

# Weather Modeling and Dissemination Process Integration: A key to efficient dissemination processes

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**Abstract** - Weather information is increasingly becoming vital in everyday lives of people across Uganda and the world at large. Weather affects all walks of life either directly or indirectly and this includes economic sectors like agriculture, road construction and disaster preparedness. ICTs are being used all over the world to provide this weather information to the relevant stakeholders. However there are inadequacies in delivering this information that include; the time spent in generating the advisories and the lack of relevant sector specific information that is useful in making decisions in the different sectors. This paper presents results of an investigation into the need for relevant weather information in different sectors of the economy, the information that is most pertinent to those sectors and to determine the relevance of creating a linkage between the weather modeling tool and the weather information dissemination tool for better customization of weather information and delivery of real time and reliable weather information. The

investigation was carried out using an interview based approach at the Uganda National Meteorological Authority (UNMA) which is the organization that is mandated by law to perform weather predictions in the country and also disseminate this information together with advisories to the public and stakeholders. A theoretical analysis, together with R, a statistical tool was used to present results of the investigation. It was established that weather information needed to be disseminated to more sectors with more relevant information. Furthermore, it was noted that a weather prediction model, especially its output can be used to provide better customized information. Based on the findings, it can confirm that the use of a weather prediction model is very possible and necessary if reliable and timely information is to be delivered to the relevant stakeholders.

## 1.0 INTRODUCTION

Climate change is a fast growing phenomenon in the world and Uganda is not excluded from

the countries that are severely impacted by this climate change [1]. Almost all activities carried out in the country are either directly or indirectly affected by the weather patterns in the country [2], [3]. For example, construction activities cannot move forward if there is heavy rainfall in the area of work and weather information is very vital in the road management value chain right away from planning to operation of roads [4]. The oil and gas industry is also severely affected by the weather conditions in the exploration and mining areas. All the stakeholders in these sectors need access to fast and reliable weather information in ways that are relevant and of use to the sector, in which they operate [4], [5]. The general public is interested in all kinds of forecast from the daily to the dekadal (ten day) forecasts and relevant information that comes with it. The construction sector needs information on an undefined basis which may range from daily, hourly and weekly [5].

The Uganda National Meteorological Authority is the organization that is mandated to perform weather forecasts and is currently the only organization that disseminates this information to the different stakeholders through news bulletins, print media, SMS and workshops [6].

There are challenges to the approaches currently used to disseminate this information. One major challenge is the delay and overheads involved in the creation and

delivery of this information. Information is then received when there's no value for it.

The forecasts are first received in English by the various experts, then analyzed and translated into various languages and then provided to be released to the public. UNMA has to correlate with experts from different sectors like agriculture, water and health and they come up with advisories basing on the weather forecast [6]. This is a necessary step that is required by UNMA however it is a slow process and most times produces the same results more or less in cases of similar forecasts. Another challenge is that the information is not beneficial to all sectors of the economy. The forecasts and advisories that are provided by UNMA are not sector specific [6]. Most of the information that is provided does not provide the content that is required by stakeholders in other sectors. Many of the forecasts produced in bulletins, radio and TV media does not include the necessary information required by the stakeholders in these different sectors to aid in their decision making. Another challenge is that users do not choose which information they receive. The current dissemination channels offer users with information and there is no way the users decide what they want and do not want [6]. Users in other sectors that request for information directly from the Authority get this information in unfriendly formats, that is, static PDF maps that only work for that period of time with no options to change when new

information is needed at a later time. This greatly affects the time they spend to make decisions and for each time period required, they make calls to the Authority to get new information. The purpose of the paper is to present the results of a survey carried out to establish the kind of information required by the stakeholders in these sectors and also establish the possibility of direct linkage between the prediction of weather information through the modeling tool and the generation and dissemination of this information to stakeholders. The study is geared towards expanding and including more sectors into the dissemination of weather information, improving the experience of stakeholders in accessing timely, reliable, relevant and personalized weather information to enhance their decision making and also improve the experience of the mandated authority in faster generation and provision of this weather information and advisories to relevant stakeholders.

## **2.0 RELATED WORK**

Dissemination channels are already in place currently to deliver weather information to those who require it. An example is the application that was rolled out for fishermen to provide warnings about the weather conditions on the lake before they could head out for fishing [6]. This was done with an application that uses the traffic lights symbolism of the red, yellow and green colors to indicate the

degree of safeness of the lake for fishing activities [7], [8].

Other channels of dissemination used in Uganda include the media, TV and Radio, news bulletins at the end of weather seasons and dissemination workshops. The authority makes weather forecasts for different regions in the country. These regions fall under different climatological zones. The regions that are currently used for dissemination include; Northern, Eastern, Western, Central and Lake Victoria Basin [6]. After the forecasts are created, UNMA contacts experts in different sectors that include water, agriculture and health to provide advisories in their areas of expertise for each sector in correspondence with the forecasted weather conditions. These advisories are then translated to different local languages and sent out to the stakeholders.

There are challenges that lie with this kind of weather information dissemination which include the apparent size of the regions for which these advisories are made. The information provided is very general and may not apply even to different areas of the same climatological zones. Also, due to the nature of weather and perishability of weather information specifically, it is very important to provide information to people who need it, at the exact time when they need it and this information needs to be specific to the areas where they originate from [9].

In other parts of the world, many initiatives have been started to disseminate weather information to stakeholders especially in the agricultural sector. In India, work has been started to provide agro meteorology services to farmers in the country at district level. These services are meant to aid farmers in livestock management, crop production and food security [9].

The India Meteorology Department started the dissemination of weather information at district level in 2008, with forecasts for rainfall, temperatures, wind speed and cloud cover [9]. The analysis included information on how to manage pests when the information is of relative humidity, high and low temperatures and how to manage irrigation through rainfall. Further studies showed the numerical weather predictions were reliable and farmers used them to make decisions on when to plant and harvest [9], [10], [11].

The National Weather Service of America has also taken huge strides in disseminating and providing real time weather conditions to all parts of the United States of America [12]. As part of its service, it provides a map of the USA with ability to request for timely weather forecast parameters and their distribution across the country [13].

A slight setback in this is that it doesn't incorporate agro-meteorology services and this information is raw. This is evidenced by an annual report in 2011 that showed the most respondents and users accessed the system for

personal and recreational purposes and less for agricultural uses or economic sector usage [14]. Part of the objectives of this project is to provide such information but also interpret it to meet the needs of the local farmers and workers in other sectors who would require interpretations of the raw, live data produced by the weather modeling tools.

### 3.0 METHODOLOGY

To optimize the efficiency of the weather forecast information, the information that is presented to the stakeholders must be relevant and specific to their area, and include all information that they wish to have in order to make decisions in their respective sectors.

There is need to take advantage of the respective features of the various dissemination channels so as to present a product that answers all questions that are raised with the current modes of dissemination. Specifically, aspects of weather information that are pertinent to stakeholders' interests need to be noted, so that they are able to receive relevant information with all required parameters and in the right time. It should be concise and easy to understand and interpret, but when necessary, emphasis should be placed on the most important meteorological phenomena and their impacts. There is also need to take advantage of the streamlined process from weather data collection to prediction to dissemination. The forecasts from the prediction model should be harnessed more

in order to directly aid in the dissemination of the information.

### 3.1. Setup

The team conducted one training session with the UNMA representatives after an invitation to Makerere University and another interview session at UNMA offices again with select representatives from the respective departments. All departments were well represented including the dissemination team and the weather modeling team. This provided a basis to getting views from both ends of the table, that is, from the dissemination end and from the weather prediction end and find ways of bridging them together.

*Session Management:* A moderator and an assistant were in-charge of each session. All outputs of the interviews were noted by the moderator with the consent of the participants. The average session time was half an hour. The moderator provided information about them and told the participants the reason behind the interview and promised impartiality of the results.

*Question Guides:* Questions were categorized into three themes, each designed to capture a different aspect of the current and proposed weather information dissemination. Each theme consisted of both open ended and closed ended questions. All questions were in English because all the respondents were comfortable and preferred to be addressed in the English language.

### 3.2. Data Collection

The survey was distributed to UNMA as they comprise the ownership and operation of the system used to disseminate weather information.

As the survey was intended to be a collaborative effort between those overseeing operations and management of the existing system used to disseminate weather information, recipients of the survey were asked to work together, as needed, to complete the survey [15].

In general, the survey consisted of 18 questions that guided in the collection of the required data. (A copy of the full survey can be found in the Appendix A).

#### 3.2.1 Sample Space.

The sample space for the survey included;

1. Stakeholders at UNMA under the weather modeling department.
2. Stakeholders at UNMA under the Agro-meteorology department.
3. Stakeholders at UNMA under the dissemination department.

#### 3.2.2 Covered Areas.

Some of the reasons for choosing the sample include;

1. The chosen sample has representatives from both components that we expect to bridge together therefore responses and reactions can be got from both ends of the spectrum

2. The sample is a general representation of the kind of information that can be provided to the various sector specific stakeholders

### 3.2.3 Relevance of Data Collection to the Project

The relevance of the Data collection to the entire project includes;

1. Gathering data for use in the Software Requirement Specification documentation.
2. Gathering data to aid in the design and implementation of a software solution, the “Weather Information Dissemination System.

## 4.0 SURVEY RESULTS

This study sought to establish the need of ICT-supported dissemination to all sectors of the economy and to establish the need to improve dissemination of the advisories.

### A. Analysis

The team conducted interviews with people selected from the two components, that is, weather modeling and prediction and weather information dissemination and the interviews were classified into three parts in order to get more information regarding both the current and intended approach to weather dissemination [16].

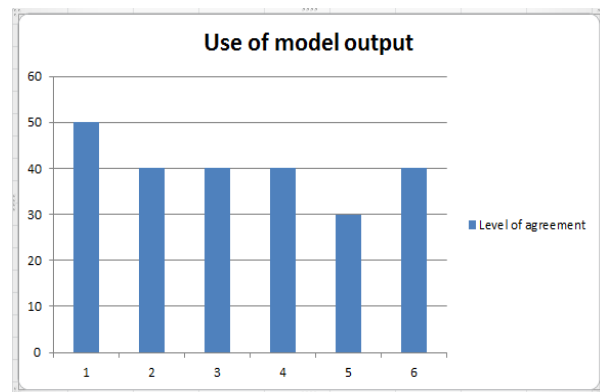
### B. Classifications

The discussion focused on three areas of the entire process, the Weather Modeling and Prediction, the Weather Information Dissemination and the possibility of a linkage between the two components.

#### a) Weather Modeling and Prediction:

Outputs from this model or component are used to support further weather predictions currently. However, no work has yet been done to make the outputs of this model applicable to dissemination. Participants in these interviews were open and willing to promote the use of the model’s output in order to answer the pending questions and inadequacies in the dissemination process.

The graph shows the level of agreement with the notion of lineage between the WRF model and the dissemination component with the highest level being 50 and the lowest being 10.

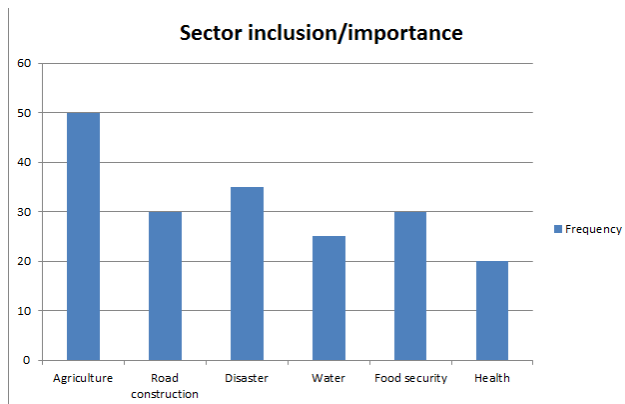


#### b) Weather Information Dissemination:

It was established that this dissemination is not efficient as it is supposed to be.

UNMA would like to include and promote the dissemination to all sectors however this has not been done diligently but is one of the priorities to consider. Provision of an interactive map was a welcomed idea in order to take care of the weather information needs of all sectors especially those that require weather parameters often. The proposed solution was seen as a good strategy to include the youth and the stakeholders showed willingness to accommodate the change from the traditional dissemination system to the proposed product.

The graph emphasizes which sectors were emphasized and vital to the dissemination project according to percentages.



#### C. System Requirements

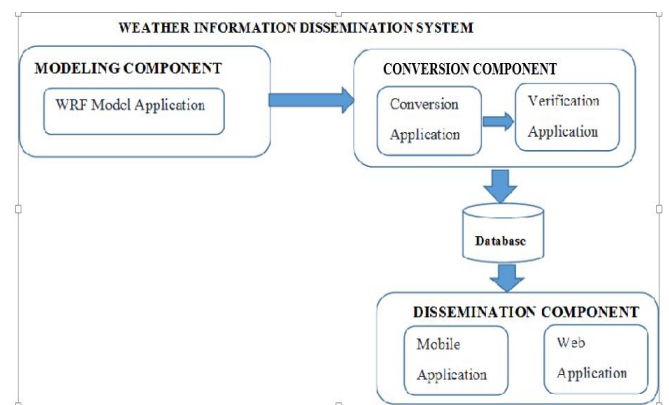
Some sample requirements for the proposed system include;

The software system shall provide analysis and visualizations of weather parameters across the country.

The system shall provide timely and reliable advisories basing on the output of the weather prediction model.

The system shall provide weather alerts about extreme weather conditions experienced in various parts of the country.

#### D. Proposed Architecture



The proposed architecture consists of three components;

The weather modeling component; This component comprises the WRF model which will produce the weather forecast information and whose output shall be used by the dissemination component.

The conversion component; This component comprises the conversion and verification applications. These components will be responsible for extracting the parameters and the data that will be most useful to realize the functions of the dissemination system. The WRF model produces different kinds of output

however not all of it is necessary in the dissemination of information hence the conversion and verification component will filter out the most useful data.

The dissemination component; This is the final component of the system that shall take as its input the verified output from the WRF model and use it to automate the generation of advisories and provide real-time and reliable information to stakeholders. It has the web and mobile applications that will be the front end applications that users will interact with to obtain relevant information.

## 5.0 CONCLUSIONS AND FUTURE WORK

This paper presents the results of an investigation carried out to establish the need for ICT-support dissemination to all sectors of the economy and to establish the need to improve the dissemination process by communication with a weather prediction model [16], [17], [18].

We made interviews and listened to personnel from the Uganda National Meteorological Authority give their views and understanding of the current situation and problem, ideas, suggestions and possible support for the use of the weather prediction model in carrying out their tasks [19], [20]. The interviewed stakeholders unanimously agreed that the weather prediction model can be used to complement the work done by the

dissemination model and expressed their interest in considering the live map as one way to disseminate this weather information in a more tailored and specific way.

The findings indicate the need to use the output of the Weather and Research Forecast (WRF) model to aid in the fast tracking and automation of the generation of advisories and quick dissemination of weather information on demand that includes weather parameters that other current dissemination channels cannot provide [3:294].

The next steps are to provide a complete integrated system that is translated into other Ugandan local languages so that the information becomes of use to all the people in different parts of the country.

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## APPENDIX A – SURVEY TEXT

### SAMPLE SURVEY GUIDING QUESTIONS.

#### Sample questions;

1. What are the technical skills needed to use the WRF model’s output?
2. How are the maps generated by the WRF models used?
3. Has there been any request to use the WRF model’s output for other purposes in addition to the current usage?
4. Are forecasts produced from the WRF model incorporated into weather information disseminated to stakeholders?

5. If not, is that of interest to UNMA?
6. Is there any connection between the weather modeling and weather information dissemination or do these teams interact?
7. In your view, can the WRF model together with its output improve weather information dissemination?
8. In your view, how can this happen?
9. Who are all the users of the weather information that is disseminated?
10. Are there any groups of users that require information presented on maps from UNMA?
11. If so, what weather information do they request for on these maps?
12. How often do they request this information on maps?
13. Does UNMA currently provide all this information?
14. What are the challenges in providing this information?
15. Is a clickable map with information a welcome addition for UNMA or any users?
16. If so, what are your suggestions to roll this out?
17. Is UNMA willing to accommodate this change in terms of work schedules/activities?
18. Does this solution in your view provide value to UNMA and its stakeholders?