Mobile Phone Application Based on Collaborative Conceptual Modeling (CCM) for sustainable development in Mali

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SUMMARY: Today, the introduction of information and communication technologies (ICT) in played an important role in daily life; it can be used as a tool to improved development. Sustainable development is a challenge for Sahel Countries and Mali in particular. Mali economy is mainly based on rain fall activity, which depends on weather variability. Reach sustainable development need efficient Collaboration between weather scientists, End users, ICT operators and decision makers. Based on CCM concept In this paper, we proposed and Agro_pastoral mobile service application based on android and cloud computing. The software is based on cloud android computing to store the data. Data are collected through meteorology agency, mobile phone, telecommunication operation and satellite data. The propose service will alert the farmers at the same time collect weather parameters from the registered users to cloud servers. Our application is reachable and also helps End user to plan the pre-post agriculture activities.

Keywords: Android and Cloud Computing, Internet of Things (IoT), Data Collection, CCM, Smart Sensors, Sustainable Development

I. INTRODUCTION

Few years ago the connection between climate change and conflict was contested by researchers [1]; but recently a correlation has been proved between climate variation, socio-economical situation and conflicts. According 2014 IPCC report, indirect causal connection between poverty and economic shocks amplified by climate change and intra-state violence [2, 3, 4], affecting the sustainability. A changing climate has exacerbated tensions causing water scarcity, food shortages, natural resource competition, underdevelopment and overpopulation.

As time passes the goal of sustainable development becomes a dream for most African countries, in general and Sahel countries in particular; due to the lack of efficient climate mitigation policy. Sustainable development is impossible without efficient weather data network collection, processing for better prediction. The recent development of ICT technology, computer science and remote sensors have give an opportunity to build an efficient weather data collection network.

However, planning an efficient decision for climate adaptation varies from location to location and country to country as it is influenced by government structures, legal systems, geography, national culture, and stage of economic development. [5, 6]. There is a big gap between the availability and delivery of agriculture inputs and agriculture infrastructure that can be a bridge by the use mobile technologies. Today the increasing penetration of mobile phone (smartphone) can be used to improve the resolution of the collected data, and the communication between End users data and scientists [7, 8].

ICT technology has played a powerful role in daily life even in developing countries. [3, 9, 10], Use mobile smart sensors (smart phone) in Agro_Patoral Business is an emerging field. Mobile smart sensors held device such as smart phones the most popular of ICT devices has increasingly became powerful year to year; because of the development of internet and wireless access. With the advent development of cloud computing application for android services, ICT can be used as an efficient for development, and social stability improvement tools [4]. In some countries

several services are been developed supported by smart phone, in order to improve the productivity of farmers. Very few of them have been developed in Sahel countries for population particularly in Mali [11,12].

Build an efficient application for sustainable development in order to improve the adaptation and resilience of human kind, due to the negative variations of climate, short and long term collaboration between all actors is necessary. This paper is organized as follow the next section is focused on the methodology of our approach. The third section discusses the efficiency of ICT for data collection to better plan sustainable development. All software application is based on computation in this paper we proposed cloud android computing, which is presented in section four; section five is focused on our proposed service. Finally, we concluded the paper in section six

II. METHODOLOGY

Climate mitigation and resilience due to climate change required collective learning and new modes collaboration between all actors. This challenge is firstly based on efficient data collection network; secondly design an appropriate weather data in order to manage the uncertainty (complexity); and finally, we used popular and efficient communication approach to communicate the processing result to End users and decision makers. The Sustainable Development Goals require new, evidence-based on science; because the most actors on agro- pastoral activities in Mali are characterized by their illiteracy; importance will be accorded to graphic data and video in local language.

The aim of this paper is to use ICT for monitoring climate change mitigate and resilience the negative effects of climate change remains a challenge for Africa and other developing countries [15,14]. An efficient used of ICT can help all users whom activities depend on climate variation to take necessary decision for better planning. The methodology is composes in three major steps:

data collection based on ICT tools: in this step telecommunication operator, satellite, ground and end mobile users data will be associated in data collection, in order to increase the resolution.

Data processing and simulation:, in order to transform the collect data into predictable data. One of a big problem for weather prediction is the climate information that reaches End users which information usually ill-matched to their demands and easily leads to misunderstanding of the uncertainties associated with it. This process is done by scientists, using recent weather advance processing theory. (3) finally; communicate the result of simulation to End users and decision makers; through smart phone application used cloud and android computing.

III. EFFICIENCY OF ICT SENSORS FOR DATA COLLECTION

3.1 Tools penetration in Africa

Advances in information and communication technology (ICT) over the past 20 years have enabled individuals to gather, analyze, and share data more effectively, as well as to visualize and understand, as never before, what this information means for sustainable development. With efficient weather collection network: farmers can make better planting decisions based on more accurate weather predictions and better prepare themselves to adapt the changing conditions. The decision makers can use more accurate information on local weather patterns. Another advantage is that because these data can be processed in real time by data collection platforms, the parties collecting the data can access them almost immediately.

The development of computer programming has allowed the creation of plethora new services applications and innovation that are integrated in mobile smart sensor. In developing countries the inventions in technology in agriculture domain are not getting to the farmers; because of either most of them are illiterates or due to unawareness of the location from where they can have information. Mobile applications in the arena of agriculture can be the best option to increase countries agriculture production [15,16]. Several mobile applications have been developed based on ICT to improve several fields: livestock management [17], agroMobile [18], Krishiville [19] etc.. Today farmers can received diverse facts or information about faming like seeds, crop selection, crop processing weather, fertilizer, pesticides etc. from various resources which are distributed on many different locations according to origin. Recently, African countries are experiencing major growth in the deployment to ICTs, and Mali is no exception. According ITU 2011 estimation 53 per cent of Africa’s population had a mobile-cellular telephone subscription [14]. The rate of mobile smart phone penetration in Sahel countries and particularly in Mali is more than 60% . Statistically 21 Million of mobile subscribers are been registered at the end of 07/2017; e. i. at least one phone [20, 21].

In general, Climate data collection is traditionally attributed to national meteorological agencies; in Sahel countries, this service is characterized by the scarcity and the lack of professional data collectors tools and experts on data processing; which is characterized by the lack of professional collectors and the quality of

collected data resolution. to improve the quality of collected data, ground data provided by meteorological agency must be combined with End users data (Mobile smart phone), telecommunication operators data and satellite data. The collection process must include all human groups which activities depending on climate; Fig 1.1 represented the main groups which must be associated.

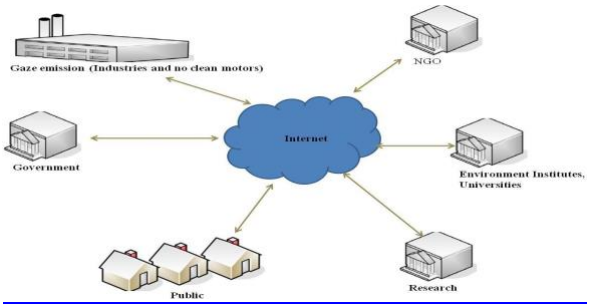

Fig 1.1 associate structure for efficient climate change modeling

Fig (1.1) represent the main socio-economical group which collaboration is necessary for efficient weather data, modeling and predicting. The concept of Collaborative Conceptual Modelling (CCM) is used between all stakeholders. this concept has been developed by Newell and Prousta [22]. The aim of a CCM exercise is to articulate, mesh and extend the mental models of the groups; which blends (a) a wide range of disciplinary research, (b) in-depth real- world experience, and (c) a broad view of the interplay between the parts of the overall system- of-interest.

3.2 Proposed weather data collection structure

Most methods of adaptation involve some form of technology, which in the broadest sense includes not just material and equipment but also diverse forms of knowledge. Promoting the development and diffusion of technologies with traditional knowledge as well as modern technologies for adaptation are important activities for improving and enabling adaptation to climate change to enhance the resilience of livelihoods and economies [21, 23]

Recent development of computer science and internet access development based on ICT support allowed communication and information to be provider everywhere, even in small farming.

The unprecedented adoption and convergence of mobility, cloud virtualization, computer science and security technologies is rendering smart phones becoming powerful tools of development.

Weather forecasting is deal with science and technology to predict the state of the atmosphere for given time and for a given location. Human beings have attempted to predict the weather informally using their experiences. By combining grown data, satellite data and smart sensors data, we can make a better prediction. For efficient data collection network sensors fig 1.2 is proposed.

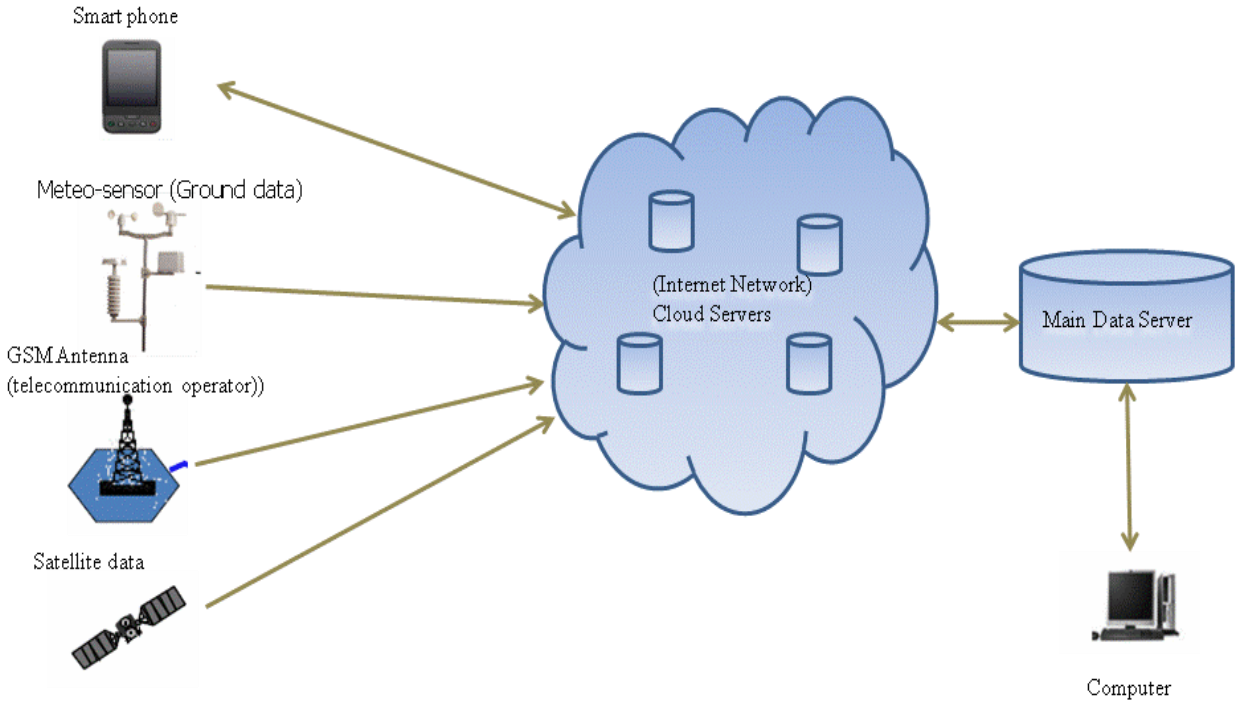

Fig 1.2 Structure of Data collection

Figure 1.2 represented the structure of our data, the main tools which are used are: traditional metrological agency, satellite, telecommunication operators through BTS (Base Transceiver station) and mobile smartphone through Google platform weather service. The combination of these tools allowed getting efficient resolution data. The data will be send on Google cloud platform IoT service. The Google cloud provides unprecedented scalability and resources for the collection and analysis of large-scale sensor data. [24].

IV. CLOUD ANDROID COMPUTING

4.1. Brief introduction of Cloud Structure

Cloud computing is based on three services (layers) concepts which are [for more information see reference [25]:

- (1) *Software as a Service (SaaS)*: implemented to provide application and process-oriented services to users. It's provides domain-specific service to registered users for using applications into cloud as a service over the Internet.
- *(2) Platform as a Service (PaaS):* provides all kinds of required software development life cycle model as design, development debugging, testing, and deployment tools.
- *(3) Infrastructure as a Service (IaaS):* the key characteristics of an IaaS cloud are scalability and elasticity, enabling computing resources to level up and down. This layer is also divided in three sub-layers: (i) Computing as a service (CaaS): it offers clients raw power for computing on virtual cloud services or virtual machine instances. CaaS gives users self-service interface for on- demand dynamic provisioning and management of virtual machine instances. (ii) Storage as a services. provides online demand storage service from cloud service to end users. In this project data will be store on government environment agency, research institutes , telecommunication operators or NGO working on environment area. (iii) Database as a service (DaaS): it is a sub- service model of IaaS, which standardizes processes for controlling, manipulating, and accessing (i.e., read, update, write, and deleted), Data in database are accessed by the cloud in the cloud storage and provided as DaaS to ends users and Scientist by a simple querying.

4.2 Advantage of using cloud computing

Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks, to provide dynamically scalable infrastructure for application, data and file storage. It is defined as applications that are delivered as internet services: where the hardware and system software

in the data centers are used to provide these services. This solution is useful for synchronizing information between several devices of different types, for example between the computer and the smart phone in addition, the data protection is more reliable compared to the ordinary computer. Three kind of data sharing concepts exist in cloud computing: Public, Private and Hybrid; we will selected an hybrid cloud sharing data mode, which combine public and private cloud properties. So, the simulate data result will be classified in two kind no-common data (data which has not bee process to eliminate the bias error or transformed as graphic) and common data (data which can be shared).

One of the most compelling assets of public cloud starage services is their ability to easily archive large volumes of data, without having to worry about the underlying management of the underlying structure.

Climate services need to meet users needs, capabilities and thus collaboration with potential users from an early stage of the service design process is necessary to provide products and services that are likely to be used, which h can be provided by cloud computing.

V. PROPOSED APPLICATION

5.1 Propose service diagram flow

We enhance existing application that retrieved a device's location with GCM(Google Cloud Mobile) features [26] using IoT based on android computing. Cloud IoT Core is a fully managed service that allows you to easily and securely connect, manage, and ingest data. Cloud IoT Core, in combination with other services on Google Cloud IoT platform, provides a complete solution for collecting, processing, analyzing, and visualizing IoT data in real time to support improved operational efficiency [Andrew L]. Use IoT data stream for advanced analytics, visualizations, machine learning and more to help you improve operational efficiency, anticipate problems, and build rich models that better describe and optimize your application.

An other advantage of Cloud IoT Core supports the standard MQTT (Message Queuing telemetry Transport) and HTTP (Hyper Text Transfer Protocol) protocols, so you can use your devices with minimal firmware changes. Google Cloud IoT Core runs on Google's serverless infrastructure, which scales automatically in response to real-time changes and adheres to stringent industry- standard security protocols that secure the receive and send data from cloud server or data collectors tools.

5.2 Service presentation

The aim of this project is to warning end users (agro-pastoral) by sending them weather information at the same time received them through their android weather data like: temperature, position, humidity, etc in order to improve resolution for better prediction. User can sign in their username and password. Considering the Ends users capacity limitation; we faced different design choices, integration challenges in realizing a decentralized, scalable, and easy-to-use solution. The purpose of our research was thus to overcome the limitations in the existing weather warning system by investigating a solution that will be decentralized, scalable, and easy- to use as well as provide real-time notifications while minimizing the uncertainty planning End users activities. Our solution is supported by mobile Android. The proposed service allowed End users to receive the past information of the weather as a graphic or number; and at the same time the daily weather information. For example, taking the decade of August 2018 we will send to the End subscriber application from Google Cloud platform, a graphic representing the rainfall or the number of precipitations during the past 30 years, and the estimated probability that to rain in the first decade of August. At the same time the proposed application will collect the weather information from the End user mobile phone and send them to the cloud server. This approach will help them to take appropriate decision to start their activities.

VI. CONCLUSION

The work presented in this paper is motivated by the limitations we observed with an existing severe weather warning system in Mali. In literatures, different applications are developed and used by farmers for their specific purpose in other countries. All these applications have different usage as per its functionalities, regarding the users activities. But many of them are static. The use case for this research was the bi-relation (real-time communication) between data collection and receiving from remote collect sensors, to remote cloud servers. In case user loss the mobile they can retrieve all the data through web. The main advantage of our propose service is dynamic. The server can distribute messages scalable to relevant android devices that are in the potential path of the weather incident. Also, the proposed application functionalities are bundle into the one single application and in the native language of the farmer, and then it is easy to utilize it.

REFERENCES

[1] Huq, Saleemul and Reid, Hannah. "A vital approach to the threat that climate change poses to the poor". International Institute for Environment and Development, 2007.

[2] IPCC TAR Climate Change 2001: Impacts, Adaptation and Vulnerability. IPCC Third Assessment Report, Cambridge University Press 2001.

[3] Salome Bronkhorst. Climate change and conflict: lessons for Conflict Resolution from the southern Sahel of Sudan . A report based on desk research and fieldwork conducted by the African Centre for the Constructive Resolution of Disputes (ACCORD), funded by the Swedish International Development Cooperation Agency (Sida), 2012 Salome Bronkhorst

[4] Prf Alhousseini Bretaudeau. Unite Nations Environnent Programme. Livelihood Security: Climate Change, Migration and Conflict in the Sahel. Climate change, conflict and mitigation in the Sahel 2011

[5] Black, R., et al., Adapting to Climate Change: A Risk-based Guide for Local Governments, 2010 October, vol.1, p.1

[6] Maani, K 2013, Decision-Making for climate change adaptation: A systems thinking approach, National Climate Change Adaptation Research Facility, Gold Coast, 66 pp

[7] Heeks, R. (2010). 'Coherent ICT-for-Development Policies', paper presented at the workshop Policy Coherence in the Application of Information and Communication Technologies for Development, Organization for Economic Co-operation and Development (OECD) and info- Dev, Paris, France, 10-11 September.

[8] Anup Prakash Upadhyay, Arvind Bijalwan. Climate Change Adaptation: Services and Role of Information Communication Technology (ICT) in India. American Journal of Environmental Protection 2015; 4(1): 70-74

[9] Haruna Iddrisu, Sherry Ayittery, Daniel Amialo, Malcolm Johnson, Christiana Figueres. Information and communication technologies (ICTs) and climate change adaptation and mitigation: the case of Ghana. Ministrer of Communication , Republic of Ghana ITU 2013

[10] Ann Weeks, Malcolm McCaskill, Mathew Cox, and Subhash Sharma. An SMS and Email Weather Warning Systemfor Sheep Producers. Environmental software systems Infrastructures, services and Applications. IFIP International Federation for Information Processing 2015, 131-140

[11] Kya Abraham Berthe, Oumar G. Traore, Abdoulaye Traore, Yanyang. Maitrise des Technologies de l'information et de Communication (TIC) et la presence de nos langues dans le Cyberspace outils necessaire pour la Decentralisation. 3eme Colloque inter universitaire « Turin-Sahel » Bamako 2005. P 23-34

[12] Kya Abraham Berthe, Oumar G. Traore, Abdoulaye Traore, Yanyang. Technologies de l'information et de la communication (TIC) outil approprie pour la Decentralisation. 3eme Colloque inter universitaire « Turin-Sahel » Bamako 2005. P 192-206.

[13] Republic of Ghana. (2011) Ghana's Second National Communication to the UNFCCC, http://unfccc.int/resource/docs/natc/ghana_second_nationalcommunication_final_version.pdf

[14] ITU Statshot, August 2011 www.itu.int/net/pressoffice/stats/2011/03/index.aspx

[15] Hetal Patel and Dharmendra Patel. Survey of android Apps for Agriculture sector. Internationsl jornal of information sciences and techniques (IJIST) vol. 6. No. ½, March 2016

[16] Steinberger. G. Rothmund, M. & Auermhammer, H. (2009). Mobile farm equioment as a data source in an agricultureal service architecturel. Computers and Electronics in Agriculture, 65(2), 238-246.

[17 heta]Voulodimos, A. S. Patrikakis, C. Z., Sideridis, A. B., Ntafis., V. A. & Xylouri, E. M., (2010). A complete farm management system based on animal identification using RFID technology. Computers and Electronics in Agriculture. 70(2), 380-388.

[18] Prasad, S., Peddoju. S. K. Ghosh, D. (2013). AgroMobile: A Cloud-Based Framework for Agriculturists on Mobile Platform. International Journal of Advanced Science and Technology, 59, 41-52.

[19] Singhal, M., Verma, K. & Shukla, A. (2011), December). Krishi Ville, Android based solution for Indian agriculture. In Advanced Networks and

Teleccommunication Systems (ANTS), 2011 IEEE 5th International Conference on (pp. 1-5). IEEE

[20] National jornal of AMRTP (Agence Malienne de Regulation de Telecommunication et des Postes) Frequence la revue, N0 37 of July –septembre 2017 pp 14 – 19

[21] UNFCCC. (2007) Assessing Climate Change Impacts and Vulnerability: Making Informed Adaptation Decisions, United Nations Framework Convention on Climate change (UNFCCC), http://unfccc.int/files/adaptation/application/pdf/11unf051_nwp-wasweb[1].pdf p: 36-41

[22] Newell, B. and Proust, K. (2012) Introductionto collaborative conceptual Modeling Working Paper, ANU Open Access Research.

[23] Hetal Patel and Dharmendra Patel. Survey of android application for agriculture sector. International Journal of Information Sciences and Techniques (IJIST) Vol.6, No.1/2, March2016

[24] Yu-Pin Lin, Tsun-Kuo Chang, Chihhao Fan, Johnathen Anthony, Joy R. Petway, Wan-Yu Lien, Chiu-Ping Liang and Yi-Fong Ho. Applications of Information and communication Technology for Improvements of Water and Soil Monitoring and Assessments in Agricultural Areas – A Case Study in the Taoyuan Irrigation District Environments 2017, 4, 6.

[25] Blesson Varghese. Next Generation Cloud Computing: next Trends and Research Directions. Future Generation Computer Systems, 07 September 2017.pp1 -22.

[26] Mohd Afizi Mohd Shukran, Kamaruzaman Maskat, Wan Sharif Sham Sharif, Mohd Sidek Fadhil Bin Mohd Yunus, Mohd Suhaili Ariffin. Proposed system model for android augmented reality system in Malasia Military Operations – Unit Positions. Applied Mechanics and Materials Vols 548-549 (2014)

[27] 27 Andrew L. Molthan, Jonathan L. Case, Jason Venner, Richard Schroeder, Milton R. Checchi, Bradley T. Zavodsky Ashutosh Limaye, and Raymond G. O'Brien. Cloud in Cloud: Weather forecasts and applications within cloud computing environments. American Meteorological society August 2015 BMS pp 1369-1379.