GCRF African SWIFT
Science for Weather Information and Forecasting Techniques

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GCRF AFRICAN SWIFT

Project Deliverable Cover Sheet

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.

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SHORT SUMMARY:

This report describes activities and outcomes of weather and climate information user survey carried out in four countries (Ghana, Kenya, Nigeria and Senegal). The Global Challenges Research Fund African (GCRF) Science for Weather Information and Forecasting Techniques (SWIFT) programme partnered with National Meteorological and Hydrological Services (NMHSs) in the four partner countries with a view to developing African weather forecasting capability to enhance the livelihood of African populations and improve African economies. he SWIFT project in collaboration with Ghana Meteorological Agency (GMet), Kenya Meteorological Department (KMD), Nigerian Meteorological Agency (NiMet) and Senegalese Agence Nationale de l'Aviation Civile et de la Météorologie (ANACIM) conducted country level user surveys and interviews during the period of November 2019 to February 2020. The main objective was to understand how key sectors - Agriculture, Disaster Risk Management, Energy and Water use weather and climate services.

The survey sought to understand weather and climate information needs within the four key sectors in the four partner countries, and seek ways to better understand how to improve weather and climate information exchange between the producers (usually NMHSs) and the users from the four key sectors. It will help improve and better inform weather and climate information use for climate sensitive decisions. This includes understanding the actors, processes involved in information exchange, functions played by actors, and barriers and enablers to the exchange and use of weather and climate information. The selection of countries both from West (Ghana, Nigeria and Senegal) and East Africa (Kenya) is intended to provide a comparative analysis between the two regional blocks.

Impact of this work towards the three primary outcomes of SWIFT

1. **Research advances needed for significant improvements in weather forecasts in Africa, and the tropics more generally, from the hourly to the seasonal timescale**

   (How does this work advance our scientific understanding of the weather and climate of tropical Africa? How has collaborative research with our African partners benefitted these scientific outcomes?)

Understanding weather and climate information user needs provides much needed information to improve forecast products that are impactful. Through these National user surveys, weather and climate needs for key sectors were identified, and more appropriate communication channels suggested.

2. **Capability-building among UK and African partners to improve, maintain and evaluate operational tropical forecasts in future**

   (How does this work link through to help inform or design potential future weather services? What specific economic development or social welfare outcomes in tropical Africa could this work contribute to?)

These national user surveys were conducted in African countries taking part in the African SWIFT project. conclusions and recommendations emanating from this study will inform the broader project team on how to utilise the remaining project term to improve weather services provided by NMHSs. In addition, this serves as a guide to future related projects that will explore this field.

3. **Development of African partners' capacity for sustained training of forecasters, in partnership with African academic institutions and international agencies**

   (How does this work progress collaborative relationships between UK and African weather scientists? e.g. is it a joint paper / collaborative project? Does the work involve visiting scientists? Has a training programme been devised?)

Through these national user surveys, we have identified that training users on interpretation of forecast uncertainty is an area that should be given more focus. African SWIFT project can contribute to this through project programs like testbeds. This work will also lead to a collaborative paper involving partners from all the four countries.

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1.0 INTRODUCTION

This report outlines the results and implications of National Weather and Climate Services (WCS) user surveys carried out in Ghana, Kenya, Nigeria and Senegal. These were undertaken to improve our understanding of user needs within key sectors of Agriculture, Disaster Risk Reduction, Energy & Water and identify ways to improve weather and climate information exchange between producers (usually NMHSs) and users.

Climate is a major driver of disasters worldwide, especially in Africa, which is particularly vulnerable due to the magnitude of impacts and the (lack of) capacity to respond. The impacts of droughts (Masih et al., 2006[1]), floods (Hallegatte et al., 2016[2]), and extreme events (Handmer et al., 2012[3]), are well documented. Evaluating the quality of climate information and effectively integrating this information into decision making processes within key sectors can build resilience to these climate-driven disasters.

Although several weather forecast products are routinely generated at varying timescales and lead times by NMHSs and regional centres like African Centre of Meteorological Application for Development (ACMAD[4]) and IGAD Climate Prediction and Applications

[1] Masih, I., Maskey, S., Mussá, F.E.F. and Trambauer, P., 2014. A review of droughts on the African continent: a geospatial and long-term perspective. Hydrology and Earth System Sciences, 18(9), pp.3635-3649.

[2] Hallegatte, S., Bangalore, M. and Vogt-Schilb, A., 2016. Assessing Socioeconomic Resilience to Floods in 90 Countries. Policy Research Working Paper;No. 7663. The World Bank. https://openknowledge.worldbank.org/handle/10986/24503 License: CC BY 3.0 IGO.

[3] Handmer, J., Honda, Y., Kundzewicz, Z.W., Arnell, N., Benito, G., Hatfield, J., Mohamed, I.F., Peduzzi, P., Wu, S., Sherstyukov, B. and Takahashi, K., 2012. Changes in impacts of climate extremes: human systems and ecosystems. In Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation Special Report of the Intergovernmental Panel on Climate Change (pp. 231-290). Intergovernmental Panel on Climate Change.

[4] http://www.acmad.net/new/

Centre (ICPAC[5]), it is generally recognized that there are several potential constraints to the optimal use of these products in Africa. These are generally centered on use of technical language, lack of trust or comprehension of the information, or poor relevance of the forecast products to the operational needs of various sectors.

1.1 Objectives of the Survey

The primary objectives of the national user survey were to:

1) Understand weather and climate information needs in the four countries within the four key sectors.
2) Evaluate the effectiveness of existing methods of disseminating weather and climate information exchange from producers (NMHSs) and the four key sectors.
3) Establish the current value of weather and climate information products generated by NMHSs and recommend ways to improve weather and climate service delivery.

The key research questions which guided this survey were:

1. What is the current state of weather and climate information use by the four sectors?
2. How do the users from the key sectors receive weather and climate information?
3. What source(s) of weather/climate information are used by users from the four sectors?
4. What are some of the challenges users face in the process of utilizing weather and climate information?

1.2 Survey Countries

The survey was conducted in four countries: - Ghana, Kenya, Nigeria and Senegal. A short description of each country is given in table 1 below:

[5] https://www.icpac.net/

Table 1: Key country characteristic

	Ghana	Kenya	Nigeria	Senegal
Population	30,955,204[6]	47,564,296[7]	140,431,790[8]	16,708,608
Gross domestic product (GDP) - 2019	$66.984	$95.50	$2,341.86	$24.96
Average annual rainfall	North: - 900 to 1300 mm. South: - 700 to 1900 mm.	200 to 1000mm	South: 2000 to 3000mm Middle belt: 600 to 1500mm North: 400 to 800mm	612.13mm
Average annual minimum temperature	20°C to 25°C	7.7°C to 23.9°C	20°C to 23°C	21.9°C
Average annual maximum temperature	28°C to 36°C	21.7°C to 35.2°C	34°C to 39°C	36.3°C
Key economic sectors	Agriculture, Transport, Mining, Energy, Tourism, Oil & gas and Construction	Agriculture, forestry, real estate, fishing, mining, manufacturing, energy, tourism and financial services	Agriculture, Oil, transportation, mining and tourism	Agriculture & fishing, mining, construction, tourism

[6] www.statsghana.gov.gh
[7] https://www.knbs.or.ke/?p=5621
[8] https://www.nigerianstat.gov.ng/

Climate change vulnerability	Negative impact on national economy because it is dependent on climate sensitive sectors such as agriculture, energy & forestry[9]	Loss of lives, diminished livelihoods, reduced crop and livestock production, and damaged infrastructure[10]	Flooding affecting farmlands, homes and livelihood. Increased probability of occurrence of some diseases such as meningitis, cholera, heat stress e.t.c	Degradation and salinization of land, loss of biodiversity, reduced flow of rivers, drying up of ponds, coastal erosion, etc
NMHS's mandate	Provide meteorological services in the country and ensure the operation and maintenance of international standards and practices in meteorology in the country[11].	Provision of meteorological and climate information and services to various sectors and public[12].	Observing, analysing, timely and accurate reporting of weather and climate information for socio-development and safety of lives and property[13].	Supervising and coordinating all weather, climate and scientific activities on climate change[14].

[9] https://www.adaptation-undp.org/sites/default/files/downloads/ghana_national_climate_change_adaptation_strategy_nccas.pdf
[10] https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/10/8737.pdf
[11] www.meteo.gov.gh
[12] http://www.meteo.go.ke/
[13] https://www.nimet.gov.ng/
[14] http://www.anacim.sn/

2.0 SURVEY METHODOLOGY

This section provides a brief on how the survey was conducted. Particular attention is placed on the sampling framework, research process and tools, data analysis and presentation of findings. This study was conducted within the larger GCRF African SWIFT project. Thus, the methodology presented here dovetails with the project's focus areas, objectives and deliverables.

2.1 Study Design

This survey was conducted concurrently across all the four partner countries between November 2019 and February 2020. The study was an anonymous, unlinked, cross-sectional survey. The study population included key sector users of weather and climate information in Ghana, Kenya, Nigeria and Senegal. These sectors were: Agriculture, Disaster Risk Reduction (DRR), Energy and Water.

The survey was administered using questionnaires, collecting some demographic details (excluding personal identifiers such as names and addresses) and archived online using google forms. English language was used in three countries except Senegal where French was the medium in which the survey was conducted to help users appreciate and understand the questions.

2.2 Sampling Methodology

Key sector institutions, whose staff participated in this survey, were in most cases those that have existing relationships with NMHSs in each country. Online questionnaires (using google forms) were emailed, and in some cases follow up via telephone calls in Ghana, Kenya and Senegal. However, in Nigeria questionnaires were printed and administered manually and there after responses filled into online google forms for archiving.

2.3 Research Process

The survey process consisted of four main stages, namely:

i. Tool preparation,
ii. Workshop,
iii. Tool piloting
iv. Survey administration.

i. Tool Preparation

The survey tool was prepared collaboratively with survey leads from partner countries based on GCRF African SWIFT project indicators.

ii. Workshop

Workshop was conducted on the sidelines of the GCRF African SWIFT Science meeting in Kumasi on 5th August 2019 and focused on refining the survey tool.

iii. Tool Piloting

The survey tool was piloted during GCRF African SWIFT Science meeting in Kumasi, and the pilot testing helped to refine some questions and changed ambiguous terms.

iv. Survey administration

The survey mainly used google forms, complimented by printed questionnaires in situations where google forms could not be used, but these manually filled questionnaires were also archived in google forms for easy storage of data and analysis.

2.4 Study administration

A review of the study protocol, study methods, planning of field logistics and standard operating procedures was as usual the first step in the preparatory process.

The survey co-ordinating researcher based at ACMAD ensured the overall co-ordination of the survey including support to country teams, conducting the procedural audit of the

survey, data management quality assurance, data analysis, and lead the compilation of this report.

2.5 Data entry and analysis

Data was uploaded into Google drive via Google forms in real time, except in instances where survey was manually administered. In the latter, the data was keyed into the google forms at the earliest opportunity by the country teams. The Co-ordinating researcher was responsible for quality control, data analysis and lead in the report writing. The analysis included exporting data to excel and eventually using Python for analysis. Incomplete entries were deleted from the data set.

3.0 FINDINGS AND DISCUSSION

The results presented in this report will complement existing studies and projects and provide updated insights into the growing awareness and use of forecast products produced by NMHSs by different sectors in East and West Africa.

3.1 Distribution of survey participants

A total of 189 people participated in this survey, distributed across the four countries, and divided into four sectors as shown in table 2. Of the four sectors surveyed, Agriculture and Fisheries sector is the largest consumer of weather and climate information generated by the respective NMHSs, unsurprisingly so because it is a key economic sector is the four countries as shown in table 1. Majority of the survey participants were male and held technical positions in their various organisations (see table 3).

Table 2: Total number of survey responses per country and percentage for each of the four sectors

	Total responses	**Sectors**			
		Agriculture & Fishery	Disaster Risk management (DRM)	Water Resources	Energy
Ghana	32	65.6%	9.4%	12.5%	12.5%
Kenya	68	67.6%	11.8%	8.8%	11.8%
Nigeria	68	39.7%	29.4%	22.1%	8.8%
Senegal	21	42.9%	14.3%	19.0%	23.8%

Table 3: Gender of survey respondents and position in their organization

	Gender		Position	
	Male (%)	Female (%)	Technical (%)	Managerial (%)
Ghana	90.6	9.4	75.0	25.0
Kenya	85.3	14.7	76.5	23.5
Nigeria	77.9	22.1	69.1	30.9
Senegal	71.4	28.6	85.7	14.3

3.2 Current weather and climate information, communication and perceptions

Based on the results of the survey; it is established that users find weather and climate information provided by NMHSs to be very useful (Table 5) and prefer to get this information directly from the NMHSs either directly, via SMS, verified social media platforms, mobile application or directly from their websites (Table 4). Furthermore, users in the four countries prefer to have forecasts presented as statistical summaries (Table 5), most likely because it is easy to use these forecasts in this form when applying them to various applications in their sectors e.g flood monitoring softwares for the water sector.

Users surveyed in all the four countries acknowledged that forecast accuracy has improved and are satisfied with the currently available forecast products (Table 6). However, users in Ghana and Kenya believe that forecast products generated by the NMHSs are inadequate and their availability does not meet their operational needs (Table 6). Of the four countries, users in Senegal are most satisfied and highly rate the products generated by ANACIM.

Table 4: Current weather and climate information received & communication channel and preferred communication channel.

	Weather/climate information received	Current communication channel	Preferred communication channel
Ghana	Daily forecast (36.8%) Seasonal forecasts (17.1%) Weather Warnings (15.8%) 7-day forecast (7.9%) Extreme rainfall forecast (6.6%)	TV (23.6%) GMet (18.1%) Social media (16.7%) Radio (16.7%) Internet (11.1%)	GMet (12.9%) SMS (12.1%) Internet (11.2%) Mobile App (10.3%) Social media (9.5%)
Kenya	7-day forecast (22.5%) Seasonal forecast (19.4%) Monthly forecast (15.7%) Daily forecast (14.7%) Extreme rainfall forecast (14.7%)	KMD (25.1%) Social media (21.1%) Internet (19.9%) Mobile App (11.15) TV (6.4%)	KMD (21.3%) Social media (18.9%) Internet (17.2%) Mobile App (14.2%) SMS (8.9%)
Nigeria	Seasonal forecast (32.7%) Daily forecast (22.0%) Extreme rainfall forecast (11.3%) Agromet bulletin (10.7%) Monthly forecast (8.7%)	NiMet (29.7%) TV (24.8%) Radio (13.9%) Mobile App (9.7%) Internet (9.1%)	NiMet (22.2%) Mobile App (14.3%) Internet (13.8%) TV (11.1%) SMS (10.6%)
Senegal	Seasonal forecast (25.0%) Daily forecast (11.7%) Extreme rainfall forecast (11.7%) Monthly forecast (10.0%) Agromet bulletin (8.3%)	Internet (22.6%) ANACIM (21.0%) TV (12.9%) SMS (11.3%) Radio & Social media (@8.1%)	Internet (24.2%) ANACIM (22.6%) SMS (16.1%) Mobile App (9.7%) Social media (6.5%)

Table 5: Frequency, lead time and usefulness of weather and climate information.

	Frequency	Preferred frequency	Lead time	Preferred lead time	Preferred form	Usefulness
Ghana	Sub-daily (47.7%) Weekly (22.7%) Seasonally (18.2%) Monthly (9.1%) Annually (2.35)	Daily (37.9%) Seasonally (16.7%) Sub-daily (15.2%) Monthly (12.1%) Weekly (12.1%)	<24hrs (62.5%) <7days (12.5%) Seasonally (10.0%) Month (7.5%) Week (7.5%)	Hours (30.8%) Days (26.9%) Month (15.4%) Seasonally (15.4%) Week (11.5%)	Statistical summaries (46.9%) Raw data (21.9%) Maps (15.6%) Indicators (15.6%)	Very high (62.5%)
Kenya	Weekly (37.6%) Sub-daily (21.4%) Seasonally (20.5%) Monthly (18.8%) Annually (1.7%)	Daily (34.0%) Weekly (24.3%) Monthly (17.4%) Seasonally (13.2%) Sub-daily (6.9%)	<7days (32.2%) <24hrs (32.2%) Week (21.8%) Month (13.8%)	Days (39.8%) Hours (27.2%) Week (21.4%) Month (11.7%)	Statistical summaries (40.2%) Maps (28.0%) Raw data (19.5%) Indicators (12.2%)	Very high (64.7%)
Nigeria	Seasonally (27.0%) Sub-daily (22.5%) Annually (21.6%) Weekly (18.0%) Monthly (10.8%)	Daily (27.5%) Monthly (19.6%) Weekly (17.4%) Seasonally (15.9%) Annually (12.3%)	<24hrs (46.7%) Month (24.4%) Week (14.4%) <7days (14.4%)	Days (38.3%) Hours (28.7%) Week (17.0%) Month (16.0%)	Statistical summaries (41.2%) Maps (17.6%) Raw data (17.6%) Indicators (16.2%)	Very high (75.0%)

Senegal	Seasonally (29.3%) Sub-daily (26.8%) Monthly (17.1%) Weekly (17.1%) Annually (9.8%)	Daily (25.0%) Weekly (20.3%) Seasonally (18.8%) Monthly (17.2%) Sub-daily (9.4%)	<24hrs (35.5%) Month (25.8%) <7days (22.6%) Week (16.1%)	Days (43.6%) Week (25.6%) Month (15.4%) Hours (15.4%)	Statistical summaries (27.0%) Maps (24.3%) Raw data (21.6%) Indicators (18.9%)	Very high (52.4%)

Table 6: Perception rating of weather and climate information.

	Accuracy	Adequacy	Timeliness	Clarity	Satisfaction	Availability
Ghana	High	Moderate	Moderate	Moderate	High	Moderate
Kenya	High	Moderate	High	Moderate	High	Moderate
Nigeria	High	High	High	High	High	High
Senegal	Very high	High	Very high	Very high	Moderate	Very high

3.3 Web-based Weather and Climate service(s)

Users in all four countries and sectors surveyed do use and incorporate web-based Weather and Climate service(s) in their organisations (Table 7). Users surveyed in Nigeria and Senegal indicated that they use web-based Weather and Climate service(s) because these services allow them to download data, while those in Kenya prefer them because of their interactive maps/chart features and in Ghana because they are able to view time series of various variables.

Table 7: Web-based Weather and Climate service(s).

	Do you use web-based climate services	Web-based climate services	Most useful feature
Ghana	Yes (75%)	NOAA (29.4%) ECMWF (17.6%) IRI & UKMO (@ 17.6%)	Timeseries
Kenya	Yes (57.4%)	UKMO (31.6%) NOAA (24.6%) IRI (17.5%)	Interactive maps, charts & graphs
Nigeria	Yes (73.5%)	NOAA (11.8%) UKMO (5.9%) Others (76.5%)	Downloadable data
Senegal	Yes (61.9%)	NOAA (18.2%) IRI (9.1%) Others (72.7%)	Downloadable data

3.4 Level of Accuracy, Training and Willingness to pay for customized forecast products

Users surveyed in the four countries all indicated that training on interpretation of forecast uncertainty would improve their increased uptake of weather and climate information in their decision making (Table 8). While users in Ghana and Kenya want level of accuracy to be given as probabilities of possible outcomes, those in Nigeria and Senegal prefer level of accuracy to be explained in words. Strangely, all surveyed users have lukewarm tendencies when it comes to paying for more sector specific customized forecasts.

Table 8: Level of accuracy, factors that would enhance use of weather and climate information, climate-related training and willingness of organisations to pay for customized weather/climate products.

	Level of accuracy presentation	Enhancing use of weather/climate information	Most relevant climate-related training	Willingness to pay customized Weather/climate products
Ghana	Probabilities of possible outcomes	Training	Interpretation of forecast uncertainty	Very low
Kenya	Probabilities of possible outcomes	Training	Interpretation of forecast uncertainty	Moderate
Nigeria	Explanation in words	Training	Interpretation of forecast uncertainty	Moderate
Senegal	Explanation in words	Access to relevant tools e.g computers and software	Interpretation of forecast uncertainty	Moderate

4.0 CONCLUSIONS AND RECOMMENDATIONS

1. All respondents agreed that weather and climate information is important to their organisation.
2. Majority of survey respondents were technical staff who are not necessarily responsible for making decisions in their organisations.
3. In all the four countries surveyed, Agriculture and fisheries sector is unsurprisingly the largest of weather and climate information generated by the respective NMHSs.
4. Information authority: - users surveyed in the four countries prefer to get weather and climate information from their NMHSs, either directly, via SMS from NMHSs, NMHSs verified social media platforms, directly from their websites or mobile application.
5. Surveyed users in the four countries use and incorporate web-based Weather and Climate service(s) e.g United Kingdom's Meteorological Office (UKMO) in their organisations, mainly because these platforms allow them to download data, have interactive maps/charts and time series features.
6. Surveyed users in the four countries indicated that training on interpretation of forecast uncertainty would improve their increased uptake of weather and climate information in their decision making.
7. All surveyed users are unwilling to pay for customized forecasts.
8. Despite the relatively high degree of collaboration between NMHSs and surveyed users, and the awareness of the existence and role of weather and climate information among the users, it is clear that NMHSs should make effort to train and collaborate with more sector specific organisations working in DRR, Water and Energy sectors in their countries.