differences) $\mu_1 = \mu_2$ and therefore $\mu_1 - \mu_2 = 0$ equation (3.1) becomes equation (3.2)

(3.2) $$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{(\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2})}}$$

3.3.2 Binary logistic regression model

The logistic regression model has been used in many applications due to its mathematical convenience (Greene, 2003); in this paper it was used to test the significance of access to various ICTs on climate change awareness. The formula for binary logit (Long, 1997; `Field, 2009) is

shown in equation (3.3) below. (3.3) $$Pr(y = 1|x') = \frac{exp(x'\beta)}{1 + exp(x'\beta)} = (x'\beta)$$

$\Pr(y = 1 \mid x')$ represent the probability of an event happening, the dependent variable takes a value of 1 given an independent variable x'. x' Represents vectors of all the independent variables. The explanatory power of the independent variable is explained by the coefficient

β. The dependent variable is the probability of a respondent being aware of climate change. This dependent variable takes two discrete values, which is 1 if the respondent is aware of climate change or 0 if the respondent is not aware of climate change.

The model predicts the maximum likelihood of a respondent being aware of climate change versus not being aware of climate change. The coefficient β in the model depicts a relationship of how variations in the independent regressors affect the predicted log of odds of a respondent being aware versus not being aware of climate change. This relationship between the dependent and the independent variable can be depicted using the antilog of the β (exp β) which is the odds ratio. The formula of the odds ratio is presented below.

(3.4) $$\frac{P_i}{1-P_i} = \frac{1+e^{(x'\beta)}}{1+e^{-(x'\beta)}} = e^{(x'\beta)}$$

Where Pi is the probability of being aware of climate change ($\Pr(y=1 \mid x)$) in equation (1) and $1-P_i$ is the probability of not being aware of climate change ($\Pr(y=0 \mid x')$). Equation (2) represents the odds ratio in favour of being aware of climate change which is the ratio of the probability that a respondent is aware of climate change to the probability of not being aware of climate change. An odds ratio that is greater than 1 implies that a unit increase in the continuous variable or discrete change in the categorical variable in the regressors leads to a decrease in the odds of a respondent being aware versus unaware of climate change .

4. Results and Discussions

4.1 Household characteristics

From the sampled households, 32.1 percent were female-headed while 67.9 percent were male-headed households. The minimum and maximum ages of household heads were 23 and 98 years respectively with a mean age of 52.23 years. The minimum and maximum household sizes were 1 and 18 respectively with a mean of 5.84 members. The majority of the household heads had basic education while only 4.3 percent of the household heads did not have any basic form of formal education.

4.2 Knowledge of and access to Information and Communication technologies

Both old and new ICTs were analysed namely: radio; television; video cassette recorder (VCR); digital video disc (DVD) player; fixed telephone; mobile phone; satellite decoder; computer; internet; and the really old ICTs in print format (newspapers; farming/ environmental magazines; business magazines; entertainment magazines; church magazines; and posters). Greenberg (2005) noted that the categorisation of ICTs (new, old, and really old) generally apply to the developed world, in many parts of the developing world, and particularly in areas where literacy rates are low, they are all relatively new. This implies that those ICTs that are generally classified as old might be new or even unknown in some rural areas. Therefore in exploring access to ICTs the initial step was to evaluate whether the respondent knew the various ICTs, which was then followed by assessing ownership of the ICTs by different members of the household. Ownership of ICTs by any household member was taken as a proxy of access to ICTs by the respondent. A shortcoming of the approach was the failure to incorporate access to ICT through people who were not part of the household. The results on ICT knowledge and access are presented in table 1.

Table 1: Knowledge of and access to ICTs disaggregated by district

ICT	Knowledge			Access		
	Murewa	Seke	Average	Murewa	Seke	Average
	%	%	%	%	%	%
Radio access	98.7	97.3	98.0	77.9	71.8	74.8
Television access	86.7	92.6	89.6	40.7	51.7	46.2
Satellite decoder access	65.3	60.4	62.9	8.0	13.4	10.7
Video Cassette Recorder access	63.3	61.1	62.2	8.0	14.8	11.4
Digital Video Disc player access	65.3	60.1	62.7	15.3	14.1	14.7
Fixed Telephone access	76.0	65.8	70.9	2.0	2.0	2.0
Mobile phone access	94.7	95.3	95.0	70.7	85.2	77.9
Computer access	65.3	60.4	62.9	2.0	4.7	3.3
Internet access	52.0	45.0	48.5	1.3	2.7	2.0

Source: Survey data, 2011

Generally the majority of respondents knew the ICTs, with more than half knowing each of the ICTs except for the internet in Seke district. Most respondents knew the radio (98%); closely followed by the mobile phone (95%); television (89.6%); fixed telephone (70.9%); computer and satellite decoder (62.9%); DVD (62.7%); VCR (62.2%) and the least known was the internet (48.5%). In terms of access to ICTs, the greatest percentage of households had access to the mobile phone (77.7%); followed by the radio (74.8%); television (46.2%); DVD (14.7%); VCR (11.4%); satellite decoder (10.7%); computer (3.3%); internet (2.0%); and the least owned was the fixed telephone (2.0%).

The newspapers; farming/environmental magazines; business magazines; entertainment magazines; church magazines; and posters, were assessed if the respondent or any household member read them. The results are shown in table 2 below. The greatest number of respondents indicated that they read the newspaper (72.4%); followed by church magazines (55.2%); farming/environmental magazines (51.5%); posters (50.2%); entertainment magazines (41.5%) and the least read were business magazines (40.5%).

Table 2: Readership of various forms of print media

	District		
	Murewa	**Seke**	**Average**
	%	%	%
Newspapers	67.3	77.9	72.6
Farming/environmental magazines	45.3	57.7	51.5
Business magazines	30.7	50.3	40.5
Entertainment magazines	34.0	49.0	41.5
Church magazines	48.0	62.4	55.2
Posters	40.5	59.7	50.2

Source: Survey data, 2011

4.3 Climate change awareness

The results on climate change awareness are shown in table 3 below. The majority of the respondents indicated that they were aware of climate change, with about 86.3% indicating that were aware while 13.7% were not. A greater proportion of respondents who were aware of climate change were from Murewa district (94%) while Seke had 78.5%. The level of climate change awareness was further evaluated using the climate change awareness index[2]. The index ranged between -1 to 1; an index value close to 1 means an individual is more aware of climate change while an index value of 0 or below indicates the respondent is not aware of climate change. The average index in the two districts was 0.54. Murewa district had a higher climate change awareness index of 0.59 compared to Seke district's index of 0.48.

Table 3: Climate change awareness by district

	Seke	**Murewa**	**Average**
Aware of climate change (Yes)	78.5%	94%	86.3%
Climate change awareness index	0.48	0.59	0.54

Source: Survey data, 2011

4.3 Exploring the relationship between access to ICTs and climate change awareness

4.3.1 Testing for differences in climate change awareness between respondents who had access and respondents who did not have access to ICTs

T-tests[3] were conducted to evaluate if there were differences in the level of climate change awareness between respondents who had access and those who did not have access to ICTs. The results are presented in table 4 below. Significant differences were observed in the level of climate change awareness between those who had access and those who did not have access to various ICTs except for the computer. Owners of any of the ICTs tools had a higher level of climate change awareness than non-owners. Significant differences in the level of climate change awareness were also observed between those who read and those who did not read the various forms of print media under study. Those who read had a higher level of climate change awareness than those who did not.

2. The calculation of the change awareness index was described in section 3.2
3 T-tests were discussed in the analytical framework in section 3.3.1

Table 4: T-test results in climate change awareness between owners and non-owners of various ICTs

ICT	Mean Climate change awareness index		Difference	Hypothesis: difference >0
	Own	**Do not own**		
Radio	0.56	0.46	0.10	0.0076***
Television	0.57	0.51	0.06	0.0513*
Satellite decoder	0.63	0.53	0.10	0.0429**
VCR	0.67	0.52	0.15	0.0040***
DVD	0.62	0.52	0.10	0.0287**
Fixed telephone	0.79	0.53	0.26	0.0245**
Mobile phone	0.57	0.43	0.14	0.0013***
Computer	0.55	0.54	0.01	0.4459
Internet	0.72	0.53	0.19	0.0820*
Print Media	**Read**	**Do not read**		
Newspapers	0.56	0.46	0.10	0.0092***
Farming/Environmental magazine	0.58	0.48	0.10	0.0062***
Business magazines	0.58	0.51	0.07	0.0328**
Entertainment magazines	0.59	0.50	0.09	0.0045***
Church magazines	0.57	0.50	0.07	0.0398**
Posters	0.57	0.49	0.08	0.0162**

Source: Survey data, 2011 *Significance level: * is 10%; ** is 5%; *** is 1%*

4.3.2 Testing for significance of access to ICTs in climate change awareness using Logistic regression

To further explore the relationship between access to ICTs and climate change awareness, a logistic regression model was used. The dependent variable was a binary variable (1=yes, 0=no) to the question (Are you aware of climate change?) and the independent variables were access to various ICTs (radio; television; satellite decoder; video cassette recorder; digital video disc player; mobile phone; computer; internet); and the frequency of: reading newspapers; reading farming/ environmental magazines; reading business magazines; reading entertainment magazines; reading church magazines; and reading posters. The logistic regression results are presented in table 5 below. The table has two columns, one for the odds ratio[4] and the other for the significance level. Fixed telephone and internet connection variables were dropped as they predicted success perfectly in the model.

4. Odds ratio is an indicator of the change in odds resulting from a unit change in the predictor. Odds ratio can be interpreted as: if the value is greater than 1, it means as the predictor increases, the odds of an outcome occurring also increase; a value less 1 indicates that as the predictor increases, the odds of an outcome occurring decreases (Field, 2009: 270-271).

Table 5: Logistic regression results

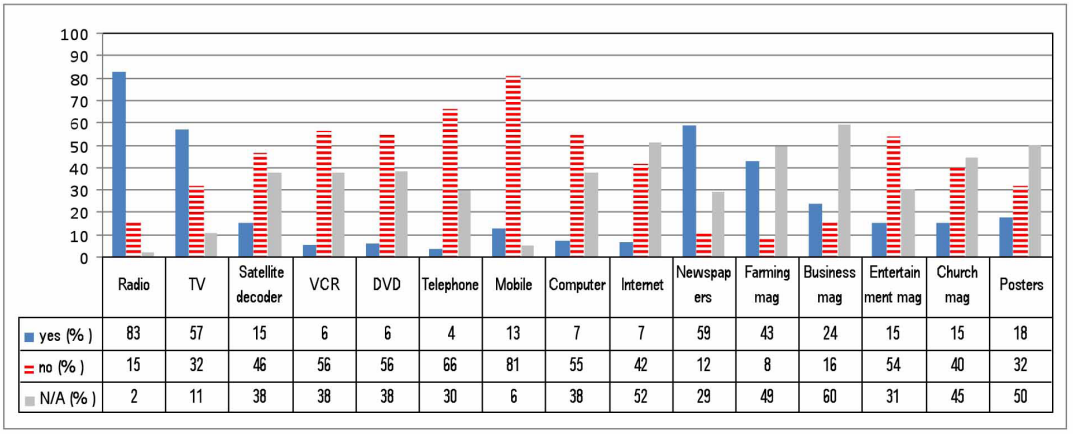
Variable	Odds Ratio	Significance level
Radio access	3.4226	0.003***
Television access	0.2915	0.009***
Satellite decoder access	0.7651	0.776
Video Cassette Recorder access	11.4425	0.185
Digital Video Disc player access	1.8946	0.480
Mobile phone access	1.8269	0.011**
Computer access	0.1440	0.140
Frequency of reading Newspapers	0.8841	0.456
Frequency of reading Farming/ Environmental magazines	1.6723	0.022**
Frequency of reading Business magazines	0.8754	0.657
Frequency of reading Entertainment magazines	1.0247	0.930
Frequency of reading Church magazines	1.0242	0.867
Frequency of reading Posters	0.7907	0.108

Source: Survey data, 2011 *Significance level: * is 10%; ** is 5%; *** is 1%*

Four variables were found to have a significant relationship with the dependent variable and these were access to: radio; television; and mobile phone; and reading of farming/ environmental magazines. The most significant variables were: access to radio and television ownership, which were significant at 1% significance level. Access to mobile phone and frequency of reading farming/environmental magazines were significant at 5% level. The odd ratios of access to: radio; mobile phone; and frequency of reading farming/environmental magazines are greater than 1, which means access to radio and mobile phone; and reading farming/environmental magazines increased the odds of an individual being aware of climate change. The odds ratio of television ownership is less than 1, which means access to television reduced the odds of an individual being aware of climate change.

4.3.3 Assessing perceptions on the importance of access to ICTs in climate change awareness

Perceptions of individuals are important determinants in the adoption and use of technologies and ideas. To further explore the role of ICTs in climate change awareness, respondents were asked whether they considered the ICTs to be important in climate change awareness. The results are presented in figure 3 below; the figure shows the percentage of respondents who indicated whether they perceived each particular ICT to be important or not in climate change awareness. Yes represents the percentage that perceived the ICT to be important while no represents the percentage that perceived the ICT not to be important in climate change awareness. N/A is not applicable it represents the percentage of respondents who did not know the ICT or those who knew the ICT but did not have access to the ICT.



	Radio	TV	Satellite decoder	VCR	DVD	Telephone	Mobile	Computer	Internet	Newspapers	Farming mag	Business mag	Entertainment mag	Church mag	Posters
yes (%)	83	57	15	6	6	4	13	7	7	59	43	24	15	15	18
no (%)	15	32	46	56	56	66	81	55	42	12	8	16	54	40	32
N/A (%)	2	11	38	38	38	30	6	38	52	29	49	60	31	45	50

Figure 3: Perceptions on whether the ICT is important in climate change awareness
Source: Survey data

The results indicate that the following ICTs namely: radio; television; newspapers; farming/environmental magazines; and business magazines had a greater proportion of respondents who perceived them to be important than the proportion who considered them not to be important in increasing climate change awareness. The radio was perceived as the most important (83%); followed by newspapers (59%); television (57%); farming/environmental magazines (43%); and business magazines (24%). The other ICTs namely: satellite decoder; VCR; DVD; fixed telephone; mobile phone; computer; internet; entertainment magazines; church magazines; and posters had a greater proportion of respondents who perceived them as not important than the proportion who considered them important in climate change awareness.

4.4 Discussion of Results

The first finding was that the majority of respondents indicated that they were aware of climate change. The second finding is that there are significant differences in the level of climate change awareness between those who had access and those who did not have access to ICTs. Those who had access to ICTs had a higher level of climate change awareness than those who did not have. The third finding is access to some ICTs such as radio; mobile phone; and reading of farming/environmental magazines had a significant positive relationship with the likelihood that a respondent was aware of climate change. However, access to the television was found to have a significant negative relationship with the likelihood that a respondent was aware of climate change. These findings indicate that access to old ICTs such as the radio and really old ICTs such as reading farming/environmental magazines increased the likelihood of an individual being aware of climate change while in terms of the new ICTs only the mobile phone increased the likelihood of being aware of climate change. This makes it imperative to briefly discuss each of the ICTs that were found to have a significant influence in climate change awareness.

4.4.1 Radio

Access to the radio was found to have a significant positive relationship with the likelihood that a respondent is aware of climate change. Its importance as a source of information has been widely acknowledged by many researchers and it is one of the old ICTs which is widely adopted even in rural areas. The positive relationship was expected, it was further confirmed by respondents' perceptions on the importance of the radio in climate change awareness presented in Figure 3 in section 4.4.3. The radio was perceived as the most important ICT

in climate change awareness with 83% of respondents perceiving it as important compared 15% who perceived it as not important.

4.4.2 Mobile phone

Access to the mobile phone was found to have a significant positive relationship with the likelihood that a respondent was aware of climate change. This finding was expected, however the results on perceptions (in section 4.4.3) indicate respondents perceived the mobile phone as not important in contributing to climate change awareness. Only 13% perceived the mobile phone to be important against 81% who perceived it as not important; while 6% was not applicable. This paradox can be explained by looking at some of the attributes of mobile phone technology.

The ITU (2010) noted that important ICT developments have taken place in recent years such as the rise of mobile telephony and its associated applications. The launch of new standards in the mobile sector, the convergence of technologies (such as broadcasting and telecommunication) and the steady expansion of high-speed communication infrastructure have significantly changed the way ICTs are accessed and used. The convergence of broadcasting and telecommunication applications on the mobile phone has transformed the way the phone is used, it is no longer just a communication device but also a source of information since users can also access radio and television applications. This is also being enabled by the proliferation of cheaper brands of mobile phones (mainly from the Asian continent) which are popular because they are: cheaper; have converged applications (radio; television; multimedia); can handle more than one Subscriber Identity Module (SIM) card (which makes them appropriate in areas where network coverage is poor especially in rural areas, as the user can easily switch between networks).

The significance of the mobile phone can also be explained by looking at the benefits associated with its use. Bhavnani et al, 2008 (citing other authors) categorised the benefits of mobile telephony into three categories: direct; indirect; and intangible benefits. The direct benefits occur at the macro-level where it has a positive impact on economic welfare by: generating GDP; job generation; productivity increases; and taxation revenue. Indirect benefits occur at the social or micro-level, as it can produce follow-on economic and social benefits such as: enhancing entrepreneurship, reducing information asymmetries and market inefficiencies, and substitution of transportation. Intangible benefits are difficult to value, may not have direct economic benefit, but enhance and promote the growth of culture, society and societal ties. In this regard the mobile phone has benefits in: aiding disaster relief; enabling the dissemination of locally-generated and locally-relevant educational and health information; and promoting social capital and social cohesion (ibid). In the context of rural areas, it is through the indirect and intangible benefits the access to the mobile phone increases the likelihood of climate change awareness.

4.4.3 Farming/ Environmental magazines

Reading farming/ environmental magazines was found to have significant positive influence on the likelihood of a respondent being aware of climate change. They were also perceived to be the fourth most important in climate change awareness. 43% of the respondents perceived them as important while 3% perceived them as not important and 49% not applicable. The positive relationship was expected since these magazines carry agricultural and environment information of which climate change issues are cross-cutting. Though reading newspapers did not have a significant influence on the likelihood of being aware of climate change, the respondents perceived newspapers to be the second most important ICT after the radio in contributing to climate change awareness.

4.4.4 Television

The regression results show that access to television had a significant negative relationship with the likelihood of a respondent being aware of climate change. This does not mean access to television reduced an individual's level of climate change awareness but it means it reduced the likelihood that a respondent was aware of climate change. This finding is contra to a priori expectation, whereby access to television was expected to have a positive relationship with the likelihood of an individual being aware of climate change. The a priori expectation is also supported by respondents' perceptions on the importance of television in climate change awareness. Television was perceived by the respondents to be the third most important ICT after radio and newspapers in contributing to climate change awareness; 57% of the respondents perceived the television to be important compared to 32% who perceived it not to be important; while 11% were not applicable.

To explain the unexpected negative relationship between access to television and the likelihood of a respondent being aware of climate change, there was need to explore how these variables relate with other variables. Correlation analyses were conducted on four variables namely: access to television; aware of climate change; whether the household got agricultural income only; and whether the household got non-agricultural income. The results of the correlation analysis are presented in Table 6 below.

Table 6: Spearman's rho correlation coefficients

		Aware of climate change	Agricultural income only	Non-agricultural Income
Agricultural income only				
	Correlation Coefficient	0.199		
	Sig. (2-tailed)	0.001**		
Non-agricultural Income	Correlation Coefficient	0.081	-0.044	
	Sig. (2-tailed)	0.161	0.452	.
Access to television	Correlation Coefficient	0.041	0.013	0.212
	Sig. (2-tailed)	0.482	0.818	0.000**

Source: Survey data ** Correlation is significant at the 0.01 level (2-tailed).

Significant association was found between Aware of climate change and Agricultural income only, however no significant association was found between Aware of climate change and Non-agricultural income. Significant association was also found between having Non-agricultural income and access to television. About 65.6% of household heads who had non-agricultural income sources had access to a television while 41.2% of household heads who had agricultural income only had access to a television. This could give possible reasons for the negative relationship between access to television and the likelihood of being aware of climate change. The positive correlation between having agricultural income only and aware of climate change suggests that people who are mainly dependent on agriculture are likely to be aware of climate change compared to those with non-agricultural income sources. For those with non-agricultural income sources, they could be less concerned in climate change issues, so even if they have access to the television they might be less interested in programs that relate to climate change and agricultural issues.

5. Conclusion and Recommendations

Significant differences in the level of climate change awareness were observed between those who had access and those who did not have access to ICTs, with those who had access having a higher level of awareness than those who did not have access. However not all ICTs were found to significantly influence the likelihood of a respondent being aware of climate change. The following ICTs were found to have a significant positive influence on the likelihood of an individual being aware of climate change: reading the farming/environmental magazines (really old ICTs); access to radio (old ICTs); access to mobile phone (new ICTs). The importance of the mobile phone in climate change awareness can be attributed to the indirect and intangible benefits associated with the mobile phone, and these benefits are being reinforced by the convergence of applications (broadcasting and telecommunications) on the mobile phone.

A negative relationship was observed between access to television and the likelihood of being aware of climate change. This result does not mean access to television reduces climate change awareness but it means it decreased the likelihood that a respondent was aware of climate change. Respondents who had non-agricultural income had greater access to the television than respondents who had agricultural income only which implied that those who were less dependent on agriculture are less likely to be interested in climate change issues hence might not utilise the ICT in that regard. These findings highlight an important aspect of ICTs, that is ICTs are just technologies that facilitate information dissemination and communication, but how these technologies and their capabilities are utilised is dependent on the users.

This paper looked specifically at the role of ICTs in climate change awareness, it did not look at other sources and means such as extension; farmer to farmer interactions; own observation; formal and informal school, therefore further research is required in this area. The study targeted rural areas but it is important to also look at the same aspects in different settings e.g. in urban areas. Another area of further research is to look at the content that is being transmitted in terms of its appropriateness in settings such as rural areas. There is also need to conduct comparative adoptions studies of new versus old ICTs.

Recommendations

- ICTs should be embraced in enhancing climate change awareness especially in areas that have limited access to other sources of information. However, this should not be done in isolation but should intergrated with the broader development agenda.
- There is need to initiate public awareness about climate change encompassing all the different aspects such as: causes; effects; mitigation and adaptation strategies.
- How individuals perceive the technology and its capabilities is an important determinant in its utilisation to enhance development. Hence these perceptions should be taken into account.
- The promotion and use of ICTs should not be determined by how long they have been in use but should be based on the appropriateness of the technology in each particular setting.

References

ACCRA. (2010). Consultation document: the ACCRA adaptive capacity framework. Oxfam GB, the Overseas Development Institute (ODI), Save the Children Alliance, Care International and World Vision International. available at: http://community.eldis.org/accra

Ahmed, A. (2007). World Sustainable Development Outlook 2007: knowledge and sustainable development in the 21st Century. Sheffield, UK: Greenleaf.

Balling (Jr), R. C. (2005). Interactions of Desertification and Climate change in Africa. In P. S. Low (Ed.), Climate change and Africa (pp. 41-49). UK: Cambridge University.

Baskaran, A., and Muchie, M. (Eds.). (2006). Bridging the Digital Divide: Innovation systems for ICT in Brazil, China, India, Thailand and Southern Africa. London: Adonis & Abbey.

Bhavnani, A., Chui, R. W.-W., Janakiram, S., Silarszky, P., & Bhatia, D. (2008, June 15). The role of mobile phones in sustainable rural poverty reduction. (44678). ICT Policy Division, Global Information and Communications Department (GICT), The World Bank.

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., (2007). Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergo. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.). Cambridge: Cambridge University Press.

Bureau of African Affairs. (2010, November 3). Background Note: Zimbabwe. Retrieved February 15, 2011, from http://www.state.gov/r/pa/ei/bgn/5479.htm.

Cameroon, A. C., & Trivedi, P. K. (2005). Microeconometrics methods and applications. New York: Cambridge University Press.

Cooper, P. J., Dimes, J., Rao, K. P., Shapiro, B., Shiferaw, B., & Twomlow, S. (2008). Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change? Agriculture, Ecosystems and Environment, 126, 24-35.

CSO. (2004). Census 2002: Provincial Profile- Mashonaland East. Harare, Zimbabwe: Central Statistical Office.

CwDCC (a). (n.d.). Coping with Drought and Climate Change project. Harare: Government of Zimbabwe-UNDP/GEF: Coping with Drought and Climate Change (CwDCC).

CwDCC (b). (n.d.). Factsheet: climate variability and change in Zimbabwe. Harare: Government of Zimbabwe-UNDP/GEF: Coping with Drought and Climate Change (CwDCC). du Plooy, G. (2009). Communication research: techniques, methods and applications. Cape Town: Juta & Co.

Duncombe, R. (2006). Analysing ICT Applications for Poverty Reduction via Microenterprise Using the Livelihoods Framework. Working Paper Series (27) . Manchester: Development Informatics Group, University of Manchester.

FAO. (2005, November). “e-Agriculture”: A Definition and Profile of its Application. Retrieved 10 11 2011 from: http://www.slideshare.net/sarper/e-agriculture-a-definition-and-profile-of-its-application

Field, A. (2009). Discovering statistics using SPSS. 3rd ed. London: Sage Publications.

Gbetibouo, G. A. (2008). Understanding Farmer’s perceptions and adaptation to climate change and variability: the case of Limpopo Basin, South Africa. International Food Policy Research Institute (IFPRI), Environment and Technology Policy Division. Policy Brief 15-8.

Greenberg, A. (2005). ICTs for Poverty Alleviation: Basic Tool and Enabling Sector. Montreal, Quebec: Department for Infrastructure and Economic Cooperation, Sida.

Greene, H. W., (2003). Econometric analysis. (Fifth edition). Pearson Education, Upper Saddle River, New Jersey, USA.

Heeks, R. (1999). Information and Communication Technologies, Poverty and Development. Working Paper Series (5) . Development Informatics, University of Manchester.

Heeks, R. (2005 a, October). Foundations of ICTs in Development: The Onion-Ring Model. eDevelopment Briefing (4) . Manchester: Development Informatics Group, University of Manchester.

Heeks, R. (2005 b, October). Foundations of ICTs in Development: The Information Chain. eDevelopment Briefing (3) . Manchester: Development Informatics Group, University of Manchester.

Hulme, M., Doherty, R., Ngara, T., and New M. (2005). Global warming and African Climate change: a reassessment. In Low, P. S (ed) 2005. Climate change and Africa. United Kingdom: Cambridge University Press. (p 29-40).

ITU. (2010). World Telecommunication/ICT Development Report 2010- Monitoring the WSIS targets: A mid-term review. Geneva: International Telecommunication Union.

ITU. (2009). Manual for Measuring ICT Access and Use by Households and Individuals. International Telecommunication Union

ITU. (2008). ICTs for e-Environment Guidelines for Developing Countries, with a Focus on Climate Change (Vol. Final report). Geneva: International Telecommunication Union (ICT Applications and Cybersecurity Division).

ITU. (2007). World information society report 2007: Beyond WSIS. Geneva: International Telecommunication Union and United Nations Conference on Trade and Development. Retrieved 14 10 2011 from: www.itu.int/osg/spu/publications/worldinformationsociety/2007/index.html.

Lambrou, Y., & Nelson, S. (2010). Farmers in a changing climate: Does gender matter? Food security in Andhra Pradesh, India. Rome: Food and Agricultural Organisation (FAO).
Long, Scott. (1997). Regression models for categorical and limited dependent variables. Thousands Oak, CA Sage Publications.

Lorenzoni, I., & Pidgeon, N. F. (2006). Public views on climate change: European and USA perspectives. Climatic Change , 77, 73-95.

Mansell, R. (1999). Information and communication technologies for development: assessing the potential and the risks. Telecommunications policy, 23 (1), 35-50.

Mansell, R. and Wehn, U. (Eds). (1998). Knowledge Societies: Information Technology for Sustainable Development, Oxford: published for the United Nations Commission on Science and Technology for Development by Oxford University Press.

Meinke, H., Nelson, R., Kokic, P., Stone, R., Selvaraju, R., & Baethgen, W. (2006). Actionable climate knowledge: from analysis to synthesis. Climate Research , 33, 101-110.

Ministry of Environment and Natural Resources Management. (2009). Report on the climate change roundtable. Ministry of Environment and Natural Resources Management in conjunction with the Common Market of Eastern and Southern Africa (COMESA) Secretariat with financial support from the Norwegian Embassy.

Ministry of Mines, Environment and Tourism. (1998). Zimbabwe's initial national communication on Climate change: Prepared for the United Nations Framework Convention on Climate Change. Harare: Climate Change Office (Ministry of Mines, Environment and Tourism) Government of Zimbabwe.

Mudombi, S. (2007). Socio-economic determinants of smallholder farmer's adoption of improved sweet potato: case study of Wedza community in Zimbabwe. (Vol. MSc Thesis). Harare: University of Zimbabwe (Department of Agricultural Economics and Extension).

Munyua, H. (2007). ICTs and small-scale agriculture in Africa: a scoping study (Final Report). International Development Research Centre (IDRC).

Mutekwa, V. T. (2009). Climate change impacts and adaptation in the agricultural sector: the case of smallholder farmers in Zimbabwe. Journal of Sustainable Development in Africa , 11 (2), 237-256.

Ngigi, S. N. (2009). Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa. New York: The MDG Centre, East and Southern Africa, The Earth Institute at Columbia University.

NICT Project. (2006, December 7). Zimbabwe ICT4D National Policy. National Information and Communication Technology Project. Retrieved February 20, 2011, from Communication Initiative site (ICT Policies & Studies): http://d6.comminit.com/wrap/en/node/148509/308

Nyirenda-Jere, T. (2010, 08 17). Unlocking the Promise of ICTs for Transforming Agriculture in Africa. Retrieved 10 10, 2010, from http://knowledge.cta.int/en/Dossiers/S-T-Issues-in-Perspective/ICT-for-transforming-research-for-agricultural-and-rural-development/Articles/Unlocking-the-Promise-of-ICTs-for-Transforming-Agriculture-in-Africa

Ospina, A. V., and Heek, R. (2010). Unveiling the links between ICTs and Climate change in Developing countries: A scoping study. UK: Centre for Development Informatics, Institute for Development Policy and Management, SED, University of Manchester; Canada: International Development Research Centre (IDRC).

Ospina, A. V., and Heeks, R. (2011). ICTs and Climate Change Adaptation: Enabling Innovative Strategies. Climate Change, ICTs & Innovation Project- Strategy Brief 1 . Centre for Development Informatics, University of Manchester.

Patt, A., & Gwata, C. (2002). Effective seasonal climate forecast applications: examining constraints for subsistence farmers in Zimbabwe. Global Environmental Change , 12, 185–195.

Saravanan, R. (2011). eArik: Using ICTs to Facilitate "ClimateSmart Agriculture" among Tribal Farmers of North-East India. CASE STUDY: ICTs and Agricultural Adaptation to Climate

Change category . (R. Heeks, & A. V. Ospina, Eds.) Climate Change, Innovation & ICTs Project, Centre for Development Informatics (CDI), University of Manchester, UK.

Sife, A. S., Kiondo, E., & Lyimo-Macha, J. G. (2010). Contribution of mobile phones to rural livelihoods and poverty reduction in Morogoro region, Tanzania. The Electronic Journal on Information Systems in Developing Countries (EJISDC) , 42 (3), 1-15.

Stork, C., & Stork, M. (2008). Towards Evidence-based ICT Policy and Regulation: ICT Household Survey Methodology & Fieldwork. Policy Paper 1: Volume ONE . Retrieved 23 09 2011 from Research ICT Africa (www.researchICTafrica.net).

Thioune, R. M. (2003). Information and Communication Technologies for development in Africa: opportunities and challenges for community development (Vol. 1). Ottawa, Canada: IDRC; Dakar, Senegal: CODESRIA.

UNEP. (2003). How will global warming affect my world? A simplified guide to the IPCC's "Climate Change 2001: Impacts, Adaptation and Vulnerability". Geneva: United Nations Environment Programme .

UNFCCC. (2007). Climate change: impacts, vulnerabilities and adaptation in developing countries. Bonn, Germany: United Nations Framework Convention on Climate Change.

Unganai, L. S. (1996). Historic and future climatic change in Zimbabwe. Climate research. Vol. 6: 137-145.

Whyte, A. (2000). Assessing Community Telecentres: Guidelines for Researchers. Ottawa: Acacia Initiative, International Development Research Centre.

World Bank. (n.d.). ICT Glossary Guide: 100 ICT Concepts The World Bank . Retrieved 20 10, 2011, from Information and Communication Technologies: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/0,,contentMDK:21035032~menuPK:282850~pagePK:210058~piPK:210062~theSitePK:282823,00.html.

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ISBN: 978-9966-030-62-7