SECOND AFRICA DIGITAL HUMANISM SUMMER SCHOOL

USE CASES/SERVICES CO-CREATED FOR/WITH FARMERS AND RADIO STATIONS IN MALI, BURKINA FASO, GHANA AND THE DEMOCRATIC REPUBLIC CONGO

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1. The Digital Transition in the Global South

In this Second Africa Digital Humanism Summer School we will discuss the Digital Transition for countries in the Global South, with focus on Africa. There are different approaches how to address this problem. In this Summer School we will use a practice-oriented digital design approach that has been developed to serve people and communities in a fair and sustainable way, following with ethical, human-centric Digital Humanism principles.

2. Perspectives on the Digital Divide

The digital divide refers to the disparity between countries, regions, and people in the assess to digital services [see e.g. 1,2,3,4,5,6,7,8]. In Africa, for example, in 2026, about 35% of the population is still unconnected from the global Digital Society[1].

Of course, not being connected can be attributed to a lack of physical and digital infrastructure. For example, due to the absence of an Internet infrastructure in poor regions or countries, many people simply cannot use digital services and content. This withholds participation in the information society and hampers economic growth. So, rolling out the Internet in every corner of the planet, as suggested in the Sustainable Development Goals, notably SDG-9, would then the solution to the problem. The ensuing question is how this can be done, who will make it happen, and what about the consequences?

Alternatively, the digital divide can also be seen as a snapshot in an ongoing process of technological innovation and its diffusion. Developing regions are still lagging, but will soon catch up in their technological and organizational capacity and will adopt digital technologies at a later stage. This will lead to progress and economic development [1,2].

These are just two of the myriads of perspectives on how to address and mitigate the problems related to the digital divide. One central question should be asked: is digital technology a driver of progress and improvement, or are there additional requirements? Are perspectives on the digital divide which prioritize human values, inclusion and human-centric approaches in digital development? We will further discuss this in the Summer School.

3. A methodology which combines action-research, design science and ethics & sustainability by design

When we explore alternative approaches to serve communities and individuals in low-resource environments, there are principles we want to discuss first. Firstly, digital services must serve local people's/users' self-defined objectives and goals. To do so, local users must be involved in the decision-making on the goals and objectives of the digital service. Obviously, digital technologies must not in any way, be evil or harmful to people.

Secondly, the digital technology must be adapted in a flexible way to the complexity of the envisaged context, such that it can overcome local barriers. We can think of barriers in language, (il)literacy, no or limited infrastructure, low purchasing power or other context-related issues.

Thirdly, there must be local ownership of data and the local domain knowledge, to prevent that the property rights of local users are compromised or misused. In the case of co-design, the ownership of the designed artefacts must also be shared. Research data are not automatically owned by the researcher or allowed to be published.

Summarizing this, development of digital services for unconnected people or communities in low resource environments, must be done in co-design with local users. The software developers are often not

[1] Source: https://www.internetworldstats.com/stats.htm

knowledgeable about low-resource environments, *for example* rural regions in sub-Sahara Africa. Therefore, socio-technical approaches, for example collaborative design workshops, rapid prototyping during field visits and Living Labs are useful research methods to share and exchange information and knowledge, to gain understanding and bridge the distance between users and developers [6].

In this Summer School we propose a methodology that combines action-research, design science, ethics by design. The basic concepts are: co-design, collaborative, iterative, adaptive to context. Local users are considered domain experts on their own work and context. It is framed as ICT4D 3.0. This framework has been designed and iteratively improved during 15 years of ICT4D field work in West Africa, Southeast Asia and various other placed in the world.

4. DEVELOPING ICT SYSTEMS FOR LOW RESOURCE ENVIRONMENTS

In this Summer School you are going to collaboratively design/develop an ICT system for people and communities in a low resource environment. This document guides you and your team through the design process, in a collaborative, inclusive but also systematic way. This document also describes a number of use cases, of which you will select one to further elaborate.

In this Summer School, a sociotechnical approach/framework dubbed *ICT4D 3.0* is used (see Figure 1). This covers the full lifecycle of ICT system development. Figure 1 shows the five iterative phases in the information system's engineering lifecycle (see also Baart 2018, Dittoh 2021, Bon 2020). ICT4D 3.0 is based on extensive field research/experience in developing and emerging countries.

The central idea of ICT4D 3.0 is:

(i) to work with the user(s) and meet their local needs/objectives;

(ii) to design for sustainability, i.e. to adapt the solution to the local context.

The process is *agile* and iterative, because you will need more than one cycle to get the solution right. Since the context is commonly unfamiliar to us as ICT4D developers, context analysis is very important.

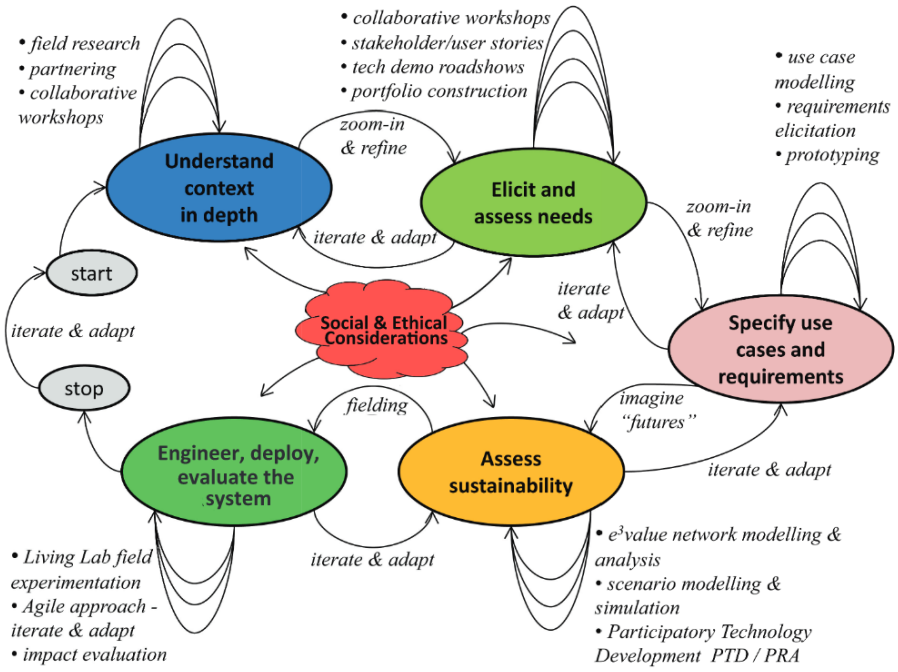


Figure 1: A conceptualization of the ICT4D 3.0 method, presented as an iterative process/goal model. From: Bon, 2020, page 204 [6]. It is based on an adapted version of the process/goal modeling approach by Colette Rolland [21].

ICT4D 3.0 is based on ethical principles. It aims to bring benefits to the users and do no (intentional or unintentional) harm to their lives, work and the environment. Therefore, we take a reflective approach, in which co-creation and deliberation with the users, and within in your team, are central.

The structure of this syllabus is as follows:

Chapters 1-6 give the general idea behind ICT4D, the theoretical framework and methodologies used to carry out an ICT4D project.
Chapter 6 presents the *structured narrative format*. You will use this method to analyse, describe and present your use case and group project in a structured way, throughout the design and implementation of your project.
Chapter 7 describes many different user stories and use cases, collected in West and Central Africa. You will select one of them for your group project. These reflect the complexity of the real world: they are rather unstructured, information is scarce or incomplete, the context may be unfamiliar to you. It is your task to analyze the problem, the various stakeholders, their operational goals, the context of the use case. You will collect as much information as needed to carry out your project.
Annex describes examples of ICT projects based on use cases that have previously been collected/analyzed in low-resource development contexts, and that have previously been elaborated in collaboration with local users. These use cases can be used as reference or as a source of inspiration for your own group project.

5. How to do a needs assessment/use case and requirements analysis

In this Summer School you will design and build a prototype for an ICT service for a community in a low resource context. This is based on use cases/user stories, which are described in this document, that have been collected over the past few years through interviews, focus-group discussions and meetings with communities in West Africa.

The use cases and user stories described in this document are from a variety of low resource contexts: Ghana, Burkina Faso, Mali, Congo (DRC). It is the task of the requirement engineer to structure the complex information into a structured narrative format. This will be described in the next section. The format provided in this document is useful to communicate with the user (did I understand your problem well?) and to structure the requirements into semi-formal specifications that can be modeled into a technical system architecture, consisting of several views and concepts [7].

Figure 2: Two ICT4D researchers (André Baart and Gossa Lô) doing a use case and requirements interview in Bamako, with the Mr. Adama Tessougué, director of Radio Sikidolo, a local community radio in Konobougou, Mali, October 2016.

6. ICT4D 3.0: How to capture all information in a Structured Narrative Format

The information in this section is adapted from an original technical paper by Hans Akkermans & Anna Bon - 2011

In this section, a uniform format is presented on how to describe and elaborate the use case and use case idea that you selected for your project. The user stories are described in section 4. This format is required in the assignments of the ICT4D course.

The structured narrative format, see below, was developed, adapted and validated, during extensive requirements engineering field research in rural West-Africa, (Mali, Burkina Faso and Ghana), from 2009 to 2020 [6]. It follows a mixed-method approach, where informal methods (short narratives, scenario scripts) are combined with semi-

formal technical ones (UML diagrams). Namely, use case scenario descriptions and corresponding requirements analysis are ideally carried out such that:

- Their essentials are understandable by everyone, also by stakeholders outside the project.
- They provide a clear narrative for the future users (also people with no ICT background).
- Meanwhile, they provide an information baseline that is useful for and can be gradually extended by technical developers (especially for the pilot technical specifications).
- They provide a simple, but shared information basis and reference point for all VOICES participants in different activity areas (e.g. work packages, WPs) and tasks, in a uniform format.
- They are compatible with architecture, system, and development international standards.
- Each use case scenario has a limited size and requires no more than a few working days to develop (e.g, 1 workshop/brainstorm meeting and 1 structured write-up, to achieve a first-cut version).

The set-up of the structured narrative format in 11 steps is simple, and at the same time compatible with guidelines, standards, and requirement and IS development methodologies for development of information architectures.

0. A name for your project
Give your project and envisaged application a characteristic, understandable, and distinctive label. If possible, you can design a logo that conveys the idea of your project.

1. Give a short summary of your key idea
What's the key (business) idea collected from the users and why is it valuable or of interest to consider this? Make a short abstract, max 200 words.

2. Actors and goals
Who are the actors, also known as, *stakeholders* in the use case scenario and what are their roles/responsibilities and operational goals? Structure this information in this table.

Stakeholder	Stakeholder's goal or objective	Responsibility in the envisaged system

3. Context and scope (max 400 words)
This can be described by answers to a checklist of questions:

a. Make a sketch or diagram of the layout or network configuration of the interactions between the parties involved in the scenario.

b. Who are the (external) stakeholders to the use case and what are their concerns?

c. What is the scope of the scenario (especially, what is outside it, not considered, system boundary)?

d. What are success or performance measures for the scenario (especially in relation to what a pilot demonstration should be able to show)?

e. What are important (pre)conditions that must be or are assumed to be satisfied for the scenario (context features, e.g. needed resources or infrastructure or other characteristics of the environment)?

4. Use case scenario script (make a conceptual model or storyboard)

The central storyline (just like in a movie, video clip storyboard, animation, or demo; the script might for example be given in the form of slides or a Flash animation showing the event-state chain of the actors' activities and interactions).
The main scenario is given in a well-structured narrative, e.g. through a limited number of steps (commonly 5-10), of the following type:

<actor1> <(inter)action> <actor2>.
Not all possible sub-scenarios, just the main and typical one is needed as a first step.

5. Interaction and communication (max. 100 words)
Further script information, e.g. in the form of a few UML sequence, state or activity diagrams. (This gives some info about dynamics, interaction and control flows).

6. Information concepts (as UML diagram)
Further script information, e.g. in the form of a few UML class diagrams showing the meaning of important concepts. (This gives some info on static data structures).

7. Technology infrastructure (as UML diagram)
What are the consequences of the above for technologies and technology components (Internet/Web, mobile, information, communication, voice services, both hardware and software) that must be (made) available in order for the scenario to work?

8. Cost considerations (as a table)
What are estimated associated costs (operational, investment, development, in/outsource) for these technology infrastructure and components? Who carries these costs?

9. Key requirements (as a table)
So-called MoSCoW list of requirements (Must have, Should have, Could have, Won't have) as a starting point for further architecture design, and system and component development.

10. Feasibility and business sustainability of your system (max. 150 words)
Previous sections must be as factual as possible. This section is the start of assessment and judgment. The following checklist of questions needs answers:

a. What is the technical feasibility of the scenario (e.g. [project] risk analysis, technical obstacles to overcome, system-level impacts)?

b. What is the business and (socio-)economic feasibility and sustainability of the scenario?

c. What are possible goal conflicts and dependencies in the collaboration between the actors in the scenario?

d. Are there important general preconditions for the scenario to work, and is it sufficiently interoperable with the wider context both in a business process and a technical sense?

7. USE CASES COLLECTED IN MALI, BURKINA FASO AND GHANA (2015-2023)

In the following sections several use cases are described. You are requested to select one of the use case ideas and elaborate this during this Summer School. You will have to interview one of the domain experts to make sure you have a design that fits the users' needs and requirements, so that your application is well adapted to the local context.

Your design and prototypes will be shared with users. You will receive user feedback during the course, to improve your system and adapt it to the users' requirements.

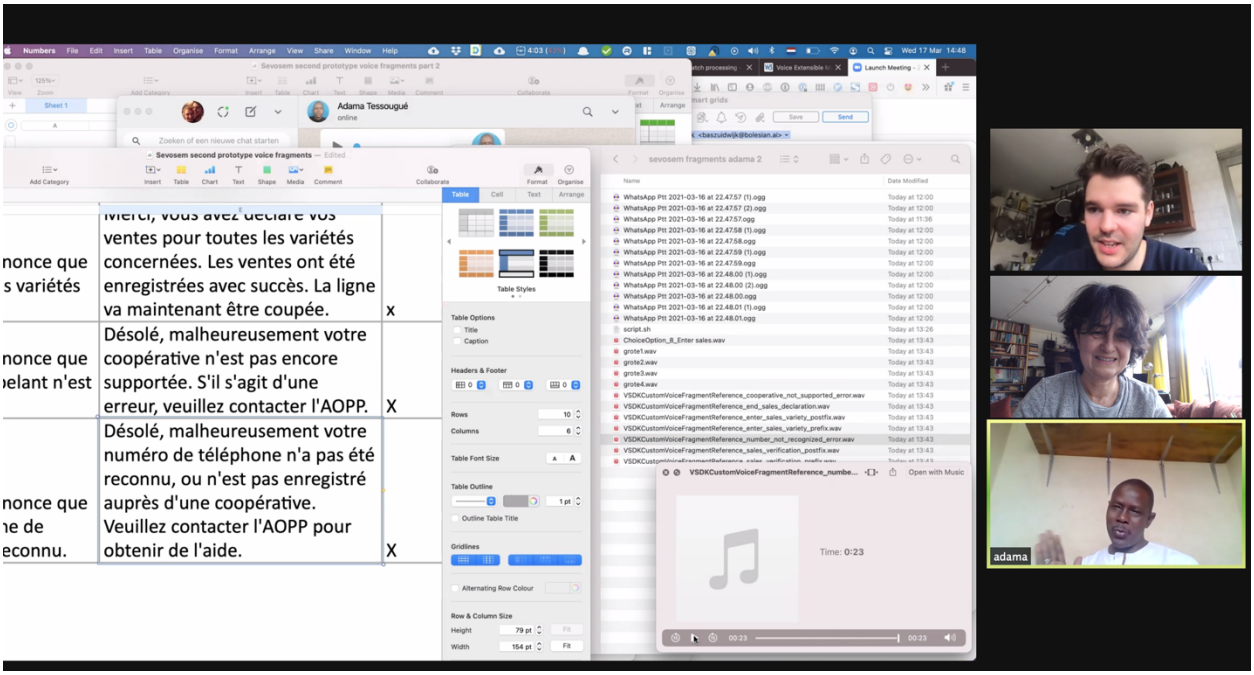


Figure 3: Example of a project meeting to build an information system for farmers in Mali, 17 March 2021. During the Covid-19 period, the field work was done at a distance, using online tools, if the (often intermittent) local internet connection allowed us to do this.

List of use cases

a. TIBALLI, PROVIDING RAIN DATA FOR CROPPING CALENDARS IN NORTHERN GHANA

In January 2023, ICT4D researcher Francis Saa-Dittoh initiated the Tiballi project, to make ICTs work for people in northern Ghana. The project, dubbed Tiballi, is a 2-year project supported by the Internet Society. Tiballi is a word in Dagbani language. It means *our language*.

The design of the Tiballi project was built on an explicit wish of local farmers in northern Ghana, to have better access to meteorological data in the rainy season, as this information is essential for their practices in rain-fed agriculture. Useful weather data are currently not available. These were the findings of the collaborative meetings with farmers in a local community, see Figure 3b.

The Tiballi project is designed such that it will collect, process and deliver local weather data combined with Web-based global climate information and make it sharable beyond the Internet's current boundaries and in the local community's own language.

Figure 3b: 18 February, Tiballi meeting in Tingoli, women attending the focus group discussion about the Tiballi project and the requirements of the envisaged system for the women farmers.

The research approach followed in the project is participatory field experimentations in collaboration with rural communities in northern Ghana. The project's focus is: (i) communications to and from people on highly relevant

local domains such as weather and climate information as pertaining to farming in the Sahel; (ii) delivering such information via automatically generated voice messages in a domain-focused speech vocabulary that is crowd-sourced from rural communities themselves.

What can be learned from the Tiballi project is that Decolonizing the Internet does not just reside in having affordable Internet access everywhere. It is also in the ability (i) to provision locally important information (ii) in the languages and modalities people are familiar with. In particular, it considers (i) local content, relevance and salience of offered Internet information (ii) the local language(s) and their modality (speech; given high levels of illiteracy) in which Internet information is provided.

The kick-off meeting of Tiballi took place from 16 -18 February 2023, in Tamale and in the small village of Tingoli, in the Nyankpala community, in Ghana. Farmers and ICT/Ai specialists were present (in total about 40 people) and discussed the requirements of a envisaged ICT system.

These participants were present and questions were discussed in a breakout room:

Team members of this break-out group:

- Awabu Adullai –farmer from Tingoli (f)
- Alhassan Salamatu - farmer from Nyankpala(f)
- Zakaria Samata - farmer from Tingoli (f)
- Asaah Saratu – interested stakeholder (f)
- Elizabeth Apuseyine – researcher/lecturer water management UDS (f)
- Anna Bon – researcher ICT4D VU Amsterdam (f)
- Adam Abdul Aziz – Extension Officer (m)

QUESTIONS AND **ANSWERS** IN BOLD (TO THE FARMERS FOR TIBALLI)

1. Let's assume we have a system that can answer your questions; what three questions would you ask? (let each farmer ask 3 questions.) **see answers below**
2. Are there farmers in the community everyone relies for:
   a. General information – **yes see below**
   b. Climate information – **yes, rain and weather**
   c. Information on what to plant **yes**
   d. Other information: **animal health, prevention and treatment, especially guinea fowl, chicken, goats.**
3. If yes is this information provided by experts generally accurate?
   Information about predicted rainfall is not always accurate, about 40% of the times it is not correct.
4. If the system can only give climate information on what has already happened (e.g. yesterday there was heavy rain at Tingoli) would that be useful too?
   Yes that is very useful.
   a. What other information would be useful besides climate information? **animal health, prevention and treatment, especially guinea fowl, chicken, goats.**

Answer by the farmer women: three questions to the voice-based ICT system:

Will it rain in the next couple of hours, today?
What can I plant given the previous rainfall?
What is the best time to plant to get the maximum yield? – for each of these crops:

Background information, we mainly plant here:

Groundnuts
Maize
Soya beans

If rain starts early, which of the above crops should I plant first?

Other questions to the Tiballi system:

1.What is the weather prediction for the season? Will it be a dry/intermediate/wet season? When are the dry in-between periods? (These are used by the farmers to take various actions).

Observations by extension officer Aziz and the farmers: (i) If it does not stop raining soyabeans will be spoiled. (ii) Different maize varieties have different crop calendars.

2. **In the community there are people with knowledge. The women farmers would consult their husbands, but also other elderly or knowledgeable people whom they trust, men or women, in the community.**

Other questions:

When (in which month) will it stop raining?
Frequency and intermittency of rains are regular, predictable, variable?
Normally, maize crops are planted between mid-June and mid-July. When I plant it in August, will it still mature (obs. Women have to collect money to invest, sometimes this causes a delay until August).
Can I have the weather conditions of today (rain, dry, temperature?) What is the best period to plant maize to avoid drought?

The use case idea here is: build a voice-based system, preferably in Dagbani language, (or such that it can be easily translated) that can provide information when to start the seeding of the three main crops in Tingoli: maize, groundnuts, soja beans.

Provide an option to enter recent rainfall, of the previous day, using the categories: Storm, Heavy rain, moderate rain, drizzle.

b. CARPA: Reporting issues in the value chain of Conflict minerals in DR Congo using a voice-based reporting and monitoring tool.

CARPA in a nutshell

CARPA (Crowdsourcing App for Responsible Production in Africa) is a project funded by the Netherlands Organization for Scientific Research (NWO) as part of the SDG research initiative. CARPA aims at improving sustainable business in Africa through the development of a crowdsourcing app and website which will be used to report cases of responsible production initiatives as well as cases of irresponsible production in supply chains in Africa, in order to promote sustainable solutions. CARPA's underlying goal is to foster dialogue between citizens, governments and companies through this platform, improving transparency and knowledge exchange, and thereby strengthening local institutions. Data visualization technology will enable stakeholders to follow cases over time. The focus will be on the Democratic Republic of the Congo, Mali and South Africa.

More details

Firms are under increasing pressure to ensure sustainable, responsible production in their supply chains. This can be challenging in supply chains extending to low and middle income countries (LMICs) lacking infrastructure and institutions for accountability and transparency, particularly in post-conflict zones in Africa. Lack of transparency about labor and environmental issues has led some firms to cease purchases from the region, which has caused the loss of livelihoods. With an interdisciplinary partnership of universities and local organizations in DRC, Mali, and South Africa, CARPA aims to generate new evidence-based knowledge to improve transparency about business impacts, positive and negative, on sustainability. Co-creating a mobile telephone web-application ("web-App"), we will use crowdsourcing methods to obtain reports of social and environmental business impacts in these regions, and follow them over time to understand best practices and/or remediation of negative impacts. Data integration and visualization methods will identify patterns in order to provide context and clarity about business impacts on sustainability over time. A website will be developed to provide ongoing public access to this data, including a mapping function pinpointing impact location.

Project goal

This project aims to: 1) improve best practices and vigilance for sustainability in LMICs; 2) increase transparency for business and its stakeholders by providing public access to benchmarking data; 3) provide a forum to improve the dialogue between stakeholders and corporations with regard to solutions and remedies to resolve sustainability issues; and 4) provide real-time empirical evidence to inform academics, practitioners and policymakers about progress in sustainable development.

For Whom

- For the citizens and civil society organizations in the three countries in order to voice their views, report on cases (positive and negative) linked to corporate supply chains, engage in a dialogue with businesses, and contribute to improved transparency.
- For businesses to report on best practices for responsible production, find remedy when incidents occur, engage in a dialogue with stakeholders, and better understand the impact of their operations.
- For investors to research potential investment projects, gain insight into regions surrounding existing investments, participate in ongoing dialogue, and promote the sustainability of their investments.
- For governments (local and national) to understand the challenges linked to responsible production, and (better) monitor corporate activities and citizens views to maximize positive impacts.

- For academics, to gather data on issues surrounding responsible production, document cases, and provide evidence based knowledge that can be translated into policy.

- **What**: a web-app that works on mobile phones and desktops/laptops
- For **Whom**: citizens, business, government, civil society, investors, academics
- **Why**: improve corporate supply chain by increasing transparency
- **How**: reporting cases (positive and negative), fostering a dialogue, finding solutions

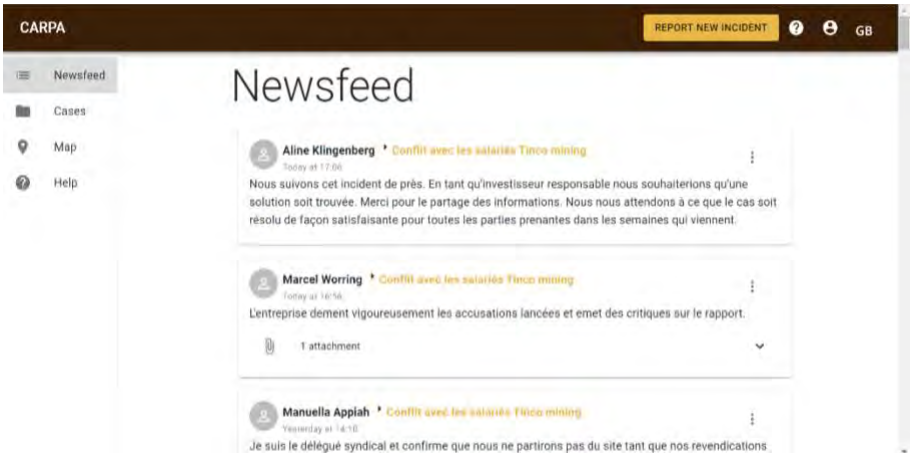
CURRENT STATUS

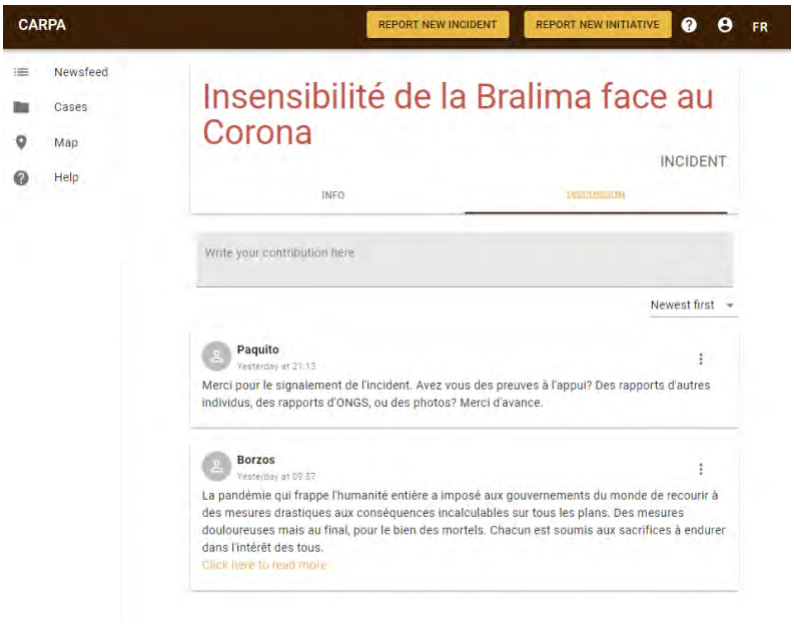
A first and improved version of the application has been developed. Initially, an Android application was developed. However, after an initial round of workshops in Democratic Republic Congo (DRC) and Mali, it was found that for many people, installing the application was not possible (due to storage restrictions/old versions of Google play etc). Therefore, the 2nd version of CARPA is a progressive web application. This application is found at https://carpa.io.

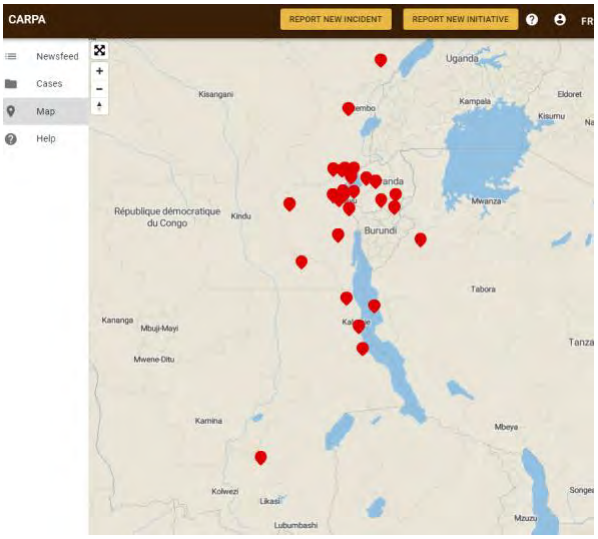
The application allows for:

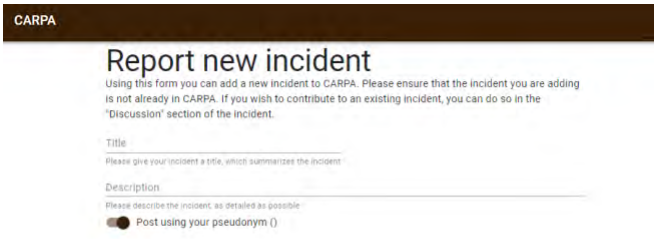
- Reporting incidents, using a simple form and optionally several categorizations/tags. Photos can also be uploaded and geolocation can also be added
- Reporting initiatives, similar to incidents, but positive in nature
- Browsing and viewing submitted incidents through a map view, a news feed etc.
- Discussing and reporting on other people's incident reports.

Below, you see several screenshots









Figures 3a, 3b, 3c Screenshot of reports to incidents.

PROJECT IDEA

During a second round of workshops in March 2020 in Rwanda, with visitors from DRC, the application was further demonstrated. The application was well-received, although some usability issues remain (for example two-factor authentication is an issue). Based on feedback from the earlier workshops, we also presented the idea to integrate the platform with other channels such as Whatsapp or a voice channel. A possible extension is to integrate such an alternative channel in CARPA as in the picture below. For such a project, we have support from Robert Bwana, PhD student at UvA who is working on the project.

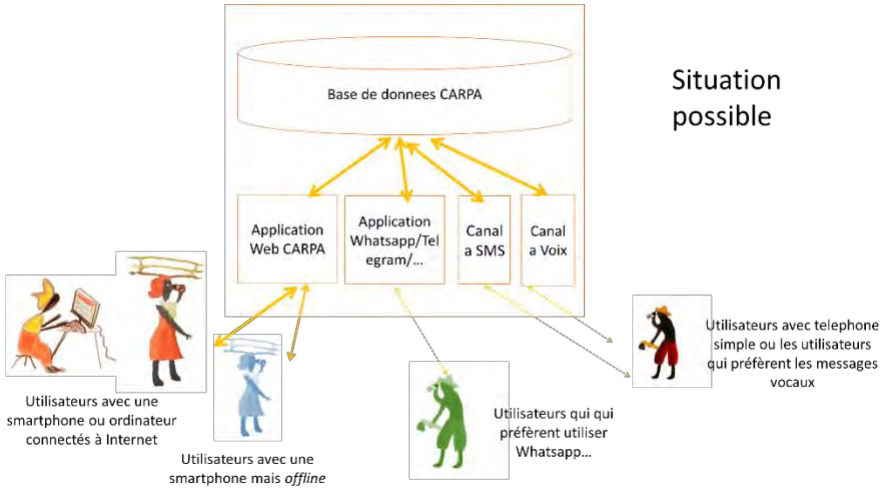


Figure 4: The use of CARPA.

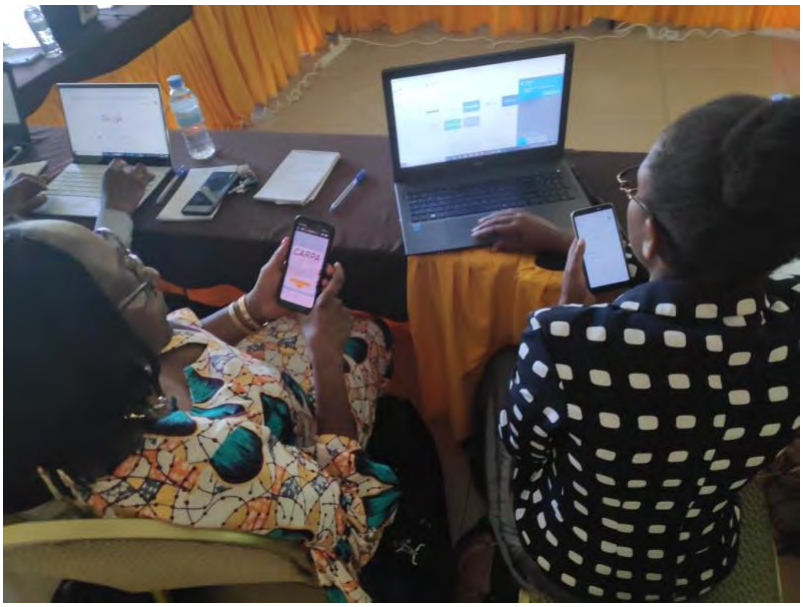


Figure 5: Digitally skilled people in the CARPA workshop.

c. Supporting Commercialization of Non-timber Forest Products by Women farmers/entrepreneurs in Burkina Faso - February 2022

About Non-timber forest products

Non-timber forest products (NTFPs) can be defined as "any good of biological origin (other than wood and wildlife except insects), derived from forests and trees, except those made up of spontaneous, domesticated plants, and those intended for reforestation. They include leaves, flowers, fruits, bark, non-lignified stems, sap, latex, essential oils, gum, resins, fungi, honey, insects". NTFPs are of great importance for rural development for various reasons: nutritional, environmental, economic, and because they play a role in women's empowerment.

Figure 6: Small informal bio boutique in Réo, Burkina Faso, where NTFP are sold.

NTFPs and the rural economy

For many very low-income populations, forest products are one of the options to reduce their socio-economic vulnerability. The challenge is to establish a sustainable market for NTFPs, whose customers are in Burkinabè society. The nutritional value of NTFPs must be recognised, as well as all the other benefits. Currently people prefer imported products to local ones. Raising awareness among the local population is relevant.

In most economic and rural development support projects, export is seen as a major objective. It is true that shea butter is increasingly seen as a valuable cosmetic product on international markets. However, the dependence on large international companies as the only customers makes this emerging business activity vulnerable. There is still a need to sell for the local market, to develop this market and to market locally by targeting local customers. This will be more sustainable in the long term and make the market less volatile and less subject to fluctuations caused by external actors.

Figure 7: Context and problem analysis about NTFP, by women farmers, during a collaborative workshop, February 2022.

THE NUTRITIONAL VALUE OF NTFPS

The importance of edible NTFPs in enhancing food and nutrition security in West African countries is widely recognized. According to Sawadogo (2010) NTFPs are consumed in 43% of households in Burkina Faso. NTFPs are recognized as a valuable source of supplementary food for the rural population, particularly during the lean season. Edible NTFPs are rich in provitamin A and mineral elements such as iron, zinc, magnesium, which would otherwise be lacking in the diet of pregnant women and young children in rural areas.

Figure 8: The NTFP products exposed during a workshop: oil, seeds, nuts, herbs, soap.

NTFPS, REGREENING AND THE ENVIRONMENT

The growing interest in NTFPs is also giving a new impetus to tree protection. Several studies by Reij et al, Sendzimir et al [1,2] have already highlighted the urgency of regreening rural areas in Sahelian countries. Trees and agroforestry systems bring multiple benefits to rural populations. Trees on cultivated fields have a considerable

impact on agricultural production, improving soil fertility and percolation capacity, and producing fodder for livestock. In general, trees increase farmers' yields, enabling them to cope with periods of drought. Tree protection and management provides an affordable solution for farmers to intensify and diversify their rural production systems [4]. The production, processing and marketing of NTFPs represents a sustainable economic activity, which does not compromise the environment, but rather promotes the protection and sustainable use of trees on agro-ecological land.

Figure: 9 :A field of a group of women. They have re-greened 6 hectares of previously degraded land.

WOMEN'S EMPOWERMENT THROUGH NTFPS

Women benefit greatly from NTFPs. Through the production, processing and marketing of NTFPs. Women are self-organizing in groups, which gives them more autonomy. Together they are better able to communicate and link with other women's groups, and exchange knowledge in field visits, fairs, sales events etc. Working in groups and sharing knowledge gives them new opportunities for division of labor, marketing, community awareness, etc. Meanwhile, women farmers are doing a great job of "greening" their fields with the protection and management of woody species and spontaneous regeneration, without the need for expensive inputs. NTFPs are increasingly giving women some income to better support their families. In the meantime, women's NTFP groups are becoming increasingly important in their advocacy work for the protection of trees and biodiversity.

Figure 10: Interview of Francine Sawadogo by the journalist from Radio l'espoir La Voix du Sanguié on 9 Feb 2022.

THE CHALLENGES

Women NTFP producers are not yet recognised by many policy makers, and NTFPs are not yet known for their multiple benefits and great potential for the environment, biodiversity, local economy, and food and nutritional value. Currently, awareness of the nutritional and commercial benefits of NTFPs among the rural and urban population in Burkina Faso is very high. In the meantime, advocacy at the national and also international level on the benefits of NTFPs for biodiversity and the rural economy is essential.

HOW TO INTENSIFY COMMUNICATION WITH NEW/OLD VOICE-BASED ICT SERVICES

In discussions with women producers during our workshop in Reo, it was perceived that the use of ICTs has also started in rural areas. A quarter of the women here have a smartphone and use Whatsapp to communicate with their customers. The use is still a bit limited, but it will spread. The digital, telecom network is expanding more and more in the country and also in the rural areas. Despite the relatively high price for a 4G internet connection, especially for people in rural areas, the benefits of communication for marketing are considerable.

ABOUT THE KNOWLEDGE SHARING WORKSHOP AND LOCAL CONTEXT ANALYSIS

A workshop in the framework of W4RA's action research and supported by Nuffic in the Orange Knowledge Program, of the Dutch Ministry of Education, took place from 7 to 11 February 2022 in Réo, Sanguié province, Burkina Faso.

Figure 11: Workshop by VU team, Reseau MARP and the women producers of NTFP

The site chosen by Réseau MARP for this workshop was the UGF/CDN: Union des Groupement Féminins Ce Dwayne Nyee (L'Union fait la force). This is a cooperative of women who produce shea butter. The UGF/CDN is certified organic and produced for the outside world. They have only one or two major clients in the cosmetics industry in France and the Netherlands. The French company Occitane is their biggest customer. This union is unique in Burkina. It produces 150-200 tonnes of shea butter per year. 10% is for local consumption, 90% for export. The union provides work for 6914 women.

The majority of women's groups in our workshop produce small quantities for local consumption. The women in our workshop are presidents of small groups. They are confronted with the problem of (mis)sales. The challenges are in processing, marketing, organization and market access.

In our workshop the aim of this first meeting is to analyze the context and together try to find solutions for the communication and marketing of NTFPs. Community/local radio, local cyberspace and small digital training enterprises are ideas to support local awareness.
For communication and awareness raising at national and international level, one could look for other means such as a website, a Knowledge Graph connecting knowledge on non-timber forest products.

Figure 12: Group work brainstorm sessions and their outcomes during the workshop.

Read the interviews made on 10 February and broadcast on the Radio.

Possible project ideas: use radio/web and mobile for dissemination of information about NTFP; use mobile phones to sell NTFP, design/build a system to create awareness about the nutritional value of NTFP; make an information system to collect or share best practices about the use of NTFP.

d. Facilitating Knowledge Sharing between producers of Artemisia seeds, to treat malaria in Mali - February 2022

Malaria is a primary cause of morbidity and mortality in West Africa. In Mali, an estimated 7,2 million malaria cases in 2020 and over 19.300 death cases were reported by the WHO, in a population of 20 million. The costs of conventional Malaria drugs, (produced by the pharmaceutical industry) are quite high for many people in a country with an average income of 2 dollars a day. High cost prevents treatment and increases mortality. Fortunately, a low cost solution for malaria treatment has been introduced in Mali, recently: *Artemisia annual* and *afra*, adopted from Chinese traditional medicine. Artemisia has the advantage that it can be easily produced by smallholder farmers in Mali, at low production cost. Artemisia as a new trade product can provide smallholder farmers with a better income. And Artemisia has been scientifically proven to be an effective and affordable treatment against malaria and bilharzia.

Figure 13: Artimisia sold in bags.

Together with 30 Malian farmers – both men and women – the W4RA team of VU, together with Malian farmer organization AOPP (Wendelien Tuijp and André Baart) visited the field of farmer Mr. Baya Siaka, in February 2022. Baya has been producing and selling seeds for Artemisia. Baya Siaka is a representative of the Maison d'Artemisia. During the collaborative workshop, participants exchanged knowledge and learned how to improve Artemisia production.

Figure 14: Farmer-to-farmer visit during AOPP-VU project workshop, February 2022.

The interest to grow Artemisia is big among farmers. Farmer-to-farmer visits are very useful to exchange knowledge, to observe the fields and talk about the contextual issues of growing and selling Artemesia. However, these visits

are costly and not scalable to many people. To share knowledge, best practices and tips and tricks about Artemisia, a mobile/radio based platform could be designed and possibly hosted e.g. at the farmer organization AOPP.

Figure 15: Some farmers are already using smartphones, but this is still a minority in rural Mali.

To analyze and elaborate on this use case you can contact a content expert at VU. Ask your lecturers how you can arrange an expert interview. See also https://w4ra.org/2022/03/13/aopp-vu-collaboration-malian-farmers-producing-seeds-for-malaria-treatment/

Possible project ideas: use radio/mobile for knowledge exchange between producers and buyers of Artemisia. Provide an information system how to use Artemisia in case of malaria.

e. VOICE-BASED PARTICIPATORY GUARANTEE SYSTEMS IN RURAL MALI - OCTOBER 2021

Participatory guarantee systems are locally focused quality assurance systems, also sometimes called Community Certification systems. They are commonly used in the organic sector, for biologically/ecologically grown crops. They certify producers on active participation of stakeholders and are built on a foundation of trust, social networks (not necessarily digital) and knowledge exchange.

In Mali a small, local non-governmental organization NGO called AMSD (*Association Malienne Pour la Solidarité et le Développement*) aims to support smallholder farmers in Mali to produce according to environment-friendly and participatory principles.

To do so, they have set up a community-based process of certification. This is done to certify the quality of the produce, making sure that the principles have been applied throughout the farming process.

At this moment the process of certifying is done in community gatherings, in which farmers vote and express their trust in a certain produce. One of the plans of the AMSD is to facilitate the process by adding a digital (voice-based) functionality to the process, in which the results/and or the statistics of the certification process can be stored and accessed. Project ideas: a mobile voice-based system for community certification.

Figure 16: A community of farmers and domain experts in Réo, Burkina Faso, May 2022

f. IMPROVING CEREAL SEED SYSTEMS IN RURAL MALI - 2016-2021

Founded in 1993, AOPP is a large farmer association in Mali: *Association des Organisations Paysannes Professionnelles*. The work of AOPP consists of support and representation of 250 farmer organizations all over the country. The work of AOPP reaches about 3 million people, mainly in poor rural regions of Mali. One of the concerns of AOPP is about cereal seeds.

Seed systems contribute to annual growth of the agricultural-sector (AOPP estimates this as a contribution of 30-40% of the growth). For smallholder farmers and family farms (about 70% of the population) and the restoration of degraded parklands and landscapes, a growing demand for quality seeds and seedlings opens opportunities for entrepreneurship, notably for women and youth.

Figure 17: Focus group discussion in Sibi with seed producers, April 2019. Cereal and food tree seed systems are important contributors to food and nutrition security in Mali -- particularly in the light of climate change, severe droughts following inadequate and erratic rainfall, widespread land degradation and a fast-growing population.

In Mali's drylands, combining trees with the cultivation of cereals, is central to the improvement of crop yields, the sustainable management of land and the restoration and maintenance of healthy landscapes. Trees integrated into farm landscapes provide a cornucopia of goods and services, including sustaining a green cover on the land throughout the year, replenishing soil fertility through the bolstering of nutrients available to crops and cycling nutrients up from deep soil layers, and replenishing soil organic matter through their leaf and twig litter. Trees are essential to improve crop yields -their roots boost the soil ability to absorb and retain water. They slow strong winds and shade hot sunlight, boosting cereals and other crops still further. Intercropped food trees (such as baobab and shea butter tree) produce food with high nutritional value (fruits, nuts, honey, vegetables, oils) fuelwood, fiber, fodder and medicine In the light of climate change and soil degradation, a systemic, integrated agroforestry approach is promoted (as one of the CGIAR's CRPs: FTA) for improved food and nutrition security in Mali. To this

end, access to, and knowledge about quality seeds, seedlings and the management of high quality tree propagation materials, in combination with quality seeds for cereal crops (millet, sorghum, maize, rice) is crucial for smallholder farmers and family farms in Mali's drylands.

Despite the opportunities, seed and seedlings systems can be largely improved to serve the local farmers' needs.. Lack of knowledge and information on food tree seeds systems still hampers local agroforestry crop yields and holds back proper management of seeds. Lack of access to value chains holds back farmers' entrepreneurship and adoption of quality seeds, due to difficulties in accessing markets, certification agents, packaging and transporting agents. This is exacerbated by a lack of communication channels with the least connected/ most vulnerable groups, (due to lack of internet, diversity of local languages and low literacy -- especially the rural female population). With the support of several donor agencies, AOPP has developed a website in which customers can order seeds from cooperatives, see link http://www.agro-mali.com/

A problem is that many smallholder farmers do not have internet, or do not have literacy skills, or do not speak English or French, (only the local languages Bambara, Peul or Bomu etc). AOPP requested VU to develop several applications to support farmers in their commercialization of seeds. Farmers can be buyers but also sellers of seeds, so information on seeds is crucial for them:

1. They want to know what to plant, what is of high demand this year? What should he/she plan to do?
2. They want to know prices of hybrid seeds
3. They want to sell their own seeds but cannot find customers.
4. They want to report their crops to the certification agency: what is the size of production this year in kg.
5. They want to report ongoing sales

If you select the use case on seeds, it is advised to do a use case analysis interview with Anna Bon, Hans Akkermans or André Baart. They can give you more information about the seed use case. There are various options to tackle. Please make an appointment for a full interview.

Figure 18a *Cooprosem* is the seed producing cooperative, a member of AOPP.

Figure 18b: (source Wikipedia https://fr.wikipedia.org/wiki/Semence_(agriculture)) Different types of seeds.

Use case ideas on seeds:

Build a voice-based information system in French and another language (e.g. Bambara or start with Dutch to test how this works), in which farmers can retrieve information where to buy seeds. You can use this website to have inspiration on the type of seeds requested. http://www.agro-mali.com/

Build a voice-based application where farmers can report the type of seeds, the amount and price. Assume that they have only three seed types available (e.g. rice, cotton, sorghum), for the sake of simplicity.

Build a web/voice application in which a farmer can announce which seeds he has for sale. The information is processed into a voice-message that can be downloaded or retrieved via a phone number.

Build an application which is a marketplace for local (traditional)seeds. These seeds do not have a price in currency but are exchanged against other seeds. The traditional seeds are typically sorgho, millet, petit mil, fonio etc. Create a solution that allows users to enter and retrieve voice-based information, leave a message, reply on a message, broadcast a voice-message to a group.

g. IMPROVING CERTIFICATION PROCESS OF CEREAL SEEDS IN MALI - OCTOBER 2021

The AOPP farmer umbrella organization in Mali aims to improve the efficiency of the seed certification process of cereal seeds between the national certification laboratory and the seed producing farmers in the country.

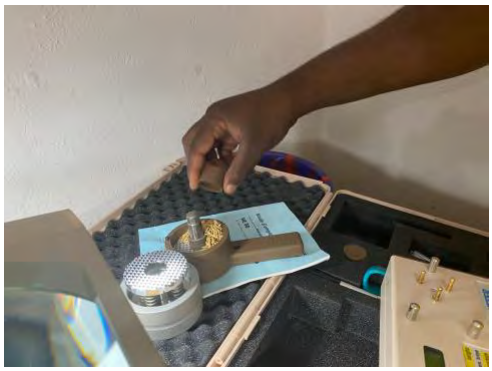


Figure 19A left: M. Dramane Diabate showing two types of maize. The white one is from a certified seed type.Figure 19 B right: Certification is based on the analysis carried out at the LaboSem national laboratory in Mali.

The production and commercialization of the above mentioned seed systems has two instances, one group of farmers grows "certifiable seeds' '. the other, larger group produces "peasant seeds". The latter are traditionally exchanged/not sold. They are nowadays considered agro- ecological.

Figure 20a: The certification papers are glued to the bags before sales starts. 20b: rice sample being analyzed.

The certifiable seeds are produced according to strict rules and regulations, issued by the Malian government. According to the Malian law, all seeds need a certificate of purity and quality. This certificate is issued by the national laboratory Labosem, in Bamako. Farmers must send a sample of each of their plots/crops to the Labosem. These are analyzed on purity/germination and other characteristics/criteria. When the certification is achieved, the certificate is printed by Labosem, on paper and sent back to the farmer. With this certificate, the farmer can start the sales. However, the regular mail in Mali is very slow and often unreliable. Certificates are often lost. One of the use cases

discussed with the director of Labosem was the possibility that farmers could have a voice- and web interface to a system that gives access to the certificate. Authorization must prevent you from seeing anything other than your own certificate.

h. TREES IN MALI, IN DANGER OF EXTINCTION: REGREENING INITIATIVES

At this moment, in West Africa, many trees are being cut in the fields. Some trees are even at danger of extinction. Some trees grow very slowly and give seeds only after many years. An NGO in Mali, Tree Aid, wants to inform farmers in the field about the need to protect trees, and also to make a collection of the seeds for these trees. The problem is, where are the trees left that still have seeds?

Figure 21: “Guéni” tree

A west African tree: Pterocarpus erinaceus : in the local Malian language this tree is called “Guéni”.Source of picture: https://commons.wikimedia.org/wiki/File:B%C3%A9nin-Pterocarpus_erinaceus.jpg

One way is to work with local radio stations and make voice-based communiques that they can broadcast. Another way is to request farmers to report the trees they have on their fields. The trees currently in danger are:

- Pterocarpus erinaceus (en Bambara Guéni)
- Terminalia habeensis (en Bambara Wôlo)
- Afzelia Africana (en Bambara Lengué)
- Khaya senegalensis (en Bambara Djala)
- Dalbergia melanoxylon (en Bambara Djènè Yiri)

The key user of this use case is Amadou Tangara, country manager of Tree Aid in Bamako. The key-idea would be to have an application based on voice/local language that can help to restore and protect biodiversity in Africa. Involve radio to make people aware of the importance, and call to geo-localize or report the location of the still existing trees, through a voice-interface.

i. BIP VOTE: AN INTERACTIVE RADIO VOTING SYSTEM FOR RADIOS IN RURAL MALI - 2012 - 2021

Logo designed by *Hans-Dieter Hiep, Roy Overbeek & Paweł Ulita*

This use case is modified and adapted after a student project by Hans-Dieter Hiep, Roy Overbeek & Paweł Ulita (also designers of the logo), 2018. The key user is Adama Tessougué, radio journalist in Konobougou, Mali.

This use case describes a request from radio stations in Mali who want to make "interactive radio programs". In short: during a popular radio program they pose for example a yes/no question to the radio listeners, for example: "*do you think trees on farmland are better than clearing the land before sowing*?" Farmers who listen to the program can phone ("beep" or "bip" *en français*) to the radio to leave a "yes" or "no". They dial a number for "yes" and another number for "no". They hang up before answering, to avoid costs of a call. The radio journalist wants to count the number of "yes" and "no" voters during the program. We assume there is no internet in the regions where the farmers live, and the farmers only have simple GSM phones.

Figure 22: Radio journalist Adama Tessougué, from Radio Sikidolo in Konobougou, interviewing a farmer in the field.

Radio is, among all other ICTs, the most deployed in Mali. Calling or texting is too expensive for the listeners, and (female) listeners may be illiterate. For this reason, listeners presently send a bip to a phone number representing their feedback. A bip is a call that is canceled before the recipient picks up: it is free of charge. Radio hosts in Mali often want to ask listeners for feedback on a radio session. For instance, they might want to know whether the listeners understood the information that was shared.

When the voting period is over, radio hosts manually count and deduplicate the missed calls to register the results of the voting. The purpose of the envisaged application is to do this automatically. Moreover, radio hosts should be able to manage votes through a voice-based application, since computer literacy might be low.

There are two groups of actors in this use case. The actors are organizers of the voting, and the voting participants. The goal of the organizers is to let the participants take part in the voting in a cheap (even free), easy, and reliable way. The participants, on the other hand, want to be able to take part in such a voting without worrying about the costs or whether their vote is counted. The responsibilities of the organizers are: preparing the system for voting (setting a start date), broadcasting the voting phone numbers, shutting down the voting (setting an end date), and retrieving the vote counts. The participants have to find out what the voting numbers are, and make at least one bip to at least one voting number. The radio wants to know the number of incoming vote bips, per voting option.

Web interface: BipVote is accessible through a web interface for the radio journalist, who wants to count the incoming bips.

j. METEO – RAIN DATA AND RAIN PREDICTION FOR FARMERS IN THE SAHEL

By Chris van Aart, Jari Ferguson, Anna Bon, Victor de Boer, Francis Dittoh

Context analysis

Agriculture in West Africa is mainly rain-fed. In the Sahel zone in Burkina Faso and Mali the rainy season extends from June to October while the dry season from November to April. Cropping and harvesting is done during the rainy season. Meteorological information is of great importance for farmers in Burkina Faso. For farmers, obtaining daily information on the amount of fallen rain is important to plan cropping calendars.

Local NGO Réseau MARP is concerned about the effects of climate change for farmers, and explains that in recent years (1991-2009) rains have become more erratic and less predictable. Heavy rains and floods in various regions which have caused casualties and soil erosion.

In January, April and July 2014 the W4RA team held various focus group discussions with farmers- innovators from the Zondoma and Yatenga regions in Burkina Faso. They also talked with local radio stations “La voix du paysan”, Radio Solidarité, Radio Notre Dame du Sahel, Radio Savanne and a few others. The radios often broadcast information on rainfall for the local communities.

Figure 23a: Visit to the fields of farmer innovator Ousséni Kindo. From left to right: Ousséni Kindo, Julien Ouedraogo (Réseau MARP), Wendelien Tuyp, Anna Bon, Hans Akkermans (VUA), Francis Dittoh (University of Development Studies, Ghana)

NEEDS ASSESSMENT IN GHANA - APRIL 2015

In 2014 and 2015 the W4RA team held a workshop with researchers from the University for Development Studies in Ghana – Walewale. Jointly a visit was made to the Guabuliga community.The following text as part of a field trip report was written from the meeting between the villagers of Guabuliga and the UDS/W4RA teams about weather and climate:

What do you see as the important challenges for farmers related to climate and weather?

The main challenges are erratic, unpredictable rainfalls, low soil fertility (tired soil) and excessive sunshine.

How do you try to address these problems?

We leave crop residue on our farms and then plough them back into the soil during the farming season to improve the soil moisture. We use stone bunds to direct the flow of run-off water, and apply contour plowing. We use manure and compost to improve soil fertility. We make sheds to minimize the consequences of excessive sunshine and rain water for vegetable nurseries, where we grow e.g. pepper and tomatoes.

What kind of weather information would be helpful to address this?

Daily rainfall forecasts would be useful. Information on rainfall duration in the rainy season – to help farmers in making planning decisions which types of crops to sow/plant, where and when. Information on the severity of wind and its direction is highly needed to help farmers prepare in advance, e.g. reinforcing house roofs, planting trees to serve as windbreaks.

Figure 23b: Field visit – focus group discussion Guabuliga, lead by researchers from the University for Development Studies in Ghana, December 2014.

NEEDS ASSESSMENT/FIELD VISIT IN GOURCY, ZONDOMA REGION BURKINA FASO 21-24 JUNE 2016

By Anna Bon, Wendelien Tuyp, Hans Akkermans, Francis Dittoh in collaboration with Réseau MARP

TMT-BF group work sessions flipover results atelier Gourcy, Burkina Faso, 21-22 June 2016
Day 1, 21Jun2016, on meteo data collection projects going on
Day 2, 22Jun2016, on meteo information needs and possible applications

Group I:
Members: Zoromé Ousseini, Naba Tigré, Kindo Rasmane, Dango Alfred, Ouédrago Ismael, Gnanou Adama, Sinaré Adama, Haro Illiassa

Day 1

- Project going on with INERA and Direction Generale Meteorologique
- Bulletin with data emailed around by meteo directorate
- From this, twice a week radio broadcast (La voix du paysan) containing meteo info and including advice for farmers

- Difficulties: (1) not enough rain gauges in the field; (2) phone network weak (3) internet weak (4) not enough radio receivers in homes (so many families cannot listen to radio); (4) info broadcast based on administrative regions rather than real geographic regions; (5) radios complain about the costs for them
- Solutions: (1) give farmers rain gauges and radios; (2) improve network connections / choose a good network; (4) make farmers aware of the admin regions issues; (5) revise tariff/cost structure for radios.

Day 2:
- Want to have weekly and daily weather forecasts in the rainy season, for example when it will start and end; want meteo alerts, and want to have accumulated rain data per week (mm, cm)
- Channel preferred: (1) mobile (2) radio
- Like to receive the info daily and weekly
- Why of interest: forecast for season helps to know which seeds to use on what locations and in what period; daily info allows to plan the daily operations
- What is missing: (1) radio as well as meteo orgs have no or weak internet; (2) not enough training in meteo domain for radio people; (3) meteo org understaffed; (4) not all farmers have radio

Group II:
Members: Zoungrana Nicodème, Ouedraogo Issaka, Yameogo Daouda, Ouédraogo Aimée, Gansonie Idrissa, Kindo Ousseini

Day 1:
- Project going on of RM: actual rain data collected in villages (pluviometry via rain gauges), then aggregated centrally at commune level, then aggregated centrally to RM, then from there sent to Radio Savane that distributes this weekly on Friday 08.00h
- There is said to feedback from the population to Radio Savane
- The same info is sent also every 10 days to the province level (the northern region, to DRAAH) and the rain info from Gourcy and Tayo is also sent to the national meteo service Direction Generale Meteorologique (DGM)
- Several meteo stations also send their info to the DGM
- DGM sends around an email bulletin to a mailing list (unspecified, but includes Radio Voix du Paysan) and do short radio and tv broadcasts
- Difficulties: (1) telephone network weak; (2) poor coordination of all the info streams; (3) sustainability of the system is questionable
- Solutions: -

Day 2:
- Want to have: (1) rain forecast; (2) forecast of wind; (3) forecast of the sun intensity; (4) number of rains that have fallen
- Channel preferred: (1) mobile (2) radio
- Frequency: (1) weekly; (2) every 3 days; (3) every day (4) every month
- Why: for cropping calendar; the choice of which variety of seeds (e.g. early or late ones); knowing about wind helps to avoid crop diseases; sun intensity is a factor in crop growth; accumulated rain data helps forecast on productivity

Group III:
Members: Ouedraogo Oumarou, Sankara Hamidou, Sawadogo Oumarou, Ouedraogo N. Julien, Tinta Salifou

Day 1:
- Actual rain data collected in villages, then aggregated centrally at commune level, then sent by mobile phone to resource persons, then it goes to the radio by mobile (and apparently broadcast)
- Diffusion of information gives an idea locally of the evolution of the rainy season; it allows farmers to take decisions e.g. on seeding; gives also flooding alerts

- Farmers are already collecting rain data for 20 years; 33 rains is a good year; 4 rains or more in June is a trigger to start seeding and will give a good harvest
- Difficulties: (1) poor mobile network; (2) farmers do not have rain gauges and do not know how to use them; (3) there is not a formal organized system in place to diffuse the info

Day 2:

- Want to have (1) rain forecasts every 3 days; (2) rain fallen (in mm); (3) strong winds
- Channel preferred: (1) mobile (2) radio [Note: costs]
- Frequency: every 3 days
- Why? (1) helps plan cropping calendar; (2) prepare yourself for strong winds
- Missing: (1) info not available in the right language

Figures 24 and 25: Presentation of farmers after needs assessment workshop, June 2016. This information is what the farmers innovators from the Yatenga area would like to access via their mobile phones. Workshop about meteo with farmers and Wendelien from the W4RA team.

A workshop was done by the W4RA team in June 2016 in Gourcy with a group of farmers-innovators, staff from the Burkina Faso meteorological service and by a number of local radio journalists. The aim was to brainstorm about a good system to access meteo information for the farmers. The outcomes were surprising: the farmers want to have the information voice-based in Mooré accessible by phone. The relevant information is: (reliable) rain forecast for the day, next few days, and cumulative rainfall in cm during the rainy season.

Figure 26: Manual rain gauge and rain data collection by farmer in Burkina Faso

Field visit with the whole group on 23 June 20166 to the field of Oumarou Ouedraogo near Gourcy (longitude-2.25889919 ,latitude 13.26655021): Oumarou has a rain gauge and collects the amount of rain after every rain, and writes this down in his field log. He informs the neighboring villagers by phone. The amount of rain is relevant. E.g. in June, the cropping season starts as soon as 20 cm of rain has fallen (cumulatively).

During the field visit farmers exchange ideas and experiences. Zoromé and Ousseyni Kindo criticize Oumarou's application of the zaï method : the distance between the hole centers should be 80 cm and 40 cm between the whole, but here the holes are apparently closer to each other. Oumarou replies that his children have dug these holes for him.

Oumarou has 4 hectares of sandy fields. Only one hectare is being cultivated. He would need 25 carts of manure but he can currently only afford to buy 11 carts. The stone bunds have considerably reduced surface water run-off. This can still be further improved according to the other visiting farmer-innovators Ousséni Kindo and Ousséni Zoromé. Zoromé suggests to better protect the upcoming sprouts (this is called farmer-managed natural regeneration).

After Oumarou's field we walk over to Arouna's field. He is a young successful farmers with a few women and many children.

-2.23860785,13.29993367 are the coordinates of the place called Minima Durga, which still did not appear on any (Google, OpenStreet map).

Those who are not in the Ramadan now, share a nice lunch with sardines. Anna and Francis visit a small shop to rechange your phone. There is no electricity in the village, but this young entrepreneur has bought a solar panel to offer mobile recharge (investment costs 30.000 fcfa = 45 EUR).

2016 Burkina Faso Réseau Marp – indigenous knowledge on rainfall

Réseau MARP has recently done a workshop on indigenous knowledge. Farmers often use indigenous knowledge to predict the start of the rainy season, or the quality of the expected season by the observation of certain birds, flowers and often a combination of signs. This will be further elaborated in the next workshops in 2017.

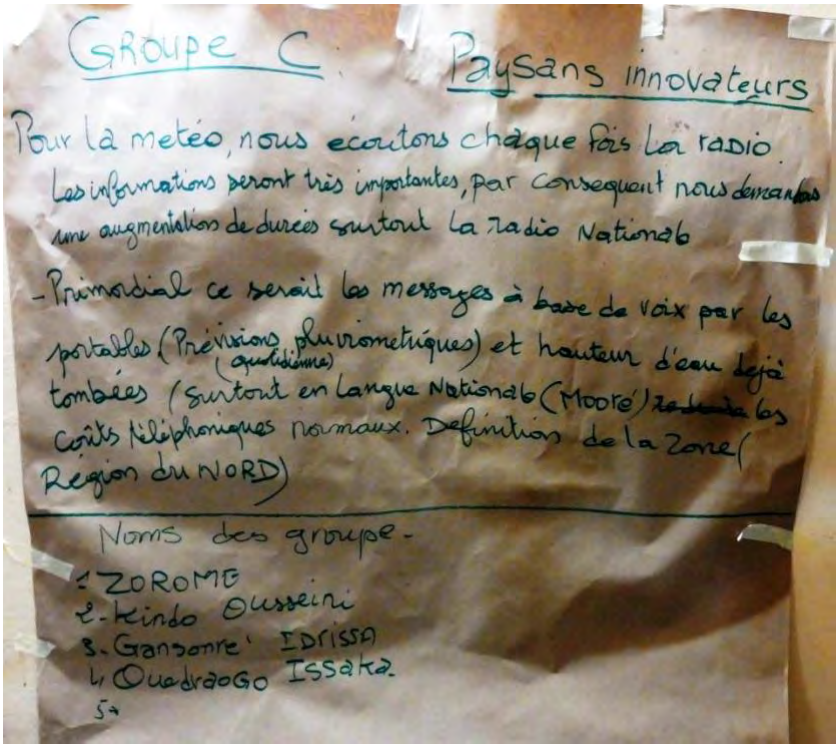


Figure 27: Group C needs assessment by group of farmers

At the end of the workshop (24 June 2016) the following observations are made by the group: The following partners/data are needed to build and deploy the system :

- Global data and local data integration (internet) service météo burkinabe (DGM, INERA) Réseau Marp, donnée locaux au niveau des communes etc.
- Collaboration with VU-Réseau MARP for the recording of speech/dialogues in Mooré for the application
- Developers at VU/2Coolmonkeys design/build a new prototype based on the requirements of this workshop
- *Key users* : farmers, radios, for the evaluation of the systems during their développement.
- Business/technical partners : local technical/ICT/radio people, entrepreneurs (radios, NGOs, entreprise TICs)
- Lobbying at national level to raise awareness of the need for accurate/localized/timely local rain data. This can be done by Réseau MARP

USE CASE AND REQUIREMENTS ANALYSIS

By Chris van Aart, Julien Ouedraogo, Anna Bon, Francis Dittoh, Wendelien Tuyp. Use case 1 Système d'Alerte Précoce (SAP) Réseau MARP

Name of the weather application as suggested during the workshops: Saas Kibaya in Mooré (Burkina Faso)

Summary of key idea:

Use case 1: manual field meteo data collection by a group of farmers who have rain gauges. They have been trained in 2013 (see picture) how to collect the data (manually) and send this data by SMS text messaging to Julien

Figure 28: the meteo data collecting farmers, by key user: Julien Ouedragogo

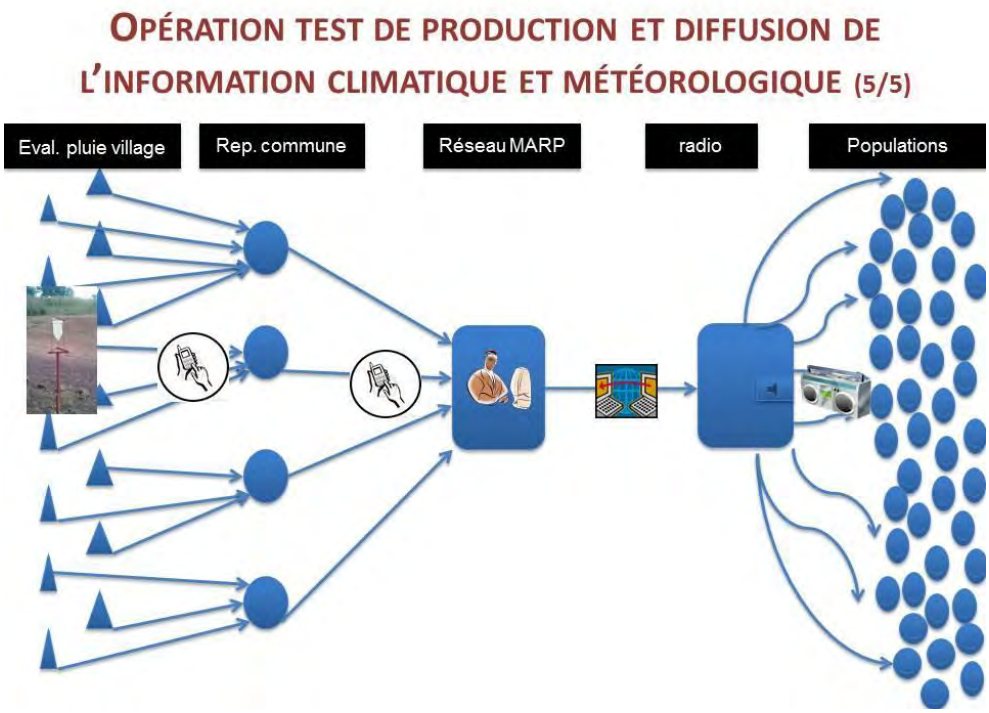
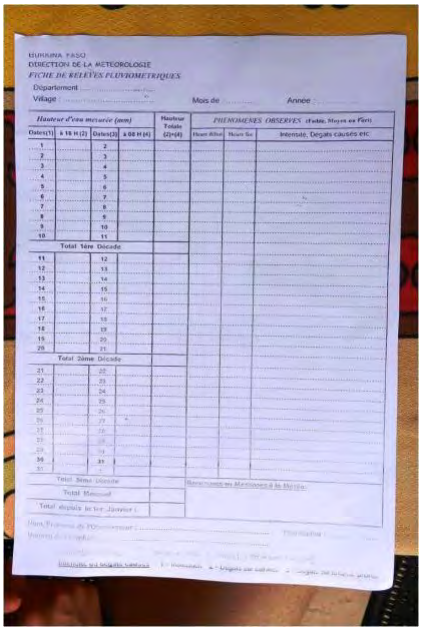


Figure 29 : Model of the (legacy/paper based system) use case to collect and broadcast local rain data.

Villages concernés	Totaux août	Totaux septembre	Totaux octobre	Totaux des totaux des 3 mois
Guiri-guiri	247 mm	183 mm	11 mm	441 mm
Saye	186 mm	222 mm	43 mm	451 mm
Lintiba	233 mm	181 mm	00 mm	414 mm
Keradouré	111 mm	205 mm	34 mm	350 mm
Ouettigué	153 mm	**229 mm**	25 mm	407 mm
Kindbo	303 mm	161 mm	32 mm	496 mm
Kéléguem	259,5 mm	165 mm	25 mm	449,5 mm
Ridimbo	**382 mm**	154 mm	16 mm	**552 mm**
Bouloulou	75,7 mm	169,3 mm	13 mm	258 mm
Masboré	126,1 mm	163 mm	25 mm	314,1 mm
Minima	181 mm	197 mm	33 mm	411 mm
Gourcy	261 mm	149 mm	00 mm	410 mm

Figure 30: Results from this data collection pilot in 2014 by Réseau MARP and the farmers



Julien Ouedraogo from Réseau MARP explains the legacy system/use case : « Gestion/Collecte/Diffision de l'information pluviométrique locale au Burkina Faso ».

(i) les collecteurs villageois relèvent systématiquement les informations pluviométriques et les transmettent à des points focaux communaux pour centralisation. Les collecteurs villageois jouent également le rôle de diffuseurs de l'information climatique et de conseillers au niveau local. (ii) Chaque point focal transmet les données centralisées à un gestionnaire de l'information au Réseau MARP chaque jeudi avant midi. Le téléphone portable est utilisé comme canal (SMS ou appel). (iii)Le gestionnaire du Réseau MARP transmet l'information synthétisée à Savane FM via le net (ou à défaut par téléphone**).** This legacy system is very time consuming and could be replaced by a more efficient system, e.g. similar to RadioMarché in Mali, which has a similar organization structure/scope.

(ii)

Figure 31 : Paper form used by Reseau MARP's contact persons to write down the data. The data is manually entered into an excel sheet and sent to Radio Savanne by email.

APP/PROTOTYPE 1 METEO AFRIQUE

Meteo Afrique/Waati Kunnafoni is the name of a suite of graphical web-based mobile apps developed by W4RA/2CoolMonkeys for meteo services in African countries. The app(s) integrate ***locally collected and global weather data*** and plots it on maps presenting it through a user-friendly, contextualized interface. Waati Kunnafoni/meteo Afrique (the name given to the app by AOPP in Mali) is open source. 2CoolMonkeys designed this web interface as a replacement for Julien's form.

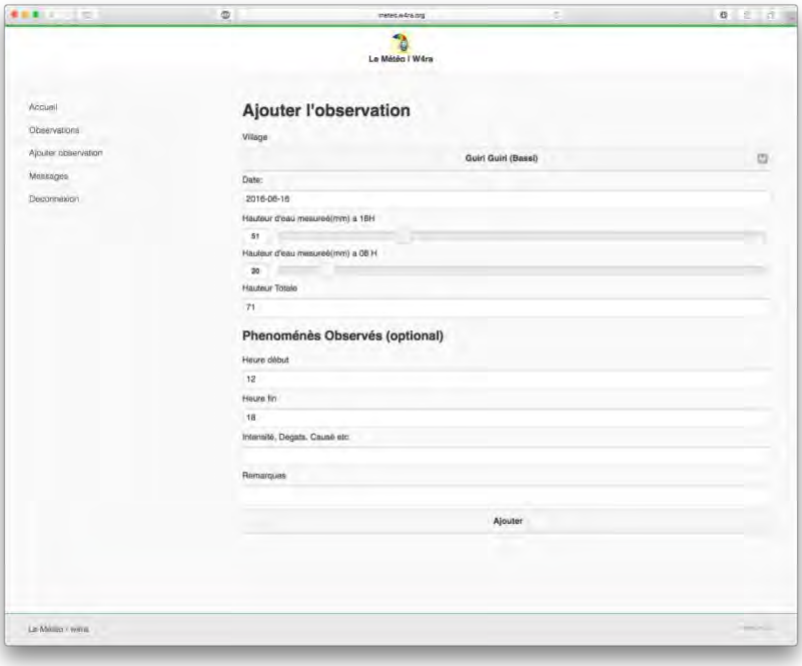


Figure 32: Web form to enter the rain data for Réseau MARP. Farmers from AOPP in Mali and farmers-innovators from Zondoma/Yatenga in Burkina Faso.

Given to AOPP farmers for evaluation.

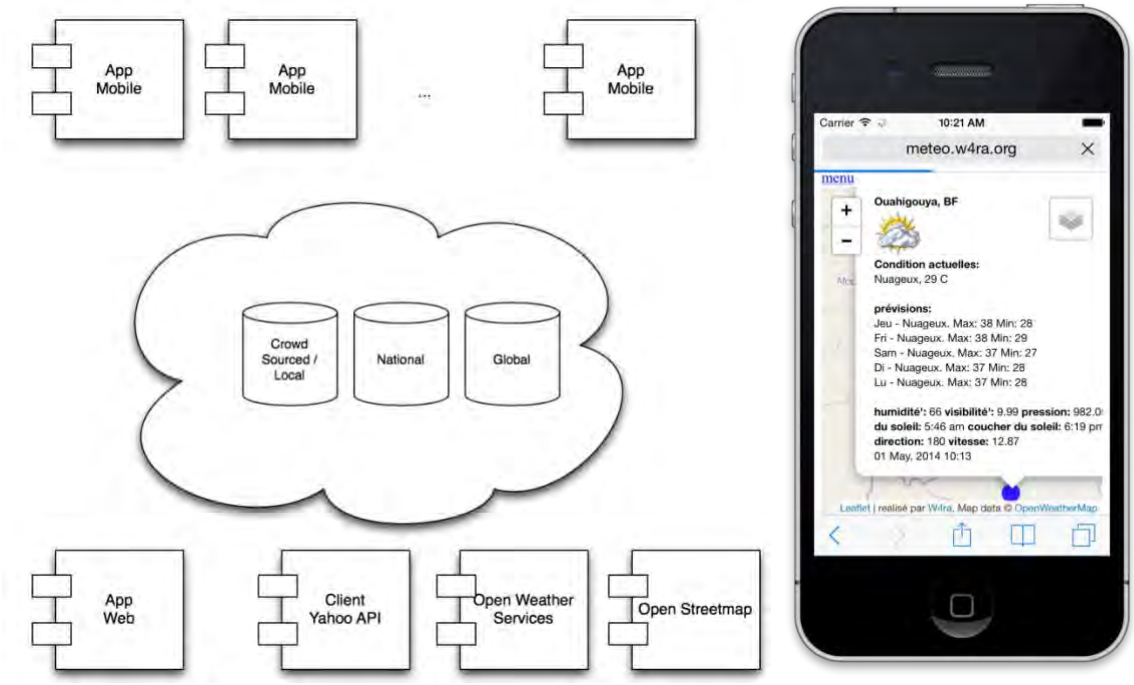


Figure 33: Architecture of Meteo Afrique; Figure 33: Meteo Afrique, a map of Burkina Faso with rain data (Blue dots) which can be expanded by clicking on it.

ANNEX A

EXAMPLES OF USE CASES/CONTEXT ANALYSIS/NEEDS ASSESSMENT AND SOME DESIGN BY ICT4D RESEARCHERS IN THE PERIOD 2011-2024

MALI MILK - IMPROVING THE DAIRY VALUE CHAIN IN MALI WITH INNOVATIVE VOICE-BASED ICTS

By Aske Robenhagen, Victor de Boer and Anna Bon

CONTEXT ANALYSIS

With more than 10 million cattle and 32.7 million sheep and goats, livestock rearing in rural Mali is an important source of food and livelihoods for nomadic and sedentary pastoralists and farmers, and it contributes considerably to rural household production systems. Rural pastoralist organizations and newly formed cooperatives strive to improve the economic position of milk producers at various levels. Where milk was formerly sold by the producers standing with their products along the road, value chains for dairy are gradually improving due to improved local organizations [Hamet Cissé, 2016, Chapon et al 2010].

Figure 34: Poster of the cooperative of milk producers of Ouelessebougou.

Needs assessment by W4RA team in Mali

In January 2011, the W4RA team held a roadshow and several field visits to rural communities and held workshops and focus group discussions with farmers and pastoralists in Mali, including in the capital Bamako, and in the local towns: Segou, Bandiagara, Tominian, Bankass. One of the key ideas that emerged from the discussions about information needs, during the meetings with pastoralists was about the value chain for milk. The match between producers and buyers is difficult to make. For milk the problem is that it is a highly perishable product that cannot be stocked. Moreover, the production varies from a considerable offer in the rainy season to a very small offering during the dry season, when there is not much to graze for the herds.

On 8 May 2016, the W4RA team (Wendelien, Hans, Victor, Anna and Leeuw) visited a small milk cooperative (of local dairy producers) "*Cooperative de producteurs de lait Ouelessebougou*", together with Amadou Tangara and partners from AOPP (Seydou Tangara, Issa Coulibaly and many others who helped to translate between Bambara and French).

This cooperative is a member of the Union of Milk producing cooperatives in Mali. They are a grouping of 514 villages from 3 communes with a total of about 600 milk producers. 1500 liters of milk arrives here per day. The cows do not give much milk as in the Netherlands. 2 - 7 liters is a normal daily production. Normally this milk is collected by hand. A member of the cooperative collects the milk in the villages and brings it to the *laiterie* by motorcycle.

Figure 35: Needs assessment focus group discussion by W4RA team and AOPP at the *Cooperative de producteurs de lait Ouelessebougou, Koulikoro,* Mali 8 May 2016

The milk is tested here, pasteurized and packed for sale with an official certification. Milk can be kept for 4 days after pasteurization (when kept cool). Part of the milk is transformed to yogurt. The milk is sold at 300 fCFA per liter. On the market in Bamako milk is sold at 450 fCFA. Milk has to arrive here within 4 hours after leaving the cow. The temperature has to be between 21 and 35 degrees C during this period, and has to be tested within that temperature range. Conservation of milk is a problem.

The members complain about the value chain. In Bamako milk is sold with milk powder added to it. This is an inferior quality, however, the price is lower and therefore this product represents a competition for the cooperatives. Communication between the producers and the dairy is a problem. Radio and mobile phones are used, but communication could be largely improved.

Formerly, people would collect the milk from the cattle and sell it along the road. This was not profitable at all. Now, the organization into cooperatives of producers, is leading to an emerging value chain for dairy.

A problem is also the fluctuation in milk production: excess milk in the rainy period and shortages or very low production during the dry period. A poor sales network and inadequate refrigeration facilities mean that resellers can only buy a certain quantity. In Mali there is hardly a demand for yogurt or cheese. There is still a long way to go for the milk value chain.

Figure 36: All data in this milk factory is collected on an office wall. No digital data yet, as of 8 May 2016.

USE CASE AND REQUIREMENTS ANALYSIS M-MILK ORDERING & DELIVERY SERVICE– MILK PRODUCERS IN TOMINIAN AND NGO

Current situation: milk sellers often go from door to door to sell milk to potential customers. There is a need for better/faster communication between producers and customers/resellers.

NAME

A characteristic, understandable, and distinctive label for each use case scenario.
Currently the name of the use case is ***Mali Milk*** , but we are waiting for a good local name, e.g. in Bambara.

SUMMARY OF KEY IDEA

What's the key (business) idea and why is it valuable or of interest to consider? (Short abstract)
Customers/resellers phone a certain number and place their order for milk. How much milk they want, their name and delivery address. The orders (in voice messages) are recorded. The milk distributor phones into the voice system and retrieves the messages and (asynchronously) listens to them and then delivers the milk. The NGO/cooperative/hosting org facilitates the service and the website where the order can be retrieved. The milk seller gets a phone-alert when a new milk order is placed.

ACTORS AND GOALS

Who are the actors in the scenario and what are their role/responsibilities and goals? (Can be given in the simple form of a Table).

Actors	*Operational goals*
Hosting organization (ICT business/NGO/Cooperative)	Provide the voice/web service
Milk producer in small village	Find customers/communicate with resellers
Customer/reseller	Easy placing orders by phone

Cooperative	Sell collectively at better price/improve milk value chain in the region for the small producers.

ARCHITECTURE OF THE PROTOTYPE

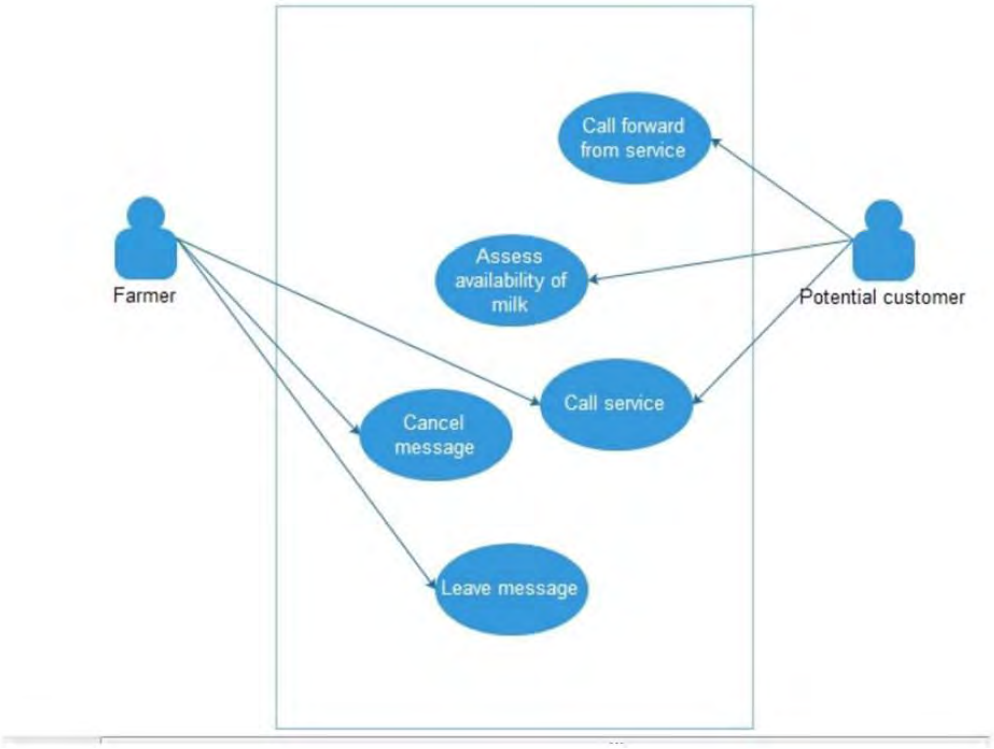


Figure 37: Use case diagram for the Mali Milk prototype.

Use case: Kasadaka Weather Service Mali

by Jari Ferguson 2016

Name Saas Kibaya Burkina Faso (in Mooré “rain information”)/ Kasadaka Weather Service Mali

Logo

Summary of key idea

Farmers want to receive timely and accurate rain data on their phones.

Key idea: Provide farmers in Mali/Burkina Faso with an opportunity to call directly to a weather service, in order to obtain weather forecasts for the area of interest. After the initial deployment, the system should work autonomously. The idea is to assist farmers in deciding when to take action regarding sowing and harvesting of crops. However, this service can be useful to many other businesses that are
dependent on the weather as well.

Actors/goals

Actors	**Operational goals**
Farmers and other users depending on weather information	Learn when the weather is suitable for sowing or harvesting
System owner	Provide a working system
Weather Stations	Provide accurate weather information

Prototype by Jari Ferguson (designed and built during the ICT4D course 2016 based on use case from Mali/Burkina Faso. It is deployed on the Kasadaka, small-hardware server for rural deployment.

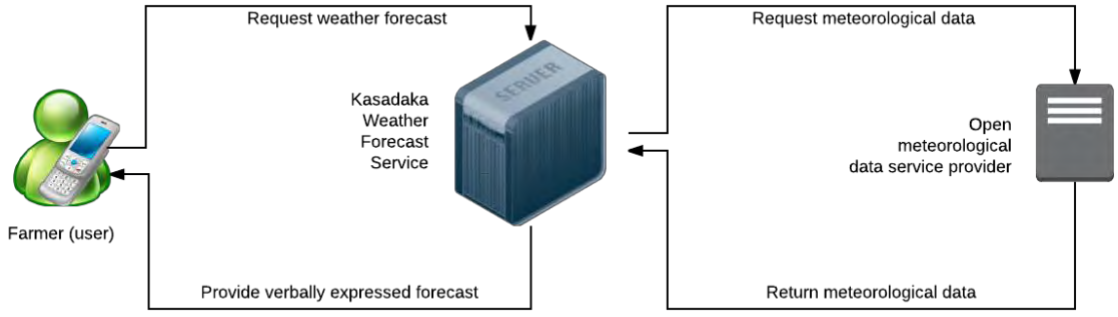


Figure 38: Network configuration of the voice-based meteo app.

Use case scenario

For end-users, such as farmers, using the intended system is straightforward.

1. The end-user calls the number of the service
2. The system offers a choice of languages
3. The end-user selects a language
4. The system offers a selection of regions to choose from
5. The end-user selects a region of interest
6. The system offers a selection of places in the chosen regions
7. The end-user selects a place of interest
8. The system offers the user a number of days (up to five) for the forecasts
9. The end-user selects a number of days
10. The system gives a verbal weather forecast for each day the user has selected

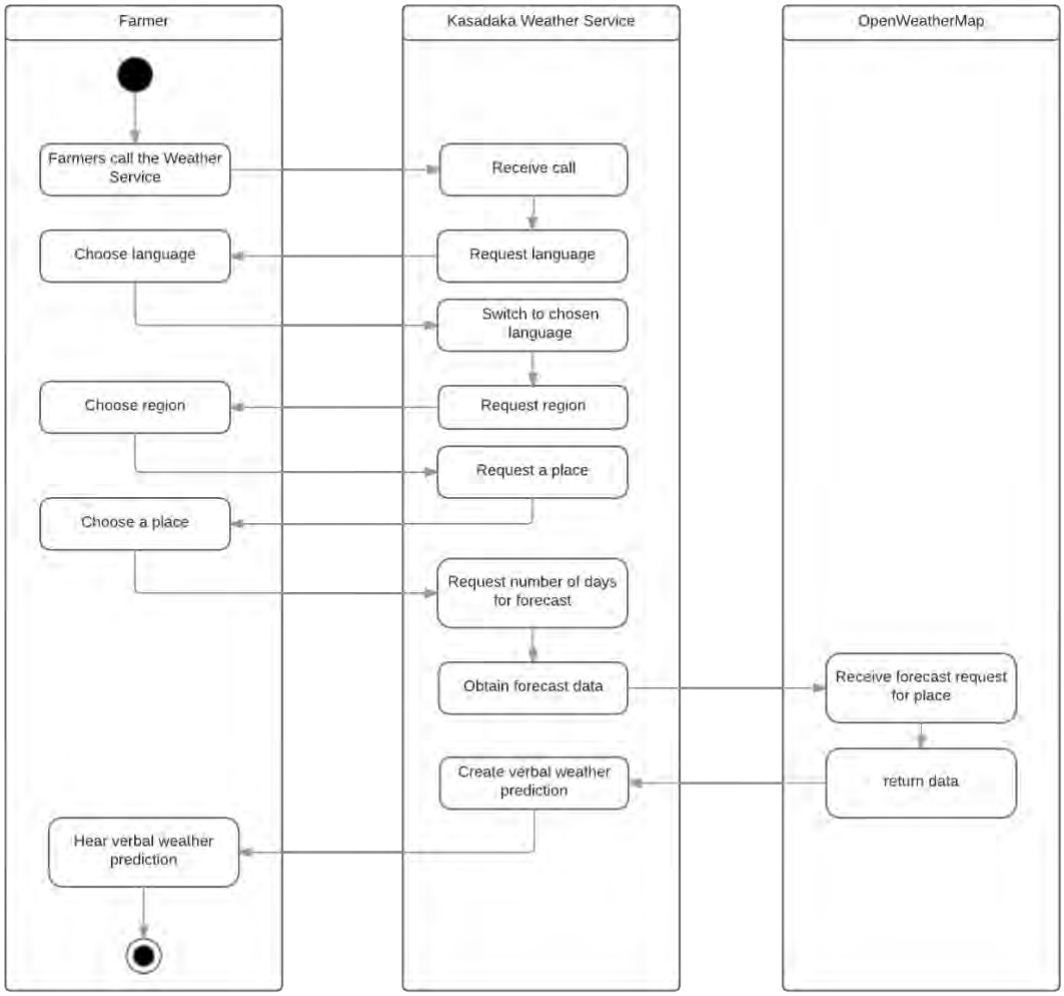


Figure 39: Example of an activity DIAGRAM for Saas Kibaya

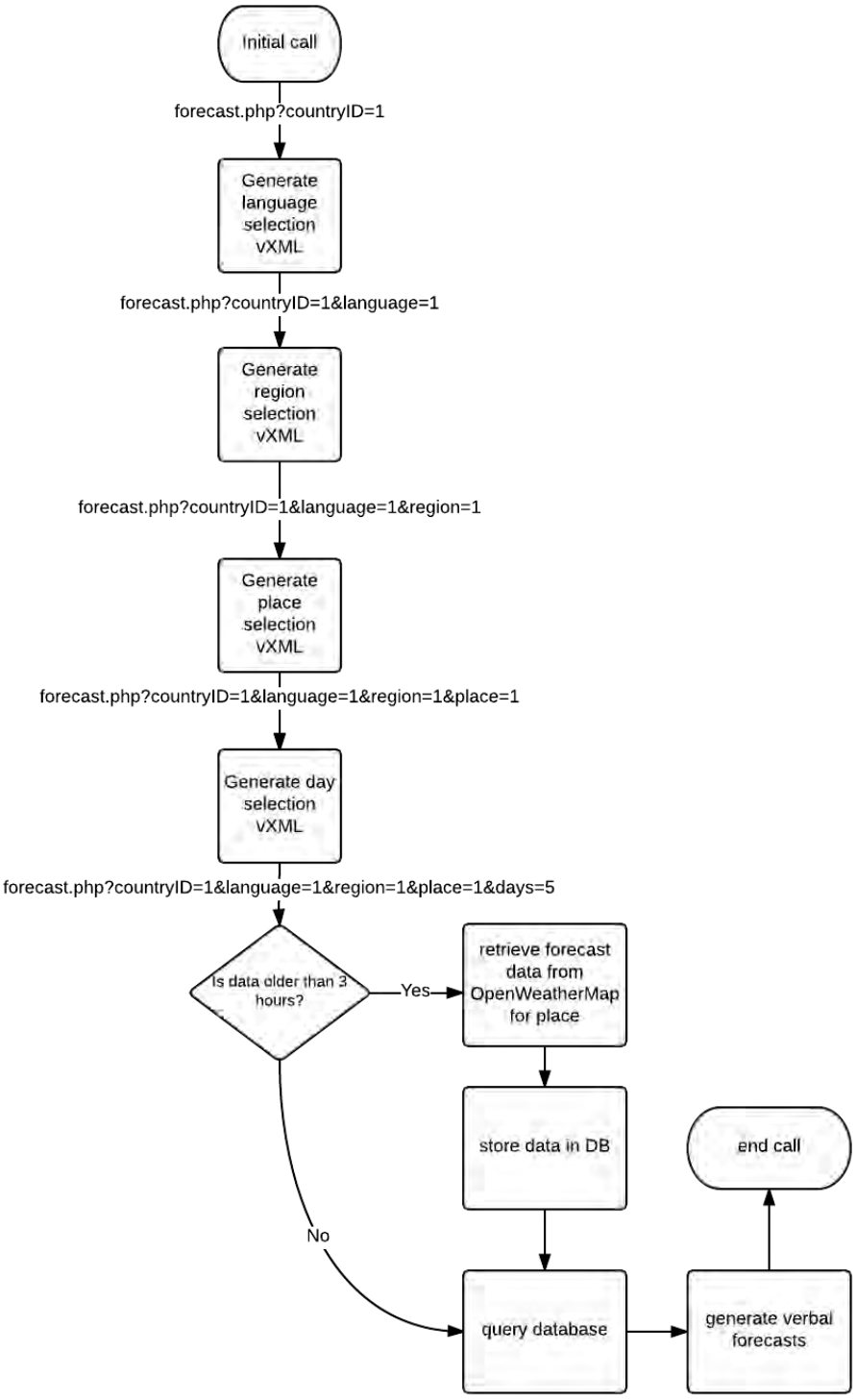
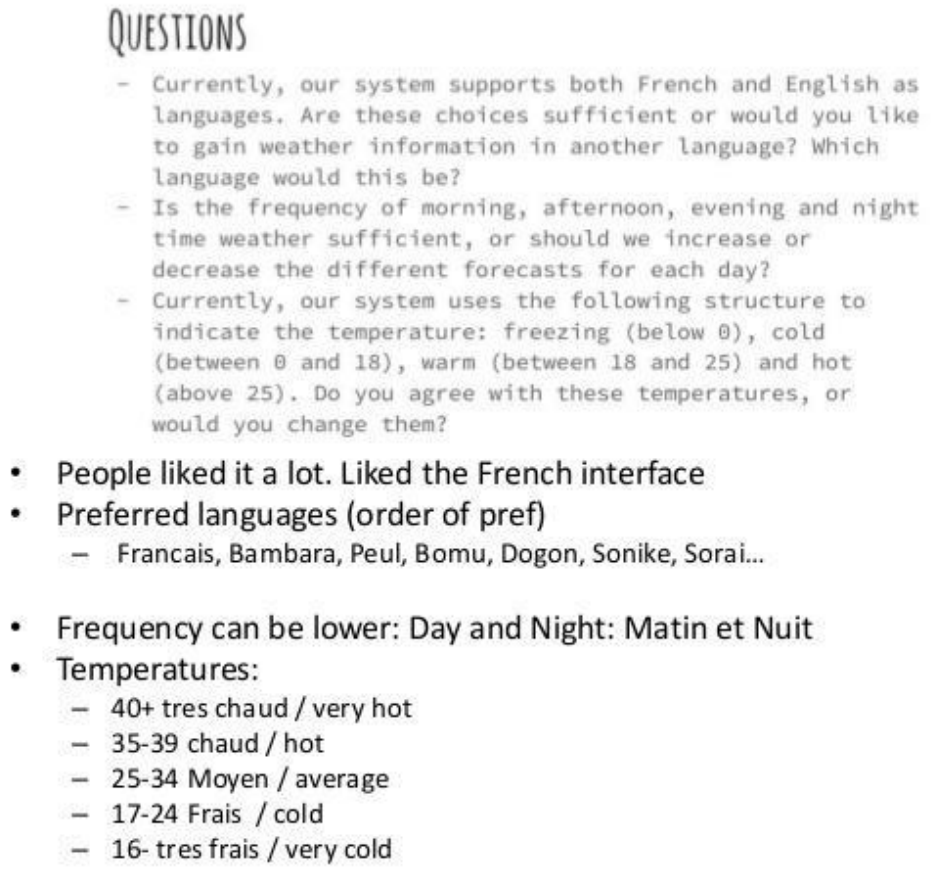


Figure 40: Call flow for Saas Kibaya system prototype.

Figure 21: Below Feedback by farmers in Mali (AOPP, May 2016) on the Kasadaka Weather system



TESTING THE DIGITAL (IOT) RAIN METER – A DEMONSTRATION OF SMALL INEXPENSIVE HARDWARE/LOCAL METEO DATA COLLECTION/DIFFUSION SERVICES FOR FARMERS IN MALI

By Chris van Aart – 2CoolMonkeys - October 2016

Concept

There is a great demand for weather observations, especially rainfall. Farmers are interested in prediction, but also the history of rainfall.

Solution

A rain gauge (also known as an udometer, pluviometer, or an ombrometer) is a type of instrument used by meteorologists and hydrologists to gather and measure the amount of liquid precipitation over a set period of time. A tipping bucket rain gauge consists of a funnel that collects and channels the precipitation into a small seesaw-like container.

There are relatively cheap tipping rain gauges (ticking buckets <40$) on the marker, these consist of a plastic collector balanced over a pivot. When it tips, it actuates a switch (such as a reed switch) which is then electronically recorded or transmitted to a remote collection station. This can be connected to internet of things (IoT) devices, such as Arduino or Raspberry pi. The idea is that the IoT device counts the number of tips and reports this to a central server for further processing.

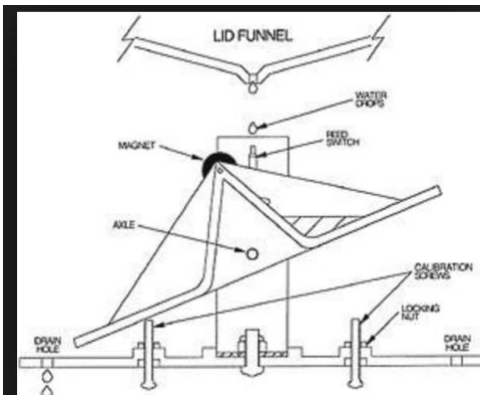


Figure 41: Pluviomètre diagram for a ticking bucket.

Figure 42: rain gauge/pluviomètre, now deployed in Mali

Business development

A tipping bucket was connected to an Arduino (IOT) in combination with a solar USB charger and display. Every “tip” is 0.2794mm of rainfall.

When it tips, it actuates a switch (such as a reed switch) which is then electronically recorded or transmitted to a remote collection station:

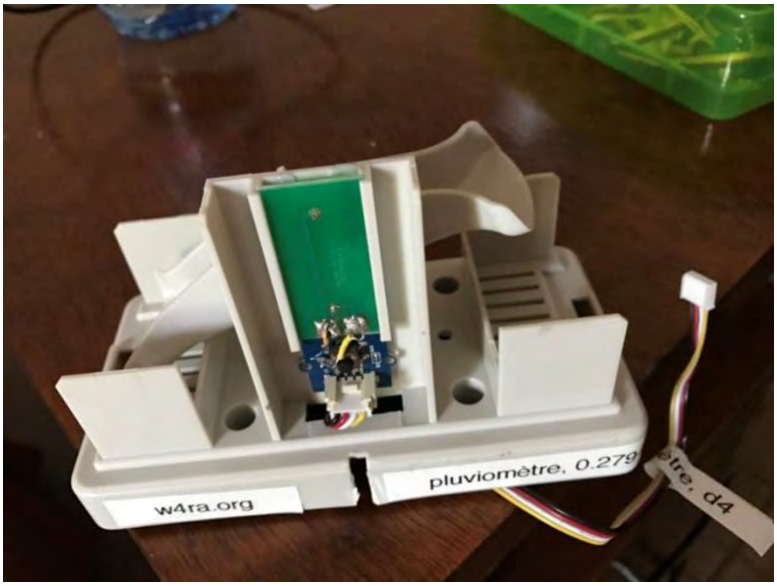
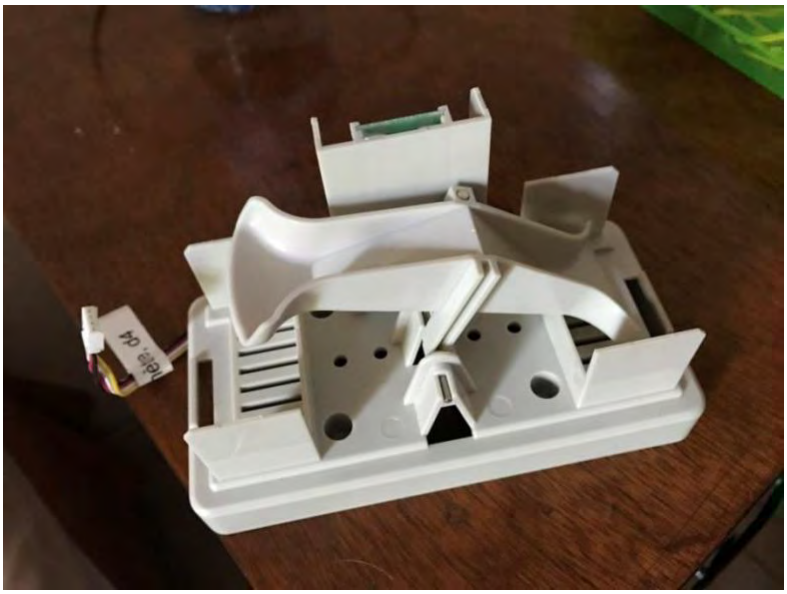


Figure 43-45 : Internet des objets



Complete set-up:

Figures 46 Complete setup

Given the code below, the set-up demonstrated rainfall detection.

```
#include "rgb_lcd.h"
#include "Wire.h"

int inPin = 4;
int val = 0;
double rainAmount = 0.0;

rgb_lcd lcd;

void setup() {
  Serial.begin(9600);
  lcd.begin(16,2);
  lcd.print("Ready");
  pinMode(inPin,INPUT);
  pinMode(6,OUTPUT);
}

void loop() {
  val = digitalRead(inPin);
  if(val == 1) {
   rainAmount = rainAmount + 0.2794;
   digitalWrite(6,HIGH);
   lcd.clear();
   lcd.print(rainAmount);
   lcd.print("mm");
   delay(500);
  } else {
   digitalWrite(6,LOW);
  }
}
```

Smoke test

The setup was demonstrated at various meetings. The initial reception was positive. Questions were related to:

- Protection of the hardware: we can do this with a weather casing
- Power: this can be done with the solar panel
- Data: this can be done with exchanging the data via the web
- (Historical): this can be done with a web/mobile interface

Figure 47: Ousmane Barke Diallo, Executive secretary of AOPP and prof. Hans Akkermans with a digital rain gauge.

Next steps

There are plans to deploy multiple IOT devices in the field to test the function of the tipping, data exchange and analysis.

Air quality measurement

Concept

There is a great demand for understanding air quality in Mali (both urban as rural). The idea is to user low cost sensor for measuring air quality.

Business Development

We constructed an IOT device with a number of small sensors:

- CO2

- Temperature
- Air quality
- Sound
- Barometer

With a display the actual conditions are displayed. The device was charged with a Solar panel.

Figure 48: Meteo station displayed at Radio Rurale

Code:

```
void setup() {
  Serial1.begin(9600);
  Serial.begin(9600);// put your setup code here, to run once:
  lcd.begin(16, 2);
  lcd.print("2CoolMonkeys");
  delay(5000);
  lcd.clear();
  lcd.print("Warming up..");
  airqualitysensor.init(14);
  airstarttime = millis();

  myBarometer.init();
  lcd.clear();
}

void loop() {
    lcd.setCursor(0, 0);
    //getRain();
    getSound();
    lcd.setCursor(4,0);
    lcd.print("|");
    lcd.setCursor(5,0);
    getCo2();
    lcd.print(String(val_co2));
    lcd.print("PPM");
    getBarometer();
    lcd.setCursor(12,0);
    lcd.print("|");
    lcd.setCursor(13,0);
    lcd.print(val_temp);
    lcd.setCursor(15,0);
    lcd.print("c");
    lcd.setCursor(0,1);
    getAir();
    lcd.print(val_air);
    lcd.setCursor(13,1);
    lcd.print(airRaw);
    //getBarometer();
    delay(250);
    lcd.clear();
}
```

Smoke test

The setup was demonstrated at various meetings. The initial reception was positive. Questions were related to:

- Protection of the hardware: we can do this with a weather casing
- Preciseness of the sensors
- Power: this can be done with the solar panel
- Data: this can be done with exchanging the data via the web
- (Historical): this can be done with a web/mobile interface

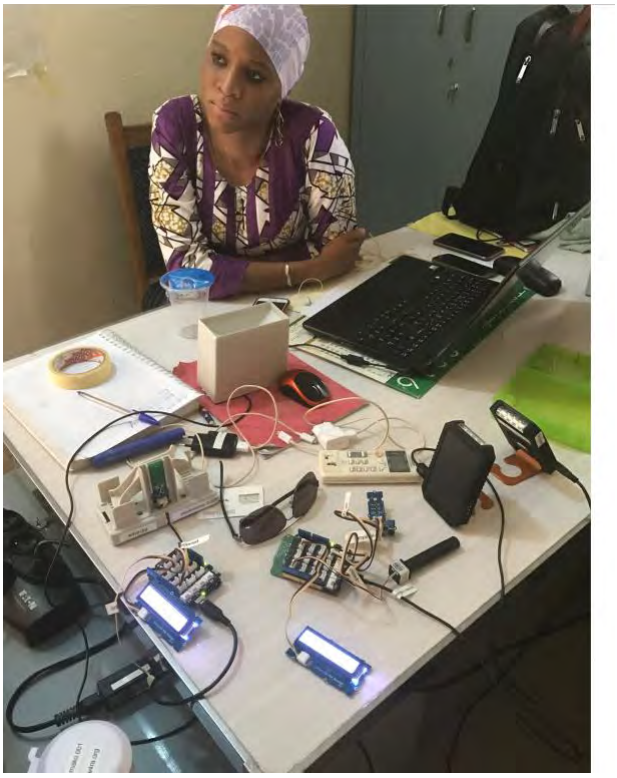


Figure 49: Maryana at Radio Rurale office in Bamako, Mali, with small digital devices for rain data collection.

WAATI KUNNAFONI BY CHRIS VAN AART – FOR AOPP FARMERS IN MALI 2016

Figure 50 logo W4RA weather app suite (design logo by Victor)

Concept

WAATI KUNNAFONI (knowing everything about the weather) is a service that collects data about weather predictions and actual conditions. In order to test the quality of the predictions; a system is needed to compare the prediction (prevision) and actual condition (*mesures*).

Business development

We created a system that crawls +400 locations in Mali, Ghana and Burkina Faso. See: http://waati.w4ra.org

For every location there is a GEO location (x,y), name of the place (name1), region (name2) and country.

x	y	name1	name2	created_at	updated_at	country
-7.97913446	12.61101731	Bamako	Bamako	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
0.66766491	15.66524489	Gao	Ansongo	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
-0.39315364	17.74591967	Gao	Bourem	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
0.41090358	16.66195024	Gao	Gao	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
2.77874540	16.69205039	Gao	Mnaka	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
-10.56928475	13.71291343	Kayes	Bafoulab	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
-9.17609584	14.58866001	Kayes	Dima	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
-11.47535280	14.52630820	Kayes	Kayes	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
-11.02115488	12.71095884	Kayes	Kniba	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
-9.43404556	13.23062464	Kayes	Kita	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
-9.59602818	15.06260945	Kayes	Nioro	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali
-10.55870300	15.08846688	Kayes	Yliman	2016-10-15 09:36:12	2016-10-15 09:36:12	Mali

Predictions are crawled every 3 hours from http://api.openweathermap.org/data/2.5/forecast

Predictions are computed per 3 hours.

Example:

{"dt":1465689600,"main":{"temp":26.41,"temp_min":26.41,"temp_max":26.41,"pressure":985.13,"sea_level":1027.72,"grnd_level":985.13,"humidity":74,"temp_kf":0},"weather":[{"id":500,"main":"Rain","description":"l\u00e9g\u00e8res pluies","icon":"10n"}],"clouds":{"all":0},"wind":{"speed":4.96,"deg":193.506},

"rain":{"3h":0.07},

"sys":{"pod":"n"},"dt_txt":"2016-06-12 00:00:00"}

These predictions can be displayed on a map:

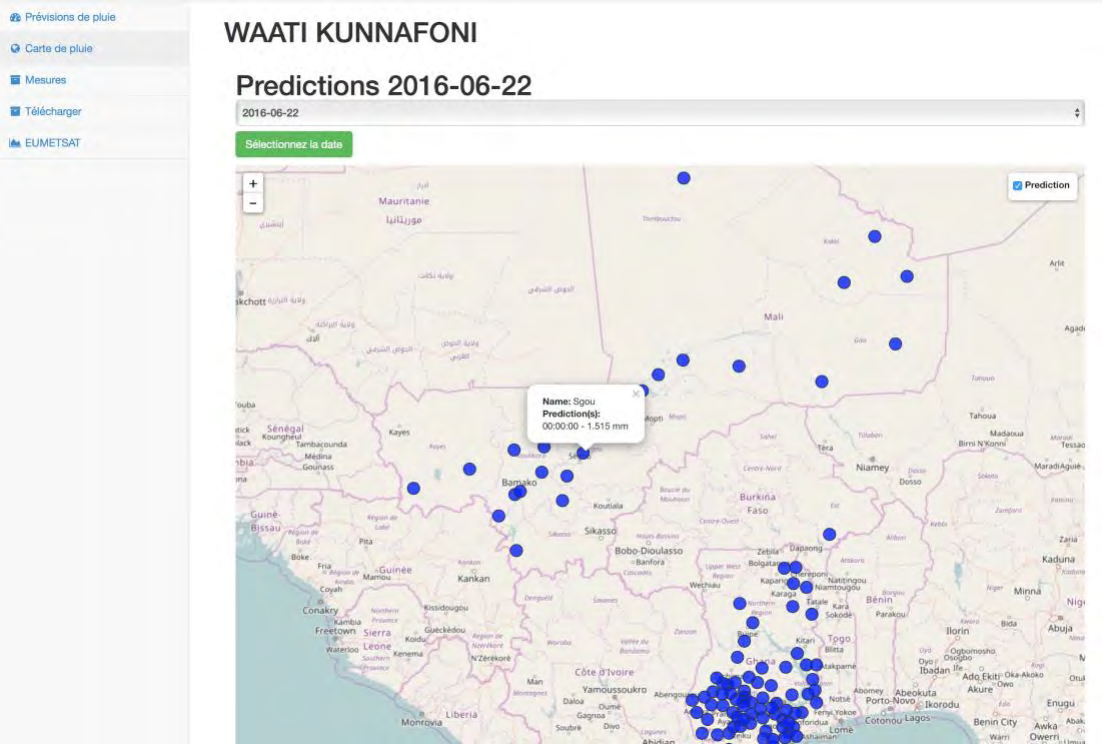


Figure 51: Weather prediction measurement points

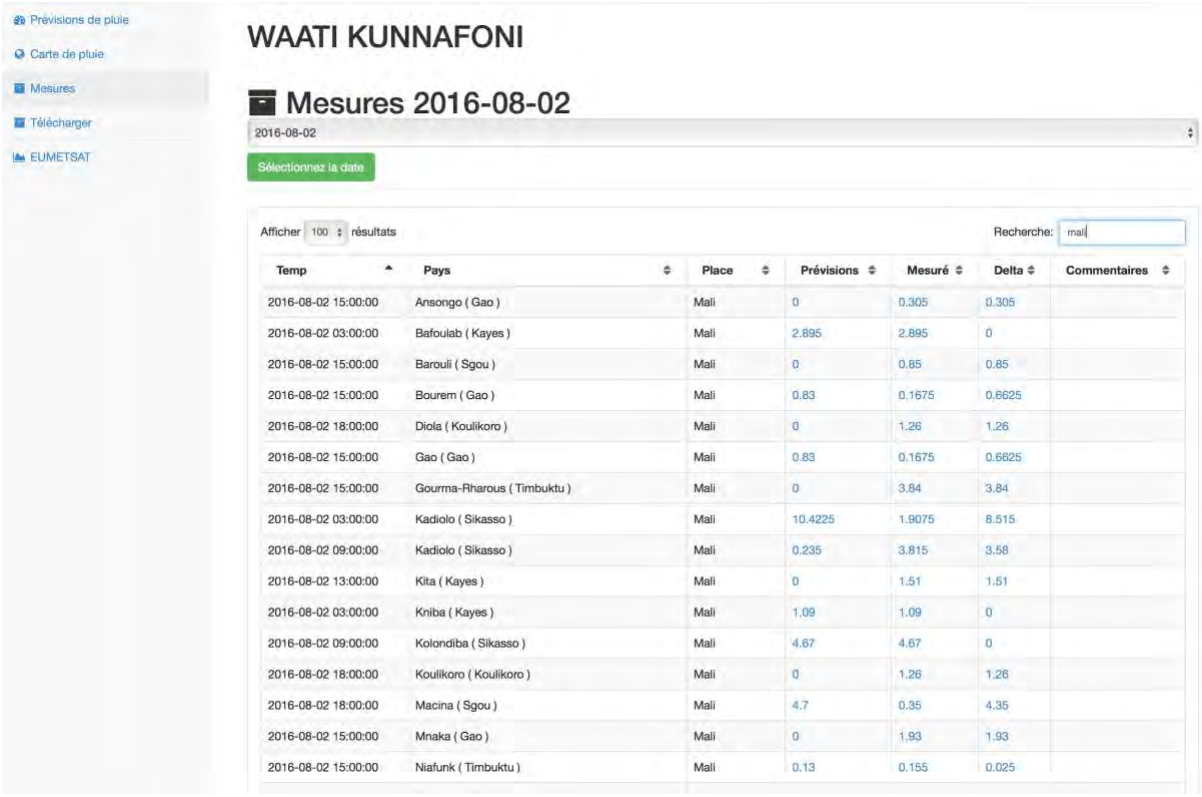
Observations are also crawled from http://api.openweathermap.org/data/2.5/weather every 3hours. In case of observed rainfall this is added to the predictions in order to make a comparison:

{"coord":{"lon":-1,"lat":9.5},"weather":[{"id":503,"main":"Rain","description":"tr\u00e8s fortes pr\u00e9cipitations","icon":"10d"}],"base":"cmc stations","main":{"temp":24.33,"pressure":1007.46,"humidity":100,"temp_min":24.33,"temp_max":24.33,"sea_level":1026.11,"grnd_level":1007.46},"wind":{"speed":3.57,"deg":205.501},

"rain":{"3h":121.597},

"clouds":{"all":24},"dt":1468577002,"sys":{"message":0.0027,"country":"GH","sunrise":1468561883,"sunset":1468607321},"id":2297169,"name":"Northern Region","cod":200}

This data can be compared, per day:



Temp	Pays	Place	Prévisions	Mesuré	Delta	Commentaires
2016-08-02 15:00:00	Ansongo (Gao)	Mali	0	0.305	0.305	
2016-08-02 03:00:00	Bafoulab (Kayes)	Mali	2.895	2.895	0	
2016-08-02 15:00:00	Barouli (Sgou)	Mali	0	0.85	0.85	
2016-08-02 15:00:00	Bourem (Gao)	Mali	0.83	0.1675	0.6625	
2016-08-02 18:00:00	Diola (Koulikoro)	Mali	0	1.26	1.26	
2016-08-02 15:00:00	Gao (Gao)	Mali	0.83	0.1675	0.6625	
2016-08-02 15:00:00	Gourma-Rharous (Timbuktu)	Mali	0	3.84	3.84	
2016-08-02 03:00:00	Kadiolo (Sikasso)	Mali	10.4225	1.9075	8.515	
2016-08-02 09:00:00	Kadiolo (Sikasso)	Mali	0.235	3.815	3.58	
2016-08-02 13:00:00	Kita (Kayes)	Mali	0	1.51	1.51	
2016-08-02 03:00:00	Kniba (Kayes)	Mali	1.09	1.09	0	
2016-08-02 09:00:00	Kolondiba (Sikasso)	Mali	4.67	4.67	0	
2016-08-02 18:00:00	Koulikoro (Koulikoro)	Mali	0	1.26	1.26	
2016-08-02 18:00:00	Macina (Sgou)	Mali	4.7	0.35	4.35	
2016-08-02 15:00:00	Mnaka (Gao)	Mali	0	1.93	1.93	
2016-08-02 15:00:00	Niafunk (Timbuktu)	Mali	0.13	0.155	0.025	

Figure 52*: Feedback* There are ideas to display the history of rainfall per location.

Solution

Display data per location in order to assess amount of rainfall to determine, e.g. quality of crops and understand climate change:

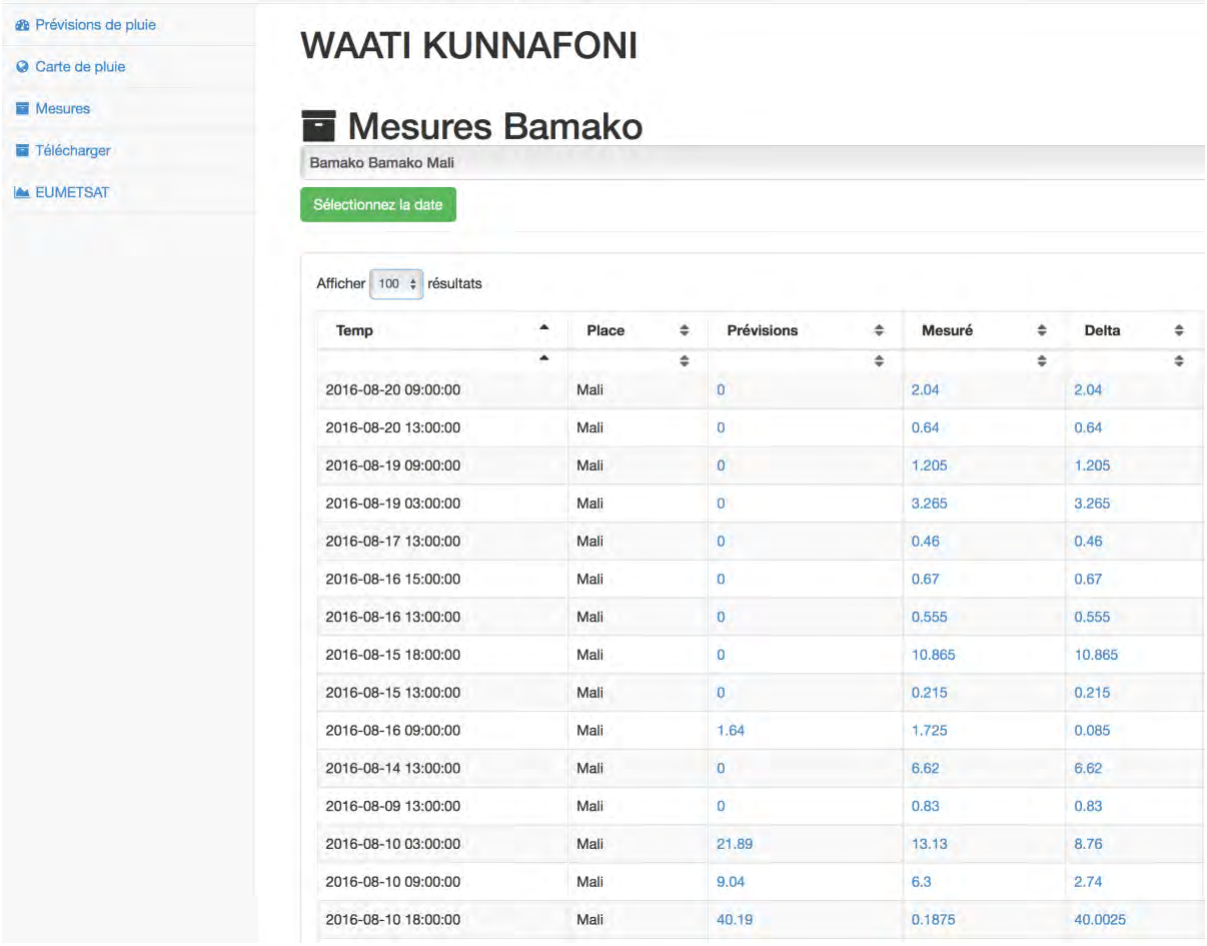


Figure 53/54: Measurement points

As an example, for Bamako, measured within the period 2016-06-11 and 2016-10-16.

Sum predicted rain: 1427

Sum observed rain: 114

The (average) difference between predicted rainfall and observed rainfall is 1476 (mm)

Top 10 mali within the period 2016-06-11 and 2016-10-16.

name2	name1	predicted	observed	diff
Yanfolila	Sikasso	2362	642	2337
Kadiolo	Sikasso	1702	519	1969
Kangaba	Koulikoro	1915	483	1874
Kolondiba	Sikasso	1613	465	1662
Bougouni	Sikasso	1688	463	1465
Kita	Kayes	1344	431	1388
Bafoulab	Kayes	1128	378	1034
Sikasso	Sikasso	1520	350	1535
Kayes	Kayes	875	305	822
Koutiala	Sikasso	1165	286	1139
Kniba	Kayes	1505	280	1532
Yorosso	Sikasso	1302	280	1230
Koulikoro	Koulikoro	1313	270	1344
Barouli	Sgou	829	239	925
Diola	Koulikoro	1361	233	1392
San	Sgou	856	218	890

select name2, name1, floor(sum(predictedrain)) as predicted,floor(sum(observedrain)) as observed, floor(sum(abs(observedrain-predictedrain))) as diff from predictions where country='Mali' group by name2

ORDER BY sum(observedrain) DESC

(i) DIGITAL VET – A TOOL FOR DIAGNOSIS AND MANAGEMENT OF ANIMAL HEALTH IN GHANA AND MALI

By Gossa Lo, Myrthe van de Wekken, Romy Blankendaal, Anna Bon, Amadou Tangara, Victor de Boer, Stefan Schlobach

Context analysis by Myrthe van der Wekken, March 2015 Zanlerigu – North of Ghana: local life in a poor, remote and rural area (from Myrthe's master thesis)

Zanlerigu is a low-resource rural community in Upper-East Ghana near the city of Bolgatanga. The climate is characterized by one rainy season from May/June to September/October. The natural vegetation is savannah woodland: dried grass with scattered drought-resistant trees. The soil is dry and low in fertility. Soil erosion is a problem for farming. The villagers are subsistence farmers, living from rain-fed farming and small-scale rearing of animals. Only a few farmers own farmland with access to ground water enabling irrigation during the dry season. During the dry season the day temperatures are > 35 C. People get up early to carry out daily tasks and stay inside during the hot afternoons.

Crop failure and animal illness are serious problems without easy solutions. The land holdings are small and often fragmented keeping the overall production low. Shea butter production by women, trade at the local market or working or jobs as stone carver at the local stone mine are additional income generating activities. Men are occupied with small-scale breeding and selling of animals. Most villagers did not attend school. Some went to evening school when they were adults and learned some basic reading and writing in the local dialect Frafra. Still, the majority is illiterate and do not know the symbolic meaning of numbers. In the local dialect they did know the meaning of numbers.

Most of the informants noted they were happy to live in the small village of Zanlerigu. The majority of them were born there and felt therefore connected to it: "I am connected to my land. I was born here. I am brought up here. My father grew up here. He did everything here." (Bernardus, male, subsistence farmer, Zanlerigu).

Needs assessment

Gossa Lô wrote in her bachelor thesis, after her field research in Zanlerigu, Ghana:

During one of the interviews conducted in Zanlerigu village, one of the farmers stated:

"I would love to hear information on how to take care of the animals. For instance, if I could hear information on how to feed them and how to take care of them if they are sick, that would help a lot. If the vet could give me this information via the mobile phone I would use it. I would gain knowledge on how to take care of the animals. So it would not matter if the vet would come in person, because I can do the procedure myself." - David, subsistence farmer, Zanlerigu Ghana, March 2015

Morbidity and mortality of livestock have a major impact on farmers. Animals are seen as a form of savings; whenever a farming family needs some money, they can opt to sell one of their animals. Livestock is not only crucial as income, but also for giving milk, meat, manure for crops and as means of transport. The fact that the death of livestock cannot be prevented has multiple causes, one of which is shortage of expertise in the livelihoods of the farmers. According to an assessment on farmers living in three regions in Northern Ghana, diseases of animals was considered the number-one problem[25]. Several farmers brought up the need for information about livestock diseases and spreading thereof. A lot of animal diseases require a certain expertise of disease patterns and

medication that the smallholder farmers in SSA do not possess. Veterinarians on the other hand, do have the knowledge required to cure diseases. A lack of knowledge about the diseases is one of the reasons why the mortality rate of livestock is high.

2014 Ghana – Walewale/Guabuliga

Our UDS partners introduced us to the Guabuliga community, where we held several focus group discussions, in December 2014, and April 2015. Several of our UDS partners could communicate with the community in the local language Mampruli. After a courtesy visit by our team leader to the village chief, the focus groups discussions took place. Four different groups of UDS and VU researchers worked with different members of the community in parallel. One of the group meetings took place e.g. under a giant mango tree (See figure 11). In total 130 participants, of which 85 women participated in the focus groups. Below is an impression of one of the focus groups. The questions are in italics, the answers are a summary of all the reactions of the participating farmers, men and women, translated to English, semi-simultaneously, by our partners from UDS. The focus group started with seven women and five men, at the village square named Maasuyiri. After half an hour the numbers grew to about 30 people: 12 men and 18 women. The UDS/VUA team explained the purpose of the visit and the reason for the focus group. Amongst a few other topics, the following was discussed with the villagers : (i) land, water & ecosystems (ii) weather and climate (iii) livestock.

Questions by W4RA team (Anna Bon, Nana Gyan, Hans Akkermans, Victor de Boer, Wendelien Tuyp, Francis Dittoh, Saa Dittoh) to the Guabuliga community April 2015 about livestock:

How beneficial has livestock been to you, and in what ways?

Livestock is used in Guabuliga as savings. Livestock can be sold whenever there is a need to diversify sources of income, when there is low food production. Sales of livestock is done to provide an income to buy food, pay school fees, health care insurance, house building,
clothing. Other advantages of livestock are: manure on farms, payment of dowry. Cattle, especially bullocks are used to plow on farm land.

What are important problems you face related to livestock?

Prevalence of animal diseases is increasing, and is currently a major cause of livestock mortality. Unpredictable patterns of disease outbreaks that lead to death are occurring. The known disease cycles/calendar are not applicable anymore. There is a perception that livestock imported from neighboring countries have diseases that infect local breeds. The symptoms are enlarged organs, such as heart and lungs. This is a major cause of death of the cattle of Guabuliga. Other challenges in relation to livestock are: there are not enough water points or wells for animals to drink from. As herds have to walk large distances to find water, this increases the risk of livestock theft,
especially amongst roaming grazing herds.

What are people doing to address these problems with livestock?

Veterinary officers (from Wulugu) are often contacted (via mobile phone) whenever there is an outbreak of disease that affects livestock in the community. Vets provide vaccination services and curative advice. In the past, community members dug ponds to collect and supply drinking water to their livestock. This has stopped because of low rainfall. What kind of information would help to address these problems? Information related to the signs and symptoms of various animal diseases, categorized and sorted would be very helpful. This should include timely information on what to do when an animal shows signs and symptoms of diseases, and information on disease incubation period.

Interview with a vet in Ghana by Anna

The meeting took place Thursday 17 December 2015 12:15 – 13.45h

To obtain more background knowledge on animal health in rural Ghana, in December 2014 and May 2015, we were introduced by our colleague Francis Dittoh, computer scientists at UDS, for an interview to the local public veterinarian service in Tamale, from the Ministry of Agriculture. We wanted to know if an application to diagnose

animal diseases would make sense. We wanted to have more knowledge on how animal health works in this rural context. I interviewed the vets. My colleagues took pictures and did the recordings.

The veterinarians we met in Tamale, in the Northern District of Ghana, are traveling vets from a public service. They travel around and visit rural villages in the region around Tamale. We talked to Abubakari Zibuila, technical officer Tamale Veterinary Clinic, Dr. Amoro
Nelson Agemga, from Tamale Metro Veterinary Clinic, and Senior Dr. Baba Issah, Zonal Officer in Tamale East, who actually gave most of the interview. In our interview we focused our questions on the most important animals, cows, goats and sheep.

What is a veterinarian's working day like in Ghana?
We attend to cattle at the community, when a farmer approaches us if an animal is sick.
It is too stressful to bring the animal, so we go there when they call us. Sometimes it happens when the animal gives birth. We work from Monday to Saturday, visiting the [rural] communities.
How many veterinarians does each region have on average? There are 14 vets in Tamale, working for the Metropolitan Agricultural Development Unit. There are 11 vets in the metropolitan area and 3 in the outside district.

Which types of animals are taken to the veterinarian?
Vets treat all kinds of animals: cows, goats, sheep, horses, donkeys, chicken, pigs, birds,
fowls, and even dogs, cats and sometimes snakes. All the species you can think of.

What are the common diseases of animals brought to the vet?
If we base on cattle we distinguish the following diseases often reported: Foot Mouth Disease (FMD). Farmers here are married to poverty, so they do not vaccinate. Some treat with antibiotics. Some do not, by the second or third disease the cattle die. Set one comes, and it seems to heal by themselves. Then it can spread the disease. Black leg or black water is a bacterial disease. It affects the arm or the high limb. It is acute. It can occur overnight. CBPP (Contagious Bovine Pleuropneumonia) is the third endemic disease here in Ghana. Anthrax is the last one. For now it has not occurred. We have taught the farmers about Anthrax. When they understand it, they agree on a date to confine the animal on a certain date for vaccination. The last time we experienced anthrax in Tamale was in 2001. In other regions Anthrax is endemic, and it occurs every year. Since we had a vaccination, every community has to vaccinate. They have to pay for this and we do the vaccination. Sometimes they do not confine [the animals]. You go to the community that has responded. Anthrax is a highly infectious and fatal disease of mammals and humans, and is caused by a relatively large spore-forming rectangular shaped bacteria called Bacillus anthracis.

How much does a veterinary consultation or surgery cost on average?
The farmers are married to poverty. They may have 30 cattle but they do not want to pay for a vaccination, until the disaster suddenly occurs at their farm. They do not vaccinate because of the cost. They would like to have free vaccination. Formerly, the Ghanaian government paid for 5 vaccinations, but due to economic motives, they now leave it to the owners. Only the farmers who see the importance, call us and pay for it. The cost of Anthrax [vaccination] is 3 Ghana cedis, for CBPP it is 4 cedis; for Black Leg is 2 cedis. The FMD does not have a vaccination; by contact it will spread; you collect the sample from an infected animal; in Ghana there is no vaccine. What we do is, we prevent the
spread to other animals in two or three days. The treatment of FMD is with antibiotics, which can cure it. The cost of antibiotics is difficult to estimate, as it depends on the body size, on the condition of the cow and sometimes you also need other medicines. We can charge below 5 cedis, but it can go up to 20 or 40 cedis.

What are the diseases that are characteristic of the rainy season/the dry season?
During the wet season there is Foot Mouth Disease, foot rot and parasites, tics on the grasses. Cattle graze and the tics invade the system of the animal. Tick diseases can break the system. The most contagious of all diseases is Foot Mouth Disease, as this can affect any four-legged animal (no birds). During the dry season, in the peak of the heat, Anthrax and black leg are the usual diseases. Animals are grazing closer to the ground. Anthrax can live in the ground for 30-40 years. They can also get tetanus. How are these diseases treated/prevented in general? All the diseases

are vaccinated, only the FMD does not have vaccines, only antibiotics. Do you use ICTs, such as computers or cell phones, in order to complete your daily tasks? We use our mobiles to take pictures of a disease, snapping with your phone to show the authorities. Our system is so poor, we do not have notebooks. Farmers do not use pictures, they are sometimes illiterate. They can only call you. An animal died so they called us. When they have a situation they want us to come within an hour.

Does the government provide some service or subsidy for vet services?
Only for fertilizers, but not related to animal health. Do you use the internet for consulting vet info? We do not use ICTs for professional use. Only for personal use. About goats and sheep: Do farmers vaccinate goats, what diseases do they get? Yes, goats are affected by similar diseases as cattle. They can get PPR (Peste des Petits ruminants), a sheep virus disease, to which we also vaccinate. Sheep and goats can get Black Leg, Foot Rot, Anthrax, basically the same diseases as cattle.

Can farmers easily recognize the diseases?
We give workshops to farmers. Serious farmers are the ones who care for their cattle and say 'oh it is time to confine and vaccinate the animals'. These are the serious farmers. A whole community can be a serious community. They have an interest. The rest of the farmers do not do that.

Why do farmers keep cattle?
For economic benefits. They cannot slaughter themselves. Use the donkeys for plowing. They apply the manure for the land. Treatment and service is hard for them. The most important thing to teach to farmers is how to know when the animal is healthy or when it is diseased. Some conditions are not diseases, but only [due to] nutritional conditions. Some things can happen when they [the animals] do not get good food. E.g. in the rainy season you see when a calf has worms: it will walk in a wobbly way. So, you ask the farmer to confine the animal and de-worm it and give it supplementary food. When animals have Foot Rot you advise them to bring the animal out of a wet area in the rainy season and to take the animal to a dry place so the foot will heal. When its immunity goes down, the animal can get other diseases. You can do some prophylactic activities by boosting their immune system. We give them calcium or multivitamin. This is expensive to farmers. Our farmers are married to poverty. They may have 100 animals, but they will say 'I do not have money'. They will categorize it as difficult. We tell them not to plow with [sick] animals, but they refuse. When problems occur, they call us. When the rain has reduced they come. Rains start around June until October. We also give them advice about cropping. We say: go to other communities to learn from each other. We train them.

How often do you train the communities?
Community training is done when you give a vaccination. We do that and we take the opportunity to talk and train.

We showed the vets a prototype of the system which is shown in Figure X. What do you think of this DigiVet system? Would you use the system? Do you think the system would be used when implemented? Can you give us any tips or advice regarding the systems? Could you think of any additional things the system should be able to do? Would you be willing to answer some questions regarding this project in the future?

Show the farmers the application and they will start using it. A veterinary officer can show it. If they know the condition and diagnosis, you do not have to go there anymore. So, it will help them, certainly in combination with the vet officer's visit. Sometimes it is difficult for them to diagnose a black leg from a snake bite. Depending on the number of tablets, we want to do a test with two or three tablets to see if it works. We will start building a prototype based on your input and then show it to you again. It will not work the first time. It will take months or a year before it works.

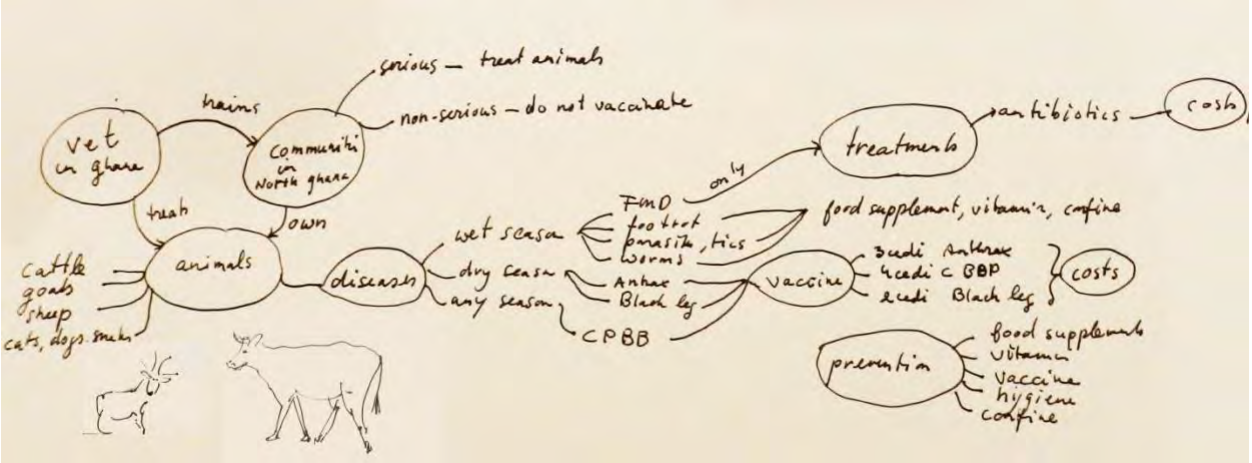


Figure 55: Concept map of Vet interview about animal diseases and work of a vet in Mali (Anna)

Prototype of the DigiVet by Gossa Lô, 2015

A prototypical design has been developed for DigiVet, which is a simple representation of the final service. Figure 4, 5 and 6 display the three different states of DigiVets' user interface. Fig. 4. Opening screen Fig. 5. Symptom screen Fig. 6. Outcome screen Figure 4 shows the opening screen, which is the initial state of the DigiVet service. It shows an overview of the livestock that lives in Zanlerigu village. The presence of certain animals is context specific, for the prototype we chose to include the animals that live in Zanlerigu. When the user taps the touchscreen to select an animal of choice, he is guided to a screen similar to the symptom screen in figure 5. There is both a red and a green part of this screen. These colors represent the choice that the end user makes following a question asked by the voice guide. The choice of colors is equal to a traffic light, with red meaning: 'yes, I recognize this symptom in my sick animal' and green meaning 'no, I do not recognize this symptom'. Of course, the identification of the meaning behind these colors is culturally specific and should be determined in accordance with the end user.

Every time the user taps on a part of the screen, a new question arises, until an outcome screen appears, as displayed in Figure 6. The voice explains to the user what the most likely outcome of the disease is. A short description of the disease follows, together with a sequence of steps that should be taken in order to cure the animal. Of course, there are also diagnoses that are incurable. In either case, the user is provided the opportunity to select a suitable veterinarian to consult. Once the user has selected a veterinarian, DigiVet sends a SMS message through the GSM dongle to the mobile phone of the veterinarian. This message contains a summarized version of the steps and outcome of the service in semantic data. The veterinarian that receives the URL is able to detect the different symptoms and the most likely diseased that were identified by DigiVet.

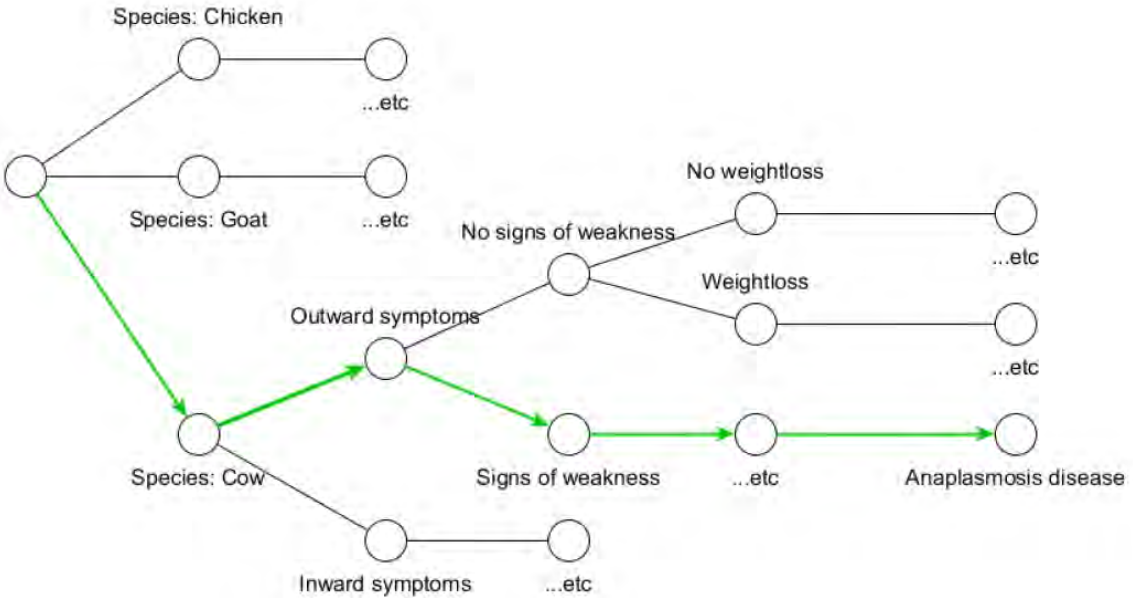


Figure 56: Structure of the knowledge about animal diseases

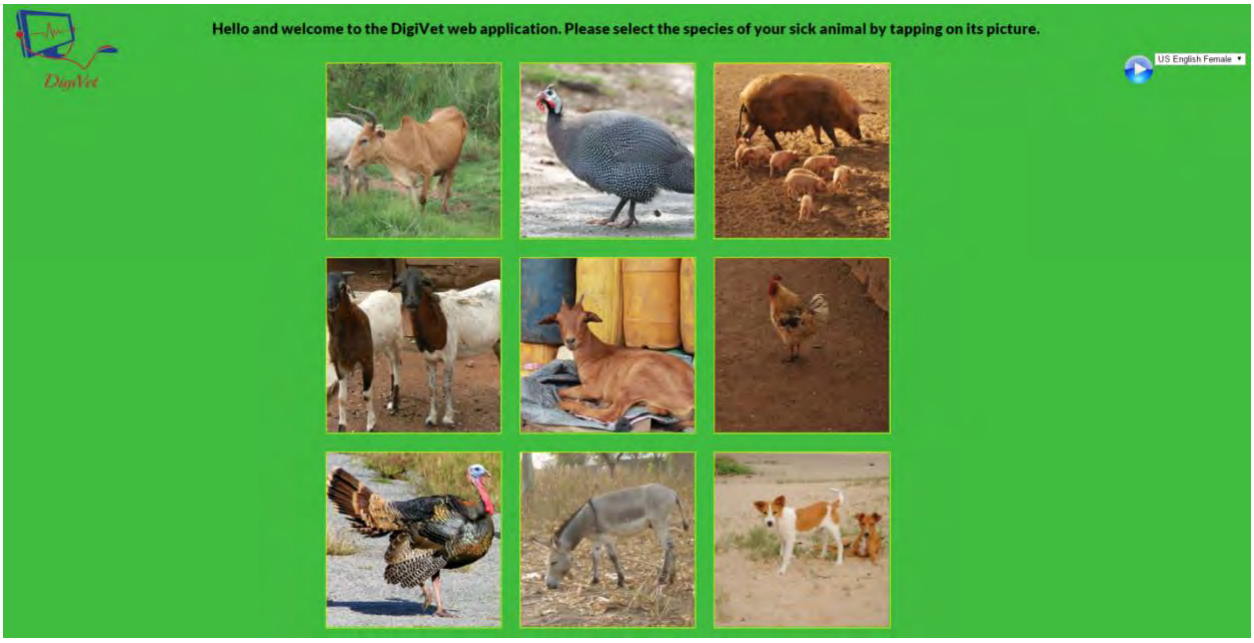


Figure 57: Opening screen DigiVet App, select which animal

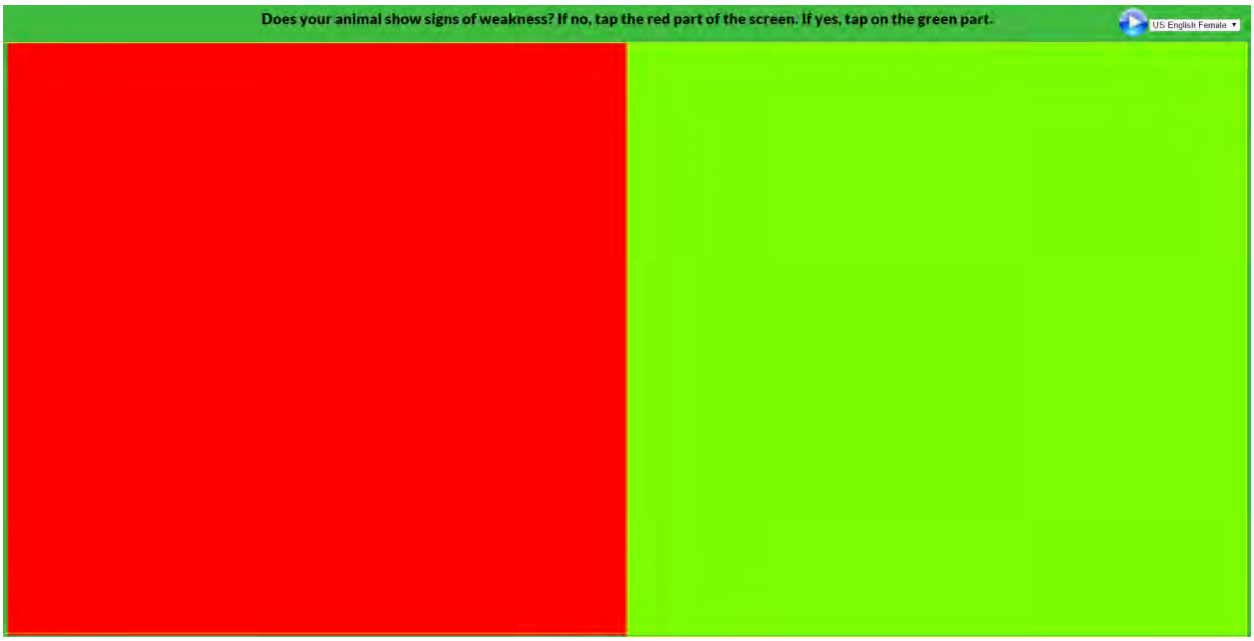


Figure 58: Selection screen for symptoms: green = yes red = no

Figure 59 : Outcome screen of DigiVet

Second iteration of DigiVet after evaluation in Ghana by users in May 2015

In May 2015, W4RA organized a collaborative workshop together with a team of researchers from UDS, in Northern Ghana. The goal of this workshop was to discuss and identify situated information needs, with the aim to improve food and water security in the Sahel. ICTs are seen as the tools that can close the bridge between an information need and its solution. As part of the trip, the researchers presented the idea of DigiVet to the researchers from UDS. According to them, there is a high need for better information and communication between farmers and veterinarians. When visiting Guabuliga, a village in Northern Ghana with about 2000 inhabitants, they were told that

every day a cow was dying of a yet to be identified cause. During the visit, a veterinarian was present alongside the W4RA and UDS researchers, who was then brought into contact with the chief of the village. This veterinarian performed a post-mortem examination and found that the death of the cows could be linked to enlarged organs due to pesticides. The importance of close contact between a qualified veterinarian and farmers was made very clear by this example. The DigiVet was well received and, when implemented and evaluated thoroughly, could support both farmers and veterinarians, while saving the lives of animals.

Use case description DigiVet by Gossa Lô and Romy Blankendaal – April 2015

The subject of the use case described in this paper is animal health care. Some animal diseases spread within and between villages, others can only be cured with the intervention of a veterinarian. The problem that arises in these rural areas is that the expertise is often not locally available and poor infrastructures prevent information and knowledge from being accessible. Some farmers indicated that they would like to receive information on animal diseases, disease patterns, diagnosis and symptoms, to enable them to take preventive action and preclude cattle loss. Gaining information from a local veterinarian could thus be relevant and useful in these cases. The idea of the elaboration of the use case is to enable veterinarians to enter the up to date news and knowledge regarding common diseases verbally into a voice-based system.

Use case scenarios based on user stories from Mali

The following scenario indicates how a farmer would use the voice-based version of DigiVet as introduced in this report.

Farmer Adama, who lives in a little village in the north of Mali, sees that one of his cows is moving abnormally and is eating less than usual. He hesitates whether he should contact a veterinarian or not. Reason of his doubt is that consulting a veterinarian might be expensive, and the harvest was a disappointment this year, he does not want to overspend if not necessary. He remembers DigiVet, about a conversation with his neighbor a couple of days ago. His neighbor Mamadou, also one of the farmers had used it to find out whether or not he should consult a veterinarian in response to the spreading of an infectious disease among poultry that was afflicting the neighboring villages.
Adama asked Mamadou what the phone number of DigiVet was, and then dialed the number. A cordial voice-message welcomes Adama in his local language Bambara to DigiVet, and explains to him what he should do. Adama indicates by tapping the right digits what type of animal he has, the types of food his cow eats, how his animals are accommodated and specific questions regarding the symptoms his animal is showing.

The voice tells Adama that he did right by contacting DigiVet, and that, based on his answers, the system recommends him to consult a veterinarian to cure the cow. He then is given the option to contact one of the three veterinarians listed by DigiVet, and he taps 2 to consult Ousmane N'diaye, a governmental veterinarian specialized in cattle. Dr. N'diaye answers the call and the two of them make an appointment the next day to have the cow checked in a neighboring village. Thanks to DigiVet, the sick cow was diagnosed with CBPP disease, was given a vaccination and survived. Adama made sure all the farmers he talked to knew of the benefits of DigiVet.

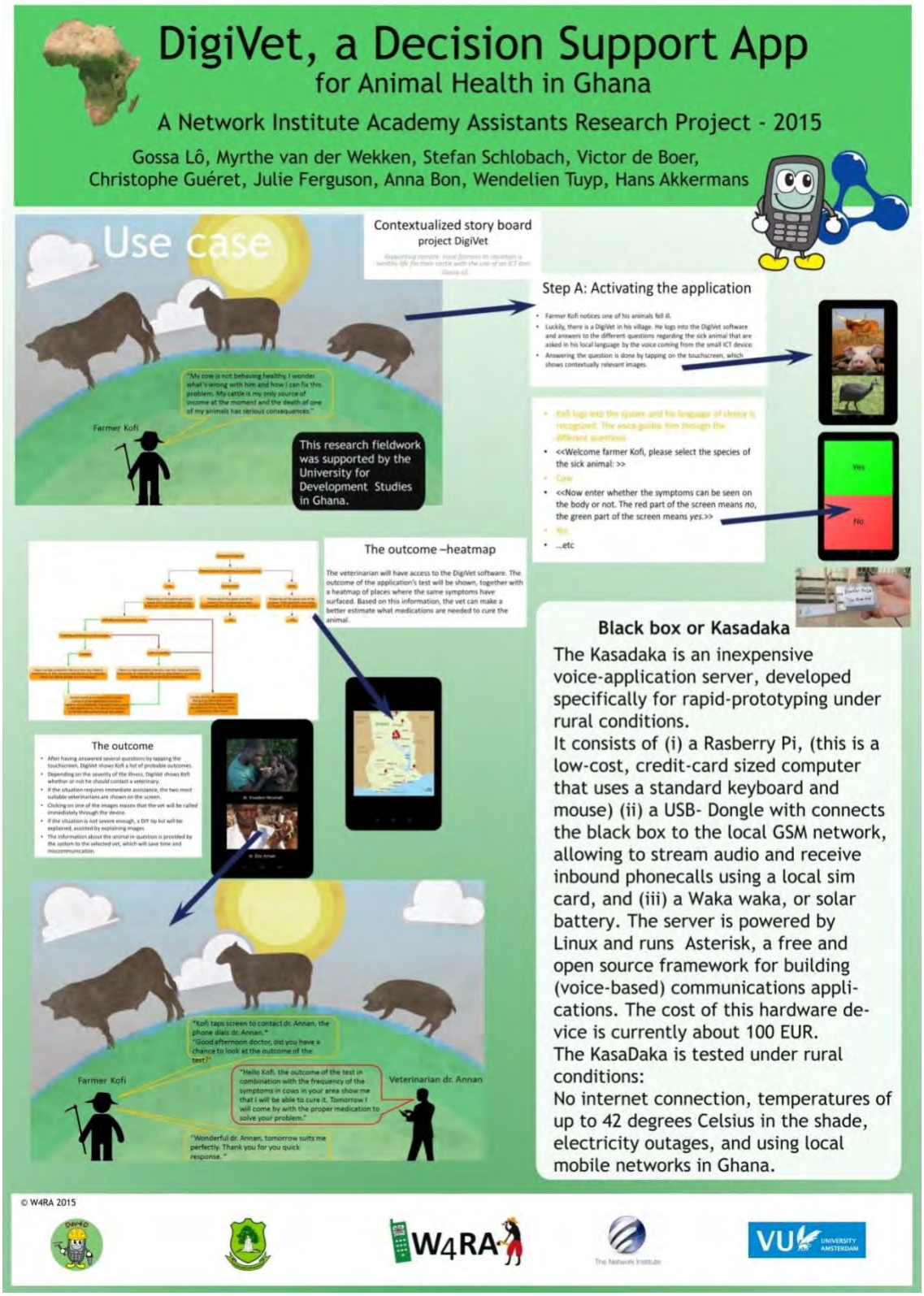


Figure 60: Poster of DigiVet by Gossa Lô, AI student 2015, presently, alumna of VU.

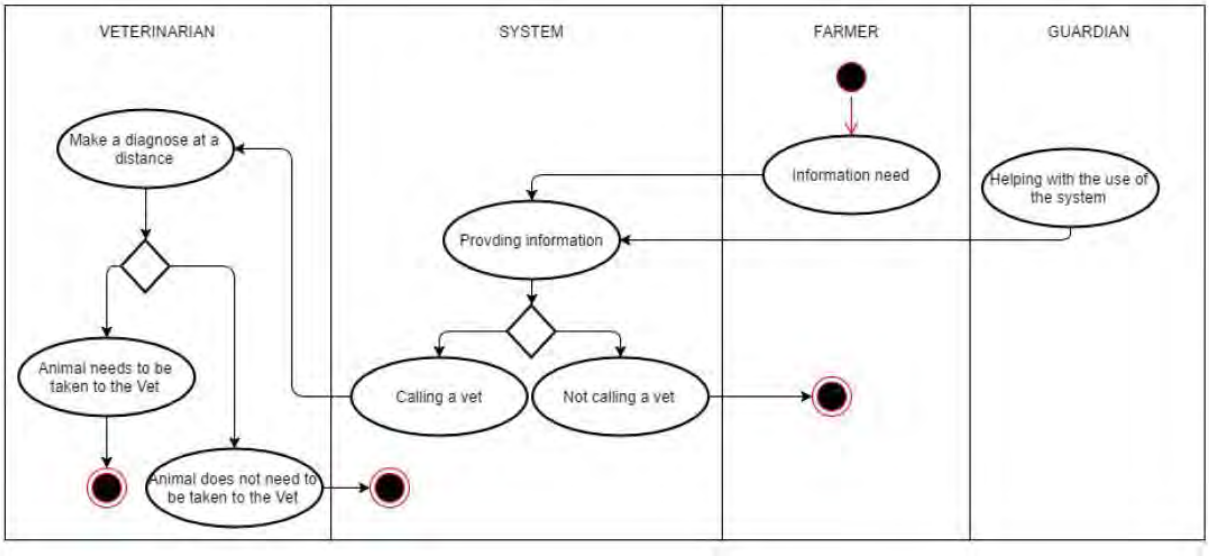


Figure 61: Activity diagram of DigiVet

First prototypical cycle of DigiVet
A first voice-based prototype was built in 2015 that showed a simple interface in which farmers could click through a set of symptom related questions on a touch screen connected to the Kasadaka [8]. The Kasadaka is a rapid prototyping platform consisting of a Raspberry Pi [9] and a GSM dongle. The main idea behind the Kasadaka is that it is composed of some basic hardware and software requirements that enable the rapid development of new voice-based information services. The first prototype of DigiVet did not yet contain animal disease information that could be used in the real world.

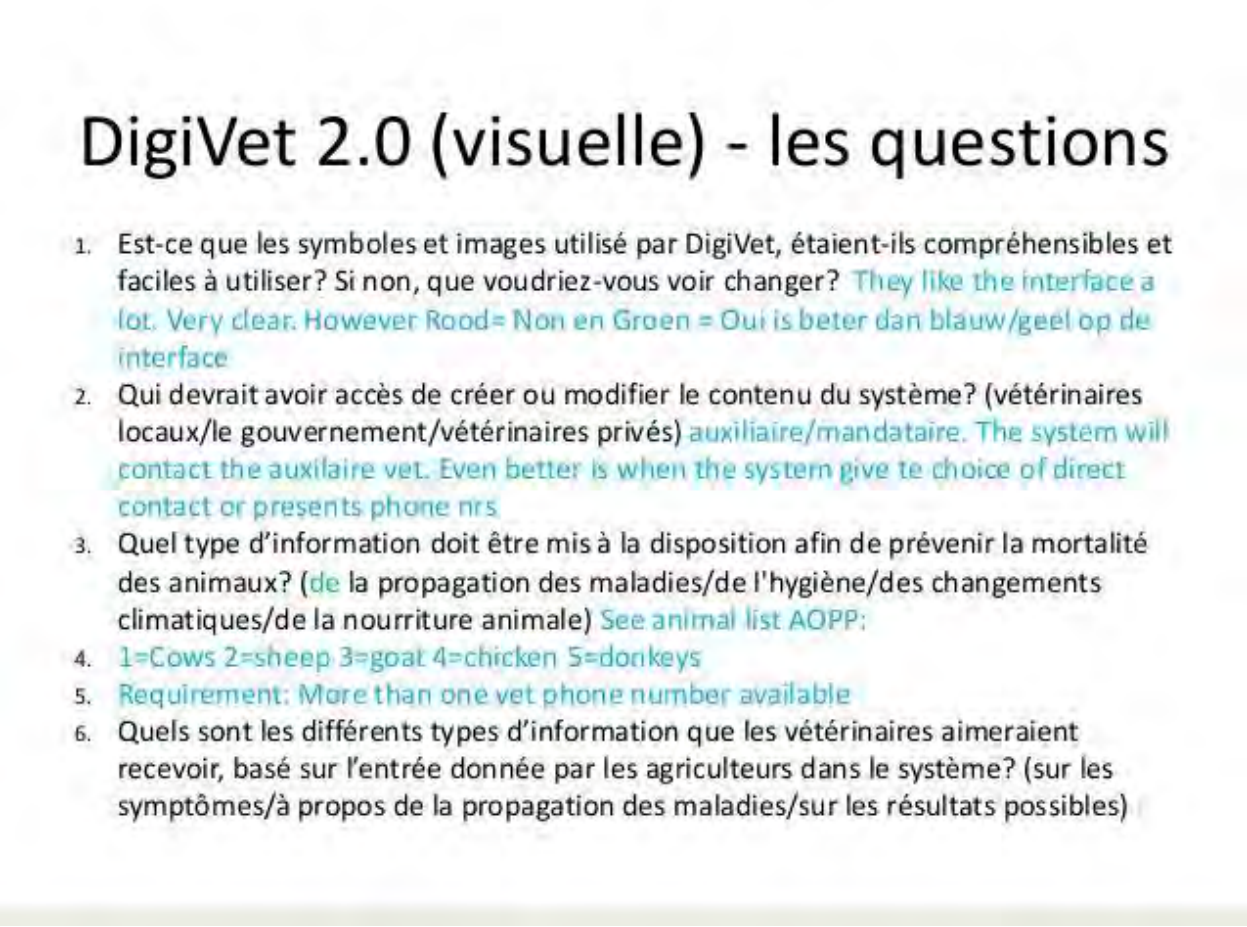
Second prototypical cycle of DigiVet
In the beginning of 2016, the second prototype of DigiVet was created. This included an improved knowledge base, based on the CommonKADS methodology [10]. In order to develop this new version, interviews were held with a Dutch as well as local, Ghanaian veterinarians. The latter was done by the W4RA group, by interviewing three veterinarians working in rural Northern Ghana. The Dutch veterinarian that we interviewed had stayed in Tamale, Ghana for a couple of months, working in a veterinary clinic. Based on these interviews, the objective of the system was changed from providing a diagnosis to giving an outcome of the decision whether or not a farmer has to go see a veterinarian. This was done in order to prevent that farmers would cure the animals themselves and in order to stimulate them to more proactively visit a veterinarian.

Prototype description / System design DigiVet Romy and Gossa
As DigiVet aims to make veterinary information more accessible to all farmers living in remote areas, the reach of the service can be increased by creating a telephonic accessible version of it. Therefore, a prototype is developed which elaborates on the already developed visual version of DigiVet by adding a second one that enables local farmers to call to Kasadaka, and in this way accessing DigiVet.
Figure 2 shows the call flow diagram of the system. If a farmer calls the system, he/she is primarily welcomed and is asked to indicate the type of animal that he/she would like to obtain information on. Subsequently, the farmer can answer all of the symptom related questions by pressing the corresponding Dual Tone Multiple Frequency (DTMF) number. For instance: "Press 1 if you have a dog" will guide the farmer to more specific questions regarding dog diseases. Once the system knows what kind of animal the farmer has, a general question is asked. If a farmer answers this question with yes, more specific questions will be asked, if not, the next general question is prompted. Subsequently, if the system has enough information, it will give the output to the farmer regarding the decision whether or not to go see a veterinarian. Finally, the decision

is given and an option should be provided to contact a veterinarian. In order to make the system easier to use, improvements were made based on the first prototypical version. Focusing primarily on increasing the usability, the user now receives more feedback when calling to the system. Sentences such as: "We will now list the symptoms, please indicate for each of the symptoms if it is experienced by your animal." were added to improve the flow of the call. The second extension was made by adding the option to switch between the languages English and French by adding the latter as a possible language. French is one of the main languages spoken in Mali where the application is being tested, which is why this is a logical addition.

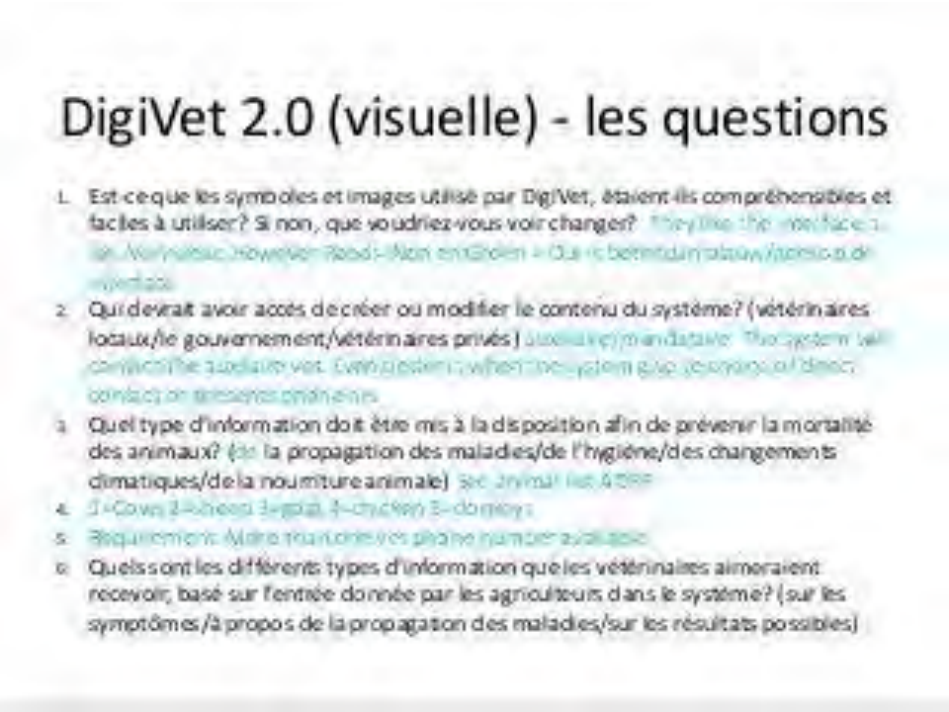
Evaluation by users in Bamako Mali – 2016 by W4RA team Anna, Hans, Victor, Wendelien
In the mid of May 2016, a part of the W4RA team went on a field trip to Bamako, Mali. One of the objectives of this trip was to demo the prototypes made by the students to an invited group during a session. During this demo session, 25 men from all over Mali showed up, among whom a local tech entrepreneur.

During previous field trips conducted by the team in both Ghana and Mali, the DTMF (see section 4) was not working properly. This time, however, the DTMF seemed to work properly, which meant that the prototypes could be tested using a mobile phone. Moreover, this means that one challenge of deploying the Kasadaka successfully in at least Mali, but probably in other West-African countries as well, is taken care of. After the field trip, we were provided with part of the feedback given by the participants of the demo session. Since both the visual and the voice-based version of DigiVet were demonstrated, feedback for both versions was given. The participants of the feedback session indicated that they really liked DigiVet as demonstrated, although they did have some remarks. We will thus make a distinction between feedback applicable to both versions (general feedback), feedback based on the visual version, and feedback based on the voice-based version as introduced in this report.


DigiVet 2.0 (visuelle) - les questions

1. Est-ce que les symboles et images utilisé par DigiVet, étaient-ils compréhensibles et faciles à utiliser? Si non, que voudriez-vous voir changer? They like the interface a lot. Very clear. However Rood= Non en Groen = Oui is beter dan blauw/geel op de interface
2. Qui devrait avoir accès de créer ou modifier le contenu du système? (vétérinaires locaux/le gouvernement/vétérinaires privés) auxiliaire/mandataire. The system will contact the auxilaire vet. Even better is when the system give te choice of direct contact or presents phone nrs
3. Quel type d'information doit être mis à la disposition afin de prévenir la mortalité des animaux? (de la propagation des maladies/de l'hygiène/des changements climatiques/de la nourriture animale) See animal list AOPP:
4. 1=Cows 2=sheep 3=goat 4=chicken 5=donkeys
5. Requirement: More than one vet phone number available
6. Quels sont les différents types d'information que les vétérinaires aimeraient recevoir, basé sur l'entrée donnée par les agriculteurs dans le système? (sur les symptômes/à propos de la propagation des maladies/sur les résultats possibles)

Figure 42/43: Q&A to the farmers of AOPP, May 2016 in Bamako, to evaluate the DigiVet system.



General feedback

The general feedback is mostly based on the cultural differences between Mali and Ghana. The first two versions of the DigiVet prototype, as described in sections 3.1 and 3.2, had been developed for Ghana.

Zanlerigu, the village in North Ghana where the DigiVet use case was developed, is a Christian village. This means that the animals they hold include pigs and dogs. The feedback given by the Malians, who are Islamic, was that these two animals did not occur in the villages and can be taken out of the application. Instead, and after a lively discussion, they mentioned that the following list of animals would be relevant given their context:

- Cows
- Sheep
- Goats
- Chickens
- Donkeys

This list more or less matches the Ghanaian list, but the differences are important to keep in mind.

The second general feedback we received was to have an optional list of veterinarians to contact. This idea corresponds to our future plans. There are different types of veterinarians, both in Ghana and Mali, and not only their expertise differs, but also their prices. If we were to recommend veterinarians to contact, these different types should be taken into account. The third point of feedback was that the participants would like the end users to be able to copy the telephone number of the veterinarian. In this way, they can choose to call back later if this is more convenient, or if the veterinarian does not return the call.

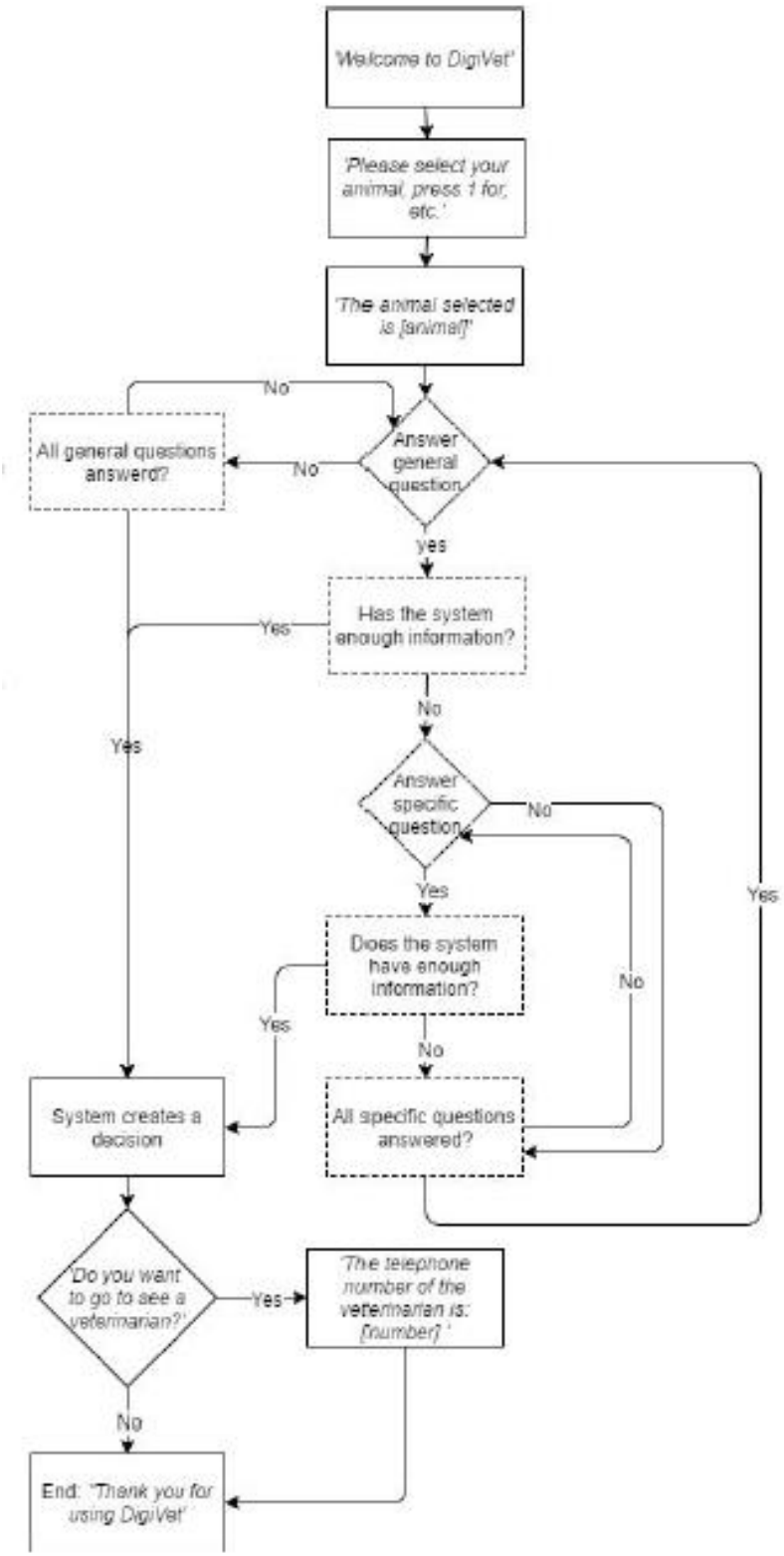


Figure 43: Call flow for DigiVet

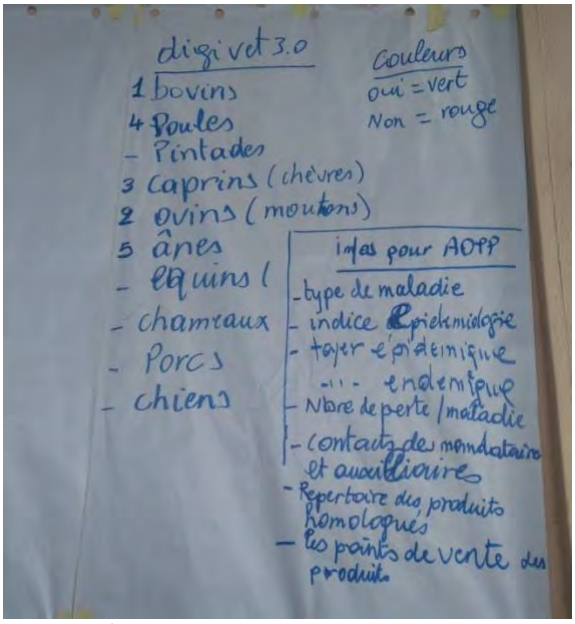


Figure 46/47: Amadou Tangara moderates the discussion of the AOPP farmers about DigiVet (pictures Victor)

Feedback based on visual DigiVet

The feedback described in this subsection focuses on the visual version of DigiVet, as mentioned in subsection 3.2. The interface (see figure 3) that shows the questions regarding the symptoms can be answered by the user by tapping either the yellow part of the screen or the blue part. The feedback given in Bamako was that they would rather see a red and green part of the screen, instead of blue and yellow. Red and green were actually chosen in the first prototype of DigiVet, the one mentioned in section 3.1. Blue and yellow were then chosen for the second prototype, since colorblind people can see those colors. We agree with the feedback that red and green fit better, and will add two symbols in the two parts of the screen in the next version of DigiVet, such that colorblind people can still understand what is asked of them.

Feedback based on voice-based DigiVet

The most relevant feedback we received regarding the voice-based version of DigiVet (DigiVet 3.0), was that they would like to see a next version in which farmers can give background information. This information would regard for instance animal food, hygiene and other topics that might correlate with specific symptoms or disease patterns. This sounded like a great addition to our existing prototype. If the farmers indicate what their cow has eaten the week before it fell ill, and the system knows that the specific type of food causes a symptom or disease pattern, this feedback could immediately be given to the farmer. Another option could be that this background information would be sent via SMS to the veterinarian, together with the information regarding the symptoms. This information would be very relevant to the veterinarian and would give a more complete overview of what the animal might be suffering from. Information regarding the amount of animals being held or being ill would also be relevant for organizations working in the region. Other feedback we got for the voice-based DigiVet version was that the participants would like to know where the animals that are sick are situated, this would mean that location based information should be made available to veterinarians or organizations. We understand that this information would be interesting to analyze, but this is of course privacy sensitive. And before we make these kinds of decisions, more discussions and feedback rounds should be held.
The last correlation they would like to be able to make was between the weather (rainy or dry season) and specific illnesses or symptoms. These types of feedback have been taken into account, as we would like our system to be able to indicate certain patterns regarding the diseases and symptoms prevalent in a region or between regions.

Implementation and installation of DigiVet

In this section, the data model of the system and its architecture is discussed. How DigiVet can be used in then explained using two possible usage scenarios. Section 5.3 contains an installation guide for the system so everyone can use it. De code for the prototype can be found on the GitHub page: https://github.com/Rromulus/DigiVet_audio .

Data model and system architecture

The data, available in the database as well as in the triple store, contains all the information used by the system, such as the symptom questions. These can be found on the DigiVet 3.0 Github repository2, as well as the earlier version of DigiVet (2.0) and the prototype described in this paper.
Figure 4 shows the domain schema based on the CommonKADS methodology that is used for this prototype and figure 5 displays the system architecture.

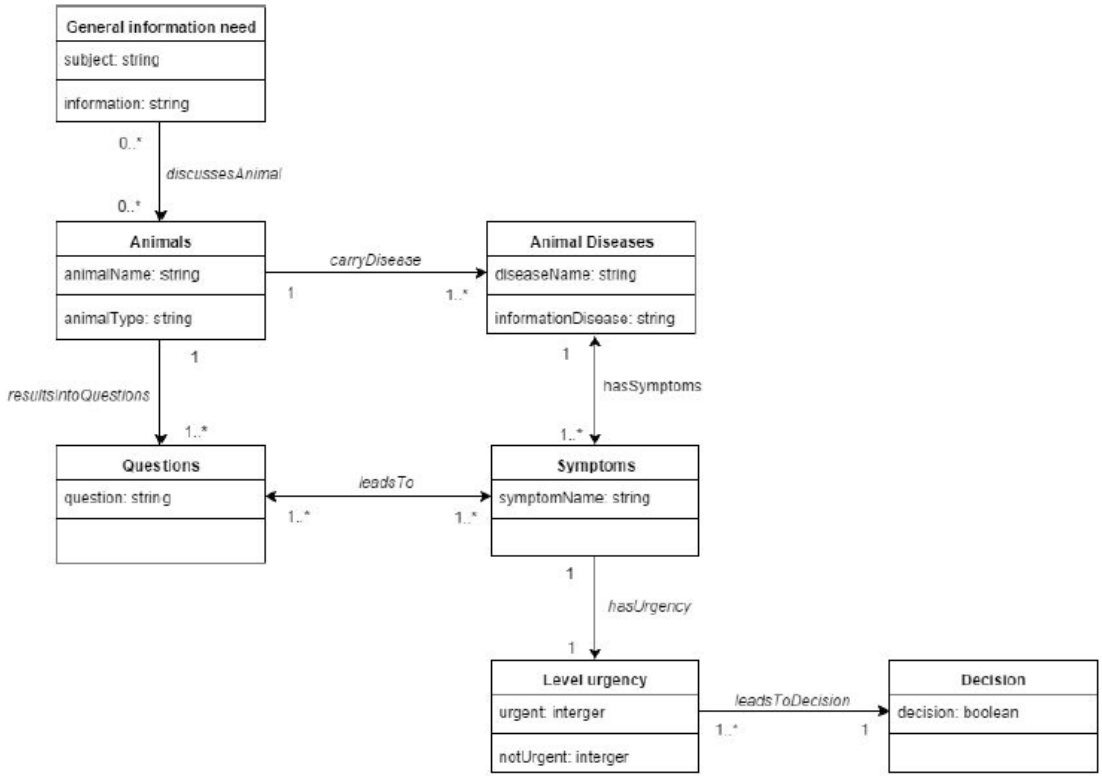


Figure 48: Domain schema for DigiVet-related knowledge

As can be seen in the domain schema, the symptoms are given a level of urgency, meaning that they are either urgent or non-urgent. The scoring of the urgency of the symptoms taken together eventually lead to the decision whether or not it is recommended to visit a veterinarian. This structure was applied in the visual version of DigiVet that uses a database. The purely voice-based version that is currently being made will eventually follow the same scoring structure. At this point, however, the questions are hardcoded, which means that the specific questions that are answered with yes or no, up to the last very last question, are leading to the next question in line. The final specific question in given a general question can have two different outcomes based on the input. If the user acknowledges that his/her animal suffers from that specific symptom, the system will recommend this farmer to visit a veterinarian. If this specific symptom is not recognized, the decision will be to not visit a veterinarian. In future work the scoring system will be adjusted in order for it to correspond to a real world situation.

Deployment of Digivet

The prototype can be downloaded from the GitHub Repository. The prototype is made with the use of VoiceXML files, which is a document standard for voice dialogs. With the XML files, the described dialog (see figure X, the call-flow diagram) is programmed. A XML file has been made that enables farmers to call a veterinarian directly if they would like to contact one, based on the decision of the system. Further tests should prove whether this method is sufficient. Audio files were generated in both English and French that were then placed in the XML files. Audacity, a software tool for editing and recording sounds, is used to record spoken text from text-to-speech websites.

(ii) FOROBA BLON – INTERACTIVE RADIO TOOL FOR RURAL MALI

By Anna Bon, André Baart, Victor de Boer, Chris van Aart, Amadou Tangara, Adama Tessougué

Context analysis

Rural radios are important local information providers/hubs in rural Africa, in the absence of other mass media. The Malian community radios in our study reach about 80,000 listeners, within a radius of coverage of 100 to 200 km. They create programs and broadcast local and regional news, music, round table programs and paid announcements. Some of these radios in rural Mali have computers and a connection to the Internet, some only have computers without Internet connection, some have no computer facilities at all, depending on their business size and location. All radio stations are situated within the coverage area of (2G) mobile telephony.

In January and November, 2011 the W4RA team visited a few radios in Mali. These are important information hubs in rural Africa, in the absence of internet and other media. Since radios could be potential business partners for the envisaged ICT deployments, we visited and interviewed the radio journalists. This is what we learnt about rural radios: This is done using the USSD channel of the mobile network. Some of the community radios in rural Mali have computers and internet, some have computers and no internet and some have no computer facilities at all6. These rural radios reach between 80.000 and 150.000 listeners, having a radius of radio coverage between 100
- 200 km. Rural radio stations create their own localized programs by round table programs and paid announcements. All radios we visited had mobile coverage.

We visited the following radios:
(i) Radio ORTM Ségou, a state owned radio with only computers and a 2 Mbps fixed line (DSL) internet connection. Radio ORTM Ségou broadcasts programs in French and Bambara, the most widely spoken language in Mali;
(ii) Radio Moutian, in Tominian, a private radio financed by paid announcements broadcasting and private gifts. Radio Moutian has a computer but no internet. Programs are mainly in Bomu, a local language of the Tominian region;
(iii) Radio Seno, Bankass, a private radio. There are no computers, no internet. The radio has many listeners in the region. The main language is Dogon.
(iv) Radio Sikidolo, Konobougou, a private radio with computers, was at the time of writing, still using a Dongle to access the internet.
The language was Bambara (although the journalist Adama Tessougué was from Dogon region).

In 2011, these radio stations still used old analogue equipment, such as tape recorders. The information broadcast by the community radio was not stored and kept for access or re-use. The radios did not have ways to manage or reuse the spoken radio content. We brainstormed that combining mobile phone and radio would give opportunities for innovative data services. E.g. radio listeners phone to the radio station and leave voice messages that they want to have broadcasted, or react to popular radio programs leaving news, opinion, regional information etc.

2012 Mali: Segou, Tominian, Konobougou

2016 May, Mali: Bamako, Radio Sikidolo

201 October Mali Bamako Radio Sikidolo

Needs assessment

In many rural regions in Africa, community radio is the most important source of information. Many people have radios at home and listen to programs in local African languages every day. Radio stations in rural areas in Africa operate under harsh conditions. Some stations only have old-fashioned equipment, such as tape-recorders. Others have computers but no internet connection. Still, they have many listeners.

Many people in these rural regions have a mobile phone, a simple one, used for chatting. The availability of both phones and radios is opening new opportunities for communication. Radio listeners often phone to the radio station and leave a message that they want to broadcast. This can be local news, or interesting regional information, from village reporters and citizen journalists.

The Web Alliance for Regreening in Africa is now building this innovative radio service named FOROBA BLON. You could see it as a type of "Voice-Twitter". The new radio system will allow citizen journalists and village reporters to phone to the radio and leave their message. To make the computer dialogue as user friendly as possible, Malian voices had to be collected. The new platform will help the radio stations to organize the recorded incoming messages. It will also provide a Web interface so that people abroad, living far from their home village, will be able to hear the news from their families and home town. The radio platform will help to bring the benefits of the World Wide Web to people who are currently out of reach of computers and the Internet.

The Foroba Blon service is still a small initiative, involving 4 community radio stations in Mali. However, Foroba Blon is designed so that it can be replicated elsewhere. The different radio platforms will eventually be linked together forming: a Web of African Radios, in support of citizen journalism and free and independent press.

Use case and requirements

Key ideas

Listeners from the local community radio phone to the radio and leave a spoken message, they want to have broadcasted on the radio. Their phone call is picked up by the system and recorded and stored. The radio journalist can retrieve the messages asynchronously, and add metadata to them, moderate them, and decide what to do with the data. He can either use a very simple voice interface or a more sophisticated web interface to access the messages. The radio is able to change the "welcome message" to the listeners.

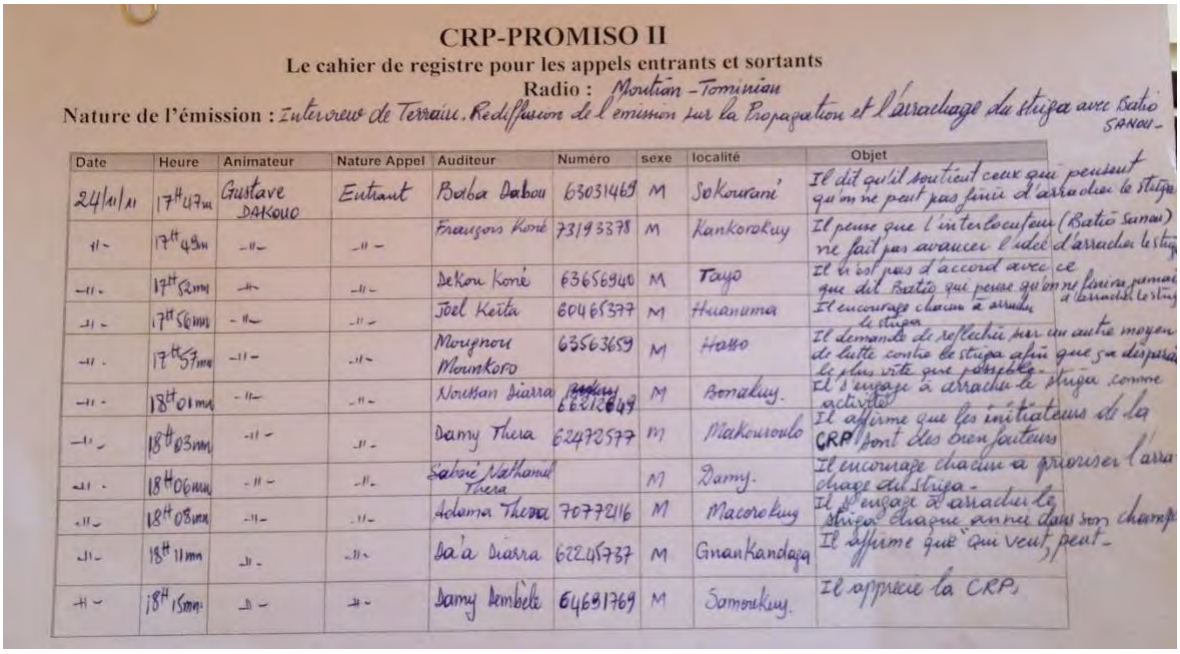
Current workflow:

The radio broadcasts programs about certain topics: agriculture, health, family affairs etc. Listeners are invited to phone and leave a message as a reaction to the program. There is a time slot of one hour to phone in. The radio staff picks up the phone and either records the messages on a cassette recorder or writes the content + metadata on paper. The capacity of the single phone line and the radio staff member is insufficient to attend all incoming calls during one hour.

Actors	**Goals**
Listeners from the region	Leave a message that will be broadcasted on the radio
Radio journalists	Retrieve the messages and organize them in an efficient way; Store the messages for later use.

Village people in the diaspora	Access messages from their village members remotely (on the Web)

Mockup:



CRP-PROMISO II

Le cahier de registre pour les appels entrants et sortants

Radio : Moutian - Tominian

Nature de l'émission : Interview de Terrain. Rediffusion de l'emission sur la Propagation et l'arrachage du striga avec Batio SANOU -

Date	Heure	Animateur	Nature Appel	Auditeur	Numéro	sexe	localité	Objet
24/11/11	17H47mn	Gustave DAKOUO	Entrant	Barba Dabou	63031469	M	Sokourani	Il dit qu'il soutient ceux qui pensent qu'on ne peut pas finir d'arracher le striga
11	17H49mn	11	11	Francois Koné	73193378	M	Kankoroku	Il pense que l'interlocuteur (Batio Sanou) ne fait pas avancer l'idée d'arracher le striga
11	17H52mn	11	11	Dekou Koné	63656940	M	Tayo	Il n'est pas d'accord avec ce que dit Batio qui pense qu'on ne finira jamais d'arracher le striga
11	17H56mn	11	11	Joel Keita	60465377	M	Huanuma	Il encourage chacun à arracher le striga
11	17H57mn	11	11	Mougnou Mountoro	63563659	M	Hako	Il demande de reflechir sur un autre moyen de lutte contre le striga afin que sa disparition le plus vite que possible.
11	18H01mn	11	11	Nouhan Diarra	66212649	M	Bonakuy.	Il s'engage à arracher le striga comme activité
11	18H03mn	11	11	Damy Thera	62472577	M	Makourodo	Il affirme que les initiateurs de la CRP sont des bienfaiteurs
11	18H06mn	11	11	Salvé Nathanel Thera		M	Damy.	Il encourage chacun à poursuivre l'arrachage du striga.
11	18H08mn	11	11	Adama Thera	70772116	M	Macorokuy	Il s'engage à arracher le striga chaque année dans son champ
11	18H11mn	11	11	Da'a Diarra	622.05737	M	Gnankandaga	Il affirme que "Qui veut, peut"
11	18H15mn	11	11	Damy Dembélé	64681769	M	Samorokuy.	Il apprecie la CRP.

Figure 49: Form currently used by Radio Moutian for callers that want to drop a messsage to programs

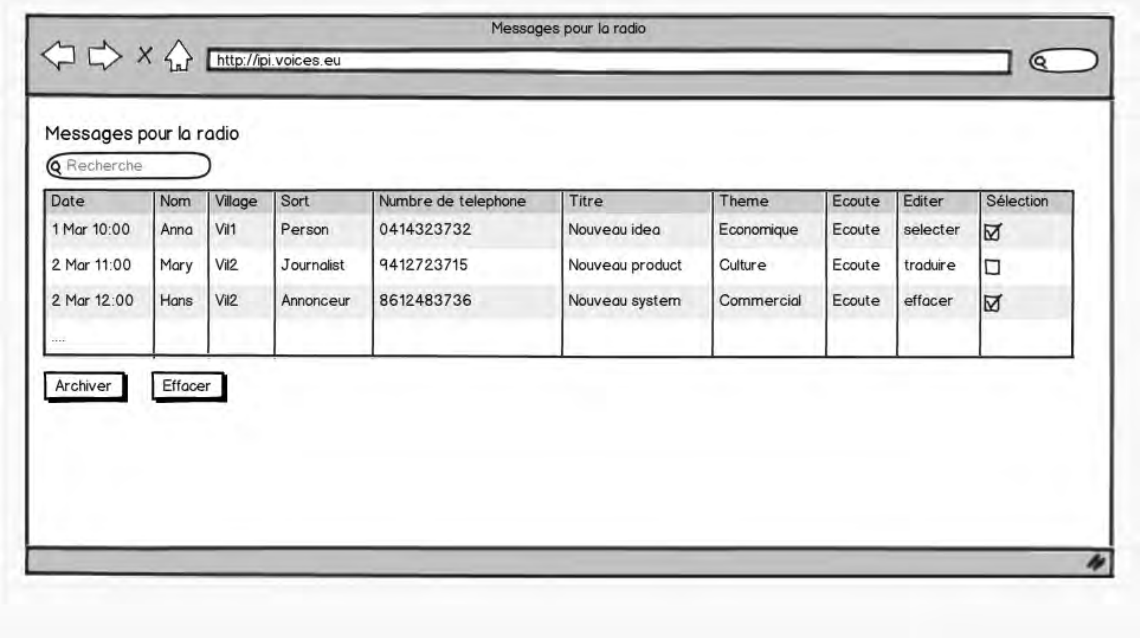


Figure 50: Building deploying testing evaluating

Voice-based Prototype of Foroba Blon

Dialogue to be recorded by local radio journalists

```
======== Interface Radio (francais) =========
Fin des messages
Pour ORTM Ségou, tapez 1
Pour Radio Moutian, tapez 2
Voici les messages de votre radio
Pour réécouter le message, tapez 1
Pour le diffuser à l'antenne, tapez 2
Pour l'effacer, tapez 3
Pour passer au suivant, tapez 4
Pour retourner au menu principal, tapez 5
Menu principal
Message effacé
Message suivant
Pas de messages
Je n'ai pas entendu votre voix. Veuillez recommencer.
Pour Radio Marché, tapez 1.
Pour les journalistes citoyens, tapez 2.
Pour le courrier des auditeurs, tapez 3
Vous allez entendre votre message.
Pour le garder, tapez 1.
Pour l'effacer, tapez 2.
Pour abandonner et revenir au menu principal, tapez 3.
Enregistrez votre message après le bip. Quand vous avez terminé, appuyez sur
une touche.
Pour enregistrer un message, tapez 1.
Pour gérer les messages de la radio, tapez 2.
Message enregistré.
Bienvenue sur la plateforme Radio.
Choisissez une radio.
Une erreur du système s'est produite. Veuillez réessayer.
======== Interface Journaliste (français, bambara) =========
* les prompts à traduire en Bambara
-Pour continuer en Bambara, tapez 1.
-Pour continuer en Français, tapez 2.
-Pressez n'importe quelle touche pour revenir au menu précédent, ou raccrochez.
-Vous allez entendre votre message.
-Pour le garder, tapez 1.
-Pour l'effacer, tapez 2.
-Pour abandonner et revenir au menu principal, tapez 3.
-Pour réécouter le message, tapez 1.
-Pour l'effacer, tapez 2.
-Pour passer au suivant, tapez 3
-Pour retourner au menu principal, tapez 4.
-Reportage effacé.
-Liste des reportages.
-Reportage suivant.
-Pas de reportages.
-Fin des reportages.
-Une erreur du système s'est produite. Veuillez réessayer
-Je suis désolé, mais votre entrée n'est pas correcte. Essayez à nouveau.
-Vous n'avez pas entré votre choix. Utilisez le clavier de votre téléphone pour
sélectionner un choix qui vous convient.
```

========= UC2 (Francais, Bambara, Dogou, Bomou) =========
-Pour continuer en Français, tapez 1. [en Français]
-Pour continuer en Bambara, tapez 2. [en Bambara]
-Pour continuer en Bomou, tapez 3. [en Bomou]
-Pour continuer en Dogon, tapez 4. [en Dogon]
Dans les 4 langues:
-Bonjour, bienvenue à Sahel Eco
-Bonjour. Ceci est un message de Sahel Éco.
-Je n'ai pas compris.
-Si vous comptez assister à l'événement, tapez 1.
-Si vous ne comptez pas y assister, tapez 2.
-Si vous ne le savez pas encore, tapez 3.
-Veuillez réessayer.
-Erreur du système: pas de message.
-Veuillez laisser un message après le bip. Une fois enregistré, vous pouvez raccrocher.
-Merci
-Au revoir

Fix Foroba Blon for Android

By Chris van Aart and André Baart

Context

Foroba Blon for Android (app) is a telephone answering machine. The user – in this case Adama - can record a welcome message, e.g. “Leave your message after the beep” and deploy an Android device for automatically recording messages, in this case radio listeners.

The original deployment was an Android device and headphones for playing the welcome message.

Issues

Difficulties were reported by the use of the Android version of Foroba blon. The user assumed that the headphones are not required. Furthermore, the user required wanting to know all recordings and download them to its laptop

Solution

It turned out that the auto answering function only works when the headphones are plugged-in. The recordings are stored on the SD card of the smartphone and metadata is stored in a (CSV) metadata file.

The complete setup with headphone, listen-back function and storage were demonstrated to the user. The user reported back to be very happy.

Next steps

The next version of the app will check whether headphones are plugged in.

(http://developer.android.com/reference/android/content/Intent.html#ACTION_HEADSET_PLUG)

Furthermore the app will display more instructions in French about the number of messages and the location of the recordings and metadata.

BIBLIOGRAPHY

[1] Heeks, R. (2017). Information and communication technology for development (ICT4D). Routledge.

[2] Bon, Anna, Francis Saa-Dittoh, and Hans Akkermans. "Bridging the digital divide." *Hannes Werthner· Carlo Ghezzi· Jeff Kramer· Julian Nida-Rümelin· Bashar Nuseibeh· Erich Prem·* (2024): 283.

[3 Fuchs, C., & Horak, E. (2008). Africa and the digital divide. *Telematics and informatics*, *25*(2), 99-116.

[4] Van Dijk, J. (2020). *The digital divide*. John Wiley & Sons.

[5] Potter, R. B., Binns, T., & Elliott, J. A. (2008). *Geographies of development: An introduction to development studies*. Pearson Education.

[6] Mubarak, F. (2015). Towards a renewed understanding of the complex nerves of the digital divide. *Journal of Social Inclusion*, *6*(1), 71-102.

[7] Bon, A. (2020). Intervention or Collaboration?: Redesigning Information and Communication Technologies for Development. Pangea Amsterdam. https://doi.org/10.26481/dis.20201215ab

[8] Bon, A. Akkermans, H, (Eds) (2011) Use cases and requirements. Technical Report D.1.1 VOICES. EU FP7, pp 1-146. https://w4ra.org/wp-content/uploads/2014/08/VOICES_D1.1-v1.0-VUA_FT-28Sep2011-final.pdf

[9] Bourque, Pierre, et al. "Guide to the software engineering body of knowledge (swebok) and the software engineering education knowledge (seek)-a preliminary mapping." *Proceedings 10th International Workshop on Software Technology and Engineering Practice*. IEEE Computer Society, 2002.

[10] Article about Dairy cooperatives in Mali Source: https://www.theguardian.com/journalismcompetition/mali-milk-production Accessed 13-1-2017

[11] Baart, A. et al.: Affordable Voice Services to Bridge the Digital Divide: Presenting the Kasadaka Platform, in Selected Papers from the WEBIST 2018 International Conference, Springer LNBIP Book Series, Berlin, Germany, 2019, in press.

[12] Baart, A., Bon, A., De Boer, V., Tuijp, W. & Akkermans, H., "Ney Yibeogo – Hello World: A voice service development platform to bridge the web's digital divide." 2018 WEBIST 2018 – Proceedings of the 14th International Conference on Web Information Systems and Technologies. Escalona, M. J., Monfort, V., Majchrzak, T. A. & Mayo, F. J. D. (eds.). SciTePress, p. 23-34 12 p.

[13] Bon, Anna, Jaap Gordijn, and Hans Akkermans. "E-Service Innovation in Rural Africa Through Value Co-Creation." Handbook of Research on Strategic Alliances and Value Co-Creation in the Service Industry. IGI Global, 2017. 355-373.

[14] Bon, Anna and Hans Akkermans: Digital Development: Elements of a Critical ICT4D Theory and Praxis, to be presented at the IFIP WG 9.4 15th International Conference on Social Implications of Computers in Developing Countries, Dar es Salaam, Tanzania, 01-03 May 2019, and to appear in the IFIP Advances in Information and Communication Technology (IFIP AICT) Conference Proceedings, Springer International Publishing AG, Cham, Switzerland, 2019, in press.

[15] Chapon, M., Tourette Diop, I., & Minta, O. (2010). Local milk sector in West Africa, role of RPOs, small

and medium farmers in the full growth of its potential. In Proceedings of workshop held in Bamako on september 15 through 17, 2010. Available at: www. inter-reseaux. org/IMG/pdf_2a2_FILLAO-SMALL-UK. pdf (accessed 13-1-2017)

[16] Cissé, Hamet (2016) Organization of pastoralists civil society in Mali. Internal report Swiss Agency for Development and Cooperation SDC and Agriculture and Food Security Network. Available at https://www.shareweb.ch/site/Agriculture-and-Food-Security/aboutus/Documents/pastoralism/pastoralism_brief_societe_civile_f.pdf (accessed 13-1-2017).

[17] Dittoh, Francis, Hans Akkermans, Victor de Boer, Anna Bon, Wendelien Tuyp, and André Baart. February 2021. Tibaŋsim: Information Access for Low-Resource Environments. Conference proceedings by Springer AISC. ISBN Number – 2194-5357 Series. [PDF].

[18] Dittoh, Francis, Hans Akkermans, Victor de Boer, Anna Bon, Wendelien Tuyp, André Baart. Mr. Meteo: Providing Climate Information for the Unconnected. 2019 Submitted to the WebSci19 Conference. Authors' version:

[19] Dittoh, Francis, Chris van Aart, Victor de Boer: Voice-Based Marketing for Agricultural Products: A Case Study in Rural Northern Ghana. Presented at ICTD Conference, Cape Town 2013.

[20] Anna Bon, Francis Dittoh, Gossa Lô, Mónica Pini, Robert Bwana, Cheah WaiShiang, Narayanan Kulathuramayir, André Baart (2022) Decolonizing Technology and Society: A Perspective from the Global South. In: Werthner H., Prem E., Lee E.A., Ghezzi C. (eds) Perspectives on Digital Humanism. Springer, Cham. https://doi-org.vu-nl.idm.oclc.org/10.1007/978-3-030-86144-5_9

[21] Rolland, Colette. "Capturing system intentionality with maps." *Conceptual modelling in Information Systems engineering*. Berlin, Heidelberg: Springer Berlin Heidelberg, 2007. 141-158.

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