Talking about the rain in Ghana
Creating a system to support local weather data exchange
Thesis Design Proposal

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Abstract. This Thesis Design Proposal outlines the research about developing a system that collects meteorological information from farmers in Ghana. During some literature research, it was discovered that most of the literature focuses on getting data towards the farmer instead of retrieving data from the farmer. Therefore, this research aims to iteratively develop a system that uses mobile phones to retrieve the amount of fallen rain from the local farmers and combine this with the weather forecast in a dashboard.

1 Introduction

More than 70% of Africas population depends on agriculture for the basic life needs [Yeboah, 2017], however reliable data is often not available due to lack of internet connectivity, language and literacy barriers. In the cases the information does exist, about 80% has a poor quality [Yeboah, 2017] partly because the African government doesn't invest in collecting weather data and weather stations are especially sparse in Africa [van de Giesen et al., 2014]. The lack of weather information may affect the optimal use of the agricultural land [Gyan, 2016], as the combination of unpredictable rainfall and low soil fertility affect crop growth [Fox and Rockström, 2003]. Recent studies in rural areas of Burkina Faso and Ghana have shown that timely, accurate and localized rainfall data is considered important information by local farmers [Bon et al., 2017].

My research will focus on the development of a meteorological information service for farmers in rural regions in Africa. In the following sections, I will describe the already done research on this area, the detected problem, the project plan, the research methodology and the time frame.

2 State of the art of meteo applications in rural Africa

During some research done to the current available literature, one thing was discovered: the found research papers have in common that they only focus on getting data towards the farmer without the use of Internet connectivity. Less attention has been given to the collection and sharing of locally collected data. For

example in the area of meteo data in rural Africa, the paper *'The Trans-African Hydro-Meteorological Observatory (TAHMO)'* [van de Giesen et al., 2014] gives an explanation of the project where 20,000 hydro-meteorological stations are being installed and operated in sub-Saharan Africa. The objective is to have one station per 1000 km2 to improve the quality of weather predictions, climate change assessments and development and management of natural resources.

Another paper,*'Using smart ICT to provide weather and water information to smallholders in Africa: The case of the Gash River Basin, Sudan'* [Amarnath et al., 2018] explains how remote sensing from satellite data can help to monitor crop growth and water consumption within agricultural fields. And predict when flood flows might occur. The study also operationalized information systems for farmers, which helped them to optimize farm profits and achieve more crop per drop information for improving agricultural productivity and rural incomes in Africa.

Not only research done on meteorological services has an connection with this proposal, but also voice-based systems play an important part. Like the paper *Ney Yibeogo - Hello World: A Voice Service Development Platform to Bridge the Webs Digital Divide* [Baart et al., 2018] which describes the technical implementation of the Kasadaka platform. A platform that together with the Voice Service Development Kit (VSDK) provides the residents in rural Africa without access to the internet to share knowledge and create content in a similar way to how the internet works. It also describes a case study to evaluate the VSDK on site in Mali to provide the villages with a system to submit spoken messages or important events that are offline stored in the system to be broadcast at a later time at the local radio station.

Another paper called *'A dialogue with linked data: Voice-based access to market data in the Sahel'* [De Boer et al., 2015] focusses on knowledge sharing services in the Sahel with the help of simple mobile phones, GSM architecture and voice technologies. It also describes a prototype voice application that provides voice-based access to collected linked data about the market.

The paper *'Voice-based Web access in rural Africa'* [Gyan et al., 2013] describes three systems, RadioMarch, Foroba Blon and Tabale which are designed and built to fit into the conditions in remote rural regions in Africa. RadioMarch is a system that can be used to distribute up-to-date market information via community radio in the area. With the system, voice messages can be processed to create market messages which are then automatically generated. Foroba Blon helps the citizens of different communities in Mali by offering a way to send important news and stories to the local radio station to be broadcast. This can be done with voice messages which are stored offline and can be broadcasted when necessary. Lastly, Tabale is a system that can send out messages (in their own language) to the phones of members in case of an event happening. When they want, the members could listen to the message again or leave their own message.

Because of the limited studies done on how farmers could send their own collected data, preferable in their own language [Bon et al., 2017], and without the need for internet, this leave a gap to fill with this research.

3 Problem Definition

As mentioned before, in the current literature there is little attention given to the information that the farmers can collect themselves and use to improve the optimal use of the agricultural land. Therefore, to examine if it is possible to set up a meteorological service to retrieve weather data from the farmers, the following research problem and research question(s) have been composed.

3.1 Research Problem

The current way in which farmers in the Sahel pass on information about the fallen rain is through phone calls. At first, the amount of fallen rain is collected in the villages with the help of rain gauges. This data is aggregated in a central way at commune level by the village collector. After which the village collector sends the data by a phone call to an information manager at a central location who saves the collected data in an Excel file. This central location transmits the information to the local radio stations which broadcast the data at a fixed time. In some places in the Sahel, the collected information is sent every 10 days to the province level or to the national meteo service. See *'Fig. 1. The current process'* for a visual presentation of this process.

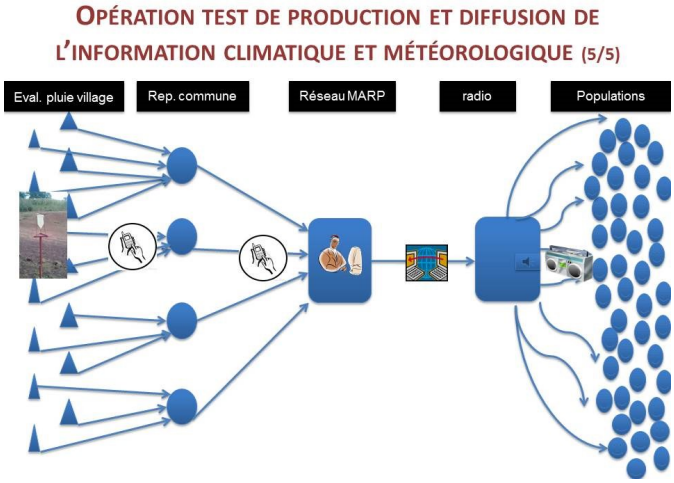


Fig. 1. The current process

However, this method requires a lot of time from both the village collector and the information manager receiving the weather information. Not to mention that the village collector and the information manager might not speak the same language and the high error rate that occurs when the data has to be transferred with speech through the phone [Bon et al., 2017].

The phone calls to the information manager cannot happen every single day, so the farmer or the village collector needs to write down the rainfall every day on a piece of paper, store this paper and pass on the information once a week. There are many things that could go wrong, like losing the piece of paper, not writing it down correctly or forgetting to check the rain gauges.

3.2 Research Question

The main question that will be answered is:

Can a data collecting system be designed that allows farmers in Ghana to share local weather data?

The main question will be answered with the help of the following sub-questions:

1. How can the local farmers receive requests to submit their weather data?
2. What is the process of sending the weather data to the system from the mobile phones of the local farmers?
3. What is an applicable method to store the retrieved weather data from the local farmers?
4. How can the system provide access to the collected weather data for interested parties?
5. How can the system be implemented locally in Ghana?

4 Project plan

Previous research has been done to investigate the wishes and needs of the farmers in the Sahel regarding a system for processing the fallen rain. This research will be the input to develop a system that will gather the amount of fallen rain from the farmers through their mobile phone. This will be done via voice messages in the farmer's own language and DTMF. The farmers will receive the request for data via the voice messages and can send their answers via DTMF. The answers will be automatically stored in a database which will serve as input for a business intelligence dashboard available for viewing on a website. The dashboard will combine the data collected from the farmers with the general weather predictions from Ghana.

There is already a system in place in Ghana called the Kasadaka which is a rapid prototyping platform aimed to meet the information needs of subsistence farmers in rural development areas [Baart et al., 2018]. This research will use the Kasadaka platform as a basis to expand the uses of the Kasadaka to also include receiving data from the farmers instead of only sending data towards the farmers.

5 Methodology and Approach

The project will be executed according to the ICT4D Field research methodology [Bon et al., 2016]. This methodology consists out of 5 steps:

- **Understand the context in depth;** is about getting the same kind of view and bridge cultural distances with the environment the project is going to take place.
- **Elicit and assess needs;** finding out what the users want with the to built system; how they can work with it and what benefit it gives them
- **Specify use cases and requirements;** developing use cases to translate the needs into understandable context for the development process.
- **Engineer, deploy, evaluate the system;** a working prototype is developed and tested in the field.
- **Assess sustainability;** takes a look at the business model and determines if the proposed solution is workable in the field. [Bon et al., 2016].

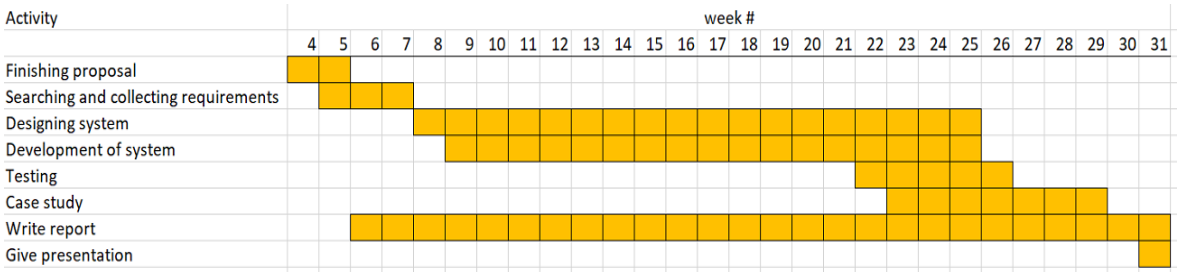
The first two steps have already been done by the W4RA workgroup during workshops in The Sahel [Bon et al., 2017]. This research will use the outcome of these workshops to gather the wishes and needs regarding the system as a small literature review. The last three steps will be executed in this research, with a focus on specifying the use cases and requirements and engineering the system in an iterative way. Meaning that the use cases needed for the design of the system will continue to evolve during the development of the system. The system will consist out of three main parts; collecting the data, storing the data and displaying the data. Collecting the data will be done with the help of DTMF and some coding to automate the collecting process, the data will be stored in a (SQL) database and the displaying is a Business Intelligence dashboard which will combine the collected data with the local weather forecasts. The specific programs and techniques needed will be investigated during the research and development. The sustainability of the system will not be assessed in depth during this research.

During the third step (use cases and requirements), interviews will be held with different people involved in (ICT) projects in Ghana to get a clear image of the different steps needed to implement a system in rural Africa. A (remote) case

study will be done for testing a prototype of the system in the field in the last step.

The programming language Python will be learnt to be able to create the system. After surveying the available documentation on the Kasadaka, this language is the core programming language used in the development of the Kasadaka and the Voice Service Development Kit. By learning this language, a good connection can be made with the existing parts when building the addition to the Kasadaka.

6 Time frame


Activity
week #
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Finishing proposal
Searching and collecting requirements
Designing system
Development of system
Testing
Case study
Write report
Give presentation

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