Survey of Mozambique Public on Weather, Water, and Climate Information

Jeffrey K. Lazo

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SURVEY OF MOZAMBIQUE PUBLIC ON WEATHER, WATER, AND CLIMATE INFORMATION

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EXECUTIVE SUMMARY

ES-1. Purpose

The Pilot Program for Climate Resilience (PPCR) of the Climate Investment Funds (CIFs) finances the integration of resilience measures into core development planning. The objective of the PPCR-funded *Climate Resilience: Transforming Hydro-Meteorological Services* project for Mozambique is to strengthen hydro-meteorological (hydro-met)[1] information services to deliver reliable and timely climate information to local communities and to support economic development.[2] In 2013, US$15 million in PPCR-funding was approved for the project *Mozambique Climate Resilience: Transforming Hydro-Meteorological Services* with US$6 million in parallel financing from the Nordic Development Fund. The project has an objective to "strengthen hydrological and meteorological information services to deliver reliable and timely climate information to local communities and to support economic development" and is comprised of three components:

- Strengthening Hydrological Information Management
- Strengthening Weather and Climate Information Management
- Piloting Resilience Through Delivery of Improved Weather and Water Information

Overall, the components will improve hydro-met observation networks, data acquisition and management, modeling, forecasting, and warning systems. This includes capacity building as well as new and repaired infrastructure. This report reviews economic analysis of public values for current and potentially improved hydrological, meteorological, and climatological services and products as part of the project appraisal (leading up to the 2013 project approval).

ES-2. Geographic, Economic, and Hydro-Meteorological Context

Mozambique is located in the southeastern corner of Africa covering 799,380km^2. Nine of Mozambique's 13 largest rivers originate in upstream countries and drain into the Indian Ocean and the Mozambican Channel. As such, upstream activities and neighboring countries' weather and water conditions directly affect the country. Tropical to sub-tropical climates prevail in the

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[1] Throughout the report we use the term hydro-met as a shortening of hydrological, meteorological, and climatological.

[2] http://www-cif.climateinvestmentfunds.org/projects/climate-resilience-transforming-hydrometeorological-services

northern and central provinces and dry, arid desert climate overtakes the south. Droughts affect southern provinces 7 out of 10 years and central areas along the Zambezi River valley 4 out of 10 years. In addition, major floods have hit Mozambique in recent years. In 2000, 2001, 2007, 2013, and 2015 the extreme weather and water events collectively resulted in over 1,200 deaths, displacement of 1.5 million people, and destruction of US$1.5 billion in infrastructure. It is estimated that as much as 58% of the population is vulnerable to natural disasters and that these shocks result in a 1.1 percentage points lower annual economic growth. Climate change presents a considerable risk as rainfall in Mozambique is expected to become more variable, and the risk of flooding is expected to increase in the southern and eastern regions of the country.

Mozambique has a population of approximately 24.1 million (July 2013 estimate) with nearly 46% in the 0-14 year age range and females comprising 51.3% of the total. There is a 2.44% population growth rate and life expectancy at birth is 52.3 years. With a 2010 gross domestic product (GDP) purchasing-power-parity (PPP) of US$21.81 billion, the per capita PPP GDP was US$1,010.38. The percentage of Mozambicans living below the poverty line "based on per capita consumption measured at the household level" is reported as 54.7% in 2010. The overwhelming majority of the population is employed in the agricultural sector providing income for more than 80% of the population. The majority of farms in Mozambique are smallholders, representing more than 98% of total farms, and 96% of the national agricultural production.

ES-3. Hydro-meteorological monitoring and forecasting

The mandate for water and weather observation and forecasting is delegated to several agencies across two government ministries in Mozambique. The Ministry for Transport and Communication delegates responsibility to the National Institute for Meteorology (INAM, Instituto Nacional de Meteorologia) to monitor and forecast weather and climate and to produce and disseminate climatological data, analyses, and services, as well as weather forecasts and forecasting services. The Ministry of Public Works and Housing, the National Directorate of Water (DNA, Direcção Nacional de Águas), and the five Regional Water Authorities (ARAs, Administrações Regionais de Águas) are responsible for matters relating to hydrology including policy development and management, strategies and investment mobilization for the water supply and sanitation in rural and urban areas, management of water works planning, and sharing agreements issues for water resources in transboundary basins.

ES-4. Methodological-Theoretical Background

Figure ES-1 presents a conceptual model of the weather information value chain to emphasize that there is not a simple direct relationship between hydro-met information (e.g., products and services) and economic value for that information.

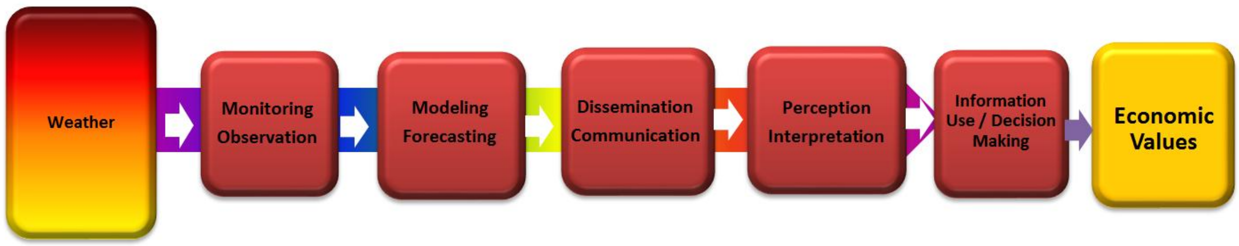

Figure ES-1. Weather Information Value Chain.

Monitoring and observations, modeling and forecasting, and dissemination comprise the "traditional model" of hydro-met services. Once information is disseminated, it undergoes transmission and modification through various channels (e.g., internet, radio, TV, friends and family) before being received by a decision-maker who then has to perceive and interpret that information subject to his or her capacities, resources, and constraints before making a decision or using that information. Only at that point where decisions interact with hydro-met realizations (e.g., what the weather actually is) do outcomes occur that can translate into economic values. Thus, economic value is realized at the end of the chain and not at the point of information creation. Without a basic understanding of the value chain, it would not be reasonable to assert that economic valuation of hydro-met products and services are valid or reliable. Therefore, in the public survey for this analysis, considerable effort was spent in evaluating the process of respondents' sources, uses, perceptions, and preferences for hydro-met information prior to implementing the valuation exercises. Doing so also provides critically useful information on where, how, and why people get and use hydro-met information even without considering the economic aspects of the information.

ES-5. Survey Development, Implementation, and Sample

A survey of the general public was developed based on 1) prior surveys assessing the economic value of hydro-met information; 2) prior work on sources, understanding, preferences, and uses of hydro-met information; 3) surveys implemented in other contexts in developing countries; 4) surveys on other topics implemented in Mozambique; 5) focus groups with Mozambique's National Institute for Meteorology (INAM) employees; and 6) a stakeholders workshop held in Maputo. The survey was conducted from June 11, 2013, through June 18, 2013, across a limited number of sites attempting to achieve a cross-section of the population based on a range of country characteristics and different weather and climate regimes. 576 completed surveys were obtained across 13 sites with no less than 20 responses from any one site. Figure ES-2 shows the locations of respondents and the provinces of Mozambique.

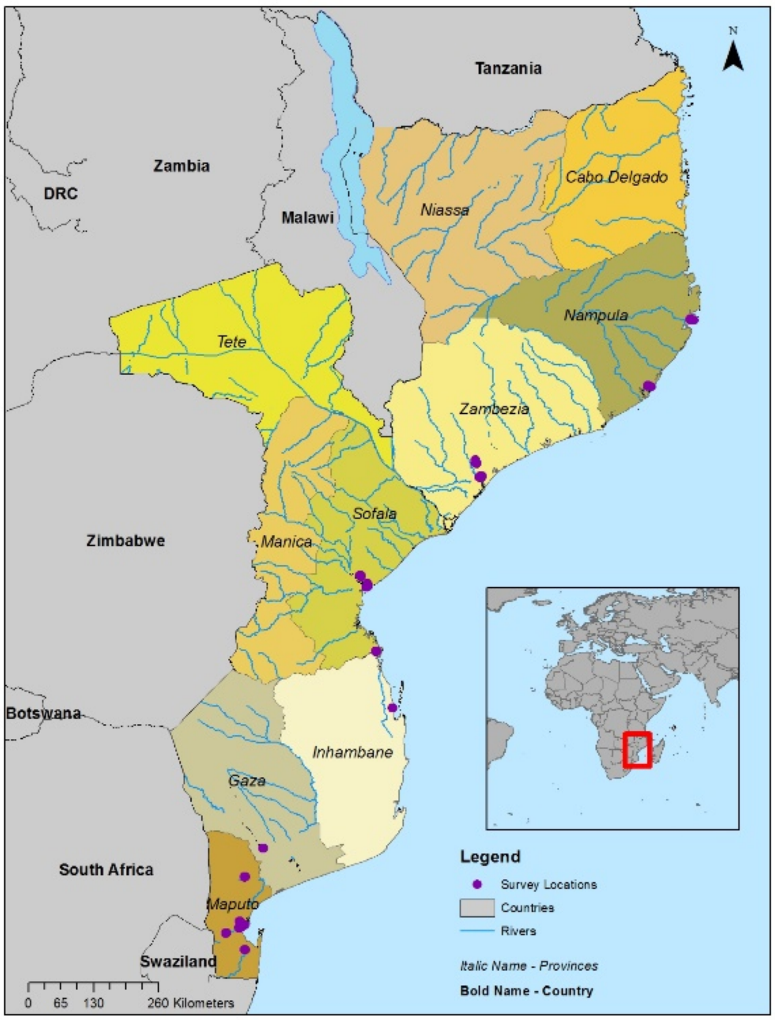

Figure ES-2. Locations of respondents in Mozambique.

Clusters of respondents are indicated by (•) dots.

ES-6. Results

Prior to the economic value elicitation several aspects of the weather information value chain were examined in the survey including 1) experience, concern, and awareness with hydro-met events; 2) sources and uses of hydro-met information; 3) importance of this information; 4) satisfaction with current information; 5) awareness of hydro-met agencies; and 6) importance of improving information. Analysis was conducted on the entire sample as well as making comparisons between certain subsamples based on respondent location to allow 1) comparison of respondents in the north-central parts of the country to those in the south and 2) comparison of respondents in urban areas to those in more rural areas.

ES-6.1. Experience, concern, and awareness

Almost 90% of respondents indicated that the effects of weather are very or extremely important to them personally. Less than 14% had experienced no impacts from hydro-met events in the last 10 years. The most common impacts were disruption of power or water supply along with impacts on the transportation system. Economic impacts from either the loss of crops or livestock or disruption of household income had affected more than 50% of respondents, more than 30% of the individuals indicated that the weather or weather-related events had caused injury or illness to themselves or injury, illness, or death to a family member within the last 10 years, and more than one in four indicated that they had either temporarily or permanently moved residence to a safer location. These responses suggest a very significant personal, social, and economic level of weather impact in Mozambique.

Respondents in the north-central parts of the country indicated a higher level of weather impact causing personal or family injury, illness, or death as well as crop and livestock losses, while those in the south regions reported more disruptions to water, power, and transportation systems.

When asked how concerned they are about the probability of 11 potential weather events occurring during the next 10 years, flooding engendered the greatest concern with the group with only 1.7% of respondents indicating no concern about flooding and more than 86% indicating that they are very or extremely concerned about flooding in the next 10 years. Respondents were least concerned overall about typhoons even though more than 45% still indicated they are very or extremely concerned about typhoons.[3] Southern residents indicated a higher level of concern for extreme heat, extreme cold, lightning, dust storm, extreme humidity, and typhoons. Conversely, north-central residents indicated a higher level of concern for heavy rains and drought.

ES-6.2. Sources and uses

Over 86% of respondents indicated that they do read, hear, or use weather forecasts at some point in time. As may be expected, a statistically significantly higher portion did not have access in rural areas (20.5% in rural areas and 5.0% in urban areas).

When asked "How often do you get, see, or use weather forecasts from the sources listed below?" TV and radio were the primary information channels and internet and telephone the least. The average total frequency across all sources was slightly over 600 per year with a median of 365 or about once a day strongly suggesting that weather information plays a role in day-to-day decision-making for average Mozambicans.

When asked "On average, year round, how often do you use weather forecasts for the activities listed below?" respondents indicated using forecasts most for planning travel to work or school, simply knowing the weather, and how to dress for the day – common daily decisions. The average of total uses across all activities was slightly less than 780 times per year with a median of 365 (or once a day). Again, this strongly suggests that weather information does play a role in day-to-day decision-making for average Mozambicans.

ES-6.3. Importance of weather information

After being told that weather is "…everything from temperature, clouds, sunshine, winds, rainfall, floods, drought, lightning, humidity, waves, to climate," respondents were asked "How important is it to you to have information about the weather?" Only half of 1% of respondents felt that weather information was not at all important while more than 80% of respondents rated information about weather as very or extremely important.

In one question, respondents were asked to rate on a 1 to 5 scale the importance of weather information and, in a parallel question, to rate the important of climate information. Overall

[3] Fitchett and Grab (2014) Table 1 indicates 9 landfalling tropical cyclones in Mozambique in the nineteen year period 1994-2012.

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respondents considered climate information slightly more important than weather information (mean of 4.25 for climate information versus 4.00 for weather information).

ES-6.4. Satisfaction

After eliciting information on their sources, uses, and perceptions of weather, water, and climate information, respondents were asked to rate their level of overall satisfaction with the weather forecast information that they currently receive. As indicated in Figure ES-3, on average, respondents indicated that they were slightly more satisfied than "Neither satisfied nor dissatisfied" with a modal response of "satisfied.[4] There were no significant differences in satisfaction ratings between the geographic regions or the urban-rural areas.

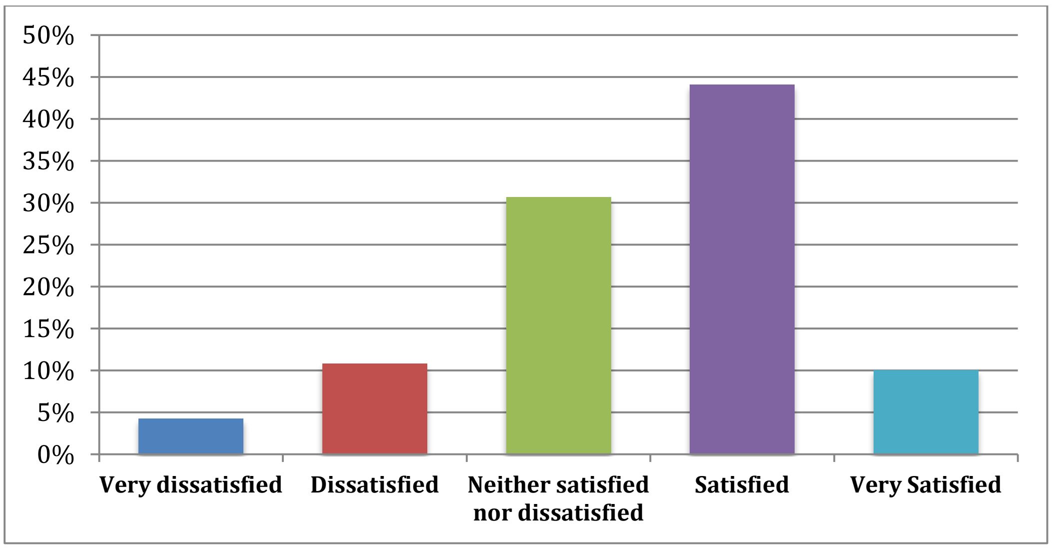

Figure ES-3: Satisfaction with the weather forecast information that you currently receive

ES-6.5. Awareness of Agencies

Respondents were asked asks if they had ever heard of INAM or the ARAs before as well as if they were previously aware of the warning and advisory information provided by INAM.[5] As shown Figure ES-4 slightly more than 70% indicated that they had heard of INAM before and 50% were aware of the additional information INAM provides. Further, of those indicating that

[4] As up to this point in the survey, the interviewers had not specifically mentioned or discussed INAM, DNA, or the ARAs and as there is a range of information sources, this rating cannot be interpreted as a rating of the services and products specifically of INAM.
[5] Due to an error on the part of the survey company, a parallel question asking if respondents had ever heard of DNA was omitted

they had heard of INAM before, 71% were also aware of the specific information provided by INAM suggesting that this information is an important component of the awareness and perception of INAM by the public.

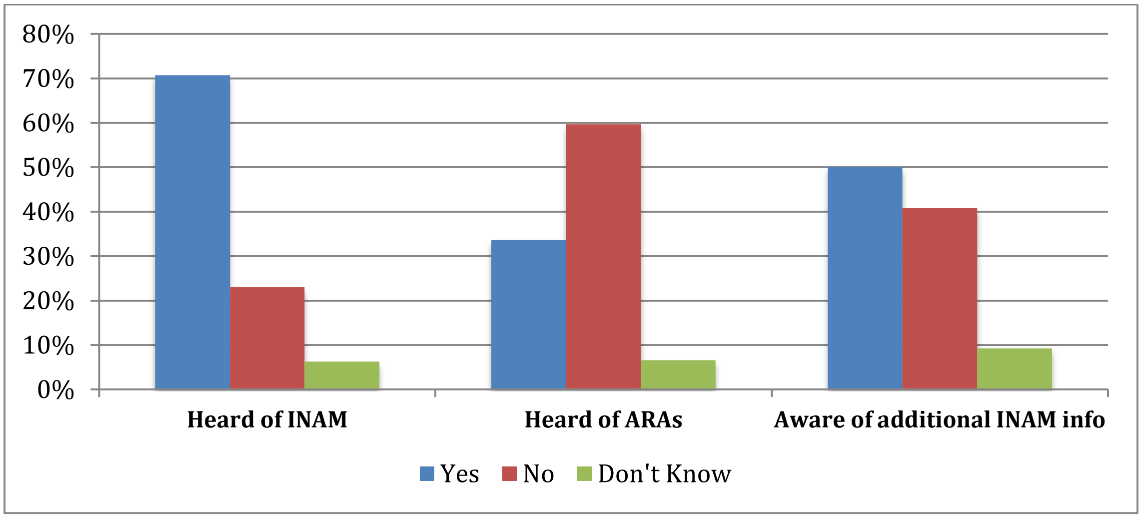

Figure ES-4: Awareness of Mozambican Hydro-meteorological Organization and Activities

Regression analysis on whether or not individuals had heard of INAM indicated that those who had heard of INAM were more likely to not be employed full- or part-time, have experienced lower losses due to weather in the past, have higher education, have higher income, have greater concern about weather events, use forecasts more for short term decision-making, use national or local government agency and non-government organization for information, and use radio, TV, and friends, family, co-workers, etc. more for weather information. Future work along similar lines may be useful to better understand who INAM's users are and what factors affect whether or not individuals are using INAM product and services.

ES-6.6. Importance of improving information

The next section of the survey began to deal in depth with specific products and services of INAM and potential improvements in these products. For each information "attribute" or product, the interviewers first provided an example or explanation, indicated a measure of the current level of service or accuracy, and then elicited preferences (measures as "importance to improve") for two potential levels of information improvements. For several of the attributes, the respondent was also presented a graphical example (in Portuguese) captured from the INAM website. As shown in Figure ES-5 all information attributes rated above 4.0 in importance on a 1 to 5 scale (with 5 being “extremely important”).

While there is a significantly greater rating for all attributes in the north and central areas of Mozambique than in the southern area, there is not a significant difference for any of the attributes between urban and rural areas.

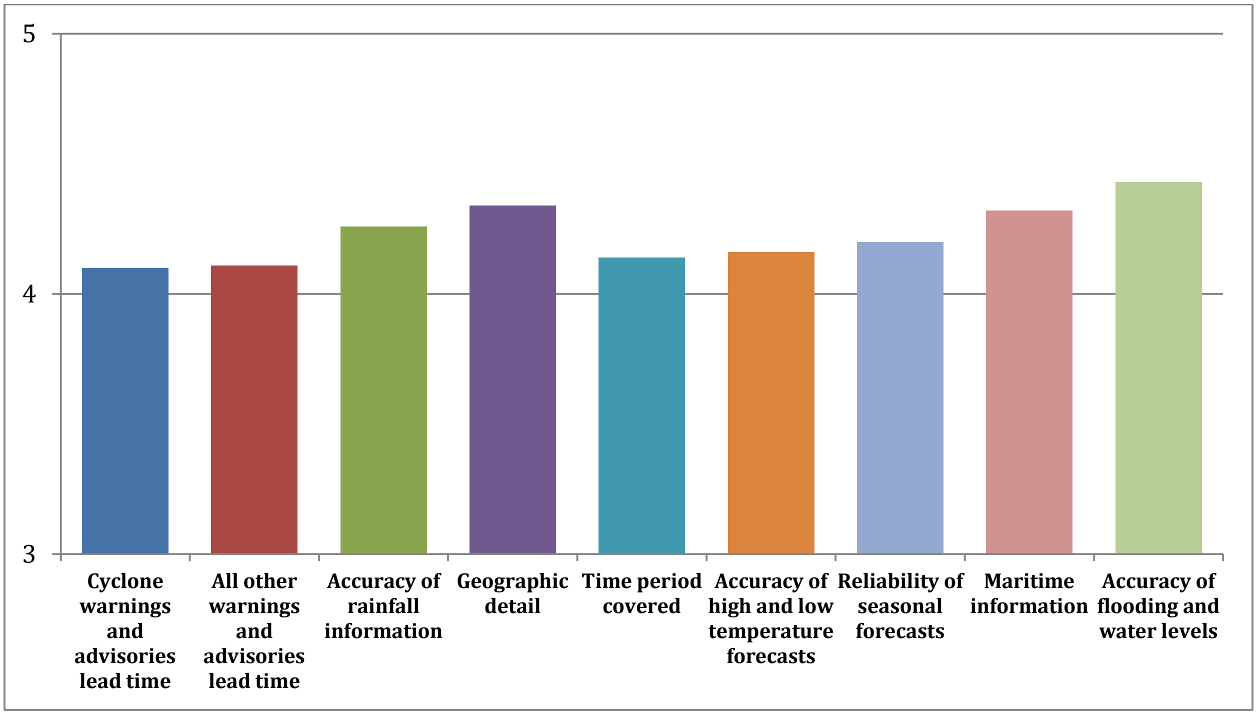

Figure ES-5: Importance of Maximal Forecast Attribute Improvements

In response to the question “Overall, how important to you is to that INAM, DNA, and the ARAs improve the accuracy of the information they provide?” Figure ES-6 shows the frequency distribution of responses wherein the majority of respondents (78.1%) indicated that improving forecasts is either very or extremely important to them.

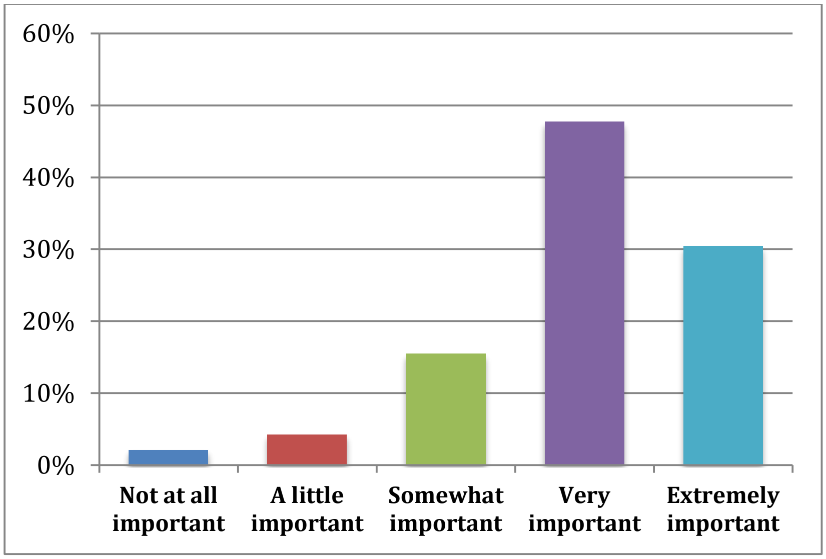

Figure ES-6: Importance of INAM, DNA, and ARAs Improving Information Accuracy

ES-7. Economic benefit estimates

As hydro-met products and services are public goods, they are generally not bought and sold in markets and thus there is no direct information on the economic value of these services. It is therefore difficult to determine the economic value of the changes in these services that are provided as a result of programs to improve this information. However, this is exactly what is required in benefit-cost analyses. Stated Preference (SP) methods allow for the estimation of non-market values to the public of hydro-met information. In SP studies, value is estimated using surveys in which a representative sample of the relevant population expresses a stated preference that can be directly or indirectly used to determine willingness to pay (WTP) for a good or service. In this study three SP methods were implemented eliciting:

1. The value of current weather information services and products
2. WTP for improved weather information using a discrete choice experiment (DCE) and
3. WTP for improved weather information using the contingent valuation method (CVM)

ES-7.1. Values for Current Services

In this approach, respondents are informed that hydro-met products and services are publicly provided services and that they are supported by the national government through household taxes, fees, and licenses at a certain per-person level. A value of 15, 60, 240, or 960 meticals

(MT) per year was randomly indicated to respondents as the funding levels.[6] They are then asked if they feel that the products and services (hydro-met information) they currently receive is worth less than, worth about, or worth more than the amount indicated with different levels indicated to different respondents. By assessing the percent of individuals responding whether or not the amount suggested is worth it to them, the responses map out a demand curve for current values.

Figure ES-7 shows the percent of "Worth at least or more than *X* MT a year to me" responses to the four offer levels. The monotonically decreasing number of responses is expected as economic theory generally would indicate fewer and fewer people are willing to buy a commodity (in this case weather, water, and climate information) the higher the price (or cost). This is equivalent to a downward sloping demand curve for current hydro-met information.

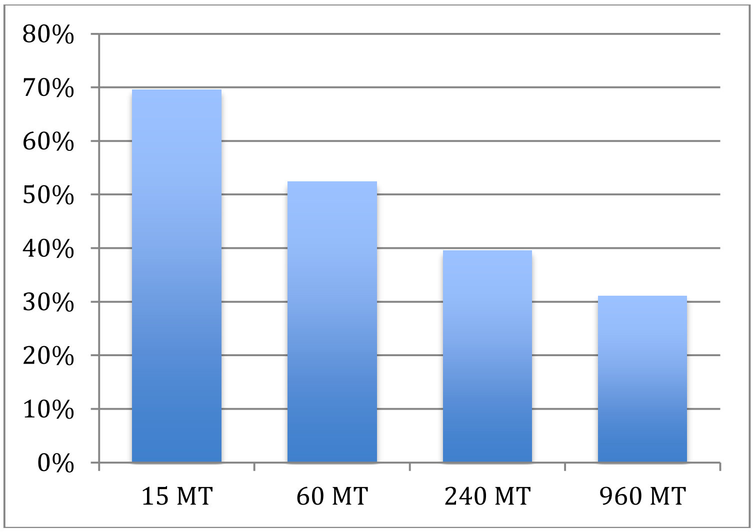

Figure ES-7: Percent saying forecasts are "Worth at least or more" than cost indicated

Regression analysis on individuals' values for current services indicated higher value for the following, those in the north-central regions; those with higher income or less monetarily constrained or lower educational levels; those who use forecasts for short-term decision-making; those who did not reject the hypothetical nature of the valuation exercises; and for those who expressed a value for the use of information by others (e.g., altruistic and bequest values).

[6] As of July 2013 (when the survey was implemented) there was roughly 30MT per USD (as per http://fx-rate.net/MZN/USD/ historical exchange rate lookup).

Counterintuitively, those who felt temperature information was more important expressed a lower value for current information.

Based on the regression analysis, the median value for current product and services was estimated at about 250 MT per year with a 95% confidence interval from roughly 125 MT to 375 MT. Under assumptions of sample representativeness and taking this as a per household value, this measure was aggregated to all of Mozambique for an annual estimate of the value of current hydro-met information of 1.15 billion MT per year or approximately US$37.4 million per year.

ES-7.2. Discrete Choice Experiment

In stated preference (SP) studies, the value obtained for the good or service is contingent on the nature of the constructed market described in the survey scenario. Stated preference methods include stated value (SV) methods such as the contingent valuation method (CVM) and stated choice (SC) methods both of which are used in the study. Stated choice (SC) methods use a hypothetical context in a survey format, but questions are designed as choices between alternatives that include differences in hydro-met goods and services as well as in costs. The alternatives that a subject choose reveal information about his or her underlying preferences for the goods and services included in those alternatives. Through statistical modeling of the choices, an estimate is "backed out" of preferences and values for improvements in hydro-met services.

Building on prior questions about the importance of improving the accuracy of specific forecast attributes, the SC focused on only four weather forecast attributes and added the cost attribute to the choice sets to allow for calculation of marginal WTP measures. The attributes, the baseline levels of accuracy (current levels or Level 1), and two levels for potential improvements (a medium improvement and a maximal improvement) are shown in Table ES-1.

Table ES-1: Attribute Table for Preference Evaluation and Choice Sets			
Attribute	Current (Level 1)	Medium (Level 2)	Maximum (Level 3)
All other warnings and advisories lead time	Current lead time 24 hours (one day)	Increase lead time to 48 hours (two days)	Increase lead time to 96 hours (four days)
Geographic detail	Three sections of country (south, central, north)	Province level (10+Maputo City)	District level (128 districts)
Accuracy of high and low temperature forecasts	24 hours (one day) generally accurate ±2°C	Extend to 48 hours (two days) with same accuracy as current 24-hour	Extend to 120 hours (five days) with same accuracy as current 24-hour
Accuracy of rainfall information	Correct 75% of the time	Being correct 80% of the time	Being correct 90% of the time
Annual Cost to Household	No Cost (0 Mt)	15 MT; 30 MT; 60 MT; 150 MT; 240 MT	

Each respondent answered a set of initial three "learning" questions, followed by one of three different sets of seven choice questions each with a follow up on whether or not the respondent would prefer no changes. There were thus 17 choice responses from each respondent. Figure ES-8 shows an example of one of the choice set questions.

CS1.4. **The table below shows two different programs, Program C and Program D, for improving forecasts. You are now being asked to compare all of one column (Program C) to all of the next column as a different program (Program D).**

Please indicate which Program, if you had to choose, you would prefer.

	Accuracy of Current Forecasts	Program C	Program D
Warnings and advisories lead time	Current lead time one day	Increase lead time to 4 days	Increase lead time to 2 days
Geographic detail	Three sections of country (south, central, north)	District level (128 districts)	Province level (10+Maputo City)
Accuracy of high and low temperature forecasts	one day generally accurate ±2°C	No change	Extend to 2 days with same accuracy as current 24-hour
Accuracy of rainfall information	Correct 75% of the time	No change	Being correct 80% of the time
Increase in Annual Cost to Your Household		15 MT	No Cost
I would prefer (please click on the program you prefer)		Program C ☐	Program D ☐

Figure ES-8: Standard Full Choice Question

Statistical analysis indicated that individuals didn't have strong preferences for more geographic detail in the forecasts, but it is suggested that further investigation of this result would be warranted before deciding to not provide more geographic detail. Respondents did reveal strong preferences for improved warning lead time, and accuracy of temperature and precipitation information. The modeling also suggests that improving the accuracy of temperature forecasts would have significantly greater benefit to those in the north-central areas than those in the south and that improving the accuracy of “all other advisories and lead time” and accuracy of temperature forecasts would generate higher value to urban respondents than those in rural areas.

Using values for the “median” respondent total WTP for the maximal improvement program are estimated as 2.808 MT per year, per respondent. This value is equal to $US0.0918. Taking this as a per-household value estimate and assuming that the sample was representative of the overall population of Mozambique, this measure is aggregated to the 4.6 million households in Mozambique. Aggregating this over 50 years of a program lifetime using a 3% rate of discount indicates a present value estimate of $US11.2 million benefit for a maximal weather information improvement program. We fell this may represent a lower bound estimate and also feel more econometric analysis is warranted to assess the value estimates from the SC questions.

ES-7.2. Contingent Valuation Method

Following the discrete choice experiment, a contingent valuation method (CVM) question was asked for a single program. Individuals were randomly assigned to one of two versions of the program – one with improvements on all attributes to intermediate levels and one with improvements on all attributes to maximum levels presented earlier in the survey.

Stated value (SV) refers to the use of a hypothetical transaction framework in which subjects are directly asked to give information about their values for specific goods or services. This is implemented by describing a hydro-met improvement program and then asking, “How much would you be willing to pay for X?” Table ES-2 shows the attributes and levels (current and potentially improved) for the two programs evaluated in the CVM analysis.

Table ES-2: Contingent Valuation Method Question and Versions

Question: Rather than comparing programs, we now want you to consider a single program to improve weather forecasts as indicate by Program Q below.

	Current Accuracy of Forecasts	Medium (Level 2)	Maximum (Level 3)
Cyclone warnings and advisories lead time	Current lead time two days	Increase lead time to three days	Increase lead time to five days
All other warnings and advisories lead time	Current lead time one day	Increase lead time to two days	Increase lead time to four days
Geographic detail	Three sections of country (south, central, north)	Province level (10+Maputo City)	District level (128 districts)
Time period covered	Currently for entire day	Information broken down between night and day	Information broken into three-hour increments
Accuracy of high and low temperature forecasts	One day generally accurate ±2°C	Extend to two days with same accuracy as current one day	Extend to five days with same accuracy as current one day
Accuracy of rainfall information	Correct 75% of the time	Being correct 80% of the time	Being correct 90% of the time
Maritime information	Correct 70% of the time	Being correct 80% of the time	Being correct 90% of the time
Reliability of seasonal forecasts	Reliable 65% of the time	Being reliable 70% of the time	Being reliable 80% of the time
Accuracy of flooding and water levels	Correct 70% of the time	Being correct 80% of the time	Being correct 90% of the time

In this study a "payment card" approach is used (shown in Figure ES-9) in which individuals are presented with a hypothetical scenario of improved hydro-met services and asked to indicate their maximum WTP by circling a number on a card listing a range of different monetary values, or to indicate their value as an open-ended response. Individuals were also able to indicate a specific value (other amount) if they didn't want to circle one of the specific levels offered.

CVM1 **What is the maximum amount you would be willing to pay each year for this single program to improve weather forecasts? Please circle the number below indicating the maximum annual amount your household would be willing to pay for this program.**

MT 0 (I would pay nothing)	**MT 15**	**MT 30**	**MT 60**	**MT 120**
MT 240	**MT 480**	**MT 720**	**MT 1,440**	**MT 2,160**
MT 3,240	**MT 5,400**	**MT 9,000 or more**	**Other (enter amount) ___________**	

Figure ES-9: CVM Payment Card

Regression analysis indicated a higher WTP for improved hydro-met information by those who 1) have experienced more weather related losses in the past; 2) do not currently get their information from government or non-government agencies; 3) use forecasts more than others for short-term decision-making; 4) have lower satisfaction with current weather information; 5) were aware of INAM prior to the survey; 6) feel improving forecast information is important; 7) feel improving hydro-met information would be useful to them; 8) want information improved for other to use as well as themselves (e.g., altruistic and bequest values); and 9) did not reject the hypothetical nature of the valuation scenario.

Using the results from the regression analysis, an average respondent's WTP for the maximal improvement program was estimated to be 40.89 MT per year (equal to US$1.16). Using this as a per-household value estimate assuming our sample to representative of the population of Mozambique, this can be aggregated across the 4.6 million households in Mozambique. Calculating this over a 50-year program lifetime with a 3% rate of discount derives a present value estimate of US$141.4 million benefit for a maximal weather information improvement program. This represents a significantly higher benefit estimate than the estimate from the SC experiment but as noted above we feel that estimate is a lower bound and requires additional analysis.

ES-8. Summary

ES-8.1. Shortcomings

Some of the survey results are counter-intuitive (such as a lower WTP value for those saying temperature information is important) and require more assessment or evaluation in future work. In addition, given a lack of historical forecast verification, INAM did not have a good assessment of current and future quality of hydro-met information. Valuation scenarios are therefore based on "best guesses" of current and improved information. It was also noted that the survey contained multiple valuation formats and involved a relatively long interview with each subject, which may have involved some respondent fatigue and subsequent data variation. Overall, there was insufficient time for pre-testing the survey and development, and future work should allow for more time in implementation to enhance data quality.

ES-8.2. Major findings

Even when recognizing shortcomings, the survey indicated a positive and significant WTP for current and improved hydro-met information in Mozambique. Underlying these key results, it was found that weather, water, and climate are significant and important factors in all areas of life in Mozambique, and that improvements in information will likely add significant benefit for the general public. Results also indicate that in the longer term, more information (e.g., climate) is as important, if not even more important, to respondents than short-term information; that there are substantive regional and urban-rural differences that should be considered in developing hydro-met services; and that there is a general need for increased awareness and access to hydro-met information.

ES-8.3. Future work

Building on the current research, it is recommended that there be similar work following program implementation to assess program results. Future work should also more thoroughly assess respondent heterogeneity beyond the south versus north-central and urban-rural analysis assessment that have been undertaken so far. And, given the relatively low values suggested in the stated choice analysis (much lower than in the CVM analysis), ongoing analysis is suggested especially on DCE responses to assess value estimates.

1 INTRODUCTION

1.1 Overview

This report reviews economic analysis of public values for improved hydrological, meteorological, and climatological services and products undertaken for the World Bank as part of the *Climate Resilience: Transforming Hydro-Meteorological Services* project in Mozambique.

The Pilot Program for Climate Resilience (PPCR) of the Climate Investment Funds (CIFs) finances the integration of resilience measures into core development planning. A Strategic Program for Climate Resilience (SPCR) for Mozambique was created, which included a pilot investment in hydro-meteorological (hydro-met) services. Since the approval of the SPCR, Mozambique's Council of Ministers endorsed a National Strategy for Climate Change in which the need to strengthen the work of the National Directorate of Water (DNA, Direcção Nacional de Águas), the five Regional Water Authorities (ARAs, Administrações Regionais de Águas) and the National Institute for Meteorology (INAM, Instituto Nacional de Meteorologia) was specified as a key national priority.

The objective of the PPCR-funded project *Climate Resilience: Transforming Hydro-Meteorological Services* Project for Mozambique is to strengthen hydro-met information services to deliver reliable and timely climate information to local communities and to support economic development. CIF funding totals US$15 million along with US$6 million leverage funding from the Nordic Development Fund. The project focuses on financing hydro-met services in Mozambique — part of the World Bank's expansion into meteorology, and part of a growing mobilization of financial and technical resources targeting climate services.

Delivering relevant, timely, and accurate information on water and weather in Mozambique could have socio-economic benefits for sectors such as aquaculture, artisanal fishers, commercial agriculture and fisheries, aviation industry, disaster management, hydropower production, infrastructures such as roads, rails and bridges, and subsistence farming, to name a few. Hydro-met information can enhance productivity of these sectors of the economy by providing information that can translate into economic output. Equally important, greater understanding of extreme weather events from more accurate, relevant, and timely hydro-met information can minimize their negative impacts.

However, there is an assumption that such benefits can be achieved in a country such as Mozambique, which motivated the objective of the economic analysis contained in this report. The analysis focused on how to evaluate and quantify the assumption that improved hydro-met services will increase productivity in economic sectors, and enhance resilience to water and weather-related hazards. It also estimated the value of hydro-met services in economic terms in order to improve dialogue and decision-making on policy, planning, and budget allocation (as well as inform project design and implementation). Equally important, the analysis should enable the responsible government agencies to evaluate their interventions, optimize the use of current resources, and guide future research and investments. Finally, the process of better understanding the economics of hydro-met services can also strengthen the responsible agencies' relations with user groups, both within and outside government.

Chapter 1 provides an overview of the socio-economic context of Mozambique. It also includes an overview of the meteorological, hydrological, and climatological conditions of the country; the related government services and agencies; example World Bank programs that assist these agencies; and the purpose and objectives of the socio-economic analysis. As part of the socio-economic analysis a survey of the general public was conducted to elicit information on sources, uses, perceptions, and values related to hydro-meteorological events and information. Chapter 2 presents information on the development and implementation of the survey of the public used to gather data for this study. Chapter 3 covers the analysis on the sources, uses, and preferences from the survey. Chapter 4 provides the analysis of the three economic valuation exercises from the survey. Finally, Chapter 5 summarizes and concludes. The appendices contain details of the dataset, analysis methods, and the survey codebook (with all questions and summary data).

1.2 Geographic Context and Economy

Mozambique is located in the southeastern corner of Africa covering 799,380km^2 (slightly less than twice the size of California in the United States)(see Figure 1-). It has borders extending 4,571 kilometers along with 2,470 kilometers of coastline. Mozambique has primarily coastal lowlands bordering the Mozambique Channel and Indian Ocean with uplands in north and central parts of the country and high plateaus in the northwest with mountains in western regions. High grassland, and evergreen forest covers large parts of the western highlands and interior mountain ranges and coastal ecosystems bound the eastern lowlands.

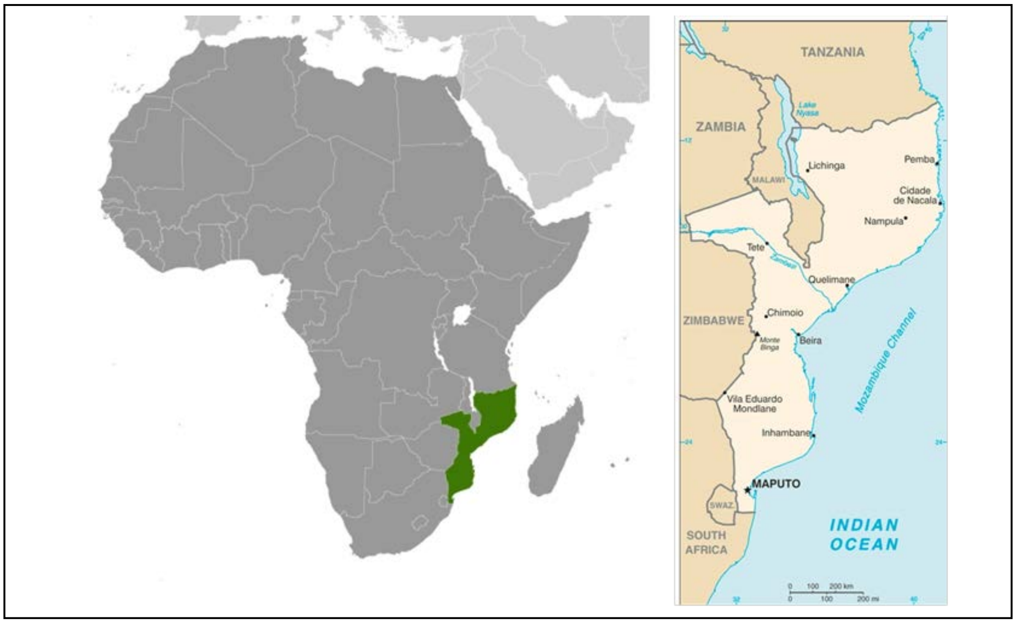

Figure 1-1. Mozambique

Source – CIA World Factbook.

From 1510 when the Portuguese controlled all of the former Arab sultanates on the east African coast, Mozambique was under the control of Portugal until it became an independent nation on June 25, 1975. Mozambique has a population of approximately 24,096,669 (July 2013 estimate) with nearly 46% in the 0-14 year age range and females comprising 51.3% of the total. There is a 2.44% population growth rate and life expectancy at birth is 52.3 years. As of 2011, 31.2% of the population was considered as urban with a 3.05% annual rate of change (2010-2015 estimates). Approximately 56% of the population is literate (71% of males and 43% of females) and school "life expectancy" is an average of 10 years (Central Intelligence Agency. 2012a). Child mortality for children under five years olds is 89.7 per thousand, malnourishment affects nearly 40% of the population.

With a 2010 gross domestic product (GDP) purchasing-power-parity (PPP) of US$21.81 billion the per capita PPP GDP was US$1,010.38. GDP per capita in current prices in 2012 is estimated at US$458.33 making Mozambique one of the poorest countries in the world (213th of 227 countries. (Central Intelligence Agency. 2012b). The growing per capita GDP is still well below the Sub-Saharan African average (US$1,417). Additionally, Mozambique's Gini coefficient index, or GINI index, which represents the income distribution of a nation's residents, is 45.7. This reflects substantial income inequality. Despite the booming extractive industries, "translating this performance into the creation of decent jobs is still an enormous challenge since these are capital intensive projects which do not create much direct employment (International Labour Organization. 2014)" (Labour Minister Helena Taipo).

Inflation remains relatively high, but stable at about 13% (Economy Watch. 2010). As indicated in Figure 1-2, approximately one-third of GDP value-added comes from agriculture, 45% from services, and 25% from industry.

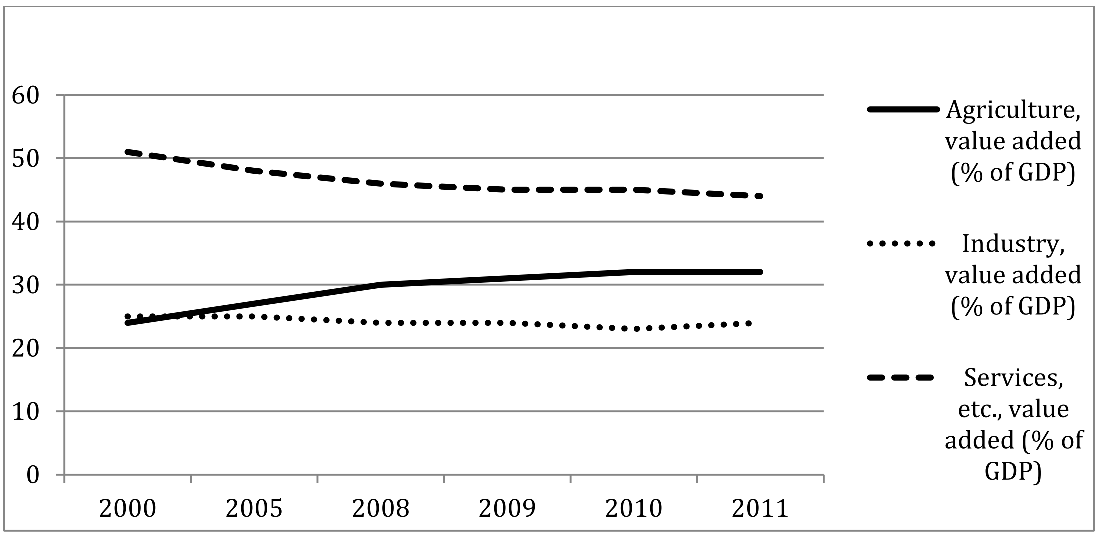

Figure 1-2: GDP Composition Value Added by Sector

Among Africa's growing economies, Mozambique is experiencing consistently high growth rates. Between 2002 and 2012, the economy expanded by 6-8% per year (World Bank. 2014a) and in 2014, GDP was forecasted to grow by 8.5% (African Economic Outlook. 2015). Growth is largely driven by an influx of large-scale investments in extractive industries following recent discoveries of huge reserves of natural gas and coal in northern and central parts of the country. In 2013, the extractive sector represented 38.2% real GDP growth, which was followed by the transport and communications sector, and financial services sector (16.1% and 15.2% real GDP growth in 2013, respectively) (African Economic Outlook. 2015). Expanding extractive industries has not translated into job-creation and unemployment remains high at 17%. Despite the improvements, the general state budget of Mozambique continues to be chronically deficient and heavily dependent on external assistance.

As presented in Figure 1-3, the overwhelming majority of the population is employed in the agricultural sector providing income for more than 80% of the population. The agricultural sector grew by 7.9% from 2003 to 2008, mainly due to increasing cultivation areas and favorable rainfall. Crop yields remain weak due to a number of factors limiting productivity.

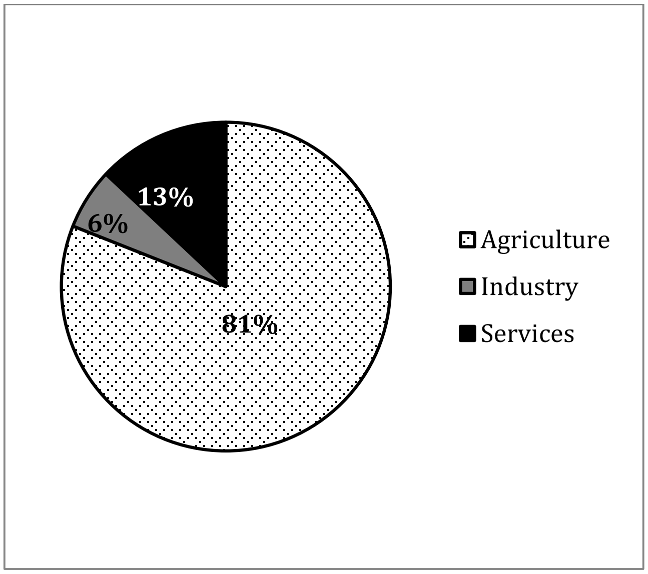

Figure 1-3: Labor Force Distribution (2011)

1.2.1 Extractive and Productive Industries

Titanium extraction and production as well as garment production are two industries that have the potential to grow significantly, but a lack of electrical energy for both have limited their growth. As reported in the Fifth EITI-Mozambique Report (Intellica. 2012) of the Extractive Industry Transparency Initiative, the annual growth rate in Mozambique's GDP of about 7% has been largely driven by Foreign Direct Investment directed particularly towards extractive industries. This includes aluminum production in Maputo province, coal mining in Tete province, and natural gas exploitation Inhambane province. As of the 2012 EITI report, work was underway for the building of a Liquefied Natural Gas (LNG) facility. Despite the growth of Mozambique remaining high in recent years, a heavy reliance on aluminum, which accounts for around one-third of exports, exposes the country to the volatility of international prices (Energy Business Review. 2012a; Energy Business Review. 2012b)

1.2.2 Agriculture and Fishing

The majority of farms in Mozambique are smallholders, representing more than 98% of total farms, and 96% of the national agricultural production. These farms use traditional farming methods, manual cultivation techniques (with only 11% using animal traction and a small number using mechanized tools), and very little agro-chemicals. The absence of modern inputs including seeds, technologies, and financing, results in low yields and low returns on crops. These farms are almost all subsistent, with little or no goods made available to the marketplace (less than 20% of farmers sell their products). Climate change presents a considerable risk as rainfall in Mozambique is expected to become more variable, and the risk of flooding is expected to increase in the southern and eastern regions of the country. Significant investment would be required to grow the current irrigation, from only 118,000 hectares irrigated to the potential 49,000,000 hectares of agricultural lands. (FAOSTAT. 2012b; IFAD. 2011). By another measure only 4% of the agriculturally viable 2.7 million hectares is equipped with irrigation infrastructure (World Bank. 2010).

The largest employer is the agricultural sector, engaging roughly 80% of the labor population of which 65% are women (FAOSTAT. 2012a). Collectively, land farmed for subsistence agriculture represents 97% of total cultivated land. Agricultural output is lower than anticipated (Pauw et al. 2012) despite that the sector's value added is 30% of GDP (World Bank. 2014b). Between 2010 and 2014, food output and productivity was severely hampered by adverse hydro-met conditions and extreme events such as cyclones and floods (International Monetary Fund. 2014). Catch volumes in the fishery sector on the other hand, has experienced rapid growth with 449% increase against the Government's target for 2013 (IMF. 2014) set out in the five-year poverty reduction strategy (Plano de Acção para Redução da Pobreza. 2011-2014).[7] Over 95,000 people are formally employed in the fishery sector (FAO. 2005), which makes up 4% of GDP and 28% of foreign exchange earnings (FAO. 2003).

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[7] See http://www.news24.com/Africa/News/Mozambique-floods-carnage-continues-20150202 regarding 2015 flooding. This article also notes that such floods have significant impacts on agriculture due to the highly agriculture dependent nature of the Mozambique population.

The percentage of Mozambicans living below the poverty line "based on per capita consumption measured at the household level" is reported as 54.7% in 2010 although there are potential data issues with official estimates[8]. Marco-regional estimates range from 15.9% in southern urban areas to 71.2% in Central rural areas in 2008 and 2009 (Alfani et al. 2012, p.23).

1.3 Weather, Water, and Climate

Nine of Mozambique's 13 largest rivers originate in upstream countries and drain into the Indian Ocean and the Mozambican Channel. More than half of the country's total-mean-annual runoff originates outside Mozambique's boundaries, and the country has some of Africa's largest renewable water resources of 216km^3/year[9]. As such, upstream activities and neighboring countries' weather and water conditions directly affect the country. Tropical to sub-tropical climates prevail in the northern and central provinces and dry, arid desert climate overtakes the south. The rainy season lasts from October to March, averaging 25-27°C, and the dry winter season is from April to September, averaging 20-25°C (McSweeney et al. 2012). The timing and magnitude of the seasons are influenced by the oscillations of the Inter-Tropical Convergence Zone and the El Niño/La Niña phenomena. The national average rainfall of 1,032 millimeters/year (McSweeney et al. 2012) varies across seasons as well as geographies. The majority of rain falls between December and March (60-80%); 1,000-2,000millimeters/year can fall in the wetter north and in the south rainfall averages 500millimeters/year. Droughts affect southern provinces 7 out of 10 years and central areas along the Zambezi River valley 4 out of 10 years (UNISDR. 2011). The topography of Mozambique is often low-lying across its many river deltas along the coastline measuring 2,470 kilometers, where more than 60% of the population lives. As such, Mozambique is especially exposed to the impact of tropical cyclones and floods. Reoccurring cyclones originate as warm-core air centers over the Indian Ocean and the Mozambique Channel and move westward towards the mainland. Cyclones bring heavy downpours and wind gusts that can reach velocities of 300 kilometers/hour. Variable inter-annual river flows and frequent flooding is exacerbated by rainfall extremes combined with limited storage and flood-control infrastructure.

[8] "It is determined that at least two significant weaknesses affect the official poverty-rate estimates: measurement errors in consumption data and flaws in the methodology used to calculate poverty lines (the cost-of basic-needs approach based on provincial food bundles with entropy correction)." (Alfani et al. 2012, p.2)

[9] Surface waters constitute the majority of resources. (World Bank. 2007)

Major floods have hit Mozambique in recent years. In 2000, 2001, 2007, and 2013 the extreme weather and water events collectively resulted in over 1,200 deaths, displacement of 1.5 million people, and destruction of US$1.5 billion in infrastructure. It is estimated that as much as 58% of the population is vulnerable to natural disasters and that these shocks result in a 1.1 percentage points lower annual economic growth. Most recently, extreme floods hit Mozambique in the lower stretches of the Limpopo, Incomati, and Zambezi River basins during January and February 2013. More than 170,000 people were evacuated, 113 lives were lost, and 89,000 hectares of crops were destroyed in the provinces of Gaza, Maputo, Zambezia, and Sofala. Almost 50,000 hectares of highly productive cropland was destroyed along with damages to the country's largest irrigation system, health and education facilities, road and railway infrastructure, water supply systems, urban drainage and sanitation systems, and flood protection dykes. The spread of malaria and schistosomiasis increased with the rising, stagnant waters. The economic costs of the physical damages were in the order of US$403 million (World Bank, 2013a).

1.4 Hydro-meteorological monitoring and forecasting

1.4.1 History and Institutional Structure

The earliest consistent meteorological observations in Mozambique began in 1883 in the second largest city in the country – Beira. The Mozambique Meteorological Services (Servico Meteorologico de Moçambique) was founded in 1950 and continued operating after the country gained independence in 1975, after 500 years of Portuguese colonial rule came to an end. Two years later, the country fell into 15 years of civil war. During this time, the network of observation stations for monitoring water and weather across the country deteriorated steadily. Although the government and external donor support has invested in improving hydro-met observation, only a third of the existing network is providing hydro-met data today.

The mandate for water and weather observation and forecasting is delegated to several agencies across two government ministries in Mozambique.

The Ministry for Transport and Communication (MTC, Ministério dos Transportes e Comunicações) delegates responsibility to the National Institute for Meteorology (INAM, Instituto Nacional de Meteorologia) to monitor and forecast weather and climate and to produce and disseminate climatological data, analyses and services as well as weather forecasts and forecasting services. INAM was created in 1989. INAM monitors and forecasts weather and climate, and produces and disseminates climatological data and analyses on parameters ranging from rainfall through to wind and temperature (Resolution 30/89). As such, INAM also provides technical assistance to institutions on meteorological analysis and has the duty to promote standards in accordance with the World Meteorological Organization (WMO). INAM's plan for modernization is articulated by the INAM Strategic Plan for 2013-2017 which clarifies its vision, objectives, and action plans to improve meteorological services.

Within the Ministry of Public Works and Housing (MOPH, Ministério das Obras Públicas e Habitação), the National Directorate of Water (DNA, Direcção Nacional de Águas), and the five Regional Water Authorities (ARAs, Administrações Regionais de Águas) are responsible for matters relating to hydrology including policy development and management, strategies and investment mobilization for the water supply and sanitation in rural and urban areas, management of water works planning and sharing agreements issues for water resources in transboundary basins.

The Water Law (No. 16/91. August 03, 1991) and the 2007 National Water Resources Management Strategy outline the mandate and purpose of hydrological monitoring and modelling. The National Directorate for Water (DNA) has the strategic management responsibility for water resources. Overseeing water data collection, quality standards, and modeling is done by DNA's Department of Water Resources (DRH, Departmento de Recursos Hídricos). DRH also provides technical input to the five Regional Water Authorities, ARAs, who are public institutions divided among key groups of river basins from south to north. The ARAs manage monitoring networks, collect and send data to DNA and other stakeholders at the basin level, perform flow forecasting, and manage water infrastructure.[10] These tasks are organized according to River Basin Management Units (UGB, Unidade de Gestão da Bacia). The ARAs consist of ARA-Sul, ARA-Centro, ARA-Zambeze, ARA-Centro Norte, and ARA-Norte.

[10] The website http://www.limpoporak.org/en/governance/water+governance+in+the+limpopo+basin/national+policies+and+laws/mozambique.aspx?print=1 provides an overview of water law in Mozambique (accessed June 19, 2015)

To a much lesser extent, other government agencies administer climatological monitoring stations, but for specific purposes; for example, the National Institute for Agrarian Research (IIAM, Instituto de Investigação Agrária).

The ability for DNA, the ARAs, and INAM to fulfill their mandate is challenged by a number of factors, including financial sustainability, fragmented institutional responsibilities and challenging context for interagency collaboration, and severe shortage of staff capacity, technical skill, and availability. The government's budget allocations, donor support, and revenues are not commensurate with the collective hydro-met service's estimated economic value and fluctuate significantly[11]. Limitations are also faced in the implementation of quality standards and calibration of monitoring stations and dissemination of raw data and advanced forecasts.

1.4.2 Observation Systems

An evaluation of Mozambique's meteorological observation network in 2013 showed that 38 of 154 manned meteorological stations are reporting regularly (i.e., 25%). Additionally, automatic weather stations increased from three to twelve between 2005 and 2011, but remain low in comparison to needs. The country's two Doppler Radars, which provide the only upper air monitoring, are not operating[12]. At INAM's headquarters in Maputo, there is one access point for satellite/remote sensing data through a EumetSat portal. However, INAM faces challenges in ensuring updates and operating the station to access regional data. There is no monitoring system for maritime meteorology, but the National Institute for Hydro-geography and Navigation (INAHINA, Instituto Nacional de Hidrografia e Navegação) has five tidal stations, and some offshore buoys exist.[13]

The ARAs manage a larger network of monitoring stations than INAM, which includes extensive monitoring of rainfall, temperature, and evaporation (often in stations owned but not operated directly by INAM). Yet the proportion of the ARAs' manual monitoring network that is

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[11] For example, despite overall national budget resources increasing to INAM an average of 8%/year, the overall budget has been drastically decreased since 2009 due to a reduction in international donor support.
[12] The country's two Doppler Radars in Beira and Xai-Xai are being rehabilitated in 2014 after several years of being non-operational. There is no lightning-detection system or upper-air monitoring.
[13] According to INAM, the buoys do not have instruments for measuring meteorological/oceanographic parameters and INAM has no access to these data. According to a report by INAHINA there are several ocean buoys for purposes of navigational safety and activities related to tidal measurement and ocean physics but no mention of monitoring and reporting to INAM http://www.iho.int/mtg_docs/rhc/SAIHC/SAIHC8/SAIHC8-5.3F_National_Report_Mozambique.pdf (Accessed June 19, 2015).

operational and provides data is similar to INAM's 25% noted above. For example, 218 of 592 stations monitoring river stage/runoff (i.e., 37%) and 329 of 1,318 of stations monitoring rainfall (i.e., 25%) are providing data[14]. These stations are monitored by locally-hired readers who take one rainfall reading and three river-stage readings per day in the dry season. The ARAs are also responsible for operating water infrastructure such as large dams and weirs, where monitoring of water levels are regularly done. The use of automatic stations to monitor river level or water quality data has tripled since 2004, enabling storing of data in data collection platforms and transmission via the Global System for Mobile Communications (GSM) or high frequency radio. These stations are used in key river basins, such as the Maputo, Limpopo, Incomati, and Zambezi Rivers. However, the type and technology of automatic stations often differ among river basins and it is persistently difficult to maintain and rehabilitate dysfunctional automatic stations.

Mozambique has eight Southern African Development Community – Hydrological Cycle Observing System (SADC – HYCOS) stations installed (four on the Zambezi, two on the Púnguè and one each on the Incomati and Maputo rivers). The SADC – HYCOS is part of the WMO's global effort to atomize data collection and transmission (via satellite and presented on global websites) of river monitoring at key strategic locations. The HYCOS stations are, however, facing temporary station-specific interruptions to communication or web-based services are not accessible due to missing passwords. River rating curves are few, inhibiting the measurement of discharge and current/velocity meters (both mechanical and Acoustic Doppler Current Profiler, or ACDP) are insufficient and not regularly calibrated. The ARAs communicate with the operators of the country's largest, and one of the region's largest dams – the Cahora Bassa Hydropower operators (HCB, Hidroeléctrica de Cahora Bassa). ARA-Sul and ARA-Zambeze have the most active monitoring networks, which reflect greater water dependencies, economic activity, commercial farming, population densities, and dam infrastructures in the basins they manage.

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[14] The diagnostic of ARAs stations showed that some stations that were not reporting were closed in the early 1970s as they did not serve an integrated watershed management purpose.

1.4.3 Forecasting and Early Warning Systems

Daily forecasting, or prediction, is done by hydro-met agencies. Forecasts are communicated in "bulletins" (produced centrally at headquarters in Maputo) and disseminated using email and fax to reach a set list of recipients and agencies. In times of high rainfall/river flows or severe weather events, forecasting information are provided three times per day according to a protocol of procedures for early warnings as managed by the National Institute for Disaster Management (INGC, Instituto Nacional de Gestão de Calamidades). Unfortunately, early warning systems are plagued by short lead times, low spatial and time-resolution of data, and generic format of information that fails to meet key users' information needs.

1.4.4 Challenges

The often-overlooked reality for Mozambique's hydro-met agencies is that they lack sufficient number of trained and adequately paid staff. The inability to ensure that staff even comes to the office due to low pay or lack of transport, is a serious threat to modernizing services and sustaining them. These human resources constraints are not unique to INAM, DNA, and the ARAs, but reveal deep-set institutional capacity gaps in civil service agencies in Mozambique. The three institutions have highly educated and skilled staff, yet, they are few in number and allocated to address only the most critical monitoring and forecasting needs at strategic locations.

1.5 World Bank Program

1.5.1 History of World Bank engagement and current portfolio

Since the mid-1990s, the World Bank and other international partners has actively supported the water sector in Mozambique. Building on a program of water sector support, the World Bank developed a Country Water Resources Assistance Strategy (CWRAS) for Mozambique in 2009. The CWRAS identified and committed the Bank to identify financial resources for enhancing hydrological and meteorological data for the core operation of water resources planning, infrastructure development and transboundary cooperation with neighboring countries (World Bank. 2007). In 2011, a National Water Resources Development Programme began with the support of the World Bank's International Development Association assistance (IDA)[15], which included a dedicated project for strengthening the country's hydro-met services. Globally, the value of strengthening hydro-met agencies in developing countries is increasingly recognized;

[15] World Bank Project ID No. P107350, US$70 million IDA.

especially in terms of building resilience or adaptation capacity of less developed countries, and in strengthening country's ability to predict and manage water/weather related disasters. As such, global funding for associated investments has increased. One of the objectives of the Climate Investment Funds (CIFs) is to promote climate-resilient growth[16]. In 2008, the Pilot Program for Climate Resilience (PPCR) was approved as one of the CIF's strategic funds to finance the integration of resilience measures into core development planning (Climate Investment Funds. 2015). In June 2011, a Strategic Program for Climate Resilience (SPCR) for Mozambique was created and it included a pilot investment in hydro-met services (CIF. 2011). Since the approval of the SPCR, Mozambique's Council of Ministers endorsed a National Strategy for Climate Change in which the need to strengthen the work of INAM, DNA, and the ARAs was specified as a key national priority. In 2013, PPCR-funding was approved for a dedicated project *Mozambique Climate Resilience: Transforming Hydro-Meteorological Services*[17]. The project is also supported by parallel financing from the Nordic Development Fund. The project to specifically finance hydro-met services in Mozambique represents the World Bank's expansion into meteorology and is part of growing mobilization of financial and technical resources targeting climate services. The project is closely aligned with a portfolio of support from the World Bank and other international partners[18].

1.5.2 Climate Resilience: Transforming Hydrological and Meteorological Services Project

The Pilot Program for Climate Resilience (PPCR) of the Strategic Climate Fund (SCF) *Climate Resilience: Transforming Hydrological and Meteorological Services* Project has an objective to "strengthen hydrological and meteorological information services to deliver reliable and timely climate information to local communities and to support economic development."[19] The project is comprised of three components:

[16] The CIFs channel funds through the Multilateral Development Banks, including the World Bank.
[17] World Bank PPCR Hydro-Met Project ID No. P131049, US$15 million with US$6 million in parallel financing from the Nordic Development Fund.
[18] For example, closely associated World Bank investments include: PPCR Climate Change Development Policy Operation (Project ID No. P146398), Global Facility on Disaster Reduction and Recovery for programmatic support to Disaster risk management (Project ID No. P124755), and the National Water Resources Development Project (Project ID No. P107350). Other key international partners providing associated support include: the Netherlands, Japan, the One UN group, and the African Development Bank amongst others.
[19] Project Appraisal Document on a Proposed Grant from the Pilot Program for Climate Resilience (PPCR) of the Strategic Climate Fund (SCF) to the Republic Of Mozambique for a Climate Resilience: Transforming Hydrological and Meteorological Services Project. April 01, 2013.

- Strengthening Hydrological Information Management
- Strengthening Weather and Climate Information Management
- Piloting Resilience Through Delivery of Improved Weather and Water Information

Overall the components will improve hydro-met observation networks, data acquisition and management, modeling, forecasting, and warning systems. This includes capacity building as well as new and repaired infrastructure. Pilot projects will be implemented related to early flood warning systems, informational products for agriculture, coastal weather alerts, and inter-agency data management.

1.6 Socio-economic Analysis of Mozambique Hydro-met Services

Socio-economic analysis was undertaken to estimate the value of hydro-met services in economic terms to improve dialogue and decision making on policy, planning and budget allocation (as well as inform project design and implementation). Equally important, the analysis was designed to enable the responsible government agencies to evaluate their interventions, optimize the use of current resources and guide future research and investments. The process of better understanding the economics of hydro-met services may also strengthen the responsible agencies' relations with user groups, both within and outside the Government. Understanding the socio-economic context of hydro-met information may also play an role at the international level as Mozambique is the downstream riparian in nine of its 13 major river basins, and transboundary cooperation and exchange of hydro-met information is vital for securing water for economic use and for advance notice of impending floods or weather related hazards. Further, as part of the World Bank's preparation of PPCR support to Mozambique's hydro-met services, the economic analysis will also inform the project's appraisal document (PAD).

The objective of the economic analysis was to evaluate and quantify the assumption that improved hydro-met services will increase productivity in economic sectors, and to enhance resilience to water and weather-related hazards. This was intended to assess the full range of costs and benefits associated with strengthening hydro-met services across multiple time-periods. (i.e., both direct and indirect impacts from proposed World Bank support). A comprehensive cost-benefit investigation may also allow for greater insight into opportunities for assessing different levels of effectiveness and potentials for efficiencies and strengthen project design.

2 METHODOLOGICAL-THEORETICAL BACKGROUND AND SURVEY DESIGN, PRETESTING, AND IMPLEMENTATION

Chapter 2 provides background information on the economic and methodological approaches, survey design and implementation, and basic results on the implementation and sampling. First discussed is the conceptual approach for elicitation of information on respondents' sources, perceptions, and uses of weather, water, and climate information that offers useful input to the policy process and creates a foundation for the valuation elicitation. An overview of nonmarket valuation methods used in this survey is provided followed by information on survey development and implementation. Basic results on sample socio-demographics characteristics are presented as well as information on data analysis adjustments, the survey codebook, and segmentation of the sample into subsamples for more in-depth analysis.

2.1 Sources, Perceptions, Uses, and Values

Figure 2-1 presents a conceptual model of the weather information value chain to emphasize that there is not a simple direct relationship between hydro-meteorological (hydro-met) information (e.g., products and services) and economic value for that information.

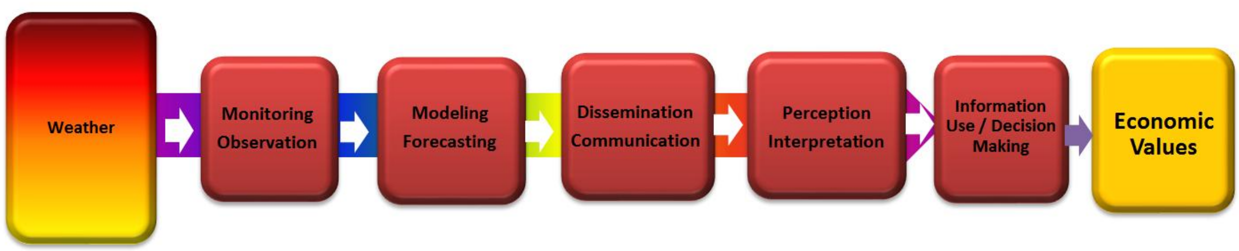

Figure 2-1. Weather Information Value Chain.

Although specifically calling out weather this conceptual approach is equally applicable to climate and water information. The traditional "weather provision model" lies on the left side of Figure 2-1 in terms of monitoring and observations, modeling and forecasting, and even into dissemination. Once information is disseminated though it usually goes through further transmission and modification through various channels (e.g., internet, radio, TV, friends and family) before being received by a decision-maker. Even then the decision-maker has to perceive and interpret that information subject to his or her capacities, resources, and constraints before making a decision or using that information. Only at that point where decisions interact with hydro-met realizations (e.g., what the weather actually is) do outcomes occur that can translate into economic values. Thus, economic value is realized at the end of the chain and not at the point of information creation.

It should also be noted that value can be added or removed at several points along the weather information value chain and thus no single point in the process can be credited with all of the value added. For instance even a perfect forecast will have no economic value if it is not communicated, understood, and potentially used to make decisions.

While Figure 2- is generic in not specifying any particular hydro-met phenomena (e.g., cyclones or floods) or end users / decision-makers, the basic conceptual approach can be applied to construct a value chain for any hydro-meteorological good or service. Without a basic understanding of the value chain it would not be reasonable to assert that economic valuation of hydro-met products and services are valid or reliable. It is noted that where it is difficult to describe or quantify the process indicates a potential need for a better understanding to ensure continuation of the value creation process.

Therefore in the public survey and the analysis presented in Chapter 3, considerable effort is spent in evaluating the process of respondents' sources, uses, perceptions, and preferences for hydro-met information prior to implementing the valuation exercises. Doing so provides critically useful information on where, how, and why people get and use hydro-met information even without considering the economic aspects of the information. It also allows us to better understand and assess and validate the various valuation elicitations discussed in Chapter 4.

2.2 Nonmarket Valuation Methods[20]

2.2.1 Public goods and Non-Market Valuation

Many authors discuss hydro-meteorological information as public goods (e.g., Anaman and Lellyett. 1996; Johnson and Holt. 1997, Freebairn and Zillman. 2002a,b). Public goods are defined as goods or services that are nonrival and nonexcludable. Nonrival means that one person's consumption of the good does not diminish others' ability to consume the good (e.g., one person knowing the weather forecast does not diminish anyone else's ability to derive a

[20] The following section is based largely on material from Lazo and Chestnut, 2002.

benefit from knowing the forecast).[21] Nonexcludable means that once the good is provided no one can be excluded from using the good. Some weather, water, and climate information is excludable and it is this characteristic that provides the basis for private weather forecasting services. Hydro-met information is thus better defined as quasi-public goods because of the potential for exclusion.

Given the quasi-public goods nature of hydro-met information, the economic value of most hydro-met information services is not directly observed in the market. It is therefore difficult to determine the economic value of the changes in these services that are provided as a result of programs to improve this information, but this is exactly what is required in benefit-cost analyses.[22]

Willingness-to-pay (WTP) is defined as the maximum amount an individual is willing to pay to ensure that a welfare-increasing activity takes place or to prevent a welfare-decreasing activity from being implemented. For market goods, such values can often be derived from analysis of market transactions. Measures of WTP for public goods and quasi-public goods are important for determining the appropriate provision of public goods and are appropriate for use in benefit-cost analysis.

There are two basic approaches that economists use to estimate the economic value of nonmarket goods: revealed preference (RP) methods and stated preference (SP) methods. RP methods are applied to actual behavior and market transactions that may reveal the values implicitly placed on a nonmarket good in the context of choices made regarding market goods. SP methods involve individuals indicating (or "stating") a preference between hypothetical options describing products or services and generally do not involve an actual transaction as in RP methods.[23] As hydro-meteorological products and services used by the public are generally not bought and sold in markets and generally not directly related to products and services sold in markets, RP methods have not been useful to estimate values for this information. Therefore SP methods allow for the estimation of values to the public of hydro-met information.

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21. "Nonrivalry also often characterizes the benefits from . . . weather monitoring stations . . ." (Cornes and Sandler, 1996, p. 8).
22. For a more detailed treatment of these issues, see Just et al. (1982) and Freeman (1993).
23 Some economists prefer RP measures because they are actual market transactions and SP values might differ from what would be observed in markets although there is a large literature in SP methods for addressing potential biases.

In this study we use three SP methods to value current goods and services and improved goods and services. For valuing improved goods and services we use two SP approaches – a stated value method and a stated choice method. For the value of current information we use a method similar to stated choice methods. These three approaches are reviewed in the following sections.

2.2.2 Value of Current Products and Services

The value of all current products and services to hydro-met services is often a critical question, but from the perspective of economic analysis is a very difficult problem to assess using valid and reliable methods. A "whole-of-services" valuation implies an extremely wide range of products and services related to a multitude of hydro-met phenomena and being used by the whole range of private and public sector agencies, organizations, businesses, and individuals. In addition it is very difficult to measure the value of an existing system if there is little likelihood that it will go away – in other words the baseline is the current services and the alternative is no services but no services may not be a realistic alternative.

This report covers the implementation of a method developed in Lazo and Chestnut (2002) to elicit basic valuation of households' values for all current products and services. In this approach, it is first ensured that respondents have a basic idea of the whole range of products and services by identifying and "defining" the provider agency(ies). It is then suggested that, as these are publicly provided services, they are supported by the national government through household taxes, fees, and licenses at a certain per-person level. This level of cost provision is varied between different versions of the survey so different individuals see different amounts. The respondents are then asked if they feel that the products and services (hydro-met information) they currently receive is worth less than, worth about, or worth more than the amount indicated.

By assessing the percent of individuals responding whether or not the amount suggested is worth it to them, the responses map out a demand curve for current values. Then, these responses are evaluated for consistency with economic theory (e.g., higher income individuals generally place a higher value on normal products and services) and other factors likely to affect such values (e.g., individuals who state they use forecasts more often likely place a higher value on them than those who use them less). Using this approach, the report shows a derived estimate of the median value to households of current products and services and aggregate this to a national estimate. The report notes though that with this method as implemented, you cannot distinguish between individuals' value specifically for information from the national hydro-met agencies and potential value added by downstream parties including private sector meteorologists and media in transforming and communicating the information.

2.2.3 Stated Preference Methods

In stated preference (SP) studies, value is estimated using surveys in which a representative sample of the relevant population expresses a stated preference that can be directly or indirectly used to determine WTP for a good or service. The value obtained for the good or service is contingent on the nature of the constructed market described in the survey scenario. Stated preference methods include stated value (SV) methods such as the contingent valuation method (CVM) and stated choice (SC) methods (also known sometimes as discrete choice experiments, or DCE), both of which are used in the study.

The reliability and validity of SP methods depend on the extent to which they measure true values. Carson et al. (1996) review comparisons between stated value results and revealed preference results (primarily travel cost and hedonic prices) for valuation of comparable quasi-public goods. Carson et al. (1996) found that the SP results are comparable to, or slightly lower than, the revealed preference results for similar amenities. The goal of SP is to elicit individuals' willingness to trade nonmarket goods and services for other goods and services, usually measured in monetary terms, under conditions consistent with those that make market transactions reliable measures of welfare change. Practitioners of SV have attempted to develop methods to make individuals' choices in SP studies as consistent as possible with market transactions.

Relative to information a respondent may already have about a commodity, SP studies need to define the commodity to be valued, including characteristics such as the timing of provision, certainty of provision, and availability of substitutes and complements. For weather, water, and climate information, it is often the case that individuals already have experience with and a reasonable understanding of this information. This reduces the cognitive burden of defining and explaining the commodity compared to other commodities (e.g., endangered species or environmental services often evaluated using SP methods).

Respondents must also be informed about the framework of the transaction, including the method and timing of payment, and they should be aware of their budget constraints. The social context (the marketplace) is also defined to create incentives to enhance preference revelation, so individuals are able to identify their own best interests, as well as minimize strategic behavior. When these conditions are met, it is more likely that individuals' stated preferences would be consistent with economic measures of welfare change.

2.2.4 Stated Value Analysis

Stated value (SV) refers to the use of a hypothetical transaction framework in which subjects are directly asked to give information about their values for specific goods or services. This is often defined to include direct open-ended questions such as "How much would you be willing to pay for X?" In this study we use a "payment card" approach in which individuals are presented with a hypothetical scenario of improved hydro-met services and asked to indicate their maximum WTP by circling a number on a card listing a range of different monetary values or to indicate their value as an open-ended response.[24]

2.2.5 Stated Choice Analysis

Stated choice (SC) methods include conjoint analysis, contingent ranking, and contingent behavior. These methods also use a hypothetical context in a survey format, but questions are designed as choices between, or rankings of preferences for, alternatives that include differences in goods and services as well as in costs. The alternatives that a subject prefers reveal information about his or her underlying values for the goods and services included in those alternatives.

Choice questions evolved from conjoint analysis, a method used extensively in marketing and transportation research.[25] Conjoint analysis requires respondents to rank or rate multiple alternatives where each alternative is comprised of multiple characteristics (see, e.g., Johnson et al. 1995; Roe et al. 1996). Choice questions ask respondents to choose the most preferred alternative (a partial ranking) from multiple alternative goods (i.e., a choice set), where the alternatives within a choice set are differentiated by their characteristics.

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[24] See http://www.fao.org/docrep/003/x8955e/x8955e03.htm for more details on contingent valuation methods and payment card design.

25. Cattin and Wittink (1982) and Wittink and Cattin (1989) survey the commercial use of conjoint analysis, which is widespread. For survey articles and reviews of conjoint, see Louviere (1988, 1992), Green and Srinivasan (1990), Batsell and Louviere (1991), and Adamowicz, Louviere, and Swait (1998). Transportation planners use choice questions to determine how commuters would respond to a new mode of transportation or a change in an existing mode; Hensher (1994) provides an overview of choice questions as they have been applied in transportation. See also Ben-Akiva and Lerman (1994) and Louviere et al. (2001).

There are many desirable aspects of SC methods, not least of which is the nature of the choice being made. Choosing the most preferred alternative from some set of alternatives is a very common decision experience, especially when one of the attributes of the alternatives is a price. Johnson et al. (1995) note that by going through the process of evaluating pairwise comparisons of attribute respondents are encouraged to explore their preferences across attribute combinations.

In SC, the task of the respondent is to choose the most preferred alternative from each choice set. In this respect, this type of choice task is markedly different from the SV approach. Rather than being presented with one hypothetical state of the world and stating or choosing one's WTP for it, the SC task requires respondents to choose the good that is most preferred from multiple choice sets. One can argue that such a decision task encourages respondents to concentrate on the trade-offs between attributes rather than to take a position for or against an initiative or policy. This type of repeated decision process may also diffuse the strong emotions often associated with environmental goods, thereby reducing the likelihood of "yea-saying." Adamowicz et al. (1996) discuss this possible effect and also suggest that respondents are less able to behave strategically when responding to SC questions.

As with SV, choice questions allow for the construction of goods characterized by characteristics levels that (currently) do not exist. This feature is particularly useful in marketing studies when the purpose is to estimate preferences for proposed goods. For instance, researchers may estimate the value of nonmarket goods are often valuing a good or condition that does not currently exist, e.g., weather forecasts that are accurate out to 14 days. When using SC questions to value nonmarket goods, a price, often a tax or a measure of travel costs, is included as one of the attributes of each alternative so that preferences for the other attributes can be measured in terms of dollars, i.e., WTP or WTA.

As in all elicitation techniques, the responses to choice questions may contain biases or random errors. Choosing can be difficult if the individual is almost indifferent between two alternatives. If each respondent is asked to answer a number of choice questions, there can be both learning and fatigue. Respondents can become frustrated if they dislike all of the available alternatives, and they may have no incentive for sufficient introspection to determine their preferred alternative. A number of studies have investigated these issues.[26] The general consensus is that if stated preference choice questions are carefully designed and implemented they can elicit important and relevant information about preferences, information that often cannot be deduced solely on the basis of observed behavior.

A variety of formats have been used in the design of choice questions. Choice questions may include choices between two or more alternatives, one of which may represent a status quo or baseline condition. This allows individuals to indicate that they prefer no change from the baseline. It may also involve a significant loss of data about how individuals value or trade off attributes if many respondents choose the no change alternative. In this study, we first ask individuals to choose between alternative improvements in weather forecasts and then, in a follow-up question, allow them to indicate whether they would actually prefer to have no improvements made and have no change in cost.

2.3 Survey Development

2.3.1 Initial Survey Development

The survey was developed based on prior work using the contingent valuation approached primarily in the United States (Lazo et al. 2010; Schulze et al. 1998; Lazo et al. 1997; Lazo et al. 1992) and a limited number of developing countries (Brown and Kramer. 2012; Isangkura. 1998; Nguyen. 2014; Nguyen and Robinson. 2013). Prior work on sources, understanding, preferences, and uses of hydro-met information were built on as well (Demuth et al. 2012; Lazo et al. 2010; Lazo et al. 2015). Prior surveys implemented in other contexts in developing countries were also consulted specifically to address issues of income limitations (for instance see United Nations 2005). A number of surveys on other topics implemented in Mozambique were used as well to base questions specific to Mozambique (e.g., Fote et al. 2009; WE Consult Lda. 2009). For the stated choice portion of the survey a set of weather forecast improvement attributes were defined and quantified based on a set of focus groups with Mozambique's National Institute for Meteorology (INAM) employees and through a stakeholders workshop held in Maputo, the capital of Mozambique. Once the survey was developed and translated into Portuguese a small

26. For more details, see for example, Louviere (1988), Green and Srinivasan (1990), Agarwal and Green (1991), Gan and Luzar (1993), Bradley and Daly (1994), Mazzotta and Opaluch (1995), and Swait and Adamowicz (1996).

number of in-person pre-tests were conducted to identify potential survey issues. Based on these pre-tests, the survey was revised prior to final implementation.

2.3.2 Attributes and Choice Set Design

A critical part of the survey was presenting information about products and services specific to Mozambique, and evaluating respondents' preferences and values for the current quality of these and potential improvements. To develop this information for the survey, we first chose a set of forecast attributes largely from the INAM website and found to be relevant to members of the public in prior work in the United States with the understanding that preferences are likely different in Mozambique (Lazo and Waldman. 2011; Lazo et al. 2009). We then implemented a small focus group at INAM in January, 2013 to help define the attribute set and attribute levels. Based on the focus group and additional discussions, a template (see Appendix B) was developed to elicit additional information from INAM on attribute definitions, representations, and appropriate baseline and improvement levels. This was completed by INAM staff in April and May 2013 to quantify current accuracy of forecasts and potential accuracy with the improvement program. These levels were used by Jenn Thacher of the University of New Mexico to design the choice set for the conjoint experiment. More detail on the design of the economic valuation approaches is provided in Chapter 4.

2.4 Survey Implementation

2.4.1 Sampling

As the survey was conducted in person, it was not possible to undertake a random sample national survey. Instead, the study selected a limited number of sites for implementation, attempting to achieve a cross-section of the population based on a range of country characteristics: urban to be compared to rural areas; southern to be compared to central and northern; and different weather and climate regimes, etc. Table 2-3 indicates the sampling plan and actual number of respondents by location. It is also indicated how the report study created subcategories relating to characteristics of each location that we believe may influence responses to survey questions.[27] Dummy variables were created for the Urban/Rural and Zone subcategories for subsequent analysis. The Coastal/Inland, Rainy/Drought, and High Flood Risk

[27] The subcategories were determine subjectively by Chisomo Chilema, the survey company point of contact, based on his experience in Mozambique.

categorizations were incomplete and have not been considered for further analysis in this report. Future work could further evaluate these categorizations and their relation to experience with hydro-met events, perceptions on vulnerability, and uses and values for hydro-met information.

Table 2-3: Sampling plan, actual respondent counts, and subcategories								
City/District	Province	Target	Actual	Urban/ Rural	Zone	Coastal/ Inland	Rainy/ Drought	High Flood Risk
Maputo	Maputo	120	141	Urban	South			
Beira	Sofala	50	47	Urban	Central			
Quelimane	Zambezia	50	51	Urban	Central			
Boane	Maputo	35	20	Rural	South		Rainy	
Nicoadala	Zambezia	35	36	Rural	Central		Rainy	
Magude	Maputo	35	38	Rural	South		Drought	
Matutuine	Maputo	35	34	Rural	South		Drought	
Chokwe	Gaza	35	35	Rural	South			High
Dondo	Sofala	35	35	Rural	Central			High
Gouvro	Inhambane	35	34	Rural	South	Coastal		
Vilanculos	Inhambane	35	35	Rural	South	Coastal		
Angoche	Nampula	35	35	Rural	North	Coastal		
Island of Moçambique	Nampula	35	35	Rural	North	Coastal		
Total		570	576					
Categorizations were provided by Chisomo Chilemba personal correspondence (October 11, 2013)								

Figure 2-2 shows the locations of respondents and the provinces of Mozambique. Some provinces were not sampled at all due to the sparse population, difficulty in getting to locations, and, at the time of implementation, potential violence and political conflicts in certain areas.[28] Future work should target some of these less accessible areas, as they are also less likely to have access to weather, water, and climate information.

[28] See http://sedac.ciesin.columbia.edu/data/set/grump-v1-population-density/maps/2?facets=region:africa for a 2000 map of population density in Mozambique.

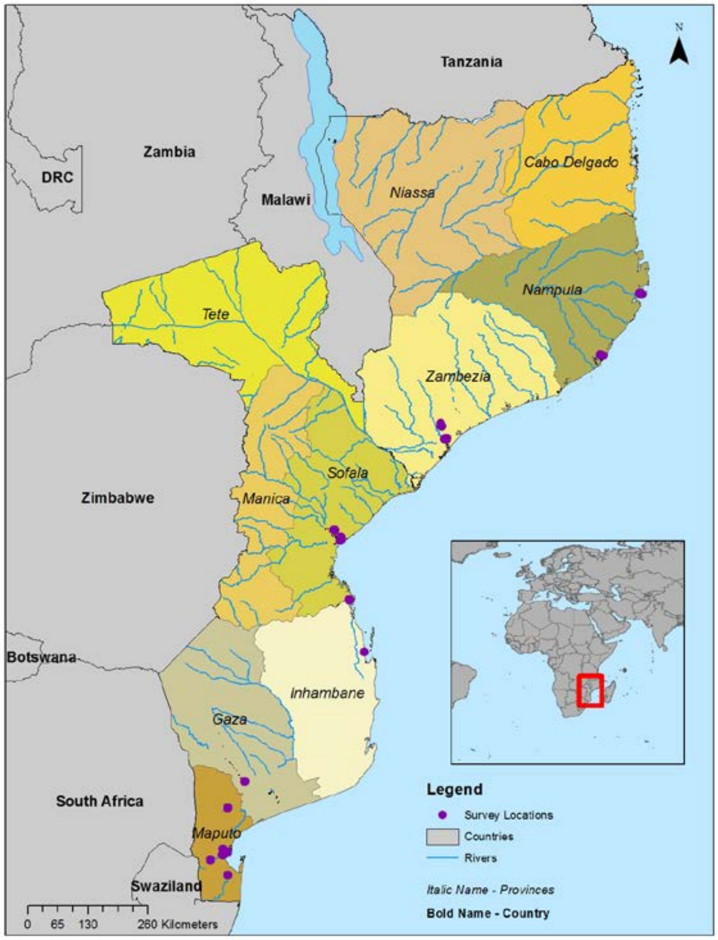

Figure 2-2. Locations of respondents in Mozambique.

Clusters of respondents are indicated by (•) dots.

2.4.2 Survey Implementation

The survey was conducted from June 11, 2013, through June 18, 2013. Data was collected either onto hard copy written survey instruments by the interviewer or using personal digital assistant (PDA) data capture. No incentive was provided to respondents. In some areas, a local public official accompanied the interviewer and assisted in translation if needed. The survey company did not record the number of contacts made in order to achieve the target sample size, so the report does not compute response rates. While the interviewers did record interview start times, they did not record completion time or time to complete. Verbal reports indicated that interviews lasted 30 minutes or more in general.

Figure 2.3: Pictures of Survey Implementation

Photos provided by Chisomo Chilemba.

2.5 Results

2.5.1 Population Socio-Demographics and Sample Comparison

As noted in Table 2-3 we had a target sample size of 570 but achieved 576 complete responses. Table 2.4 shows summary data on several socio-demographic measures and comparable information on the general population.

Table 2.4: Socio-demographics of population and survey respondents		
	Sample Respondents	National / Population
Population	Survey	Census
Total	576	24,692,144 [1]
Household Size - Mean	4.84	4.8 [2]
Gender (percent)	Survey	Census
Female	50.35%	51.10% [3]
Age (percent)	Survey	Census [4]
Median Age (years)	27	
15-24 years	39.06%	38.94%
25-54 years	60.07%	49.38%
55-64 years	0.87%	6.33%
65 years and over	0.00%	5.35%
Total	100.00%	100
Religion	Survey	Census [5]
Roman Catholic	37.30%	28.40%
Anglican	4.30%	1.30%
Islamic/Muslim	14.90%	17.90%
Zion/Zionist Christian	6.30%	15.50%
Evangelical (Sample)/Pentecostal (population)	18.60%	10.90%
No Religion	5.70%	18.70%
Other Religion	9.40%	6.70%
Unknown	2.40%	0.70%
Refused	1.00%	0.00%
Total	100%	100%
Language	Survey[6]	Census [7]
Emakhuwa	7.29%	25.30%
Portuguese (official)	55.03%	10.70%
Xichangana	13.72%	10.30%
Cisena	3.13%	7.50%
Elomwe	0.69%	7%
Echuwabo	0.00%	5.10%
Other (including other Mozambican languages)	20.14%	34.10%
Total	100%	100%

[1] Obtained March 17, 2015 from http://www.indexmundi.com/mozambique/demographics_profile.html (July 2014 est)

[2] Other survey work has indicated average and median household size as 4.8 and 5.0 respectively. http://reliefweb.int/report/mozambique/republic-mozambique-comprehensive-food-security-and-vulnerability-analysis-2010

[3] Calculated based on data obtained March 17, 2015 from http://data.un.org/CountryProfile.aspx?crName=mozambique

[4] Calculated based on data obtained March 17, 2015 from http://www.indexmundi.com/mozambique/demographics_profile.html

[5] Calculated based on data obtained March 17, 2015 from http://www.indexmundi.com/mozambique/demographics_profile.html (2007 est.)

[6] Indicates respondents' self-identified primary language

[7] Calculated based on data obtained March 17, 2015 from http://www.indexmundi.com/mozambique/demographics_profile.html (1997 Census.)

The sample has a comparable split on gender, but a somewhat younger population than the national average. Additionally, there is a reasonable diversity in stated religion and language although the report may underrepresent some language sub-populations. As primary language was self-reported to the interviewers we cannot determine comparability with official statistics on language distributions.

For several socio-demographics characteristics we did not easily find national data for comparison. For instance, the report findings show that:

- A little less than half of respondents indicated they are single (48%). 45% are married or in a marital union and the remainder (7.0%) divorced or widowed.
- The average length of residence within 50 kilometers or current location is 14.5 years (median was 13 years).
- Only 9.9% of the respondents indicated being employed full time. Another 23.8% indicated part time employment and 22.2% unemployed. 13.9% are self-employed or business owners (this is not exclusive of full or part time employed).
- A little less than 19% are students, 24.3% retired, and ½ of 1% consider themselves homemakers.

2.5.2 Data Adjustments, Codebook, and Subsamples

Prior to data analysis, all data was checked for reasonable values (e.g., nothing in the data set outside the range of offered or reasonable responses suggesting data entry errors). In the very few cases where data was found to be entered incorrectly, the original hard-copy survey instruments were referred to for clarification. As needed, several variables were also revised into measures more amenable to data analysis or replaced missing data as appropriate as described in depth in Appendix A. As also explained in Appendix A, a regression-based approach was developed to infer respondents actual income if they didn’t provide that information. Appendix C – contains the survey codebook, which shows for each question the frequency of responses, mean, median, standard deviation, number of responses, and number of missing responses.

3 GENERAL FINDINGS ON WEATHER, WATER, AND CLIMATE INFORMATION

3.1 Introduction

As discussed in Section 2.1, to better understand economic values, the analyses explored in-depth respondents sources, perceptions, uses, and preferences for weather, water, and climate information. As presented in Figure 3-1, this represents links in the value chain between the hydro-meteorological (hydro-met) process and economic values.

Figure 3-1. Weather Information Value Chain.

(Same as Figure 2-1)

Few economic studies assess the entire value chain process to ensure consistency, validity, and reliability of the value estimates with behavioral factors related to the goods and services being values. Doing so though provides critical information to the responsible agencies in understanding and improving their products and services. In the following sections of this chapter, the following aspects are covered, which can be mapped into the value chain with respect to respondents:

- Experience, concern, and awareness,
- Sources and uses,
- Importance of weather information,
- Satisfaction,
- Awareness of agencies, and
- Importance of improving information.

The report presents data on the entire sample as well as making comparisons between certain subsamples to evaluate how respondents may differ in their sources, perceptions, uses, and values for hydro-met information. Specifically, as discussed above and shown in Table 2-3, each individual was classified based on location to allow the following:

- Comparison of respondents in the north-central parts of the country to those in the south
- Comparison of respondents in urban areas to those in more rural areas.

In addition to this analysis being useful as a prelude to the economic analysis, it:

- Provides critical and useful information and guidance relevant to development and delivery of current and potentially improved products, and
- Provides baseline information to evaluate the impacts of improvements under the improvement program.

3.2 Experience, concern, and awareness

To focus respondents on the survey topic, the first question they received was, "How important are the effects of weather to you personally?" with a response scale of "Not at all important" = 1 to "Extremely important" =5.[29] Figure 3.2 shows the distribution of responses (n=576). As indicated, almost 90% of respondents feel that the effects of weather are very or extremely important to them personally. Overall the, weather is a very salient topic to respondents and likely helped maintain their engagement throughout the survey interview.

[29] At this point in the survey we had not defined or explained what we meant by "weather" so responses are likely indicative of individuals' interpretation of what weather is. In Question 5 we do indicate that "Weather includes everything from temperature, clouds, sunshine, winds, rainfall, floods, drought, lightning, humidity, waves, to climate." and thus assume individuals carry this interpretation with them on all subsequent questions unless specifically noted otherwise.

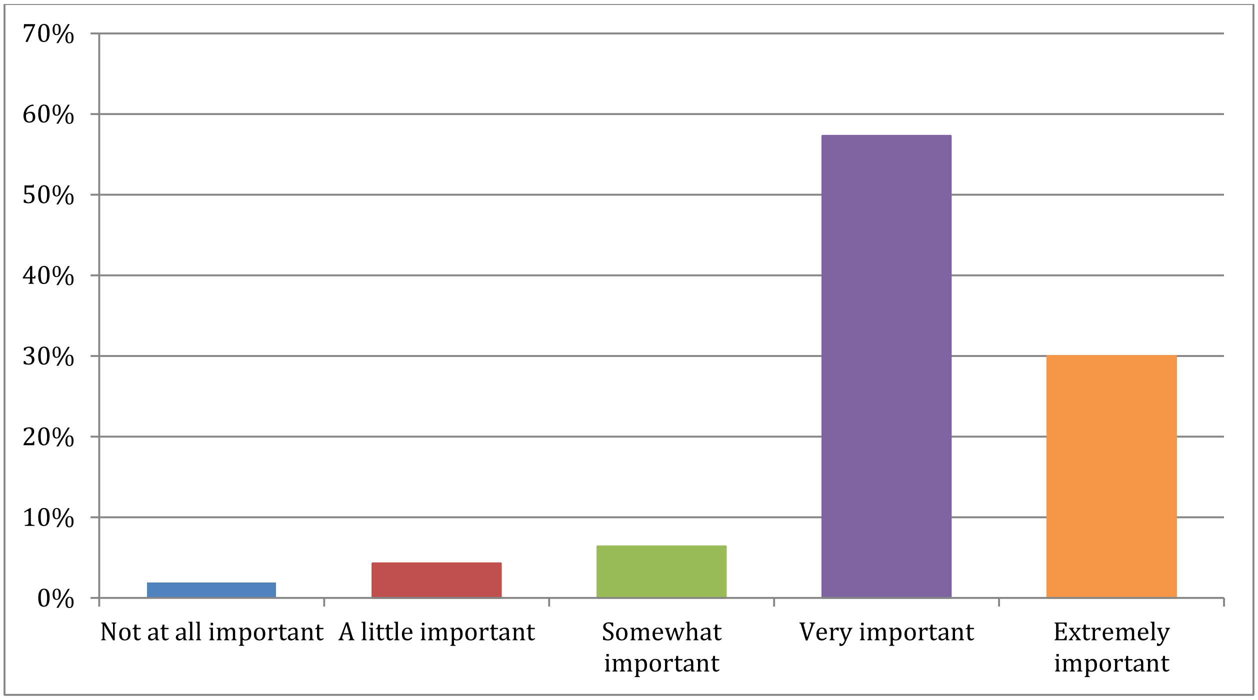

Figure 3.2: Personal Importance of weather (Q1) (n=576)[30]

3.2.1 Experience with weather impacts

We next asked about individuals' personal experiences with weather and weather impacts during the previous 10 years. While it is likely that individuals do not have perfect recall over a 10-year period, we asked about these impacts over the longer period rather than just recent impacts to get a better idea of the range of common weather impacts. Figure 3.3 shows the percent of respondents answering that the weather or a weather event affected them in one of ways listed at some point during the past 10 years.

[30] In general n=576 for all graphs unless otherwise noted or for graphs of subsamples.

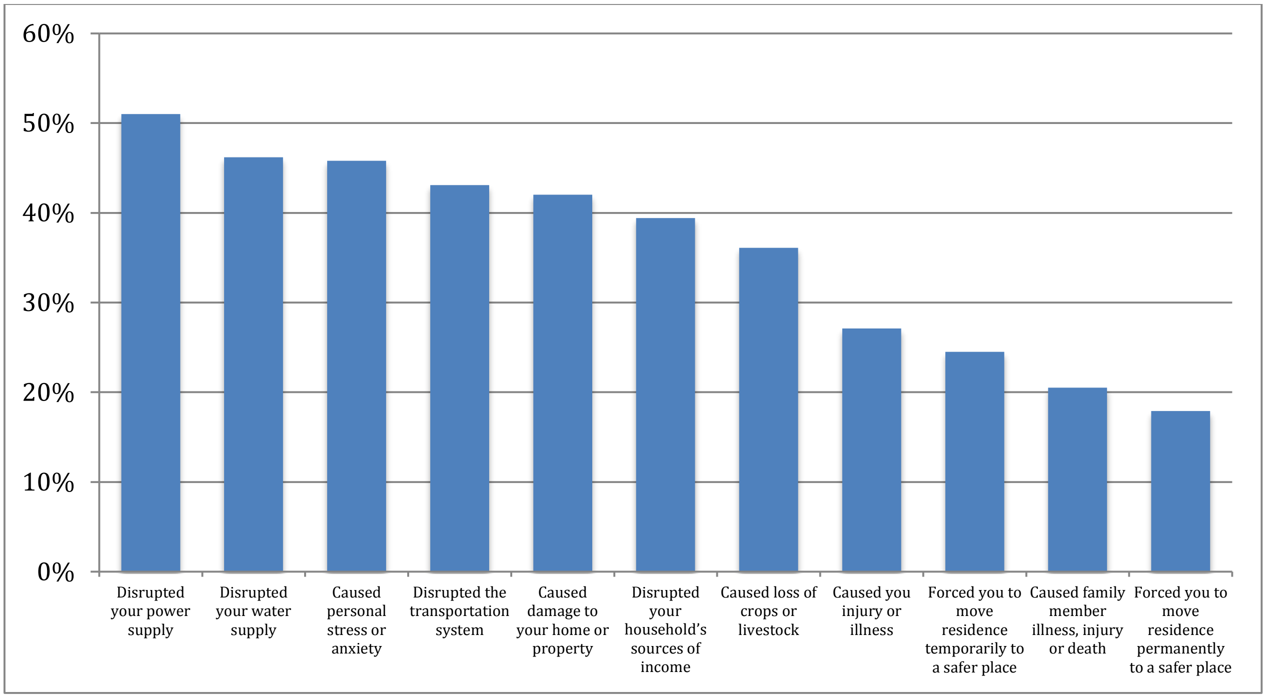

Figure 3.3: Personal Impact of Weather Events

Percent indicating "Yes" to "Thinking about the last 10 years, has the weather or a weather event affected you in the following ways?" (Q2)[31]

Across all possible impacts, less than 14% had experienced none of these impacts in the last 10 years. The most common impacts were disruption of power or water supply. Along with impacts on the transportation system, the results suggest a high level of impact on critical infrastructure due to weather in Mozambique. Economic impacts from either the loss of crops or livestock or disruption of household income had affected more than 50% of respondents, and 24% had experienced both of these economic impacts. More than 30% of the individuals indicated that the weather or weather-related events had caused injury or illness to themselves or injury, illness, or death to a family member within the last 10 years. Slightly more than one in four (26.7%) indicated that they had either temporarily or permanently moved residence to a safer location. These responses suggest a very significant personal, social, and economic level of weather impact in Mozambique.

[31] All questions, response options, and response frequencies are reported in Appendix C.

Throughout the report, urban-rural and regional (labeled zone) differences were tested for a number of variables to explore whether there are different experiences, concerns, perceptions, preferences, etc. for the different groups. This subsample analysis was undertaken to better understand the nature of experiences, perceptions, and preferences with respect to weather and weather information. These differences were also examined to support the "external validity" of survey results.[32] Developing a deeper understanding of the heterogeneity of issues, needs, and preferences should also be used to better guide current and future decisions on service provision.

The variable "Zone" [33] was used for regional differences where the sample was split into "South" and "North-Central." Kruskal-Wallis test statistics were calculated to assess differences between the subsamples.[34] As shown in Table 3.1, respondents in the North-Central parts of the country indicated a higher level of weather impact causing personal or family injury, illness, or death as well as crop and livestock losses (note that as the responses were coded "Yes" = 1, and "No" = 2, a lower average represents a larger portion of the respondents answering they had experienced the impact). Those in the South regions reported more disruptions to water, power, and transportation systems. There were not statistically significant regional differences in weather impacts causing relocation, property damage, income impacts, or personal stress and anxiety. There also wasn't a difference in a "total impacts" measured simply as the sum of the individual impacts.

[32] External validity refers to the generalizability of results beyond the specific conditions of the study. In this sense, finding that individuals concerns about non-weather risks appear to be valid and meaningful in the overall context of Mozambique lends support to the idea that survey results are representative of the general population. (With respect to external validity see for instance, Research Methods Knowledge Base. 2006).

[33] As described previously, the variable "Zone" is equal to South for anyone surveyed in the Districts of Boane, Chokwe, Gouvro, Magude, Maputo, Matutuine, and Vilanculos and is equal to North-Central for anyone surveyed in the Districts of Angoche, Beira, Dondo, Island of Mozambique, Nicoadala, and Quelimane.

34 As the response scales are discrete and generally only ordered (do not have nominal meaning), the Kruskal-Wallis test is used as a non-parametric method for test of whether the sub-samples originate from the same distribution – i.e., "are there regional differences?" A significant result (e.g., probability of the chi-squared statistic ($\chi 2$) less than 0.10) indicates that there are differences between the subsamples. It does not indicate what these differences actually are which can usually be determined by assessing the frequency distributions or median responses. See Wikipedia (2015) reference for a basic explanation of the Kruskal-Wallis test.

Table 3.1: Comparison of Weather Impacts by Zone				
Weather Impact	South (n=337) Average Impact	North-Central (n=239) Average Impact	Kruskal-Wallis Test	Pr > Chi-Square
Forced you to move residence temporarily to a safer place	1.760	1.749	0.086	0.769
Forced you to move residence permanently to a safer place	1.810	1.837	0.679	0.410
Caused you injury or illness	1.813	1.611	28.893	0.000
Caused family member illness, injury or death	1.869	1.690	27.475	0.000
Caused damage to your home or property	1.564	1.603	0.859	0.354
Disrupted your water supply	1.451	1.661	24.780	0.000
Disrupted your power supply	1.392	1.628	31.092	0.000
Disrupted the transportation system	1.475	1.703	29.636	0.000
Disrupted your household's sources of income	1.588	1.632	1.145	0.285
Caused personal stress or anxiety	1.537	1.548	0.068	0.794
Caused loss of crops or livestock	1.674	1.590	4.232	0.040
Total Weather Impacts	17.932	18.251	1.164	0.281
As the responses were coded "Yes" = 1, and "No" = 2, a lower average represents a larger portion of the respondents answering they had experienced the impact. "Total Weather Impacts" is the sum of responses to the individual impacts and ranges from 22 indicating no impacts to 11 indicating all impacts experienced.				

Table 3.2 shows a similar subsample comparison between urban and rural respondents. For every potential impact except power and transportation system disruptions, a significantly greater portion of the rural residents indicated that they had experienced the impacts.[35]

[35] We note that although we find significant differences between in urban-rural and south-north/central comparisons throughout this analysis, in general, we do not have substantive theoretical or empirical basis for determining the causes of such differences. While many we would consider obvious results and provide confirmatory validity in many cases, many results indicate that further research may be worthwhile in understanding behavior related to hydro-met events and information.

Table 3.2: Comparison of Weather Impacts by Urban-Rural				
Weather Impact	Urban (n=239)	Rural (n=337)	Kruskal-Wallis Test	Pr > Chi-Square
Forced you to move residence temporarily to a safer place	1.891	1.659	40.802	0.000
Forced you to move residence permanently to a safer place	1.925	1.748	29.752	0.000
Caused you injury or illness	1.795	1.682	8.944	0.003
Caused family member illness, injury or death	1.883	1.733	19.257	0.000
Caused damage to your home or property	1.690	1.501	20.444	0.000
Disrupted your water supply	1.586	1.504	3.714	0.054
Disrupted your power supply	1.481	1.496	0.115	0.734
Disrupted the transportation system	1.561	1.576	0.128	0.720
Disrupted your household's sources of income	1.711	1.531	18.970	0.000
Caused personal stress or anxiety	1.611	1.493	7.868	0.005
Caused loss of crops or livestock	1.749	1.561	21.413	0.000
Total Weather Impacts	18.883	17.484	30.091	0.000
As the responses were coded "Yes" = 1, and "No" = 2, a lower average represents a larger portion of the respondents answering they had experienced the impact. "Total Weather Impacts" is the sum of responses to the individual impacts and ranges from 22 indicating no impacts to 11 indicating all impacts experienced.				

Table 3.3 shows results of a factor analysis of the responses to this question to examine what impacts tended to be associated with each other.[36] Using standard criteria for factor analysis[37] resulted in three factors being retained, which are labeled (1) personal loss, (2) mortality/morbidity, and (3) infrastructure disruption, based on the items loading into each factor. The first factor related to personal losses of having to move residence, economic loss, psychological impacts, and property losses. The second factor related to injury, death, and illness. This was distinct from the personal losses identified in Factor 1. The third factor related to impacts on local infrastructure such as power, water, and transportation.

[36] Technically the analysis we are labeling as factor analysis (or exploratory factor analysis – EFA) here is generally closer to principal components analysis (PCA). The analysis processes for EFA and PCA are often very similar and the two terms are often interchanged in the literature. As we are more interested in the underlying factors influencing responses rather than treating the analysis as data reduction we retain the factor analysis terminology. See Hatcher (1994) for more on these distinctions.

[37] These criteria include retaining factors with eigenvalues of 1.0 or greater and assigning to a factor if the loading is 0.40 or greater.

Table 3.3: Factor Analysis of 10 Year Weather Impacts			
	Factor1	Factor2	Factor3
Item	Personal Loss	Mortality/ Morbidity	Infrastructure Disruption
Forced you to move residence temporarily to a safer place	0.707		
Caused loss of crops or livestock	0.662		
Caused personal stress or anxiety	0.659		
Disrupted your household's sources of income	0.646		
Forced you to move residence permanently to a safer place	0.637	0.403	
Caused damage to your home or property	0.471		
Caused family member illness, injury or death		0.827	
Caused you injury or illness		0.823	
Disrupted your power supply			0.776
Disrupted your water supply			0.725
Disrupted the transportation system			0.664
Variance Explained	2.491	1.893	1.878
Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.759. Bartlett's test is highly significant ($p < 0.05$), therefore factor analysis is appropriate for these data. These 3 factors explain 56.9% of the total variance. The determinant of the correlation matrix is 0.060 (> 0.00001), so multicollinearity is not a problem for these data.			

For each factor analysis here and as described elsewhere, factor scores were retained for potential use in subsequent analysis (e.g., regression analysis on willingness to pay for current or improved forecast information). Factor loadings less than 0.40 are not reported. As factor analysis works in part as a "data reduction" method, this allows the option to use fewer explanatory variables in such analysis as well as to try to capture the latent or underlying variables in the analysis. Factor scores are normalized (mean equal to zero and standard deviation equal to one), and thus for each respondent it provides a measure on the latent factor relative to other respondents. Table 3.4 shows summary statistics for the factor scores resulting from the factor analysis on weather impacts. Summary statistics on other factor analysis are similar in terms of mean equal to zero and standard deviation equal to one and thus are not presented.

Table 3.4: Summary Statistics on Weather Impact Factor Scores						
Variable	Mean	Std Dev	Minimum	Maximum	N	Median
Wx_Impacts_Factor_1_Scores (Personal Loss)	0.000	1.000	-2.760	1.859	576	0.186
Wx_Impacts_Factor_2_Scores (Infrastructure Disruption)	0.000	1.000	-2.863	1.525	576	0.396
Wx_Impacts_Factor_3_Scores (Mortality/ Morbidity)	0.000	1.000	-1.835	2.123	576	0.050

As a further avenue of exploration, the report presents results of testing for equality of factor scores based on zone (South versus North-Central) and urban-rural. Table 3.5 shows results of these tests (t-tests are used as the factor scores are normalized standard normal variables). [38] Several of the factor scores are significantly different between the zones and between urban-rural again indicating that respondents in these different areas perceive or experience significantly different weather impacts as elicited in the survey. For instance the mean factor score on personal loss for urban respondents ($\bar{x}$=0.33) was significantly greater (t-value = -7.18, p<0.0001) than mean factor score on personal loss for rural respondents ($\bar{x}$=-0.23).

On the other hand there was not a significant difference between mean factor score on mortality/morbidity for urban respondents ($\bar{x}$=-0.05) was significantly greater (t-value = 1.02 p=0.31) than mean factor score on personal loss for rural respondents ($\bar{x}$=0.04). These factor scores thus continue to capture the heterogeneity in the underlying data as shown in Table 3.1 and Table 3.2. The use of these factor scores in subsequent analysis will continue to capture individual as well as geographic heterogeneity.

Table 3.5: T-Tests Equality of Factor Scores by Zone and Urban-Rural

	Zone South (n=337) North-Central (n=239)			Urban-Rural Urban (n=239) Rural (n=337)		
Variable	DF	t Value	Pr > |t|	DF	t Value	Pr > |t|
Wx_Impacts_Factor_1_Scores (Personal Loss)	539.77	0.04	0.9647	569.24	-7.18	<.0001
Wx_Impacts_Factor_2_Scores (Infrastructure Disruption)	445.78	-4.97	<.0001	563.75	-4.00	<.0001
Wx_Impacts_Factor_3_Scores (Mortality/ Morbidity)	532.71	7.01	<.0001	523.13	1.02	0.3089
DF = degrees of freedom.						

[38] We use the Satterthwaite approximation for the variances of the subsamples, which results in non-integer degrees of freedom. “The Satterthwaite approximation of the standard errors differs from the Pooled method in that it does not assume that the variances of the two samples are equal. This means that if the variances are equal, the Satterthwaite approximation should give us exactly the same answer as the Pooled method.” (See reference: University of Nevada, Reno. No date.)

Separate factor analysis of the rural and urban subsamples yielded similar results; except for the rural subsample, the "move residence" items loaded onto a separate fourth factor. Looking specifically at responses to these two impacts, the report finds that the rural respondents reported a significantly greater rate of having had to relocate either temporarily or permanently in response to severe weather at some point in the last ten years. As shown in Table 3.6, 34% of rural residents had moved temporarily and 25% permanently (note that these are not necessarily exclusive responses so the percentages cannot be added together). This is significantly more than the 11% temporary and 8% permanent relocations reported by urban respondents.

Table 3.6: Percent of rural-urban respondents indicating relocation in last 10 years in response to severe weather

Item	Rural % Yes	Urban % Yes	Kruskal-Wallis Test	Pr > Chi-Square
Moved Temporarily	34.3 (n=335)	10.9 (n=239)	40.80	<.0001
Moved Permanently	25.3 (n=336)	7.6 (n=238)	29.75	<.0001

3.2.2 Concern with future weather events

Next, participants were asked how concerned they are about the probability of eleven potential weather events occurring during the next 10 years (Figure 3.4). Flooding engenders the greatest concern with the group with 1.7% of respondents indicating no concern about flooding and more than 86% indicating that they are very or extremely concerned about flooding in the next 10 years. Respondents were least concerned overall about typhoons even though more than 45% still indicated they are very or extremely concerned about typhoons.[39]

[39] We used the term typhoons in the survey. The term tropical cyclone ("ciclone tropical" in Portuguese) appears to be more common in Mozambique and thus the difference in terminology may have affected responses. To maintain consistency with the way the question was asked in the survey we use the term "typhoon" in reporting results.

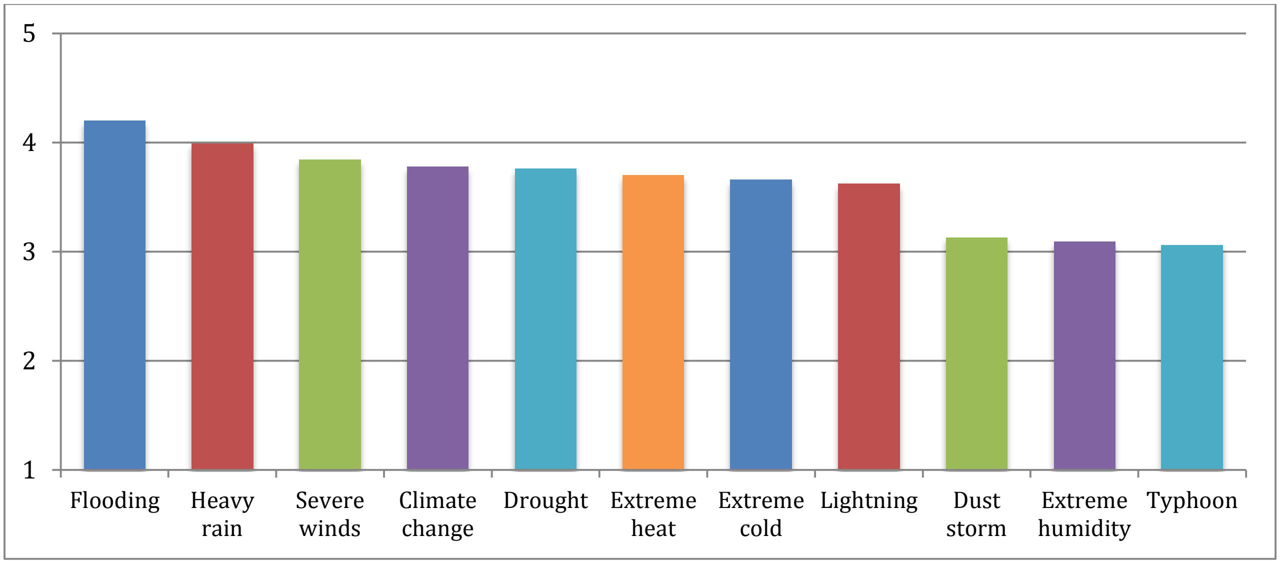

Figure 3.4: Concern about potential weather events – Mean response (Q3)

(Not at all concerned = 1; Extremely concerned= 5)

Table 3.7 shows a test for urban-rural differences in concern for future weather events. Urban residents indicated a higher level of concern for flooding, heavy rain, extreme heat, extreme cold, and lightning. Conversely, rural residents indicated a higher level of concern for severe winds. There was no significant difference in concern levels for climate change, drought, dust storms, extreme humidity, or typhoons. These results are somewhat counter to the report's *a priori* expectations that rural residents in general would be more vulnerable to weather impacts and thus more concerned.

Table 3.7: Comparison of urban-rural concern about future weather impacts

Variable	All (n=576)	Rural (n=337)	Urban (n=239)	Kruskal-Wallis Test	Pr > Chi-Square
Flooding	4.20	4.09	**4.35**	12.21	0.001
Heavy rain	3.99	3.90	**4.13**	6.85	0.009
Severe winds	3.84	**3.89**	3.76	3.91	0.048
Climate change	3.78	3.71	3.87	1.91	0.167
Drought	3.76	3.76	3.75	0.35	0.553
Extreme heat	3.70	3.53	**3.93**	17.28	<.0001
Extreme cold	3.66	3.50	**3.89**	14.94	0.000
Lightning	3.62	3.56	**3.72**	2.82	0.093
Dust storm	3.13	3.07	3.21	1.97	0.161
Extreme humidity	3.09	3.07	3.11	0.15	0.700
Typhoon	3.06	3.06	3.05	0.06	0.810

Table 3.8 shows a test for zonal differences with concern for future weather events. Southern residents indicated a higher level of concern for extreme heat, extreme cold, lightning, dust storm, extreme humidity, and typhoons. Conversely, North-Central residents indicated a higher level of concern for heavy rains and drought. While still rated as of considerable concern, there was no significant zonal difference in concern levels for flooding, severe winds, or climate change, which suggests these are broad concerns across all of Mozambique.

Table 3.8: Comparison of zones concern about future weather impacts

Variable	All (n=576)	South (n=337)	North-Central (n=239)	Kruskal-Wallis Test	Pr > Chi-Square
Flooding	4.20	4.15	4.27	2.30	0.13
Heavy rain	3.99	3.91	4.11	7.20	0.01
Severe winds	3.84	3.81	3.88	0.69	0.41
Climate change	3.78	3.79	3.76	0.09	0.77
Drought	3.76	3.68	3.87	5.06	0.02
Extreme heat	3.70	3.78	3.58	6.31	0.01
Extreme cold	3.66	3.74	3.55	2.99	0.08
Lightning	3.62	3.90	3.23	40.07	0.00
Dust storm	3.13	3.39	2.76	40.25	0.00
Extreme humidity	3.09	3.22	2.90	12.04	0.00
Typhoon	3.06	3.46	2.49	76.63	0.00

Table 3.9 shows results of a factor analysis of the responses to a question about concern for potential weather, water, and climate impacts and if these tended to be associated with each other. Using standard criteria for factor analysis resulted in two factors being retained that are labeled (1) Lower Concern, and (2) Higher Concern, as they appeared to group based on their mean response as shown in the column labeled "mean response."

Table 3.9: Factor Analysis of Concern About Potential Weather Events			
		Factor1	Factor2
Item	Mean Response	Lower Concern	Higher Concern
Dust storm	3.13	0.772	
Extreme humidity	3.09	0.738	
Typhoon	3.06	0.730	
Lightning	3.62	0.682	
Extreme cold	3.66	0.632	
Extreme heat	3.70	0.624	0.431
Flooding	4.20		0.771
Drought	3.76		0.703
Heavy rain	3.99		0.687
Climate change	3.78		0.549
Severe wind	3.84		0.502
Variance Explained		3.139	2.484

N=576. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.822. Bartlett's test is highly significant ($p < 0.05$), therefore factor analysis is appropriate for these data. These two factors explain 51.1% of the total variance.
The determinant of the correlation matrix is 0.035 (> 0.00001), so multicollinearity is not a problem for these data.

3.2.3 Relative Importance of Hydro-meteorological Risks

In reference to respondents' level of concern with the weather, the survey asked them to indicate the importance of the weather risks relative to the importance of other potential risks that they face. This helps put weather, water, and climate risks in context and in general may help to reduce respondents overstating concern with respect to the specific survey topic. Figure 3.5 shows that, for the most part, individuals considered most of these other risks as "a little" or "much more important" than weather risks. Only for "Political Instability" was the median response of "about the same level of importance." It is worth noting that the survey was implemented during a period of some political instability in June 2013.[40]

[40] "About a dozen soldiers and police and three civilians have been killed in armed attacks since April in central Mozambique following threats from Renamo leader Afonso Dhlakama to initiate a campaign of violence unless the party's demands on electoral reform were met." (CNN. 2013)

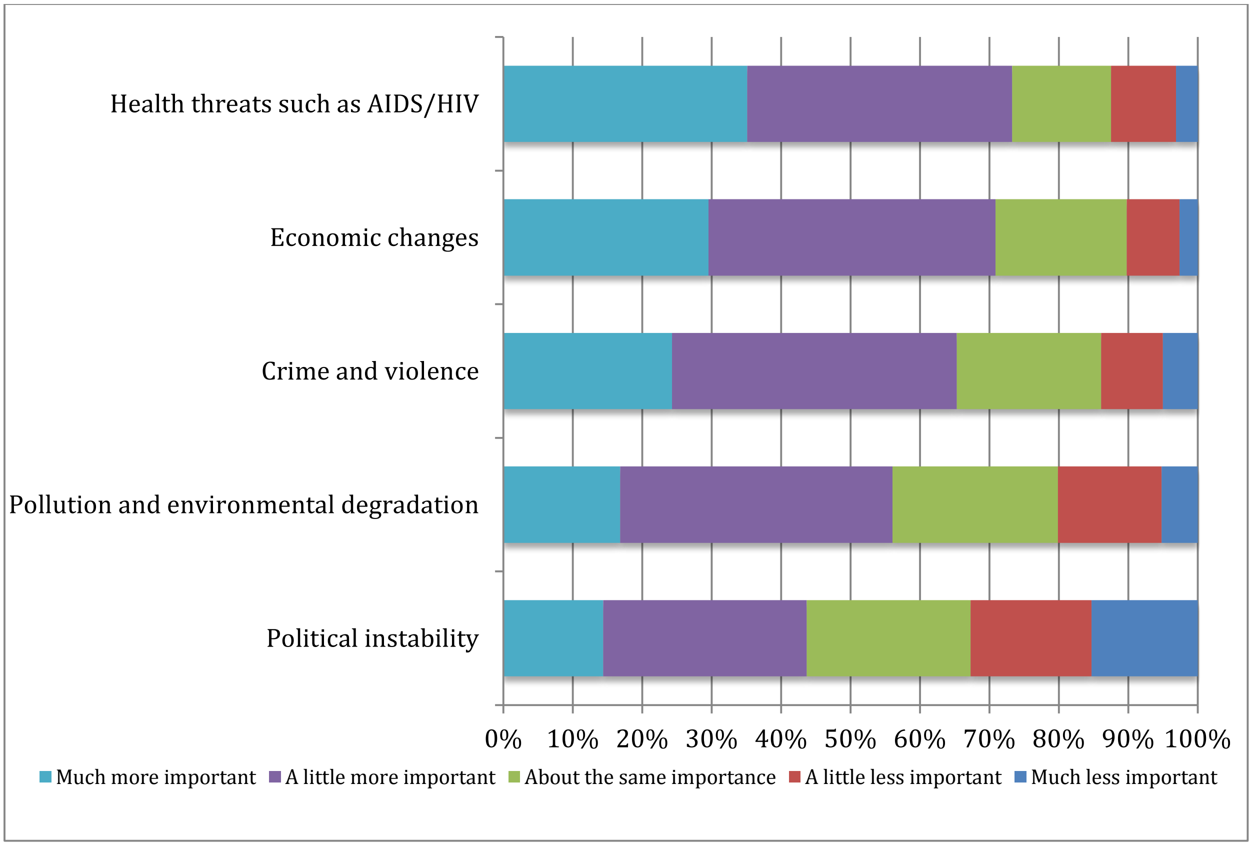

Figure 3.5: Concern about potential weather events relative to other risks

Compared to weather risks, urban residents rated violence relatively more important than rural respondents (χ^2=3.20, df=1, Pr<0.074). As urban residents also tended to indicate a higher level of concern for weather risks than did rural residents (Table 3.7), this suggests that urban residents feel violence is significantly more important than did the rural respondents. Compared to the weather risks that they rated, individuals in the south rated violence, pollution, and health threats significantly more important risks than did respondents in the central and northern areas of Mozambique.[41] And while respondents in the central-north areas rated political instability a greater threat compared to weather than did southern respondents, the difference was not statistically significant. While these other risks were not the primary focus of the survey, it is worth keeping these in mind relative to weather risks and related weather information.

[41] Kruskal-Wallis statistics for violence, pollution, and health respectively: χ^2=20.10, df=1, Pr<0.0001; χ^2=33.14, df=1, Pr<0.0001; χ^2=13.24, df=1, Pr<0.0001.

Considering respondents' perspective on these other risks also allows some degree assessing external validity.

3.3 Sources and Uses

3.3.1 Sources of hydro-meteorological information

Several questions then elicited information on respondents' sources and uses of weather information; it started by simply asking if they had access to weather information. The interviewers provided respondents a definition of the type of information included in weather forecasts such as water and climate conditions in order to clarify use of the terminology throughout the remainder of the survey. Specifically, the interviewers indicated that "Weather forecasts are predictions about future weather, water, or climate conditions." Only 81 respondents (14.1%) overall indicated that they did not have access to weather forecasts through any means (such as television, radio, newspapers, or friends). As may be expected, a statistically significantly higher portion did not have access in rural areas (20.5% in rural areas and 5.0% in urban areas[42]).

As shown in Figure 3.6, over 86% of respondents indicated that they do read, hear, or use weather forecasts at some point in time.

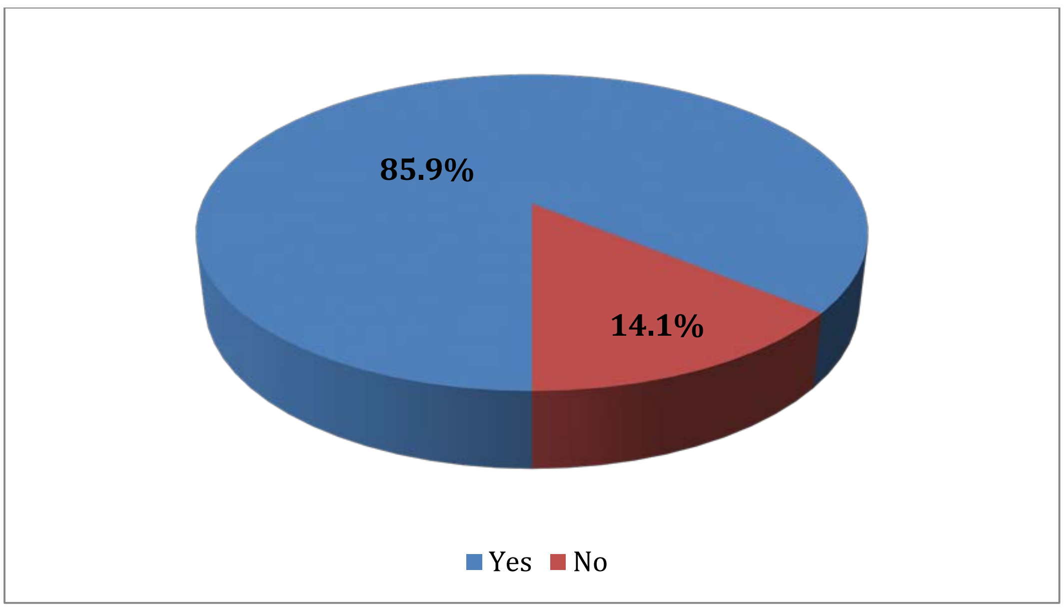

Figure 3.6: Percent of respondent who read, hear, or use weather forecasts (n=576)

[42] Urban-Rural Comparison - Kruskal-Wallis $\chi 2$ 27.59, DF=1, Pr > Chi-Square<.0001.

Table 3.10 shows a cross-tabulation of the "access" and "use" questions. The findings show that as expected most individuals who indicated having no access (i.e., answered "no" to Q7) do not indicate using forecasts. However, it was found that a portion of the 72 respondents who indicated no access in fact do also indicate that at some point they do read, hear, or use weather forecasts. While this does not necessarily indicate incorrect responses on the part of participants, it does remind us that questions can be misinterpreted or incorrectly responded to and thus any policy decision-critical results are best validated with appropriate methods. The report also notes that of the 504 individuals who do have access to forecasts, 36 (7.1%) indicated that they don't actually use them.

Table 3.10: Cross-tabulation of access and use (Q7 and Q8)

		Q8: Do you personally ever read, hear, or use weather forecasts		
		Yes	No	Row Total
Q7: Do you have access to weather forecasts through any means	Yes	468	36	504
	No	27	45	72
	Column Total	495	81	576

Based on initial survey design, individuals indicating that they didn't access or use forecasts were intended to skip the following questions regarding their access and use of weather information. Instead, all individuals were asked these questions. As suggested by the cross-tabulation shown in Table 3.10, it is possible that individuals misinterpreted those screening questions and thus we treat all responses as useful and include that data.

The interviewers next asked (Q9) what a respondent's sources were for weather information and the frequency with which they used a number of potential communication channels[43] (see Lazo et al. 2009, for results from a similar question asked in the United States). The question is phrased ("How often do you get, see, or use weather forecasts from the sources listed below?") to determine all exposure to forecasts and not just how often they actively seek information. Response options ranged from "Never/Rarely" to "Two or more times a day" for each of eight possible information channels. The responses were recoded into "times per year" using lower

[43] "Channels" in communication terminology refers to all information pathways and not just "television channels." Thus a friend or family member can be an information channel just as the internet, public weather services, or television can be channels.

bound values so as to not overstate frequencies. For instance, “Two or more times a day” was recoded to 730 times per year.

Figure 3.7 shows the average annual frequency by source (as recoded from verbal items indicating frequency). The average total frequency across all sources was slightly over 600 per year with a median of 365 (or once a day). This strongly suggests that weather information does play a role in day-to-day decision-making for average Mozambicans.

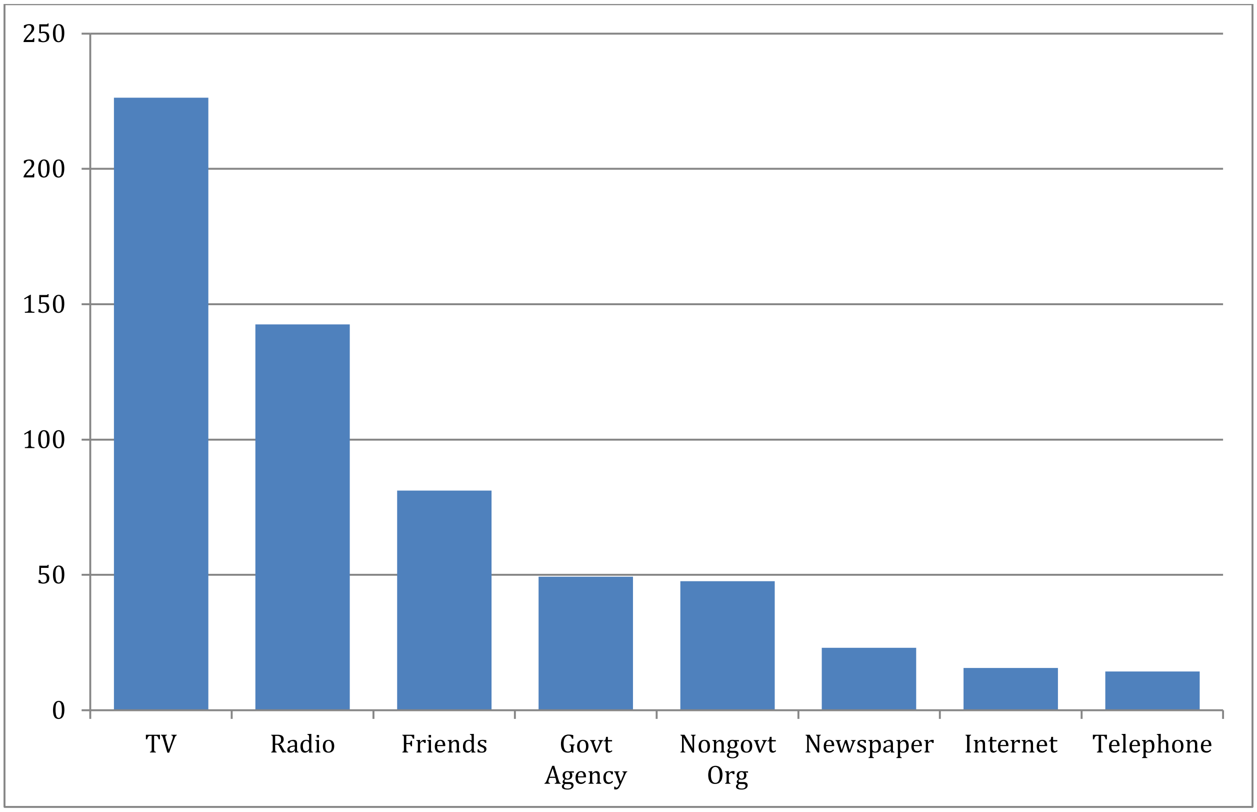

Figure 3.7: Annual frequency of exposure to weather information sources (n=576)

Figure 3.8 repeats the frequency information shown in Figure 3.7, but now compares this to results from an earlier study conducted in the United States using a very similar question (Lazo et al. 2009). The U.S. data has been aggregated in some categories to be comparable to the response categories offered in the Mozambique survey. In addition, the category “Nongovernmental Agencies” was not offered in the U.S. study. As can be seen in the frequency of information access/use, the U.S. is considerably greater than in Mozambique across all sources except telephone. The average total annual use in the U.S. study was 1,384 times a year compared to a little over 600 times a year in Mozambique. This comparison is provided primarily to suggest the potential for increased access and use of weather information by Mozambicans as the overall weather information system improves and develops.

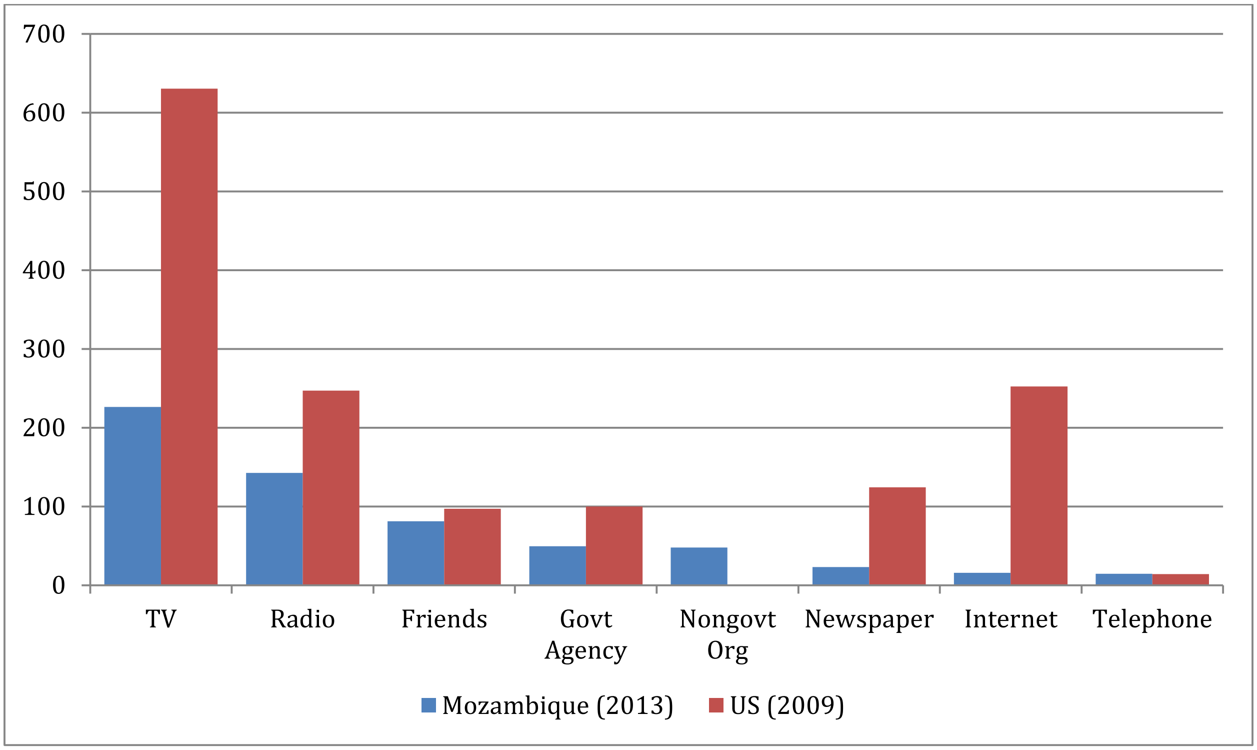

Figure 3.8: Comparison of source frequency between Mozambique and the United States

(US – Source: Lazo et al. 2009 – converted from monthly to annual frequencies)

The survey also examined the frequency of sources by Zone (South versus North-Central as identified in Table 2-3). Table 3.11 shows the average annual access frequency for the different sources and the Kruskal-Wallis test for significant differences between the different geographic areas. In general, respondents in the South accessed weather information about 50% more often than those in the upper areas in Mozambique (almost 700 times per year in the South versus 463 in the rest of Mozambique). Those in the South were significantly more likely to access weather information by television, government agencies and non-government organizations as information sources whereas those in the South were significantly less likely to access weather information by newspaper. There was no geographic difference for telephone, radio, or internet access. One interesting finding includes that those in the South indicate a significantly higher level of access from friends than those in the North and Central areas of the country. There were no *a priori* expectations or explanations for this perhaps cultural or social difference.

Given that weather information in newspapers is likely "older" than electronic communication and the significant differences in use of government and non-government sources, it appears that those in the southern part of the country have better and more access to weather information.

Table 3.11: Comparison of Source Frequency by Zone				
Source	North-Central (n=239) Average Annual Frequency	South (n=337) Average Annual Frequency	Kruskal-Wallis Test	Pr > Chi-Square
TV	177.167	261.231	23.444	0.000
Newspaper	25.485	21.472	5.575	0.018
Telephone	15.854	13.288	0.072	0.788
Radio	142.494	142.522	0.018	0.894
Internet	14.946	16.071	0.309	0.579
Friends	49.682	103.448	13.088	0.000
Govt Agency	18.887	70.920	5.579	0.018
Nongovt Org	18.787	68.196	5.538	0.019
Total	463.301	697.148	23.444	<.0001

The interviewers also examined the frequency of sources by rural versus urban (as identified in Table A.). Table 3.12 shows the average annual access frequency for the different sources and the Kruskal-Wallis test for significant differences between the rural and urban areas. In general, respondents in the rural areas accessed weather information about 60% more often than those in the urban areas in Mozambique (almost 770 times a year in the rural Mozambique versus 480 in urban areas). Those in the rural areas were significantly more likely to access weather information by television, newspaper, telephone, and internet. There was no statistically significant urban-rural difference for radio, government or non-government agencies access. It is also interesting that there was not a significantly different level of access from Friends for the rural-urban analysis compared to the difference found for the difference in North and Central areas of the country discussed above.

Table 3.12: Comparison of Urban-Rural Source Frequency				
Source	Urban (n=239)	Rural (n=337)	Kruskal-Wallis Test	Pr > Chi-Square
Television	165.632	311.967	65.449	0.000
Newspaper	13.228	37.109	16.386	0.000
Telephone	13.003	16.255	3.036	0.081
Radio	133.549	155.146	0.391	0.532
Internet	5.279	30.163	12.721	0.000
Friends	68.567	98.866	1.059	0.304
Government Agency	42.763	58.590	1.088	0.297
Nongovernment Org.	38.062	61.276	0.754	0.385
Total	480.083	769.372	26.772	0.000

Table 3.13 shows results of a factor analysis on source frequency. Based on the criteria of eigenvalues greater than one, three factors were retained as shown. The resulting factors also lined up closely with the average frequency of use as shown in Figure 3.7 with radio and television being the most frequent sources as well as loading together – thus named "Frequent Sources." Non-government organizations and government agencies loaded together and as shown in Figure 3.7 incurred medium levels of access. Finally, as shown in Figure 3.7, internet, newspaper, and telephone were the least used sources and loaded together in Factor 2 – thus named "Infrequent Sources." Friends loaded on two factors but more heavily on the third factor "Frequent Sources."

Table 3.13: Factor Analysis of Source Frequency			
	Factor1	**Factor2**	**Factor3**
Item	**Agencies**	**Infrequent Sources**	**Frequent Sources**
National or local government agency	0.945		
Non-government organization	0.941		
Internet		0.839	
Newspaper		0.720	
Telephone		0.672	
Radio			0.856
TV			0.680
Friends, family, co-workers, etc.	0.445		0.617
Variance Explained	2.135	1.717	1.656
N=576. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.652. Bartlett's test is highly significant ($p < 0.05$), therefore factor analysis is appropriate for these data. These three factors explain 68.9% of the total variance. The determinant of the correlation matrix is 0.032 (> 0.00001), so multicollinearity is not a problem for these data.			

3.3.2 Uses of hydro-meteorological information

Question 10 asked "When you get weather forecasts, how often do you get them for the following areas?" and then five areas were listed ranging from the respondents' immediate area to international uses. The five-item response scale was from "Never"=1 to "Always"=5. As this was asked as for "when you get forecasts" it is relative to the frequency of actually getting forecasts previously examined. Overall "other places in your province" rated higher than very local or district levels (2.64 versus 2.41 and 2.22 respectively) probably reflecting that the current geographic specificity of forecasts is province level.

Table 3.14 shows the overall responses as well as the Kruskal-Wallis test for urban-rural differences. For each of the areas individuals indicated getting forecasts between "less than half the time" and "half the time." Individuals in urban areas obtained forecasts significantly more often for areas outside their district (their province, country, and internationally) than did those in rural areas. This may reflect a generally broader area of decision-making relevant to urban residents than rural residents.

Table 3.14: Area for Which Individuals Obtain Forecasts – Overall and by Urban-Rural

Location for forecast	Overall Mean	Urban (n=239) Average Annual Frequency	Rural (n=337) Average Annual Frequency	Kruskal -Wallis Test	Pr > Chi-Square
The area immediately around where you live or work	2.411	2.498	2.350	0.485	0.486
Other areas in the district where you live or work	2.220	2.218	2.223	0.101	0.751
Other areas in your province	2.644	2.828	2.513	8.228	0.004
Other areas outside your province around Mozambique	2.540	2.854	2.318	23.137	0.000
Areas in other countries around Africa or elsewhere around the world	2.181	2.435	2.000	13.677	0.000

Table 3.15 shows the Kruskal-Wallis test for zonal differences in areas for which respondents indicated getting forecasts. Those in the south indicated significantly greater relative access for areas above and beyond the immediate area where they live and work compared with those in the north and central parts of Mozambique. This may reflect the greater overall level of access to weather information sources (Table 3.11).

Table 3.15: Comparison of Average Annual Area of Use by Zone				
Location for forecast	South (n=337) Average Annual Frequency	North-Central (n=239) Average Annual Frequency	Kruskal -Wallis Test	Pr > Chi-Square
The area immediately around where you live or work	2.493	2.297	1.120	0.290
Other areas in the district where you live or work	2.309	2.096	3.337	0.068
Other areas in your province	2.866	2.331	23.186	0.000
Other areas outside your province around Mozambique	2.780	2.201	24.703	0.000
Areas in other countries around Africa or elsewhere around the world	2.303	2.008	6.938	0.008

Table 3.16 shows results of a factor analysis on frequency that covers the area where individuals obtain forecasts. Two factors were retained as shown. The three response items that are measured at the province level or broader loaded on Factor 1 and are thus named "Obtain for Broader Area". The respondents' immediate area and other areas in their district loaded on the second factor and are labeled "Obtain for Local Area."

Table 3.16: Factor Analysis of Area for Which Individuals Obtain Forecasts		
	Factor1	**Factor2**
Item	**Obtain for Broader Area**	**Obtain for Local Area**
Other areas outside your province around Mozambique	0.896	0.016
Areas in other countries around Africa or elsewhere around the world	0.812	0.084
Other areas in your province	0.795	0.209
The area immediately around where you live or work	0.059	0.933
Other areas in the district where you live or work	0.160	0.919
Variance Explained	2.123	1.766
N=576. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.631. Bartlett's test is highly significant ($p < 0.05$), therefore factor analysis is appropriate for these data. These two factors explain 64.8% of the total variance.		

We asked respondents "On average, year round, how often do you use weather forecasts for the activities listed below?" (Q12) and with response options again ranging from "Never/Rarely" to "Two or more times a day" for each of the 12 activities listed (see Lazo et al. 2009 for results from a similar question asked in the United States). As with the question about information sources described above, the responses were recoded into "times per year" using lower bound values so as to not overstate frequencies. For instance, "Two or more times a day" was recoded to 730 times per year.

Figure 3.9 shows the average annual frequency of use for the different activities (as recoded from verbal items indicating frequency). The average of total uses across all activities was slightly less than 780 times per year with a median of 365 (or once a day). Again, this strongly suggests that weather information does play a role in day-to-day decision-making for average Mozambicans.

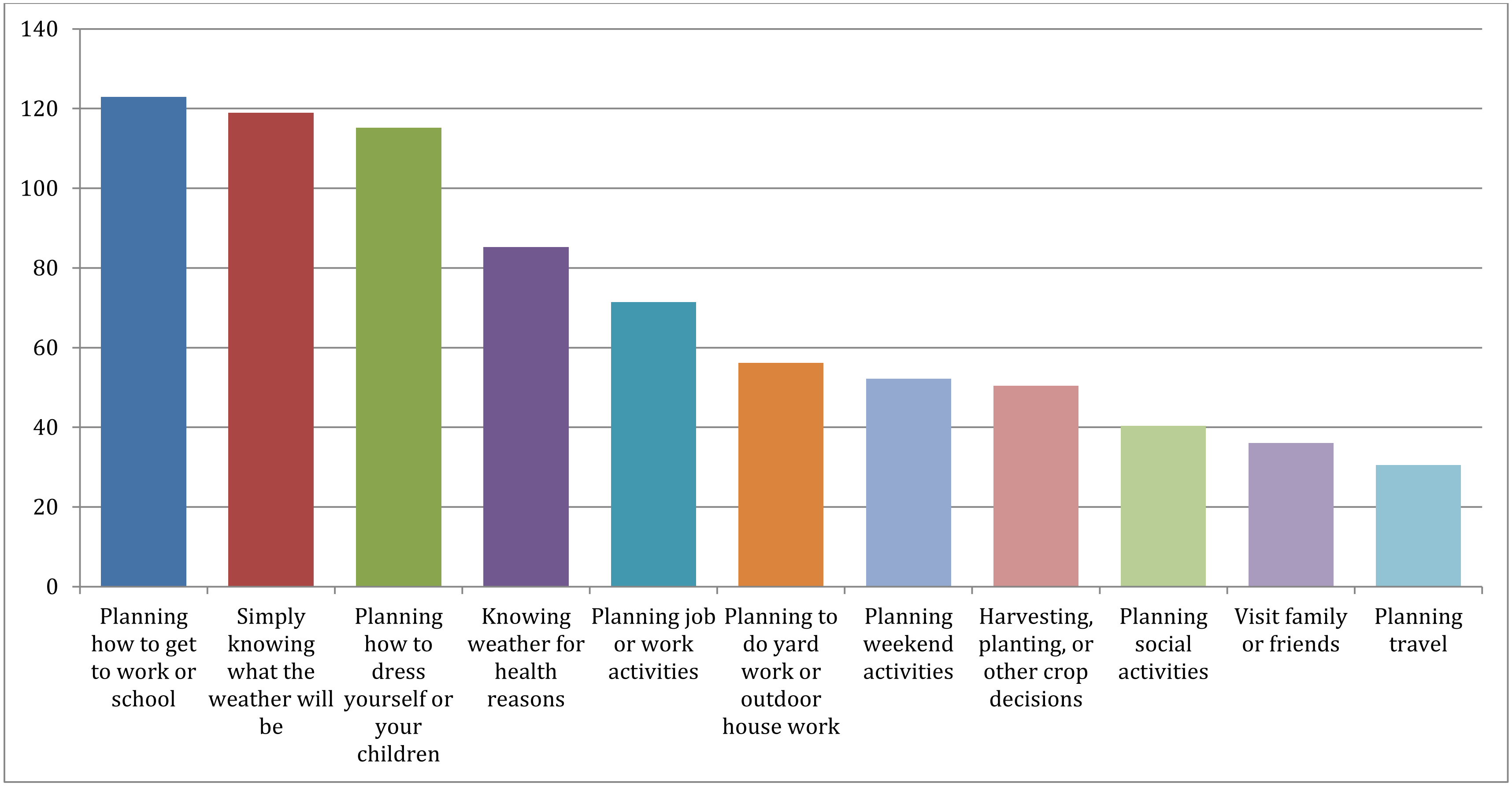

Figure 3.9: Average annual frequency of use for different activities (n=576)

Table 3.17 shows the average annual use frequency for the different activities by zone and the Kruskal-Wallis test for significant differences. In general, respondents in the South used weather information about 17% more often than those in the upper areas in Mozambique (830 times a year in the South versus 708 in the rest of Mozambique). Those in the South were significantly more likely to use weather information for planning how to dress, how to get to work or school, to do yard work or outdoor house work, for job or work activities, weekend activities, as well as simply knowing what the weather would be. There was no statistically significant difference in frequency of the use of forecasts for planning social activities, travel, health reasons, or cropping decisions between the South and the rest of Mozambique.[44]

Table 3.17: Comparison of Average Annual Uses by Zone

Variable	**North-Central (n=239) Average Annual Frequency**	**South (n=337) Average Annual Frequency**	Kruskal-Wallis Test	Pr > Chi-Square
Planning how to dress yourself or your children	83.891	137.261	19.393	0.000
Planning how to get to work or school	91.234	145.362	19.433	0.000
Planning to do yard work or outdoor house work	48.004	61.944	12.333	0.000
Planning job or work activities	64.661	76.240	2.873	0.090
Planning social activities	39.854	40.780	0.183	0.668
Planning travel	38.201	25.142	0.004	0.951
Planning weekend activities	41.418	59.774	16.230	0.000
Simply knowing what the weather will be	91.096	138.742	30.840	0.000
Visit family or friends	40.490	32.923	1.499	0.221
Knowing weather for health reasons	108.084	69.018	0.013	0.910
Harvesting, planting, or other crop decisions	61.326	42.730	1.108	0.292
Total	708.259	829.917	13.874	0.000

Table 3.18 shows the average annual use frequency for the different activities and the Kruskal-Wallis test for significant differences between the rural and urban areas. In general, respondents in the urban and rural areas use weather information for pretty much the same activities with the

[44] We also note that even where the average annual frequency appears to be quite different for the different zones (for instance with respect to using weather information for health reasons the North-Central average is 108 times a year versus 69 in the South) they may not be statistically significantly different because of the non-parametric nature of the responses (that is they are not normally distributed and thus the "average" isn't necessarily the best measure of central tendency.

same frequency. As may be expected though, those in the rural areas were significantly more likely to use weather for "yardwork" and "crops."

Table 3.18: Comparison of Average Annual Uses by Rural-Urban

Variable	Rural (n=337) Average Annual Frequency	Urban (n=239) Average Annual Frequency	Kruskal-Wallis Test	Pr > Chi-Square
Planning how to dress yourself or your children	115.703	114.289	0.162	0.687
Planning how to get to work or school	119.300	127.983	0.129	0.720
Planning to do yard work or outdoor house work	61.196	49.059	6.797	0.009
Planning job or work activities	72.220	70.331	0.437	0.509
Planning social activities	50.599	26.008	1.427	0.232
Planning travel	30.519	30.619	1.954	0.162
Planning weekend activities	51.009	53.778	0.233	0.630
Simply knowing what the weather will be	113.543	126.628	1.278	0.258
Visit family or friends	35.982	36.176	0.216	0.642
Knowing weather for health reasons	85.718	84.536	0.397	0.529
Harvesting, planting, or other crop decisions	63.246	32.397	11.533	0.001
Total	799.036	751.803	0.873	0.350

Table 3.19 shows results of a factor analysis on use of forecasts. Two factors were retained as shown. The first factor seemed to be comprised primarily of uses related to short-term decisions such as daily planning for work, travel, and school. The second factor was comprised of longer-term uses such as visiting friend and family and planting and harvesting decisions. "Planning travel" loaded onto both factors perhaps reflecting travel planning both in the shorter- and longer-term.

Table 3.19: Factor Analysis of Use Weather Forecasts		
	Factor1	Factor2
Item	Short Term Decisions	Longer Term Decisions
Planning how to get to work or school	0.796	
Planning how to dress yourself or your children	0.796	
Simply knowing what the weather will be	0.646	
Planning job or work activities	0.615	
Knowing weather for health reasons	0.553	
Planning weekend activities	0.446	
Visit family or friends		0.748
Planning social activities		0.657
Planning to do yard work or outdoor house work		0.563
Planning travel	0.432	0.534
Harvesting, planting, or other crop decisions		0.471
Variance Explained	2.908	2.172
N=576. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.844. Bartlett's test is highly significant ($p < 0.05$), therefore factor analysis is appropriate for these data. These two factors explain 46.2% of the total variance. The determinant of the correlation matrix is 0.012 (> 0.00001), so multicollinearity is not a problem for these data.		

3.4 Importance of weather information

3.4.1 General importance of information

After defining weather as "…everything from temperature, clouds, sunshine, winds, rainfall, floods, drought, lightning, humidity, waves, to climate," we continued exploring respondents' perceptions and uses of weather information by simply asking, "How important is it to you to have information about the weather?" We purposively provided the definition of weather to include water and climate to simplify language throughout the remainder of the survey as well as to continue assessing issues across all hydro-met conditions. As indicated in Figure 3.10, only half of 1% of respondents felt that weather information was not at all important. Consistent with earlier findings (see Figure 3.2), more than 80% of respondents rated information about weather as very or extremely important.

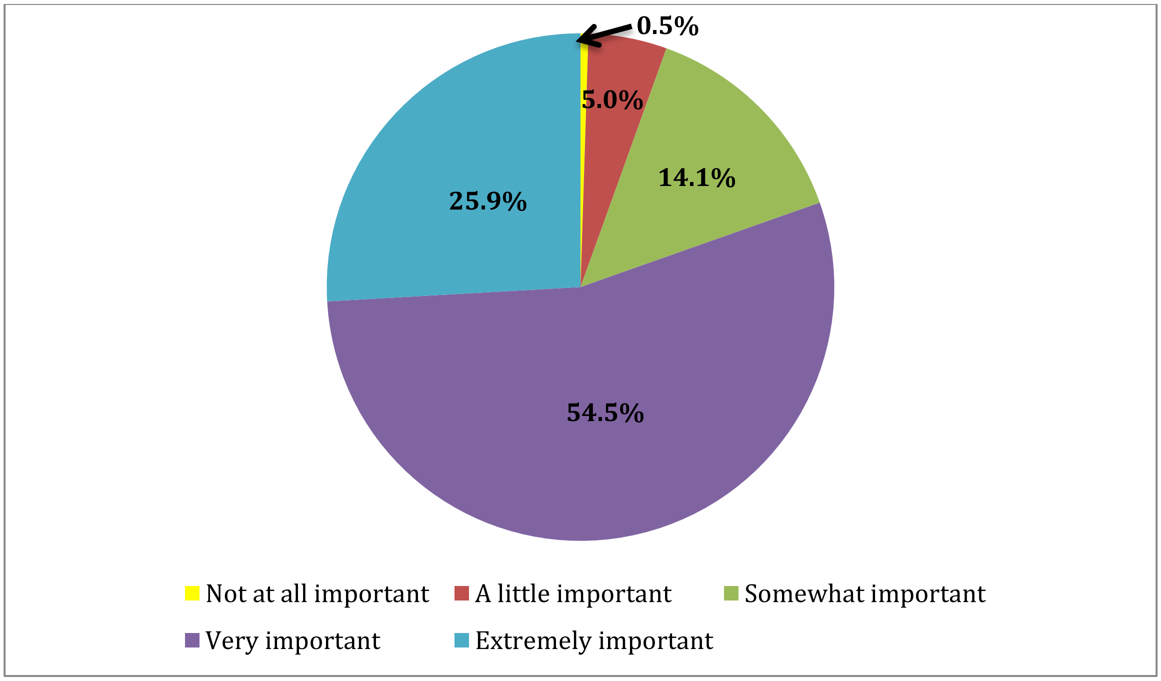

Figure 3.10 Importance of Weather Information

3.4.2 Seasonal importance of information

The survey questions then began to dig deeper into the importance of weather information across a range of characteristics including temporal scales and weather characteristics. Asking about what time of year respondents felt weather information was most important revealed that information during the "wet season" and "summer" was rated as very important on average.[45] In fact, more than 50% of respondents indicated that weather information during the wet season was extremely important to them. Conversely, weather information was rated as being only little to somewhat important during fall (and only slightly more important in spring) as shown in Figure 3.11.

[45] As noted on https://www.expertafrica.com/mozambique/info/mozambique-weather-and-climate "…the whole country broadly follows a southern African weather pattern, with the rains falling largely between December and March" which corresponds to the Southern Hemisphere summer.

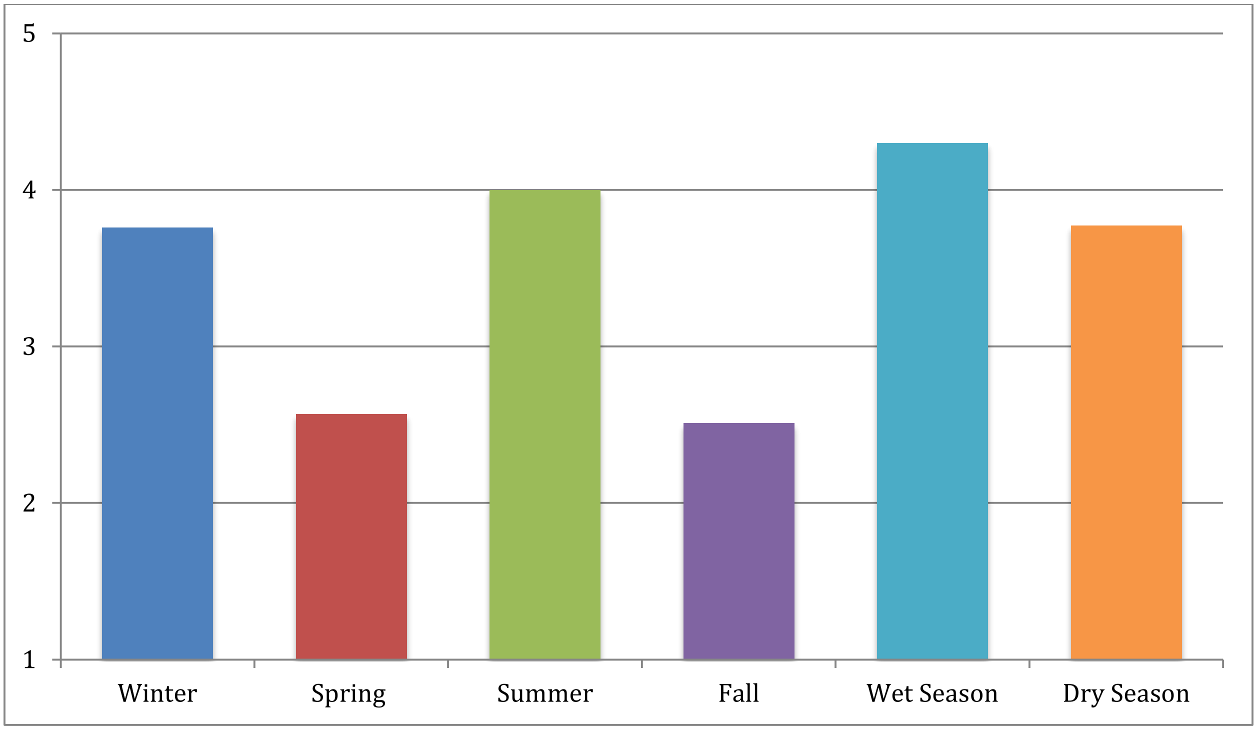

Figure 3.11 Average Rating of Importance of Weather Information by Seasons

3.4.3 Importance of weather information attributes

Respondents were provided a definition of "short term" forecasts as those covering periods of up to two weeks and asked, "…how important is it to you to have the information listed below as part of a weather forecast?" Respondents then rated the 21 weather characteristics listed on the five-point scale of "Not at all important" = 1 to "Extremely important" = 5. The median response on all of the characteristics was somewhat or very important. Rain and flooding related measures (amount, location, timing, probability, and flooding) were rated most important overall (even above severe weather warnings). Rated lowest overall were evaporation rates, barometric pressure, and humidity. These results are consistent with findings in a similar study in the United States (Lazo et al. 2009) that found respondents quite often don't know what barometric pressure or humidity measures mean. Figure 3.12 shows the average ratings for all 21 weather attributes.

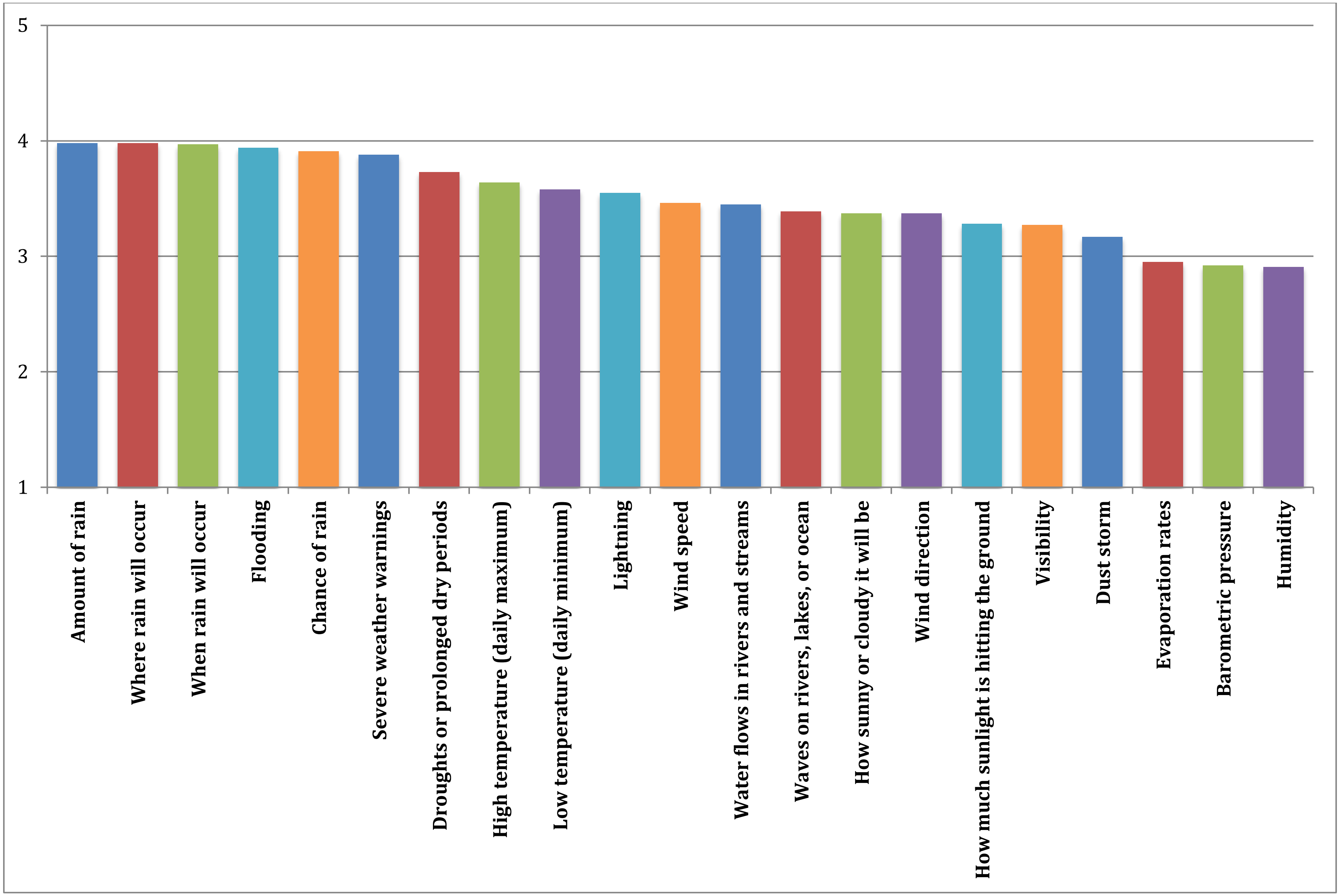

Figure 3.12: Average Rating of Importance of Information about Specific Weather Attributes

Of the weather measures, 14 of 21 were rated as significantly more important by those living in the south compared to those living in the northern parts of Mozambique as shown in Table 3.20. Only drought or prolonged dry periods was rated as more important by those living in the northern areas compared to those in the south.

Table 3.20: Comparison of Importance of Information about Specific Weather Attributes by Zone

Weather Attribute	South (n=337) Average	North-Central (n=239) Average	Kruskal-Wallis Test	Pr > Chi-Square
Chance of rain	3.958	3.849	3.627	0.057
Amount of rain	3.982	3.971	0.382	0.536
When rain will occur	4.045	3.870	7.308	0.007
Where rain will occur	4.039	3.887	4.646	0.031
Low temperature (daily minimum)	3.656	3.477	5.617	0.018
High temperature (daily maximum)	3.715	3.544	4.487	0.034
How sunny or cloudy it will be	3.442	3.272	4.626	0.031
Humidity	3.050	2.720	15.568	0.000
Wind speed	3.706	3.117	38.404	0.000
Wind direction	3.611	3.038	34.777	0.000
Dust storm	3.421	2.812	37.836	0.000
Barometric pressure	3.190	2.548	42.826	0.000
Visibility	3.433	3.042	16.014	0.000
Lightning	3.861	3.100	62.640	0.000
How much sunlight is hitting the ground	3.332	3.205	1.505	0.220
Evaporation rates	3.036	2.833	4.252	0.039
Severe weather warnings	3.864	3.895	0.414	0.520
Water flows in rivers and streams	3.433	3.477	0.598	0.439
Droughts or prolonged dry periods	3.647	3.849	6.947	0.008
Flooding	3.991	3.858	1.212	0.271
Waves on rivers, lakes, or ocean	3.445	3.314	1.886	0.170

As may have been expected, those in rural areas rated some weather information attributes significantly more important than did urban residents (Table 3.21). None of the 21 weather information attributes was rated as significantly more important by urban residents than rural respondents, suggesting the relatively less weather-sensitive nature of urban dwellers. This difference may be related to the greater reliance on agriculture in rural areas than in urban areas and thus create greater sensitivity to weather conditions such as where rain will occur, amount of sunshine, and evaporation rates which – along with wind speed and direction – determine evapotranspiration from plants and crops.

Table 3.21: Comparison of Importance of Information about Specific Weather Attributes by Urban-Rural

Weather Attribute	Urban (n=239) Average	Rural (n=337) Average	Kruskal-Wallis Test	Pr > Chi-Square
Chance of rain	3.912	3.914	0.710	0.400
Amount of rain	3.962	3.988	0.410	0.522
When rain will occur	3.946	3.991	1.659	0.198
Where rain will occur	3.904	4.027	4.112	0.043
Low temperature (daily minimum)	3.607	3.564	0.082	0.775
High temperature (daily maximum)	3.678	3.620	0.194	0.660
How sunny or cloudy it will be	3.301	3.421	3.651	0.056
Humidity	2.883	2.935	0.374	0.541
Wind speed	3.389	3.513	3.004	0.083
Wind direction	3.268	3.448	4.450	0.035
Dust storm	3.100	3.217	1.423	0.233
Barometric pressure	2.908	2.935	0.066	0.797
Visibility	3.305	3.246	0.250	0.617
Lightning	3.540	3.549	0.075	0.784
How much sunlight is hitting the ground	3.205	3.332	2.235	0.135
Evaporation rates	2.824	3.042	5.412	0.020
Severe weather warnings	3.858	3.890	0.196	0.658
Water flows in rivers and streams	3.301	3.558	13.005	0.000
Droughts or prolonged dry periods	3.678	3.769	2.081	0.149
Flooding	3.900	3.961	0.157	0.692
Waves on rivers, lakes, or ocean	3.176	3.543	16.436	0.000

Table 3.22 presents the factor analysis of the responses on the importance of weather information attributes that yielded three factors, which are labeled wind, temperature, and rain. Each have multiple attributes related to these weather phenomena loading within the factor. The first factor (wind) is also comprised of weather attributes that generally were rated as somewhat less important than the temperature and rain attributes (see Figure 3.12). The third factor (rain) is comprised of the five attributes related to timing, location, amount, and probability of rain along with flooding that also rated as the five most important attributes overall (see Figure 3.12). It is interesting to note that the "hydrological" attributes of water flows, waves, and drought loaded in the second factor along with high and low temperature and amount of sun and clouds, may

conceptually be associated with a mental model of temperature-water volume rather than with "atmospheric water" such as rain.

Table 3.22: Factor Analysis of Importance of Weather Information Attributes			
	Factor1	Factor2	Factor3
	Wind	Temperature	Rain
Barometric pressure	0.749		
Dust storm	0.746		
Wind direction	0.722		
Wind speed	0.721		
Humidity	0.668		
Visibility	0.645		
Lightning	0.597		
Evaporation rates	0.536	0.469	
How much sunlight is hitting the ground	0.444	0.401	
Water flows in rivers and streams		0.704	
Droughts or prolonged dry periods		0.671	
High temperature (daily maximum)		0.668	
Low temperature (daily minimum)		0.636	
How sunny or cloudy it will be		0.567	
Waves on rivers, lakes, or ocean		0.534	
Severe weather warnings		0.457	
Where rain will occur			0.742
When rain will occur			0.731
Amount of rain			0.723
Chance of rain			0.719
Flooding			0.418
Variance Explained by Each Factor	4.264	3.483	2.782

N=576. We retained three factors based on the interpretability of three factors and the scree plot rather than the minimum eigenvalue criteria. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.902. These three factors explain 50.1% of the total variance.

3.4.4 Importance of longer term hydro-meteorological information

Question 14 asked a similar "level of importance" question, but focused more on attributes the survey questions defined as longer-term (longer than two weeks to months or even years). These may be considered seasonal and climate forecasts and included the concept of climate change projections, which are technically not be the same as a forecast. On the scale of 1 to 5 from "Not at all important" to "Extremely important," all eight long-term forecast attribute rate 3.35 or greater on average – see Figure 3.13. In fact, the average rating of the eight longer-term forecast attributes (average of the mean ratings 3.65), which is larger than the average rating of the 21 near-term forecast attributes shown in Figure 3.12 (average of the mean ratings 3.51). While this is likely due to the longer-term forecast information being largely comprised of rain-related concepts, which also rated very high in the short term, it also indicates the importance of longer-term weather conditions and thus longer-term weather information to Mozambicans. It seems likely this is due in part to the larger portion of respondents likely involved in subsistence farming as well as the large number of people who have experienced serious impacts from drought or flooding or both.

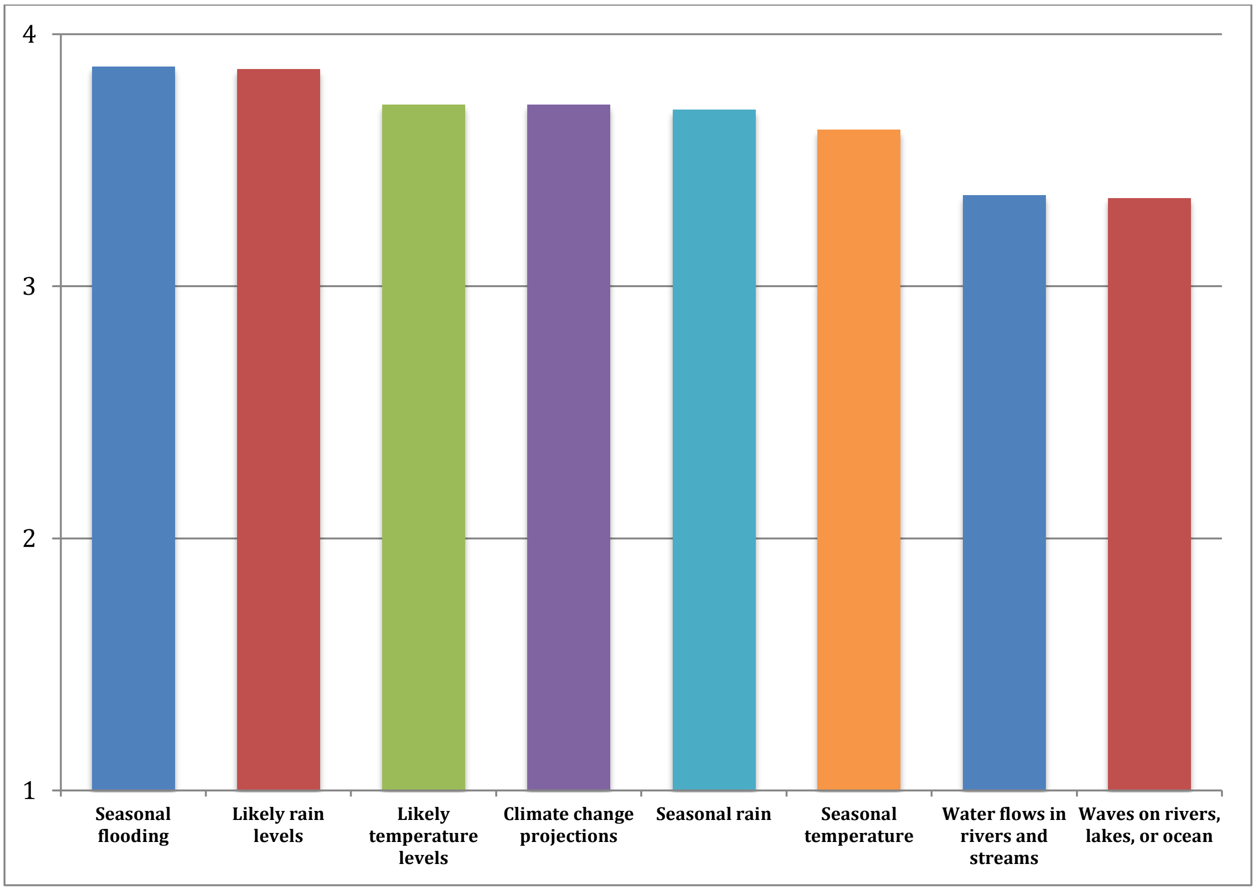

Figure 3.13: Importance of Longer-Term Hydro-meteorological Information

Regional differences also existed with those in the south rating long-term information on water flows and waves as more important than respondents in the north-central areas (Table 3.23). Conversely, those in the north-central region rated seasonal flooding information as more important.

Table 3.23: Comparison of Longer-Term Hydro-met Information Importance by Zone				
Information Attribute	South (n=337) Average	North-Central (n=239) Average	Kruskal-Wallis Test	Pr > Chi-Square
Likely rain levels	3.840	3.891	0.694	0.405
Likely temperature levels	3.721	3.720	0.018	0.893
Climate change projections	3.703	3.732	0.114	0.736
Seasonal rain	3.680	3.732	0.889	0.346
Seasonal temperature	3.647	3.586	0.233	0.629
Seasonal flooding	3.792	3.979	7.111	0.008
Water flows in rivers and streams	3.493	3.172	11.099	0.001
Waves on rivers, lakes, or ocean	3.457	3.197	7.246	0.007

Table 3.24 shows the urban-rural comparison for long-term forecasts. As with shorter-term weather information (Table 3.21), rural respondents rate some information attributes significantly more important than urban residents did. This was the case for climate change projections, seasonal rain, water flows, and waves that may directly affect agricultural activities or in some cases fishing. There was not an urban-rural difference concerning temperature information, which may indicate in part that longer-term temperature information isn't as important in agriculture as is water information.

Table 3.24: Comparison of Longer-Term Hydro-met Information Importance by Urban-Rural				
Information Attribute	Urban (n=239) Average	Rural (n=337) Average	Kruskal-Wallis Test	Pr > Chi-Square
Likely rain levels	3.841	3.875	1.027	0.311
Likely temperature levels	3.724	3.718	0.000	0.986
Climate change projections	3.636	3.772	3.824	0.051
Seasonal rain	3.615	3.763	4.543	0.033
Seasonal temperature	3.598	3.638	0.304	0.582
Seasonal flooding	3.824	3.902	0.850	0.357
Water flows in rivers and streams	3.146	3.510	17.273	0.000
Waves on rivers, lakes, or ocean	3.142	3.496	14.163	0.000

A factor analysis (Table 3.25) of these longer-term information attributes yielded two factors roughly related to (1) atmospheric and (2) hydrological information components.

Table 3.25: Factor Analysis of Importance of Longer-Term Hydro-meteorological Information		
	Factor1	Factor2
Information Attribute	Atmospheric	Hydrological
Seasonal rain	0.810	
Seasonal temperature	0.745	
Seasonal flooding	0.738	
Likely rain levels	0.720	
Climate change projections	0.637	
Likely temperature levels	0.628	
Waves on rivers, lakes, or oceans		0.890
Water flows in rivers and streams		0.870
Variance Explained by Each Factor	3.171	1.935

N=576. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.834. Bartlett's test is highly significant ($p < 0.05$), therefore factor analysis is appropriate for these data. These 3 factors explain 63.8% of the total variance.
The determinant of the correlation matrix is 0.033 (> 0.00001), so multicollinearity is not a problem for these data.

3.4.5 Importance of weather information across time periods

The following questions in the survey elicited information on the relative importance of weather forecasts over different time periods. Specifically, interviewers asked respondents to use the five-point importance scale to rate, "How important to you are weather forecasts for the following time periods?" Then, respondents were offered seven time periods ranging from "less than one day from now" to "more than three months." Figure 3.14 plots the average responses indicating a monotonically increasing level of importance when going further into the future. This is the exact opposite of the survey expectations, which focused more on shorter-term forecasts as being more important than longer-term. In a related question in Lazo et al. 2009, the interviewers inquired about respondents' confidence and found monotonically decreasing confidence as the time period was extended out to 14 days (Lazo et al. 2009, Figure 3, p. 790).

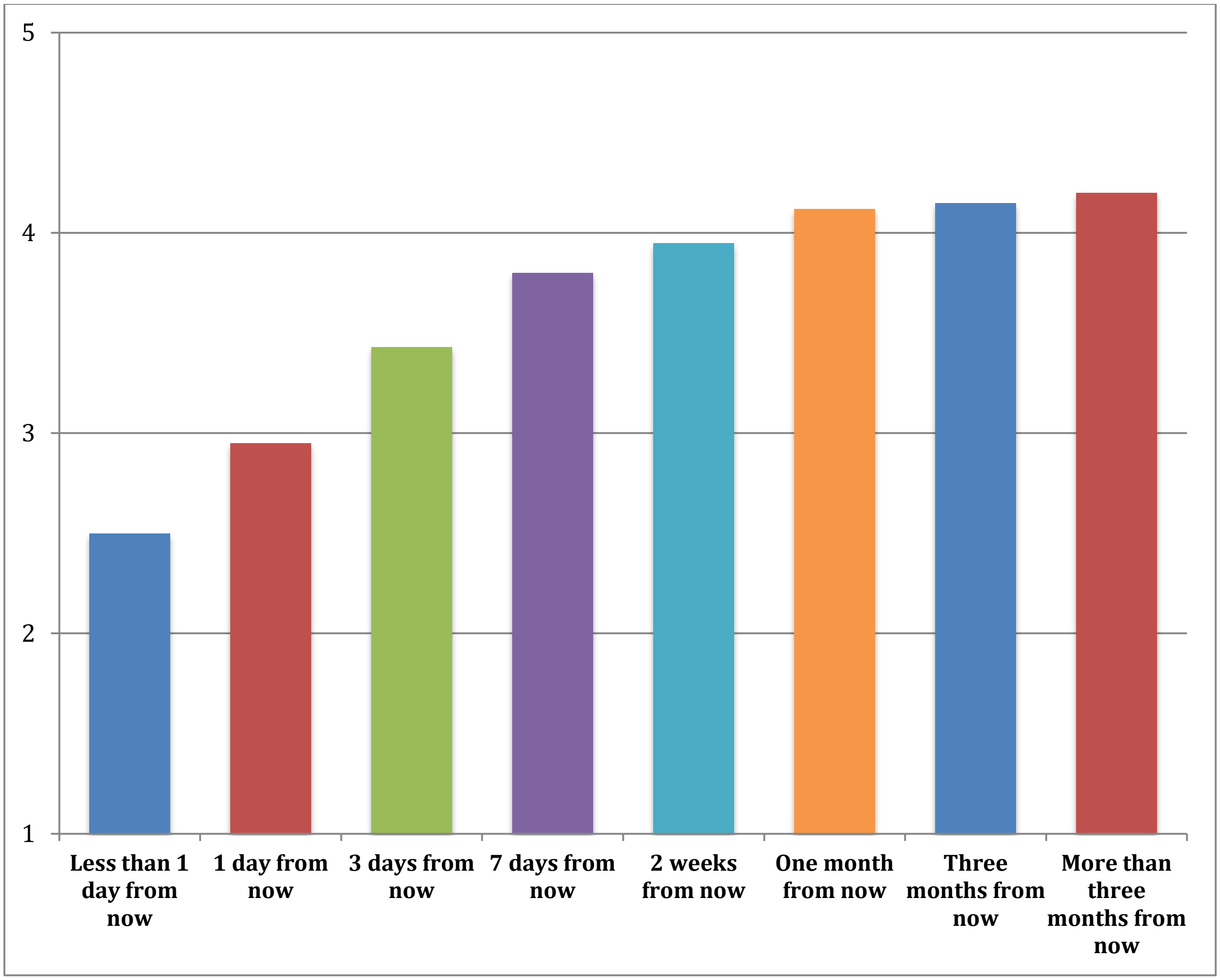

Figure 3.14: Importance of Weather Forecasts Across Time Periods

This possible anomaly was explored and further testing assessed whether the increased importance of longer-term information was driven by rural residents concerned about agricultural issues. Figure 3.15 plots the average importance ratings by time period comparing the urban and rural subsamples.

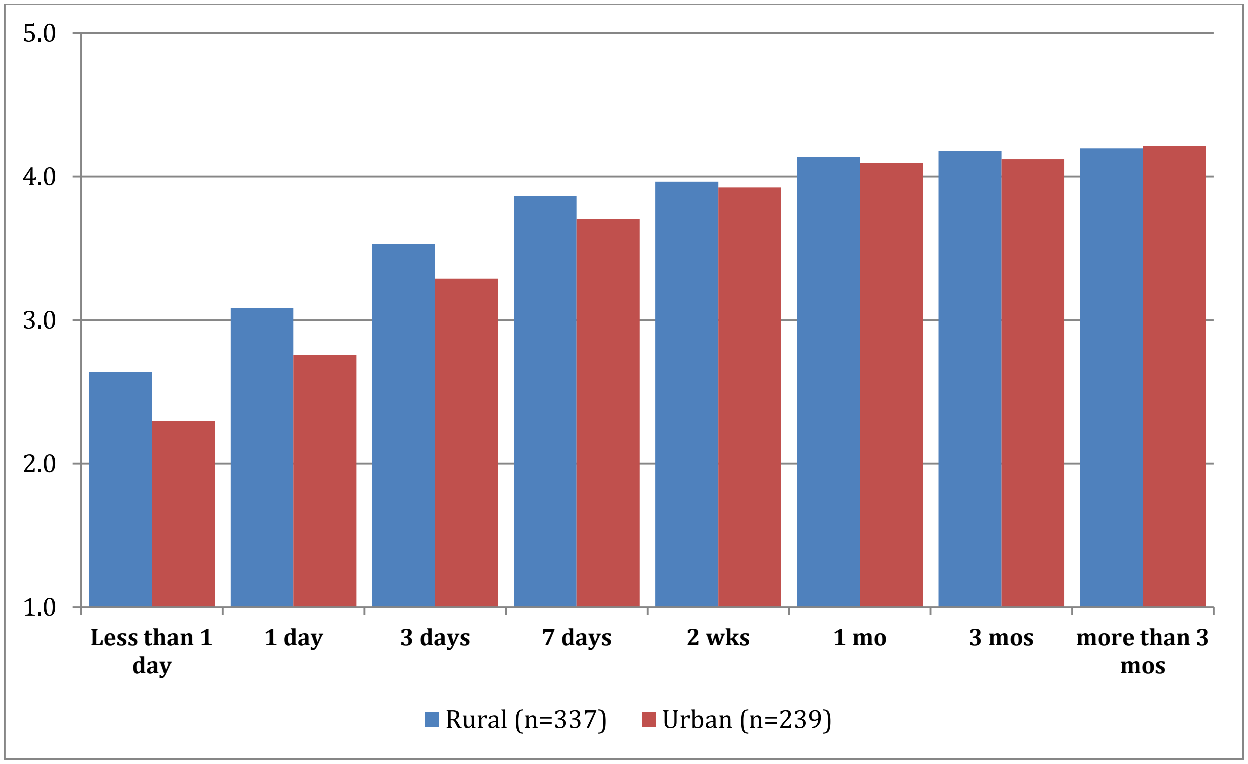

Figure 3.15: Comparison of Importance of Weather Forecasts Across Time Periods Between Urban and Rural Respondents

Table 3.26 shows the urban-rural comparisons for the eight time periods elicited in the survey. For both subsamples, the indicated importance is still monotonically increasing with time, but for rural respondents shorter-term information (out to seven days) is significantly more important than it is for urban residents. This issue requires further examination to determine if this is a true result or if there was a potential problem in survey implementation, data recording, or question interpretation for this specific question.[46]

[46] This issue further emphasizes the importance of assessing face validity of results as well as being able to undertake repeated data collection if results of a specific question are potentially policy critical.

Table 3.26: Comparison of Importance of Weather Forecasts Across Time Periods Between Urban and Rural Respondents				
Variable	Rural (n=337)	Urban (n=239)	Kruskal-Wallis Test	
			Chi-Square	Pr > Chi-Square
Less than 1 day	2.64	2.30	10.08	0.00
1 day	3.08	2.76	11.76	0.00
3 days	3.53	3.29	8.09	0.00
7 days	3.87	3.71	3.41	0.06
2 weeks	3.96	3.92	0.21	0.65
1 month	4.14	4.10	0.89	0.35
3 months	4.18	4.12	0.51	0.47
more than 3 months	4.20	4.21	0.40	0.53

3.4.6 Relative importance of weather and climate information

Given these unexpected results in stated importance for information across the different time periods, it is fortunate that the survey also included direct questions on importance of weather information and importance of climate information. As discussed above, Question 5 respondents were to rate on the scale of 1 to 5 the importance of weather information (Figure 3.10). Question 16 asked a parallel question with respect to climate information. This shows the frequency counts and mean of responses for weather and climate, which indicates that overall respondents considered climate information slightly more important than weather information.

Table 3.27: Comparison of Stated Importance of Weather and Climate Information						
	Not at all important	**A little important**	**Somewhat important**	**Very important**	**Extremely important**	**Mean**
	1	**2**	**3**	**4**	**5**	
Importance of weather information (Q5)	3 0.5%	29 5.0%	81 14.1%	314 54.5%	149 25.9%	4.00
Importance of climate information (Q16)	10 1.7%	17 3.0%	62 10.8%	217 37.7%	270 46.9%	4.25

This information is plotted as well in Figure 3.16 to graphically present this result. This result supports the results presented in Figure 3.14 showing an increasing rated importance of information as the time period increased. As noted above, these results were unexpected and different from results of a similar question asked in the United States (Lazo et al. 2009). It would be worthwhile to examine this issue in further detail with interviews or focus groups to better understand the Mozambican public's needs and preferences for weather and climate information and the extent to which these results may be dependent on needs for information for agricultural purposes. It would also be worthwhile to better understand people's perceptions of the reliability of weather and climate information over different time periods and how that relates to the decisions made with that information. This may help guide INAM and other agencies in prioritizing the development and dissemination of information to meet the needs and interests of the public.

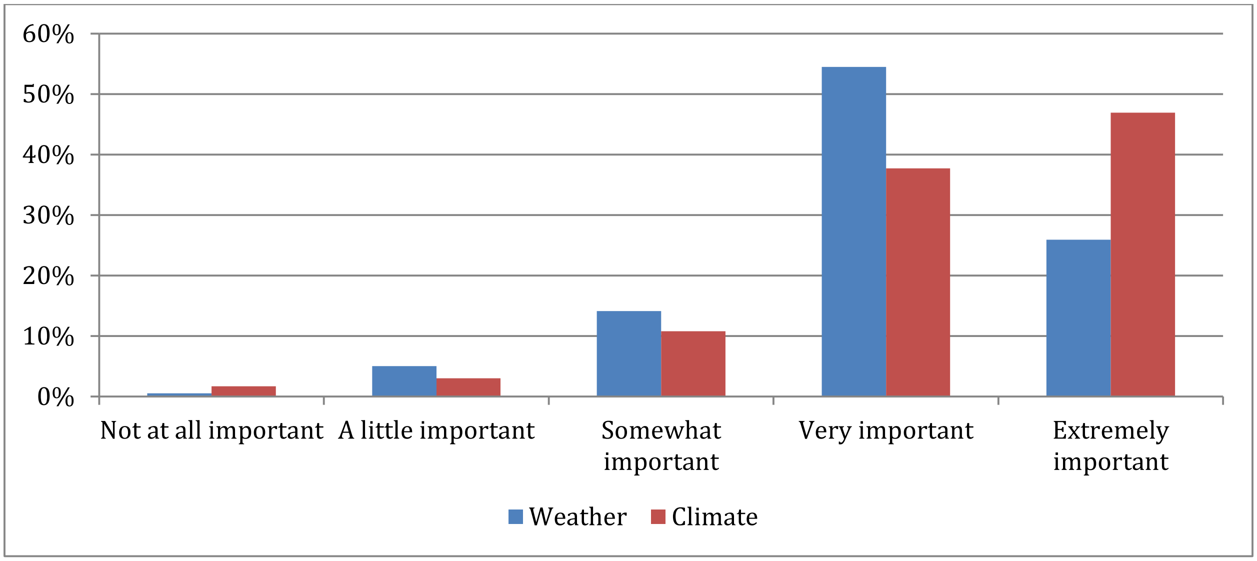

Figure 3.16: Comparison of Stated Importance of Weather and Climate Information

3.4.7 Importance of water information

In a similar question, the interviewers then asked respondents to rate the importance of information on hydrological attributes of stream or river flows, reservoir levels, groundwater levels, and water availability. Overall, this information rated somewhat lower than the weather and climate information discussed above but still on average was a little more than "somewhat important." Water availability was rated as the most important of these four hydrological attributes as shown in Figure 3.17.

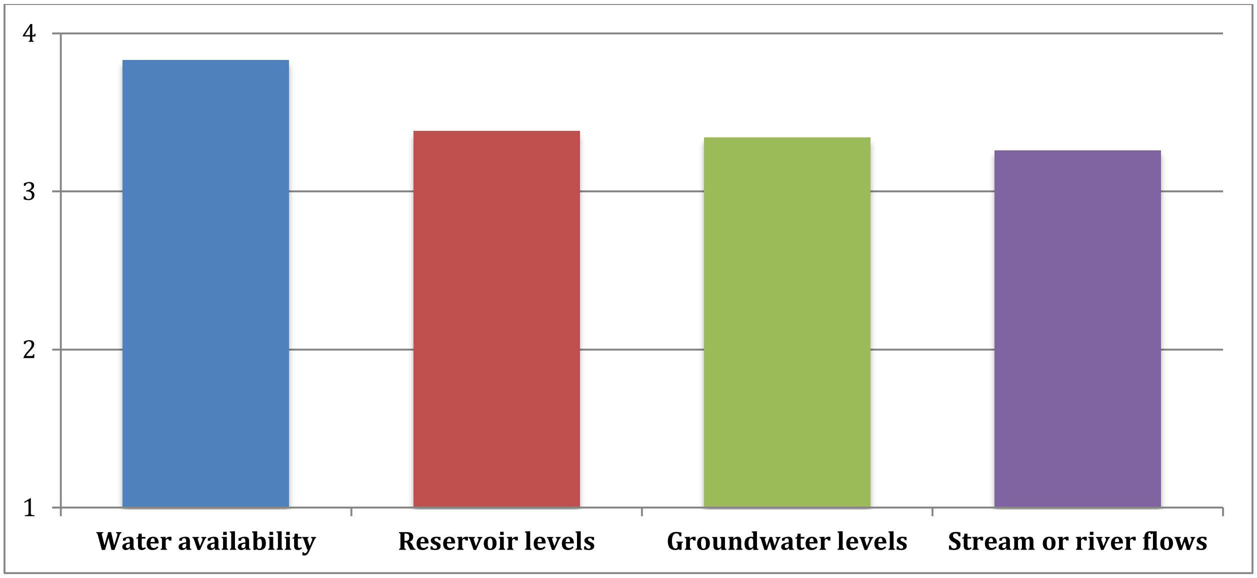

Figure 3.17: Importance of Water Resources Information

A comparison of the importance of hydrological information between urban and rural respondents indicated that rural respondents rate all aspects of hydrological information as significantly more important than urban residents (Table 3.28). Given the importance of water resources for agriculture, as well as the "disconnect" with primary water supplies that urban residents may have, (e.g., they get their water from the water system potentially with little awareness of primary sources), the report concludes that this is a reasonable finding.

Table 3.28: Comparison of Hydrological Information Importance by Urban-Rural

Variable	Overall Mean (N=576)	Rural (n=337)	Urban (n=239)	Kruskal-Wallis Test	
				Chi-Square	Chi-Square
Stream or river flows	3.26	3.43	3.03	21.03	0.000
Reservoir levels	3.38	3.52	3.20	17.64	0.000
Groundwater levels	3.34	3.49	3.14	18.79	0.000
Water availability	3.83	3.92	3.71	8.46	0.004

Alternatively, the comparison of the importance of hydrological information between southern and north-central Mozambican respondents indicated that southern respondents rated hydrological information about stream or river flows as significantly more important that north-central (Table 3.29), but north-central respondents consider water availability information significantly more important than southern respondents.

Table 3.29: Comparison of Hydrological Information Importance by Zone				
Variable	North-Central (N=239)	South (n=337)	Kruskal-Wallis Test	
			Chi-Square	Chi-Square
Stream or river flows	3.08	3.39	11.68	0.00
Reservoir levels	3.37	3.39	0.19	0.66
Groundwater levels	3.27	3.39	1.99	0.16
Water availability	3.97	3.73	6.42	0.01

3.5 Satisfaction

3.5.1 Satisfaction with current weather information

After eliciting information on respondents' sources, uses, and perceptions of weather, water, and climate information, the interviewers asked them to rate their level of overall satisfaction with the weather forecast information that they currently receive. As there is a range of information sources, this rating cannot be interpreted as a rating of the services and products specifically of INAM. It should also be noted that up to this point in the survey, the interviewers had not specifically mentioned or discussed INAM, DNA, or the ARAs.

On average, respondents indicated that they were slightly more satisfied than "Neither satisfied nor dissatisfied" with a modal response of "satisfied" as shown in Figure 3.18. There were no significant differences in satisfaction ratings between the geographic regions or the urban-rural areas (South versus North-Central χ^2=1.633, df=1, p=0.201; Urban-Rural χ^2=0.031, df=1, p=0.860).

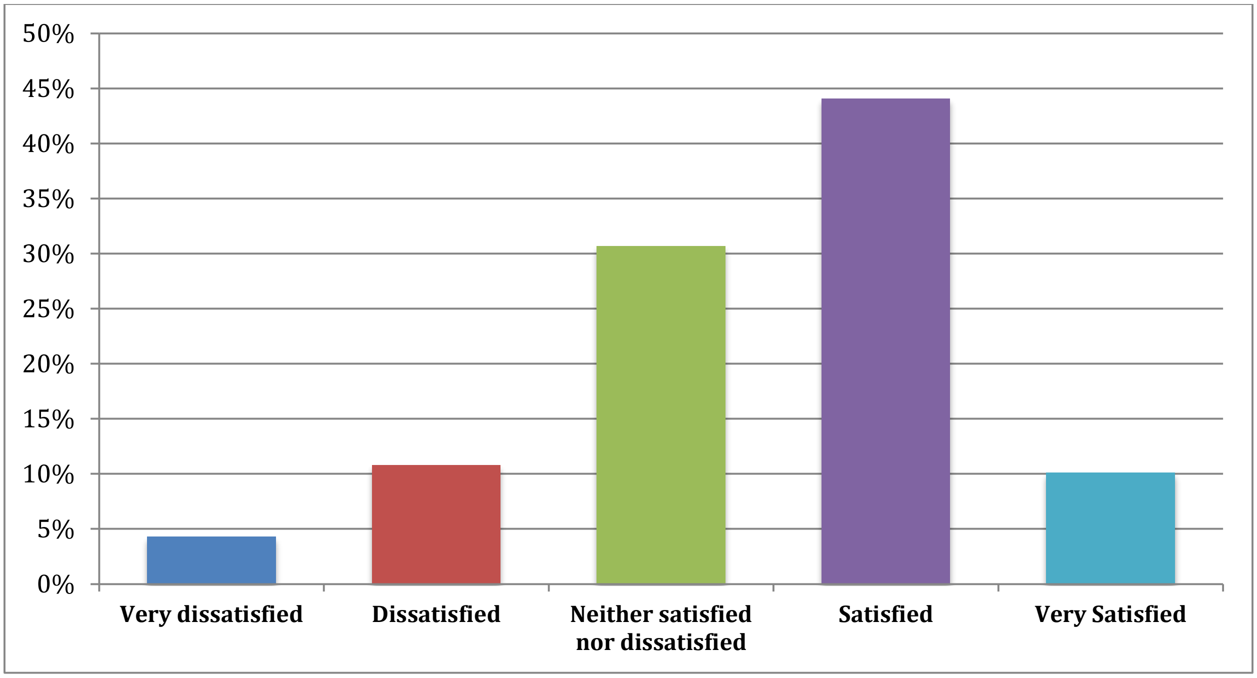

Figure 3.18: Satisfaction with the weather forecast information that you currently receive

3.5.2 Factors affecting satisfaction with weather information

To better understand respondents' stated level of satisfaction with the weather information they currently receive, the responses to this question were regressed on a range of socio-demographic variables and other measures of experience with weather and weather information. An ordered logistic regression was used because the response variable (satisfaction) is an ordinal categorical (non-continuous) variable. Table 3.30 shows results of this regression analysis. Note that some of the independent variables included in the regression have not be discussed yet in this report, but are covered later as indicated by an "§".

Table 3.30: Categorical Logistic Regression on Level of Satisfaction With Current Weather Information				
Parameter	Estimate	Wald Chi-Square	Pr>ChiSq	Odds Ratio Estimates (Point Estimate)
Intercepts				
Intercept – 5	-0.086	0.018	0.894	
Intercept – 4	2.491	14.956	0.000	
Intercept – 3	4.244	40.796	<.0001	
Intercept – 2	5.715	67.317	<.0001	
Socio-Demographics				
Urban-Rural (Rural = 0; Urban = 1)	0.145	0.549	0.459	1.156
South-North (South = 1; North-Central = 0)	-0.012	0.003	0.954	0.989
Married (Non Married = 0; Married or Marital Union = 1)	0.351	4.084	0.043	1.421
Monetary Constraint (0 to 12 increasing money constraint)	-0.080	7.040	0.008	0.923
Employed (Not Employed = 0; Full Time, Part Time, Self = 1)	-0.147	0.441	0.507	0.863
Education (Years)	-0.019	0.350	0.554	0.981
Income (Continuous)	0.000	0.341	0.559	1.000
Don't Need Info CVMF1 Factor 2 Score § (see Table 4.7)	0.267	9.668	0.002	1.306
Weather Information				
Use Weather Forecasts (Q8: No = 2; Yes = 1)	-0.461	2.711	0.0996	0.631
Aware of INAM (Q21: No=2; Yes =1) §	-0.335	1.739	0.187	0.715
Aware of ARAs (Q23: No=2; Yes =1) §	-0.034	0.026	0.872	0.967
Aware of INAM Warnings (Q24: No=2; Yes =1) §	-0.521	5.915	0.015	0.594
Weather Impact Factors (see Table 3.3)				
Wx Impact Factor 1 Personal Loss	-0.030	0.117	0.733	0.970
Wx Impact Factor 2 Mortality/ Morbidity	-0.099	1.258	0.262	0.905
Wx Impact Factor 3 Infrastructure Disruption	0.173	3.614	0.057	1.189
Use of Forecasts Factors (see Table 3.19)				
Uses Factor 1 Short-Term Decisions	-0.252	7.825	0.005	0.777
Uses Factor 2 Longer-Term Decisions	0.107	1.495	0.222	1.113
Sources of Weather Information Factors (see Table 3.13)				
Sources Factor 1 Agencies	0.141	2.846	0.092	1.152
Sources Factor 2 Infrequent Sources	0.118	1.677	0.195	1.125
Sources Factor 3 Frequent Sources	0.212	4.644	0.031	1.236
§ This variable has not been discussed yet but is explained later in this report. N= 514; Max-rescaled R-Square: 14.76%; Likelihood Ratio Test Chi-Square=75.8, df=20, Pr>ChiSq<0.0001 Percent Concordant: 67.1%; Somers' D: 0.35				

Overall, the regression fits the data well with an Adjusted R-Squared of nearly 15% and with more than two-thirds of the fitted values concordant with the observed values. Given the categorical analysis, estimates were derived for four intercepts (one between each successive pair of response levels). A positive estimate on a parameter indicates that an increase in the value of that parameter (or dummy variable equaling 1 instead of 0) relates to an increased level of satisfaction.

After controlling for the other variables in the analysis, there was not a significant difference in level of satisfaction between the south and north-central regions or between urban and rural respondents.[47] There was also not a significant difference in level of satisfaction as a function of employment, education, or income. Even though income was not a significant predictor, being monetarily constrained was significant. The negative parameter estimate indicates that those who are more money constrained have a lower level of satisfaction with current weather information. Married individuals have a higher level of stated satisfaction with weather information.

The factor score labeled "Don't Need Info" is a factor derived from the follow-up questions to the contingent valuation question discussed later. The intent of this question is to identify respondents with valid reasons for having low or zero willingness to pay (WTP) for improved information from INAM. This factor is comprised of respondents who rated higher on the three items (1) I get my forecasts from other sources than the government, (2) I wouldn't be affected by the program because I don't use weather forecasts, and (3) I think weather forecasts are good enough now. Thus, individuals with higher scores on this factor likely have no need for weather information, are already satisfied with what they are receiving, or have sought another non-governmental source that provides higher satisfaction levels.

Under the subcategory of "Weather Information," two parameter estimates are significant and negative indicating an increased level of satisfaction for those who answered "Yes." Responses to these questions are coded as Yes=1 and No=2, so a negative parameter estimate indicates that those who answer Yes (have a lower response value) have a higher satisfaction level. This was the case for (1) those who indicated in Question 8 that they "Use Weather Forecasts" and (2) those who indicated in Question 24 that they were aware of INAM "weather warnings and advisories, maritime forecasts, climate records and seasonal forecasts, and forecasts used for aviation," had a higher level of satisfaction. Being aware of INAM or the ARAs did not relate to

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[47] Multiple regression analysis is said to "control for other variables" by including all of the variables expected to have an influence in the same statistical analysis. In this sense the parameter estimate on any one independent variable is attributed just to changes in that variable if all the other variables were then held constant.

stated level of satisfaction. This is a reasonable finding in that those who are not satisfied with weather information seem less likely to use it in the first place.

In each of the next three subcategories of independent variables, factor scores are regressed rather than the raw responses to reduce the total number of independent variables as well as to regress on the underlying latent construct constituting the factors. The sets of factor scores were from the weather impacts, weather information uses, and weather information sources questions.

The weather impacts factor scores can be considered a measure of the respondents' prior experiences with weather during the past 10 years (see Table 3.3). The significant and positive estimate on "Wx Impact Factor 3 Infrastructure Disruption" indicates that those who have experiences a larger level of infrastructure disruption over the last 10 years also have a higher level of satisfaction with current weather information. This may suggest that they have been satisfied with the information that they have received during past events or have had more experience with weather information because of these past weather related infrastructure disruptions and have satisfied with the information they've received. Satisfaction was not significantly related to past personal loss or past mortality and morbidity (of which there was relatively little in the sample overall).

Conversely, the negative and significant estimate on the first uses factor "Short Term Decisions" suggests that those who use forecasts more for the decisions constituting this factor (i.e., planning how to get to work or school, dress themselves or their children, job or work activities, weekend activities, social activities, yard work or outdoor house work, or simply knowing what the weather will be) are less satisfied with the current weather information. Satisfaction was not related to longer-term decisions. This result may suggest that current weather forecasts are not meeting the needs of Mozambican's for short-term decisions and that there is room for improvement in this type of information.

In the final set of factors "Sources of Weather Information Factors," satisfaction is positively and significantly related to two source factors: Factor 1 Agencies and Factor 3 Frequent Sources. It was not related to the second factor that we've labeled "Infrequent Sources." Again this is a reasonable finding in that individuals who use these sources more are only likely to do so if they are satisfied (using similar scales Demuth et al. 2011 did not find a statistically significant relationship between satisfaction and frequency of use).

3.6 Awareness of Agencies

3.6.1 Awareness of INAM and ARAs

The report successively indicates to respondents what the INAM and ARAs are, and then simply asks them if they had ever heard of these agencies before. Due to an error on the part of the survey company, a parallel question asking if respondents had ever heard of DNA was omitted.[48] Another question probed deeper with respect to INAM services informing respondents that "In addition to normal weather forecasts of rainfall, temperature, cloudiness, and winds, INAM also provides weather warnings and advisories, maritime forecasts, climate records and seasonal forecasts, and forecasts used for aviation" and asking if they were aware of these services before. Figure 3.19 shows the distribution of responses to each of these three questions. Slightly more than 70% indicated that they had heard of INAM before and 50% were aware of the additional information INAM provides. Of the 122 respondents indicating they had not heard of INAM before, only five (4.1%) indicated they were aware of the specific information provided by INAM. This suggests a reasonable level of internal consistency. Further, of the 396 indicating that they had heard of INAM before, 71% were also aware of the specific information provided by INAM suggesting that this information is an important component of the awareness and perception of INAM by the public.

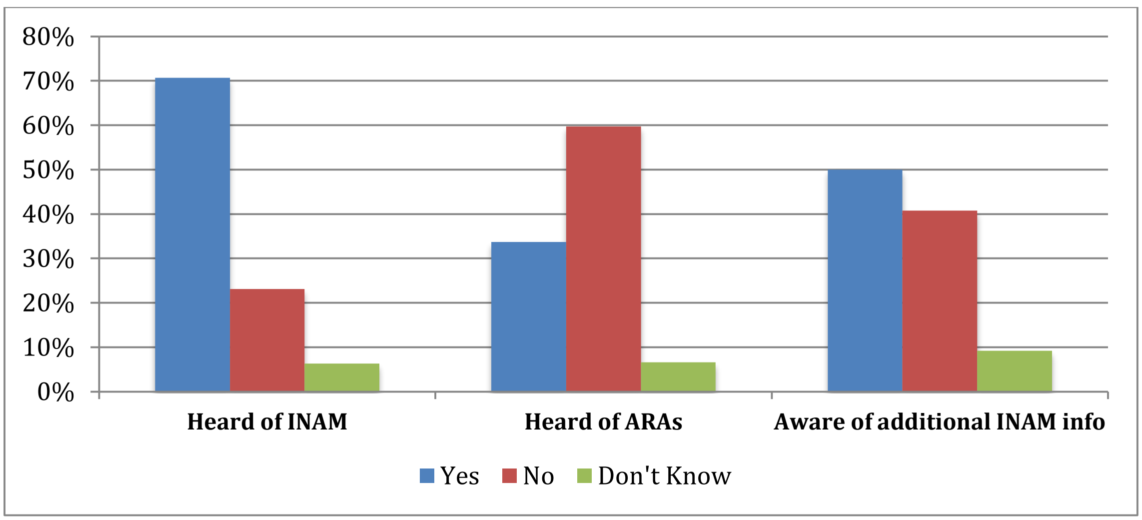

Figure 3.19: Respondents Awareness of Mozambican Hydro-meteorological Organization and Activities

[48] We also note that we did not elicit information on respondents' awareness of INGC (the emergency response agency) who are also a critical link in the weather-water-climate information and response process. Future work should specifically elicit information on INGC's role and the public's awareness thereof.

Table 3.31 shows the statistical test of difference in level of awareness of the agencies and the information provided by INAM by the south versus north-central classification. As shown, there is a statistically significant greater level of awareness of these agencies and INAM's information provision in the southern part of Mozambique than in the north and central areas sampled. The level of awareness is 10% to 15% higher in the south than the north-central suggests a much lower level of reach of these agencies in these more northern areas.

Table 3.31: Comparison of Awareness of Agencies Importance by Zone

Agency	South (n=337) Average	North-Central (n=239) Average	Kruskal-Wallis Test	
			Chi-Square	Chi-Square
Aware of INAM	74.5%	65.3%	5.710	0.017
Aware of the ARAs	38.0%	27.6%	6.717	0.010
Aware of the Additional Information from INAM	56.1%	41.4%	12.001	0.001

Table 3.32 shows the urban-rural comparison of agency awareness indicating a statistically significant level of reach in urban areas than rural for INAM and the ARAs. The level of penetration is roughly 10% higher in urban areas than rural for both agencies as well as awareness of INAM's specific products and services.

Table 3.32: Comparison of Awareness of Agencies by Urban-Rural

Agency	Urban (n=239) Average	Rural (n=337) Average	Kruskal-Wallis Test	
			Chi-Square	Chi-Square
Aware of INAM	77.8%	65.6%	10.097	0.001
Aware of the ARAs	40.2%	29.1%	7.682	0.006
Aware of the Additional Information from INAM	54.8%	46.6%	3.777	0.052

3.6.2 Factors affecting awareness of INAM

Table 3.33 shows a regression on whether or not individuals had heard of INAM before. This is a probit regression as the dependent variable is binary (No or had not heard of INAM=0; Yes or had heard of INAM=1). It is noted that although zone and urban-rural both showed significant differences in having heard of INAM (see Table 3.31 and Table 3.32), neither were significant in the regression analysis. This indicates that other variables in the regression account for the zonal and urban-rural differences (i.e., education, income, length of residency, and the various factor scores capture these differences rather than the zonal and regional dummy variables). Being employed (full- or part-time) and having experienced greater loss due to weather in the past, related to being less likely to have heard of INAM before. Higher education, higher income, having greater concern about weather events (both high concern and low concern events as per the factor analysis), using forecasts more for short term decision-making, and more use of "Agencies" (national or local government agency and non-government organization) and "Frequent Sources" (radio, TV, and friends, family, co-workers, etc.) of weather information are all related to being more likely to have heard of INAM before. Future work along similar lines may be useful to better understand who INAM's users are and what factors affect whether or not individuals are using INAM product and services.

Table 3.33: Logistic Regression on Heard of INAM Before				
Parameter	Estimate	Standard Error	Wald Chi-Square	Pr>ChiSq
Intercepts				
Intercept	0.383	0.394	0.943	0.331
Socio-Demographics				
Urban-Rural (Rural = 0; Urban = 1)	0.086	0.161	0.289	0.591
South-North (South = 1; North-Central = 0)	0.092	0.163	0.318	0.573
Age (Years)	-0.007	0.007	1.022	0.312
Married (Non Married = 0; Married or Marital Union = 1)	-0.007	0.138	0.003	0.957
Monetary Constraint (0 to 12 increasing money constraint)	-0.037	0.025	2.143	0.143
Employed (Not Employed = 0; Full-Time, Part-Time, Self = 1)	-0.808	0.165	23.879	<.0001
Gender (Female = 0; Male=1)	0.050	0.133	0.142	0.706
Household Size (Total number living in household)	-0.005	0.026	0.044	0.833
Length of residency (Years)	0.000	0.007	0.003	0.958
Education (Years)	0.096	0.027	12.607	0.000
Income (Continuous)	0.000	0.000	3.068	0.080
Concern About Potential Weather Events Factors (see Table 3.9)				
Lower Concern Events	0.123	0.074	2.754	0.097
Higher Concern Events	0.197	0.077	6.545	0.011
Weather Impact Factors (see Table 3.3)				
Wx Impact Factor 1 Personal Loss	-0.151	0.075	4.041	0.044
Wx Impact Factor 2 Mortality/ Morbidity	0.075	0.065	1.316	0.251
Wx Impact Factor 3 Infrastructure Disruption	-0.018	0.070	0.067	0.796
Use of Forecasts Factors (see Table Table 3.19)				
Uses Factor 1 Short-Term Decisions	0.152	0.084	3.265	0.071
Uses Factor 2 Longer-Term Decisions	0.016	0.090	0.030	0.863
Sources of Weather Information Factors (see Table Table 3.13)				
Sources Factor 1 Agencies	0.310	0.142	4.727	0.030
Sources Factor 2 Infrequent Sources	0.145	0.112	1.666	0.197
Sources Factor 3 Frequent Sources	0.813	0.127	41.295	<.0001
*This variable has not been discussed yet but is explained later in this report. N= 576; Max-rescaled R-Square: 41.56%; Likelihood Ratio Test Chi-Square=198.7, df=23, Pr>ChiSq <0.0001. Percent Concordant: 84%; Somers' D: 0.681				

3.7 Importance of improving information

3.7.1 Attributes of potentially improved information

The next section of the survey began to deal in depth with specific products and services of INAM and potential improvements in these products. The primary purpose of this was to lead into the valuation questions; this also provides useful information on preferences for specific types of information and potential improvements in this information. For each information "attribute" or product, the interviewers first provided an example or explanation, indicated a measure of the current level of service or accuracy, and then elicited preferences (measures as "importance to improve") for two potential levels of information improvements. For several of the attributes, the respondent was also presented a graphical example (in Portuguese) captured from the INAM website.

Table 3.34 shows the attribute and level information for the nine attributes assessed. Not all of these were subsequently included in the valuation analysis but, based on results from that analysis and the relative "importance of improvements," it would be theoretically possible to scale values for improvements in those attributes as well. The question number is provided as well for reference. The complete question as presented is shown in the survey codebook (Appendix B).

Table 3.34: Forecast Information Attributes, Current Levels, and Potential Improvements

Question	Attribute	Current	Intermediate Improvement	Maximum Improvement
Q25	Cyclone warnings and advisories lead time	Current lead time two days	Increase lead time to three days	Increase lead time to five days
Q26	All other warnings and advisories lead time	Current lead time one day	Increase lead time to two days	Increase lead time to four days
Q27	Accuracy of rainfall information	Correct 75% of the time	Being correct 80% of the time	Being correct 90% of the time
Q28	Geographic detail	Three sections of country south, central, north	Province level 10+Maputo City	District level 128 districts
Q29	Time period covered	Currently for entire day	Information broken down between night and day	Information broken into three-hour increments
Q30	Accuracy of high and low temperature forecasts	One day generally accurate ±2°C	Extend to 2 days with same accuracy as current	Extend to five days with same accuracy as current two
Q31	Reliability of seasonal forecasts	Reliable 65% of the time	Being reliable 70% of the time	Being reliable 80% of the time
Q32	Maritime information	Correct 70% of the time	Being correct 80% of the time	Being correct 90% of the time
Q33	Accuracy of flooding and water levels	Correct 70% of the time	Being correct 80% of the time	Being correct 90% of the time

Personnel from INAM reviewed and approved the information and levels included in the analysis. We emphasize though that a lack of historical verification information makes these levels somewhat arbitrary and that they may represent more in terms of relative or ordinal improvements as opposed to truly cardinal measures of forecast accuracy. In addition, we note that we were not able to assess respondents' perception or understanding of the measurement and units used in indicating accuracy or improvements. Future work could focus more on the cognitive aspects of respondents understanding and perceptions of forecast accuracy.

3.7.2 Importance of improving information

For each information attribute, it was stated, "This information could be made more accurate with a program to improve forecasts," and the respondent was asked "How important would it be to you to improve the [attribute from current levels to …]." Respondents then assessed the two levels of improvement on the "Not at all important" = 1 to "Extremely important" = 5 scale. Table 3.35 shows the mean ratings for only the maximal improvements for each of the nine forecast attributes. Improving the accuracy of flooding and water level information rated most important and improving maritime information and geographic detail followed closely. Improving "Cyclone warnings and advisories lead time" received the lowest mean rating of the nine attributes probably due to potentially limited number of respondents likely to be directly affected by cyclones. The lowest mean rating through was 4.10 which is still considered on average as "very important" to improve.

Table 3.35 Mean Rating of Importance of Maximal Attribute Improvements

Question	Information Attribute	Mean
Q25	Cyclone warnings and advisories lead time	4.10
Q26	All other warnings and advisories lead time	4.11
Q27	Accuracy of rainfall information	4.26
Q28	Geographic detail	4.34
Q29	Time period covered	4.14
Q30	Accuracy of high and low temperature forecasts	4.16
Q31	Reliability of seasonal forecasts	4.20
Q32	Maritime information	4.32
Q33	Accuracy of flooding and water levels	4.43

Figure 3.20 shows these mean ratings and, as can be seen, overall there was not a great deal of variability in the mean importance of improving these forecast attributes.

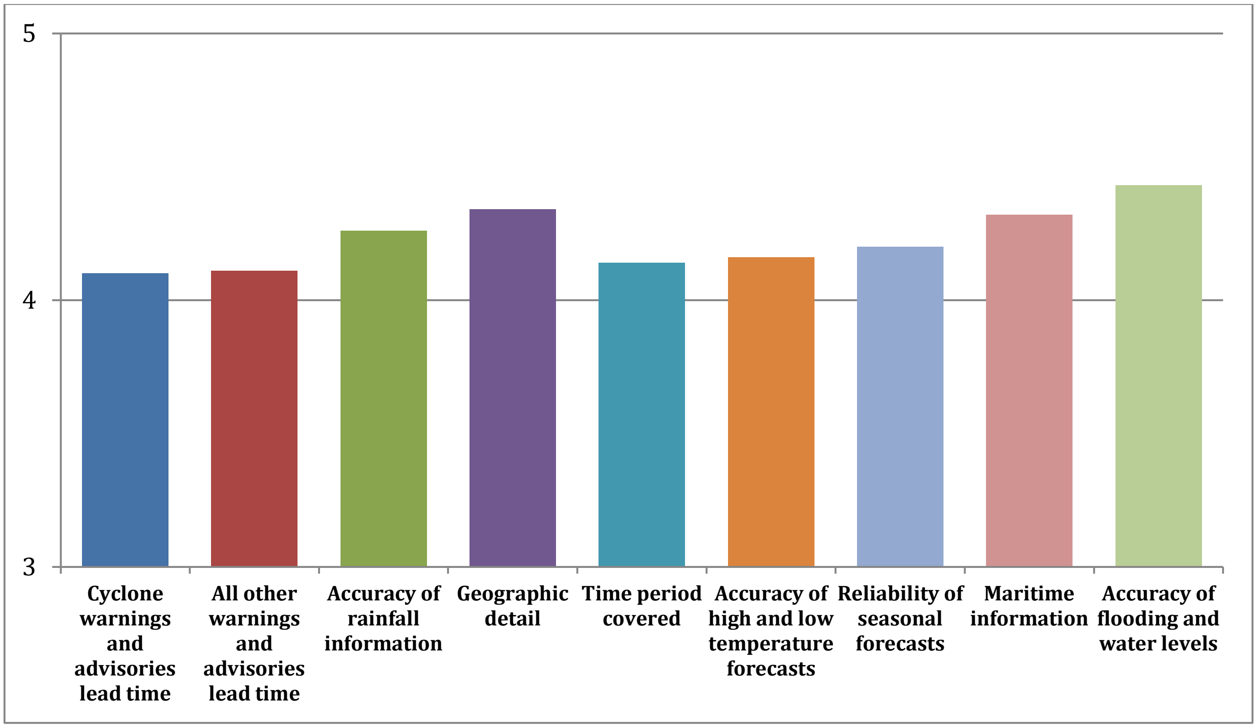

Figure 3.20: Importance of Maximal Forecast Attribute Improvements

Table 3.36 shows the statistical test of difference in improving forecast accuracy and quality (again just for the maximal improvements offered) by the south versus north-central classification. As can be seen, there is a statistically significant greater rating for all attributes in the north and central areas of Mozambique than in the southern area.

Table 3.36: Comparison of Importance of Improving Forecasts by Zone (Maximal Levels Only)				
Forecast Attribute	South (n=337) Average	North-Central (n=239) Average	Kruskal-Wallis Test	Pr > Chi-Square
Cyclone warning lead time of warnings and advisories	3.881	4.397	47.820	0.000
Severe weather warnings and advisories lead time	3.917	4.389	41.982	0.000
Accuracy of rainfall amount, location, and likelihood information	4.142	4.414	14.666	0.000
Geographic detail of weather information	4.196	4.531	24.387	0.000
Weather information time period	4.003	4.343	30.175	0.000
Extend one day temperature forecasts	3.991	4.389	30.871	0.000
Seasonal forecasts	4.172	4.238	3.246	0.072
Maritime information	4.252	4.410	11.651	0.001
Flood forecast accuracy	4.380	4.498	9.868	0.002

Table 3.37 shows the statistical test of difference in improving forecast accuracy and quality (again just for the maximal improvements offered) by the urban versus rural areas. There is not a statistically significant greater rating for any of the attributes between urban and rural areas.

Table 3.37: Comparison of Importance of Improving Forecasts by Urban-Rural (Maximal Levels Only)				
Forecast Attribute	Urban (n=239) Average	Rural (n=337) Average	Kruskal-Wallis Test	Pr > Chi-Square
Cyclone warning lead time of warnings and advisories	4.159	4.050	1.099	0.295
Severe weather warnings and advisories lead time	4.075	4.139	0.536	0.464
Accuracy of rainfall amount, location, and likelihood information	4.289	4.231	2.486	0.115
Geographic detail of weather information	4.331	4.338	0.000	0.982
Weather information time period	4.121	4.160	0.039	0.844
Extend one day temperature forecasts	4.096	4.199	0.503	0.478
Seasonal forecasts	4.184	4.211	0.141	0.707
Maritime information	4.289	4.338	0.089	0.766
Flood forecast accuracy	4.418	4.436	0.073	0.787

Factor analysis of the complete set of items on Importance of Improving Forecasts yielded factors primarily related to maximal or intermediate improvements and thus did not appear to results from an underlying latent factor of forecast information type. To create a more compact measure of the "Importance of Improving Forecasts", an alpha factor analysis was conducted on just the maximal improvement items. Alpha factor analysis is similar to a summative scale, but weights the contributing items similar to a factor score rather than simple linear summation (which is based on equal weighting of all items).[49]

Table 3.38: Alpha Factor Analysis of Importance of Improving Forecasts

(Maximal Levels Only: Q25-33)

Forecast Attribute	Factor1
Q28 Geographic Detail - 128 districts	0.819
Q27 Rainfall - 90%	0.795
Q29 Time Period - 3-hour	0.761
Q33 Flooding - 90%	0.751
Q25 Cyclone Warnings - 5 days	0.720
Q30 Temperature - 5 days	0.709
Q32 Maritime - 90%	0.705
Q31 Seasonal - 80%	0.697
Q26 Other Warnings - 4 days	0.694
Variance Explained	8.999

3.7.3 Importance of information

After individually reviewing and rating the nine attributes on intermediate and maximal improvements, the interviewers asked respondents to consider all of the attributes and rate the importance of that type of information (rather than the importance of improving the information). Given the ordering of the questions, it is suspected that many individuals wouldn't distinguish significantly between the "importance of improving" and "important of the information." This is a slightly different concept than rating the importance of improving the information but the ratings between the two approaches are highly correlated – all of the relevant correlations are highly significant and range from 0.28 to 0.47 and thus not perfectly correlated.

Figure 3.21 shows the mean attribute importance ratings for the entire sample. Overall the forecast attributes were considered somewhat (3.0) to very (4.0) important on the five-point

[49] Alpha factor analysis, which treats common factor analysis as a psychometric method, finds uncorrelated common factors based on maximizing generalizability with regard to coefficient alpha (Cronbach's alpha)(see: Bartholomew et al. 2011). It does not make distribution assumptions and has some computational advantages over maximum likelihood factor analysis (see: Kaiser and Derflinger 1990).

scale. Precipitation information is considered overall as the most important weather forecast information attribute, followed by warnings (cyclones as well as other warnings).

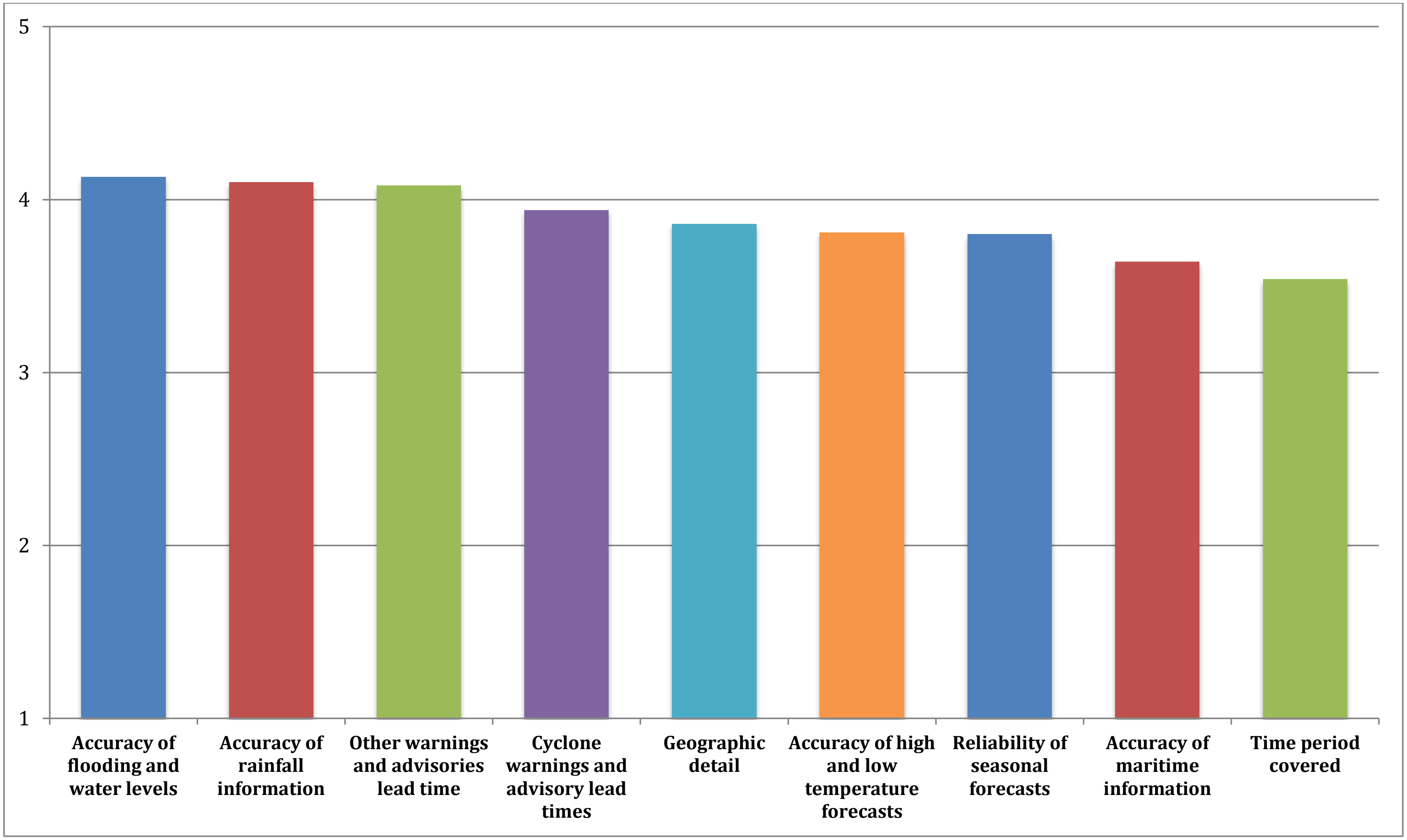

Figure 3.21: Importance of Weather Information (Q34)

Table 3.39 compares importance ratings by zone finding that some attributes (geographic detail and seasonal forecasts) are more important in the south while others (cyclone lead time and flood and precipitation information) are significantly more important to the north-central respondents.

Table 3.39: Comparison of Information Importance (Q34) by Zone

Forecast Attribute	South (n=337) Average	North-Central (n=239) Average	Kruskal-Wallis Test	Pr > Chi-Square
Cyclone warning lead time of warnings and advisories	3.822	4.109	11.237	0.001
Severe weather warnings and advisories lead time	4.042	4.130	0.630	0.427
Accuracy of rainfall amount, location, and likelihood information	4.024	4.201	5.343	0.021
Geographic detail of weather information	3.982	3.699	13.158	0.000
Weather information time period	3.585	3.477	1.809	0.179
Extend one day temperature forecasts	3.816	3.803	0.160	0.689
Seasonal forecasts	3.941	3.598	20.980	0.000
Maritime information	3.644	3.632	0.004	0.952
Flood forecast accuracy	4.006	4.305	16.302	0.000

As shown in Table 3.40, rural respondents also rated some information more important than urban respondents. Specifically, the rural respondents felt that geographic detail, time periods, and maritime forecasts were significant more important than their urban counterparts did.

Table 3.40: Comparison of Information Importance (Q34) Urban-Rural

Forecast Attribute	Urban (n=239) Average	Rural (n=337) Average	Kruskal-Wallis Test	Pr > Chi-Square
Cyclone warning lead time of warnings and advisories	3.958	3.929	0.064	0.801
Severe weather warnings and advisories lead time	4.084	4.074	0.283	0.595
Accuracy of rainfall amount, location, and likelihood information	4.105	4.092	0.103	0.748
Geographic detail of weather information	3.766	3.935	4.311	0.038
Weather information time period	3.477	3.585	2.945	0.086
Extend one day temperature forecasts	3.820	3.804	0.061	0.806
Seasonal forecasts	3.849	3.763	0.815	0.367
Maritime information	3.519	3.724	6.324	0.012
Flood forecast accuracy	4.105	4.148	0.016	0.898

Table 3.41 shows the factor analysis on Question 34. Factor 2 was comprised of the precipitation and warning (cyclone and other warning) items and we label it "Precipitation and Warnings." The other items are not conceptually closely connected so we label the first factor simply "Other

Weather Information Attributes." The close connection of precipitation and warnings suggests that rain, cyclones, and flooding are critical weather phenomena in Mozambique and information about them is critical to the public. This is a reasonable finding given the past history of severe flooding and the impacts of tropical cyclones on this coastal country.

Table 3.41: Factor Analysis of Information Importance (Q34)

Item	Q34_Factor_1 Other Weather Information Attributes	Q34_Factor_2 Precipitation and Warnings
Accuracy of maritime information	.755	
Time period covered	.745	
Reliability of seasonal forecasts	.739	
Geographic detail	.734	
Accuracy of high and low temperature forecasts	.604	.415
Accuracy of rainfall information		.833
Cyclone warnings and advisory lead times		.753
Accuracy of flooding and water levels		.711
Other warnings and advisory lead times	.451	.652
Variance Explained	2.92	2.57

(Q34. Thinking about the different types of weather information just discussed, how important to you are the different types information provided by INAM, DNA, and the ARAs?)
N=576. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.874. Bartlett's test is highly significant ($p < 0.001$), therefore factor analysis is appropriate for these data. These two factors explain 61.0% of the total variance.
The determinant of the correlation matrix is 0.027 (> 0.00001), so multicollinearity is not a problem for these data.

3.7.4 Importance of improving information from government agencies

The interviewers then asked the even more general question of "Overall, how important to you is to that INAM, DNA, and the ARAs improve the accuracy of the information they provide?" The intent is to gather a summative measure of the importance of improving forecasts while also getting respondents to assess once more the potential value or lack of value of forecast information prior to being led into the value elicitation exercise. Figure 3.22 shows the frequency distribution of responses on the five-point scale where by far the majority of respondents (78.1%) indicated that improving forecasts is either very or extremely important to them.

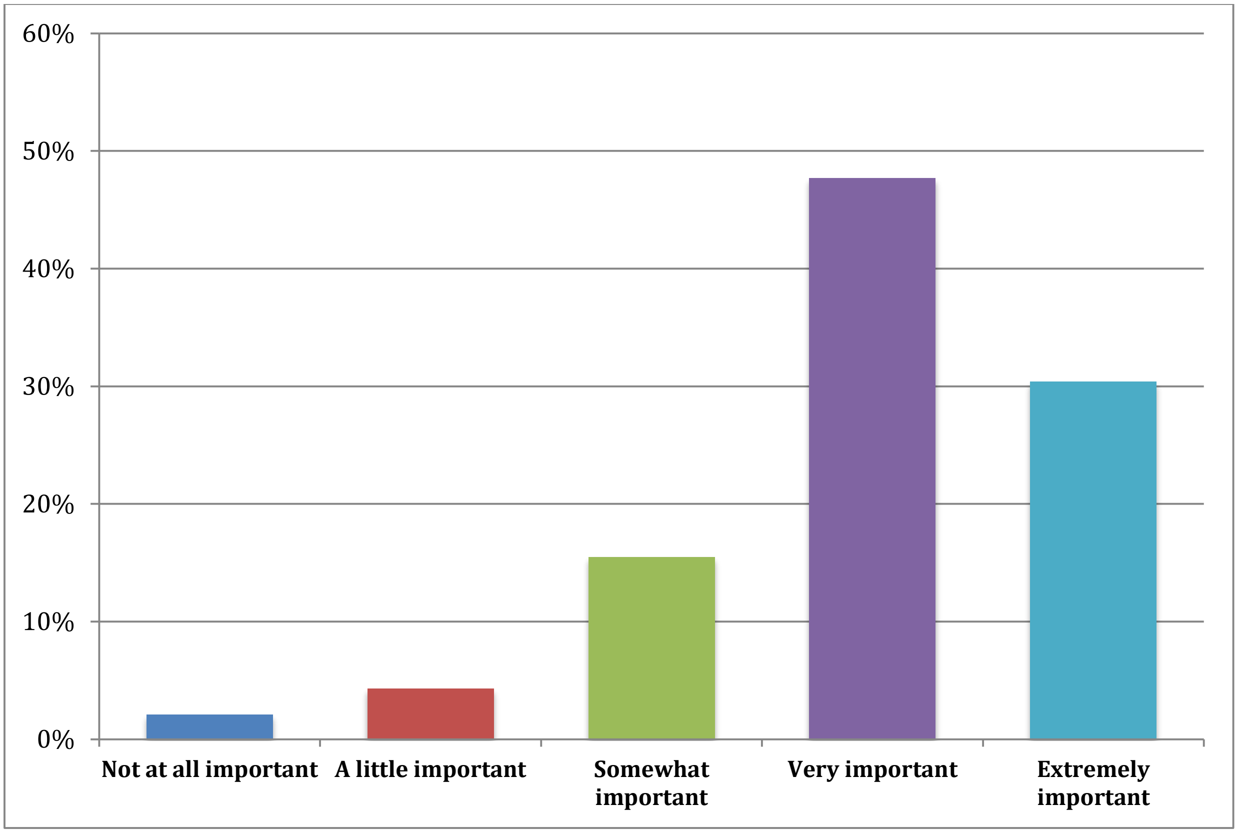

Figure 3.22: Importance of INAM, DNA, and ARAs Improving Information Accuracy

Table 3.42 shows the zonal comparison of the overall importance of improving forecast accuracy. Respondents in the north-central zone rated it more important overall to improve forecast information than did those in the south. This is consistent with results shown in Table 3.36 where those in the north-central zone rated it significantly more important to improve each of the nine forecast information attributes than did those in the south.

Table 3.42: Comparison of Overall Information Improvement Importance (Q35) by Zone

Forecast Attribute	South (n=337) Average	North-Central (n=239) Average	Kruskal-Wallis Test	Pr > Chi-Square
Q35. Overall, how important to you is to that INAM, DNA, and the ARAs improve the accuracy of the information they provide?	3.825	4.247	33.43	<.0001

Table 3.43 shows the urban-rural comparison of the overall importance of improving forecast accuracy. There is barely a statistically significant (p=0.097) greater rating of the overall

importance for forecast improvements for urban respondents than those in and rural areas. This is generally consistent with results shown in Table 3.37 where there was not a significant difference between urban and rural residents on any of the nine forecast attributes.

Table 3.43: Comparison of Overall Information Improvement Importance (Q35) by Urban-Rural

Forecast Attribute	Urban (n=239) Average	Rural (n=337) Average	Kruskal-Wallis Test	Pr > Chi-Square
Q35. Overall, how important to you is to that INAM, DNA, and the ARAs improve the accuracy of the information they provide?	4.088	3.938	2.7522	0.0971

4 ECONOMIC ANALYSIS

In this section, analysis of the economic benefit elicitation portions of the survey are presented. Prior to presenting those analyses, three issues are discussed that affect the analysis in valuation exercises:

1. Monetary constraints
2. Non-use Values: Altruistic, bequest, and existence values
3. Scenario rejection and motivations and barriers to WTP

Then, results are presented from three different economic valuation exercises included in the survey:

4. Elicitation of the value of current weather information services and products
5. Elicitation of willingness to pay (WTP) for improved weather information using a discrete choice experiment (DCE)
6. Elicitation of WTP for improved weather information using the contingent valuation method (CVM)

4.1 Related Analysis Feeding into Value Analysis

4.1.1 Monetary Constraint

A significant concern in undertaking non-market valuation studies in developing countries is that many individuals may have no monetary income and thus asking willingness to pay in monetary terms may not yield meaningful results regarding the value to a respondent. Of the respondents, 32.1% (185 of 576) indicated that they had no monetary income and another 4.7% didn't answer the question eliciting their income level. There was no significant difference in the proportion indicating no monetary income between the south and north-central respondents (χ^2=0.782, df=1, p=0.377) while significantly more rural respondents did indicate that they do not have a monetary income (χ^2=20.795, df=1, p=<.0001). Of rural respondents, 41.3% do not have a monetary income compared to 22.5% of urban respondents.[50]

[50] An ordered probit regression on having a monetary income (regression not shown) indicated that those in urban areas, male, married, and having electricity in the household were more likely to have a monetary income. Zone,

A new approach was attempted to address this issue by identifying respondents with a monetary constraint and factoring that into the analysis of responses using a scaling approach indicating their self-assessed level of monetary constraint. Rather than imputing an income based on value of labor or some alternative wealth measure, the variable "Money constrained" was developed. To do so, individuals were asked: "If you had to obtain some money, how difficult would it be for you to do each of the following?" on a scale from 1 = "Impossible" to 5 = "Not at all difficult" individuals indicated the difficulty of getting money by way of the following options: "Undertake a day of labor for 30 MT", "Sell or trade some of my crops or other possessions for 60 MT," and "Borrow 640 MT from friends or neighbors." The responses were then summed up into these three questions where a sum of 15 would thus indicate no difficulty in getting money for these activities and a sum of three would indicate it was impossible. By subtracting that sum from 15, a scale is created where zero means there is no difficulty in getting money and a twelve means it is impossible for the individual to get money for by these approaches. We feel this scale represents a potential measure of the individual's access to monetary activities whether due to restricted income or by inability to access monetary transactions. Table 4.1 and Figure 4.1 show the frequency count by level of monetary constraint ranging from no constraint (2.78% of respondents) to extreme constraint (6.60% of respondents).

Table 4.1: Monetary Constraint

(Larger number represents a more significant money constraint)

Monetary Constraint Scale	Frequency	Percent
0	16	2.78%
1	8	1.39%
2	27	4.69%
3	55	9.55%
4	59	10.24%
5	56	9.72%
6	84	14.58%
7	56	9.72%
8	52	9.03%
9	59	10.24%
10	43	7.47%
11	23	3.99%
12	38	6.60%
Total	576	100.00%

education, age, household size, and having piped water or advanced sanitation were not explanatory of having a monetary income.

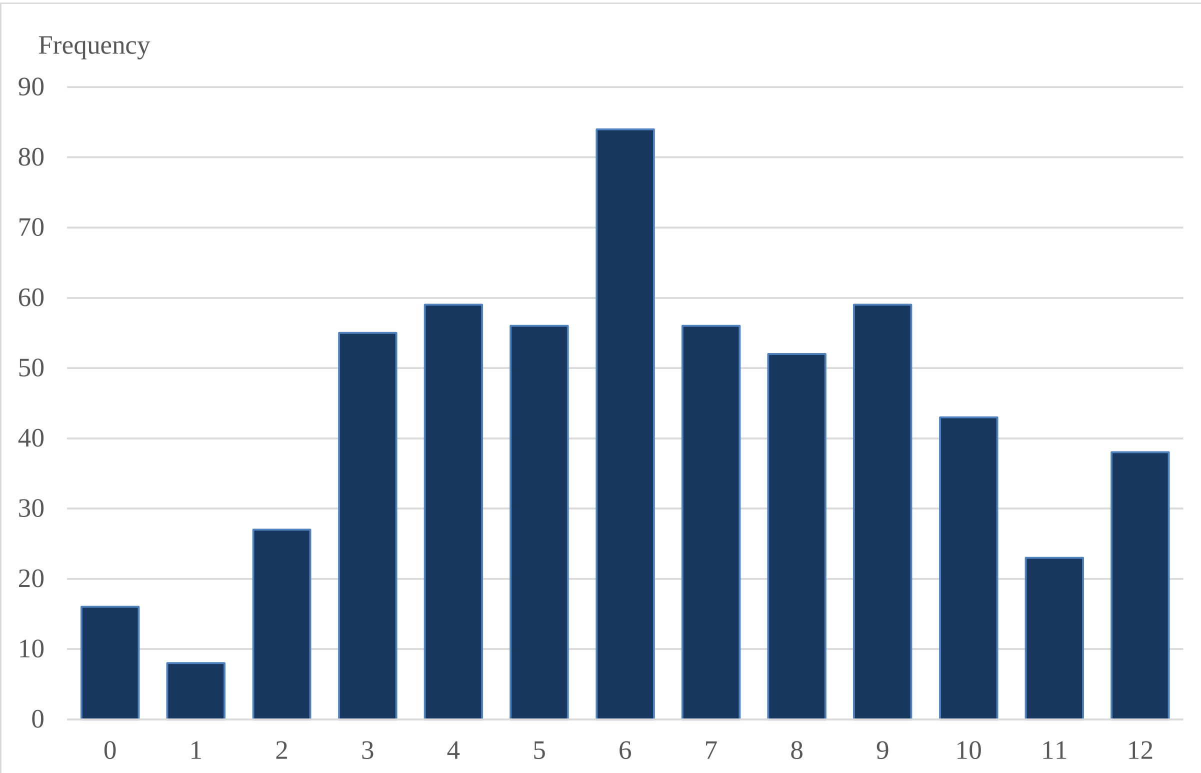

Figure 4.1: Distribution of Level of Monetary Constraint

On the zero to twelve point scale, those in the south indicated a significantly greater level of monetary constraint (average of 7.20 versus 5.43 for the north-central respondents, (χ^2=47.995, df=1, p=<.0001) and those in urban areas reported a significantly greater level of monetary constraint than those in rural areas (average of 6.770 versus 6.252 for the rural respondents, (χ^2=4.5172, df=1, p=0.034). Given that more rural residents reported that they had no monetary income, it is surprising that those in urban areas actually indicated a greater monetary constraint based on the items we used in this assessment.

As discussed earlier and in Appendix A, a fitted value was created for income for individuals who did not indicate an income level. This was weakly (negatively) but significantly correlated with the Monetary Income scale (Pearson Correlation Coefficient of -0.074; n=576; p=0.08). It is likely that the monetary constraint variable is measuring something related to but functionally different from the actual monetary income and thus we explore its explanatory power below in responses to the valuation questions.

4.1.2 Non-use Values: Altruistic, bequest, and existence values

As indicated by responses to questions regarding the likely use of information, most respondents use hydro-meteorological (hydro-met) information for some aspect of their own decision-making (e.g., how to dress for the day, weather impacts on work activities, etc.). In economic terminology, such information uses would be labeled "use values." Values for many non-market commodities have also been found to include a range of non-use values generally defined as benefits from a commodity that may be derived even if the commodity is not explicitly consumed or used by the respondent. In other words, for weather, water, and climate forecasts, it may be hypothesized that an individual has value for this information even if she does not use that information for her own decision-making. Various taxonomies of non-use values have been proposed, but theorists and researchers often suggest that an individual may have value for a good or service that is consumed by someone else (i.e., altruistic value), is available to future generations (i.e., bequest values), or simply value the fact that these goods or services exist even if never used by anyone (i.e., existence values) (Lazo et al. 1992; Lazo et al. 1997; Schulze et al. 1998; Nguyen. 2014; Nguyen and Robinson. 2013). Lazo et al. 1992 discussed several approaches for identifying non-use values including directly asking individuals for their motivations for responses to WTP questions.

Initially, it was presumed that there would likely not be non-use values for weather, water, and climate information as such information seems most likely to be used in active decision-making. Following results reported in Nguyen. 2014 (which was based in part on methods developed in Lazo et al. 1992), it was decided for this report to explore the possibility of non-use values for this information in Mozambique.

Following the contingent valuation payment card question a similar approach was used from Lazo et al. 1992. The approach was to tell respondents "Below are some motivations people indicate when answering the question about how much they are willing to pay to improve weather forecasts" and then ask them to "rate each reason based on how much it influenced your answer of how much you would be willing to pay for the single program." The motivations listed are shown below with our interpretation of the type of value for each statement indicated in italics following the statement:

1. Improving forecasts would be beneficial to me personally (*use*)
2. Improving forecasts would be beneficial to other people in my family (*altruistic*)
3. Improving forecasts would be beneficial to other people in my district (*altruistic*)
4. Improving forecasts would be beneficial to other people in my country (*altruistic*)
5. Improving forecasts would be beneficial to future generations (*bequest*)
6. Improving forecasts is simply good regardless of who they benefit (possibly interpretable as *existence*)

Respondent's rated each one on a 1 to 5 scale where 1="Did not influence my answer at all" to 5="Greatly influenced my answer." Figure 4.2 shows the mean responses indicating little difference in responses across the motivations offered. Even though the mean values appear similar, there is a statistical difference between responses. For instance, the mean value of "Improving forecasts is simply good regardless of who they benefit" is significantly larger than the mean for "Improving forecasts would be beneficial to me personally" ($t=5.16$, $p<.0001$, $n=575$). It was expected though that use values would be rated higher than non-use values in general; thus, while this could, in part, be a fatigue issue due to the length of the survey, the self-rated motivation scores were included in the analysis reported below to explore potential relationships between values for weather information and these use and non-use values.

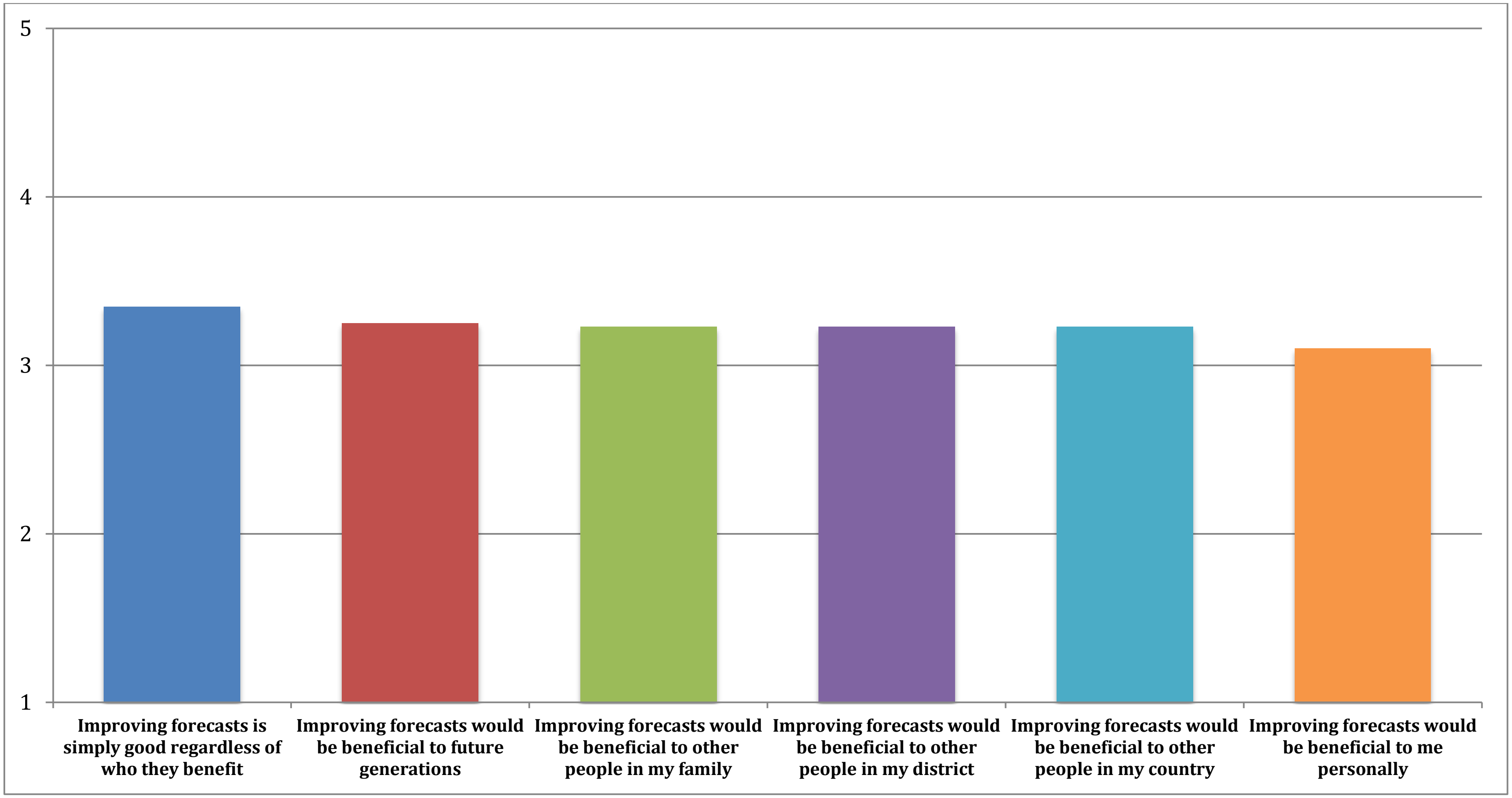

Figure 4.2: Responses to Use and Non-Use Motivations for Willingness To Pay (WTP)

As with other results in this survey, the potential locational differences were examined in motivations by zone (Table 4.2) and for urban-rural respondents (Table 4.3). Those in the south rated the statements significantly higher across all motivations than those in the north-central regions while those in urban areas rated local (family and district) altruistic values higher than those in rural areas.

Table 4.2: Comparison of WTP Motivations by Zone

Improving forecasts…	South (n=337) Average	North-Central (n=239) Average	Kruskal-Wallis Test	Pr > Chi-Square
… would be beneficial to me personally	3.252	2.883	9.128	0.003
... would be beneficial to other people in my family	3.335	3.088	3.284	0.070
... would be beneficial to other people in my district	3.404	2.975	14.013	0.000
... would be beneficial to other people in my country	3.377	3.021	9.024	0.003
... would be beneficial to future generations	3.409	3.033	9.670	0.002
… is simply good regardless of who they benefit	3.525	3.100	11.668	0.001

Table 4.3: Comparison of WTP Motivations by Urban-Rural

Improving forecasts…	Urban (n=239) Average	Rural (n=337) Average	Kruskal-Wallis Test	Pr > Chi-Square
... would be beneficial to me personally	3.197	3.030	2.139	0.144
... would be beneficial to other people in my family	3.377	3.131	5.393	0.020
... would be beneficial to other people in my district	3.343	3.142	3.416	0.065
... would be beneficial to other people in my country	3.297	3.181	1.140	0.286
... would be beneficial to future generations	3.276	3.237	0.167	0.683
... is simply good regardless of who they benefit	3.385	3.323	0.586	0.444

A factor analysis of the WTP motivations (Table 4.4) revealed only a single factor providing further indication that respondents may not have distinguished significantly between the use, altruistic, bequest, and existence motivations for their WTP for forecast improvements. As only one factor was indicated, an alpha-factoring analysis was used to generate a factor score. Alpha factor analysis, which treats common factor analysis as a psychometric method, finds uncorrelated common factors based on maximizing generalizability with regard to coefficient alpha (Cronbach's alpha, see Bartholomew et al. 2011 p. 44-45). It does not make distribution assumptions and has some computational advantages over maximum likelihood factor analysis (Kaiser et al. 1990).

Table 4.4: Factor Analysis of WTP Motivations	
	Factor1
Item	Motivation
Improving forecasts would be beneficial to other people in my country	.890
Improving forecasts would be beneficial to other people in my district	.886
Improving forecasts would be beneficial to other people in my family	.884
Improving forecasts is simply good regardless of who they benefit	.879
Improving forecasts would be beneficial to future generations	.875
Improving forecasts would be beneficial to me personally	.837
Variance Explained	76.7%
N=576. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.913. Bartlett's test is highly significant (p < 0.000), therefore factor analysis is appropriate for these data. The determinant of the correlation matrix is 0.006 (> 0.00001), so multicollinearity is not a problem for these data.	

4.1.3 Scenario rejection and motivations and barriers to WTP

Other potential issues affecting respondents' stated values are variously labeled scenario rejection, protest bids, or hypothetical bias (McClelland et al. 1992; McClelland et al. 1993; Champ et al. 2003; Groothuis and Whitehead. 2009). These overlapping issues may occur in stated preference surveys if respondents' answers do not accurately reflect their true WTP due to some aspect of the survey or scenario being offered. For instance if an individual values a commodity but dislikes paying taxes, he may state a zero WTP for that commodity if the payment mechanism is a tax and not because he does not have a true value for the commodity.

Similar to our approach in dealing with altruistic and bequest values, and again following in part methods developed in Lazo et al. 1992, statements were offered for evaluation that could be interpreted as indications of scenario rejection as well as valid motivations for stated WTP. Following the contingent valuation payment card question a similar approach was used here by telling respondents "Below are some reasons why people choose the amounts they do when answering the previous question" and then asking them to "Please rate each reason based on how much it influenced your answer of how much you would be willing to pay for the single program." The motivations listed are shown below with our interpretation of the meaning for each statement indicated in italics following the statement:

- I cannot afford to pay more for better weather forecasts (*valid WTP motivation*)
- It would be useful to me to have improved forecasts (*valid WTP motivation*)
- I should not have to pay for weather forecasts (*scenario rejection*)

- I don’t believe the program will actually improve weather forecasts (*scenario rejection*)
- I believe it is NOT my responsibility to pay for the program even if it benefits me (*scenario rejection*)
- I wouldn’t be affected by the program as I don’t use weather forecasts (*valid WTP motivation*)
- I think weather forecasts are good enough now (*valid WTP motivation*)
- I don’t think money collected in taxes would actually go to the program (*scenario rejection*)
- I need more information before being willing to pay anything (*scenario rejection*)
- I get my forecasts from other sources than the government (*valid WTP motivation*)

Respondent’s rated each statement on a 1 to 5 scale where 1=“Did not influence my answer at all” to 5=”Greatly influenced my answer.”

Figure 4.3 shows the mean responses in descending order. The “valid” responses are colored green and “rejection” responses colored red. No statement received an average rating above 3.0 on the five-point scale. The largest influence on WTP was “It would be useful to me to have improved forecasts,” which is similar to the idea of use values discussed above. And the least influential statement was, “I get my forecasts from other sources than the government,” which suggests that for the most part WTP for improved forecasts was not affected by substitutes for government provided information options.

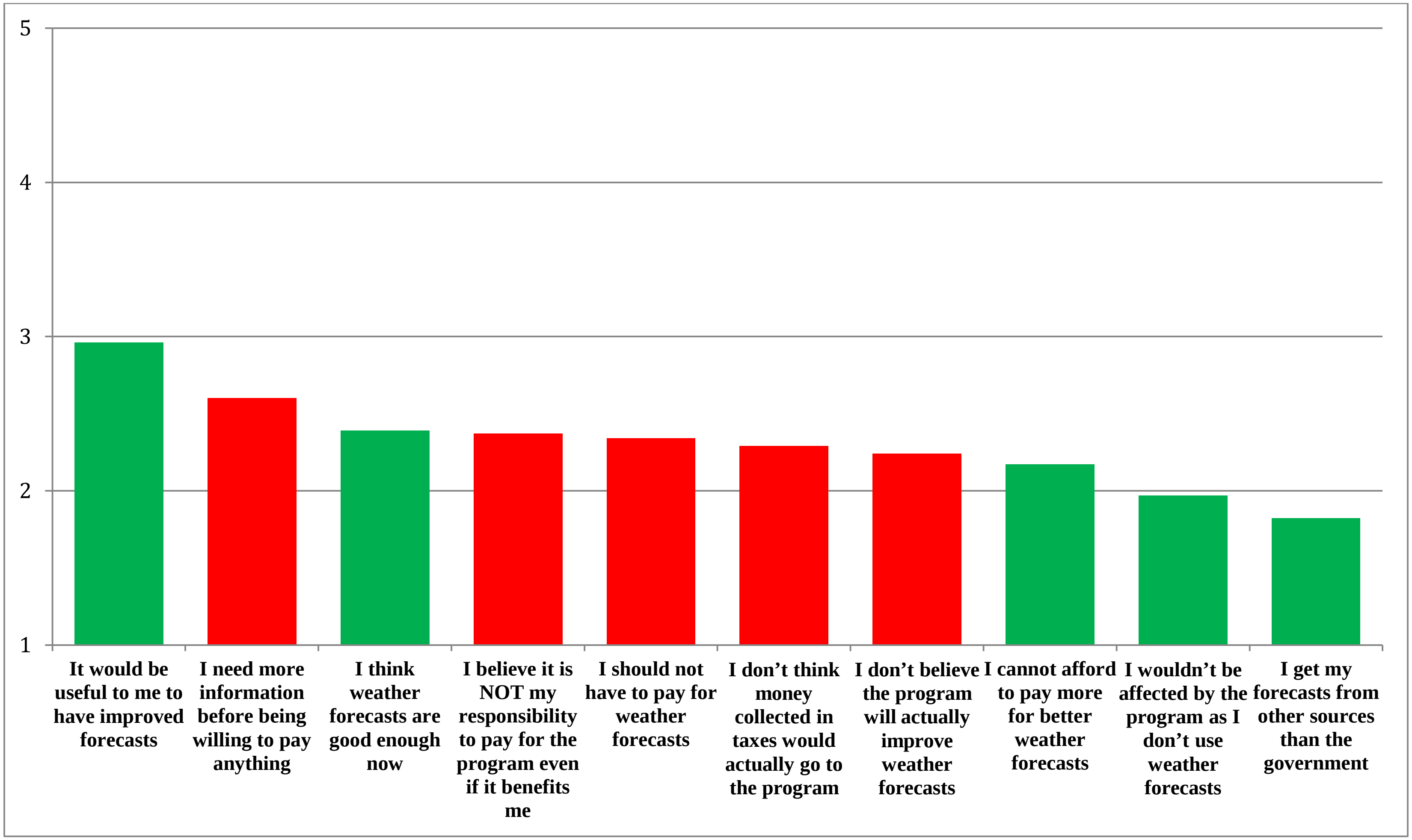

Figure 4.3: Responses to Scenario Rejection and Motivation for Willingness To Pay

(Valid responses colored green and rejection responses colored red)

Table 4.5 compares scenario rejection and valid motivation responses by zone (south versus north-central) sorted by valid responses (labeled V in the left most column) and scenario rejection statements (labeled R in the left most column). Respondents in the south indicated that their WTP responses were significantly more influenced by two of the valid reasons ("I cannot afford to pay more for better weather forecasts" and "It would be useful to me to have improved forecasts") while also indicating a larger degree of scenario rejection in feeling that "I should not have to pay for weather forecasts."

Table 4.5: Comparison of Scenario Rejection and Motivation by Zone

Valid (V) or Rejection (R)	Item	South (n=337) Average	North-Central (n=239) Average	Kruskal-Wallis Test	Pr > Chi-Square
V	I cannot afford to pay more for better weather forecasts	2.258	2.042	3.822	0.051
V	It would be useful to me to have improved forecasts	3.059	2.820	3.856	0.050
V	I wouldn't be affected by the program as I don't use weather forecasts	1.958	1.987	0.004	0.948
V	I think weather forecasts are good enough now	2.424	2.331	1.706	0.192
V	I get my forecasts from other sources than the government	1.772	1.879	2.147	0.143
R	I should not have to pay for weather forecasts	2.481	2.151	7.900	0.005
R	I don't believe the program will actually improve weather forecasts	2.270	2.197	0.702	0.402
R	I believe it is NOT my responsibility to pay for the program even if it benefits me	2.439	2.272	1.750	0.186
R	I don't think money collected in taxes would actually go to the program	2.353	2.209	2.107	0.147
R	I need more information before being willing to pay anything	2.596	2.607	0.009	0.926

Table 4.6 compares scenario rejection and valid motivation responses by urban-rural respondents sorted by valid responses (labeled V in the left most column) and scenario rejection statements (labeled R in the left most column). Respondents in the urban areas indicated that their WTP responses were significantly more influenced by two of the valid reasons ("I cannot afford to pay more for better weather forecasts" and "It would be useful to me to have improved forecasts") while those in rural areas were significantly more influenced by two of the valid reasons ("I wouldn't be affected by the program as I don't use weather forecasts" and "I get my forecasts from other sources than the government"). These findings are consistent with earlier indications that urban residents experience more significant monetary constraints. Earlier analysis (Table

3.12: Comparison of Urban-Rural Source Frequency) indicated however that rural residents in general obtain forecasts much more often from most sources than urban residents. Rural residents had a proportionately larger reliance on non-government sources than urban residents did so it is possible they perceive that more of their information is from non-government sources (even if all weather information may ultimately derive from a government agency).

Table 4.6 also shows that urban residents indicated significantly more scenario rejection on three of the five “rejection” statements than rural residents did. This may indicate a larger degree of skepticism about government programs or distrust of government agencies amongst urban residents compared to rural respondents.

Table 4.6: Comparison of Scenario Rejection and Motivation by Urban-Rural

Valid (V) or Rejection (R)	Item	Urban (n=239) Average	Rural (n=337) Average	Kruskal-Wallis Test	Pr > Chi-Square
V	I cannot afford to pay more for better weather forecasts	2.360	2.033	7.940	0.005
V	It would be useful to me to have improved forecasts	3.259	2.748	17.952	0.000
V	I wouldn’t be affected by the program as I don’t use weather forecasts	1.879	2.036	3.320	0.068
V	I think weather forecasts are good enough now	2.402	2.374	0.072	0.789
V	I get my forecasts from other sources than the government	1.640	1.941	11.209	0.001
R	I should not have to pay for weather forecasts	2.473	2.252	3.477	0.062
R	I don’t believe the program will actually improve weather forecasts	2.234	2.243	0.021	0.886
R	I believe it is NOT my responsibility to pay for the program even if it benefits me	2.397	2.350	0.023	0.878
R	I don’t think money collected in taxes would actually go to the program	2.452	2.181	4.723	0.030
R	I need more information before being willing to pay anything	2.778	2.475	5.125	0.024

Table 4.7 shows results of a factor analysis of the responses to the Scenario Rejection and Motivation question to examine what impacts tended to be associated with each other. Using standard criteria for factor analysis resulted in three factors being retained that are labeled (1) Scenario Rejection, (2) Valid, and (3) Useful, based on the items loading into each factor. The first factor is comprised of four statements that are considered to be indicative of scenario rejection as well as one valid statement (can’t afford to pay). The second factor is comprised of

three statements we consider valid influences for having a lower WTP such as simply not using forecasts. The third factor is comprised of one valid and one rejection statement and we label this "Useful" as it loaded more on the statement "It would be useful to me to have improved forecasts" which was also the most influential statement as indicated in Figure 4.3.

Table 4.7: Factor Analysis of Scenario Rejection and Motivation

V/R *	Item	Factor1 Scenario Rejection	Factor2 Valid Non-WTP	Factor3 Useful
R	I should not have to pay for weather forecasts	.858		
R	I believe it is NOT my responsibility to pay for the program even if it benefits me	.800		
V	I cannot afford to pay more for better weather forecasts	.749		
R	I don't believe the program will actually improve weather forecasts	.749		
R	I don't think money collected in taxes would actually go to the program	.730		
V	I get my forecasts from other sources than the government		.832	
V	I wouldn't be affected by the program because I don't use weather forecasts	.401	.715	
V	I think weather forecasts are good enough now		.678	
V	It would be useful to me to have improved forecasts			.870
R	I need more information before being willing to pay anything			.642
	Variance Explained	3.35	1.93	1.43

* Valid (V) or Rejection (R)
N=576. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.867. Bartlett's test is highly significant ($p < 0.000$), therefore factor analysis is appropriate for these data. These three factors explain 67.2% of the total variance.
The determinant of the correlation matrix is 0.026 (> 0.00001), so multicollinearity is not a problem for these data.

For each factor, the factor scores were retained for use in analysis described below (e.g., regression analysis on willingness to pay for current or improved forecast information).

4.2 Values for Current Services

4.2.1 Current Value Question Format

Individuals were asked to state whether or not they felt the value of current products and services was more than, equal to, or less than an amount we told them was currently being spent by the government to provide those services. This was an attempt to elicit economic values for current services with the caveat that determining the value of current services and products is technically and theoretically very difficult (especially for non-market commodities where there is no price signal). The approach used here is similar to one implemented in the United States (Lazo et al.

2009) and we treat this as much as a statement of opinions and preferences as a rigorous economic evaluation.

Respondents were first told:

> **The activities of INAM, DNA, and the ARAs are paid for through taxes, fees, and licenses as a part of the national government. This money pays for all of the equipment, personnel, and activities of INAM, DNA, and the ARAs in producing weather information.**

This information is in part to inform respondents of the activities of the various hydro-met agencies as well as lay the groundwork for the "payment vehicle" for these goods and services in terms of taxes, fees, and licenses. Respondents were then asked to:

> **Suppose you were told that every year about *XYZ* MT of the average Mozambican's taxes, fees, and licenses goes toward paying for all of the weather forecasting and information services provided by INAM, DNA, and the ARAs.**

The XYZ amount inserted was randomly varied amongst respondents as one of four funding levels: 15, 60, 240, or 960 MT per year. Using the same offer level for "XYZ", respondents were then asked:

> **Do you feel that the services you currently receive from the activities of INAM, DNA, and the ARAs are worth at least *XYZ* MT a year, more than *XYZ* MT a year, or less than *XYZ* MT a year to you? *Please select only one option.***

The objective was to have enough of a range of offers that significantly different responses across offer levels would be received.

4.2.2 Current Value Question Results

Table 4.8 shows the distribution of response with "Worth at least" and "Worth more" combined into the category "Worth at least or more than XYZ MT a year to me." The number of respondents ("n") answering each version was sufficient (n≥132 for all versions) for advanced statistical analysis.

Table 4.8 Distribution of Responses to Current Value Question			
Variable Name	Worth at least or more than ***XYZ*** MT a year to me	Worth less than ***XYZ*** MT a year to me	n
Curr15 (Version 1)	110 69.6%	48 30.4%	158
Curr60 (Version 2)	77 52.4%	70 47.6%	147
Curr240 (Version 3)	55 39.6%	84 60.4%	139
Curr960 (Version 4)	41 31.1%	91 68.9%	132

Figure 4.4 shows the percent of "Worth at least or more than XYZ MT a year to me" responses to the four offer levels. The monotonically decreasing number of responses is expected as economic theory generally would indicate fewer and fewer people are willing to buy a commodity (in this case weather, water, and climate information) the higher the price (or cost). This is basically equivalent to a downward sloping demand curve for current hydro-met information.

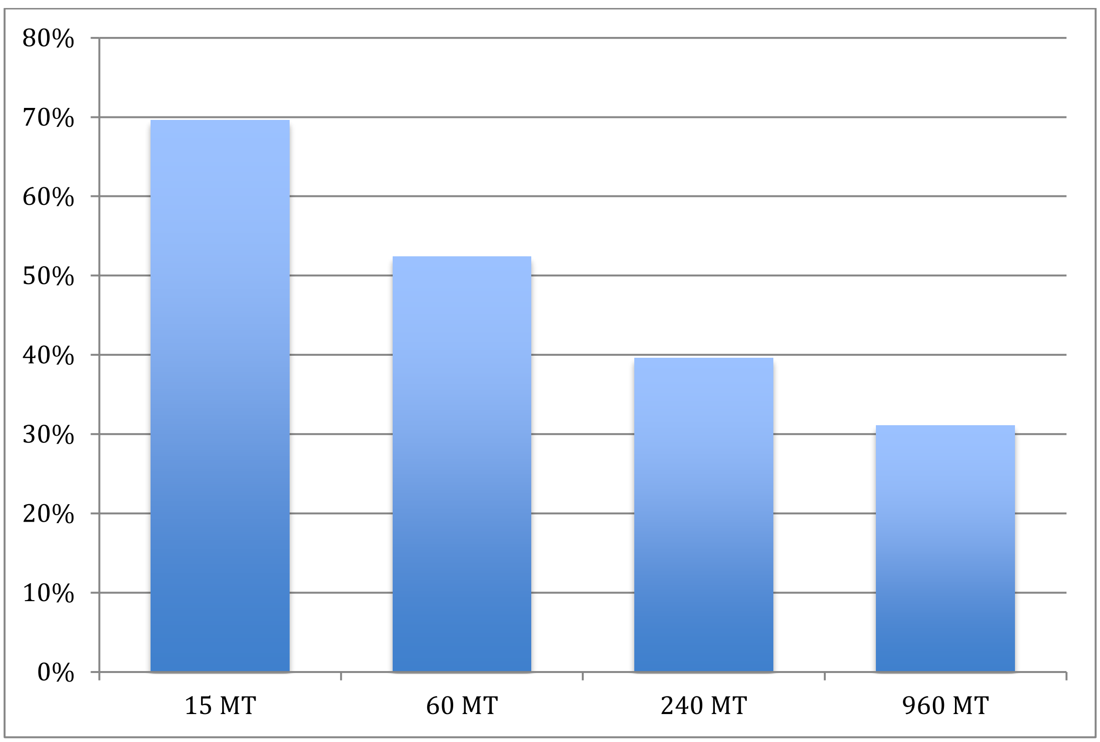

Figure 4.4: Percent of respondents saying current forecasts are "Worth at least or more" than cost indicated

4.2.3 Current Value Question Analysis

To further examine the determinants of values for current weather, climate, and water information probit regression was performed on the bivariate responses ("Worth at least" and "Not worth at least"). Table 4.9 shows five hierarchical models in which additional explanatory variables were added to each model to better understand the influence of different sets of explanatory variables on stated values. Note that a large number of significant digits were reported on some variables (e.g., income) not to suggest a level of precision but to show inter-model variation in parameter estimates (rather than rescaling the independent variables).

The row "Max-rescaled R-Square" reports a non-linear variant on Adjusted-R-squared as a measure of model fit. Model fit on all models is at an acceptable level for cross-sectional data. The likelihood ratio χ^2 is also reported which is a measure of model fit (all models are highly significant) and could be used to evaluate inter-model improvements (not reported here) if so desired.

Table 4.9: Probit Regression on Value of Current Forecast Information					
	Model 1	Model 2	Model 3	Model 4	Model 5
Max-rescaled R-Square	0.075	0.114	0.147	0.1686	0.2228
Likelihood Ratio χ^2	33.16	51.43	67.11	77.8786	105.2929
df	1	3	12	21	25
Pr > χ^2	0.0001	0.0001	0.0001	0.0001	0.0001
Association of Predicted Probabilities and Observed Responses (Percent Concordant)					
	54.80%	64.70%	69.90%	71.10%	73.70%
Parameter Estimate					
Intercept	0.221***	0.5034***	0.782**	0.8702**	1.0231**
"Offer" Cost of Products and Services					
Current_Value_Level	-0.00083***	-0.00085***	-0.00089***	-0.00086***	-0.00092***
Locational Dummy Variables					
Zone_South_Dummy_Vbl		-0.4635***	-0.408***	-0.4575***	-0.4946***
Urban_Rural_Dummy		-0.016	0.033	0.043	0.051
Socio-demographic					
Monetary Constraint			-0.037*	-0.0387*	-0.0396*
Income (MT/year)			0.00000487*	0.00000494*	0.00000345
Employed (Not = 0; Part of Full time =1)			-0.2462*	-0.2644*	-0.181
Education (Years)			-0.027	-0.029	-0.0355*
Age (Years)			0.001	0.001	0.001
Gender (Female=1; Male=1)			-0.047	-0.031	-0.036
Married (Married =1; Not =0)			-0.056	-0.081	-0.095
Length of Residency (Years)			0.002	0.001	0.002
Household Size			0.030	0.032	0.035
Forecast Use					
PartB_Q18_satis_fcst				-0.009	-0.029
Attributes_Factor_1_ (Wind)				0.032	-0.002
Attributes_Factor_2_ (Temperature)				-0.056	-0.1518**
Attributes_Factor_3_ (Rain)				0.047	0.016
Sources_Factor_1_Fac (Agencies)				-0.1066*	-0.099
Sources_Factor_2_Fac (Infrequent Source)				0.024	0.059
Sources_Factor_3_Fac (Frequent Sources)				-0.054	-0.059
Uses_Factor_1_Scores (Short Term Decisions)				0.1586**	0.113*
Uses_Factor_2_Scores (Longer Term Decisions)				0.023	0.019
CMV Motivations, Scenario Rejection, and Non-Use Values					
CVMF1_Factor_1_Score (Reject)					-0.159***
CVM_Factor_2_Score (Valid)					0.1077*
CVM_Factor_3_Score (Useful)					0.012
Use/Non-Use Alpha Factor					0.2634***

N=576 for all models. Attributes:Table 3.22: Factor Analysis of Importance of Weather Information Attributes; Sources: Table 3.13: Factor Analysis of Source Frequency; Uses: Table 3.19: Factor Analysis of Use Weather Forecasts; CVM_Factors: Table 4.7: Factor Analysis of Scenario Rejection and Motivation; Use/Non-Use Alpha Factor: Table 4.4: Factor Analysis of WTP Motivations. ***, **, * indicate significant at the 1%, 5%, and 10% levels respectively.

Model 1 simply looks at the relationship between the offer cost and responses. This is essentially the monotonic relationship shown in Figure 4.4. The highly significant negative parameter estimate on Current Value Level of -0.00083 indicates that as the offer price increases the likelihood of the respondents indicating that the services are worth that much to them decreases. The parameter estimate on "Current Value Level" is significant and of relatively the same magnitude in all five models shown.

In Model 2, the dummy variables are added for zone and urban-rural that were used throughout the prior analysis to examine locational differences in preferences. Significant negative parameter estimates on zone indicate that those in the south parts of the country have lower values for current services than those in the north and central parts of Mozambique. There is not a significant difference between urban and rural respondents' values for current services.

Model 3 adds socio-demographics explanatory variables including both the measure of monetary constraint and the income (reported or fitted if not reported as explained in Appendix A.2). Both of these measures of "ability" to pay are significant and of the expected sign. The negative parameter estimate on the monetary constraint indicates that the more monetarily constrained an individual felt they are the less they are willing to pay for current information services. The dummy variable "employed" is significant and negative in Models 3 and 4 suggesting a lower value for those with full or part time employment.[51] For the most part, other socio-demographic measures do not help explain values for current services.

Model 4 adds a series of measures and factor scores on satisfaction with forecasts, importance of forecast attributes, sources of information, and uses of this information for decision-making. The positive and significant estimate on the factor score for "Short-Term Decisions" indicates that those who use current forecasts more for short term decision-making value current information more than those who don't use them as much. For the most part, the other forecast attribute

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[51] One reviewer raised the possibility of a multi-collinearity between income and employment. Interesting while these are not correlated (Pearson Correlation Coefficient 0.95), being employed and monetarily constrained are positively correlated (i.e., counterintuitively, those who are employed were more inclined to report a monetary constraint) (Pearson Correlation Coefficient 0.16, p=.0002). Including different combinations of these three variables (income, employed, monetarily constrained) in the Model 5 did not substantively change any results.

measures do not help explain the value for current forecasts including current level of satisfaction.

Model 5 adds the use/non-use alpha factor score and the factor scores indicating scenario rejection or valid motivations from the CVM payment card question that followed later in the survey. These measures have explanatory power with respect to value for current information as three of the four measures are significant in Model 5. The negative parameter on scenario rejection suggests that those who rejected the CVM scenario may also have had some level of rejection with respect to the current value questions and thus may understate their true values for forecasts. Those with "valid" motivations for paying less for forecast improvements (including the statement "I think weather forecasts are good enough now" (see Table 4.7)) indicate larger values for current information, which is counter-intuitive and warrants further investigation. As may be expected, those who stated higher use, altruistic, bequest, and existence values for improved forecasts (from the CVM question) also have higher values for current forecast information.

4.2.4 Current Value Estimates and Aggregation

Using Model 5, SAS was used to derive fitted values for current hydro-met information as a function of the offered costs for using mean values on all explanatory variables. Figure 4.5 shows these fitted values as well as 95% confidence intervals based on the variances of the parameter estimates. From this figure, the median value estimated (50% of respondents say current information is worth at least this much) is about 250MT per year with a 95% confidence interval from roughly 125 MT to 375 MT.

Taking this as a per-household value estimate and assuming the current sample as representative of the overall population of Mozambique, this measure could be aggregated to the 23,000,000 people in Mozambique with an average of five people per household (4.6 million households). This would generate an annual estimate of the value of current hydro-met information of 1,150,000,000 MT per year or approximately US$37.4 million per year[52]. We note that this calculation doesn't account for scenario rejection (scenario rejection levels are left at their stated values) and thus this likely is an underestimate of true willingness to pay (WTP).

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[52] Converted from MT to USD using http://www.xe.com/currencyconverter/convert/?Amount=1150000000&From=MZN&To=USD on October 6, 2014.

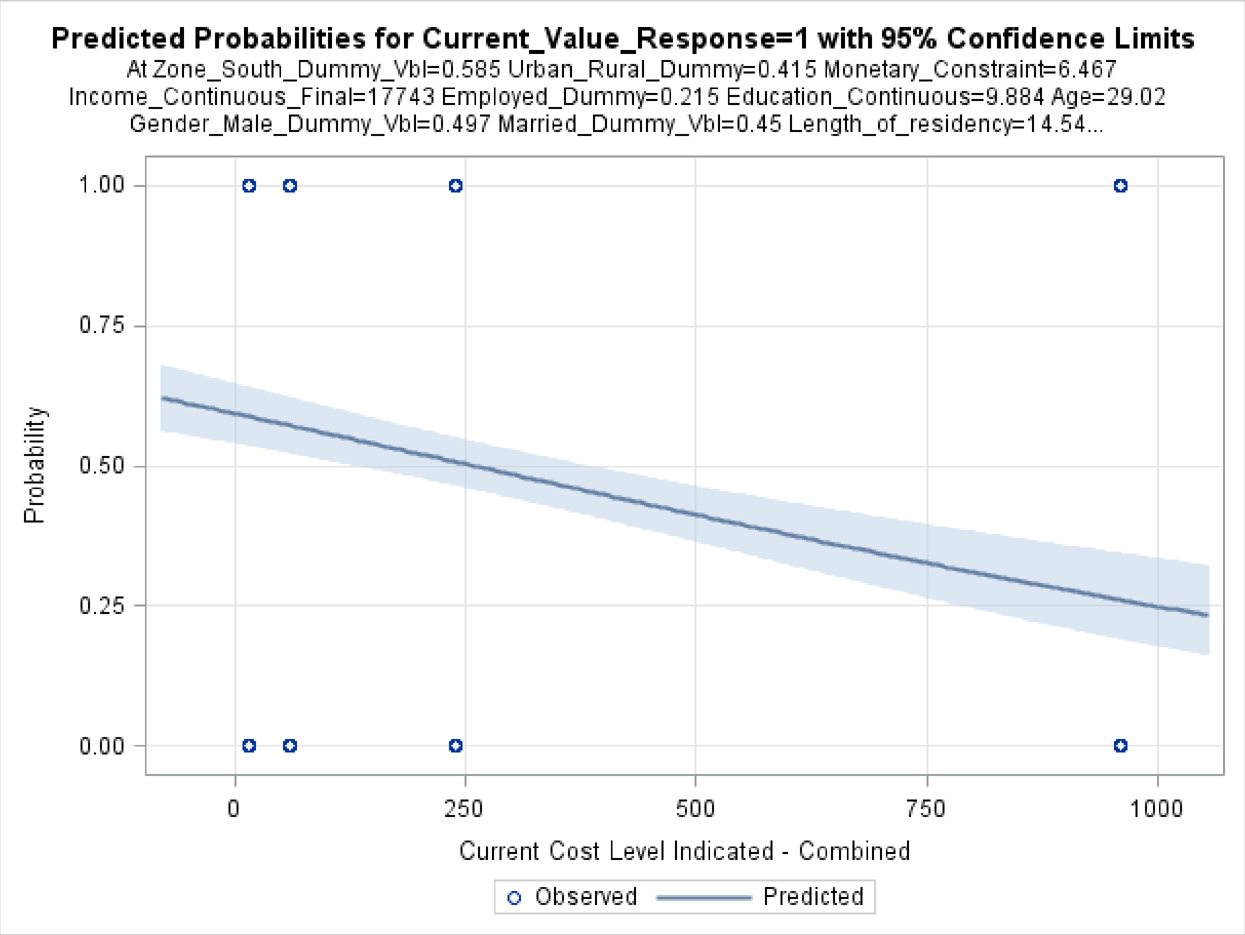


Figure 4.5: Fitted Likelihood of Responding "Yes" to Current Value of Weather Information

(as a Function of Current Costs from Model 5)

While this report author does not have complete details on agency budgets, according to data in Table 12 through Table 14 of World Bank (2013b) INAM, DNA, and ARAs revenues ranged from US$21.04 million to US$96.52 million between 2007 and 2012. The majority of variation in these revenues was variability in donor revenues (US$8.04 million and US$80.51 million). Government contributions ranged between US$10.01 million to US$18.79 million. In general then it appears current values (US$37.4 million per year) likely exceed costs.

4.3 Discrete Choice Experiment

In this section, analysis of the discrete-choice experiment (DCE) is described, in which respondents' choices between potential forecast-improvement programs and the accuracy of existing forecasts reveal their WTP for improved forecasts. DCE methods (a type of stated-choice method) use a hypothetical context in a survey format, with questions designed as choices between alternatives that include differences in goods and services as well as in costs. The alternatives that a subject prefers reveal information about his or her underlying values for the goods and services in those alternatives, (i.e., economic values for improved forecast information). The valuation approach was used to review values for improved forecasts for different subgroups following prior analysis in this report – potential differences between urban and rural respondents and potential differences between those in the south and those in the north-central parts of Mozambique.

4.3.1 Attributes and Levels

Building on prior questions about the importance of improving the accuracy of specific forecast attributes, the DCE focused on only four weather forecast attributes and added the cost attribute to the choice sets to allow for calculation of marginal WTP measures. The attributes, the baseline levels of accuracy (current levels or Level 1) and two levels for potential improvements (a medium improvement and a maximal improvement) are shown in Table 4.10. In the rightmost column, the expected sign is indicated on the parameter estimate in the subsequent regression analysis (reported below). For each of the forecast attributes we expect that improving these attributes would be beneficial (i.e., increase utility) and thus have a positive sign. For cost we expect that increased cost would lower utility and thus have a negative sign.

Table 4.10: Attribute Table for Preference Evaluation and Choice Sets

Attribute	Current (Level 1)	Program (Level 2)	Maximum (Level 3)	Expectation for Parameter Sign
All other warnings and advisories lead time	Current lead time 24 hours (one day)	Increase lead time to 48 hours (two days)	Increase lead time to 96 hours (four days)	Positive
Geographic detail	Three sections of country (south, central, north)	Province level (10+Maputo City)	District level (128 districts)	Positive
Accuracy of high and low temperature forecasts	24 hours (one day) generally accurate ±2°C	Extend to 48 hours (two days) with same accuracy as current 24-hour	Extend to 120 hours (five days) with same accuracy as current 24-hour	Positive
Accuracy of rainfall information	Correct 75% of the time	Being correct 80% of the time	Being correct 90% of the time	Positive
Cost to Household per year	No Cost (0 Mt)	15 MT / 30 MT / 60 MT / 150 MT / 240 MT		Negative

4.3.2 Choice set design

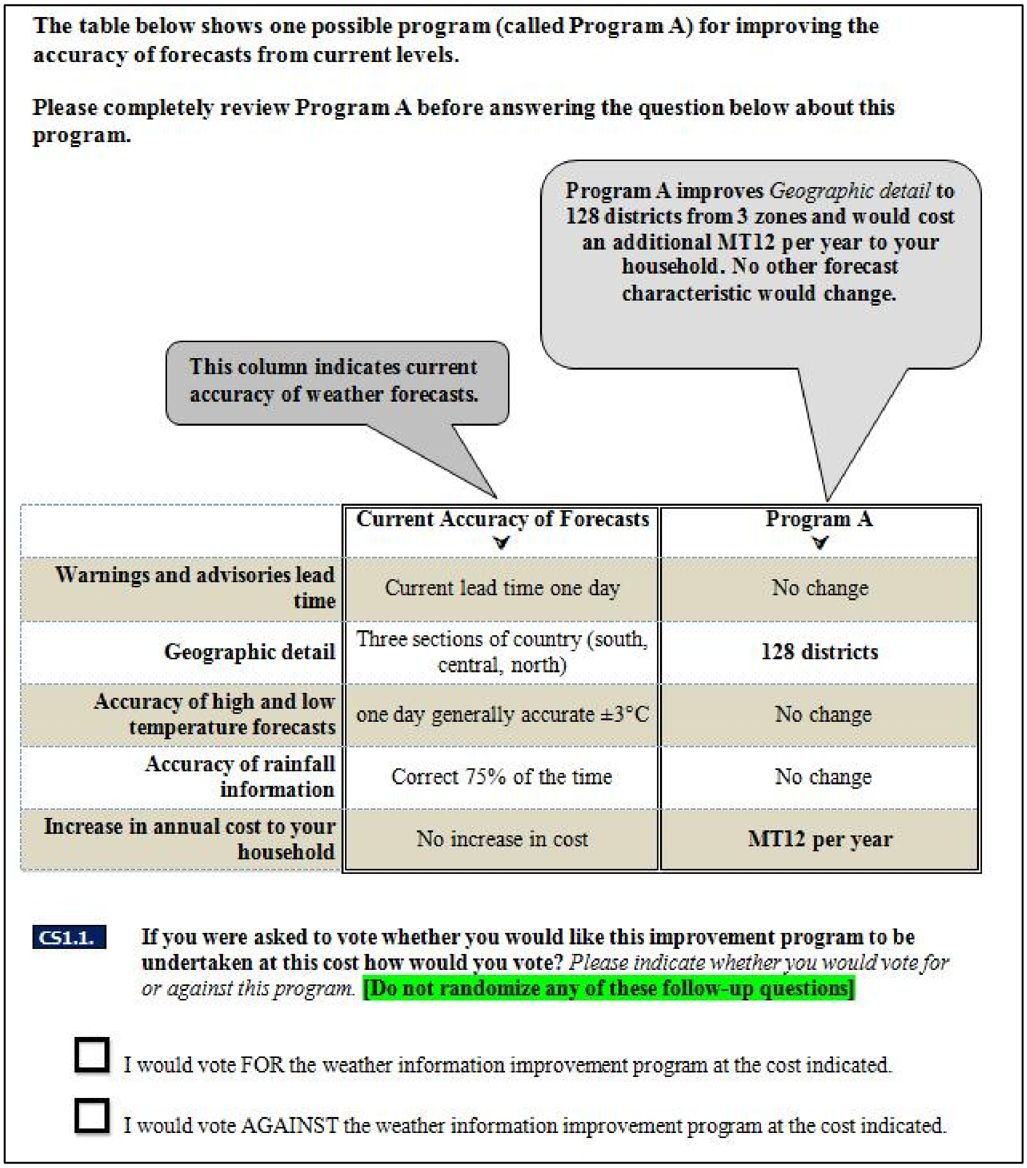
With multiple different choice conditions with different programs offered in each, statistical methods are used to estimate respondents' preferences and values for the different forecast attributes. An important component of this approach is designing the set of scenarios and programs to permit and optimize statistical analysis. The process of setting up these scenarios and choosing the levels of the attributes in each scenario is called choice set design. Jennifer Thacher of the University of New Mexico developed the choice set design based on criteria for this specific survey with respect to the attribute sets, number of choice sets, cost levels, and other criteria based on similar work in prior surveys (Lazo et al. 2010). Ultimately, the design was based on principles of efficiency and optimality for enhancing the statistical analysis of respondents' choices. Each survey included seven fully designed choice sets and three different versions of the seven questions were created – each respondent was randomly assigned to one of the three question sets.

4.3.3 Choice Question Layout

To facilitate respondents' ability to understand the choice questions, the survey began with a simplified choice question, as shown in Figure 4.6. This shows respondents a single potential improvement program with a single attribute changed from the baseline and an associated cost. They were then asked to indicate whether or not they would vote in favor or against this program. This choice set is essentially identical to a referendum style contingent valuation question.[53] Text bubbles were included to walk them through exactly what the question was asking them to do. It is unclear based on the information provided on the survey implementation how many respondents actually saw this in hardcopy, which may have affected the quality of respondents' comprehension of the choice exercise.[54]

[53] In a CVM referendum format, respondents are asked whether they would vote in favor of or against a specific program that includes the payment of some sort of increase in cost, fee, or tax should they vote in favor (Alberini and Kahn 2009).

[54] As per a reviewer comment, it is also unclear how many respondents' would have been able to read the hard copy. We did ask how many respondents were able to easily understand and speak Portuguese (89.2%) but not if they could read. But each interview was accompanied by an in-person interviewer who likely guided the respondent through the survey based on level of literacy.



The table below shows one possible program (called Program A) for improving the accuracy of forecasts from current levels.

Please completely review Program A before answering the question below about this program.

Program A improves *Geographic detail* to 128 districts from 3 zones and would cost an additional MT12 per year to your household. No other forecast characteristic would change.

This column indicates current accuracy of weather forecasts.

	Current Accuracy of Forecasts	Program A
Warnings and advisories lead time	Current lead time one day	No change
Geographic detail	Three sections of country (south, central, north)	**128 districts**
Accuracy of high and low temperature forecasts	one day generally accurate ±3°C	No change
Accuracy of rainfall information	Correct 75% of the time	No change
Increase in annual cost to your household	No increase in cost	**MT12 per year**

CS1.1. **If you were asked to vote whether you would like this improvement program to be undertaken at this cost how would you vote?** *Please indicate whether you would vote for or against this program.* **[Do not randomize any of these follow-up questions]**

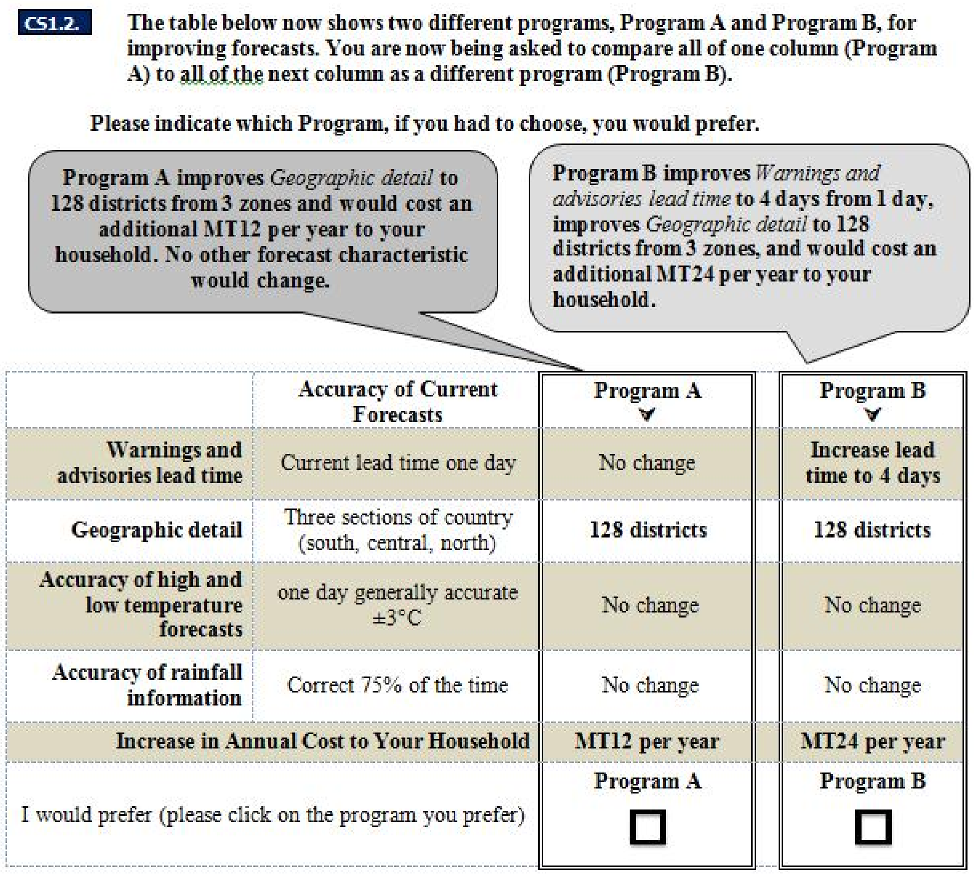
☐ I would vote FOR the weather information improvement program at the cost indicated.

☐ I would vote AGAINST the weather information improvement program at the cost indicated.

Figure 4.6: Initial Simplified Choice Question

This simplified question was followed by a choice question (Figure 4.7) comparing Program A from the simplified question to a Program B that varied a different attribute and indicated a different cost level. This second question was a very simplified version of a normal discrete choice question[55]. This second question also included the text bubbles to guide respondents through this question.

[55] Discrete choice questions ask respondents to indicate their preference between two more alternative programs comprised of program attributes of varying levels and a fee, cost, or tax component. This method developed from



CS1.2. The table below now shows two different programs, Program A and Program B, for improving forecasts. You are now being asked to compare all of one column (Program A) to all of the next column as a different program (Program B).

Please indicate which Program, if you had to choose, you would prefer.

Program A improves *Geographic detail* to 128 districts from 3 zones and would cost an additional MT12 per year to your household. No other forecast characteristic would change.

Program B improves *Warnings and advisories lead time* to 4 days from 1 day, improves *Geographic detail* to 128 districts from 3 zones, and would cost an additional MT24 per year to your household.

	Accuracy of Current Forecasts	Program A	Program B
Warnings and advisories lead time	Current lead time one day	No change	Increase lead time to 4 days
Geographic detail	Three sections of country (south, central, north)	128 districts	128 districts
Accuracy of high and low temperature forecasts	one day generally accurate ±3°C	No change	No change
Accuracy of rainfall information	Correct 75% of the time	No change	No change
Increase in Annual Cost to Your Household		MT12 per year	MT24 per year
I would prefer (please click on the program you prefer)		Program A ☐	Program B ☐

Figure 4.7: First "Guided" Full Choice Question

For this and all subsequent choice questions, respondents were asked a follow-up question of, if given the choice, they would prefer the program they had just chosen or if they would prefer to stay with the current level of forecast accuracy (no improvements) at no additional costs. Figure 4.8 shows this follow up question for the first full choice question. Including this option allows respondents to fully express their preferences over the improvement programs and improves the quality of the parameter estimates – especially the estimate of marginal utility of income (the estimate on the cost attribute).

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conjoint analysis commonly used in marketing research. (Carson and Czajkowski. 2014; Ben-Akiva and Lerman. 1994).

CS1.3. **Would you prefer to keep forecast accuracy the way it is now with no increased costs to my household or stay with the Program you indicated above at the cost indicated?**

☐ Keep forecast accuracy the way it is now with no increased costs to my household.

☐ Undertake the program chosen above at the cost indicated.

Figure 4.8: First "Guided" Full Choice Question Follow-Up Question

Following these initial "learning" questions, respondents were asked one of the three versions of the optimally designed seven-choice set questions along with the follow up question. Figure 4.9 shows an example of one of the full choice set question.

CS1.4. **The table below shows two different programs, Program C and Program D, for improving forecasts. You are now being asked to compare all of one column (Program C) to all of the next column as a different program (Program D).**

Please indicate which Program, if you had to choose, you would prefer.

	Accuracy of Current Forecasts	Program C	Program D
Warnings and advisories lead time	Current lead time one day	Increase lead time to 4 days	Increase lead time to 2 days
Geographic detail	Three sections of country (south, central, north)	District level (128 districts)	Province level (10+Maputo City)
Accuracy of high and low temperature forecasts	one day generally accurate ±2°C	No change	Extend to 2 days with same accuracy as current 24-hour
Accuracy of rainfall information	Correct 75% of the time	No change	Being correct 80% of the time
Increase in Annual Cost to Your Household		15 MT	No Cost
I would prefer (please click on the program you prefer)		Program C ☐	Program D ☐

Figure 4.9: Standard Full Choice Question

The choice set design discussed earlier pertained only to these seven choice sets and the learning questions were designed by hand and likely not as an efficient design. These were included in the data analysis, as they still provide usable information on respondents' preferences. With the initial "learning" questions (one referendum type question and one choice question with follow-up) and seven choice questions (each with a follow-up), there were 17 choice responses from each respondent. The next section explains the modeling approach used to analyze the responses.

4.3.4 The valuation model and econometric methodology

The random utility behavioral model was assumed for econometric modeling of the choice question responses (McFadden. 1976; Manski. 1977). In this approach, total utility is assumed to be the sum of the marginal utility derived from the characteristics or attributes that make up a good, in this case a weather forecast. When asked to choose between two alternatives differing only in the levels of the attributes and potential costs, individuals are assumed to choose the alternative providing the greatest utility, including the disutility of the costs. By asking many individuals to make several choices over many different combinations of alternatives, the marginal utility of the different attributes is implicitly revealed in these choices. The statistical analysis can be used to "back-out" the contribution of each attribute to total utility (Ben-Akiva and Lerman. 1985; Louviere et al. 2001). The utility of a choice is modeled as a linear combination of the choice attributes and a random error:

$$U_{ij} = \beta' x_{ij} + \varepsilon_{ij}, \qquad i = \text{A,B}; \quad j = 1,\ldots,17$$

where *i* is the alternative A or B in the choice set (or the A/B versus "do nothing" choice) for the seven-choice sets labeled *j* (1 through 17)[56] and where the elements of the vector β are the marginal utilities of the attributes in the vector ***x***:

$$x = \begin{pmatrix} \text{All other warnings and advisories lead time} \\ \text{Geographic detail} \\ \text{Accuracy of high and low temperature forecasts} \\ \text{Accuracy of rainfall information} \\ \text{Cost to Household per year} \end{pmatrix}$$

and ε is a random disturbance.

[56] Treating the initial learning question as a choice set question where all attributes of the baseline program are simply set at baseline levels allows us to include responses in the same modeling framework.

Because *U* is the total utility defined as the sum of the utility from the different attributes (*x* values), the ß values measure the change in total utility caused by a one unit change in any given *x*. The ß's can thus be interpreted as the marginal utility of the attributes. For the cost attribute, the associated ß measures the marginal utility of money and is expected to be negative because increased cost implies decreased utility (or disutility).

We extend the basic model to include interaction terms with respect to income (interacted with the cost term) and the zone dummy variable (south versus north-central) and urban-rural dummy variables. The interaction between the cost variable and income allows us to examine whether the marginal utility of income should be treated as constant (discussed further below) and these zone and urban-rural interaction terms allow us to examine if there are differences in marginal utility of the forecast attributes based on respondents location (i.e., do these subsamples have different preferences for forecast improvements).

4.3.5 Analysis and Results

The choice data were analyzed using methods similar to those used in Lazo et al. 2010 upon which the discussion here is based. Responses were analyzed using logistic regression in SAS using Proc Genmod (O'Connell. 2005). Unlike ordinary least squares regression, logistic regression does not assume a linear relationship between independent and dependent variables; it is a form of non-linear regression analysis. Additionally, it does not require normally distributed variables, and does not assume constant error variance. Because each respondent provided seventeen answers to these questions (one for each choice set and follow up as well as the "learning"), to account for potential intra-subject correlation, the method of generalized estimating equations (GEE) was used (Allison, 1999; Ballinger, 2004).

To make the regression parameter estimates more interpretable, some of the input variables were rescaled by various factors of 10. Table 4.11 shows summary statistics on the raw and rescaled variables, as well as the scaling level where applicable. For rescaled variables, the raw data was divided by the scaling factor indicated. This resulted in parameter estimates with the decimal level shifted to the right by the magnitude of the scaling. It does not change the nature of resulting estimate – only the magnitude. For instance, LeadTime_Diff was divided by 10 so that the resulting parameter estimates – including those where the variable is interacted with another variable – are 10 times larger than the unscaled parameter estimate. It should also be noted that the forecast attribute explanatory variables are labeled as the difference in that variable, which is the difference in the level offered in the choice set between the A and B programs (or the A/B versus "do nothing" choice). Interaction terms in the regression analysis were entered as the attribute (difference) "multiplied by" the interacting variable. For instance, for the interaction between cost and income, the interacting variable is labeled "Cost_Diff*Income_Con" (note that SAS truncates variable names).

Table 4.11: Summary Statistics of Raw and Rescaled Variables

		Raw		Scaling Method	Rescaled	
Variable	N	Mean	Std Dev		Mean	Std Dev
Choice	9792	1.428	0.495	None	1.428	0.495
LeadTime_Diff	9792	0.637	1.984	10	0.064	0.198
Detail_Diff	9792	30.138	79.062	10,000	0.003	0.008
Temp_Diff	9792	0.667	2.138	100	0.007	0.021
Rain_Diff	9792	4.184	8.239	100	0.042	0.082
Cost_Diff	9792	27.008	96.069	10,000	0.003	0.010
Urban_Rural_Dummy	9792	0.415	0.493	None	0.415	0.493
Zone_South_Dummy_Vbl	9792	0.585	0.493	None	0.585	0.493
Income_Continuous_Final	9792	18,116.320	23,565.210	1,000	18.116	23.565

Table 4.12 reports parameter estimates and significance for five models estimated using the GEE modeling approach. These are not strictly hierarchical as the impacts of zone and urban-rural were separately examined before combining them in the final model (Model 5).

Table 4.12: Logit Model of Choice Set Responses (n=9792)					
Analysis Of GEE Parameter Estimates					
Model	Model 1	Model 2	Model 3	Model 4	Model 5
Parameter	Estimate Pr > |Z|	Estimate Pr > |Z|	Estimate Pr > |Z|	Estimate Pr > |Z|	Estimate Pr > |Z|
LeadTime_Diff	1.354 ***	1.348 ***	1.497 ***	0.864 ***	1.012 ***
LeadTime_*Zone_South			-0.192 n.s.		-0.206 n.s.
LeadTime_*Urban_Rura				1.161 ***	1.184 ***
Detail_Diff	-4.760 *	-4.617 *	4.342 n.s.	-6.922 **	2.287 n.s.
Zone_Sout*Detail_Dif			-14.726 ***		-14.918 ***
Urban_Rur*Detail_Dif				5.422 n.s.	5.051 n.s.
Temp_Diff	6.017 ***	6.025 ***	15.603 ***	2.770 *	12.359 ***
Zone_South*Temp_Diff			-15.987 ***		-16.049 ***
Urban_Rura*Temp_Diff				7.986 ***	8.034 ***
Rain_Diff	2.157 ***	2.166 ***	2.802 ***	2.370 ***	2.998 ***
Zone_South*Rain_Diff			-0.872 n.s.		-0.889 n.s.
Urban_Rura*Rain_Diff				-0.455 n.s.	-0.413 n.s.
Cost_Diff	-20.897 ***	-29.905 ***	-31.245 ***	-29.549 ***	-30.871 ***
Cost_Diff*Income_Con		0.496 ***	0.532 ***	0.466 ***	0.501 ***
***, **, * indicate significant at the 1%, 5%, and 10% levels respectively.					

Model 1 is the simplest model of purely the choice set attributes. All of the parameter estimates are highly significant and of the expected sign except for the estimate on “Detail_difference,” which is the level of geographical detail the forecast would be presented in. The negative sign is marginally significant and of the wrong sign in the initial models (and not significant in Model 5). This suggests that individuals didn’t really care if there was more geographic detail in the forecasts than in the current presentation of forecasts for three very large sections of the country. We suspect further investigation of this result would be warranted before deciding to not try to provide more geographic detail.

The negative of the significant sign on cost is interpreted as the marginal utility of income, MU_y. The parameter estimate is negative here as increasing costs lowers utility. This parameter estimate can be used to convert the other parameter estimates into marginal willingness to pay measures as described below.

Model 2 adds an interaction term between cost and income to examine whether or not MU_y is constant as income changes. The positive sign on the interaction term indicates that MU_y falls as income increases, which is a common and expected finding – thus decreasing marginal utility of income (Haab and McConnell. 2004, p.46). Specifically, it is not meaningful to directly evaluate the magnitude of the parameter estimates in the interaction terms where there are the different scaling factors. The qualitative meaning of the significance of interactions is discussed at this point as it can best be interpreted only in combination with the non-interacted term at some meaningful level of the variables values. The quantitative meaning is discussed in the next section when the value estimates are derived at specific levels of variable values using the model estimates. All subsequent models retain the cost-income interactions.

Model 3 examines potential differences in marginal utility of forecast attributes by zone (south versus north-central Mozambican respondents, as in early analysis). The interaction terms on forecast lead time and accuracy of rainfall estimates are not significant, which suggests that preferences are similar across Mozambique. The interaction term on geographic detail is highly significant and negative, suggesting that those in the south have significantly lower marginal utility for this attribute than those in the north-central; however, the marginal utility of those in the north-central regions is not significantly different from zero. This finding deserves further investigation before making policy decisions based on this outcome. The parameter estimates on accuracy of temperature forecasts suggest that improving this would have significant marginal benefit to those in the north-central areas, but significantly less (and possibly close to zero) marginal benefit to those in the south.

Model 4 examines potential differences in marginal utility of forecast attributes between urban and rural respondents. Non-significant interaction effects for the geographic detail and accuracy of rainfall forecasts indicate that preferences for improving these attributes are similar across the country. The positive and significant interaction estimates on “all other advisories and lead time” and accuracy of temperature forecasts indicate that urban respondents perceive larger marginal benefit to improving the forecast attributes.

Model 5 combines the zone and urban-rural interactions for the most complete model estimated here. In general, the significance of the interaction terms does not change between Models 3 and 4 and when they are estimated jointly in Model 5.

4.3.6 Program Value Derivations

We use the estimates from Model 5 to illustrate the use of this approach for deriving the total willingness-to-pay (WTP) for a specific program. In this case, the value of a program that would improve forecast attributes to the maximal levels described in Table 4.10. We do not include improvements in geographic detail due to the inconsistency of model estimates.

Table 4.13: Derivation of WTP for Maximal Improvement Program

(keeping geographic detail at current levels)

Model	Parameter Estimate from Model 5	Change to Maximum Program	Interaction Variable Mean	Marginal Utility	Total Attribute Marginal Utility	
LeadTime_Diff	1.012	1		1.012		
LeadTime_*Zone_South	-0.206	1	0.585	-0.121		
LeadTime_*Urban_Rural	1.184	1	0.415	0.491	1.383	
Detail_Diff	2.287	0		0.000		
Zone_South*Detail_Dif	-14.918	0	0.585	0.000		
Urban_Rural*Detail_Dif	5.051	0	0.415	0.000	0.000	
Temp_Diff	12.359	4		49.436		
Zone_South*Temp_Diff	-16.049	4	0.585	-37.555		
Urban_Rural*Temp_Diff	8.034	4	0.415	13.336	25.218	
Rain_Diff	2.998	15		44.970		
Zone_South*Rain_Diff	-0.889	15	0.585	-7.801		
Urban_Rural*Rain_Diff	-0.413	15	0.415	-2.571	34.598	
					Total Utility	61.199
Cost_Diff	-30.871	1		-30.871		
Cost_Diff*Income_Con	0.501	1	18.116	9.076	-21.795	
					Total WTP	2.808

To calculate interaction terms, the mean values of these variables are used (zone, urban-rural, and income) from Table 4.11 for the rescaled variables, as these are the basis of the model estimates. As shown in Table 4.13 the marginal utility by parameter are the parameter estimate values from "Model 5" multiplied by "Change to Maximum program" multiplied by "Interaction Variable Mean" to estimate marginal utility. Then, the total attribute marginal utility is the sum of the marginal utilities of the un-interacted and interacted components. And, the total utility to the "average" respondent is the sum of the three attribute utilities – total utility is 61.12.

It is important to note that utility measured in this way has no substantive meaning so it is divided by the marginal utility of income to convert the utility to a monetary WTP measurement. Total WTP for the maximal improvement program (without changes in geographic detail) are calculated as 2.808 MT per year per respondent.

This value is equal to US$0.0918[57]. Taking this as a per-household value estimate and assuming (likely not validly) that the current sample is representative of the overall population of Mozambique, allows the aggregation of this measure to the 23,000,000 people in Mozambique with an average of five people per household (4.6 million households). Aggregating this over 50 years of a program lifetime using a 3% rate of discount indicates a present value estimate of US$11.2 million for a maximal weather information improvement program.[58]

4.4 Contingent Valuation Method

4.4.1 Valuation Scenario and Question Format

Following the discrete choice experiment, a contingent valuation method (CVM) question was asked for a single program. Individuals were randomly assigned to one of two versions of the program – one with improvements on all attributes to intermediate levels and one with improvements on all attributes to maximum levels presented earlier in the survey. For each version, the attributes, current accuracy, and a version of the improvement were presented (Version 1 or Version 2). Table 4.14 shows the question and the attribute levels for the two versions. For the CVM question, levels on all attributes discussed earlier in the survey were presented rather than just the four attributes evaluated in the DCE.

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57 Converted to dollars October 8, 2014, using xe.com.

58 The choice of a 50 year time horizon is somewhat arbitrary for BCA wherein the benefits and costs can be assumed to flow in perpetuity all else equal. Using a 25 year time horizon (or half of the 50 year horizon) reduces the present value to US$7.8 or about 69% of the 50 year PV. This is because benefits further out in the future play a smaller role in PV due to the discounting.

Table 4.14: Contingent Valuation Method Question and Versions			
Question: Rather than comparing programs, we now want you to consider a single program to improve weather forecasts as indicate by Program Q below.			
	Current Accuracy of Forecasts	Version 1	Version 2
Cyclone warnings and advisories lead time	Current lead time two days	Increase lead time to three days	Increase lead time to five days
All other warnings and advisories lead time	Current lead time one day	Increase lead time to two days	Increase lead time to four days
Geographic detail	Three sections of country (south, central, north)	Province level (10+Maputo City)	District level (128 districts)
Time period covered	Currently for entire day	Information broken down between night and day	Information broken into three-hour increments
Accuracy of high and low temperature forecasts	One day generally accurate ±2°C	Extend to two days with same accuracy as current one day	Extend to five days with same accuracy as current one day
Accuracy of rainfall information	Correct 75% of the time	Being correct 80% of the time	Being correct 90% of the time
Maritime information	Correct 70% of the time	Being correct 80% of the time	Being correct 90% of the time
Reliability of seasonal forecasts	Reliable 65% of the time	Being reliable 70% of the time	Being reliable 80% of the time
Accuracy of flooding and water levels	Correct 70% of the time	Being correct 80% of the time	Being correct 90% of the time

Respondents were then asked to indicate their maximum WTP for the program using the payment card as shown in Figure 4.10. Individuals were also able to indicate a specific value (other amount) if they didn't want to circle one of the specific levels offered. Only 40 of the 576 respondents (6.9%) entered a specific value rather than choosing one of the ones offered. It should be noted that while the payment card did not specify a payment vehicle, this question followed the choice questions and – as a continuation of that elicitation – it is reasonable to believe the respondents assumed the same payment vehicle as described in the stated choice exercise (i.e., increased annual taxes and fees).

CVM1 What is the maximum amount you would be willing to pay each year for this single program to improve weather forecasts? Please circle the number below indicating the maximum annual amount your household would be willing to pay for this program.

MT 0 (I would pay nothing)	MT 15	MT 30	MT 60	MT 120
MT 240	MT 480	MT 720	MT 1,440	MT 2,160
MT 3,240	MT 5,400	MT 9,000 or more	Other (enter amount) ___________	

Figure 4.10: CVM Payment Card

4.4.2 Valuation Responses

Table 4.15 shows the frequency distribution of WTP from the payment card responses as well as the number of respondents who entered another value. For both versions of the survey, approximately 20% of respondents indicated zero WTP for the forecast program.

Table 4.15: Contingent Valuation Method Question and Versions

Version	MT 0	MT 15	MT 30	MT 60	MT 120	MT 240	MT 480	MT 720	MT 1440	MT 2160	MT 3240	MT 5400	MT 9000	Other	n
Intermediate Improvement	52 19.4%	56 20.9%	33 12.3%	50 18.7%	36 13.4%	19 7.1%	3 1.1%	0 0.0%	0 0.0%	3 1.1%	0 0.0%	0 0.0%	2 0.7%	14 5.2%	268
Maxiimum Improvement	63 20.5%	73 23.7%	41 13.3%	37 12.0%	39 12.7%	22 7.1%	4 1.3%	2 0.6%	0 0.0%	0 0.0%	1 0.3%	0 0.0%	0 0.0%	26 8.4%	308

A single response that was entered as an open-ended verbal response was replaced with the median value of 30 MT.

Figure 4.11 shows the frequency distribution of CVM WTP responses by version with responses aggregated into three-response ranges to smooth the distribution. As can be seen, there is a longer right tail to the distribution with a small number of very high bids as well as a truncation of bids at the zero MT value.

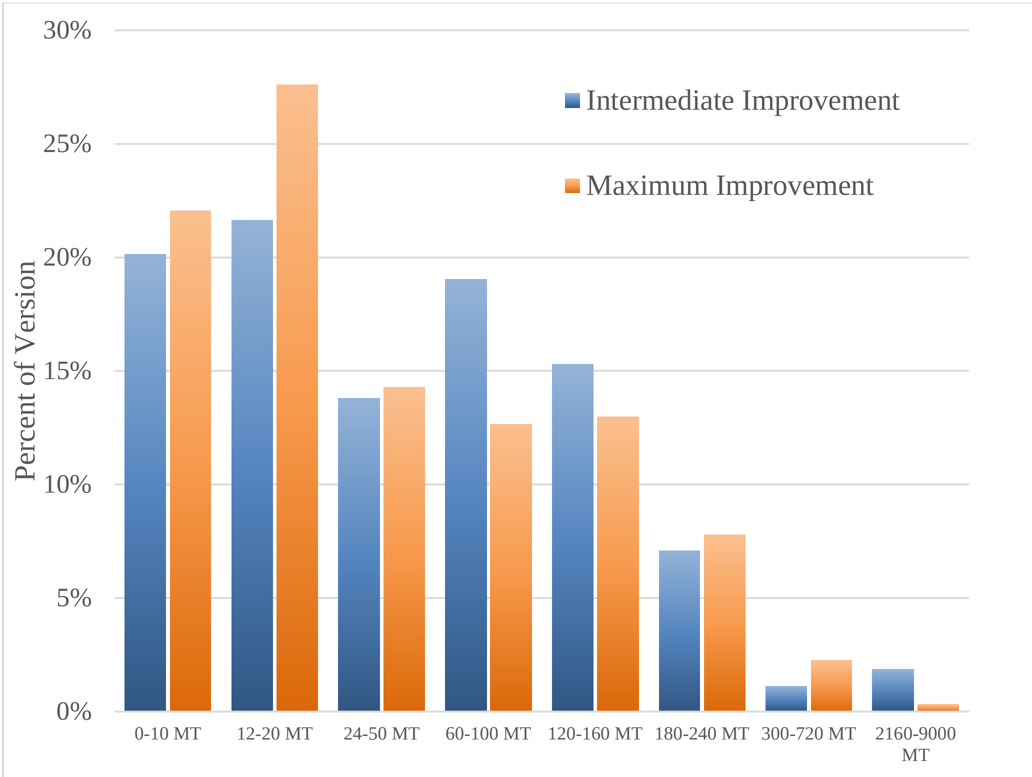

Figure 4.11: Frequency of CVM WTP Response by Version

4.4.3 Regression Analysis of WTP

The dependent variable in the regression analysis is stated WTP for the improvement programs. As stated values are truncated at zero and right skewed, the natural logarithm of WTP was taken as the dependent variable. For the roughly 20% of respondents stating zero WTP, their WTP was set to 0.01 before taking the natural log of WTP.

To explore factors influencing respondents' stated WTP for the forecast improvement programs, factors were chosen from the analyses presented in Chapter 3 on experience and concern with weather, information sources, uses of information, perceptions, and awareness of agencies. Also included were measures of the importance of weather information attributes and importance of improving weather information, as well as approaches for assessing scenario rejection and altruistic and bequest values.

Table 4.16 shows summary statistics for all the variables included in the regression.

Table 4.16: Contingent Valuation Method WTP Regression Variables					
Variable	Mean	Std Dev	Min.	Max.	Median
Dependent Variable					
Maximum WTP	109.66	569.39	0.00	9000.00	30.00
Natural Log(Maximum WTP)	2.18	3.54	-4.61	9.10	3.40
WTP Scenario Version (Scope Test)					
CVM Version Dummy (0=Intermediate Program / 1= Maximum Program)	0.53	0.50	0.00	1.00	1.00
Location comparisons					
Urban Rural Dummy (rural = 0; urban = 1)	0.41	0.49	0.00	1.00	576.00
Zone South Dummy (north-central = 0; south =1)	0.59	0.49	0.00	1.00	576.00
Socio-demographics					
Monetary Constraint	6.47	3.03	0.00	12.00	6.00
Income (MT/year)	0.63	0.48	0.00	1.00	1.00
Employed (Not = 0; Part of Full time =1)	0.22	0.41	0.00	1.00	0.00
Education (Years)	9.69	2.86	5.00	16.00	10.00
Age (Years)	29.02	9.71	15.00	55.00	27.00
Gender (Female=1; Male=1)	0.50	0.50	0.00	1.00	0.00
Married (Married =1; Not =0)	0.45	0.50	0.00	1.00	0.00
Length of Residency (Years)	14.54	9.80	0.17	40.00	13.00
Household Size	4.84	2.45	1.00	34.00	5.00
Experience and Concern with Weather (see Table 3.4 and Table 3.9)					
Wx Impacts Factor 1 Scores (Personal Loss)	0.00	1.00	-2.76	1.86	0.19
Wx Impacts Factor 2 Scores (Infrastructure Disruption)	0.00	1.00	-2.86	1.52	0.40
Wx Impacts Factor 3 Scores (Mortality/ Morbidity)	0.00	1.00	-1.84	2.12	0.05
Wx Concern Factor1 Lower Concern	0.00	1.00	-2.66	2.01	0.19
Wx Concern Factor1 Higher Concern	0.00	1.00	-4.01	2.23	0.06
Sources of hydro-meteorological information (See Table 3.13)					
Sources Factor1 Agencies	0.00	1.00	-1.92	4.81	-0.18
Sources Factor2 Infrequent Sources	0.00	1.00	-0.86	10.91	-0.20
Sources Factor3 Frequent Sources	0.00	1.00	-1.38	3.67	-0.23
Area of interest for uses of hydro-meteorological information (See Table 3.16)					
Use Area Broader Area	0.00	1.00	-1.44	2.36	-0.11
Use Area Locally	0.00	1.00	-1.38	2.37	-0.17
Uses of hydro-meteorological information for decision-making (Table 3.19)					
Uses Long-Term	0.00	1.00	-1.55	8.40	-0.30
Uses Short-Term	0.00	1.00	-1.73	3.70	-0.52
Importance of weather information (Table 3.22 and Table 3.25)					
Info Import Rain	0.00	1.00	-4.69	2.27	0.03
Info Import Temp	0.00	1.00	-3.18	2.97	0.03
Info Import Wind	0.00	1.00	-3.40	2.45	0.21
Long Term Info Atmosphere	0.00	1.00	-3.35	2.46	0.14
Long Term Info Hydro	0.00	1.00	-2.94	2.08	0.15
Satisfaction (Figure 3.18)					
Satisfaction (Q18)	3.45	0.96	1.00	5.00	4.00

Table 4.16: Contingent Valuation Method WTP Regression Variables					
Variable	Mean	Std Dev	Min.	Max.	Median
Awareness of agencies (Figure 3.19)					
Aware of INAM (Don't Knows = 0)	0.71	0.46	0.00	1.00	1.00
Aware of ARAs (Don't Knows = 0)	0.34	0.47	0.00	1.00	0.00
Aware of INAM additional info (Don't Knows = 0)	0.50	0.50	0.00	1.00	0.50
Importance of info and of improving information (Table 3.41 and Figure 3.22)					
Import Wx Info Factor1 Other Wx Info Attributes	0.00	1.00	-3.52	2.34	0.19
Import Wx Info Factor2 Precipitation and Warnings	0.00	1.00	-3.65	2.75	0.10
Import of Improving Forecasts Alpha Factor	0.00	0.96	-4.37	1.02	0.23
Scenario Rejection and Valid WTP Motivations (Table 4.7)					
Scenario Rejection Factor Score	0.00	1.00	-2.07	3.04	-0.22
Valid Non-WTP Factor Score	0.00	1.00	-1.86	3.61	-0.17
Useful Factor Score	0.00	1.00	-2.00	2.44	-0.07
Use and Non-Use Motivations (adjusted from Table 4.4)					
Own-Family Alpha Factor	0.00	0.93	-1.53	1.30	0.23
Altruistic-Bequest Alpha Factor	0.00	0.96	-1.76	1.35	0.17

For the use and non-use bequest and altruistic motivations a new separate alpha factor score different from that derived in Table 4.4 was generated where we removed the items for "me personally" and "other people in my family." This provides a factor score entirely based on the altruistic and bequest aspects of the responses. As the items for "me personally" and "other people in my family" were highly correlated with the other items in the factor, the "Own-Family Alpha Factor" variable was dropped from the following regression analysis as it generated a variance inflation factor (VIF) greater than 3.0 when included with the Altruistic-Bequest Alpha Factor.

Table 4.17 presents results for two models. In the full model, ordinary least squares (OLS) regression on all independent variables was undertaken. In the "backward elimination" model, OLS is undertaken, but only variables with significance less than 0.15 are retained through an iterative search process.[59]

All parameter estimates are standardized coefficient estimates with independent variables normalized to mean = 0.0 and standard deviation = 1.0. While not shown here, variance inflation

[59] All analysis is conducted using SAS Enterprise Guide Version 7.1 or SAS for Windows Version 9.4.

factors (VIFs) were also checked to assess potential multicollinearity.[60] While there are no accepted criteria for maximum VIFs, all VIFs in the regression were below 3.0, which is well below the general guidance that VIFs over 10.0 suggest potential problems with multicollinearity. In addition, the null hypothesis that the variance of the residuals is homogenous cannot be rejected, (χ^2 = 773.24; df=584, Pr > ChiSq=0.62)[61] so it is assumed that there is not a problem with potential heteroscedasticity.

Adjusted R-Squared values on both models are greater than 0.34 and the F-statistics are highly significant, suggesting that both are well-fit models.

Table 4.17: Regression on Contingent Valuation WTP (n=576)

	Full Model		Backward Elimination (p<0.15)	
R-Square	0.388		0.3753	
Adj R-Sq	0.342		0.3563	
F Value	8.47		19.72	
Pr>F	<.0001		<.0001	
Variable	Est.	Pr>|t|	Est.	Pr>|t|
Intercept				
Intercept	0.000	<.0001	0.000	<.0001
WTP Scenario Version (Scope Test)				
CVM Version Dummy (0=Intermediate Program / 1= Maximum Program)	-0.022	0.535	-0.026	0.443
Location comparisons				
Urban Rural Dummy	0.042	0.325	0.053	0.154
Zone South Dummy	-0.045	0.329	-0.048	0.203
Socio-demographics				
Monetary Constraint	-0.080	0.051	-0.069	0.074
Income (MT/year)	0.170	<.0001	0.182	<.0001
Employed (Not = 0; Part of Full time =1)	0.001	0.977		
Education (Years)	0.029	0.490		
Age (Years)	-0.039	0.265		
Gender (Female=1; Male=1)	0.014	0.687		
Married (Married =1; Not =0)	0.010	0.794		
Length of Residency (Years)	-0.014	0.708		
Household Size	0.037	0.302		
Experience and Concern with Weather (see Table 3.4 and Table 3.9)				
Wx Impacts Factor 1 Scores (Personal Loss)	0.091	0.018	0.081	0.023
Wx Impacts Factor 2 Scores (Infrastructure Disruption)	0.050	0.183		

[60] See http://support.sas.com/documentation/cdl/en/statug/63347/HTML/default/viewer.htm#statug_reg_sect038.htm for a discussion of VIFs in SAS.

[61] This is the White test for heteroscedasticity (http://www.ats.ucla.edu/stat/sas/webbooks/reg/chapter2/sasreg2.htm).

Table 4.17: Regression on Contingent Valuation WTP (n=576)				
	Full Model		Backward Elimination (p<0.15)	
Wx Impacts Factor 3 Scores (Mortality/ Morbidity)	-0.020	0.615		
Wx Concern Factor1 Lower Concern	0.012	0.792		
Wx Concern Factor1 Higher Concern	0.017	0.721		
Sources of hydro-meteorological information (See Table 3.13)				
Sources Factor1 Agencies	-0.112	0.004	-0.117	0.001
Sources Factor2 Infrequent Sources	0.039	0.300	0.053	0.125
Sources Factor3 Frequent Sources	-0.030	0.500		
Area of interest for uses of hydro-meteorological information (See Table 3.16)				
Use Area Broader Area	-0.030	0.486		
Use Area Locally	-0.021	0.584		
Uses of hydro-met information for decision-making (Table 3.19)				
Uses Long-Term	0.040	0.288		
Uses Short-Term	0.127	0.002	0.109	0.003
Importance of weather information (Table 3.22 and Table 3.25)				
Info Import Rain	-0.038	0.429		
Info Import Temperature	-0.098	0.048	-0.066	0.097
Info Import Wind	-0.033	0.505		
Long-Term Info – Atmosphere (Seasonal and Climate)	0.090	0.084	0.062	0.145
Long-Term Info – Hydrological (including ocean and waves)	-0.007	0.892		
Satisfaction (Figure 3.18)				
Satisfaction (Q18)	-0.066	0.078	-0.067	0.057
Awareness of agencies (Figure 3.19)				
Aware of INAM (Don't Knows = 0)	0.045	0.331	0.078	0.035
Aware of ARAs (Don't Knows = 0)	0.060	0.164		
Aware of INAM additional info (Don't Knows = 0)	0.013	0.785		
Importance of info and of improving information (Table 3.41 and Figure 3.22)				
Import Wx Info Factor1 Other Wx Info Attributes	0.016	0.746		
Import Wx Info Factor2 Precipitation and Warnings	-0.021	0.705		
Import of Improving Forecasts Alpha Factor	0.154	0.005	0.134	0.003
Scenario Rejection and Valid WTP Motivations (Table 4.7)				
Scenario Rejection Factor Score	-0.257	<.0001	-0.274	<.0001
Valid Non-WTP Factor Score	0.010	0.795		
Useful Factor Score	0.134	0.004	0.129	0.003
Use and Non-Use Motivations (adjusted from Table 4.4)				
Altruistic-Bequest Alpha Factor	0.215	<.0001	0.216	<.0001

The parameter on the CVM version is not significant (and has a negative sign), which indicates there is not a higher WTP for the "better" program (Version 2 for which all attribute levels were better than in Version 1). As this is not a statistically significant difference and potentially of the incorrect sign, this finding indicates a potential problem with respect to scope sensitivity.

The parameter estimates the location dummy variables are not significant indicating that no difference in WTP based on urban-rural or regional difference in respondents' location. This may suggest as well that the value estimates from the exercise are amenable to generalization.

The only significant socio-demographic characteristics are related to income. "Monetary constraint" is negative and significant indicating that those with larger constraint on accessing monetary transactions have a lower WTP. Income is positive and significant indicating that those with higher income are willing to pay more for forecast improvements. This is consistent with economic theory and an important finding supporting the internal consistency of the valuation exercise. It should also be noted that when (and if) the economy of Mozambique develops and people experience fewer monetary constraints and higher incomes, this will translate in to larger economic values for improved hydro-met products and services. In a benefit-cost analysis of longer-term program, projections for improved economic conditions, improved financial systems, and increased economic accessibility could be factored in to recognize increasing benefits over time.

Individuals who have more experienced personal loss due to weather in the past, indicated larger WTP for forecast improvements. Infrastructure disruptions and mortality/morbidity experiences were not related to higher WTP nor was the level of concern about weather impacts.

The parameter estimate on "Agencies" was negative and significant indicating that those who currently get their information from government or non-government agencies have lower WTP for improvements in hydro-met information. We note that this factor was not specifically about INAM, DNA, or the ARAs and may represent a reaction to government in general. If individuals were thinking of INAM or other hydro-met agencies in particular, this result would be counterintuitive and suggests the need for further investigation. It may indicate a lack of trust in these agencies or perhaps a current feeling that the information they provide is adequate. A similar result was found in the regression analysis on current values (Table 4.9). This finding should be investigated further to assess public perceptions and understanding with respect to the agencies providing hydro-met information.

The areal extents of respondents' interest in forecasts, either local or broader areas, were not a predictor of their WTP for improvements even though one of the improvement attributes is improved geographic specificity for forecasts.

Respondents using forecasts more for "Short-Term Decisions" (e.g., planning how to get to work or school, how to dress themselves or their children, or planning job or work activities) are willing to pay more for improved forecasts than those using these forecasts less whereas there "Long-Term Decisions" are not significant and even though the scenarios does involve improving "Reliability of seasonal forecasts" most of the attribute improvements were likely related to shorter term decision making.

Increases of the "temperature" factor on importance of specific weather information attributes is associated with lower WTP which is counterintuitive as the programs do offer to improve the "Accuracy of high and low temperature forecasts."

Also initially counterintuitive is the finding that those indicating higher satisfaction with weather information (Q18) have a lower WTP for improvements. This may not be counterintuitive though if those perceiving greater satisfaction with current products and services don't see a need (and thus don't have a value for) improving that information.

Interestingly, those individuals who indicated they were aware of INAM prior to the survey, do have a higher WTP for product improvements. This may also suggest an indirect benefit to increasing the public awareness of the existence and role of INAM and other agencies as programs are implemented to improve hydro-met information.

The parameter estimates on alpha-factor score of importance of improving forecast information is positive and significant lending additional support to the internal consistency and reliability of the survey results.

With respect to motivations in their value statement, individuals who indicated a higher level of rejection for the hypothetical scenario, indicated a lower WTP as expected. Accounting for this bias helps ensure that we don't underestimate the value of improved forecasts. The factor score on "Useful" is positive and significant as well indicating that those who feeling that "It would be useful to me to have improved forecasts" have higher WTP for those improvements.

Finally, with respect to use and non-use values, in general those indicating a stronger motivation for wanting improved forecast to benefit anyone who uses them (as well as even if they are not used at all – existence value) indicated a significantly larger WTP for the improvement programs. This was unexpected as we felt that weather, water, and climate information was primarily a use value commodity, but the results do suggest a significant level of altruistic or bequest motivation in respondents WTP statements.

4.4.4 Value Derivations

Fitted values of Log_WTP were retained for each respondent in the regression analysis (using the Full model). These were then converted back to WTP estimates by "exponentiating" the fitted logged WTP values for each respondent. Additionally, 95% confidence bounds on each respondent were also converted. Table 4.18 shows the mean fitted WTP for each program version (intermediate and maximum) and confidence 95% intervals around the mean. This approach does not correct for scenario rejection in respondents' fitted values and thus is likely an underestimate of true WTP values.

Table 4.18: Fitted WTP Estimates from Full Model

Version	Variable	Mean	Std Dev	Min.	Max.	Median
Intermediate Improvement (n=268)	Expected_WTP_Actual_MT	48.20	89.51	2.02	1121.96	22.93
	Expected_WTP_Lower_Bound	21.49	34.46	0.93	367.51	10.13
	Expected_WTP_Upper_Bound	110.27	245.88	4.38	3425.23	49.22
Maximum Improvement (n=308)	Expected_WTP_Actual_MT	40.89	59.98	1.09	373.98	19.64
	Expected_WTP_Lower_Bound	18.57	27.27	0.45	182.42	8.87
	Expected_WTP_Upper_Bound	91.79	138.38	2.64	939.11	42.15

There was not a significant difference in WTP between the two scenarios (t=1.13; p=0.26, df=455.88 using the Satterthwaite method for unequal variances (the test for equality of variances df=267,307; F Value 2.23; Pr > F <.0001)).

Thus, the estimate of 40.89 (18.57-91.79 95% CI) MT/respondent/year is considered the best estimate of potential maximal improvements to the hydro-met products and services. This translates to $1.16 ($0.53-$2.62 95% CI).[62]

[62] http://www.xe.com accessed March 20, 2015.

5 SUMMARY ON BENEFIT ESTIMATES AND CONCLUSION

5.1 Overview

In the economic analysis, three potential issues or biases are addressed that could affect value estimates. First, by developing the monetary constraint measure, it is attempted to control for potential willingness to pay (WTP) statement biases related to individuals not having access to monetary ransactions. Second, bequest and altruistic motivations for value statements are considered based in part on prior work in Vietnam suggesting there may be significant non-use values associated with hydro-meteorological (hydro-met) information provision (Nguyen and Robinson, 2013). And third, measures of scenario rejection are implemented that could lead to underestimates of true WTP as well as measures of valid motivations and barriers to WTP that help explain and confirm value statements.

Then, three economic valuation exercises were implemented to evaluate (1) the value of current weather information services and products and (2) WTP for improved weather information. To assess WTP for potential improvements, two methods were used including (1) a discrete choice experiment, and (2) a contingent valuation method (CVM) payment card value elicitation.

5.2 Values for Current Services

The median value for current product and services was estimated at about 250 MT per year with a 95% confidence interval from roughly 125 MT to 375 MT. Under assumptions of sample representativeness and taking this as a per household value, this measure was aggregated to all of Mozambique for an annual estimate of the value of current hydro-met information of 1,150,000,000 MT per year or approximately US$37.4 million per year.

5.3 Discrete Choice Experiment

Using a discrete-choice experiment where respondents' choices between potential forecast-improvement programs and the accuracy of existing forecasts reveal their WTP for improved forecasts, total WTP for the maximal improvement program (without changes in geographic detail) are estimated as 2.808 MT per year per respondent. This value is equal to $US0.0918. Taking this as a per-household value estimate and assuming that the sample was representative of the overall population of Mozambique, this measure is aggregated to the 23,000,000 people in Mozambique with an average of five people per household (4.6M households). Aggregating this over 50 years of a program lifetime using a 3% rate of discount indicates a present value estimate of $US11.2 million benefit for a maximal weather information improvement program.

5.4 Contingent Valuation Method (CVM) Elicitation

Using a contingent valuation method (CVM) question for a single program but with two different versions representing an intermediate improvement and a maximal improvement, total WTP was estimated for the maximal improvement program (not adjusting upward for potential scenario rejection) of 40.89 MT per year per respondent. This value is equal to US$1.16 ($0.53-$2.62, 95% CI). We then use this as a per-household value estimate (assuming our sample to representative of the population of Mozambique) to develop and aggregate measure across the 4.6 million households in Mozambique. Calculating this over a 50 year program lifetime with a 3% rate of discount derives a present value estimate of US$141.4 million benefit for an maximal weather information improvement program (95% CI = US$64.6-$319.5 million).

5.5 Conclusion

While wome of the survey results are counter-intuitive (such as a lower WTP value for those saying temperature information is important) and require more assessment or evaluation in future work, overall, the survey indicated a positive and significant WTP for current and improved hydro-met information in Mozambique. Underlying these key results, it was found that weather, water, and climate are significant and important factors in all areas of life in Mozambique, and that improvements in information will likely add significant benefit for the general public. Results also indicate that in the longer term, more information (e.g., climate) is as important, if not even more important, to respondents than short-term information; that there are substantive regional and urban-rural differences that should be considered in developing hydro-met services; and that there is a general need for increased awareness and access to hydro-met information.

There were potential shortcomings in this effort as well. It noted that the survey contained multiple valuation formats and involved a relatively long interview with each subject, which may have involved some respondent fatigue and subsequent data variation. In addition, there was insufficient time for pre-testing the survey and development, and future work should allow for more time in implementation to enhance data quality. And given a lack of historical forecast verification, INAM did not have a good assessment of current and future quality of hydro-met information. Valuation scenarios are therefore based on “best guesses” of current and improved information. Future efforts at benefit assessment of hydro-met services in developing countries could focus first on the availability and reliability of measures of forecast accuracy – either from the agency perspective or evaluated from the end-user perspective. Implementing this more thoroughly in a weather information value chain approach (see Section 2.1) would provide more reliable and valid economic assessments.

Building on the current research, it is recommended that there be similar work following program implementation to assess program results. Future work should also more thoroughly assess respondent heterogeneity beyond the south versus north-central and urban-rural analysis assessment that have been undertaken so far. And, given the relatively low values suggested in the stated choice analysis (much lower than in the CVM analysis), ongoing analysis is necessary especially on DCE responses to assess value estimates.

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APPENDIX A. DATA ADJUSTMENTS, MISSING VALUES, AND FITTED INCOME ESTIMATION

A.1. Data Adjustments and Missing Values

A set of dummy and re-coded variables were created from questions with multiple categorical responses for purposes of subsequent data analysis. Note that some of the variables described below are not used in the reported analysis.

- The dummy variable “Urban-rural” is equal to 1 for anyone sampled in Maputo, Beira, or Quelimane. All others (Boane, Nicoadala, Magude, Matutuine, Chokwe, Dondo, Gouvro, Vilanculos, Angoche, and Island of Moçambique) are coded 0.
- The variable “Zone” is equal to South for anyone surveyed in the Districts of Boane, Chokwe, Gouvro, Magude, Maputo, Matutuine, and Vilanculos and is equal to North-Central for anyone surveyed in the Districts of Angoche, Beira, Dondo, Island of Mozambique, Nicoadala, and Quelimane. Zone was also coded as a quantitative variable dummy (“Zone_South_Dummy”) with South =1 and North-Central = 0.
- The dummy variable “Married” is equal to 1 for anyone responding married or marital union to HH2. All others are coded 0.
- The dummy variable “Employed” is equal to 1 for anyone responding full time, part time, or self-employed to HH9. All others (Retired, Homemaker, Student, Unemployed, and Refused) are coded 0.
- The dummy variable “Piped water interior” is equal to 1 for anyone responding Piped water in the house to HH5. All others (Piped water outside the house, Fontenario, Pit/Hole protected, Pit pump (open), River/Lake/Lagoon, Rainwater, Mineral water, Other) are coded 0.
- The dummy variable “Advanced Sanitation” is equal to 1 for anyone responding Central Plumbing or Toilet connected to septic tank to HH6. All others (Improved latrine, Traditional improved latrine, Traditional latrine not improved, or Without latrine) are coded 0.

- The dummy variable "Electricity" is equal to 1 for anyone responding Electricity to HH7. All others (Generator/solar panel, Gas, Oil/paraffin/kerosene, Candle, Battery, Firewood, Other) are coded 0.
- The dummy variable "Monetary Income" is equal to 1 for anyone providing a response "I do have a monetary income" to Q36. All others (I have no monetary income or Refused) are coded 0.
- The dummy variable "Income Not Missing" is equal to 1 for anyone providing a valid response to question HH11. All others (Don't Know or Refused) are coded 0.

Table A.1 shows these new variables including the coding and frequency counts and percentages.

Table A.1: Dummy Variable Recoding and Frequencies		
Urban_Rural_Dummy Recoded from sample location	Rural = 0	Urban = 1
Frequency	337	239
Percent	58.51%	41.49%
Zones Recoded from Districts	South = 1	North-Central = 0
Frequency	337	239
Percent	58.51%	41.49%
Married_Dummy_Vbl Recoded from HH2	Non Married = 0	Married or Marital Union = 1
Frequency	317	259
Percent	55.03%	44.97%
Employed_Dummy Recoded from HH9	Not Employed = 0	Full Time, Part Time, Self = 1
Frequency	452	124
Percent	78.47%	21.53%
Piped_Water_Interior Recoded from HH5	No piped water in house = 0	Piped water in the house = 1
Frequency	484	92
Percent	84.03%	15.97%
Advanced_Sanitation Recoded from HH6	No central plumbing /septic= 0	Central Plumbing or Septic = 1
Frequency	427	149
Percent	74.13%	25.87%
Electricity Recoded from HH7	Other energy source = 0	Electricity in household = 1
Frequency	142	434
Percent	24.65%	75.35%
Monetary_Income	Don't have or refused = 0	Have monetary income = 1

Table A.1: Dummy Variable Recoding and Frequencies		
Recoded from Q36		
Frequency	212	364
Percent	36.81%	63.19%
Income_Not_Missing based on HH11	Don't Know or Refused	Responded to HH11 (2012 Income)
Frequency	211	365
Percent	36.63%	63.37%

Additional variables were recoded or adjusted from categorical responses to better represent the character of the data or for purposes of quantitative analysis.

- Question 2 asking whether individuals had experienced any impact from weather or a weather event over the prior 10 years was one of the only questions in the survey that permitted a "Don't Know" response. Less than 2% of the respondents provided a Don't Know response for each of the 11 items asked about. As the median response for 10 of the 11 items was "No" (51.0% of respondents answered "Yes" with respect to power supply disruption), we replaced "Don't Know" responses with "No" for purposes of data analysis (this was done for 38 Don't Know responses or 0.60% of the 6,336 responses on these 11 items).
- The variable "Money constrained" is 15 minus the sum of the three items for Q37 ("If you had to obtain some money, how difficult would it be for you to do each of the following?"). On a scale from 1 = "Impossible" to 5 = "Not at all difficult" individuals indicated the difficulty of getting money by "Undertake a day of labor for 30 MT", "Sell or trade some of my crops or other possessions for 60 MT," and "Borrow 640 MT from friends or neighbors." A sum of 15 would thus indicate no difficulty in getting money for these activities and a sum of three would indicate it was impossible. By subtracting the sum from 15 we then create a scale where zero means there is no difficulty in getting money and 12 means it is impossible for the individual to get money for by these approaches. We feel this scale thus represents a measure of the individual's access to monetary activities whether due to restricted income or by inability to access monetary transactions. Table A.2 shows the frequency count by level of monetary constraint ranging from no constraint (2.78% of respondents) to extreme constraint (6.60% of respondents).

Table A.2: Monetary Constraint *(Larger number represents a more significant money constraint)*		
Monetary Constraint Scale	**Frequency**	**Percent**
0	16	2.78%
1	8	1.39%
2	27	4.69%
3	55	9.55%
4	59	10.24%
5	56	9.72%
6	84	14.58%
7	56	9.72%
8	52	9.03%
9	59	10.24%
10	43	7.47%
11	23	3.99%
12	38	6.60%
Total	576	100.00%

- Question HH8 asked "What is the highest degree or level of school you have completed?" and provided 10 response options in addition to recording "Not known" (2.4%) and "Refused" (2.3%). The variable "Education Continuous" recoded HH8 based on converting the categorical responses to years of education. The years assigned to the categories is based on input from the survey contractor (Chisomo Chilemba) and on the researcher's interpretation of a description of the Mozambican educational system in the UNESCO website "The EFA 2000 Assessment: Country Reports: Mozambique" (UNESCO. 2000). Table A.3 shows the recoding method applied to the categorical school responses to create the Education Continuous variable as a quantitative measure of the number of years of education. As indicated, "Not known" and "Refused" were recoded to the median value of "Secondary ESG1 (8th-10th)" or 10 years for purposes of the created variable "Education Continuous."

Table A.3: Recoding Schooling to "Education Continuous"		
Code	Item	Years
0	Literacy class	8
1	Primary EP 1 (1st-5th)	5
2	Primary EP2 (6th-7th)	7
3	Secondary ESG1 (8th-10th)	10
4	Secondary ESG2 (11th-12th)	12
5	Elementary Technical	7
6	Basic Technical	10
7	Medium Technical	13
8	Normal School	12
9	University	16
10	Non-standard curriculum	10
98/99	Not known and Refused	10
Years used for recoding were indicated by Chisomo Chilemba personal correspondence (October 11, 2013)		

- The open-ended question on "How long have you lived in the area where you currently live (say within 50 kilometers of your residence)?" was recoded to numerical variable with missing values replaced with the median duration (13 years). With the new variable "Length_of_residency," recoded responses ranged from 2 months (0.166 years) to 40 years with a mean duration of 14.54 years and median of 14 years. The mean length of residency in the South was significantly greater than in the North-Central (16.1 years versus 12.3 years respectively; $t = 4.64$, $p<.0001$) and was greater, but not significantly, in the rural sample compared to the urban sample (15.1 years versus 13.8 years respectively; $t = 1.60$, $p=0.11$).

Additional socio-demographic information was provided by the survey contractor several months after the initial data set and analysis. Data on gender, age, and household size was provided in October 2013.

- For "Respondent's Gender" from the supplemental data we replaced words 'Femino,' 'feminina,' and 'feninino' with Female and the words 'Mascculino' and 'mascuino' with Male and created new dummy variable "Gender_Male_Dummy_Vbl." This was set to "1" for Male and "0" for Female. For the 21 missing gender we randomly assigned either 1 or 0 as for those that were coded almost exactly half were male and half female. The 21 missing gender represent 3.6% of the total sample.

- Age was coded in years. Missing values of age were replaced with the median value of 27 years (21 observations had missing values).
- Household size was provided as a count of the total number of household members. Missing values for "HH Size" were replaced with the median value of five household members (31 observations had missing values).

A.2. Fitting Missing Income Responses

Questions HH11, the last question in the survey, asked "What was your total personal income in 2012?" and offered a series of ranges in MT per year. Table A.4 shows the response options offered and frequency of responses. The far right column shows the point values for recoding responses to the quantitative variable "Income Continuous." "Don't Know"s and "Refused" responses were recoded to missing values. 31.9% of respondents (184 individuals) indicated that they have no monetary income, 108 (18.8%) indicated "Don't Know" and 103 (17.9%) refused to provide this information. This is common for surveys (and is the reason the income question is generally the last question asked in a survey to reduce non-participation).

Table A.4: Recoding Income Responses to "Income Continuous"

Measured in MT/Year

Variable Name	Frequency	Recoded to midpoints
I have no monetary income	184	0
less than MT 10,000	48	5,000
MT 10,000 – MT 19,999	42	15,000
MT 20,000 – MT 29,999	20	25,000
MT 30,000 – MT 39,999	16	35,000
MT 40,000 – MT 49,999	12	45,000
MT 50,000 – MT 59,999	16	55,000
MT 60,000 – MT 69,999	5	65,000
MT 70,000 – MT 79,999	6	75,000
MT 80,000 – MT 89,999	4	85,000
MT 90,000 – MT 99,999	4	95,000
MT 100,000 – MT 119,999	3	110,000
MT 120,000 – MT 139,999	1	130,000
MT 140,000 or more	4	140,000
Don't know	108	missing
Refused	103	missing

As a significant portion of the sample either refused to answer the income question (17.9%) or indicated "Don't Know" (18.8%) we used a linear regression analysis to generate fitted values of income for all individuals. The dependent variable is Income Continuous shown in Table A.4.

We included variables in the regression model normally correlated with income or that we felt may provide an indicator of wealth or other factors related to income. These included socio-demographic measures such as age, gender, household size, education, marital status, and employment. We also included potential indicators of wealth such as ownership of a computer or other internet enabled device as well as the urban-rural and Zone dummy variables. We also included the monetary constraint scale. As the primary purpose of the regression model was to fit missing values we explored a number of explanatory variables and largely chose a model based on maximization of Adjusted R-squared. We show only the final model here. 365 observations were available for the income model (211 missing observations on income) and the F-value for the overall model is 11.11 (Pr>F is <0.0001). The Adjusted R^2 was 0.265, which represents a good model fit.

Table A.5 shows the regression results including the standardized parameter estimates which indicate the relative weight of each variable in explaining the dependent variable (income) and the variance inflation factors (VIF) which quantify the severity of multicollinearity in the regression analysis. A common rule of thumb is if the VIF> 5 then multicollinearity is considered to be high and should be controlled for. None of the VIFs are greater than 2.00 so we do not consider multicollinearity to be a problem in this model.

All of the parameter estimates have the expected signs where we have a priori expectations. For instance those in urban areas, with lower monetary constraints, owning computers or other high-tech devices, and with higher education have higher income. In addition we find that students and married respondents indicate a higher level of income and those employed part time indicate a lower level of income. (Note that the last four variables is "Yes" =1 and "No" = 2 which must be appropriately accounted for in interpreting the parameter estimates).

Table A.5: Regression analysis of income to generate model for fitting missing values						
Variable	Estimates	Std. Err.	t-Value	Pr>|t|	Std. Est.	VIFs
Intercept	59,577.00	19,353.00	3.08	0.00	0.00	0.00
Age (Years)	29.68	125.31	0.24	0.81	0.01	1.04
Male (Male = 1; Female = 0)	2,215.14	2,604.43	0.85	0.40	0.04	1.11
Household Size (Number in household)	-170.35	564.03	-0.30	0.76	-0.01	1.05
Education (Continuous: Years. Missing set to median = 10 years)	1,184.72	519.53	2.28	0.02	0.12	1.37
Monetary Constraint (Scale: Not constrained = 0 to Extremely constrained = 12)	-1,189.44	424.49	-2.80	0.01	-0.13	1.07
Married (Married or Union = 1; Other = 0)	7,383.81	2,631.06	2.81	0.01	0.13	1.13
Employed (Employed =1; Not Employed =0)	349.95	3,459.45	0.10	0.92	0.00	1.09
Urban-Rural (Urban = 1, Rural = 0)	6,717.93	2,753.21	2.44	0.02	0.12	1.12
Zone (South =1; North-Central =0)	2,994.85	2,676.51	1.12	0.26	0.05	1.19
Employment – Part time (Yes =1; No =2)	-17,567.00	3,359.24	-5.23	0.00	-0.26	1.26
Employment - Student (Yes =1; No =2)	8,640.05	3,322.98	2.60	0.01	0.13	1.28
Owns Computer (Yes =1; No =2)	-8,339.61	3,576.77	-2.33	0.02	-0.12	1.29
Owns Other Internet Device (Yes =1; No =2)	-12,414.00	6,819.36	-1.82	0.07	-0.09	1.14

The model was then used to create fitted income levels for all respondents based on their values of the independent variables. These fitted values were then converted back to the midpoints for the income ranges shown in Table A.4 for all 576 respondents – including setting negative values to zero. The Pearson Correlation Coefficient (Rho) between reported and fitted income (for the 365 individuals who reported their income) was 0.54 which is highly significant (Prob > |r| under H0: Rho=0 <.0001). For the final income variable (Income Continuous Final) we used either the individuals stated income level if available (n=365) or their fitted income point estimate from the regression modeling if they had not provided a response to the income question (n=211). Figure A-1 shows the distribution of actual (stated) and actual/fitted income levels used for the final income analysis variable. As can be seen the fitted values tended to fall more into low to middle income levels (5,000 to 55,000 MT/year) and not as many in the zero income or higher (65,000 MT/year) levels.

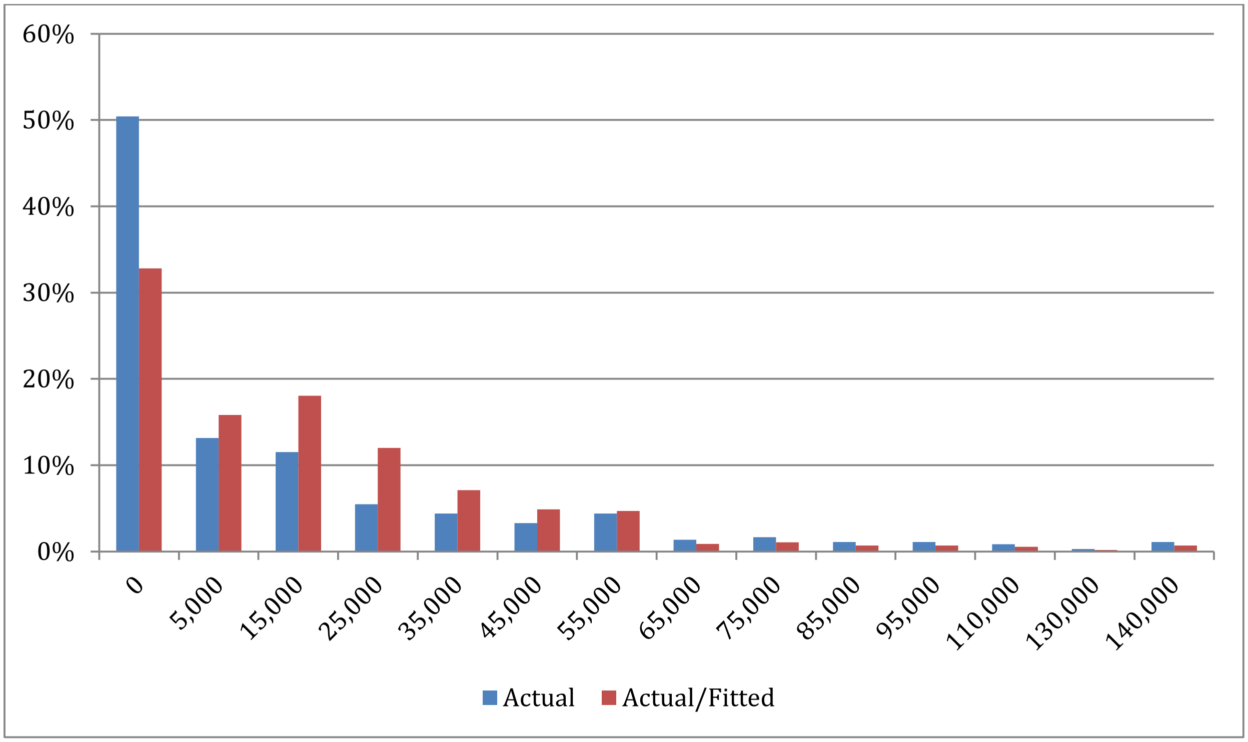


Figure A-1. Distribution of Stated and Stated/Fit Income Levels.

APPENDIX B. MEMO TO ELICIT HYDRO-METEOROLOGICAL CHARACTERIZATION – ATTRIBUTES AND LEVELS

REQUEST FOR INPUT ON FORECAST ATTRIBUTES AND LEVELS FOR PUBLIC SURVEY

April 29, 2013

On the following pages is information as currently presented in the survey about forecast attributes and levels that will be the basis of our attempt to elicit values for improved forecasts from members of the general public (noting that this will be translated as needed and appropriate).

On the next page is a single table summarizing the attribute information and levels we currently have. We've also included a blank table that we would ask you to fill in as appropriate with any corrected information. We've included some blank rows as well for any new / additional attributes you would like to suggest.

It is critical that this (1) represents accurate information about the current and potential quality of forecasts so that we estimate a value for something relevant and meaningful with respect to the World Bank program. In order to do this we would truly appreciate your feedback on some of the "technical" information we are including in the survey. This in part supplements focus groups / interviews that Chisomo Chilemba has done and likely will continue to do with you and or others at INAM, DNA, and elsewhere.

Therefore could you please look at all the attributes and information we have compiled and for each answer the following set of questions?

We have chosen a set of forecast "attributes" to ask respondents about and different "levels" for each attribute.

1) **Have we chosen the right set of attributes to represent INAM / DNA capabilities (focusing more on INAM's forecasts)?**

2) **Are there critical attributes or a critical attribute we have not included? We can't include everything but want to make sure we include attributes of forecast information of highest relevance to INAM, the public, and the Bank project.**

3) **Have we described these attributes in correctly and in a meaningful way – keeping in mind that we have very little room for providing this information? For any additional attributes can you provide appropriate descriptions that we could include as needed?**

4) **Have we chosen a way of "measuring" these that is potentially meaningful both to INAM and to members of the public?**

5) **Have we chosen a correct baseline level of each attribute – and if not what would be a realistic / meaningful level?**

6) **Have we chosen correct levels for potential improvements? Note that these are intended to include an "intermediate" level that would be achievable with the currently proposed World Bank Program and a potential "maximum" level that could be achieved with sufficient additional resources, science, and time.**

	Attribute	Current	Program	Maximum
1	Warnings and advisories lead time	Current lead time 24 hours (1 day)	Increase lead time to 48 hours (2 days)	Increase lead time to 96 hours (4 days)
2	Geographic detail	Three sections of country (south, central, north)	Province level (10+Maputo City)	District level (128 districts)
3	Time period covered	Currently for entire day	Information broken down between night and day	Information broken into 3-hour increments
4	Accuracy of high and low temperature forecasts	24 hours (1 day) generally accurate ±3°C	Extend to 48 hours (2 days) with same accuracy as current 24-hour	Extend to 120 hours (5 days) with same accuracy as current 24-hour
5	Accuracy of rainfall information	Correct 75% of the time	Being correct 80% of the time	Being correct 90% of the time
6	Maritime information	Correct 70% of the time	Being correct 80% of the time	Being correct 90% of the time
7	Reliability of seasonal forecasts	Reliable 65% of the time	Being reliable 70% of the time	Being reliable 80% of the time
8	Accuracy of flooding and water levels			

Corrected information				
	Attribute	Current	Program	Maximum
1	Warnings and advisories lead time			
2	Geographic detail			
3	Time period covered			
4	Accuracy of high and low temperature forecasts			
5	Accuracy of rainfall information			
6	Maritime information			
7	Reliability of seasonal forecasts			
8	Accuracy of flooding and water levels			

WARNINGS AND ADVISORIES LEAD TIME

This is an example of a severe weather warning from INAM. Warnings and advisories for severe weather are available for events such as extreme temperatures, heavy or dangerous rain and flooding, high winds and waves, and similar severe weather including typhoons.

Sábado, 19 de Janeiro de 2013

AVISO DE MAU TEMPO

Boletim Nº	013/INAM-DAPT/999/2013
Emitido:	10:30 Horas (Tempo Local)
Valido até:	12:00 Horas de 19 de Janeiro de 2013
Tipo de Comunicado: Informação Alerta **Aviso**	Informação
Fenómeno meteorológico:	**Chuvas em regime moderado a forte acompanhadas de trovoadas.**
Áreas de risco	Toda a zona sul do país
Descrição	O INAM prevê a ocorrência de aguaceiros e chuvas em regime moderado a forte (30 a 50 milímetros em 24 horas), acompanhadas de trovoadas, durante os dias 20 e 21 de Janeiro para toda a zona sul do país. As chuvas poderão ocorrer em regime muito forte (mais de 75 milímetros em 24 horas) nas províncias de Maputo (distritos de Magude, Moamba, Boane e Manhica), Gaza (distritos de Mapai,Chicualacuala, Chigubo, Massingir, Chibuto, Guijá, Xai-Xai e Bilene) e Inhambane (distritos de Mabote, Homoine, Panda e Funhalouro).
Recomendações:	Acompanhamento dos boletins meteorológicos e tomada de medidas de precaução e segurança.
Actualização:	Este boletim será actualizado as 10:00 de 19 de Janeiro

Elaborado por:
Meteorologista: *Acácio Tembe*

Chefe do DAPT

1. **This information is currently provided for up to 24 hours in advance. In other words severe weather warnings have a "24-hour lead time."**

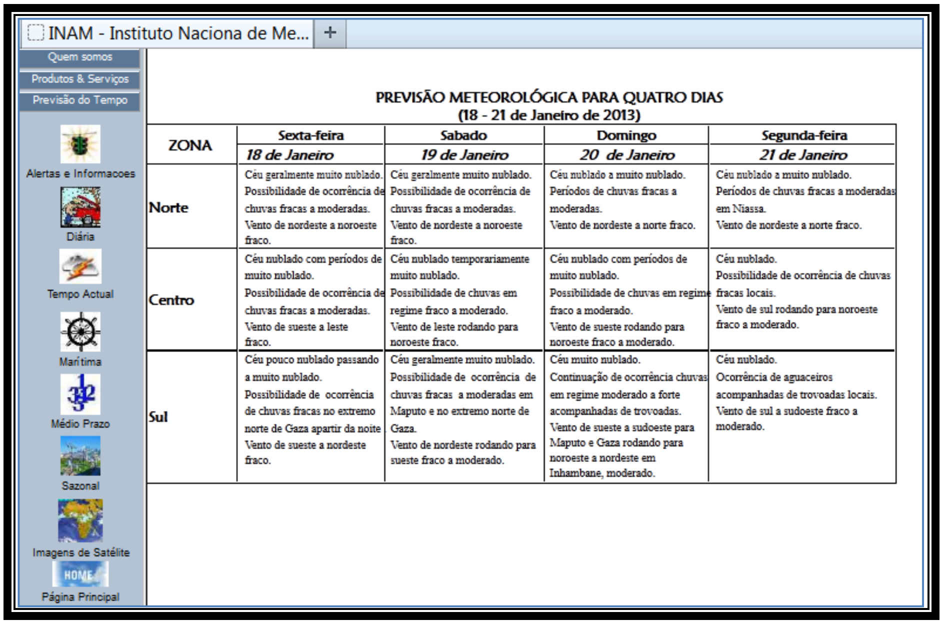
This information could be made more accurate with a program to improve weather forecasts.

How important would it be to you to improve the lead time of warnings and advisories from 24 hours to:

Improvement to:	Not at all important	Not very important	Somewhat important	Very important	Extremely important
48 hours (2 days)	1	2	3	4	5
96 hours (4 days)	1	2	3	4	5

ACCURACY OF RAINFALL INFORMATION

This is an example of a four day forecast from INAM. This shows current information on rainfall or rain including the forecasted amount, location, and likelihood for the four days in three regions of the country – Norte, Centro, and Sul.


INAM - Instituto Naciona de Me...

Quem somos
Produtos & Serviços
Previsão do Tempo
Alertas e Informacoes
Diária
Tempo Actual
Marítima
Médio Prazo
Sazonal
Imagens de Satélite
Página Principal

PREVISÃO METEOROLÓGICA PARA QUATRO DIAS
(18 - 21 de Janeiro de 2013)

ZONA	Sexta-feira 18 de Janeiro	Sabado 19 de Janeiro	Domingo 20 de Janeiro	Segunda-feira 21 de Janeiro
Norte	Céu geralmente muito nublado. Possibilidade de ocorrência de chuvas fracas a moderadas. Vento de nordeste a noroeste fraco.	Céu geralmente muito nublado. Possibilidade de ocorrência de chuvas fracas a moderadas. Vento de nordeste a noroeste fraco.	Céu nublado a muito nublado. Períodos de chuvas fracas a moderadas. Vento de nordeste a norte fraco.	Céu nublado a muito nublado. Períodos de chuvas fracas a moderadas em Niassa. Vento de nordeste a norte fraco.
Centro	Céu nublado com períodos de muito nublado. Possibilidade de ocorrência de chuvas fracas a moderadas. Vento de sueste a leste fraco.	Céu nublado temporariamente muito nublado. Possibilidade de chuvas em regime fraco a moderado. Vento de leste rodando para noroeste fraco.	Céu nublado com períodos de muito nublado. Possibilidade de chuvas em regime fraco a moderado. Vento de sueste rodando para noroeste fraco a moderado.	Céu nublado. Possibilidade de ocorrência de chuvas fracas locais. Vento de sul rodando para noroeste fraco a moderado.
Sul	Céu pouco nublado passando a muito nublado. Possibilidade de ocorrência de chuvas fracas no extremo norte de Gaza apartir da noite . Vento de sueste a nordeste fraco.	Céu geralmente muito nublado. Possibilidade de ocorrência de chuvas fracas a moderadas em Maputo e no extremo norte de Gaza. Vento de nordeste rodando para sueste fraco a moderado.	Céu muito nublado. Continuação de ocorrência chuvas em regime moderado a forte acompanhadas de trovoadas. Vento de sueste a sudoeste para Maputo e Gaza rodando para noroeste a nordeste em Inhambane, moderado.	Céu nublado. Ocorrência de aguaceiros acompanhadas de trovoadas locais. Vento de sul a sudoeste fraco a moderado.

2. **Forecasts are currently correct with this information about 75% of the time.**

This information could be made more accurate with a program to improve weather forecasts.

How important would it be to you to improve the accuracy of rainfall information from being generally correct on amount, location, and likelihood from 75% of the time to:

Improvement to:	Not at all important	Not very important	Somewhat important	Very important	Extremely important
Being correct 80% of the time	1	2	3	4	5
Being correct 90% of the time	1	2	3	4	5

GEOGRAPHIC DETAIL

3. **As shown in the four day weather forecast, weather information is currently provided for the country divided into three general zones – the north, central, and southern zones. This means that each forecast area covers about one-third of the country with no detail about different areas within that third of the country.**

This information could be made more accurate with a program to improve weather forecasts.

How important would it be to you to improve the geographic detail of weather information from the three general zones to:

Improvement to:	Not at all important	Not very important	Somewhat important	Very important	Extremely important
Province level – specific forecast for each of the 10 provinces and City of Maputo	1	2	3	4	5
District level - specific forecast for each of the 128 districts in Mozambique	1	2	3	4	5

TIME PERIOD COVERED

4. **As shown in the four-day weather forecast, weather information is currently provided for a single entire day at a time. This means that the forecast covers the entire 24-hour period with no detail about different times of the day.**

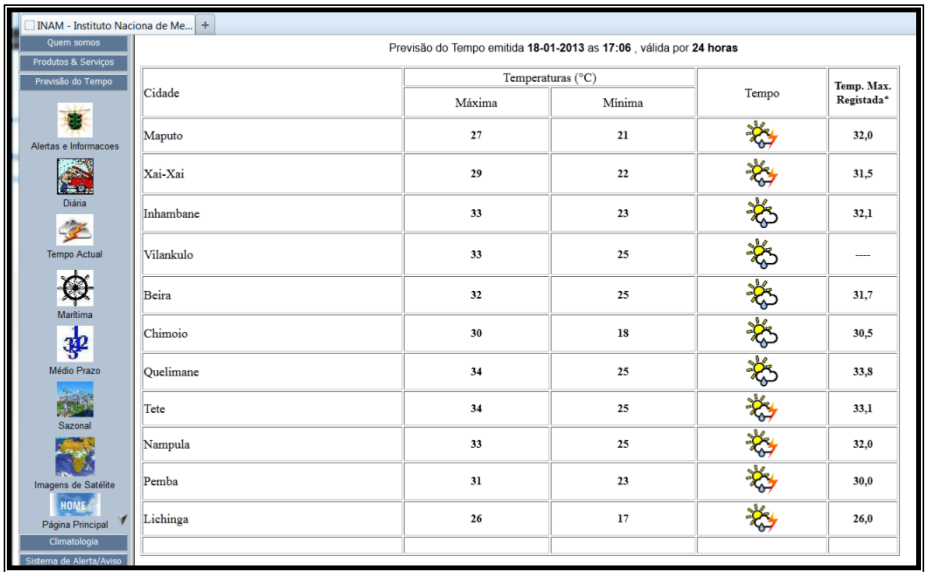
This information could be made more accurate with a program to improve weather forecasts.

How important would it be to you to improve the time period covered of weather information from an entire day per weather forecast to:

Improvement to:	Not at all important	Not very important	Somewhat important	Very important	Extremely important
Information broken down between night and day	1	2	3	4	5
Information broken into three-hour increments	1	2	3	4	5

ACCURACY OF HIGH AND LOW TEMPERATURE FORECASTS

This is an example of a 24-hour forecast of high and low temperatures from INAM. A 24-hour temperature forecast is the expected temperature for the next day. This shows the "registered" temperature, expected temperatures for 11 cities throughout Mozambique as well as a picture of expected weather conditions such as stormy or sunny.



Previsão do Tempo emitida **18-01-2013** as **17:06** , válida por **24 horas**

Cidade	Temperaturas (°C)		Tempo	Temp. Max. Registada*
	Máxima	Mínima		
Maputo	27	21		32,0
Xai-Xai	29	22		31,5
Inhambane	33	23		32,1
Vilankulo	33	25		----
Beira	32	25		31,7
Chimoio	30	18		30,5
Quelimane	34	25		33,8
Tete	34	25		33,1
Nampula	33	25		32,0
Pemba	31	23		30,0
Lichinga	26	17		26,0

5. **24-hour temperature forecasts are currently accurate within about 3°C. This means that for a forecast for tomorrow of a high temperature of 25°C, the actual temperature will be between 22°C and 28°C about 80% of the time.**

This information could be made more accurate with a program to improve weather forecasts.

How important would it be to you to extend temperature forecasts from 24 hours with a plus or minus 3°C level of accuracy out to:

Improvement to:	Not at all important	Not very important	Somewhat important	Very important	Extremely important
48 hours (2 days) with same accuracy as current 24-hour	1	2	3	4	5
120 hours (5 days) with same accuracy as current 24-hour	1	2	3	4	5

RELIABILITY OF SEASONAL FORECASTS

This is an example of a seasonal forecast of which provides information on expected rainfall over a three month period six months in advance for the north, central, and southern zones of Mozambique. Rainfall is indicated as likely to be above or below normal or about normal.

Para o período Janeiro-Fevereiro-Março (JFM) de 2013, há uma maior probabilidade de ocorrência de chuvas normais com tendência para acima do normal para a maior parte do país com excepção das províncias de Maputo, Gaza e Inhambane onde há maior probabilidade de ocorrência de chuvas normais com tendência para abaixo do normal (Figura 2).

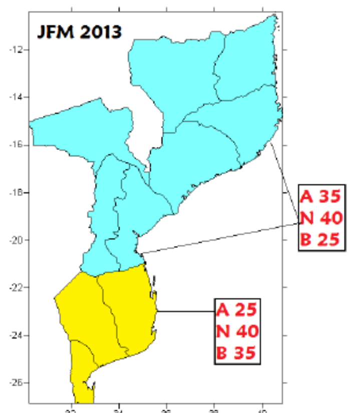


Figura 2: Previsão da Precipitação para o período JFM - 2013, em Moçambique.

6. **These forecasts are reliable about 65% of the time.**

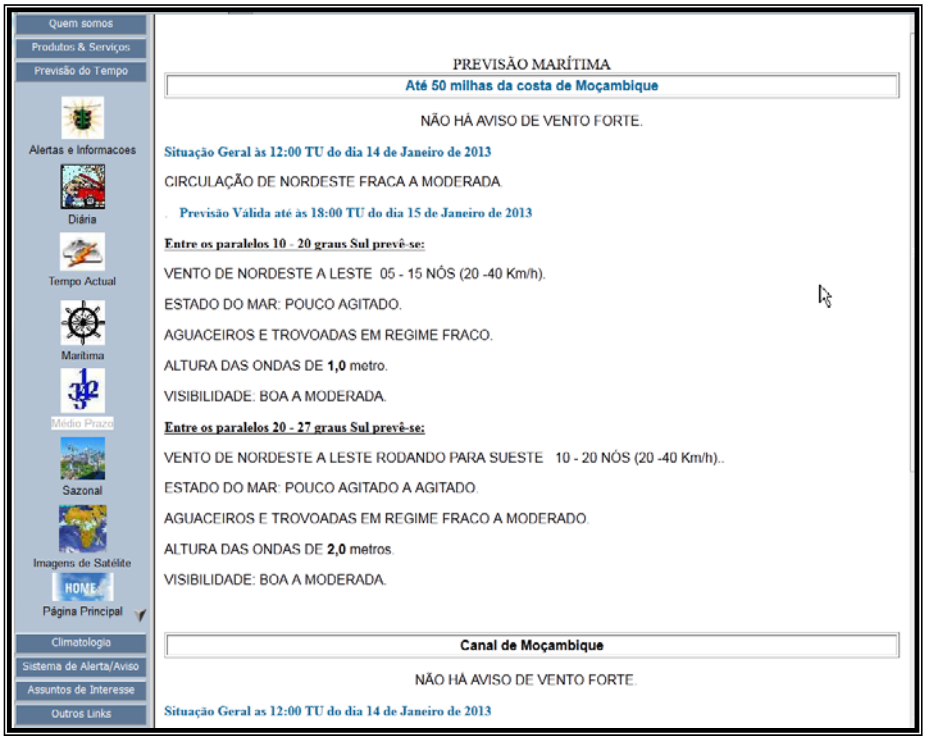
This information could be made more accurate with a program to improve weather forecasts.

How important would it be to you to have seasonal forecasts improved from being reliable about 65% of the time to:

Improvement to:	Not at all important	Not very important	Somewhat important	Very important	Extremely important
Being reliable 70% of the time	1	2	3	4	5
Being reliable 80% of the time	1	2	3	4	5

ACCURACY OF MARITIME INFORMATION

This is an example of a maritime forecast from INAM. Maritime information is currently provided on expected wave heights, state of the sea, wind conditions, visibility, and general weather conditions such as "stormy" or "clear."



7. **Using a general idea of accuracy, forecasters are currently correct with this information about 70% of the time.**

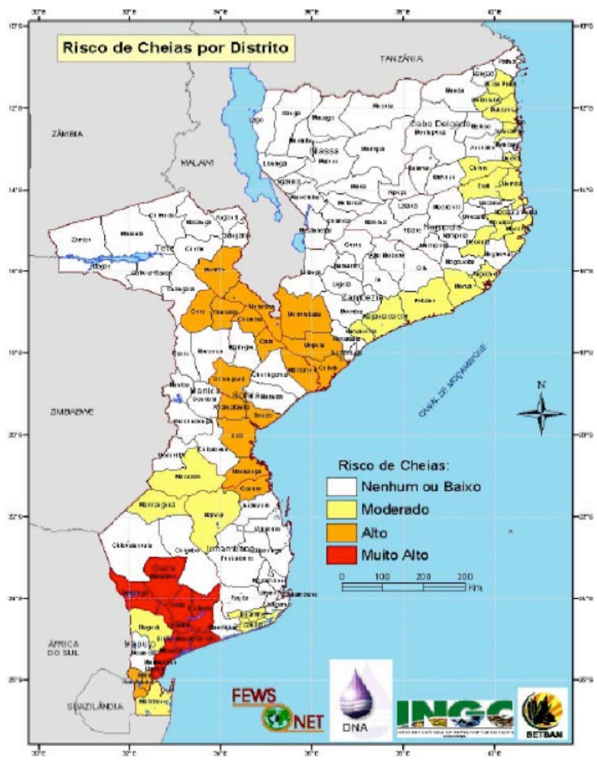
This information could be made more accurate with a program to improve weather forecasts.

How important would it be to you to improve the accuracy of maritime information from being generally correct 70% of the time to:

Improvement to:	Not at all important	Not very important	Somewhat important	Very important	Extremely important
Being correct 80% of the time	1	2	3	4	5
Being correct 90% of the time	1	2	3	4	5

ACCURACY OF FLOODING AND WATER LEVELS

This is an example of information on expected flooding including when and where flooding is forecast and how deep the water may be at different locations.



8. **Using a general idea of accuracy, forecasters are currently correct with this information about 70% of the time.**

This information could be made more accurate with a program to improve weather forecasts.

How important would it be to you to improve the accuracy of flood forecast from being generally correct 70% of the time to:

Improvement to:	Not at all important	Not very important	Somewhat important	Very important	Extremely important
Being correct 80% of the time	1	2	3	4	5
Being correct 90% of the time	1	2	3	4	5

APPENDIX C. SURVEY CODEBOOK

Not Including Open-Ended Responses

Mozambique Household Public Survey 2013
IMPROVING WEATHER INFORMATION IN MOZAMBIQUE

The purpose of this survey is to better understand whether people like you would benefit from improved information about weather and weather forecasts. Weather observations and forecasts are information about past, current or future weather conditions including:

- **_temperature**
- **_clouds**
- **_sunshine**
- **_winds**
- **_rainfall**
- **_floods**
- **_drought**
- **_lightning**
- **_humidity**
- **_waves**
- **_climate**

Weather observations are general information about past or current conditions whereas weather forecasts are about future condition.

You do not need any special knowledge about weather to respond to any of the questions. We want to learn about how you interpret and use weather and forecast information, and what your opinions are about these.

All your responses will remain anonymous. None of the information or opinions you provide can be linked back to you, so please respond as honestly as you can.

Survey Outline

Part	Question Numbering	Section/Topics	Versions
Part A		• Logistical Information • HH Structure Info • Language • Household Roaster • Kish Table	One version
Part B	Regular numbering – 1 thru 37	• Impacts • Concern • Awareness • Sources • Uses • Info Importance • Satisfaction • Agencies Awareness • Improvement Importance • Budget Constraint	One version Skip pattern at Q8
Part C	CS1 thru CS7	• Choice question lead-in • Choice questions	Three versions • Version 1 • Version 2 • Version 3
Part D		• CVM	Two versions • Intermediate program • Full program
Part E	CVMF1 & CVMF2	• CVM Follow-Up • Barriers • Motivations	One version
Part F	Curr15 – Curr960	• Current Value	Four versions • 15 • 60 • 240 • 960
Part G	HH1-HH12	• Household Information • Final Open-Ended	One version

PART A:

HH_Walls. Type of material used for the walls of your house:

Variable Name	Cement Block	Block Brick	Wooden/ Zinc	Adobe Brick	Reed/ Sticks	Paus Maticados	Tin/ Paper/ Shell	Other	Mean	Median	SD	n	# missing
	1	2	3	4	5	6	7	8					
PartA_HH_Walls	314 54.5%	70 12.2%	12 2.1%	28 4.9%	48 8.3%	98 17.0%	1 0.2%	5 0.9%	2.56	1	2.07	576	0

HH_Roof. Type of material used for the roof of your house:

Variable Name	Concrete Slab	Tile	Plate Lusalite	Zinc Plate	Grass/ Thatch/ Palm	Other	Mean	Median	SD	n	# missing
	1	2	3	4	5	6					
PartA_HH_Roof	45 7.8%	18 3.1%	52 9.0%	365 63.4%	94 16.3%	2 0.3%	3.78	4	1.03	576	0

HH_Floor. Type of material used for the roof of your house:

Variable Name	Wood/ Parquet	Marble/ granulite	Cement	Mosaic/ terrazzo	Adobe	Nothing	Other	Mean	Median	SD	n	# missing
	1	2	3	4	5	6	7					
PartA_HH_Floor	22 3.8%	8 1.4%	364 63.2%	26 4.5%	58 10.1%	95 16.5%	3 0.5%	3.67	3	1.32	576	0

Language.

☐ Portuguese (Mozambican)
☐ Emakhuwa
☐ Cisena
☐ Xichangana
☐ Elomwe
☐ Cishona
☐ Other (Please indicate___________________)

Language. Are you able to easily understand and speak Portuguese?

Variable Name	Yes	No	Mean	Median	SD	n	# missing
	1	2					
PartA_SpeakPortuguese	514 89.2%	62 10.8%	1.11	1	0.31	576	0

-> If "No", then ask if anyone else in the household can understand Portuguese and interview them.

PART B:

Q1. How important are the effects of weather to you personally?

Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
	1	2	3	4	5					
PartB_Q1_wx_effects	11 1.9%	25 4.3%	37 6.4%	330 57.3%	173 30.0%	4.09	4	0.84	576	0

Q2. Thinking about the last 10 years, has the weather or a weather event affected you in the following ways?

Sub-question	Variable Name	Yes	No	Don't Know	Mean	Median	SD	n	# missing
		1	2	9					
Forced you to move residence temporarily to a safer place	PartB_Q2_move_temp	141 24.5%	433 75.2%	2 0.3%	1.75	2	0.43	576	0
Forced you to move residence permanently to a safer place	PartB_Q2_move_perm	103 17.9%	471 81.8%	2 0.3%	1.82	2	0.38	576	0
Caused you injury or illness	PartB_Q2_personal_injury	156 27.1%	419 72.7%	1 0.2%	1.73	2	0.45	576	0
Caused family member illness, injury or death	PartB_Q2_family_injury	118 20.5%	455 79.0%	3 0.5%	1.79	2	0.41	576	0
Caused damage to your home or property	PartB_Q2_prop_damage	242 42.0%	334 58.0%	0 0.0%	1.58	2	0.49	576	0
Disrupted your water supply	PartB_Q2_disrupt_water	266 46.2%	309 53.6%	1 0.2%	1.54	2	0.50	576	0
Disrupted your power supply	PartB_Q2_disrupt_power	294 51.0%	271 47.0%	11 1.9%	1.48	1	0.50	576	0
Disrupted the transportation system	PartB_Q2_disrupt_trans	248 43.1%	320 55.6%	8 1.4%	1.56	2	0.50	576	0
Disrupted your household's sources of income	PartB_Q2_disrupt_income	248 43.1%	320 55.6%	8 1.4%	1.60	2	0.49	576	0
Caused personal stress or anxiety	PartB_Q2_personal_stress	264 45.8%	309 53.6%	3 0.5%	1.54	2	0.50	576	0
Caused loss of crops or livestock	PartB_Q2_loss_crops	208 36.1%	365 63.4%	3 0.5%	1.64	2	0.48	576	0

Other:

Variable Name	Yes	No	Don't Know	n	# missing
	1	2	9		
PartB_Q2_other	20 3.5%	510 88.5%	46 8.0%	576	0

Q2a. Other significant weather impacts (please describe)

Open-Ended Response

Q3. Now thinking about the next 10 years, how concerned are you about the following potential weather events?

Sub-question	Variable Name	Not at all concerned	A little concerned	Somewhat concerned	Very concerned	Extremely concerned	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Flooding	PartB_Q3_flooding	10 1.7%	26 4.5%	44 7.6%	257 44.6%	239 41.5%	4.20	4	0.89	576	0
Drought	PartB_Q3_drought	25 4.3%	57 9.9%	92 16.0%	262 45.5%	140 24.3%	3.76	4	1.06	576	0
Severe winds	PartB_Q3_sev_wind	19 3.3%	48 8.3%	93 16.1%	264 45.8%	152 26.4%	3.84	4	1.02	576	0
Typhoon	PartB_Q3_typhoon	91 15.8%	120 20.8%	104 18.1%	188 32.6%	73 12.7%	3.06	3	1.29	576	0
Dust storm	PartB_Q3_dust_stm	63 10.9%	122 21.2%	135 23.4%	191 33.2%	65 11.3%	3.13	3	1.19	576	0
Extreme heat	PartB_Q3_ext_heat	26 4.5%	58 10.1%	96 16.7%	281 48.8%	115 20.0%	3.70	4	1.04	576	0
Extreme cold	PartB_Q3_ext_cold	39 6.8%	51 8.9%	110 19.1%	241 41.8%	135 23.4%	3.66	4	1.13	576	0
Heavy rain	PartB_Q3_hvy_rain	16 2.8%	41 7.1%	89 15.5%	214 37.2%	216 37.5%	3.99	4	1.03	576	0
Extreme humidity	PartB_Q3_ext_humidity	58 10.1%	111 19.3%	182 31.6%	172 29.9%	53 9.2%	3.09	3	1.12	576	0
Climate change	PartB_Q3_climate_chg	19 3.3%	49 8.5%	117 20.3%	248 43.1%	143 24.8%	3.78	4	1.02	576	0
Lightning	PartB_Q3_lightning	38 6.6%	79 13.7%	99 17.2%	206 35.8%	154 26.7%	3.62	4	1.20	576	0

Other:

Variable Name	Yes	No	Don't Know	n	# missing
	1	2	9		
PartB_Q3_other	4 0.7%	572 99.3%	0 0.0%	576	0

Q3a. Other (please describe)

Open-Ended Response

Q4. We know that weather is not the only risk you face. Compared to the most significant weather risks(s) just mentioned, are the following risks more important, about the same, or less important?

Sub-question	Variable Name	Much less important	A little less important	About the same importance	A little more important	Much more important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Economic changes such as loss of income, unemployment or significant increases in prices	PartB_Q4_econ_changes	15 2.6%	44 7.6%	109 18.9%	238 41.3%	170 29.5%	3.88	4	1.01	576	0
Crime and violence	PartB_Q4_violence	29 5.0%	51 8.9%	120 20.8%	236 41.0%	140 24.3%	3.71	4	1.08	576	0
Pollution and environmental degradation	PartB_Q4_pollution	30 5.2%	86 14.9%	137 23.8%	226 39.2%	97 16.8%	3.48	4	1.10	576	0
Health threats such as AIDS/HIV	PartB_Q4_health_threats	18 3.1%	54 9.4%	82 14.2%	220 38.2%	202 35.1%	3.93	4	1.07	576	0
Political instability	PartB_Q4_political_instab	88 15.3%	100 17.4%	136 23.6%	169 29.3%	83 14.4%	3.10	3	1.28	576	0

Other:

Variable Name	Yes	No	Don't Know	n	# missing
	1	2	9		

PartB_Q4_other	1 0.2%	575 99.8%	0 0.0%	576	0

Q4a. Other concerns (please describe)

Open-Ended Response

Q5. Weather includes everything from temperature, clouds, sunshine, winds, rainfall, floods, drought, lightning, humidity, waves, to climate. How important is it to you to have information about the weather?

Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
	1	2	3	4	5					
PartB_Q5	3 0.5%	29 5.0%	81 14.1%	314 54.5%	149 25.9%	4.00	4	0.81	576	0

Q7. Weather forecasts are predictions about future weather, water, or climate conditions. Do you have access to weather forecasts through any means – such as television, radio, newspapers, or friends?

Variable Name	Yes	No	Mean	Median	SD	n	# missing
	1	2					
PartB_Q7	504 87.5%	72 12.5%	1.13	1	0.33	576	0

Q8. Do you personally ever read, hear, or use weather forecasts?

Variable Name	Yes	No	Mean	Median	SD	n	# missing
	1	2					
PartB_Q8	495 85.9%	81 14.1%	1.14	1	0.35	576	0

-> if no, skip to question Q19

Q9. How often do you get, see, or use weather forecasts from the sources listed below?

Sub-question	Variable Name	Never/ Rarely	Once or more a season	Once or more a month	Once a week	Two or more times a week	Once a day	Two or more times a day	Mean	Median	SD	n	# missing
		1	2	3	4	5	6	7					
TV	PartB_Q9_source_tv	189 32.8%	22 3.8%	18 3.1%	33 5.7%	62 10.8%	170 29.5%	82 14.2%	4.03	5	2.39	576	0
Newspaper	PartB_Q9_source_newspaper	479 83.2%	25 4.3%	25 4.3%	17 3.0%	7 1.2%	15 2.6%	8 1.4%	1.48	1	1.27	576	0
Telephone	PartB_Q9_source_telephone	511 88.7%	21 3.6%	13 2.3%	9 1.6%	6 1.0%	13 2.3%	3 0.5%	1.31	1	1.04	576	0
Radio	PartB_Q9_source_radio	263 45.7%	35 6.1%	39 6.8%	37 6.4%	56 9.7%	90 15.6%	56 9.7%	3.14	2	2.30	576	0
Internet	PartB_Q9_source_internet	511 88.7%	16 2.8%	14 2.4%	14 2.4%	7 1.2%	8 1.4%	6 1.0%	1.33	1	1.07	576	0
Friends, family, co-workers, etc.	PartB_Q9_source_friends	326 56.6%	44 7.6%	49 8.5%	40 6.9%	43 7.5%	40 6.9%	34 5.9%	2.45	1	2.00	576	0
National or local government agency	PartB_Q9_source_govt_agency	438 76.0%	33 5.7%	24 4.2%	15 2.6%	16 2.8%	30 5.2%	20 3.5%	1.80	1	1.68	576	0
Non-government organization	PartB_Q9_source_nongovt_org	447 77.6%	31 5.4%	20 3.5%	14 2.4%	15 2.6%	30 5.2%	19 3.3%	1.76	1	1.66	576	0

Other:

Variable Name	Yes	No	Don't Know	n	# missing
	1	2	9		
PartB_Q9_source_other	5 0.9%	571 99.1%	0 0.0%	576	0

Q9a. Other (please describe)

Open-Ended Response

Q10. When you get weather forecasts, how often do you get them for the following areas?

Sub-question	Variable Name	Never	Less than half the time	About half the time	More than half the time	Always	Mean	Median	SD	n	# missing
		1	2	3	4	5					
The area immediately around where you live or work	PartB_Q10_freq_imm_area	208 36.1%	136 23.6%	87 15.1%	77 13.4%	68 11.8%	2.41	2	1.39	576	0
Other areas in the district where you live or work	PartB_Q10_freq_district	229 39.8%	145 25.2%	89 15.5%	72 12.5%	41 7.1%	2.22	2	1.28	576	0
Other areas in your province	PartB_Q10_freq_province	147 25.5%	148 25.7%	119 20.7%	87 15.1%	75 13.0%	2.64	2	1.35	576	0
Other areas outside your province around Mozambique	PartB_Q10_freq_Moz	176 30.6%	144 25.0%	100 17.4%	81 14.1%	75 13.0%	2.54	2	1.39	576	0
Areas in other countries around Africa or elsewhere around the world	PartB_Q10_freq_other_countries	271 47.0%	107 18.6%	76 13.2%	67 11.6%	55 9.5%	2.18	2	1.38	576	0

Q11. How important is it to you to have weather information during the different seasons of the year?

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Winter	PartB_Q11_imp _winter	19 3.3%	49 8.5%	104 18.1%	286 49.7%	118 20.5%	3.76	4	0.98	576	0
Spring	PartB_Q11_imp _spring	133 23.1%	154 26.7%	141 24.5%	122 21.2%	26 4.5%	2.57	3	1.19	576	0
Fall	PartB_Q11_imp _fall	155 26.9%	138 24.0%	144 25.0%	111 19.3%	28 4.9%	2.51	2	1.21	576	0
Summer	PartB_Q11_imp _summer	13 2.3%	26 4.5%	87 15.1%	271 47.0%	179 31.1%	4.00	4	0.92	576	0
Dry Season	PartB_Q11_imp _dryseason	21 3.6%	52 9.0%	113 19.6%	242 42.0%	148 25.7%	3.77	4	1.05	576	0
Wet Season	PartB_Q11_imp _wetseason	6 1.0%	19 3.3%	60 10.4%	201 34.9%	290 50.3%	4.30	5	0.86	576	0

Q12. On average, year round, how often do you use weather forecasts for the activities listed below?

Sub-question	Variable Name	Never/ Rarely	Once or more a season	Once or more a month	Once a week	Two or more times a week	Once a day	Two or more times a day	Mean	Median	SD	n	# missing
		1	2	3	4	5	6	7					
Planning how to dress yourself or your children	PartB_Q12_use_dress	290 50.3%	42 7.3%	42 7.3%	32 5.6%	29 5.0%	115 20.0%	26 4.5%	2.86	1	2.20	576	0
Planning how to get to work or school	PartB_Q12_use_commute	251 43.6%	51 8.9%	48 8.3%	47 8.2%	32 5.6%	118 20.5%	29 5.0%	3.05	2	2.19	576	0
Planning to do yard work or outdoor house work	PartB_Q12_use_yardwork	314 54.5%	46 8.0%	66 11.5%	58 10.1%	34 5.9%	48 8.3%	10 1.7%	2.37	1	1.80	576	0
Planning job or work activities	PartB_Q12_use_job_activities	262 45.5%	75 13.0%	64 11.1%	64 11.1%	34 5.9%	63 10.9%	14 2.4%	2.61	2	1.88	576	0
Planning social activities	PartB_Q12_use_sociatl_activities	322 55.9%	47 8.2%	61 10.6%	77 13.4%	36 6.3%	26 4.5%	7 1.2%	2.24	1	1.65	576	0
Planning travel	PartB_Q12_use_travel	346 60.1%	68 11.8%	68 11.8%	42 7.3%	29 5.0%	15 2.6%	8 1.4%	1.99	1	1.49	576	0
Planning weekend activities	PartB_Q12_use_weekend_activities	253 43.9%	54 9.4%	72 12.5%	107 18.6%	46 8.0%	37 6.4%	7 1.2%	2.61	2	1.73	576	0
Simply knowing what the weather will be	PartB_Q12_use_gen_knowldg	211 36.6%	52 9.0%	51 8.9%	65 11.3%	57 9.9%	120 20.8%	20 3.5%	3.25	3	2.11	576	0
Visit family or friends	PartB_Q12_use_visit_family	302 52.4%	51 8.9%	82 14.2%	80 13.9%	36 6.3%	18 3.1%	7 1.2%	2.27	1	1.59	576	0
Knowing weather for health reasons	PartB_Q12_use_health	303 52.6%	43 7.5%	50 8.7%	56 9.7%	33 5.7%	67 11.6%	24 4.2%	2.60	1	2.02	576	0
Harvesting, planting, or other crop decisions	PartB_Q12_use_crops	303 52.6%	83 14.4%	66 11.5%	49 8.5%	30 5.2%	29 5.0%	16 2.8%	2.26	1	1.70	576	0

-> If "Planning job or work activities" is more than "never", go to question Q12b.

Other:

Variable Name	Yes	No	Don't Know	n	# missing
	1	2	9		
PartB_Q12_use_other	4 0.7%	572 99.3%	0 0.0%	576	0

Q12a. Other (please describe)

Open-Ended Response

Q12b. In your own words, please describe how you use weather forecasts for planning job or work activities.

Open-Ended Response

Q13. A weather forecast can provide several types of information about temperature, cloudiness, winds, rain, water levels, and other factors. Thinking about "short term" forecasts of up to 2 weeks, how important is it to you to have the information listed below as part of a weather forecast?

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Chance of rain	PartB_Q13_st_ wx_chnc_rain	12 2.1%	31 5.4%	83 14.4%	319 55.4%	131 22.7%	3.91	4	0.88	576	0
Amount of rain	PartB_Q13_st_ wx_amt_rain	8 1.4%	27 4.7%	92 16.0%	292 50.7%	157 27.3%	3.98	4	0.86	576	0
When rain will occur	PartB_Q13_st_ wx_timing_rain	4 0.7%	31 5.4%	90 15.6%	303 52.6%	148 25.7%	3.97	4	0.83	576	0
Where rain will occur	PartB_Q13_st_ wx_loc_rain	6 1.0%	29 5.0%	94 16.3%	291 50.5%	156 27.1%	3.98	4	0.85	576	0
Low temperature (daily minimum)	PartB_Q13_st_ wx_low_temp	9 1.6%	50 8.7%	199 34.5%	233 40.5%	85 14.8%	3.58	4	0.90	576	0
High temperature (daily maximum)	PartB_Q13_st_ wx_high_temp	9 1.6%	51 8.9%	163 28.3%	266 46.2%	87 15.1%	3.64	4	0.90	576	0
How sunny or cloudy it will be	PartB_Q13_st_ wx_clouds	24 4.2%	81 14.1%	193 33.5%	213 37.0%	65 11.3%	3.37	3	1.00	576	0
Humidity	PartB_Q13_st_ wx_humidity	63 10.9%	146 25.3%	175 30.4%	162 28.1%	30 5.2%	2.91	3	1.08	576	0
Wind speed	PartB_Q13_st_ wx_wind_spd	35 6.1%	76 13.2%	155 26.9%	208 36.1%	102 17.7%	3.46	4	1.11	576	0
Wind direction	PartB_Q13_st_ wx_wind_dir	41 7.1%	103 17.9%	125 21.7%	214 37.2%	93 16.1%	3.37	4	1.16	576	0
Dust storm	PartB_Q13_st_ wx_dust_storm	54 9.4%	127 22.0%	141 24.5%	176 30.6%	78 13.5%	3.17	3	1.19	576	0
Barometric pressure	PartB_Q13_st_ wx_pressure	74 12.8%	141 24.5%	159 27.6%	159 27.6%	43 7.5%	2.92	3	1.15	576	0
Visibility	PartB_Q13_st_ wx_vis	44 7.6%	89 15.5%	178 30.9%	197 34.2%	68 11.8%	3.27	3	1.10	576	0
Lightning	PartB_Q13_st_ wx_lightning	30 5.2%	75 13.0%	151 26.2%	191 33.2%	129 22.4%	3.55	4	1.13	576	0
How much sunlight is	PartB_Q13_st_	33	104	170	207	62	3.28	3	1.06	576	0

hitting the ground	wx_radiation	5.7%	18.1%	29.5%	35.9%	10.8%					
Evaporation rates	PartB_Q13_st_ wx_evap_rate	57 9.9%	147 25.5%	182 31.6%	147 25.5%	43 7.5%	2.95	3	1.10	576	0
Severe weather warnings	PartB_Q13_st_ wx_severe_wx	15 2.6%	56 9.7%	99 17.2%	221 38.4%	185 32.1%	3.88	4	1.05	576	0
Water flows in rivers and streams	PartB_Q13_st_ wx_water_flow	33 5.7%	72 12.5%	157 27.3%	230 39.9%	84 14.6%	3.45	4	1.07	576	0
Droughts or prolonged dry periods	PartB_Q13_st_ wx_drought	17 3.0%	44 7.6%	134 23.3%	263 45.7%	118 20.5%	3.73	4	0.97	576	0
Flooding	PartB_Q13_st_ wx_flood	10 1.7%	49 8.5%	108 18.8%	210 36.5%	199 34.5%	3.94	4	1.01	576	0
Waves on rivers, lakes, or ocean	PartB_Q13_st_ wx_waves	34 5.9%	112 19.4%	126 21.9%	203 35.2%	101 17.5%	3.39	4	1.16	576	0

Other:

Variable Name	Yes	No	Don't Know	n	# missing
	1	2	9		
PartB_Q13_st_wx_other	1 0.2%	575 99.8%	0 0.0%	576	0

Q13a. Other (please describe)

Open-Ended Response

Q14. Thinking about "long term" forecasts that are longer than 2 weeks to months or even years, how important is it to you to have the information listed below as part of a forecast?

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Likely rain levels	PartB_Q14_lt_wx_rain_lvls	10 1.7%	46 8.0%	99 17.2%	280 48.6%	141 24.5%	3.86	4	0.94	576	0
Likely temperature levels	PartB_Q14_lt_wx_temp_lvls	11 1.9%	49 8.5%	137 23.8%	272 47.2%	107 18.6%	3.72	4	0.93	576	0
Climate change projections	PartB_Q14_lt_wx_climate_chg	13 2.3%	64 11.1%	112 19.4%	272 47.2%	115 20.0%	3.72	4	0.98	576	0
Seasonal rain	PartB_Q14_lt_wx_seas_rain	15 2.6%	64 11.1%	122 21.2%	252 43.8%	123 21.4%	3.70	4	1.01	576	0
Seasonal temperature	PartB_Q14_lt_wx_seas_temp	16 2.8%	74 12.8%	133 23.1%	242 42.0%	111 19.3%	3.62	4	1.02	576	0
Seasonal flooding	PartB_Q14_lt_wx_seas_flood	14 2.4%	72 12.5%	87 15.1%	205 35.6%	198 34.4%	3.87	4	1.10	576	0
Water flows in rivers and streams	PartB_Q14_lt_wx_seas_water_flow	25 4.3%	117 20.3%	141 24.5%	212 36.8%	81 14.1%	3.36	4	1.09	576	0
Waves on rivers, lakes, or ocean	PartB_Q14_lt_wx_seas_waves	31 5.4%	107 18.6%	162 28.1%	182 31.6%	94 16.3%	3.35	3	1.12	576	0

Other:

Variable Name	Yes	No	Don't Know	n	# missing
	1	2	9		
PartB_Q14_lt_wx_other	0 0.0%	576 100.0%	0 0.0%	576	0

Q14a.

Open-Ended Response

Q15. Weather forecasts are available for up to some period into the future. For instance, a 1-day forecast is for the weather 1 day from now, a 3-day forecast is for the weather 3 days from now, and so on. How important to you are weather forecasts for the following time periods?

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Less than 1 day from now	PartB_Q15_fcst_lead_lessthan1day	149 25.9%	164 28.5%	116 20.1%	122 21.2%	25 4.3%	2.50	2	1.21	576	0
1 day from now	PartB_Q15_fcst_lead_1day	64 11.1%	141 24.5%	168 29.2%	167 29.0%	36 6.3%	2.95	3	1.11	576	0
3 days from now	PartB_Q15_fcst_lead_3days	28 4.9%	76 13.2%	170 29.5%	224 38.9%	78 13.5%	3.43	4	1.04	576	0
7 days from now	PartB_Q15_fcst_lead_7days	16 2.8%	44 7.6%	117 20.3%	261 45.3%	138 24.0%	3.80	4	0.98	576	0
2 weeks from now	PartB_Q15_fcst_lead_2wks	12 2.1%	41 7.1%	89 15.5%	257 44.6%	177 30.7%	3.95	4	0.97	576	0
One month from now	PartB_Q15_fcst_lead_1mo	7 1.2%	28 4.9%	71 12.3%	253 43.9%	217 37.7%	4.12	4	0.89	576	0
Three months from now	PartB_Q15_fcst_lead_1mos	9 1.6%	22 3.8%	85 14.8%	215 37.3%	245 42.5%	4.15	4	0.92	576	0
More than three months from now	PartB_Q15_fcst_lead_morethan3mos	6 1.0%	43 7.5%	64 11.1%	178 30.9%	285 49.5%	4.20	4	0.98	576	0

Q16. How important to you is climate information about long term changes in weather conditions or patterns?

Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
	1	2	3	4	5					
PartB_Q16_climate_info	10 1.7%	17 3.0%	62 10.8%	217 37.7%	270 46.9%	4.25	4	0.89	576	0

Q17. How important to you is information about the following water resources?

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Stream or river flows	PartB_Q17_water_flow	33 5.7%	119 20.7%	150 26.0%	211 36.6%	63 10.9%	3.26	3	1.08	576	0
Reservoir levels	PartB_Q17_water_res_level	27 4.7%	93 16.1%	166 28.8%	212 36.8%	78 13.5%	3.38	4	1.06	576	0
Groundwater levels	PartB_Q17_water_groundwtr_level	29 5.0%	99 17.2%	159 27.6%	223 38.7%	66 11.5%	3.34	4	1.05	576	0
Water availability	PartB_Q17_water_availability	19 3.3%	42 7.3%	112 19.4%	248 43.1%	155 26.9%	3.83	4	1.01	576	0

Other:

Variable Name	Yes	No	Don't Know	n	# missing
	1	2	9		
PartB_Q17_water_other	1 0.2%	575 99.8%	0 0.0%	576	0

Q18. Overall, to what extent are you satisfied or dissatisfied with the weather forecast information that you currently receive?

Variable Name	Very dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very Satisfied	Mean	Median	SD	n	# missing
	1	2	3	4	5					
PartB_Q18_satis_fcst	25 4.3%	62 10.8%	177 30.7%	254 44.1%	58 10.1%	3.45	4	0.96	576	0

Q19. If you know, please tell me what agencies in the government currently collect and provide weather or climate information.

Open-Ended Response

Q20. If you know, please tell me what agencies in the government currently collect and provide river, reservoir or water information.

Open-Ended Response

Q21. The Instituto Nacional de Meteorologia (INAM) is the primary source of weather information and weather forecasts, advisories, and warnings for Mozambique. Have you ever heard of INAM before now?

Variable Name	Yes	No	Don't Know	Mean	Median	SD	n	# missing
	1	2	9					
PartB_Q21_INAM	407 70.7%	133 23.1%	36 6.3%	1.25	1	0.43	576	0

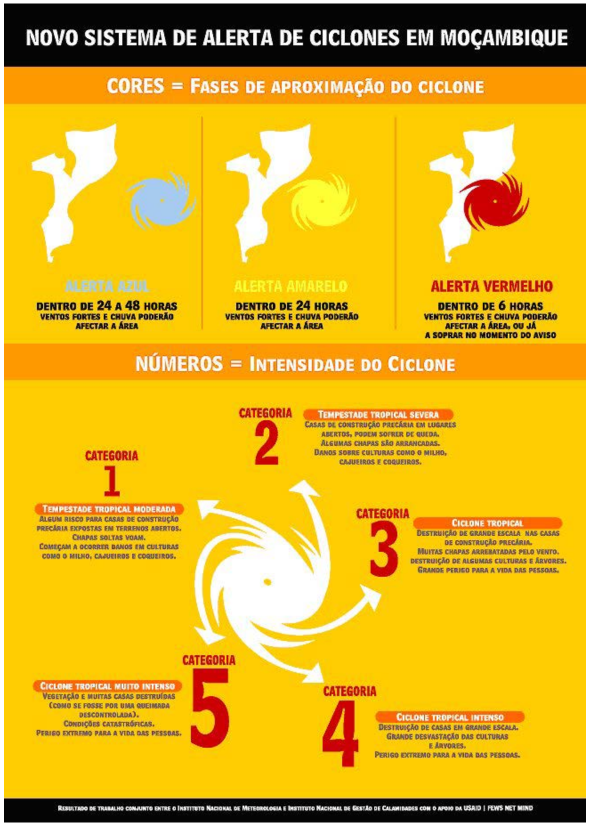
Q23. The five Regionais de Aguas (ARAs) are the primary sources of information about water and rivers for Mozambique. Have you ever heard of the ARAs before now?

Variable Name	Yes	No	Don't Know	Mean	Median	SD	n	# missing
	1	2	9					
PartB_Q23_ARAs	194 33.7%	344 59.7%	38 6.6%	1.64	2	0.48	576	0

Q24. In addition to normal weather forecasts of rainfall, temperature, cloudiness, and winds, the INAM also provides weather warnings and advisories, maritime forecasts, climate records and seasonal forecasts, and forecasts used for aviation. Were you aware the INAM provided any of this additional information?

Variable Name	Yes	No	Don't Know	Mean	Median	SD	n	# missing
	1	2	9					
PartB_Q24_INAM_addl_info	288 50.0%	235 40.8%	53 9.2%	1.45	1	0.50	576	0

This figure shows information about the types and phases of cyclone warnings and alerts for Mozambique that can be issued by INAM.



Q25. Cyclone warnings information is currently provided two days in advance. In other words, severe weather warnings have a 2-day lead time. This information could be made more accurate with a program to improve forecasts. How important would it be to you to improve the lead time of warnings and advisories from 2 days to:

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
3 days	PartB_Q25_cyc_lead_time_3days	29 5.0%	81 14.1%	136 23.6%	268 46.5%	62 10.8%	3.44	4	1.02	576	0
5 days	PartB_Q25_cyc_lead_time_5days	10 1.7%	44 7.6%	70 12.2%	209 36.3%	243 42.2%	4.10	4	1.00	576	0

This is an example of a severe weather warning from INAM. Warnings and advisories for severe weather are available for events such as extreme temperatures, heavy or dangerous rain and flooding, high winds and waves, and similar severe weather.

Sábado, 19 de Janeiro de 2013

AVISO DE MAU TEMPO

Boletim Nº	013/INAM-DAPT/999/2013
Emitido:	10:30 Horas (Tempo Local)
Valido até:	12:00 Horas de 19 de Janeiro de 2013
Tipo de Comunicado: Informação Alerta **Aviso**	Informação
Fenómeno meteorológico:	**Chuvas em regime moderado a forte acompanhadas de trovoadas.**
Áreas de risco	Toda a zona sul do país
Descrição	O INAM prevê a ocorrência de aguaceiros e chuvas em regime moderado a forte (30 a 50 milímetros em 24 horas), acompanhadas de trovoadas, durante os dias 20 e 21 de Janeiro para toda a zona sul do país. As chuvas poderão ocorrer em regime muito forte (mais de 75 milímetros em 24 horas) nas províncias de Maputo (distritos de Magude, Moamba, Boane e Manhica), Gaza (distritos de Mapai,Chicualacuala, Chigubo, Massingir, Chibuto, Guijá, Xai-Xai e Bilene) e Inhambane (distritos de Mabote, Homoine, Panda e Funhalouro).
Recomendações:	Acompanhamento dos boletins meteorológicos e tomada de medidas de precaução e segurança.
Actualização:	Este boletim será actualizado as 10:00 de 19 de Janeiro

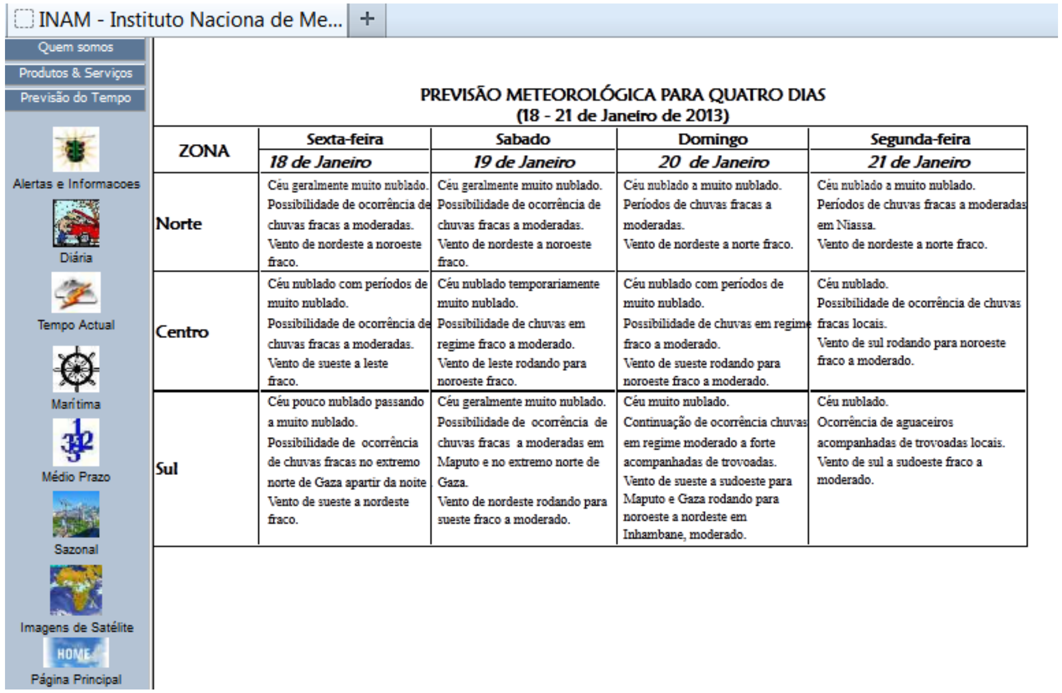
Elaborado por:
Meteorologista: *Acácio Tembe*

Chefe do DAPT

Q26. This information is currently provided for up to one day in advance. In other words severe weather warnings have a 1-day lead time. This information could be made more accurate with a program to improve weather forecasts. How important would it be to you to improve the lead time of warnings and advisories from 1 day to:

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
2 days	PartB_Q26_sev_wx_lead_time_2days	24 4.2%	83 14.4%	135 23.4%	269 46.7%	65 11.3%	3.47	4	1.01	576	0
4 days	PartB_Q26_sev_wx_lead_time_4days	10 1.7%	33 5.7%	58 10.1%	256 44.4%	219 38.0%	4.11	4	0.93	576	0

This is an example of a four day forecast from INAM. This shows current information on rainfall or rain including the forecasted amount, location, and likelihood for the four days in the three regions of the country – Norte, Centro, and Sul.



PREVISÃO METEOROLÓGICA PARA QUATRO DIAS
(18 - 21 de Janeiro de 2013)

ZONA	Sexta-feira *18 de Janeiro*	Sabado *19 de Janeiro*	Domingo *20 de Janeiro*	Segunda-feira *21 de Janeiro*
Norte	Céu geralmente muito nublado. Possibilidade de ocorrência de chuvas fracas a moderadas. Vento de nordeste a noroeste fraco.	Céu geralmente muito nublado. Possibilidade de ocorrência de chuvas fracas a moderadas. Vento de nordeste a noroeste fraco.	Céu nublado a muito nublado. Períodos de chuvas fracas a moderadas. Vento de nordeste a norte fraco.	Céu nublado a muito nublado. Períodos de chuvas fracas a moderadas em Niassa. Vento de nordeste a norte fraco.
Centro	Céu nublado com períodos de muito nublado. Possibilidade de ocorrência de chuvas fracas a moderadas. Vento de sueste a leste fraco.	Céu nublado temporariamente muito nublado. Possibilidade de chuvas em regime fraco a moderado. Vento de leste rodando para noroeste fraco.	Céu nublado com períodos de muito nublado. Possibilidade de chuvas em regime fraco a moderado. Vento de sueste rodando para noroeste fraco a moderado.	Céu nublado. Possibilidade de ocorrência de chuvas fracas locais. Vento de sul rodando para noroeste fraco a moderado.
Sul	Céu pouco nublado passando a muito nublado. Possibilidade de ocorrência de chuvas fracas no extremo norte de Gaza apartir da noite. Vento de sueste a nordeste fraco.	Céu geralmente muito nublado. Possibilidade de ocorrência de chuvas fracas a moderadas em Maputo e no extremo norte de Gaza. Vento de nordeste rodando para sueste fraco a moderado.	Céu muito nublado. Continuação de ocorrência chuvas em regime moderado a forte acompanhadas de trovoadas. Vento de sueste a sudoeste para Maputo e Gaza rodando para noroeste a nordeste em Inhambane, moderado.	Céu nublado. Ocorrência de aguaceiros acompanhadas de trovoadas locais. Vento de sul a sudoeste fraco a moderado.

Q27. Forecasts are currently correct with this information about 75% of the time. This information could be made more accurate with a program to improve weather forecasts. How important would it be to you to improve the accuracy of rainfall information from being generally correct on amount, location, and likelihood from 75% of the time to:

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Being correct 80% of the time	PartB_Q27_rain_accu_80per	14 2.4%	60 10.4%	136 23.6%	280 48.6%	86 14.9%	3.63	4	0.94	576	0
Being correct 90% of the time	PartB_Q27_rain_accu_90per	10 1.7%	25 4.3%	59 10.2%	196 34.0%	286 49.7%	4.26	4	0.93	576	0

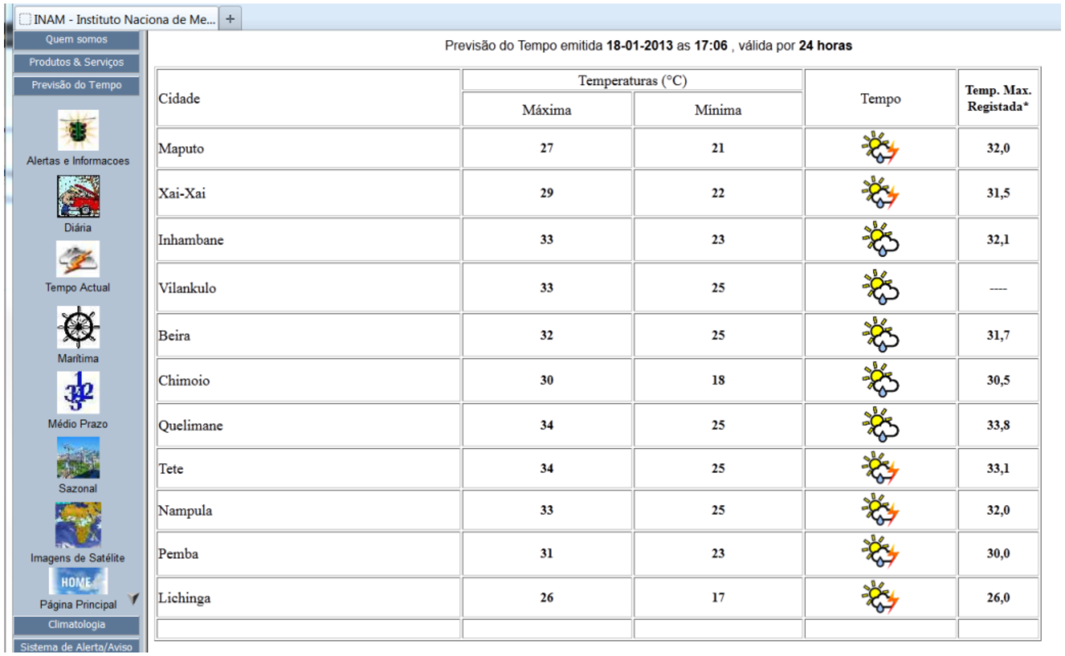
Q28. As shown in the four day weather forecast, weather information is currently provided for the country divided into three general zones – the north, central, and southern zones. This means that each forecast area covers about one-third of the country with no detail about different areas within that third of the country. This information could be made more accurate with a program to improve weather forecasts. How important would it be to you to improve the geographic detail of weather information from the three general zones to:

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Province level-specific forecast for each of the 10 provinces and City of Maputo	PartB_Q28_geog_det_province	16 2.8%	66 11.5%	154 26.7%	254 44.1%	86 14.9%	3.57	4	0.97	576	0
District level-specific forecast for each of the 128 districts in Mozambique	PartB_Q28_geog_det_district	8 1.4%	24 4.2%	51 8.9%	177 30.7%	316 54.9%	4.34	5	0.90	576	0

Q29. As shown in the four day weather forecast, weather information is currently provided for a single entire day at a time. This means that a forecast covers the entire 24-hour period with no detail about different times of the day. This information could be made more accurate with a program to improve weather forecasts. For instance, information could be shown for temperature, rain, winds, and other weather measures for night and day (broken down between 18:00 and 06:00 for night and 06:00 and 18:00 for day). Or weather forecasts could be shown in three hour increments (06:00 to 09:00, 09:00 to 12:00, 12:00 to 15:00 etc.). How important would it be to you to improve the time period covered of weather information from an entire day per weather forecast to:

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Information broken down between night and day	PartB_Q29_time_per_daynight	14 2.4%	73 12.7%	129 22.4%	250 43.4%	110 19.1%	3.64	4	1.01	576	0
Information broken into 3-hour increments	PartB_Q29_time_per_3hr_int	11 1.9%	38 6.6%	57 9.9%	221 38.4%	249 43.2%	4.14	4	0.97	576	0

This is an example of a one-day forecast of high and low temperatures from INAM. This one-day temperature forecast shows the expected maximum and minimum temperatures for the next day for eleven cities throughout Mozambique. This also shows the observed or recorded (registered) temperature as well as a picture of expected weather conditions (Tempo) such as stormy or sunny.



Previsão do Tempo emitida **18-01-2013** as **17:06** , válida por **24 horas**

Cidade	Temperaturas (°C) Máxima	Temperaturas (°C) Mínima	Tempo	Temp. Max. Registada*
Maputo	27	21		32,0
Xai-Xai	29	22		31,5
Inhambane	33	23		32,1
Vilankulo	33	25		----
Beira	32	25		31,7
Chimoio	30	18		30,5
Quelimane	34	25		33,8
Tete	34	25		33,1
Nampula	33	25		32,0
Pemba	31	23		30,0
Lichinga	26	17		26,0

Q30. One-day temperature forecasts are currently accurate within about 2°C. This means that for a forecast for tomorrow of a high temperature of 25°C, the actual temperature will be between 23°C and 27°C about 80% of the time. This information could be made more accurate with a program to improve weather forecasts. How important would it be to you to extend temperature forecasts from one day with a plus or minus 2°C level of accuracy out to:

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
2 days with the same accuracy as current 1-day	PartB_Q30_temp_fcst_2days	27 4.7%	39 6.8%	143 24.8%	276 47.9%	91 15.8%	3.63	4	0.98	576	0
5 days with same accuracy as current 1-day	PartB_Q30_temp_fcst_5days	7 1.2%	33 5.7%	74 12.8%	211 36.6%	251 43.6%	4.16	4	0.94	576	0

This is an example of a seasonal forecast. This provides information on expected rainfall for a three month period six months in advance. This example of a seasonal forecast issued in October 2012 cover the period January-February-March 2013. A seasonal forecast is indicated for each of the provinces of Mozambique showing the probability rainfall will be above (A) normal, below (B) normal, or about normal (N) for that 3-month period.

Para o período Janeiro-Fevereiro-Março (JFM) de 2013, há uma maior probabilidade de ocorrência de chuvas normais com tendência para acima do normal para a maior parte do país com excepção das províncias de Maputo, Gaza e Inhambane onde há maior probabilidade de ocorrência de chuvas normais com tendência para abaixo do normal (Figura 2).

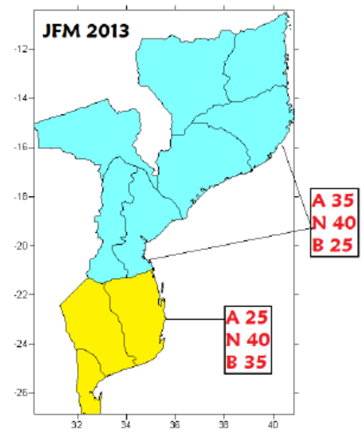


Figura 2: Previsão da Precipitação para o período JFM - 2013, em Moçambique.

Q31. These forecasts are reliable about 65% of the time. This information could be made more accurate with a program to improve weather forecasts. How important would it be to you to have seasonal forecasts improved from being reliable about 65% of the time to:

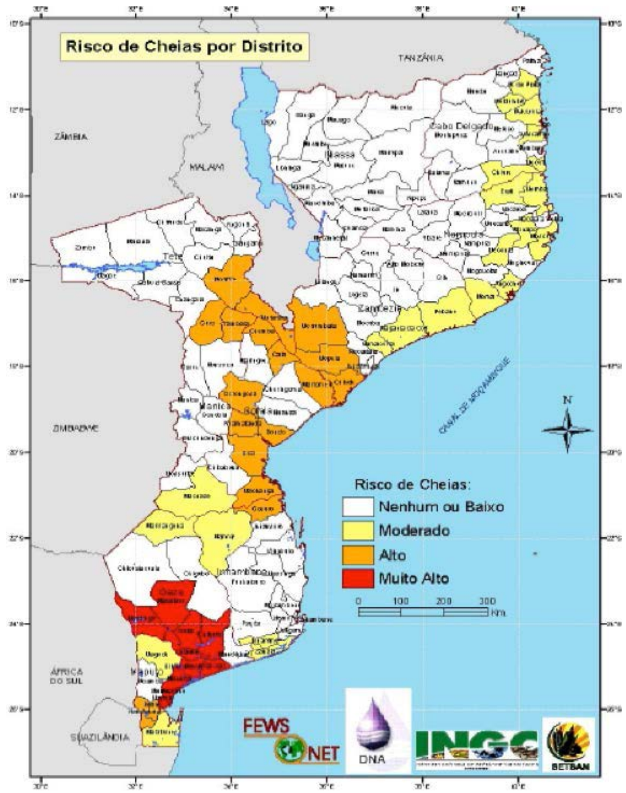
Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Being reliable 70% of the time	PartB_Q31_seas_accu_70per	16 2.8%	75 13.0%	128 22.2%	285 49.5%	72 12.5%	3.56	4	0.96	576	0
Being reliable 80% of the time	PartB_Q31_seas_accu_80per	6 1.0%	20 3.5%	63 10.9%	251 43.6%	236 41.0%	4.20	4	0.84	576	0

This is an example of a maritime forecast from INAM. Maritime information is currently provided on expected wave heights, state of the sea, wind conditions, visibility, and general weather conditions such as "stormy" or "clear."

Q32. Using a general idea of accuracy, forecasters are currently correct with this information about 70% of the time. This information could be made more accurate with a program to improve weather forecasts. How important would it be to you to improve the accuracy of maritime information from being generally correct 70% of the time to:

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Being correct 80% of the time	PartB_Q32_maritime_accu_80per	20 3.5%	53 9.2%	111 19.3%	287 49.8%	105 18.2%	3.70	4	0.98	576	0
Being correct 90% of the time	PartB_Q32_maritime_accu_90per	11 1.9%	18 3.1%	53 9.2%	189 32.8%	305 53.0%	4.32	5	0.91	576	0

This is an example of information on expected flooding including when and where flooding is forecast and how deep the water may be at different locations.



Q33. Using a general idea of accuracy, forecasters are currently correct with this information about 70% of the time. This information could be made more accurate with a program to improve weather forecasts. How important would it be to you to improve the accuracy of flood forecast from being generally correct 70% of the time to:

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Being correct 80% of the time	PartB_Q33_flood_accu_80per	8 1.4%	54 9.4%	107 18.6%	270 46.9%	137 23.8%	3.82	4	0.95	576	0
Being correct 90% of the time	PartB_Q33_flood_accu_90per	3 0.5%	20 3.5%	43 7.5%	171 29.7%	339 58.9%	4.43	5	0.82	576	0

Q34. Thinking about the different types of weather information just discussed, how important to you are the different types information provided by INAM, DNA, and the ARAs?

Sub-question	Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Cyclone warnings and advisory lead times	PartB_Q34_imp_wxinfo_cyc_warn_lead	14 2.4%	39 6.8%	88 15.3%	261 45.3%	174 30.2%	3.94	4	0.97	576	0
Other warnings and advisories lead time	PartB_Q34_imp_wxinfo_other_warn_lead	9 1.6%	24 4.2%	82 14.2%	259 45.0%	202 35.1%	4.08	4	0.89	576	0
Accuracy of rainfall information	PartB_Q34_imp_wxinfo_accu_rain_info	4 0.7%	27 4.7%	78 13.5%	267 46.4%	200 34.7%	4.10	4	0.85	576	0
Geographic detail	PartB_Q34_imp_wxinfo_geog_detail	20 3.5%	45 7.8%	108 18.8%	223 38.7%	180 31.3%	3.86	4	1.05	576	0
Time period covered	PartB_Q34_imp_wxinfo_time_per	15 2.6%	75 13.0%	159 27.6%	238 41.3%	89 15.5%	3.54	4	0.99	576	0
Accuracy of high and low temperature forecasts	PartB_Q34_imp_wxinfo_accu_temp	5 0.9%	43 7.5%	122 21.2%	292 50.7%	114 19.8%	3.81	4	0.87	576	0
Reliability of seasonal forecasts	PartB_Q34_imp_wxinfo_seas_fcst_accu	8 1.4%	49 8.5%	127 22.0%	259 45.0%	133 23.1%	3.80	4	0.94	576	0
Accuracy of maritime information	PartB_Q34_imp_wxinfo_maritime_accu	21 3.6%	85 14.8%	127 22.0%	191 33.2%	152 26.4%	3.64	4	1.13	576	0
Accuracy of flooding and water levels	PartB_Q34_imp_wxinfo_flood_accu	10 1.7%	34 5.9%	70 12.2%	219 38.0%	243 42.2%	4.13	4	0.96	576	0

Q35. Overall, how important to you is to that INAM, DNA, and the ARAs improve the accuracy of the information they provide?

Variable Name	Not at all important	A little important	Somewhat important	Very important	Extremely important	Mean	Median	SD	n	# missing
	1	2	3	4	5					
PartB_Q35_gen_imp_accu	12 2.1%	25 4.3%	89 15.5%	275 47.7%	175 30.4%	4.00	4	0.91	576	0

A major program is being undertaken to improve weather observations and forecasts across INAM, DNA and the ARAs. This program may involve improving some types of forecast information more than other types and so we want to know which improvements are more important and valuable to you!
In the following questions we will provide information about different programs that could be undertaken to improve the forecasts and then ask you which you prefer or how much you would value the program.

Q36. Can you tell me whether or not you have a monetary income?

Variable Name	I have no monetary income	I do have a monetary income	Refused	Mean	Median	SD	n	# missing
	1	2	9					
PartB_Q36_monetary_inc	185 32.1%	364 63.2%	27 4.7%	1.66	2	0.47	576	0

Q37. If you had to obtain some money, how difficult would it be for you to do each of the following? Please note that we are not asking you to actually do this and will not do so regardless of any of your answers here or throughout the survey.

Sub-question	Variable Name	Impossible	Very difficult	Somewhat	Not very difficult	Not at all difficult	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Undertake a day of labor for 30MT	PartB_Q37_diff_obt_money_1daylabor	143 24.8%	134 23.3%	156 27.1%	65 11.3%	78 13.5%	2.65	3	1.33	576	0
Sell or trade some of my crops or other possessions for 60 MT	PartB_Q37_diff_obt_money_sellcrops	93 16.1%	125 21.7%	151 26.2%	127 22.0%	80 13.9%	2.96	3	1.28	576	0
Borrow 640 MT from friends or neighbors	PartB_Q37_diff_obt_money_borrow	82 14.2%	142 24.7%	154 26.7%	136 23.6%	62 10.8%	2.92	3	1.22	576	0

PART C:

Suppose that there was a vote on a choice between programs to improve the weather forecasts or even to not improve them at all. It is not certain at this time which program will be offered so we are asking a about a number of different possible programs. If enough people vote in favor for the program that is chosen and indicate they are willing to pay to cover the costs of the program, all residents of Mozambique will pay the amount indicated each year. If not enough people vote in favor of the chosen program to cover the costs then there will be no forecast improvement program and the accuracy of forecasts will stay the same as they are now.

The table below shows one possible program (called Program A) for improving the accuracy of forecasts from current levels.
Please completely review Program A before answering the question below about this program.

CS1. If you were asked to vote whether you would like this improvement program to be undertaken at this cost how would you vote? *Please indicate whether you would vote for or against this program.*

VERSION 1:

Variable Name	I would vote FOR the weather information improvement program at the cost indicated	I would vote AGAINST the weather information improvement program at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS1_vote_progA	162 80.2%	40 19.8%	1.20	1	0.40	202	0

VERSION 2:

Variable Name	I would vote FOR the weather information improvement program at the cost indicated	I would vote AGAINST the weather information improvement program at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS1_vote_progA	145 75.5%	47 24.5%	1.24	1	0.43	192	0

VERSION 3:

Variable Name	I would vote FOR the weather information improvement program at the cost indicated	I would vote AGAINST the weather information improvement program at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS1_vote_progA	145 79.7%	37 20.3%	1.20	1	0.40	182	0

CS2: The table below now shows two different programs, Program A and Program B, for improving forecasts. You are now being asked to compare all of one column (Program A) to all of the next column as a different program (Program B).

VERSION 1:

Variable Name	Program A	Program B	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS2_prefer_progA_progB	91 45.0%	111 55.0%	1.55	2	0.50	202	0

VERSION 2:

Variable Name	Program A	Program B	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS2_prefer_progA_progB	92 47.9%	100 52.1%	1.52	2	0.50	192	0

VERSION 3:

Variable Name	Program A	Program B	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS2_prefer_progA_progB	75 41.2%	107 58.8%	1.59	2	0.49	182	0

CS3: Would you prefer to keep forecast accuracy the way it is now with no increased costs to my household or stay with the Program you indicated above at the cost indicated?

VERSION 1:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS3_wilingtopay_AB	118 58.4%	84 41.6%	1.42	1	0.49	202	0

VERSION 2:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS3_wilingtopay_AB	124 64.6%	68 35.4%	1.35	1	0.48	192	0

VERSION 3:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS3_wilingtopay_AB	110 60.4%	72 39.6%	1.40	1	0.49	182	0

CS4: The table below now shows two different programs, Program C and Program D, for improving forecasts. You are now being asked to compare all of one column (Program C) to all of the next column as a different program (Program D).

VERSION 1:

Variable Name	Program C	Program D	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS4_prefer_progC_progD	87 43.1%	115 56.9%	1.57	2	0.50	202	0

VERSION 2:

Variable Name	Program C	Program D	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS4_prefer_progC_progD	75 39.1%	117 60.9%	1.61	2	0.49	192	0

VERSION 3:

Variable Name	Program C	Program D	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS4_prefer_progC_progD	102 56.0%	80 44.0%	1.44	1	0.50	182	0

CS5: Would you prefer to keep forecast accuracy the way it is now with no increased costs to my household or stay with the Program you indicated above at the cost indicated?

VERSION 1:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS5_wilingtopay_CD	127 62.9%	75 37.1%	1.37	1	0.48	202	0

VERSION 2:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS5_wilingtopay_CD	117 60.9%	75 39.1%	1.39	1	0.49	192	0

VERSION 3:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS5_wilingtopay_CD	116 63.7%	66 36.3%	1.36	1	0.48	182	0

CS6: The table below now shows two different programs, Program E and Program F, for improving forecasts. You are now being asked to compare all of one column (Program E) to all of the next column as a different program (Program F).

VERSION 1:

Variable Name	Program E	Program F	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS6_prefer_progE_progF	130 64.4%	72 35.6%	1.36	1	0.48	202	0

VERSION 2:

Variable Name	Program E	Program F	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS6_prefer_progE_progF	71 37.0%	121 63.0%	1.63	2	0.48	192	0

VERSION 3:

Variable Name	Program E	Program F	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS6_prefer_progE_progF	75 41.2%	107 58.8%	1.59	2	0.49	182	0

CS7: Would you prefer to keep forecast accuracy the way it is now with no increased costs to my household or stay with the Program you indicated above at the cost indicated?

VERSION 1:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS7_wilingtopay_EF	122 60.4%	80 39.6%	1.40	1	0.49	202	0

VERSION 2:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS7_wilingtopay_EF	120 62.5%	72 37.5%	1.38	1	0.49	192	0

VERSION 3:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS7_wilingtopay_EF	111 61.0%	71 39.0%	1.39	1	0.49	182	0

CS8: The table below now shows two different programs, Program G and Program H, for improving forecasts. You are now being asked to compare all of one column (Program G) to all of the next column as a different program (Program H).

VERSION 1:

Variable Name	Program G	Program H	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS8_prefer_progG_progH	76 37.6%	126 62.4%	1.62	2	0.49	202	0

VERSION 2:

Variable Name	Program G	Program H	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS8_prefer_progG_progH	115 59.9%	77 40.1%	1.40	1	0.49	192	0

VERSION 3:

Variable Name	Program G	Program H	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS8_prefer_progG_progH	84 46.2%	98 53.8%	1.54	2	0.50	182	0

CS9: Would you prefer to keep forecast accuracy the way it is now with no increased costs to my household or stay with the Program you indicated above at the cost indicated?

VERSION 1:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS9_wilingtopay_GH	122 60.4%	80 39.6%	1.40	1	0.49	202	0

VERSION 2:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS9_wilingtopay_GH	121 63.0%	71 37.0%	1.37	1	0.48	192	0

VERSION 3:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS9_wilingtopay_GH	106 58.2%	76 41.8%	1.42	1	0.50	182	0

CS10: The table below now shows two different programs, Program I and Program J, for improving forecasts. You are now being asked to compare all of one column (Program I) to all of the next column as a different program (Program J).

VERSION 1:

Variable Name	Program I	Program J	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS10_prefer_progI_progJ	115 56.9%	87 43.1%	1.43	1	0.50	202	0

VERSION 2:

Variable Name	Program I	Program J	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS10_prefer_progI_progJ	60 31.3%	132 68.8%	1.69	2	0.47	192	0

VERSION 3:

Variable Name	Program I	Program J	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS10_prefer_progI_progJ	45 24.7%	137 75.3%	1.75	2	0.43	182	0

CS11: Would you prefer to keep forecast accuracy the way it is now with no increased cost to my household or stay with the Program you indicated above at the cost indicated?

VERSION 1:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS11_wilingtopay_IJ	114 56.4%	88 43.6%	1.44	1	0.50	202	0

VERSION 2:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS11_wilingtopay_IJ	117 60.9%	75 39.1%	1.39	1	0.49	192	0

VERSION 3:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS11_wilingtopay_IJ	120 65.9%	62 34.1%	1.34	1	0.48	182	0

CS12: The table below now shows two different programs, Program K and Program L, for improving forecasts. You are now being asked to compare all of one column (Program K) to all of the next column as a different program (Program L).

VERSION 1:

Variable Name	Program K	Program L	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS12_prefer_progK_progL	133 65.8%	69 34.2%	1.34	1	0.48	202	0

VERSION 2:

Variable Name	Program K	Program L	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS12_prefer_progK_progL	74 38.5%	118 61.5%	1.61	2	0.49	192	0

VERSION 3:

Variable Name	Program K	Program L	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS12_prefer_progK_progL	108 59.3%	74 40.7%	1.41	1	0.49	182	0

CS13: Would you prefer to keep forecast accuracy the way it is now with no increased cost to my household or stay with the Program you indicated above at the cost indicated?

VERSION 1:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS13_wilingtopay_KL	130 64.4%	72 35.6%	1.36	1	0.48	202	0

VERSION 2:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS13_wilingtopay_KL	125 65.1%	67 34.9%	1.35	1	0.48	192	0

VERSION 3:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS13_wilingtopay_KL	114 62.6%	68 37.4%	1.37	1	0.49	182	0

CS14: The table below now shows two different programs, Program M and Program N, for improving forecasts. You are now being asked to compare all of one column (Program M) to all of the next column as a different program (Program N).

VERSION 1:

Variable Name	Program M	Program N	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS14_prefer_progM_progN	116 57.4%	86 42.6%	1.43	1	0.50	202	0

VERSION 2:

Variable Name	Program M	Program N	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS14_prefer_progM_progN	87 45.3%	105 54.7%	1.55	2	0.50	192	0

VERSION 3:

Variable Name	Program M	Program N	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS14_prefer_progM_progN	70 38.5%	112 61.5%	1.62	2	0.49	182	0

CS15: Would you prefer to keep forecast accuracy the way it is now with no increased cost to my household or stay with the Program you indicated above at the cost indicated?

VERSION 1:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS15_wilingtopay_MN	124 61.4%	78 38.6%	1.39	1	0.49	202	0

VERSION 2:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS15_wilingtopay_MN	119 62.0%	73 38.0%	1.38	1	0.49	192	0

VERSION 3:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS15_wilingtopay_MN	125 68.7%	57 31.3%	1.31	1	0.47	182	0

CS16: The table below now shows two different programs, Program O and Program P, for improving forecasts. You are now being asked to compare all of one column (Program O) to all of the next column as a different program (Program P).

VERSION 1:

Variable Name	Program O	Program P	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS16_prefer_progO_progP	147 72.8%	55 27.2%	1.27	1	0.45	202	0

VERSION 2:

Variable Name	Program O	Program P	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS16_prefer_progO_progP	134 69.8%	58 30.2%	1.30	1	0.46	192	0

VERSION 3:

Variable Name	Program O	Program P	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS16_prefer_progO_progP	135 74.2%	47 25.8%	1.26	1	0.44	182	0

CS17: Would you prefer to keep forecast accuracy the way it is now with no increased cost to my household or stay with the Program you indicated above at the cost indicated?

VERSION 1:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS17_wilingtopay_OP	120 59.4%	82 40.6%	1.41	1	0.49	202	0

VERSION 2:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS17_wilingtopay_OP	117 60.9%	75 39.1%	1.39	1	0.49	192	0

VERSION 3:

Variable Name	Keep forecast accuracy the way it is now with no increased costs	Undertake the program chosen above at the cost indicated	Mean	Median	SD	n	# missing
	1	2					
PartC_QCS17_wilingtopay_OP	116 63.7%	66 36.3%	1.36	1	0.48	182	0

PART D:

Rather than comparing programs, we now want you to consider a single program to improve weather forecasts as indicate by Program Q below.

VERSION 1:

	Current Accuracy of Forecasts	Program Q
Cyclone warnings and advisories lead time	Current lead time 2 days	**Increase lead time to 3 days**
All other warnings and advisories lead time	Current lead time one day	**Increase lead time to 2 days**
Geographic detail	Three sections of country (south, central, north)	**Province level (10+Maputo City)**
Time period covered	Currently for entire day	**Information broken down between night and day**
Accuracy of high and low temperature forecasts	one day generally accurate ±2°C	**Extend to 2 days with same accuracy as current 1 day**
Accuracy of rainfall information	Correct 75% of the time	**Being correct 80% of the time**
Maritime information	Correct 70% of the time	**Being correct 80% of the time**
Reliability of seasonal forecasts	Reliable 65% of the time	**Being reliable 70% of the time**
Accuracy of flooding and water levels	Correct 70% of the time	**Being correct 80% of the time**

VERSION 2:

	Current Accuracy of Forecasts	Program Q
Cyclone warnings and advisories lead time	Current lead time 2 days	**Increase lead time to 5 days**
All other warnings and advisories lead time	Current lead time one day	**Increase lead time to 4 days**
Geographic detail	Three sections of country (south, central, north)	**District level (128 districts)**
Time period covered	Currently for entire day	**Information broken into 3-hour increments**
Accuracy of high and low temperature forecasts	one day generally accurate ±2°C	**Extend to 5 days with same accuracy as current 1 day**
Accuracy of rainfall information	Correct 75% of the time	**Being correct 90% of the time**
Maritime information	Correct 70% of the time	**Being correct 90% of the time**
Reliability of seasonal forecasts	Reliable 65% of the time	**Being reliable 80% of the time**
Accuracy of flooding and water levels	Correct 70% of the time	**Being correct 90% of the time**

CVM. What is the maximum amount you would be willing to pay each year for this single program to improve weather forecasts? Please circle the number below indicating the maximum annual amount your household would be willing to pay for this program.

VERSION 1:

Variable Name	MT 0	MT 15	MT 30	MT 60	MT 120	MT 240	MT 480	MT 720	MT 1440	MT 2160	MT 3240	MT 5400	MT 9000	Other	Mean	Median	SD	n	# missing
	0	1	2	3	4	5	6	7	8	9	10	11	12	13					
PartD_QCVM_max_willingtopay	52 19.4%	56 20.9%	33 12.3%	50 18.7%	36 13.4%	19 7.1%	3 1.1%	0 0.0%	0 0.0%	3 1.1%	0 0.0%	0 0.0%	2 0.7%	14 5.2%	2.84	2	3.08	268	0

Other:
Open-Ended Response

VERSION 2:

Variable Name	MT 0	MT 15	MT 30	MT 60	MT 120	MT 240	MT 480	MT 720	MT 1440	MT 2160	MT 3240	MT 5400	MT 9000	Other	Mean	Median	SD	n	# missing
	0	1	2	3	4	5	6	7	8	9	10	11	12	13					
PartD_QCVM_max_willingtopay	63 20.5%	73 23.7%	41 13.3%	37 12.0%	39 12.7%	22 7.1%	4 1.3%	2 0.6%	0 0.0%	0 0.0%	1 0.3%	0 0.0%	0 0.0%	26 8.4%	2.98	2	3.49	308	0

Other:
Open-Ended Response

PART E:

CVMF1. Below are some reasons why people choose the amounts they do when answering the previous question. Please rate each reason based on how much it influenced your answer of how much you would be willing to pay for the single program.

Sub-question	Variable Name	Did not influence my answer at all	Influenced my answer a little	Somewhat influenced my answer	Moderately influenced my answer	Greatly influenced my answer	Mean	Median	SD	n	# missing
		1	2	3	4	5					
I cannot afford to pay more for better weather forecasts	PartE_QCVMF1_infl_willingtopay_cantafford	263 45.7%	120 20.8%	78 13.5%	63 10.9%	52 9.0%	2.17	2	1.35	576	0
It would be useful to me to have improved forecasts	PartE_QCVMF1_infl_willingtopay_useful	119 20.7%	127 22.0%	101 17.5%	116 20.1%	113 19.6%	2.96	3	1.43	576	0
I should not have to pay for weather forecasts	PartE_QCVMF1_infl_willingtopay_shouldnothaveto	213 37.0%	135 23.4%	102 17.7%	69 12.0%	57 9.9%	2.34	2	1.34	576	0
I don't believe the program will actually improve weather forecasts	PartE_QCVMF1_infl_willingtopay_ineffective	228 39.6%	129 22.4%	107 18.6%	77 13.4%	35 6.1%	2.24	2	1.27	576	0
I believe it is NOT my responsibility to pay for the program even if it benefits me	PartE_QCVMF1_infl_willingtopay_notmyrespons	215 37.3%	132 22.9%	96 16.7%	67 11.6%	66 11.5%	2.37	2	1.38	576	0
I wouldn't be affected by the program as I don't use weather forecasts	PartE_QCVMF1_infl_willingtopay_dontusefcsts	284 49.3%	125 21.7%	87 15.1%	60 10.4%	20 3.5%	1.97	2	1.17	576	0
I think weather forecasts are good enough now	PartE_QCVMF1_infl_willingtopay_fcstsgoodenought	192 33.3%	137 23.8%	117 20.3%	93 16.1%	37 6.4%	2.39	2	1.27	576	0
I don't think money collected in taxes would actually go to the program	PartE_QCVMF1_infl_willingtopay_taxesnotusedforprogram	231 40.1%	114 19.8%	108 18.8%	77 13.4%	46 8.0%	2.29	2	1.33	576	0
I need more information before being willing to pay anything	PartE_QCVMF1_infl_willingtopay_moreinfofirst	182 31.6%	118 20.5%	104 18.1%	92 16.0%	80 13.9%	2.60	2	1.42	576	0
I get my forecasts from other sources than the government	PartE_QCVMF1_infl_willingtopay_fcstsfromothersources	353 61.3%	78 13.5%	65 11.3%	58 10.1%	22 3.8%	1.82	1	1.20	576	0

CVMF2. Below are some motivations people indicate when answering the question about how much they are willing to pay to improve weather forecasts. Please rate each reason based on how much it influenced your answer of how much you would be willing to pay for the single program.

Sub-question	Variable Name	Did not influence my answer at all	Influenced my answer a little	Somewhat influenced my answer	Moderately influenced my answer	Greatly influenced my answer	Mean	Median	SD	n	# missing
		1	2	3	4	5					
Improving forecasts would be beneficial to me personally	PartE_QCVMF2_motv_willingtopay_benefitme	111 19.3%	98 17.0%	110 19.1%	137 23.8%	120 20.8%	3.10	3	1.42	576	0
Improving forecasts would be beneficial to other people in my family	PartE_QCVMF2_motv_willingtopay_benefitfamily	99 17.2%	75 13.0%	118 20.5%	161 28.0%	123 21.4%	3.23	3	1.38	576	0
Improving forecasts would be beneficial to other people in my district	PartE_QCVMF2_motv_willingtopay_benefitdistrict	83 14.4%	98 17.0%	116 20.1%	164 28.5%	115 20.0%	3.23	3	1.34	576	0
Improving forecasts would be beneficial to other people in my country	PartE_QCVMF2_motv_willingtopay_benefitcountry	96 16.7%	82 14.2%	109 18.9%	172 29.9%	117 20.3%	3.23	4	1.37	576	0
Improving forecasts would be beneficial to future generations	PartE_QCVMF2_motv_willingtopay_benefitfuturegen	90 15.6%	85 14.8%	116 20.1%	159 27.6%	126 21.9%	3.25	3	1.37	576	0
Improving forecasts is simply good regardless of who they benefit	PartE_QCVMF2_motv_willingtopay_gengood	100 17.4%	58 10.1%	109 18.9%	159 27.6%	150 26.0%	3.35	4	1.41	576	0

PART F:

The activities of INAM, DNA, and the ARAs are paid for through taxes, fees, and licenses as a part of the national government. This money pays for all of the equipment, personnel, and activities of INAM, DNA, and the ARAs in producing weather information.

Suppose you were told that every year about 15 MT of the average Mozambican's taxes, fees, and licenses goes toward paying for all of the weather forecasting and information services provided by INAM, DNA, and the ARAs.

Do you feel that the services you currently receive from the activities of INAM, DNA, and the ARAs are worth at least 15 MT a year, more than 15 MT a year, or less than 15 MT a year to you? *Please select only one option.*

Curr15 (Version 1):

Variable Name	Worth at least or more than 15 MT a year to me	Worth less than 15 MT a year to me	Mean	Median	SD	n	# missing
	1	2					
PartF_QCurr15_worth_15	110 69.6%	48 30.4%	1.30	1	0.46	158	0

Curr60 (Version 2):

Variable Name	Worth at least or more than 60 MT a year to me	Worth less than 60 MT a year to me	Mean	Median	SD	n	# missing
	1	2					
PartF_QCurr60_worth_60	77 52.4%	70 47.6%	1.48	1	0.50	147	0

Curr240 (Version 3):

Variable Name	Worth at least or more than 240 MT a year to me	Worth less than 240 MT a year to me	Mean	Median	SD	n	# missing
	1	2					
PartF_QCurr240_worth_240	55 39.6%	84 60.4%	1.60	2	0.49	139	0

Curr960 (Version 4):

Variable Name	Worth at least or more than 960 MT a year to me	Worth less than 960 MT a year to me	Mean	Median	SD	n	# missing
	1	2					
PartF_QCurr960_worth_960	41 31.1%	91 68.9%	1.69	2	0.47	132	0

PART G: ABOUT YOU AND YOUR HOUSEHOLD

The remaining survey questions are about you and your household. This information will be used to help group your responses with responses of others. You do not have to answer any question you are uncomfortable answering, but all your responses will remain confidential, and none of your responses can be linked directly back to you.

HH1. How long have you lived in the area where you currently live (say within 50 kilometers of your residence)?

Open-Ended Response

HH2. What is your marital status?

Variable Name	Single	Married	Marital Union	Divorced	Widower	Unknown	Refused	Mean	Median	SD	n	# missing
	1	2	3	4	5	6	99					
PartG_QHH2_marital_status	277 48.1%	111 19.3%	148 25.7%	15 2.6%	24 4.2%	1 0.2%	0 0.0%	1.95	2	1.10	576	0

HH3. What is your religion if any?

Variable Name	Catholic	Anglican	Islamic	Zion/ Zionist	Evangelical	No Religion	Other Religion	Unknown	Refused	Mean	Median	SD	n	# missing
	1	2	3	4	5	6	7	8	99					
PartG_QHH3_religion	215 37.3%	25 4.3%	86 14.9%	36 6.3%	107 18.6%	33 5.7%	54 9.4%	14 2.4%	6 1.0%	3.20	3	2.12	576	0

HH4. Which of the following durable goods are owned by someone in this household?

Sub-question	Variable Name	Yes	No	Mean	Median	SD	n	# missing
		1	2					
Radio	PartG_QHH4_durable_goods _radio	441 76.6%	135 23.4%	1.23	1	0.42	576	0
Television	PartG_QHH4_durable_goods _tv	408 70.8%	168 29.2%	1.29	1	0.46	576	0
Landline telephone	PartG_QHH4_durable_goods _landline	24 4.2%	552 95.8%	1.96	2	0.20	576	0
Cell phone	PartG_QHH4_durable_goods _cell	427 74.1%	149 25.9%	1.26	1	0.44	576	0
Computer	PartG_QHH4_durable_goods _comp	135 23.4%	441 76.6%	1.77	2	0.42	576	0
IPAD, PDA, other mobile internet enabled device	PartG_QHH4_durable_goods _mobileint	21 3.6%	555 96.4%	1.96	2	0.19	576	0
Car	PartG_QHH4_durable_goods _car	89 15.5%	487 84.5%	1.85	2	0.36	576	0
Motorbike	PartG_QHH4_durable_goods _motorbike	63 10.9%	513 89.1%	1.89	2	0.31	576	0
Bicycle	PartG_QHH4_durable_goods _bicycle	171 29.7%	405 70.3%	1.70	2	0.46	576	0

HH5. What is the primary source of water for this household?

Variable Name	Piped water in the house	Piped water outside the house	Fontenario	Pit/Hole protected	Pit pump (open)	River/ Lake/ Lagoon	Rainwater	Mineral water	Other	Mean	Median	SD	n	# missing
	1	2	3	4	5	6	7	8	9					
PartG_QHH5_water _source	92 16.0%	216 37.5%	190 33.0%	51 8.9%	19 3.3%	5 0.9%	0 0.0%	0 0.0%	3 0.5%	2.52	2	1.13	576	0

HH6. What is the primary source sanitation for this household?

Variable Name	Central Plumbing	Toilet connected to septic tank	Improved latrine	Traditional improved latrine	Traditional latrine not improved	Without latrine	Other	Mean	Median	SD	n	# missing
	1	2	3	4	5	6	7					
PartG_QHH5_sanitation_source	53 9.2%	96 16.7%	185 32.1%	84 14.6%	100 17.4%	54 9.4%	4 0.7%	3.45	3	1.46	576	0

HH7. What is the primary source of energy for this household?

Variable Name	Electricity	Generator/ solar panel	Gas	Oil/ paraffin/ kerosene	Candle	Battery	Firewood	Other	Mean	Median	SD	n	# missing
	1	2	3	4	5	6	7	8					
PartG_QHH7_energy_source	434 75.3%	3 0.5%	1 0.2%	50 8.7%	28 4.9%	8 1.4%	43 7.5%	9 1.6%	2.09	1	2.05	576	0

HH8. What is the highest degree or level of school you have completed?

Variable Name	Literacy class	Primary EP 1 (1st-5th)	Primary EP2 (6th-7th)	Secondary ESG1 (8th-10th)	Secondary ESG2 (11th-12th)	Elementary Technical	Basic Technical	Medium Technical	Normal School	University	Non-standard curriculum	Not known	Refused	Mean	Median	SD	n	# missing
	0	1	2	3	4	5	6	7	8	9	10	98	99					
PartG_QHH8_educ	25 4.3%	79 13.7%	81 14.1%	162 28.1%	123 21.4%	2 0.3%	17 3.0%	19 3.3%	2 0.3%	35 6.1%	4 0.7%	14 2.4%	13 2.3%	3.34	3	2.20	576	0

HH9. What is your present employment status? Please select all that apply to you.

Sub-question	Variable Name	Yes	No	Mean	Median	SD	n*	# missing
		1	2					
Employed full time	PartG_QHH9_empl_fulltime	57 9.9%	519 90.1%	1.90	2	0.30	576	0
Employed part time	PartG_QHH9_empl_parttime	137 23.8%	439 76.2%	1.76	2	0.43	576	0
Self-employed/business owner	PartG_QHH9_empl_self	80 13.9%	496 86.1%	1.86	2	0.35	576	0
Retired	PartG_QHH9_empl_retired	140 24.3%	436 75.7%	1.76	2	0.43	576	0
Homemaker	PartG_QHH9_empl_homemaker	3 0.5%	573 99.5%	1.99	2	0.07	576	0
Student	PartG_QHH9_empl_student	109 18.9%	467 81.1%	1.81	2	0.39	576	0
Unemployed	PartG_QHH9_empl_unemployed	128 22.2%	448 77.8%	1.78	2	0.42	576	0
Refused	PartG_QHH9_empl_refused	169 29.3%	407 70.7%	1.71	2	0.46	576	0

HH11. What was your total personal income in 2012?

Variable Name		PartG_QHH11_total_income
I have no monetary income	1	184 31.9%
less than MT 10,000	2	48 8.3%
MT 10,000 – MT 19,999	3	42 7.3%
MT 20,000 – MT 29,999	4	20 3.5%
MT 30,000 – MT 39,999	5	16 2.8%
MT 40,000 – MT 49,999	6	12 2.1%
MT 50,000 – MT 59,999	7	16 2.8%
MT 60,000 – MT 69,999	8	5 0.9%
MT 70,000 – MT 79,999	9	6 1.0%
MT 80,000 – MT 89,999	10	4 0.7%
MT 90,000 – MT 99,999	11	4 0.7%
MT 100,000 – MT 119,999	12	3 0.5%
MT 120,000 – MT 139,999	13	1 0.2%
MT 140,000 or more	14	4 0.7%
Don’t know	98	108 18.8%
Refused	99	103

		17.9%
Mean		2.83
Median		1
SD		2.79
n		576
# missing		0

HH12. If you have any further comments, please write them below.

Open-Ended Response

We greatly appreciate the time you took to complete this survey. Thank you!