Effective Communication for Climate Information Services: *A Jamaican Case Study Assessment Using Perspectives from Multi-End-User Stakeholder Feedback.*

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Statement confirming originality: This paper is the original work of Sarah Buckland in its entirety, including the aspects of data collection, analysis and write-up. The original research was conducted under the supervision of Dr. David Miller, lecturer, Department of Geography & Geology, UWI Mona.

Context of the Paper: The work presented here is an adapted excerpt of Sarah Buckland's Undergraduate Thesis as part of the BSc Geography Programme, submitted to the University of the West Indies, Mona Campus. This was produced while being supported by the CCRIF-UWI Scholarship (2014-2015). This research received awards for Best Oral Undergraduate Presentation (10th FST Conference, UWI, 2015) and Best Undergraduate Dissertation (FST Awards, Dept. of Geography & Geology, 2016). Separate aspects of the research not included here are being processed for consideration in external publications.

Biography: Sarah Buckland is an interdisciplinary researcher with backgrounds spanning Bible evidences, language studies and the environmental and social sciences. She completed her BSc degree in Geography (Major) and Spanish (Minor) with first class honours, supported by the CCRIF-UWI scholarship (2014-2015). Sarah is presently a PhD Candidate in the Department of Geography and Geology, UWI Mona, where her research explores entry points for drought risk reduction in crop production systems across Clarendon, Jamaica, one of Jamaica's most intensive and expanding agricultural regions. This research comes immediately following the 2014/15 drought event, one of the most devastating droughts in Jamaica's recent history, and offers potential practical contributions to enhance anticipatory planning and decision-making at the farm and policy-levels. Sarah presently works under the supervision of Dr. Donovan Campbell, and along with the Climate Studies Group, UWI Mona. While pursuing her studies, Sarah has also participated in various projects & training initiatives including CCRIF's Regional Internship Programme (2015), the International

Research & Applications Project on Coffee Leaf Rust (2015-2016) and the Caribbean Climate Outlook Forum (Dry Season CariCOF, 2017). Motivated by faith in God, family support and a zeal to positively influence society, aspects of her academic work have also received recognition and support by the UWI Postgraduate Scholarship, the Prime Minister's National Youth Award for Excellence in Academics (2017).and UWI's Postgraduate Wall of Excellence (UWI Research Days, 2018).

Photograph:

ABSTRACT

Tailored Climate Information Services (CIS) have become critical components of disaster risk reduction planning globally. The efficiency and effectiveness of these services, in both production and end-user uptake aspects, are particularly crucial for resource-rationed Small Island Developing States (SIDS), which stand to experience heightened exposure to the effects of increased climate variability. Effective communication strategies are fundamental to bridge the gap between CIS producers and end-users, however, there is still a dearth in understanding the dynamics of end-user uptake, particularly in the Caribbean context. This paper forms part of a wider evaluative study aiming to develop a single integrated tool compatible with existing global frameworks for assessing National Meteorological and Hydrological Services (NMHS) in their charge to develop and disseminate tailored CIS, incorporating aspects of internal operations, information delivery and end-user uptake. The presentation below however concentrates on the end-user perspectives of CIS delivery using the Jamaican context as a case study. The study employs a concurrent triangulation mixed model design consisting of site visits and consultations, garnering perspectives from key informant end-users within the agricultural sector, with emphases on farm-level feedback (N=76). The end-user assessment is framed using a 5-dimensional criteria matrix consistent with the Global Framework of Climate Services (GFCS): The case of Jeffrey Town, St. Mary highlights that there is alignment between the relevance of climate information provided with what agricultural end-users deem most important. Limited CIS awareness and accessibility to media of transmission, limited trust in formal climate information and understandability constraints due to low formal education levels were found to be the main barriers in the CIS communication process. The results from this case provide critical farm-level guidance for CIS producers for future community-level engagement approaches.

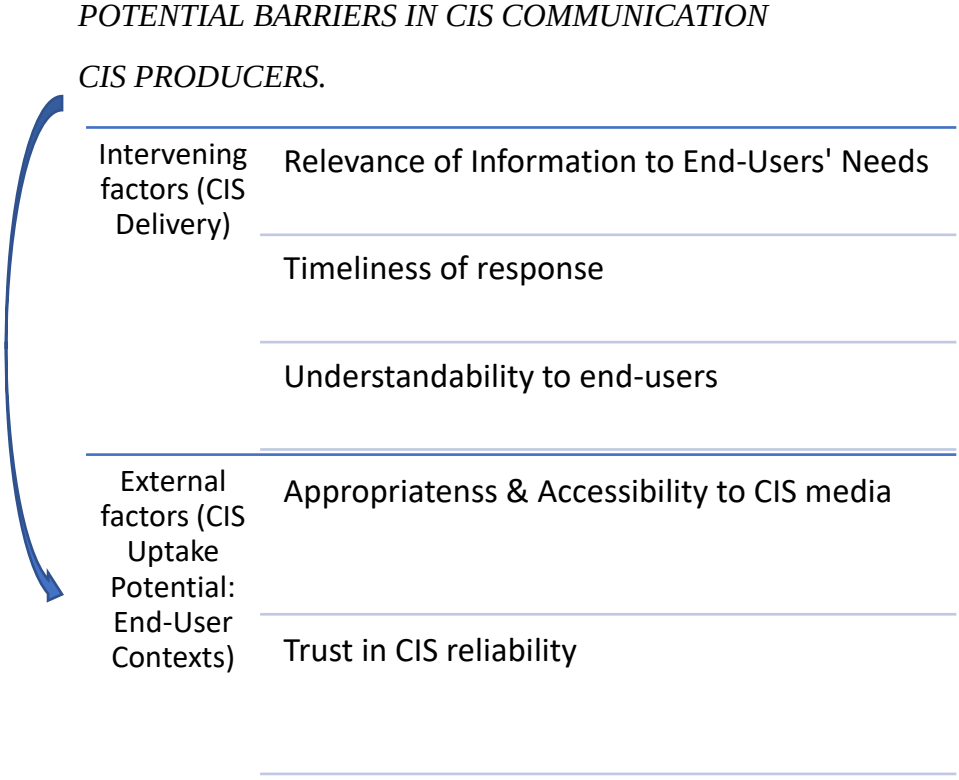
1. INTRODUCTION

1.1 Background and Context of Research Problem

Jamaica as a Small Island Developing State (SIDS) is faced with a plethora of physical and socio-economic vulnerabilities owing to its geographic characteristics and historical and contemporary processes. Of the vulnerabilities faced, the threat of weather and climate hazards is one to which Jamaica is most frequently and increasingly susceptible, owing to its location within the Atlantic hurricane belt. Effective communication of relevant climate information is critical for risk reduction.

During the past few decades, Jamaica has been affected by increasingly extreme climate events, causing severe socio-economic setbacks. According to Richards (2008), between 2002-2007 hurricane and flood climatic disasters in Jamaica amounted to J $73.19 billion. Jamaica's agricultural system has experienced heightened exposure-sensitivity with increasing external pressure from the effects of the double exposure to increased climate variability and economic globalization, the former which often limits produce quantity and quality and the latter, which demands consistently competitively priced yet high quality produce. Over the past few years, the Meteorological Service of Jamaica (MSJ) has partnered with various local and international organizations to offer more specialized climate services, embarking on initiatives such as the Caribbean Agro-Meteorological Initiative (CAMI, 2009), and the Jamaica Rural Economy and Ecosystems Adapting to Climate Change (JaREEACH, 2012). As it is unclear as to the extent of the effectiveness of climate services in Jamaica since these initiatives have been undertaken, on-going evaluation of the effectiveness of these projects is critical to ensure quality and relevant services to each stakeholder involved as needs continue to change. In light of this gap, this paper seeks to present in-depth case study feedback on the effectiveness of the CIS communication for agriculture from the perspectives of key end users and linked organizations to Jamaica's agriculture sector. The aspects of 'effective' CIS communication as presented in this paper (figure 1) include a subsect of indicators used in a wider study by this researcher, consistent with the Global Framework on Climate Services (GFCS, 2011). The additional frameworks integrated in the development of each indicator will be elaborated on in the methodology.

Figure 1.1: Variables examined in Effective Climate Information Communication Framework Used in this Study



The results from this research aim to provide useful practical and theoretical insights on the progress and barriers which may affect effective communication for climate adaptation, particularly in agriculture, specifically applicable for the region. It is hoped that this research will provide useful feedback for refining current and future approaches to climate service communication and lay the foundation for further research to foster improvement of this critical sector of society.

2. LITERATURE REVIEW

2.1 Overview

Recently much emphasis has been placed on ensuring sustainable development and food security in the face of projections of increased climate variability, which has already been detected in various sectors, including tourism and agriculture (Simpson, *et al*, 2012). The MSJ's roles have simultaneously broadened over the years from providing more generalized to more specialized weather and climate services to stakeholders deemed most vulnerable. This literature review aims to gain an overall understanding of the reason for this shift to more targeted services, as well as the gaps and changing needs of weather and climate services. This will be followed by an analysis of case studies of past climate service evaluation methodologies to examine various possible approaches and appropriate indicators as used in other studies to evaluate '*effectiveness*' of CIS communication.

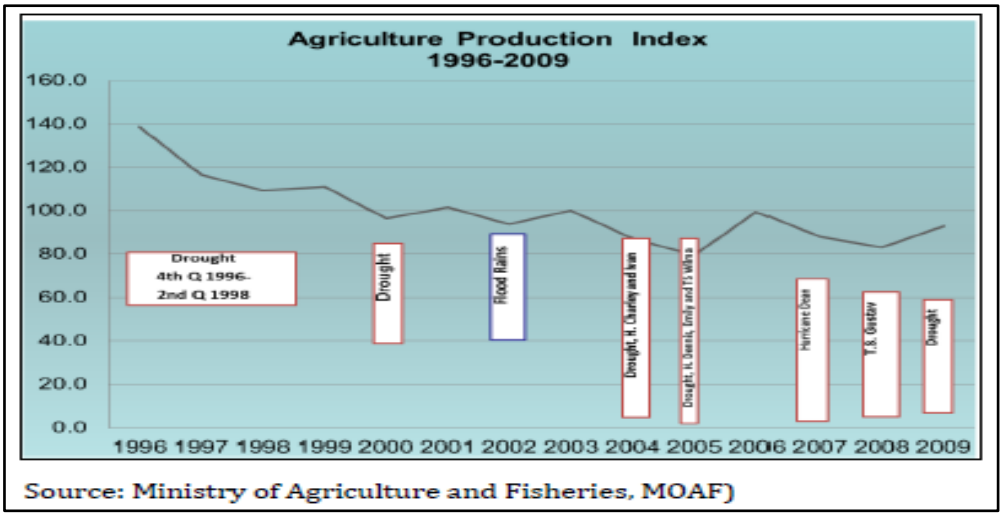
2.2 Contemporary Context: Changing Roles, Developments and Challenges

From the latter part of the 20th Century to the present, increased research globally projecting greater climate variability, extremities and climate change according to Global and Regional Climate Models (GCMs & RCMs), have resulted in a more concerted effort in local and international policy-making to mitigate climatic hazards. Specifically for the Caribbean, projections for both high and low emission scenarios by international and regional scientists mostly agree indicating a general warming and drying trend (of up to 5^{o}C), concentrated in North-Western Caribbean (including Jamaica), particularly during summer months by the 2080's, with increased severity of climatic hazards and disasters (IPCC, 2007, 2013; Taylor *et al*, 2013).

Caribbean agriculture has been noted to be particularly vulnerable to the stresses of environmental change due to our small landmass and limited adaptive capacity, which limit competitiveness in the face of economic globalization, posing challenges to Caribbean food security (Barker, 2012; Taylor *et al*, 2012). Several studies investigating conditions and perceptions at the farm-level across Jamaica, including Southern St. Elizabeth, and Northern Clarendon have also revealed that climate change effects are not only limited to theoretical projections,

but have been felt at the farm-level through lower crop quality and yields, increased pests and diseases and threatened livestock health (Campbell, Barker & McGregor, 2010; Gamble, *et* al, 2012; Campbell *et al*, 2011; Simpson *et al*, 2012; Albrecht & Tomlinson, 2014;),. General production losses have also been tangibly observed during extreme climatic events such as the El Niño Southern Oscillation (ENSO) drought of 1998 (figure 2.1).

Figure 2.1: Line graph showing fluctuations in agricultural production due to agro-meteorological hazards



Adapted from Jamaica Strategic Programme for Climate Resilience (hereafter Jamaica SPCR), 2011

In an attempt to address these hazards, various coping strategies have been employed ranging from generally indigenous techniques at the local farm-level, to the implementation of various general and targeted hazard and disaster mitigation plans, policies and projects at the community and national level over the years incorporating various stakeholders. MSJ's role in disaster risk management primarily encompasses preparedness and mitigation (table 2.1).

Table 2.1: Timeline of key general and targeted hazard/disaster mitigation plans, policies and projects in Jamaica directly or indirectly related to ADRM (Up to 2015)

Year	Plan/Policy/Project	MSJ role (direct or implied)
1997	National Disaster Action Plan	Member of National Disaster Committee (NDC) and National Disaster Executive (NDE).
2005	Jamaica National Hazard Mitigation Policy	General hazard mitigation (McAlla, 2012).
2009	Agriculture Disaster Risk Management Plan (ADRMP)	Primarily responsible for hydro-meteorological hazard analysis, including flash weather hazards and long-term climate pattern analysis, and to develop specialized tools, climate service products and Early Warning Systems (EWS) for agro-meteorological hazard mitigation in collaboration with various stakeholders through the applied meteorology section (Spence, 2010). Linked with National and Parish Agriculture Disaster Risk Management (NADRM and PADRM) committees at the community and national level to promote sustainable agricultural practices (pilot done in 5 communities) (Rhiney, 2012; ADRMP, 2012; Mclean, *personal communication*, 2014).
	Caribbean Agro-Meteorological Initiative (CAMI) [2009-2012]	In keeping with the ADRMP, this was the first major project aimed at providing direct climate products services for agriculture (Francis-Rhiney, 2013). The Caribbean Agro-meteorological Initiative (CAMI) The project came out of initial consultations in St. John's, Antigua with Regional Meteorologists from the Caribbean and representatives of the WMO/FAO (Rankine, *personal communication*, 2014). The project was implemented in 10 CARICOM countries under the direction of the Caribbean Institute of Meteorology and Hydrology (CIMH) and each National Meteorology and Hydrology Service (NMHS), funded by the European Union and the African, Caribbean and Pacific (EU/ACP) Science and Technology programme.
2011	Jamaica Strategic Programme for Climate Resilience (Jamaica SPCR)	Provided with support for improved weather-monitoring and forecasting equipment under investment project I: *Improving Climate Data and Information Management.*
2012	Jamaica Rural Economy and Ecosystems Adapting to Climate Change (JaREEACH) project	This project has a similar mandate as CAMI and aims to address the needs from the outcomes of the CAMI project. It was implemented by the MSJ, funded by ACDI/VOCA.
2013	Building Disaster Resilient Rural	Indirect link with the MSJ. Pioneered by ODPEM, the project focuses on building resilience of

	Communities (BDRC) and Livelihood Project	vulnerable farming and fishing communities to disasters across the island.
	Green paper of Jamaica National Climate Change Policy Framework and Action Plan for sectoral-specific climate change strategies	Primary source of climate data specific for Jamaica.
	Formation of a Climate Service Working Group	This group was formed around the time of the Third International Conference on Climate Services (ICCS3) held in Montego Bay, Jamaica, 2013. It is co-chaired by MSJ and RADA, and also consists of the Caribbean Agriculture Research Development Institute (CARDI), ACDI/VOCA and the Ministry of Agriculture.
2014	Disaster Risk Management Act (Revised)	Member of National Disaster Risk Management Committee.
Currently under revision	National Land and Agricultural policies to include climate change factors	Primary climate data source for Jamaica.

Compiled from National Disaster Action Plan (1997),pp. 42-44, McAlla (2012),pp.52,67, ADRMP (2012), Rhiney (2012), Disaster Risk Management Act (2014), Spence (2010), Jamaica SPCR (2011),pp.85-85, Simpson *et al*, (2012), p.111, Climate Change Policy Framework and Action Plan (2013); Spence (2013); Francis-Rhiney (2013); Linton (2014)

2.3 Measuring '*effective' Communication of Climate Information*: Comparative methodological approaches

Various strides have been made in formulating basic guidelines for evaluating climate services, most notably the Global Framework for Climate Services (GFCS) by the WMO (Global Framework for Climate Services [GFCS], 2011) and the development of a methodological framework by Tall & Njinga (2013) to evaluate climate services for farmers in Africa and Asia. Box 2.2 summarizes the main principles of each.

Box 2.2: Comparison of the principles of GFCS and Tall & Njinga, (2013)

GFCS (2011): Some of the main principles and components of the GFCS implementation are:

- Climate service user interface platform to facilitate feedback to ensure relevance of services
- Adequate climate service information systems and infrastructure for monitoring and observation of climate variables at agreed standards
- Climate services enhanced through strong partnerships, with governments playing a central role (including through research, prediction and modelling, to support capacity development for the resources needed for effective climate services)
- Better accessibility and use of climate information by users
- Continuously updated and operational climate services
- Free and open exchange of climate data
- Needs vary at different spatial scales

Tall & Njinga (2013): Similarly, among the baseline monitoring and evaluation guidelines for climate services mentioned include:

- Tracking *'information flow'*, i.e. data/information transmission
- '*Institutional assessment*', i.e. co-operation among institutions involved in climate services
- Feedback from end-users: to find out how the end-user uses the information and the impact

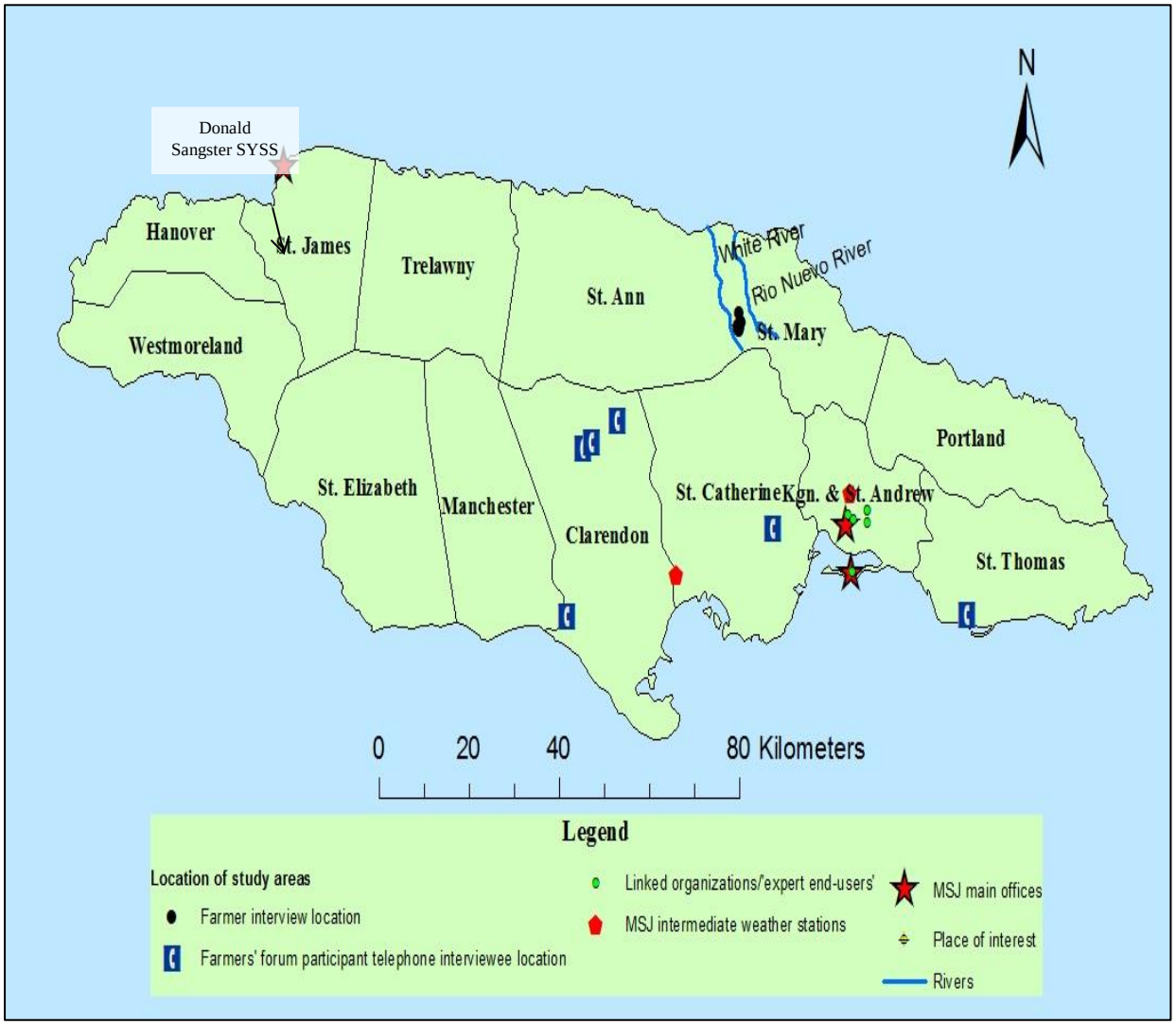
The resultant framework utilized in this paper will focus on the delivery (intermediary) and uptake-potential (decoder) aspects of the CIS communication processes. This integrated framework aims to uncover the strengths and weaknesses within the communication processes of the present Jamaican CIS context, from multiple end-user perspectives at these stages of the communication process.

3. METHODOLOGY

3.1 Overview

To effectively achieve the paper's objectives, a concurrent triangulation mixed-method approach was used. Primary data collection spanned from July 2014 to February 2015 and was done extensively through consultations with 76 key informants using both qualitative and quantitative research methods. Figure 3.1 shows the primary data collection sites visited and methods used. This paper will specifically focus on the feedback obtained through the telephone consultations mainly from participants in Southern parishes who were participants in past Farmer Forum training sessions, and field studies with farmer end-users in the case study community of Jeffrey Town, St. Mary.

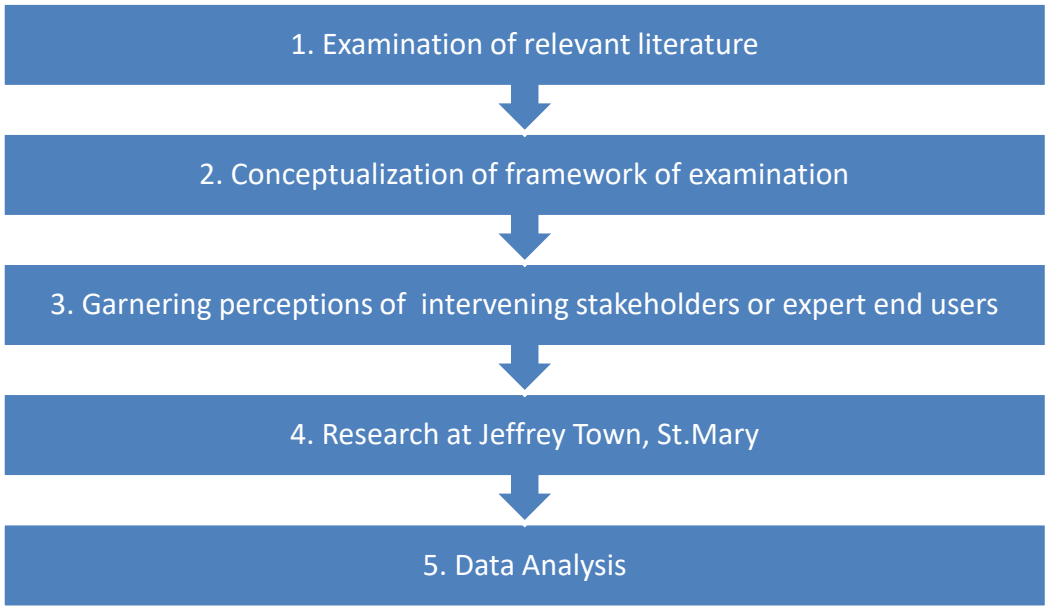
Figure 3.1: Location of Study Areas



3.2 The Research Process

The research process could be divided into 5 main phases as shown in figure 3.2. The following subsections detail each aspect of the research process.

Figure 3.2: Main stages of research process



3.2.1 Examination of literature and conceptualization of framework of examination

Prior to conducting the field studies, several pieces of literature were examined to ascertain which indicators would be appropriate in conceptualizing the '*effective communication*' of CIS, some of which were mentioned in the literature review, among which included the requirements for traditional and applied meteorological services, and past case study climate service evaluation methodologies e.g. Tall & Njinga (2013), and Vogel *et, al*, (2014). The resulting framework of factors, as expounded in Chapter 1 (figure 1.1), assimilated CIS delivery and external factors that were perceived upon examination of the literature to be central to the balance between the requirements for weather/climate service providers and the needs of the end-users in the agricultural system. This framework is used to examine 'effective CIS communication', emphasizing the importance of the micro-scale, assessing end-user needs with site visits to a farming community to which the climate services had been introduced. The data collection instrument questionnaires and interview schedule were formulated based upon this framework.

3.2.2 Selection of key informants & Garnering the Perspectives of Intervening Stakeholders.

A purposive methodology was taken in the selection of interviewees for the evaluative process, using the maximum variation principle to include the perspectives of key stakeholders with different roles within the agriculture sector. These included linked organizations and individuals in the ADRM framework (ACDI/VOCA, RADA extension officers, researchers) who provided feedback from a policy point of view. Receipt of direct grass-roots' end-user feedback was also a critical component of the evaluative process.

In examining the CIS communication process and its implications, it was deemed to be useful to examine various stakeholders who fall into the intermediate category playing a dual role, being 'primary' end users of MSJ data (i.e. directly receiving data from the MSJ prior to data processing and secondary transmission), as well as those whose operation potentially or directly affects the effectiveness of the mitigation of agro-meteorological hazards. As such, qualitative semi-structured surveys and a mixture of face-to-face and electronic consultations were done with 20 stakeholders from 6 institutions directly or indirectly acquainted with MSJ operations and data, whether through research and policy-making (Climate Studies Group, UWI Mona; select lecturers, Dept. of Physics and Geography and Geology, Caribsave), logistical connections (JCAA; WRA), or financing, implementation and execution of agro-meteorological projects (RADA; ACDI/VOCA) in order to gain feedback and recommendations concerning both the perspectives on climate information delivery and other aspects of MSJ operations pertinent to CIS. Purposive sampling methods were combined with snowballing in the selection of stakeholders who were known to have experience with MSJ data and/or agriculture.

3.2.2.1 Research at Jeffrey Town, St. Mary

Subsequent to gathering perceptions of intervening stakeholders, efforts were made to garner the perceptions of the main end-users of agriculture climate services: farmers, on a local-scale. In keeping with the research aims, the community chosen would have to be involved in at least one climate service project supported by the MSJ for the effectiveness of the services to be evaluated. The community of Jeffrey Town, St. Mary was chosen as a possible model community case study upon secondary research which revealed that the community had participated in at least two climate service projects (CAMI and

JaREEACH) in addition to having an active Farmers' Association with its own community radio station which has been the recipient of various international awards for climate resilience efforts. Internal estimates from the Jeffrey Town Farmers' Association (JTFA) state that the community has a population of around 150 farmers, including unregistered farmers.

Field work in the area began with a field reconnaissance on November 8, 2014, which included tours of sections of the community, chaperoned by a senior member of the JTFA, Mr. Lincoln Small, vice-president for agriculture. Preliminary data collection was started during this time, and completed between December 29-30, 2014. A total of 37 Jeffrey Town residents (36 sample farmers, 1 administrator of the local community station, JET FM) were surveyed, using a mixed-method approach, using cluster and judgemental sampling where farmers from each of the 9 districts in Jeffrey Town were surveyed through the administration of orally administered questionnaires, with unstructured in-depth interviews being conducted with 3 key personnel in the community. The combination of sampling at the judgement of the chaperone (geared mainly towards farmers as opposed to other groups within the community) with cluster sampling, compensated for personal lack of acquaintance with the community, while allowing for a more representative sample, including both participant and non-participant farmers in climate services. Quantitative analysis of questionnaire responses would provide a general idea of perspectives and needs of this sub-group of end-users, which could be a useful guide for future climate services. The use of a GPS device and digital camera were employed to assist in providing a spatial and visual context for interview sites.

To complement the feedback from the case study community, additional in-depth qualitative interviews were conducted using a systematic random sampling method (N=6) selecting from participants of 4 different CAMI and JaREEACH farmers' forums, spanning the parishes of Clarendon, St. Catherine, Kingston and St. Andrew and St. Thomas, using the initiatives' lists of participants as the sampling frame. Feedback from these participants and references to other similar studies will compensate to provide a wider picture where response trends may provide a useful comparative context for analysis.

3.3 Data Analysis

Qualitative and quantitative survey (interview and questionnaire) responses from the aforementioned stakeholders were synthesized, analyzed and compared alongside observation findings and relevant secondary sources in order to attain a comprehensive understanding of the data in relation to research aims. Data presentation and analysis was completed using various tools including the Statistical Package for the Social Sciences (SPSS), Microsoft Office and Geographic Information Systems (GIS) in the form of maps, diagrams, boxes, plates and graphs. Consistent with the case study approach, stakeholder feedback was primarily analyzed using descriptive statistics, rather than inferential. Manual thematic content analysis of stakeholder responses was also done.

3.4 Challenges, limitations and extensions of study

Several challenges were faced during research which led to a reduction of the research scope due to time and resource constraints. As the initial topic aimed to examine implications of MSJ efficiency on disaster management in Jamaica, efforts were made to obtain feedback from a wide cross-section of end-users island-wide. However, delayed and non-responses were experienced from various organizations, particularly for database requests of climate service forum participants, leading to the examination of a local-scale case study community, which limits the generalization of results.

Although the sample size selected within the farming community was deemed sufficient to garner the trend of end-users' needs as a starting point of analysis of the effectiveness of Jamaica's weather and climate services, use of a larger sample size and scope of end-users would decrease the margin of error and allow for a greater representativeness for end users.

4. RESULTS & DISCUSSION OF KEY FINDINGS

Knowledge and appreciation of the socio-demographic contexts of the end-users in any prospective site for climate adaptation intervention initiatives are critical for facilitating appropriate rapport and adjusting communication strategies to the context. Comparing the perspectives and preferences of various sub-populations of end-users also provides a useful basis for determining 'good practices' for CIS communication in future interventions. The following sub-section provides an overview of the socio-demographic characteristics of the primary end-user farmer population interviewed in this study.

4.1 Case Study Farming Community Context

Jeffrey Town is a small, active farming community located in St. Mary between the White and Rio Nuevo Rivers (see figure 3.1, chapter 3), consisting of predominantly small-scale subsistence male crop farmers over 60 years old, around 97% of whom have been farming for over 10 years and nearly 43% of whom have participated in some climate training (see figures 4.1A-D).

Figure 4.1 A: Pie chart showing proportion of types of farming done by respondents in Jeffrey Town, St. Mary

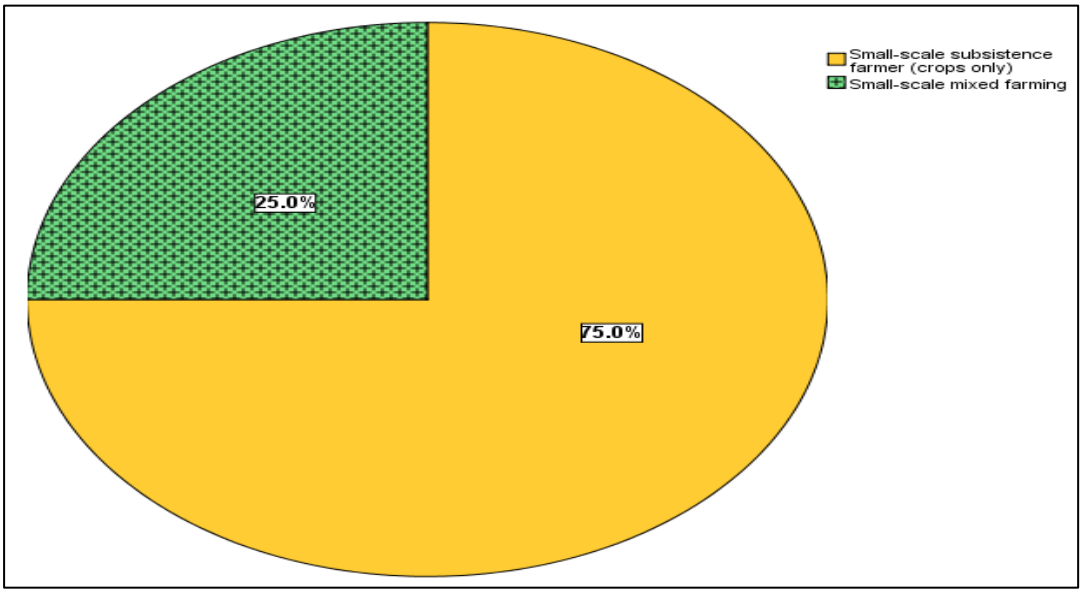


Figure 4.1 B: Population pyramid of Jeffrey Town sample farmers

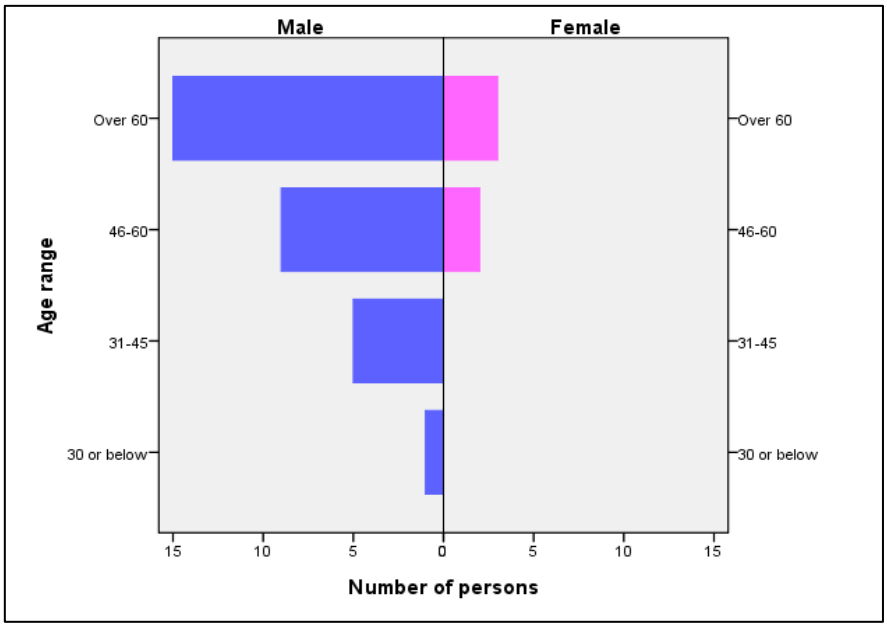


Figure 4.1 C: Pie chart showing the number of years Jeffrey Town respondents have been farming

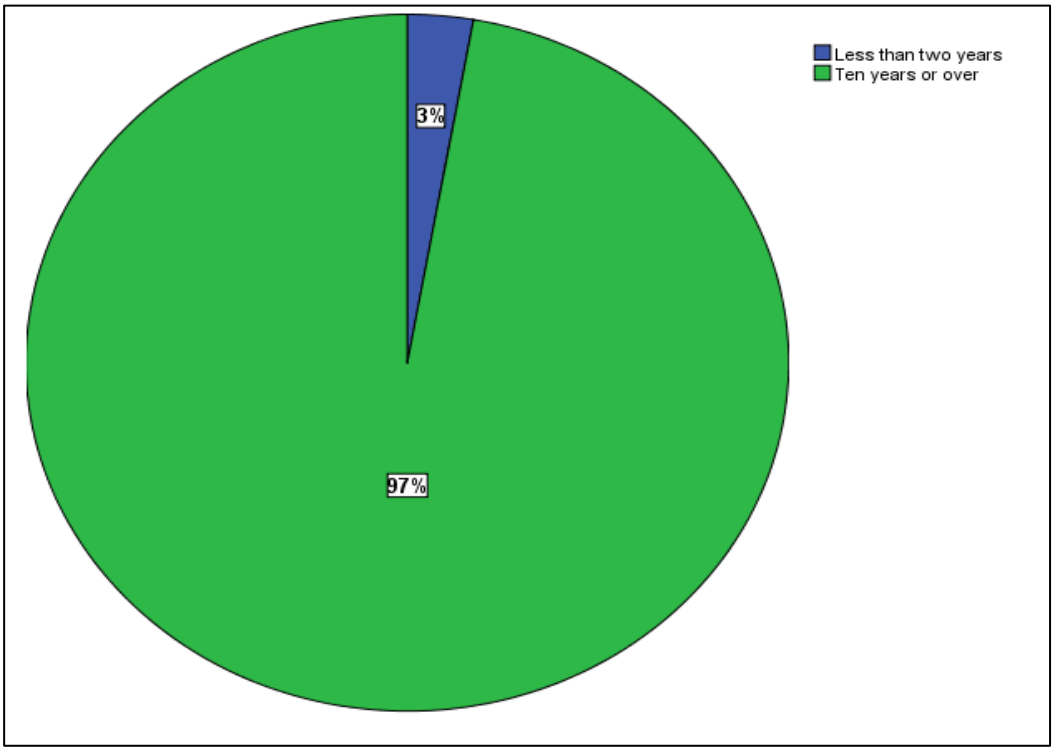
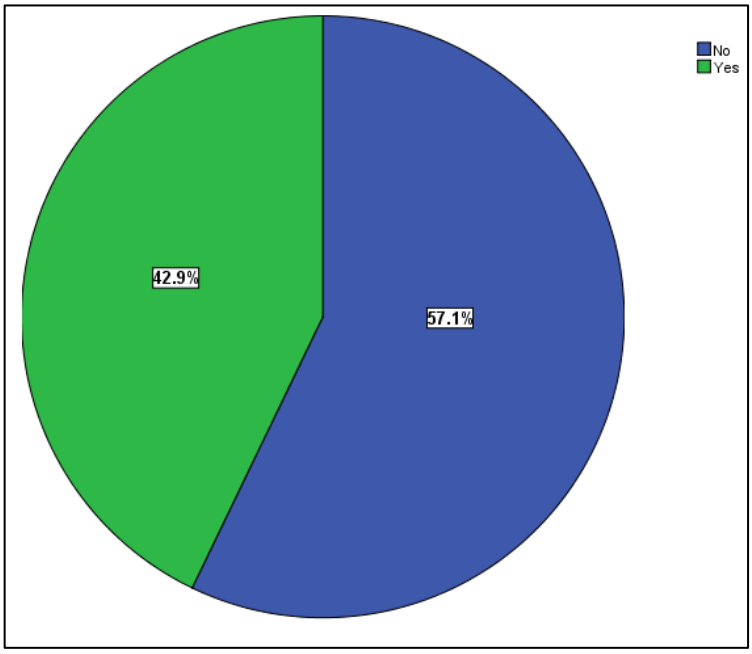


Figure 4.1D: Pie chart showing the percentage of Jeffrey Town respondents who admitted to participating in climate risk reduction training



Bearing in mind these socio-demographic tendencies, the following sections systematically detail the feedback obtained on the seven indicators of 'effective CIS communication' used in this study.

4.2. Progress & Constraints in CIS Communication: End user feedback

4.2.1 Relevance of data to end-users' needs

For climate services to be effective, the information supplied by climate service providers must directly address farm-level vulnerabilities, taking into account farmers' decision-making processes on varying temporal and spatial scales and specific agro-meteorological hazards faced (Tall & Njinga, 2013).

Farmer respondents were asked to rank information related to farming decision-making in their perceived order of importance (with a rank of '1' having the highest perceived importance). Tables 4.1A and B compare the present CIS available from the MSJ, with farm-level feedback. As indicated, it was found that the parameters of focus by the MSJ basically coincide with the main factors farmers in Jeffrey Town deem important when making farming decisions, namely rainfall and pest information. This feedback generally coincides with the most urgent needs expressed from farmers in other areas locally (Albrecht & Tomlinson, 2014). It must however be noted the high priority farmers place on non-climatic

factors such as indigenous knowledge, including astronomical data and market data, which are yet to be fully incorporated into local climate services.

Table 4.1A: Main climate products and services for agriculture currently provided by the MSJ

Main agro-meteorological element targeted	Climate product/service offered
Rainfall	• 3-month Seasonal Precipitation Index (SPI) outlooks • Drought monitoring & forecasts
Pests and/or diseases	• Pest forecasting
Temperature	• Seasonal Temperature Outlooks

Table 4.1B: Frequency table showing the most important factors taken into consideration by Jeffrey Town respondent farmers when making farming decisions.

Parameter	Rank	Frequency	Percentage of sample that mentioned the parameter as being important when making farming decisions
Rainfall	1	33	92%
Non-climatic parameters (including lunar cycles ('McDonald' almanac) and the market	2	9	25%
Pest information	3	6	17%
Wind direction	4	4	11%
Wind speed	4	4	11%
Humidity	5	3	8%
Temperature	6	2	6%
Soil moisture	6	2	6%

4.2.1.1 Specific vulnerabilities and the role of indigenous local mitigation strategies

As seen in figure 4.2, the most frequently cited agro-meteorological hazard affecting Jeffrey Town farmers was drought, followed by pests and floods. Despite expressing vulnerabilities, farmers cited numerous examples of local mitigation efforts employed as shown in plate 4.1 and figure 4.3. Interestingly, the use of scientific forecasts was not greatly evident among respondents, possible reasons for which will be subsequently discussed.

Figure 4.2: Bar graph showing the hazards cited as affecting the Jeffrey Town residents most often

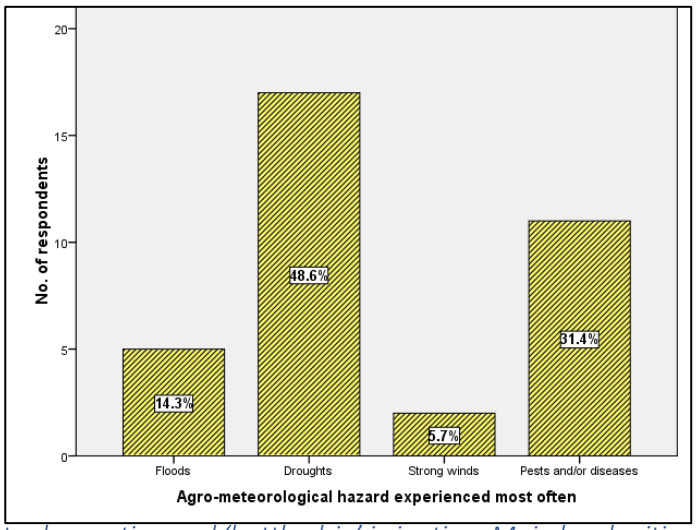
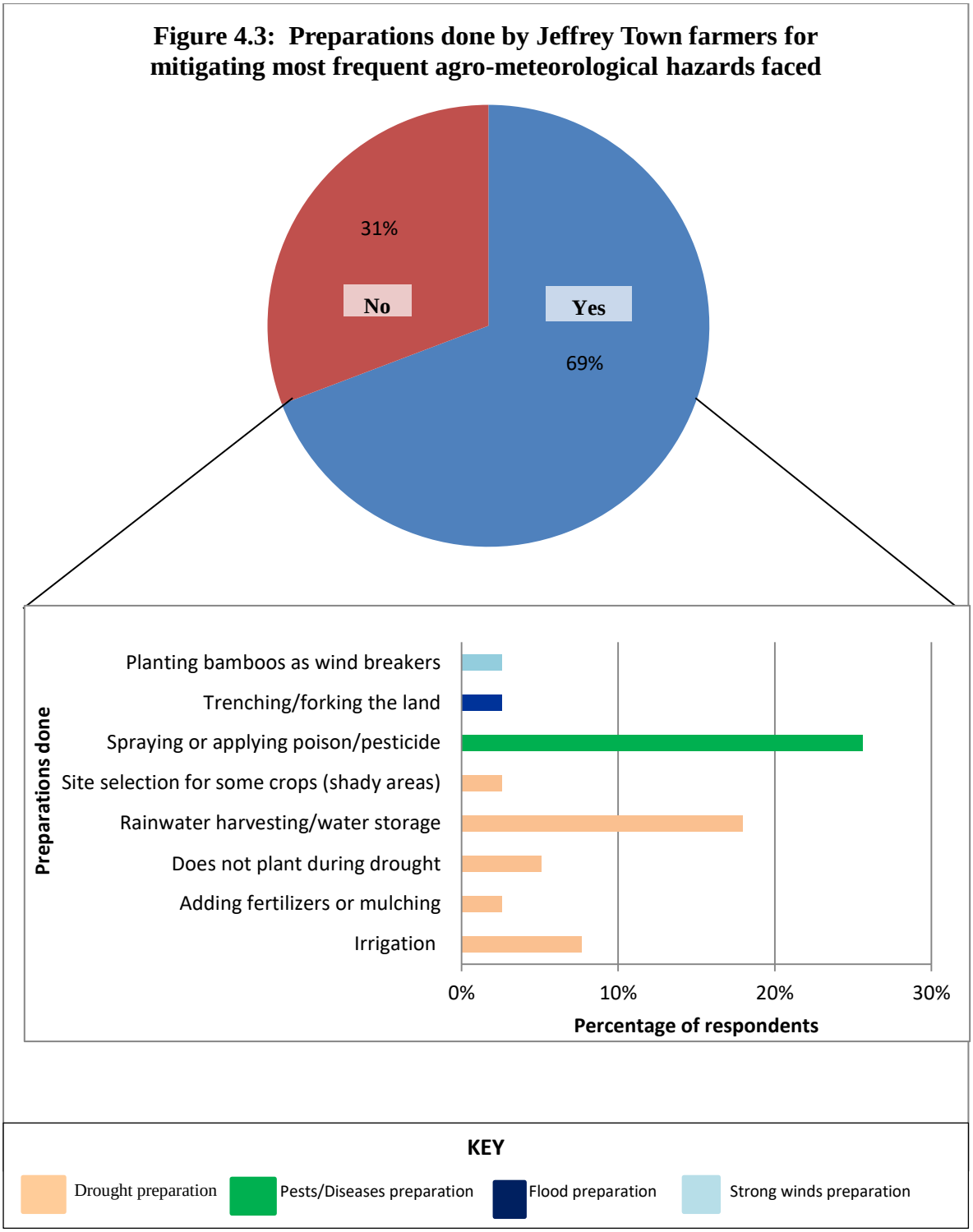


Plate 4.1: Rain water harvesting and 'bottle-drip' irrigation: Main local mitigation/adaptation strategies observed in Jeffrey Town

Figure A: Water harvesting tank implemented by the Jeffrey Town Farmers' Association; Figure B: Rainwater harvesting on a farm for livestock. Despite having these mitigation strategies in place, large losses were reported due to the 2014 drought, averaging around J$119,200 per farmer according to responses.

'Bottle-drip' irrigation allows for alleviating drought conditions through water application, water conservation (as water slowly seeps into soil) as well as recycling waste plastic bottles.

Figure 4.3: Preparations done by Jeffrey Town farmers for mitigating most frequent agro-meteorological hazards faced



4.2.2 Appropriateness and accessibility of communication media

Even with relevant information being conveyed by climate service providers, if the end-users are unable to access the information, climate services will not be effective. As shown in box 4.1, the main medium currently used by MSJ for agriculture-specific climate information is the internet. A text message system is also in place. The resolution of climate

information presented through radio and television media channels is coarse, consisting of primarily generalized reports and forecasts. There is currently limited use of radio/television media for agriculture-specific climate information.

Box 4.1: Main media currently used by the MSJ to convey climate service information for agriculture

The MSJ currently produces:

- Farmers' outlook bulletins (Generally available on the RADA website)
- Community-specific 5-day forecasts for agriculture communities (agrilinksja.com)
- Additional agricultural climate information on jamaicaclimate.net
- Email database from farmers' fora
- Text message system (particularly used during extreme events)
- Face-to-face contact with agriculture extension officers

As is shown in figure 4.4A, the main media that Jeffrey Town respondents stated they were aware of for weather forecasts was radio/television, with less than 40% of respondents being aware of internet forecasts. Despite internet access being available at the JTFA community centre, figure 4.4B highlights another barrier to internet access: nearly 70% of respondents stated that they were unable to use the internet. It is also seen that awareness of these bulletins did not necessarily translate into use, as only 11% admitted to using outlook bulletins compared with the nearly 40% who admitted awareness. Therefore, as figure 4.4C highlights, the vast majority of Jeffrey Town respondents deem the use of radio/television to be the most convenient media for agriculture climate bulletins.

Figure 4.4A: Comparison of levels of awareness of weather updates for various communication media among Jeffrey Town respondents

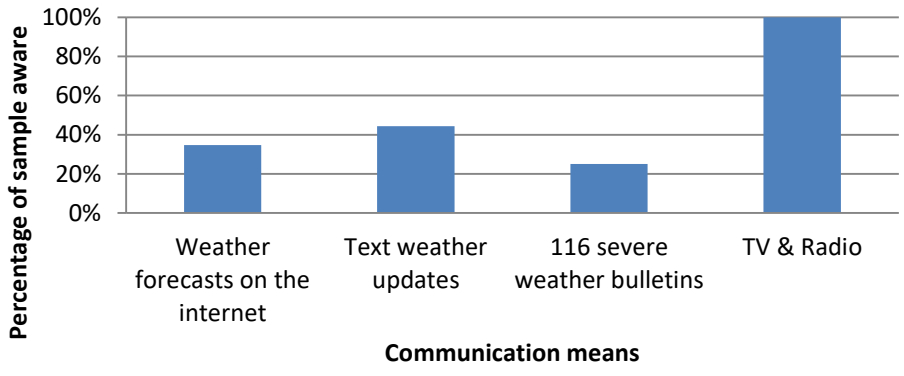
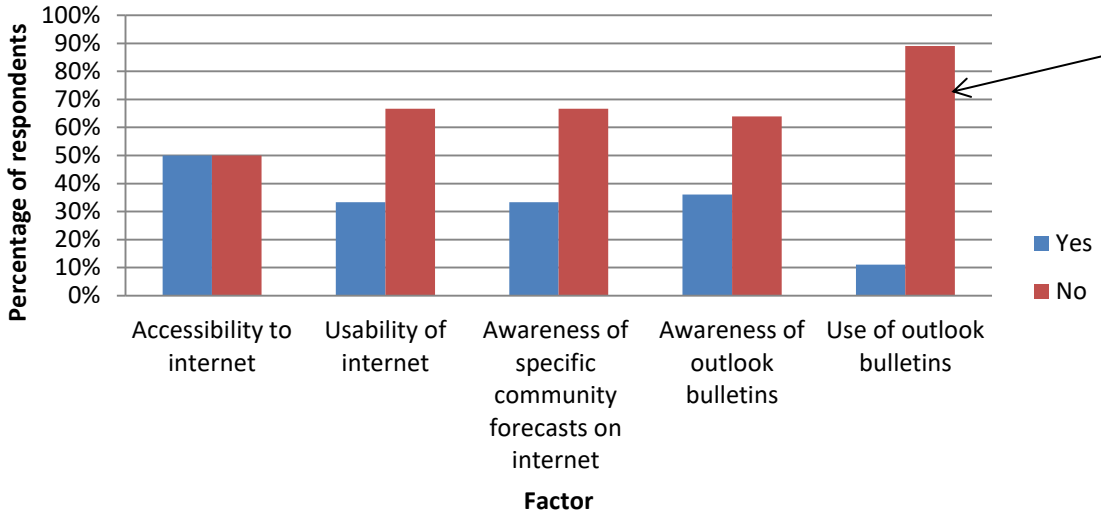
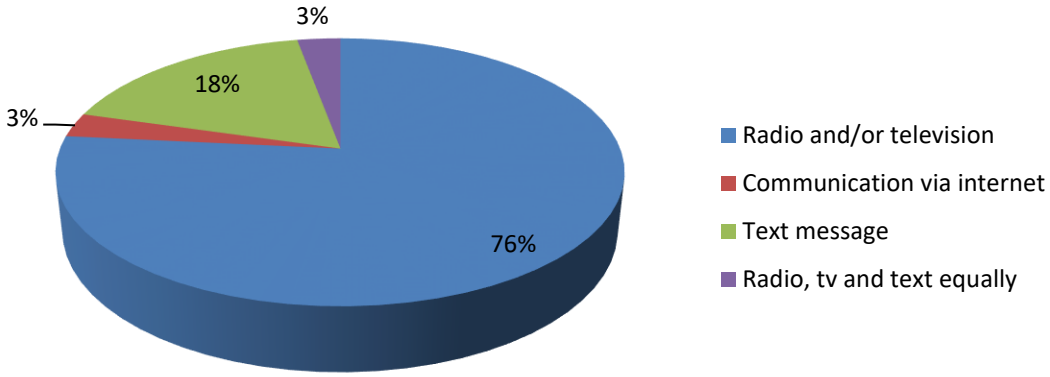


Figure 4.4B: Comparative bar graphs showing various aspects of the reach of weather bulletins via internet among Jeffrey Town Farmers



It can be seen that the reach of Farmers' Outlook Bulletins is currently very limited in Jeffrey Town (only 11%) [compare box 2.3]

Figure 4.4C: Pie chart showing most convenient means of communication for Jeffrey Town farmer respondents



It must be noted that in addition to general inaccessibility and unawareness of climate services by internet, several Jeffrey Town farmers expressed never having seen the agriculture extension officers, further limiting their access to climate information.

4.2.3 Understandability of CIS to end-users

Effective communication of climate services not only relies on the accessibility of communication media, but also that end-users understand exactly what is being conveyed and how they should respond. As figure 4.5A highlights, the jargon used in local climate service media tends to be technical, presenting a communication barrier to the average farmer, who has a low educational attainment (figure 4.5B).

Figure 4.5A: Observed communication barriers in local climate services

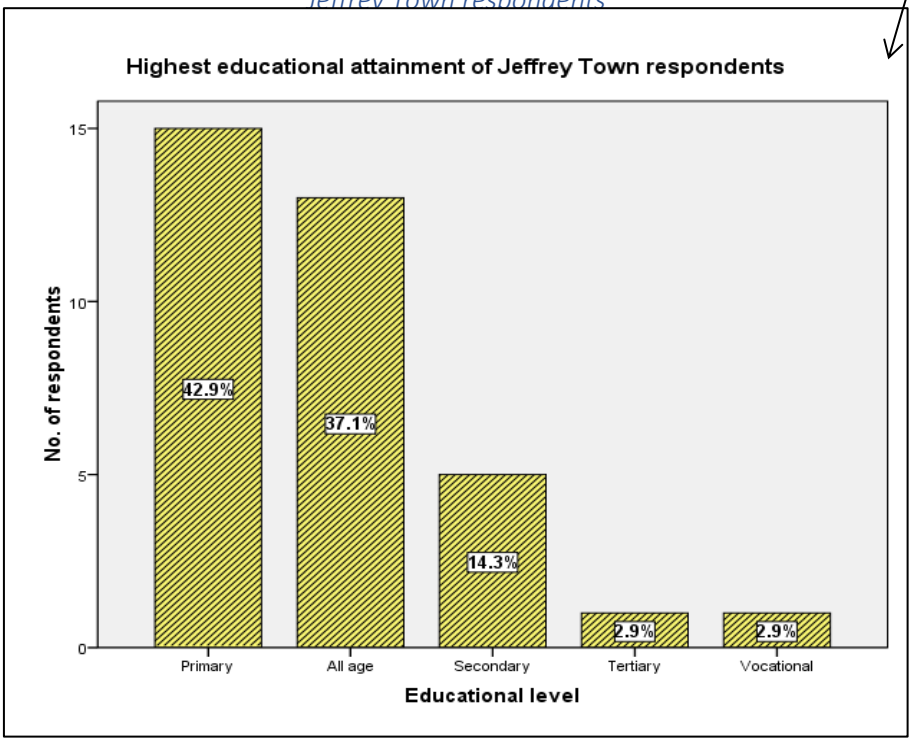
Summary and Expected Agricultural Impacts

There is medium to high confidence in the CPT precipitation outlook for August through October for below normal rainfall to continue for most stations. The greatest concern exists now for stations that are already significantly affected by drought and expecting below normal rainfall through to September. Farmers and other interests should therefore maintain alternative measures and plan for conditions to continue until the end of September before any significant change is expected. The temperature outlook forecast of above normal temperatures combined with already parched conditions in some parishes will only exacerbate evapotranspiration rate which will b a key issue for the farming sector. Increased temperatures could also see the introduction of pests in the fields and therefore preventative measures should also be considered.

Excerpt adapte from: National Agromet Bulletin, July 2014

The incorporation of various technical terms as shown (highlights added) decreases the ability of farmers to act on the information to reduce their vulnerability given their generally low educational attainment. Without simplification, there is undue dependence on agriculture extension officers (which are severely short-staffed), to convey the messages.

Figure 4.5B: Bar graph showing highest educational attainment of Jeffrey Town respondents

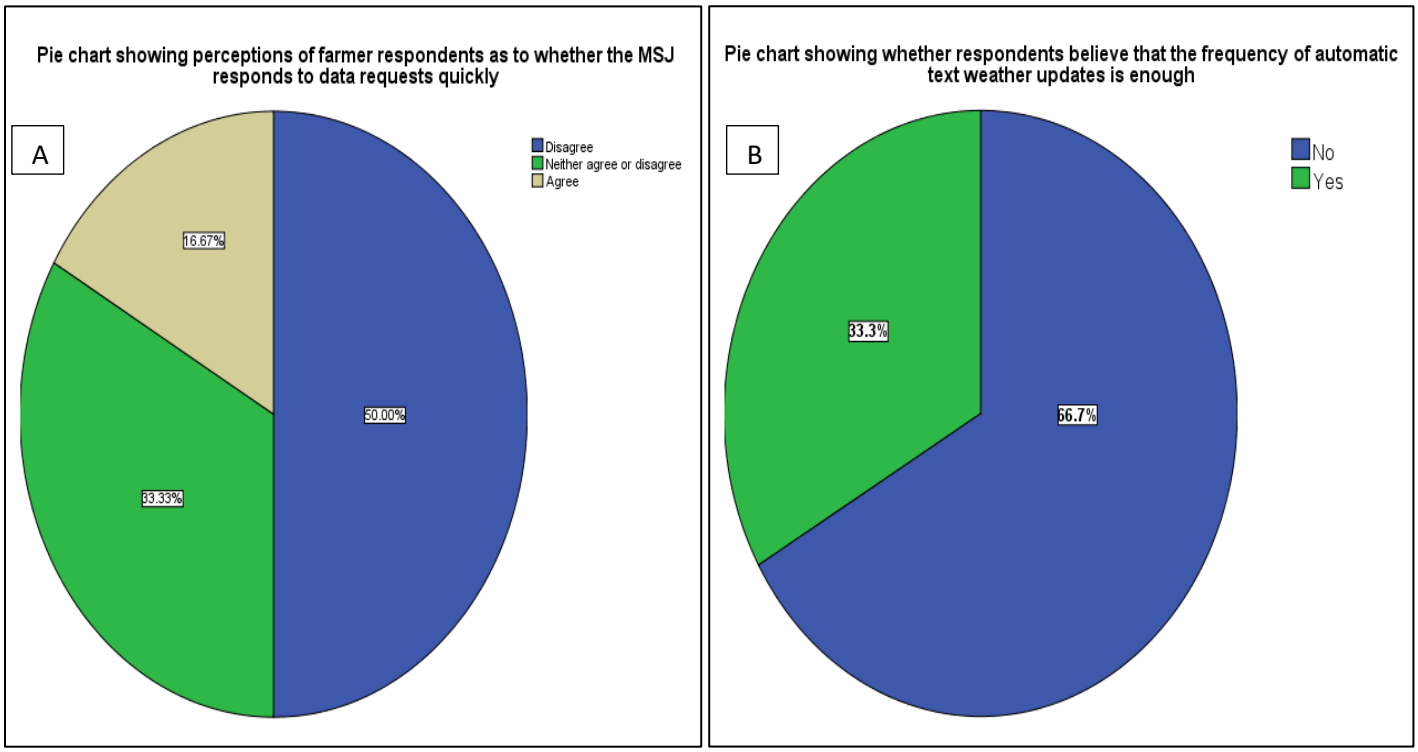


4.2.4 Local climate services feedback mechanisms: Timeliness of response

According to the Global Framework on Climate Services (2011), platforms to facilitate feedback and interaction between climate service providers and end-users are vital for effectiveness. This is particularly crucial in cases of emergency.

As shown in figure 4.6, from the relatively small percentage of respondents who actually see MSJ feedback via text messages, there is general dissatisfaction of the timeliness of response and frequency of automatic updates of the text message bulletins. Delays in feedback may limit the capacity of farmers to effectively prepare for possible hazards, thus perpetuating vulnerability.

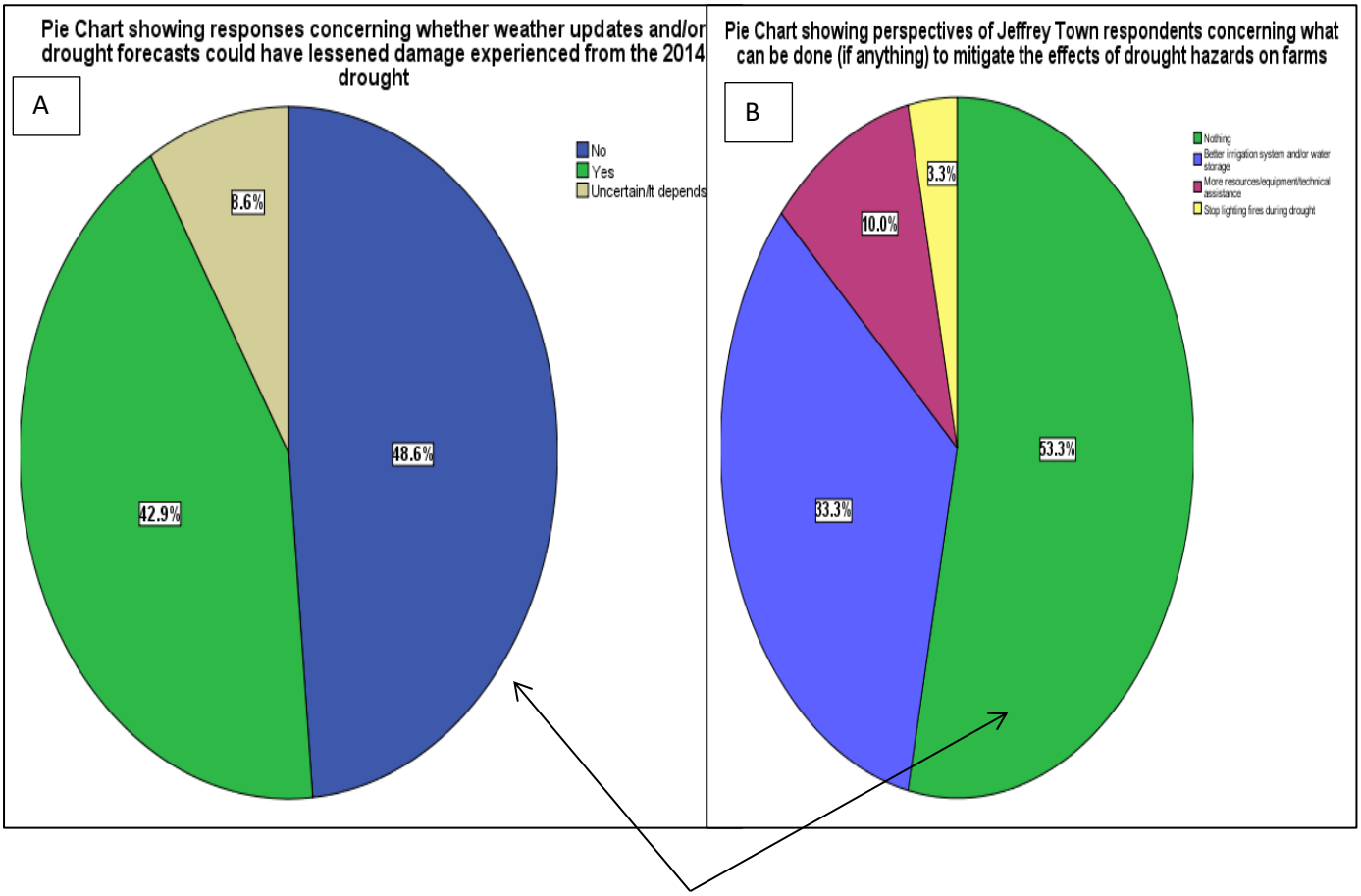
Figure 4.6: Perceptions of Jeffrey Town farmers regarding timeliness and frequency of text message updates



4.2.5 Farmer Trust in Reliability of Weather Forecasts and CIS

A major potential barrier to effective climate services is a lack of trust in the reliability of weather forecasts. Results from farmer perspectives gauged is presented in figure 4.7A). In addition to a general sentiment of distrust or uncertainty on the reliability of forecasts, respondents displayed an outlook of 'hopelessness', as over 50% believe there is little to nothing that can be done by anyone to minimize agro-meteorological hazard risk (figure 4.7B) This would limit the willingness of farmers to take warnings seriously and thus reduce the effectiveness of mitigating agro-meteorological hazards.

Figure 4.7: Perceptions of Jeffrey Town residents concerning the reliability of weather forecasts and their sbility to mitigate on-farm hazards



Reasons given for the belief that weather forecasts could not lessen damage include:

- Inaccuracy of the forecasts
- Local uncontrollable factors, including the vulnerability of the outdoor farm
- Lack of available water (including in river) to be able to prepare
- High dependency on farming for livelihoods, so many will risk loss even when warned.

Being steeped in tradition, various studies globally have found that farmer adaptive action and uptake-potential of new information is heavily based on their experiential perception of its utility for benefits on the short-term problems that are high priority based on their own observation (Maddison 2007, Banerjee 2015). Given these tendencies, the onus is on CIS providers to make use of success stories of new CIS applications and use immediate connectors to farmers' immediate environment for a potentially greater appreciation at the local level. Once this increased trust is achieved at the local level, particularly among community leaders, it may have a ripple effect across other farmer sub-populations.

4.2.5.1 Role of agriculture support groups in climate service participation

Social capital, such as membership in agriculture support groups has been noted to possibly reduce vulnerability (Cannon, Twigg & Rowell, (2002). From interview findings, it was found that nearly 75% of Jeffrey Town respondents were members of one or more agriculture support groups. To ascertain whether membership of these groups contributed to greater likelihood of climate training participation, a cross-tabulation was done (table 4.2), which showed that no significant relationship exists in Jeffrey Town between one's agriculture-group membership and participation in climate services (Approx. sig =0.212). Despite this, given the high membership in these groups, the use of these associations would be helpful in disseminating climate information among farmers.

Table 4.2: Cross-tabulation of involvement in agriculture support group and participation in climate risk reduction training

A

Count			
		Have you ever participated in any climate risk reduction training in agriculture?	
		No	Yes
Are you a part of any agriculture support group?	No	6	3
	Yes	14	12
Total		20	15

B

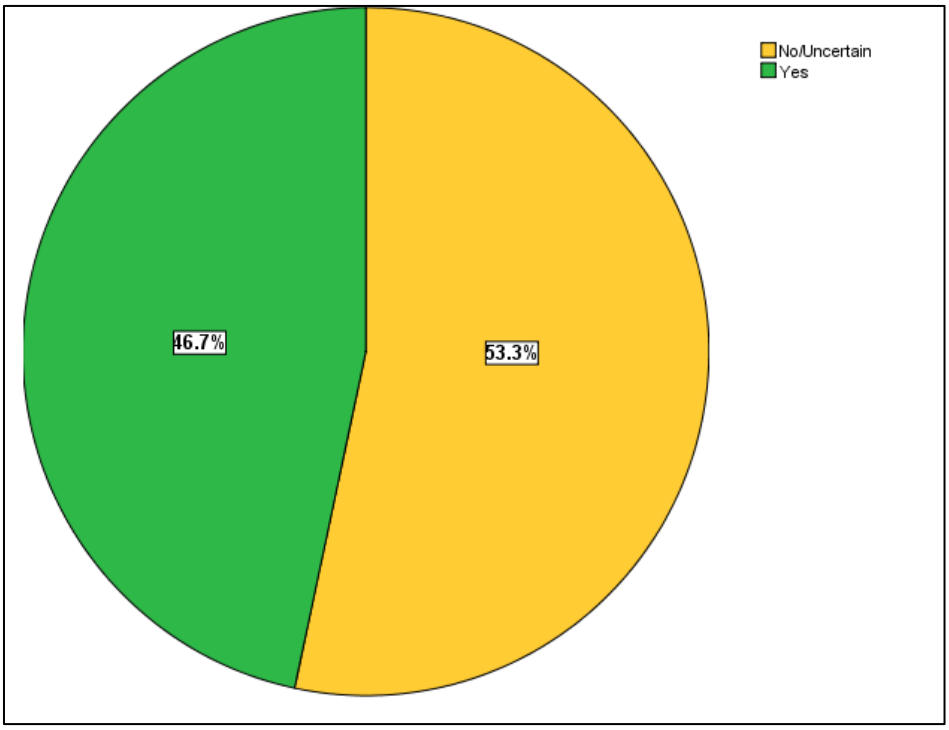
Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Cramer's V	.294	.212

4.3 Assessing the Progress of CIS: Farmers' Perceptions of Effectiveness of Climate Services in Improving Production

Direct feedback was obtained from participant farmers in climate services to ascertain the extent to which climate training was perceived to have assisted in improvements in farm production. As shown in figure 4.8 the effectiveness of climate training in reducing hazard risk and increasing production is still inconclusive, as responses are split almost evenly.

Figure 4.8: Perceptions of Jeffrey Town respondents who participated in climate training regarding whether farming production improved due to training



These results corroborate with the conclusion of Vogel et al, (2014), which indicates that the duration of local climate service implementation is too short to adequately assess its effectiveness in increasing agricultural productivity.

5. CONCLUSIONS & RECOMMENDATIONS

The results presented indicate that from multi-stakeholder feedback, end-users perceive some benefits in CIS, particularly in the areas of relevance of information to their needs. Opportunities for improvement have been expressed relating to limited accessibility to CIS, especially in the context of rural farmer end-users, as the case study of Jeffrey Town, St. Mary highlights. As was mentioned, over three-quarters of the respondents (76%) specified television and/or radio as their preferred means of obtaining climate information. It is therefore recommended that these accessible media be utilized to achieve greater effectiveness in farmer engagement with CIS, including for those who have low literacy levels, who would already have heightened levels of vulnerability. The case of Jeffrey Town also highlighted the barrier that limited formal education levels of many rural farmers may face, to understand the climate information produced in farmer bulletins. It has also been expressed that opportunities for improvement also exist for on-demand support by Climate Service Providers in terms of timeliness of response in text message CIS. Farmer trust of formal climate information also has room for improvement, and appears to compete with

indigenous information sources, such as farmer almanacs, upon which many farmers rely. Further research into an integrated, participatory approach to CIS communication, including an assessment of existing indigenous techniques, may aid to bridge this gap. In order to address these issues, a multi-dimensional approach has to be taken. Figure 4.9a highlights recommendations compiled from consultations from both intermediate end-users and farmer end-users in an effort to continually enhance climate service delivery.

Figure 4.9A: Key Recommendations from Intermediate End-Users in Study

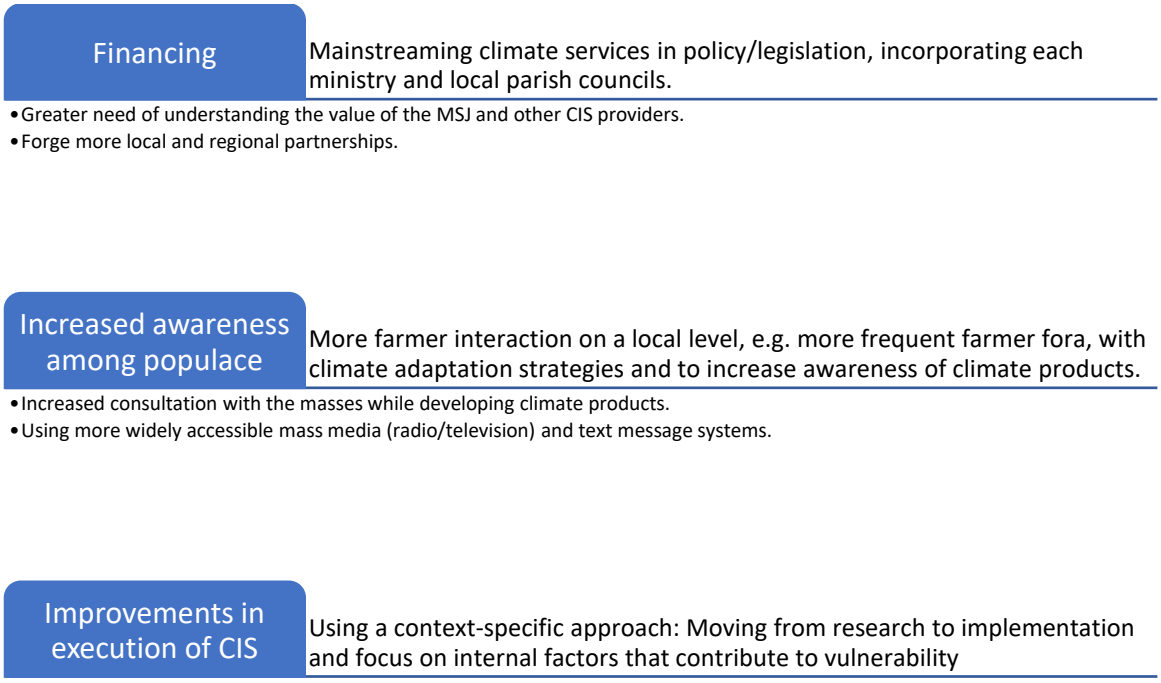
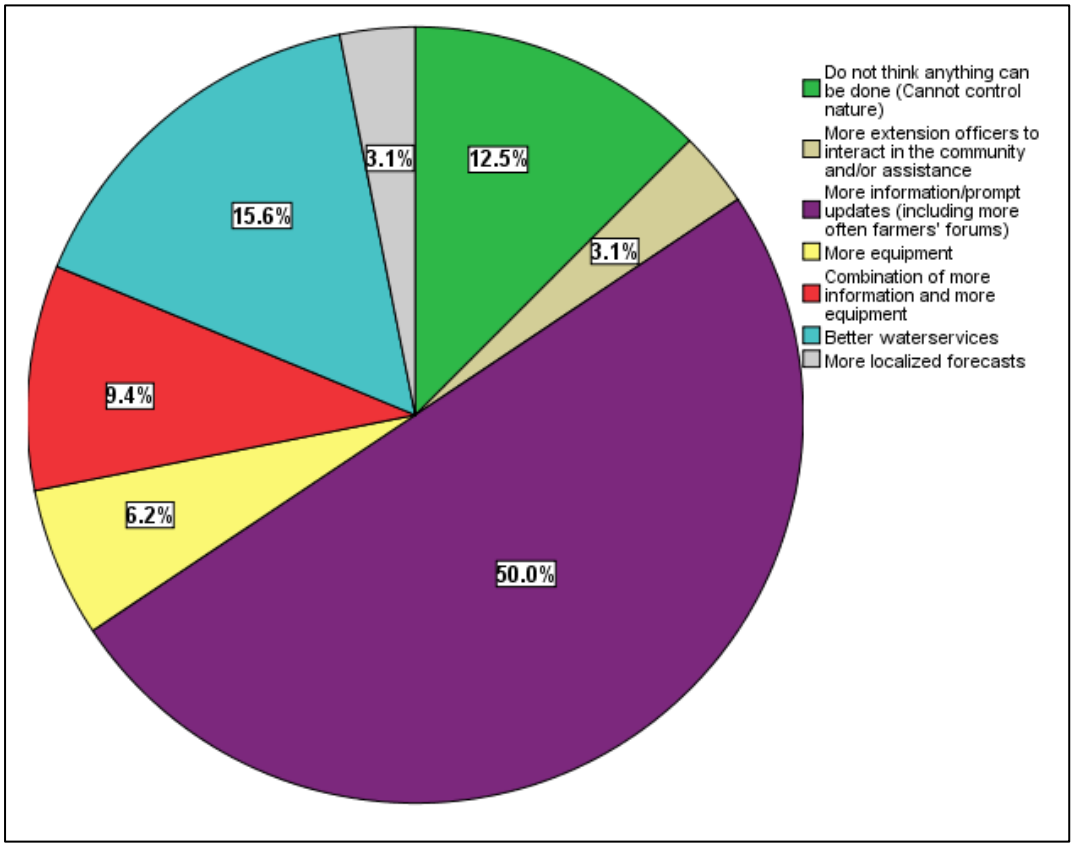


Figure *4.9B: Farm-level recommendations for improvement for climate services according to Jeffrey Town farmer respondents.*



BIBLIOGRAPHY

ACDI/VOCA. (2013). Request for proposal: Consultancy Opportunity: Climate change agriculture sector strategy. *Ministry of Agriculture and Fisheries*. Available at: http://www.moa.gov.jm/Vacancies/Tenders/RFP%20-%20CC%20Strategy%20Consultancy%20-%20FINAL%20%283%29.pdf [Accessed 31/1/15].

ADRMP. (2012). Agriculture Disaster Risk Management Plan: Rocky Point, Clarendon. *Rural Agricultural Development Authority (RADA) in collaboration with the Caribbean Coastal Area Management (C-CAM) Foundation and the Food and Agriculture Organization (FAO).* Available at: http://www.ccam.org.jm/publications/agriculture-disaster-risk-management-plan-rocky-point-clarendon [Accessed: 26/3/15].

Albrecht, M. & Tomlinson, J. (2014). Farm level evaluation of climate services.

Banerjee, Rupsha. 2015. Farmers' perception of climate change, impact and adaptation strategies: a case study of four villages in the semi-arid regions of India. Vol. 75.

Barker, D.(2012). Caribbean Agriculture in a Period of Global Change: Vulnerabilities and Opportunities. Caribbean Studies. *Institute of Caribbean Studies.* 40(2), 41-61.

CAMI. (2009). Caribbean Agro-meteorological Initiative. *ACP-EU*. Available at: http://acp-st.eu/sites/all/files/projects-factsheet/FED-2009-217069.pdf [Accessed 10/1/15].

Campbell, D., Barker, D. & McGregor, D.F.M. (2011). 'Dealing with drought: Small farmers and environmental hazards in southern St. Elizabeth, Jamaica'. *Applied Geography*. 31(1), pp. 146-158.

Campbell, D., Gamble, D., Allen, T., Barker, D., Curtis, S., McGregor, D., & Popke, J. (2010). Climate change, drought and Jamaican agriculture: Local knowledge and the climate record. *Annals, Association of American Geographers*. 100(4). pp. 880-893.

Cannon, T., Twigg, J., & Rowell, J. (2002*). Social vulnerability, sustainable livelihoods and disasters: Report to DFID Conflict and Humanitarian Assistance Department (CHAD) and sustainable livelihoods office.* Available at: ipcc-wg2.gov/njlite_download.php?id=6377 [Accessed 24/3/15].

Caribbean Meteorological Organization [CMO]. (2010). *Caribbean Meteorological Council fiftieth session: Other project updates and proposals*. Available at: http://www.cmo.org.tt/Docs/CMC50/CMC/CMC50_Doc_11.doc [Accessed 1/3/15].

CIMH. (2015).*About*. Available at: http://www.cimh.edu.bb/?p=about [Accessed 4/2/15].

Climate Change Policy Framework and Action Plan (2013). Ministry of Water, Land, Environment and Climate Change. *Government of Jamaica*. Available at: http://www.mwh.gov.jm/Library/Public/Climate%20Change/Climate%20Change%20Policy

%20Framework%20and%20Action%20Plan%20November%202013%20-%20Green%20Paper.pdf [Accessed: 29/1/15].

Creswell, J. (1998). *Qualitative Inquiry and Research Design; Choosing Among Five Traditions*. London, New Delhi, Thousand Oaks: Sage Publications. p. 372.

Creswell, J.W. (2005). Educational Research. Planning, Conducting, and Evaluating Quantitative and Qualitative Research (2 ed.). Pearson Education, Upper Saddle River: USA.

Disaster Risk Management Act. (2014).*Constitution of the National Disaster Risk Management Committee*. Section 16(2). p. 44.

Dormer, D. (n.d.). 'Capacity building support: Ja REEACH project'. Paper presented at the *Third International Conference on Climate Services (ICCS3)*. ACDI/VOCA. p. 13. Available at: http://www.climate-services.org/sites/default/files/wysiwyg/Dormer%20Agromet%20PPT.pdf [Accessed 30/1/15].

Francis-Rhiney, C. (2013). Climate information and outreach in the Jamaican agriculture sector. *Rural Agricultural Development Authority*. pp. 2, 13. Available at: http://www.climate-services.org/sites/default/files/wysiwyg/Rhiney%20ICCS3%20Presentation.pdf .[Accessed: 1/2/15].

Gamble, D. W., Campbell, D., Allen, T.L., Barker, D., Curtis, S., McGregor, D. & Popke, J. (2010) 'Climate Change, Drought, and Jamaican Agriculture: Local Knowledge and the Climate Record', *Annals of the Association of American Geographers*.100(4). Pp.880-893.

Global Framework for Climate Services. (2011). *World Meteorological Organization*. Geneva: Switzerland. Available at: http://www.gfcs-climate.org/principles [Accessed: 31/1/15].

ICAO. (2010). Annex 3 to the Convention on International Civil Aviaiton: Meteorological Service for International Air Navigation. *International Civil Aviation Organization*. 17th Edition. Available at: http://www.wmo.int/pages/prog/www/ISS/Meetings/CT-MTDCF-ET-DRC_Geneva2008/Annex3_16ed.pdf [Accessed 2/1/15].

IPCC. (2007): Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. p.15.

IPCC. (2013) Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jamaica Strategic Programme for Climate Resilience (2011). *Planning Institute of Jamaica*. pp. 7, 13, 23,85-88. Available at:

http://pioj.gov.jm/Portals/0/Sustainable_Development/Jamaica%20SPCR%20%20-%20FINAL,%20January%2031,%202013.pdf [Accessed: 28/1/15].

JaREEACH (2012). *ACDI/VOCA*. Available at: http://www.acdivoca.org/site/ID/jamaica-ja-reeach [Accessed 10/1/15].

Linton, L. (2014). More communities being made disaster resilient. *Jamaica Information Service*. Available at: http://jis.gov.jm/communities-made-disaster-resilient/ [Accessed: 31/1/15].

Maddison, D. 2007. The Perception of and Adaptation to Climate Change in Africa. In *Policy Research Working Paper*. Pretoria, South Africa.

McAlla, W. (2012). Final review of policy, plans, legislation and regulations for climate. *Planning Institute of Jamaica*. pp. 52, 67. Available at: http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Final%20Review%20of%20Policy,%20Plans,%20Legislation%20&%20Regulations%20for%20Climate.pdf [Accessed: 28/1/15].

McLean. (2014). *Personal communication. Rural Agricultural Development Authority.*

MSJ. (2002). *About the Meteorological Service of Jamaica*. Meteorological Service of Jamaica. Available at: http://www.metservice.gov.jm/aboutus.asp [Accessed 21/1/15].

National Agromet Bulletin. (2014). 7(2). p.6. *Meteorological Service of Jamaica*.

National Disaster Action Plan. (1997).*Government of Jamaica*. pp. 42, 44.

Pryor, M. G. (2015). Effectiveness and efficiency. *Encyclopaedia of business*. 2nd Edition.

Rankine, D. (2014). *Personal Communication*. *The University of the West Indies, Mona*.

Rhiney, K. (2012).Stakeholder report; National consultation on the state of the agriculture and fisheries sector in the context of the green economy and institutional framework for sustainable development in preparation for the Rio +20 Earth Summit. Report prepared for the Ministry of Water, Land, Environment and Climate Change and the United Nations Development Programme (UNDP). pp. 6,7, 12.

Richards, A. (2008). Development trends in Jamaica's coastal areas and the implications for climate change. *Planning Institute of Jamaica*. Available at: http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Climate%20Change%20and%20Jamaica.pdf [Accessed 17/2/14].

Robeldo, C., Kanninen, M., & Pedroni, L. (2005). Tropical forests and adaptation to climate change: In search of synergies. *Centre for International Forestry and Research*. p. 47.

Rogers, D. & Tsirkunov, V. (2013). Weather and climate resilience: Effective preparedness through National Meteorological and Hydrological Services. *Intergovernmental Board on Climate Services*. *WMO bulletin.* 62(special issue). Available at:

http://www.wmo.int/pages/publications/bulletin_en/weather-and-climate-resilience_en.html [Accessed: 1/2/15].

Simpson, M. C., Clarke, J. F., Scott, D. J., New, M., Karmalkar, A., Day, O. J., Taylor, M., Gossling, S., Wilson, M., Chadee, D., Fields, N., Stager, H., Waithe, R., Stewart, A., Georges, J., Sim, R., Hutchinson, N., Rutty, M., Matthews, L., and Charles, S. (2012). CARIBSAVE Climate Change Risk Atlas (CCCRA) - Jamaica. DFID, AusAID and The CARIBSAVE Partnership, Barbados, West Indies. Executive summary pp. xx, xxi, xxv, xxvi, xxix, xxx,xxxi, 111. Available at: http://dms.caribbeanclimate.bz/M-Files/openfile.aspx?objtype=0&docid=5037 [Accessed 29/1/15].

Spence, B. (2010). Agriculture Disaster Risk Management Planning: Strategy for Loss Reduction in Jamaica's Agricultural Sector. *5th Caribbean Conference on Comprehensive Disaster Management "CDM: Strengthening Partnerships for Resilience"*. pp. 13, 21, 24.

Spence, J. (2013). Developing climate services: The process. p. 6. Available at: http://www.climate-services.org/sites/default/files/wysiwyg/Spence%20ICCS%20conference%20presentation.pdf [Accessed 30/1/15].

Spence, J. (2014). *Email interview*. *Meteorological Service of Jamaica.*

Spence, J. (2015). *Email correspondence. Meteorological Service of Jamaica*.

Spence, J. & Shaw, A. (n.d.). Data management & data rescue. *Meteorological Service of Jamaica.* Available at: https://www.mona.uwi.edu/physics/sites/default/files/physics/uploads/Spence-%20Data%20Management%20%26%20Data%20Rescue.pdf [Accessed 1.2.15].

Stoute, S. (2011). Jamaica farmers' forum. *Caribbean Institute of Meteorology and Hydrology*. pp. 6-11. Available at: http://63.175.159.26/cami/files/forum_jam_%20Report11.pdf [Accessed 13/2/15].

Tall, A. & Njinga, J. L. (2013). Developing a Methodology to Evaluate Climate Services for Farmers in Africa and South Asia Workshop Report. CCAFS Workshop Report. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. pp. 8-12; 15-21. Available at: http://ccafs.cgiar.org/publications/developing-methodology-evaluate-climate-services-farmers-africa-and-south-asia-workshop#.VSQKMfnF_B0

Taylor, M., Kirton, C., Rhiney, K., Rankine, D., Atkinson, T. & Sutherland, R. (2012). Climate Change, Agriculture and Food Security Study of the Caribbean, p. 118.

Taylor, M.A., Centella, A., Charlery, J., Bezanilla, A., Campbell, J., Borrajero, I., Stephenson, T. and Nurmohamed, R. (2013). The PRECIS Caribbean Story: Lessons and Legacies. American Meteorological Society. 94(7).pp.1065-1073.

Thompson, E. (2014). *Personal interview*. *Meteorological Service of Jamaica.*

Trotman, A. & Van Meerbeeck, C. (2013). The CAMI Project – Weather and Climate Services for Caribbean Food Security. *EGU General Assembly* . Vienna: Austria. Available at: http://adsabs.harvard.edu/abs/2013EGUGA..15.6058T [Accessed: 31/1/15]

Vogel, J., St. Juliana, A., Clements, J., & Letson, D. (2014). *The Caribbean Agro-meteorological Initiative: An Evaluation of Climate Services*. Stratus Consulting Inc. Climate Service Partnership. p. 4, 7-9, 25-27, 37.

Walker, J. (2011). Chapter 20: Entropy and the second law of thermodynamics. *Fundamentals of Physics extended*. 9th Edition. John Wiley & Sons Inc. pp. 545-546.

Wilson, C. (2014).*Personal interview. ACDI/VOCA.*

Yates, M. (2014). *Personal interview. Jamaica Civil Aviation Authority.*