MAPPING OF PUBLIC RURAL WATER SERVICE IN TANZANIA: A CASE OF DATA UPDATING

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FEBRUARY, 2014

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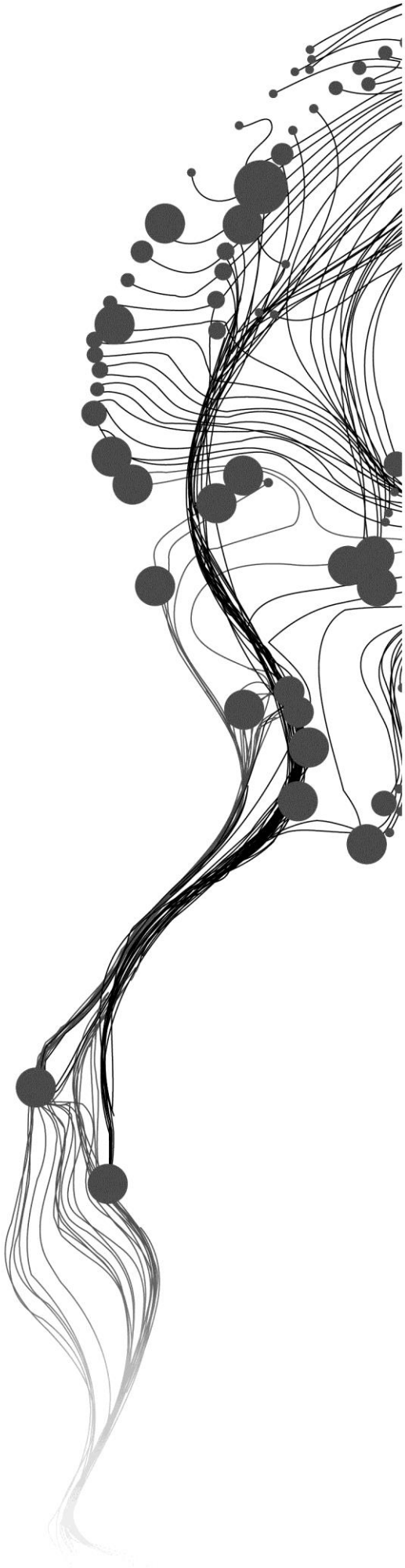

MAPPING OF PUBLIC RURAL WATER SERVICE IN TANZANIA: A CASE OF DATA UPDATING

SINGOLILE ABBY MWAMWAJA
Enschede, The Netherlands, February, 2014

Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation.

Specialization: Governance and Spatial Information Management

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ABSTRACT

Fresh water is a basic natural resource; which sustains life and provides for various socio economic needs. Therefore information about water sources is fundamental for effective utilization of the resource. Water problems have traditionally been considered a local or regional issue. It is common for rural residents to travel distances for more than two kilometers every day in search of water sources. Reason behind is unreliable data, lack of access to geographical information and duplication of data that is poorly harmonized, structured and documented. Lack of information on the current status of water points includes water supply coverage, functionality, management systems and particularly water quality.

The study focuses on identifying the mechanisms behind mapping water points and updating the available open data on water points in Tanzania and suggests improvements. The study analyzes baseline information that is available online. This includes a database of more than 65,000 water points in 20 regions. Furthermore, the study evaluates the different mechanisms applied in water data updating within Tanzania. Finally the study examines the usability of the information acquired from WPM for planning purposes, decision making, monitoring WPM status, rehabilitation for the project and an increase of responsibility to citizens and government as well.

The study uses different data collection techniques to investigate how mapping is being done. These include focus group discussions, field observations and interviews of key informants.

It was found that the status of water points is different basing on the used definition of a functional water point. As a consequence it is difficult to establish water point coverage in Tanzania.

Results obtained indicate that Community Owned Water Supply Organization (COWSO) is the main component updating system that Ministry of Water in Tanzania aims to use. This updating system however entails paper work and can easily take long time before feedback is sent to the community. It is advised to use a system based on modern mobile technology that allows the community/citizens to get feedback instantly. Thereby giving citizens a sense of ownership as government is made accountable. It is suggested that through active communication with citizens and by giving more responsibility to local government authority (LGA) water data updating could become more effective and efficient.

Keywords*: Water Point mapping, Updating Mechanism, Updating tools, Water Point mapping System, COWSO.*

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I say may God bless you all abundantly.

DEDICATION

To my lovely mother;

Regardless of the distant and length of time of separation for eighteen solid months (Sept 2012-2014 March) you have been my pillar spiritually in prayers and social well-being. Amid your poor and enduring health you have continued to advice and direct me what is required of me to humble and honour God by listening to his voice and to do His will and let His will be mirrored in me.

It is for this reason I have decided to dedicate this work to you my lovely mother Mary Andrew Mwamwaja and the Mwamwaja family.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATION AND ACRONYMS

ANOVA	-	Analysis of Variance
COWSO	-	Community Owned Water Supply Organization
DWE	-	District Water Engineer
FLOW	-	Field Level Operations Watch
Fn	-	Functional
GIS	-	Geographical Information System
MDGs	-	Millennium Development Goals
NBS	-	National Bureau of Statistics
NGO	-	Non-Governmental Organization
NonFn	-	Not Functional
RWE	-	Regional Water Engineer
RWSN	-	Rural Water Supply Network
RWSSP	-	Rural Water Supply and Sanitation Programme
SPSS	-	Statistical package for Social Science
URT	-	United Republic of Tanzania
WPM	-	Water Point Mapping
WPMS	-	Water Point Mapping System
WSSCC	-	Water Supply and Sanitation Collaborative Council

GLOSSARY OF TERMS

COWSO - According to Act No. 12 of year 2009 Par. 31, COWSO means Community Owned Water Supply Organization established and registered, under such act comprising a group of households, a village or group of villages who receive their water supply from a common source or one or more water points or a waterworks (URT, 2013d).

Water Point (WPT) - the point, at which water is intended to emerge from a public, improved water supply, such as a tap (SNV, 2010).

Water services – this refer to infrastructures, stakeholders or mechanisms to ensure access to drinking water on a territory administered by a service authority. Infrastructures include all types such as wells, protected springs, mechanised boreholes, hand pumps, water schemes.[1]

Functional - A WPT is functional if it yielded good quality water during the survey or it had no technical problems even if water was not present in a water point but it is available seasonally (URT, 2013e).

Nira/Tanira Pump –is a direct action pump for Low Lift Wells. It uses a buoyant pump rod that helps to reduce the forces on the handle. It is designed for heavy-duty use, serving communities of 300 persons.[2]

Non-functional - A WPT is non-functional if it did not yield water for more than six months of the year. Reasons for non-functionality such as being dry, poor water quality (for example too salty or too much fluoride), or due to management (WPT closed because it is not economic to place tariff collector at WPT due to under use). Non-functional also includes those WPT that are under construction but not yet operational (SNV, 2010).

Percentage of Functional WPT - The percentage of functional water points is calculated by taking the number of functioning water points divide by total number of water points multiplying by one hundred. *Calculated using: (No. of functional WPT/Total no. WPT)*100* (SNV, 2010).

Water point coverage - The number of water points per 1000 people.
*Calculated using: (No. of WPT/Population)*1000)* (SNV, 2010).

Equity in distribution - This indicator captures the difference in WPT coverage between areas. It is an expression of the average deviation from the mean WPT coverage of the areas being considered. The greater the average deviation, the greater the inequity in distribution of water points. Zero represents perfect equity, meaning that all areas have the same level of service (SNV, 2010).

Full coverage - According to the Tanzanian National Water Policy, full coverage equates to 1 WPT per 250 people. This equals to coverage of 4 WPT per 1000 people (URT, 2002b).

[1] http://www.irc.nl/page/82341 (Call for Abstract in Monitoring and evaluation of water and sanitation services in rural areas and small towns in West Africa)

[2] http://www.rural-water-supply.net/en/implementation/proprietary-handpumps/nira-af-85-pump

1. INTRODUCTION

1.1. General Introduction

This chapter briefly explains issues concerning water point mapping and its implication in Tanzania. The following sections explain about the justification of the research, the definition of the problem, the research objectives and research questions as set for the study. In addition, an overview of research methods is given and finally the thesis structure is explained.

1.2. Introduction and Justification

Fresh water is a basic natural resource which sustains life and provides for various socioeconomic needs. In its natural state, water is an integral part of the environment whose quantity and quality determine how it can be used (URT, 2012). Therefore, information about water sources is fundamental for effective utilization of the available water sources. According to United Nations *et al.* (2010), 884 million people do not have access to improved sources of water, and 2.5 billion lack improved sanitation facilities. Water problems have traditionally been considered a local or regional issue. Throughout the region, it is common for rural residents to travel distances for more than two kilometers every day in search of water sources. Such a burden has led many researchers to the conclusion that the usefulness of available water sources must be correlated to accessibility through the provision of the right information on the status of water points (Mellor *et al.*, 2012).

Water point Mapping (WPM) is the tool for collecting accurate data and gets an overview on the existence, functionality and status of improved water points constructed, and the effect this has on the communities using it. The information is collected using GPS and questionnaires that are appropriate to each water point. The Data are entered in GIS for correlation with demographic data such as population and administrative boundaries. Finally the functional coverage information is displayed through digital maps for further action.

For WPM, the biggest challenge is updating of the database as was declared by Glotzbach (2008). This problem has been proven by Hambadiahana *et al.* (2012) pg. 12 that; *In DR Congo "Data are not very reliable due to the lack of access to geographical information and multiplication of different data that is poorly harmonized, structured and documented. Furthermore there is a lack of information on the current status of water points, including water supply coverage, functionality, management systems and particularly the water quality".*

The Government of Tanzania aims at more sustainable rural water sources as it is implementing an ambitious rural water supply and sanitation plan to increase access to water from 53% in 2005 to 90% by 2025 (WHO, 2000). However, the management of water also involves the participation of all stakeholders in order to achieve sustainable access, efficiency, equitable use and adequate protection and conservation of water (URT, 2002a). There is a huge amount of data about water sources that require adequate data storage capability and processing power, both of which can become available through GIS to provide useful information.

For instance, the application of GIS during analysis provides map that shows the functional status of water points. This can help to inform targeting data user, decision maker and policy developer for improving water services in rural areas (Kistemann *et al.*, 2011). However, there is a need for a well tried-

out appropriate tool for reporting the demand of updated information on water points coverage to the user (Houndebasso Ahoga, 2009).

According to the Tanzania Water Sector Development Programme (WSDP) one of the objectives of vision 2025 is to achieve an absence of abject poverty and attaining high quality of life for all people. Where by the access to safe water in rural areas is targeted to rise for an increased proportion of the rural population with access to clean and safe water (URT, 2011).

The current available online water point mapping database shows an average functionality rates of 62% (URT, 2013c). This declared Tanzanian Government has a long way to go in achieving its vision by 2025 coverage of 90% especially for the rural areas. Figure 1-1 below shows coverage trends in the rural areas. This actual trend shows in fluctuation rate as caused by lack of updated data, reporting and GIS expertise to handle the large database. Therefore; this study will look upon the appropriate mechanism of data updating and reporting, since potential of water point mapping can only be realized if mechanisms are in place to regularly update the data as out-of-date maps value is diminished. Moreover data updating will increase stakeholder co-ordination and effective planning.

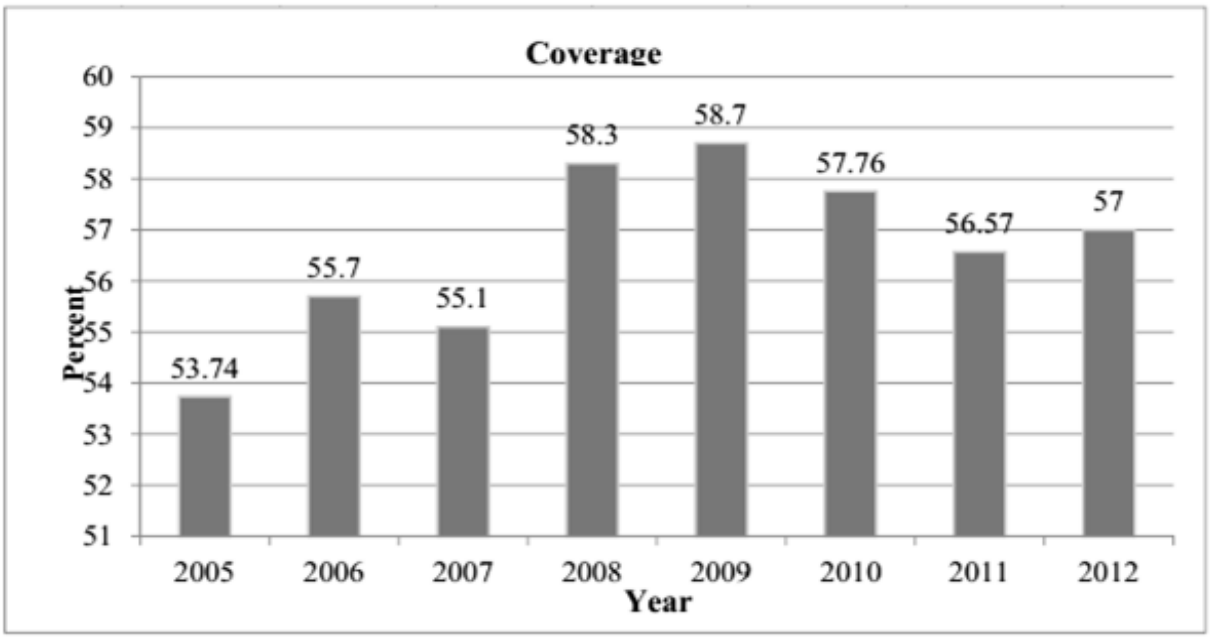

Figure 1-1: Rural Water Supply Coverage in terms of people with access to water supply (URT, 2013g).

1.3. Research Problem

Data updating and reporting water point mapping information has been the major challenge for Tanzania. It was categorized as "Operational Challenge" especially in establishing sustainable mechanisms for regular updating of water point mapping data and in institutionalizing water point mapping within routine local and national government planning and monitoring processes. Another challenge is lack of skills to update complicated sector databases from the district to the national Level (WaterAid, 2010).

Despite the efforts made by the Government to share available data online to combat the existing problem of monitoring water points functionality, there has been little systematic mechanism of data updating. The use of GIS is not open to the public, but to system administrators only. However, according to the Tanzania government water policy the information is supposed to be disseminated to the

user/local people because they are the ones who are affected for effectiveness utilization of water sources by society.

The current applications of digital mapping and GIS cover a variety of issues in the field of water and health (Kistemann *et al.*, 2011). Nevertheless, several innovative 'participatory sensing' initiatives are under way in Tanzania. They can be seen as local manifestations of the global notion of Digital Earth. The initiatives aim to amplify the voice of ordinary citizens, improve citizens' capacity to directly influence public service delivery and hold local government accountable. The popularity of these innovations is, among other things, a local reaction to the partial failure of the millennium development goals as a result of lack of information (Georgiadou *et al.*, 2011).

Eventually the argument made by Welle (2010b) strengthens the reality that, updating of the information basing on water point mapping data has become more useful in other countries like Ethiopia whereby it helps in capacity building, but the availability of water point mapping evidence in itself does not bring about any changes. The information needs to be made accessible to different actors and its use be encouraged. This is how WPM can enhance transparency and accountability. That is why data updating and reporting is necessary to Tanzanian government.

1.4. Research Objective

1.4.1. General Objective

To identify the mechanism behind mapping water points and updating of the available open data on water points in Tanzania and suggest improvements.

1.4.2. Specific Objective

The specific objectives and research questions have been formulated with regard to general objective as illustrated in the table 1-1 (Matrix table shows specific objectives with the correspondence questions).

Table 1-1: Matrix table shows specific objectives with the correspondence questions

Specific Objective	Research Questions
To examine the information collected for water point mapping.	❖ What information is collected by water point mapping and Why? ❖ How water point mapping is done regarding data capturing, storing, access and sharing? ❖ Which correlations exist within the WPM database and why?
To examine the usability of water point mapping data/information.	❖ Who uses the information and for what purposes? ❖ What requirements and demands are there for water point data?
To identify the issues arising in water points updating.	❖ What tools are used in water point mapping and updating? ❖ What mechanism is used for water point information updating?
How can water point mapping information be used more effectively?	❖ Can data fusion improve the usability of water point mapping data? ❖ What improvements can be made to the updating mechanism?

1.5. Conceptual Framework of the Study

Figure 1-2 represents the general idea behind the study to be undertaken. This is a conceptual framework of the study that focuses mainly on the tools and mechanism of data updating and how to improve them. These connections show how Community Owned Water Supply Organization (COWSO) members use them to report on water points that will bring efficiency as well as usefulness within the water sector. Thus, the COWSO reporting is captured in the water point mapping database that serves as a means of automatic updating of data. With the regularly updating of data, information can be timely derived to help in decision making process. This shall help enhance or improve the existing tools and mechanisms thus bring efficiency within the whole system of operations and monitoring of the database. Besides, Georgiadou *et al.* (2011) pg.4 states that, the *"initiatives of mobile technology aiming to amplify the voice of ordinary citizens, improve citizens' capacity to directly influence public service delivery and hold local government accountable"*.

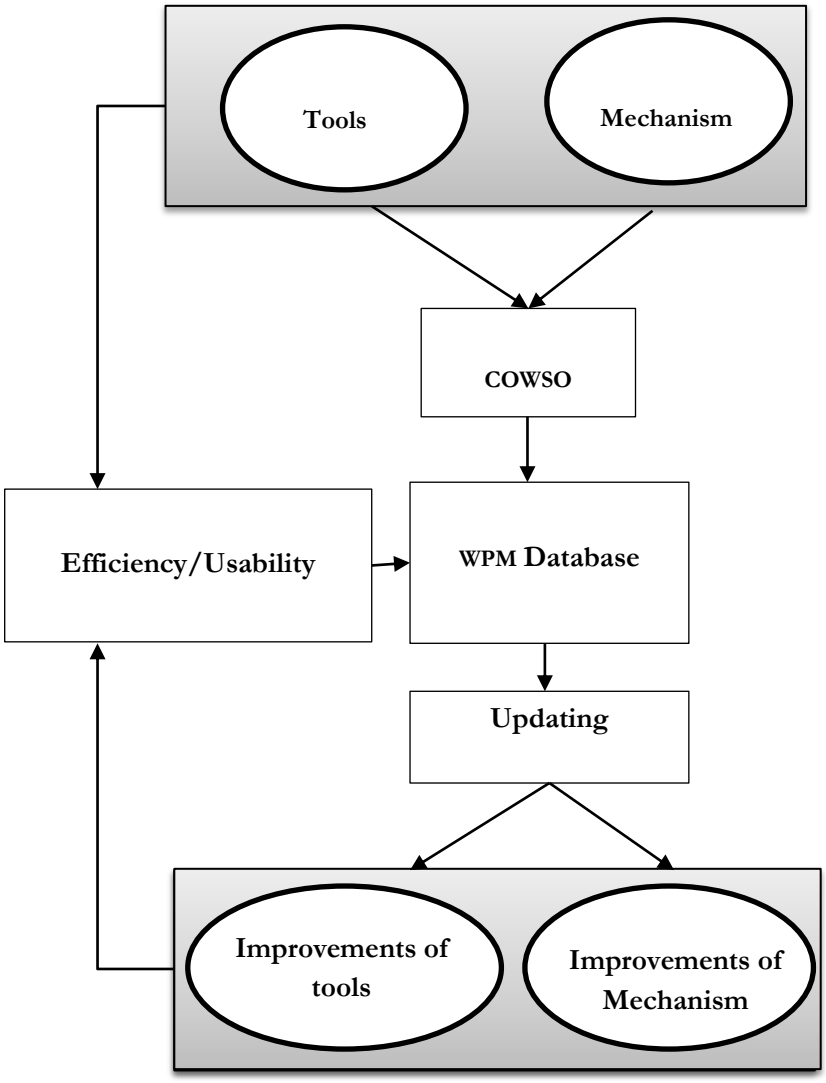

Figure 1-2: Conceptual Framework of the study

1.6. Overview of Research Design and Methodology

1.6.1. Methodology

The secondary data source of the open database was beneficial in analysing the coverage of the functionality of water points with other demographic surveyed data such as population in Tanzania to see

the effect of functionality coverage within the regions. Furthermore, the study applied a case study approach and was established in combination with qualitative and quantitative methods in order to collect different views and being a guard for the authenticity of the results and empirical findings (Johnson *et al.*, 2004).

Given the scope and time-frame of this thesis, focus group discussion method has been used in a combination of District water engineer (DWE) and technicians in order to get insightful details on the usefulness of the data and to know what they do like to do with the data and how often the data should be updated.

The study has used guided interview tool, to user/user group as water point committee, key informants in government such as water managers, mapping agencies, and other stakeholders as (Wamiruvu) and iWash. This help to bring in-depth output of reality on the requirements and demands of the information of water points as well as improvements that can be done in updating mechanism because different people want to have different demand of report of water points and update. Table 1-2 explains the matrix method with correspondent's tools.

Table 1-2 : Matrix Methods and corresponding tools and consequently how the results were analysed

Objectives	Questions	Tools	Analysis
Examine the information collected for water point mapping	What information is collected by water point mapping and why?	• Focus group discussion.	• Correlation of functionality coverage with other demographic data.
	How water point mapping is done regarding data capturing, storing, access and sharing?	• Online dataset	• GIS application in developing maps to show functionality status.
	Which correlations exist within the WPM database and why?	• Interview with key informants.	• Ms. Excel to show (%) of coverage in different regions.
Examine usability of water point mapping data/information	Who uses the information and for what purposes?	• Interview with key informants.	• Excel analysis to show the usefulness of data gained
	What requirements and demands are there for water point data?	• Focus Group Discussion	• List of requirements and demands for water point data.
Identify the issues arising in water points updating	What tools are used in water point mapping and updating?	• Direct observation	• List of tools used in water point mapping and updating.
	What mechanism is used for water point information updating? And Why?	• Interview to mappers	• Excel in showing graph of different mechanism used
How can water point mapping information be used more effectively	Can data fusion improve the usability of water point mapping data?	• Secondary data from different reviewed sources.	• Excel in showing coverage status.
	What improvements can be made to the updating mechanism?	• Interviews to key informants	• Use Case diagram on (Enterprise Architect) to indicate how the process is supposed to be.

1.7. Research Design

Given the focal multi – year project of water point mapping that have been undergone in Tanzania, the study has employed the case study approach and has had three basic phases that are pre field phase, field work phase as well as post field work phase; that has focused on developing proposal, data collection and data analysis respectively. Other methods have included secondary data collection, literature review, field observation, interviews with key decision makers using questionnaires and my own experience of having participated in some of the water point mapping workshops. Figure 1-3 summarizes the whole structure of proposal development and research design.

1.7.1. Pre-field Work

The presence of online database on water point mapping data has enabled to examine the information collected on WPM and being able to view the reality by the time being. Other elements during proposal development were formulating problem gap and justifying, developing research objectives and questionnaire, lastly research design and methodology that have been applied. Tools and techniques have been reviewed to get clear picture of the problem that is associated with mapping updating especially on WPM in Tanzania.

1.7.2. Field Work

This has been a practical time whereby tools for data updating and reporting has been identified as well as the issue arising in water point updating has been discussed, and finally the usability of water points mapping information has been explained in detail. The exercise involved the data collection process, both primary and secondary data from different communities and institutions. Primary data have been obtained through interviews and questionnaire from targeted respondents, and through observation, while secondary information has been obtained from Geodata Consultancy Ltd, National Bureau of Statistics (NBS), Ministry of water and other literature reviews and reports.

1.7.3. Post-field Work

The results from the field have verified the goodness of data updating and reporting mechanisms. At this juncture, the data obtained has been analyzed and processed by using Microsoft Excel to calculate the coverage of functional and non-functional water points, Arc GIS to develop the different maps showing the reality of the fieldwork and SPSS to show the correlation between water point with other surveyed data in the respective area on how they integrate each other. The calculation parameters are as shown in a matrix table 3-2. Additionally, this part shows clearly the extent to which the output answers the research questions hence helping to meet the objective identified.

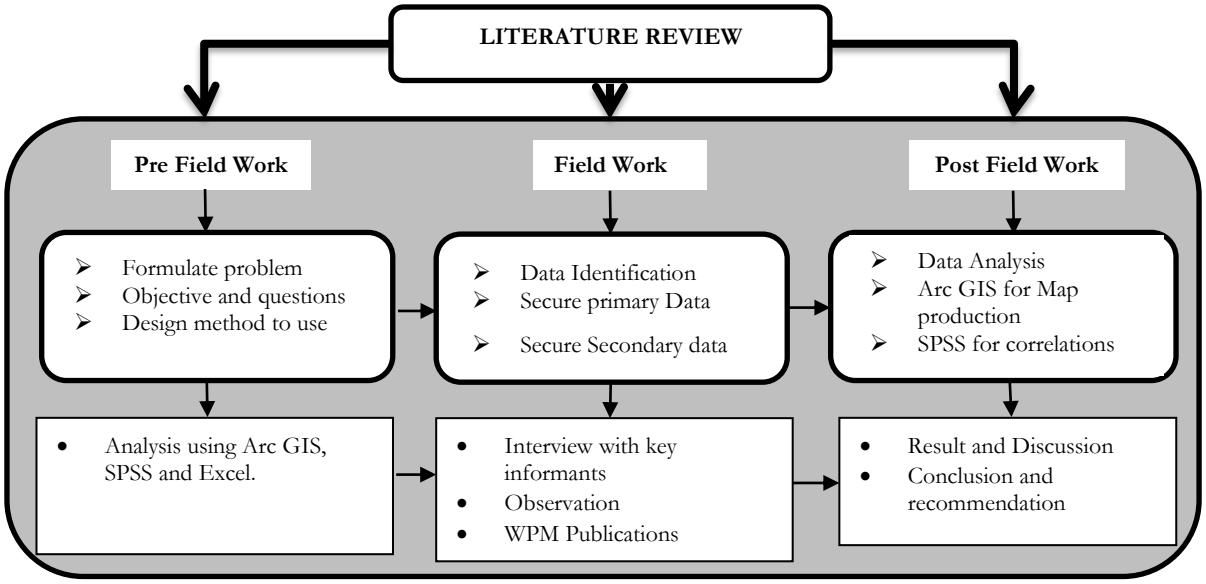

Figure 1-3: Structure of proposal development and research design.

1.8. Thesis Structure

The organization of this thesis is as follows; Chapter 1 is all about the introduction whereby it includes the general background of the research and justification. Chapter 2 continues with a literature review. Chapter 3 explains the study area, the research problem, objectives and questions. Chapter 4 elaborates findings on the research, data collection, processing and approaches together with observations of the research. Chapter 5 discusses specifically reports on the preliminary findings that are relevant to answer the specific objectives basing on different questions pointed out. Chapter 6 finally, provides for conclusion and recommendations of the research as synthesis work done in the whole study as figure 1-4 explains below.

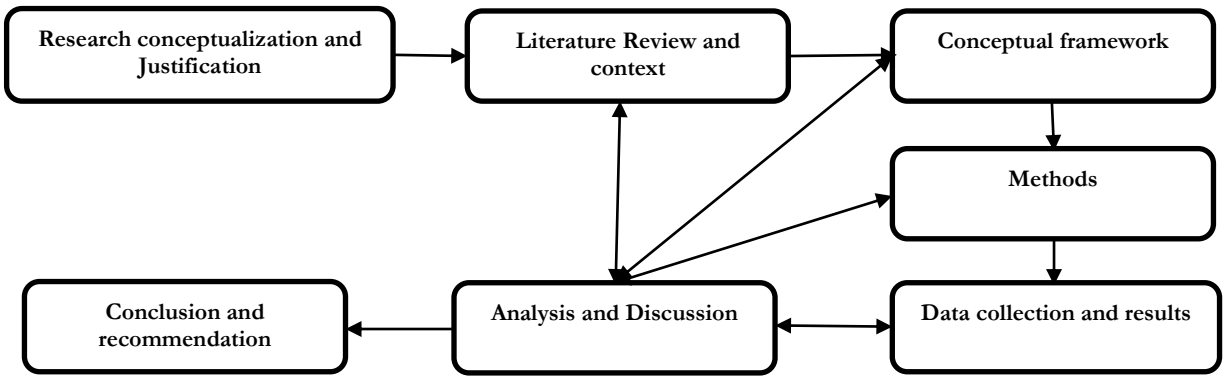

Figure 1-4: Thesis structure

2. HISTORY AND BACKGROUND ON WATER POINT MAPPING IN TANZANIA

2.1. Literature review on Rural water Supply Information

Access to water is crucial for the existence of human being and sustainability of their livelihood. In order to ensure uninterrupted access to water, the coordination and maintenance of water point is crucial. Among these activities geared towards ensuring endless access to water is the mapping and update the information about these water points. According to Prasain (2011) pg. 8, "*Safe drinking water and basic sanitation are essential needs for modern human beings. Access to safe water and sanitation plays a vital role in the overall socio-economic development of any community or country. Therefore, this sector should be given high priority for development in a sustainable and socially acceptable manner with the use of appropriate technologies*". Lack of quality, timely information on rural supply of water is one of the biggest challenges facing the sector in Tanzania today as results in dysfunctional of many water point and projects. In other words, it is impossible to solve a problem which you hardly know. How will you plan for the new investment and rehabilitate the old schemes? How to assess the sustainability of technologies and management styles and argue against political pressure to invest in areas with well above average coverage without the right information? Since having the right information will help to update data.

Mapping once is hard; keeping maps updated regularly is even harder. Data analysis needs specialized GIS skills, this is by far the biggest challenge facing any on-going monitoring tool and unfortunately there is no simple answer to the latter. There are several possible solutions to this problem and new technology which can make data collection and management more user-friendly, scalable and sustainable such as; the use of mobile phone, the use of FLOW system as it is being used by Liberian society and water Atlas as it has been used by Ugandan society (Pearce *et al.*, 2013a). These can also be adapted and contextualized to be used in Tanzania.

The process of carrying out mapping (surveying, analysis and feedback) and the active participation by the future users of information is crucial in order to encourage a continued use of the tool. In addition, carrying out mapping is only the first step in a long process of engagement. In this context, lack of a systematic mapping updating system remains a major bottleneck in Tanzania (Welle, 2005). Even though it is acknowledged that an important aspect requiring reflection by clients, partners and national governments is data updating but time and costs are major restraints. Linking Water Point Mapping to local stakeholders and national policy is said to not only improve information flow, but also to reduce cost and avoid duplication (Pearce *et al.*, 2012).

Updating of mapping information is not carried out in a systematic manner as it has been seen as example in Salima district in Malawi, whereby the District Coordination Team updates new water points on an annual basis with technical assistance from Water Supply and Sanitation Collaborative Council (WSSCC) who produces new maps. Despite the use of water point mapping as an information tool, it's potential remains underexploited because there is inadequate published reliable information system that shows the status of water services across the region in Tanzania (Jimenez *et al.*, 2010). Basically this can be done once having a website based system that could be accessed by any authorized person with access to the internet or via mobile phone messages to report changes in the functionality status of a water point and other attributes such as a number of users per point.

The work of information updating claimed to be more costly, for instance regarding the case of Sierra Leone that includes the costs of data use and updating for sustainable systems. But the use of data updating is to enable comparison between different approaches and data in different contexts and plan for the long-term use, and update of the mapping data itself (Pearce *et al.*, 2012).

It is clear that when we want to have an improved monitoring and regulated mechanisms we are supposed to have clear and updated water point mapping data for closer on-going monitoring of sustainability (WaterAid, 2009). The importance of these data can be seen after realizing the exact mechanism that have to be put in place to collect and regularly update the data and if there is willingness from the Government to use WPM as a tool for more transparent and equitable resource allocation (SNV, 2010).

According to Hirn (2011a), in order to be in a good system it is better to identify contact person in the organizations active in the water sector in order to ensure a sustainable, long-term updating of the database, this will ease the view of the map online and other detailed raw data (Excel, Shape, Stata). This is also revealed by Water Aid once they say "keeping data Live" and useful is paramount because data and maps must be "owned" by lowest appropriate decision making structure, to help emphasis on the tool and the technologies as well as updating mechanisms using pre-existing network staff. Although WPM is not a "once-off" exercise, but must be complemented with development of a consistent monitoring and evaluation framework and establishing procedures and systems for continued updating (GPS + Spread sheet + Google Earth = Updated Map)(Koroma, 2012b).

In Morogoro, Tanzania for example, a place that used to be very beautiful with plenty of water flowing from the slopes of the mountains, nowadays very little water is flowing (Uisso, 2012). The area is currently marked with a serious water shortage. Only 49% of the population in rural areas have access to water (Nassoro, 1997). That is why new mapping technique is necessary in such a region because water diminishing subjects children, particularly girls, to being denied with their right to education as they are forced to spend most of their daytime fetching water. The study will contribute towards data updating mechanism and reporting on water point status. This will reduce the challenge facing the region and finally put the government in a more accountable way.

In knowing that information is power, Anokwa (2013) declared that; decision making relies on timely and relevant information by government to the public use, in the sense that the information must be technologically inclined so as to provide the timely, accurate and relevant information for users to access wherever they maybe in the globe. This clearly shows that if a citizen can get the right information it will be vital in making the good plans and right decision. Apollos *et al.* (2012), emphasized that, information sharing has been improved through website that enables civil society to share documents with citizens and raise awareness, it also helps to avoid duplication and a move towards standardize data reporting by NGO hence increase sector investments.

When assessing how the information is disseminated to the data user, and the challenges that might occur during the data updating and reporting Schoot Uiterkamp (2013) pg. 24 said "*for example, if a citizen is not reached by a trigger to start using the system it will not become a user. If the citizen has no phone, he will not be able to participate or if he does not see any relevance in sending a message he is not willing to participate*". The SEMA project however, talks about the concept of information and accountability to be beneficial as it contributes to digital earth vision. Therefore it is an opportunity that SEMA Program has been introduced in Tanzania in order to answer the question on how information is supposed to reach to local level through the use of mobile phone and this will help in data updating and reporting.

Data updating and reporting will also help in creating useful information from an open government and create an opportunity for the public to understand issues at stake leading to participation and finally the public can give the right feedback to the government on the way to improve it. Most importantly, the citizens have the right to know what situation they are inn (Meijer, 2005). A study by Gouldson (2004) proves that, an information embedment is an important factor to necessitate participation by all stakeholders in decision making.

This growing access and amount of data causes a trend that ordinary citizens provide more data to online platforms and databases hence hold the Government to use the collected data by using mobile phones that are connected to GPS in improving effectiveness and efficiency public services rendering within a short period of time. This is because there is a wide range use of mobile phones and its ownership which is expanding rapidly in Tanzania and so it helps in making use of innovative use of mobile telephone and SMS-based services through which will help in updating and reporting as well (Georgiadou *et al.*, 2011; Schoot Uiterkamp, 2013).

As the technology grows very fast, nowadays the mapping activity and updating of information use different mobile apps. Most of the APP in data collection has been empowered by a widespread and increasing access to the Internet, mobile phones, and related communication technologies, for policy advocacy (Bott *et al.*, 2012). Here they act as the fastest way of data collection, reporting and updating and through calls and messages we can achieve some development. Basically the use of app can be found in android and window mobile phones as well. The collected data can provide useful information to local governments or other actors, to support local situations. These applications therefore are also recognized in developing countries since using mobile phone technology as a tool for collecting information has an opportunity to solve great challenges as it spreads quickly in a very short period of time. The use of information and communication technologies will help to move in the next phase of development (Bott *et al.*, 2012; Heeks, 2008; Schoot Uiterkamp, 2013). A study by Welle (2007) proves that, awareness creation as an improvements towards updating information is crucial for the validity of mapping results and updating of existing community list.

For Water Point Mapping to be successful, proper planning is vital, indicators need to be defined as well as data collection methods. The right mapping tools need to be utilized (Pearce *et al.*, 2012). Proper planning can save time and costs. Although Information Communication Technology (ICT) tools, such as mobile phones can be incredibly powerful in improving data flow, there are many wider issues undermining water and sanitation systems. These have little to do with information. We thus should not assume that smart phones are a panacea data collection tool that can fully address complex and entrenched challenges (Pearce *et al.*, 2012).

According to Werner *et al.* (2013), the built in GPS on smart phone has enabled mapping application, including apples, and nokia as well. On page 26 Matt Sheehan realizes that mobile technology is rapidly changing, "Mobile is New, Mobile is Exciting" and claim that one day we may no longer be using the acronyms GIS because of the various apps that have been installed in the androids mobile phone, and so on. Where else on page 30 Christian Carle, admit the opportunity for developers of mobile apps especially on WIFI and Bluetooth as it takes an advantage to have more accurate location. Furthermore Christian says; web map solutions look back at the history of mobile mapping and mobile GIS to see how we go here and the rise of smart phone and easy access lead to increase on inflow of information.

Welle *et al.* (2013), during SEMA workshop conducted at Twente University; explains more about challenges of data updating as technological, operational and governance as well. The author declares that

the increase of mobile phone applications has led to improved data flow during data collection and trials for updating water system functional status/service. From the given example of mWater application, is said to be cheap and anyone can upload and seek information on water on global database. However experience from Ethiopia, Rwanda, Uganda and Tanzania as a case study shows that the technology is a big challenge.

The usefulness of WPM information in the actual situation is planning and decision making. A study by (Joint Monitoring Programme, 2011; World Health Organization, 2012) declared that continuation of using data for planning and monitoring purposes is said to be hindered by lack of data updating mechanisms and inadequate sector-related institutional framework. WaterAid (2010), stressed that, reliable information on key indicators at local level often lacks, but even when it is available, the uptake for such data by policymakers is, at best, challenging. To make information more useful, (Giné-Garriga *et al.*, 2013; Jiménez & Pérez-Foguet, 2010b; WaterAid, 2010) declared that map can provide clear message on who is served and who is not; furthermore maps help to address equity issues and functionality level in districts. Apart from the best use of data, the sharing of data must be agreed upon by stakeholders so as to make user-friendly utilization because the single user entry is not versatile for multiple sharing (Prasain, 2003).

2.2. The Concept of Water Point Mapping

Water point Mapping (WPM) is the tool for collecting accurate data and get an overview on the existence, functionality and status of improved water points constructed, and effect on the communities using it. The information is collected using GPS and questionnaire appropriate to each water point. The data are entered in GIS package in correlation with available surveyed demographic data such as population and administrative boundaries. Finally the functionality coverage information is displayed through digital maps for further action such as for planning purposes.

Water Point Mapping (WPM) helps in monitoring the distribution and status of water points and can be used to inform the planning of investments to improve water supply coverage. In rural areas, WPM is most often used to highlight issues of equity and functionality at district level (URT, 2013f).

The access of water point means a ratio between the number of people served by each water point and the maximum distance travelled by users to reach it. This ratio is 250 persons per outlet within a radius of 400 m and the area is being considered to have access if its density is four or more water points per 1,000 inhabitants (URT, 2002b).

2.2.1. Classification of Functionality on Water Point Mapping and Improved Water Point

According to SNV (2010), a water point is functional if it yields water for at least six months of the year and is being used by people as a water source on a day to day basis. This definition varies a bit with MoW that hold a water point is functional if it yielded good quality water during the survey or it had no technical problems even if water was not present in a water point but it is available seasonally (URT, 2013e). Nevertheless Nepal Government described functionality of WP in a way that it includes social, technical, financial and managerial aspects because it relies on budget estimates and comparison to original construction costs and community contributions. Whereby Malawi declare that, functional WP is based on the life span of its workability (Robert *et al.*, 2009).

An improved WP is the one which is covered or cemented, that has no way to be contaminated with either by dipping bucket into a well or by using rope. (Stoupy *et al.*, 2003) proves that, any water point which provides safe water to the people living in the surrounding area qualifies as an improved water point. This include boreholes and shallow well fitted with hand pump and stand tap supplied by a piped

water scheme, but exclude unlined wells without an apron, scoop holes, rivers, lakes and ponds as well as privately owned water point. A study by Nkonya (2010) emphasized that, safe water needs to be free from contamination and acceptable in terms of colour, odour, and taste. Pearce (2013) stressed by saying that; *"an unimproved water source is the one with unprotected sources and the water source is not protected from contamination because the water is not contained in a sealed and protected area and so it does not provide reliably clean water".*

A study by (Hambadiahana *et al.* (2012); Haysom, 2006) shows that; non-functional water points caused by lack of effective management and water payment collection mechanism that is weak. In other situation water points were found to be not functional due to presence of animal who like water such as elephant. The distribution and population densities of elephants that are water dependent is related to the location of drinking water points because elephants prefer to be near drinking water points and seasonal rivers (Chamaille'-Jammes *et al.*, 2007; Ngene *et al.*, 2009; Shannon *et al.*, 2008).

2.2.2. Baseline History of Water Point Mapping in Tanzania

According to URT (2013e), "In Tanzania, the initiatives of the water sector stakeholders including WaterAid, SNV, Plan International, Concern Worldwide, ISF and AMREF, under the direct implementation by GeoData Consultants Limited, substantial administrative areas (55 out of 132 rural districts) were mapped in 2005 to 2009 using broadly the same WPM methodology. The outcomes of these initial efforts were used to feed into discussions at national sector review meetings, most notably through the 2008 and 2009 equity reports. By 2008, the above stakeholders in collaboration with the Ministry of Water had successfully made rural WPM accepted as a useful monitoring tool where by the exercise revealed a 43% functionality rate of facilities in rural areas. SNV then carried out a Validation and Inquiry Process (VIP) to gain an understanding into why facilities are non- functional. From 2011to 2013, the Ministry of Water commissioned GeoData to now carry out WPM in all districts in Tanzania. This has been done in order to build on the already existing experiences and benefits obtained from the Water Aid exercise. The WSDP adopted the methodology in order to establish a comprehensive system that will help the ministry and others stakeholders in the country to understand the status of the water supply services in terms of coverage and functionality".

2.2.3. Reason for the Initiative of Water Point Mapping

Through experience and benefits gained from the Water Aid exercise during WPM in 2005, the ministry and others stakeholders decide to undertake the exercise of mapping again using the same methodology used before in order to understand the status of the water supply services in terms of coverage and functionality. The WPM was aimed at collecting and providing accurate, reliable and up to date information as well as increasing accessibility to information regarding the current coverage of functional and non-functional public rural water points throughout the country with the view of improving decision making and allocation of resources towards improvement of water supply services in rural areas.

At the same time water point mapping was taken in order to develop the capacity of the potential users, operators, and technical staff and decision makers to be able to use and update the water point mapping system. Finally was the designing, developing and institutionalization of a functional web based system to produce and make public accessible maps and data relating to water point functionality and coverage so that every stakeholder and other different user to have a flow of information for different purposes.

Catarina de Albuquerque from UN says; "Decisions about resources are political, and so to be influential data must be communicated in a way that persuades, motivates and mobilizes people to take action. Ultimately the value of mapping depends on the extent to which individuals and communities, as well as governments themselves, can use it for political and social mobilization" (Pearce *et al.*, 2013b).

Dayo Olugboye from WaterAid Nigeria commented: "I believe Water Point Mapper simplicity of pictorial analysis and representation has a huge potential in providing tools for advocacy in water sector in developing countries particularly on issues around coverage and sustainability ." [3]

2.3. Description of Water Point Mapping Procedure

Water Point Mapping (WPM) is a tool that supports local level planning and can improve accountability for water sector performance at local and national levels. It helps in monitoring the distribution and status of water points and can be used to inform the planning of investments to improve water supply coverage in rural areas as well as in urban once the initiative is scaled up to cover urban water supply infrastructure. In rural areas, WPM is mostly potential for addressing equity and functionality issues at wards and district level. As such WPM activities can be seen as part of a broader strategy in Tanzania as a country programmes to engage with and influence sector dialogue towards permanent sustainable rural water supply services at local, national and regional levels (URT, 2013d).

The exercise of data collection in rural Tanzania include all water points as dams, domestic points (DPs), hand pumps, rain water harvesting tanks and improved springs. Normally a water point is being identified by, functionality of its extraction system with a piped distribution system. For example the case of Mono Solar Pumps that are designed for harsh conditions in order to meet the needs of rural village water supplies. The functionality status may be due to drying up of the sources, lack of financing, poor siting of the water point or unacceptable water quality by the community members(URT, 2013e).

As a survey tool originally it was designed and promoted by Water Aid in Malawi to collect data on water supply infrastructure and then adopted by Tanzanian Government. A handheld Global Positioning System (GPS) unit is used to record the precise location and approximate altitude of all water points visited. A digital camera is used to record each water point in order to present the reality of the physical conditions. At each water point a questionnaire as seen in (annex I) is completed to document its characteristics, such as: location, status, type of schemes water supply source, water quality and quantity, management arrangements, ownership and water tariff payment (SNV, 2010).

During analysis the population data which has been taken from published 2012 Census report only rural and mixed wards have been included together with boundary shape file of the whole Tanzanian region so that to have good integrations of data where by the Maps at A0 size were being able to be presented showing results of water point distribution in the wards. The results of the analysis have also been presented in A0 paper size map. The map shows the existing situation on all water points in the country. Thereafter the Ministry now decided to build Water Point Mapping System (WPMS).

2.3.1. Water Point Mapping System (WPMS)

Water Point Mapping System is an integration of hardware, software, methodologies, data, processes and users dedicated to collecting, storing, processing and analysing water related information and giving feedback for public use (URT, 2013e). Water Point Mapping System supports local level planning and can improve accountability for water sector performance at local and national levels. WPM supports the process of establishing a baseline of water supply coverage and regular reporting as part of sector performance monitoring (SPM). As such WPM activities can be seen as part of a broader strategy among country programmers to engage with and influence sector dialogue towards permanent sustainable rural water supply services at local, national and regional levels (URT, 2013f).

[3] http://www.rural-water-supply.net/en/resources (discussion conducted on e - discussion of d group of RWSN)

The results of water point mapping system form the basis for monitoring, the distribution and status of water points. The system can help to visualize different access level of water and different aspects such as maps, graphs and charts related to access to water supply in rural areas. This can be done by showing the spatial distribution of water facilities and overlaying this point data with information about population and administrative boundaries.

2.3.2. The Concept of Mobile Updating Apps

A mobile updating application (or mobile apps) is a software application designed to run on android phones, smartphone, tablet computers and other mobile devices in collecting of data on the ground. They are usually available through application distribution platforms. The collected data are connected to a geographical position system to get the exact location of the area and accuracy of the data as it help in monitoring daily services. By using mobile apps the information can be easily shared and viewed by different people within a short period of time. Furthermore, the citizen and government as well can use this information in their own activities while there can be a feedback from the data provider.

2.4. Ways of Data Updating and Reporting

According to Department of Nepal, updating mechanism is done after collecting the surveyed data, entering them, compiling and dissemination of NMIP database system at the local level. This mechanism helps in updating the database so as to enable efficient and effective information-sharing among stakeholders as well as digitally with the NMIP from district-based institutions. To put the existing system into an automatic data transferable mode, upgrading of the Oracle-based programme is being applied (Prasain, 2011). Figure 2-1 below explains data updating and sharing mechanism applied as in Nepal.

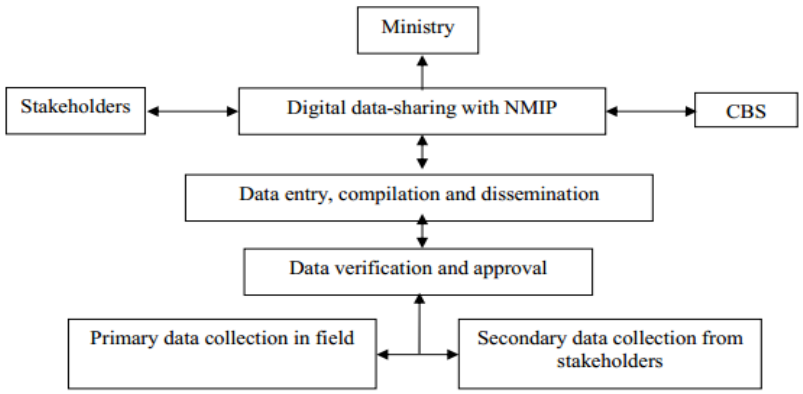

Figure 2-1: Data updating and sharing Mechanism in NEPAL.

Taking another example from Liberia, Data updating and reporting on water point mapping was intentionally planned to be done every three months in order to enable the measurement of progress against commitments on service provision. However, the situation was not the same because of budget deficit and clear dedicated staff; the regular submission of data by smartphone leading to monthly updates had not yet been achieved.

So far Liberian Government use WASH reporting template developed for use by NGOs, with Partners reporting service provision activities every three months. Even though an information through paper reporting was useful, but does not provide the same level of detail as was intended to be gathered through the use of smartphones. At the same time it is a risk that gathered data was not used, due to the absence of a dedicated individual within the NWSHPC Secretariat responsible for continuous monitoring and analysis (Apollos *et al.*, 2012).

Therefore the Water and Sanitation Program (WSP) in Liberian come up with another updating system for water point mapping named AKVO FLOW (Field Level Operations Watch). It's a system to collect, manage, analyse and display geographically-referenced monitoring and evaluation data (Thomas Bjelkeman-Pettersson *et al.*, 2012). The system use technology (Android smartphones and Google Maps) and software called FLOW, widely accessible databases and maps are being produced.[4] Using this new technology, the Liberian government is now taking the lead in increasing safe water coverage across rural Liberia (Thomas Bjelkeman-Pettersson *et al.*, 2012).

Referring to Sierra Lione, water point mapping survey provides a baseline of a status of WPTs. From this reason the Government of Sierra Leone desired to address the gap in coverage so as to keep mapping data updated after realizing updating maps and addressing non functionality is a major challenge (Souma, 2012). Therefore the Government come up with the new mechanism as depicted here under in figure 2-2.

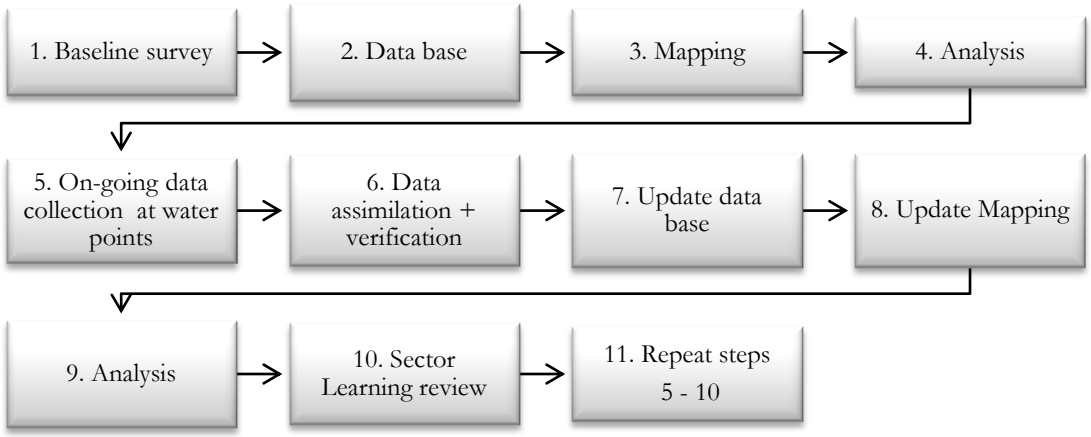

Figure 2-2: Sustaining a regular updating mechanism of Sierra Leone.

Back in Tanzania, the consultant identified and tested three option for updating the water mapping baseline information which were as follows; First, WPM data updating through mobile phone that were adopted by Maji-Matone program, Second, WPM data updating through LGA staff/DWEs office which were tested at Iringa as a pilot phase and third WPM data updating through community owned water supply organization (COWSO) which seem to work properly rather than the other two mechanisms which were applied at different districts under the support of the Embassy of the Kingdom of Netherlands.

The challenges observed was unfaithfulness on the part of DWE's office regarding the expenditure of mobile money for different purposes than the intended one as well as reporting the functionality of water points. A study by Pearce *et al.* (2012) proves that there is low objectivity when DWE's monitor their own works. This trend of practice has resulted into adopting COWSO and regarding it as a representative responsible for reporting on the status of Water Point. Figure 2-3 explain in detail both short term and long term solutions.

According to Act No. 12 of year 2009 Par. 31, COWSO means Community Owned Water Supply Organization established and registered, under such act comprising a group of households, a village or

[4] http://water.worldbank.org/node/83784

group of villages who receive their water supply from a common source or one or more water points or a waterworks (URT, 2013d).

The short term solution is directly by District Engineers in order to enable updating the system by capturing new water points because DWEs are responsible lawfully for the management of water supply services and infrastructures in their area of jurisdictions. Thereafter, DWE will send the filled form to WPMS coordinating team for input into the system.

The Long term strategy solution for updating water point mapping information will be done by Head of COWSOs (HoC) who will be responsible to fill the form and submitting them to DWE, whereby DWE will verify and upload status reporting directly into the system except for shapefiles which will still be done by the Ministry. The short term and long term solutions are as depicted in the figure below.

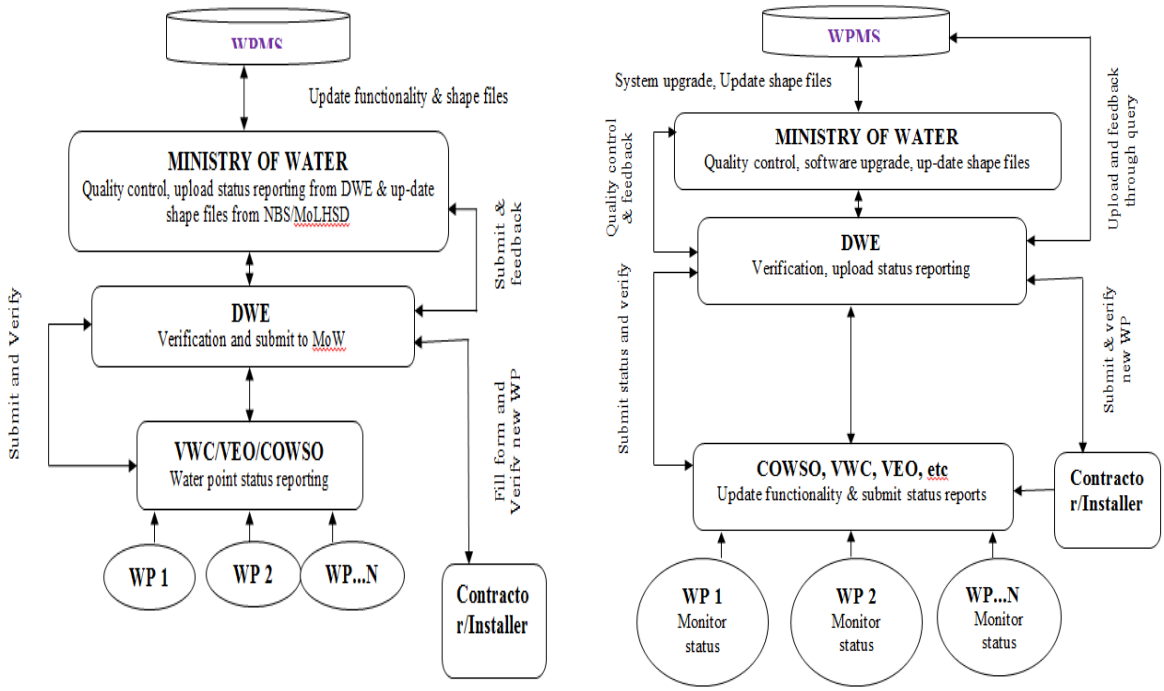

Figure 2-3: Information Flow from WP representative to the WPMS (URT, 2013d).

2.4.1. Objectives of Mobile Updating Apps

The basic objective of mobile updating apps is to keep information up to date as the information will be easily acquired. So far the information can be easily shared from different organization for different purposes they have in using such kind of information. Acquired information can be used for further decision making and planning purposes because the monitored services will automatically give the feedback on the truth within the ground so as to take initiative upon it.

The system has to be in two way traffic such that the provider of the information has to get the feedback of what he/she has provided. For example, the citizen will provide the report on the status of water point if they are functional or not functional and he/she expects to see the online database has changed and updated. This is helpful in facilitating the possession of information easily from the data provider to the system and hence eases the whole process of decision making and planning as well.

Mobile apps can act as quick and on time sensitive information provider to the respondents. The cases of Ushahidi platform or Cholera outbreak in Hawaii, where people were easily informed and took action; are

vivid examples. It thus helps the passive user to take the action on time on what has happened because ushahidi platform can be used for information collection, visualization and interactive mapping [5]. Finally mobile apps can help to reduce costs of data updating and get returns within a short period of time. The current system of sending people to the field using GPS in collecting data on the coverage of water point mapping and then transfer data to GIS package for updating is very costly both in money and time. Figure 2-4 explain the simple structure of updating via mobile phone.

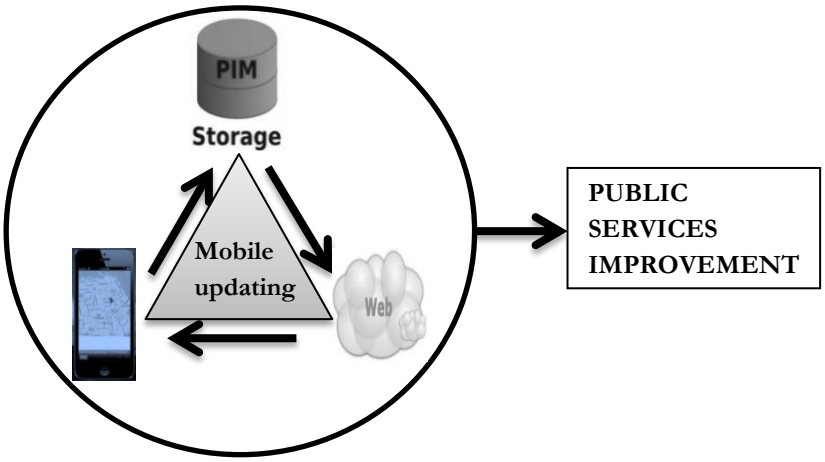

Figure 2-4: Simple Structure of updating system

2.5. Exsisting Challenges facing Information Updating and Reporting on Water Mapping

Several studies that have been conducted by various scholars on the problem of Water Point Mapping information and updating system agree on a point of categorization of the problem into three aspects namely; technical, governance and operation. They also all agree on a fact that the problem remain to be a major bottleneck particularly in third world countries that ought to be talked through the application of modern technology (de Palencia Alejandro *et al.*, 2012; Koroma, 2012a; Welle, 2005, 2010a; Welle *et al.*, 2013). Currently there has been empirical proof derived by Welle *et al.* (2013) studies. The author points out to the use of mobile phone device that reduces the problem significantly. As pointed out above, this problem is three fold; therefore the approach pointed out by Welle is viewed at as a technical aspect only leaving behind the two other aspects (governance and operation). This signifies the intensity of the problem looming.

Based on the study conducted by Welle *et al.* (2013) in Uganda, Ethiopia, Rwanda and Tanzania on the experience with updating the information of water point mapping, the challenges addressed are High staff turnover, unique identification of water points, few messages received, labels with phone numbers taken off / lost, costs related to sending SMS, Government staff experience challenges in handling mobile phone application, costs of charging, hand pump mechanics face transport problems; community development officers distracted by other duties, water user committees weak (e.g. not raising sufficient funds for repairs. Therefore there is a big need to develop a good mechanism of data updating and reporting by which the citizen will be able to use. Figure 2-5 illustrate the challenges in data updating.

Technology challenge based on ICT technology, expensiveness of the software, the capacity of the network connection, lack of GIS skills people need to run ArcGIS software application; as identified that retaining GIS skilled persons for water point mapping at district level is a problem in Tanzania (SEMA,

[5] http://ushahidi.com/products/ushahidi-platform

2013; Welle, 2006). Moreover, operational challenge relates to a situation of putting the procedures into practice, especially the case of cost incurred in collecting data and hidden costs such as charging. Finally, governance challenge; this deals with time related to reporting and updating that seems to be weak, (Welle, 2010b). At the same time the incentives for users in updating is not clear whereas there is a lack of operationalization of sector monitoring related to community based management of water supply service (Welle *et al.*, 2013).

Source: (Welle *et al.*, 2013).

Figure 2-5: Updating and Reporting Challenges

2.6. Conclusion

Water point mapping, has been used as a tool to monitor the effectiveness of its investments in service delivery, whereby its gives/provides an important contribution towards improving the governance in making the information available to the user. At the same time its assist decision making through service delivery.

Apart from differences that have been observed in updating such as technical, government and financial/operational, water point mapping can as well hold important information in improving governing service delivery to rural poor people. Furthermore, WPMS will help to put the Government accountable and provide visualization of the spatial data.

3. METHODOLOGY APPLIED IN THE STUDY

3.1. Introduction

Presented in this chapter are the methods used in achieving research objectives observed under the literature review in the immediate preceding chapter. Appropriate methods such as interviews, observation and focus group discussion have been used to answer research questions such as what mechanism is used for water point information updating and the challenges facing the software. The idea behind is to develop a mechanism for data updating as discussed in the research design and methods requirements in achieving the objectives of this study. This section also describes tools used in collecting data, techniques and mechanisms that have been used.

3.2. Type of Research

A case study method has been applied to investigate on mechanism used in water data updating. (Yin, 2011) defined a case study as; "*an empirical inquiry that investigates a contemporary phenomenon within its real-life context especially when the boundaries between phenomenon and context are not clearly evident*". A case study research is not limited to a single source of data, as in the using questionnaire in carried out a survey (Yin, 2011). In fact, good case study, benefits from having multiple source of evidence as focus group discussion, interviews and observations depending on what is available and its relevance to the studies.

Therefore a case study research has been employed in understanding how the Ministry of water in Tanzania involved in issues of updating the available online data on water point mapping to the public. Thus a flexible open ended interview and email conversation helped the participants to construct implicitly the reality and think about the situation not just providing an answer to the researcher. In addition, direct observation helps in revealing the reality on the grounds in the field of the case study and that helps to achieve the research objectives. Table 3-1 below shows case study distribution of respondents interviewed.

Table 3-1: show case study distribution of respondent interviewed.

ORGANIZATION	FUNCTION	ROLE	INTERVIEW
Geodata	Directors	Actor	2
Geodata	ICT Department	Software Developer	2
Geodata	Mappers	User	2
Government	System Analyst	Actor	3
Government	Head of ICT	Actor	1
Government	DWEs and Technician	Actor	Group Discussion
University of Dar-es-Salaam	ICT Department	Software Developer	1
SNV	Wash Advisor	Actor	e-mail + mobile conversation
I WASH and Wami Ruvu	Advisor	Actor	Email + conversation
Independents	VWC	User	2
Independents	Politicians	user	Mobile conversation
RWSN in Switzerland	Coordinator	Actor	Email conversation

3.3. Morogoro History in Brief

Morogoro Region is located on the eastern side of Tanzania Mainland 200kilmeters west of Dar-es-Salam. Its climate is highly influenced by the Indian Ocean. It is endowed by a range of Uluguru and Udzungwa mountains as well as Mahenge hills from which flow a total number of 143 rivers that traverse the vast plains in the low lands that are enriched with alluvial soils. The Region is a tourist attraction with Uluguru Nature Reserve, Sellue Game Reserve and The Mikumi National Park located within. Apart from being decorated by common animals like lion, elephant, buffalo, giraffe, zebra, hippopotamus, leopard, tiger, crocodile to mention just a few that are found at Mikumi and Sellue Reserve, the Uluguru Reserve is in addition blessed with endemic plants, birds and animal species that can only be found at the reserve. These are Bush-shrike and Loveridges Sunbird for birds, One, Two and Three-Honed Chameleons for reptiles and Allanblackia uluguensis and Saint-paulia Goezeana for vertebrate fauna.

Morogoro Region lies between 5°58′ and 10°00′latitudes, South of the Equator and between 35°25′ and 38°30′ longitudes, East of the Greenwich Meridian. It is bordered by seven regions. In the north are Tanga and Manyara while in the eastern side are the Coast Region and Lindi regions. On the western there are Dodoma and Iringa Regions while Ruvuma is located in the southern side of the Region (Nassoro, 1997).

Morogoro Region has a total area of 73,039 km² which equals to 8.2% of the total area coverage of Tanzania mainland which is 942784sq.km. 2,240 km² of Morogoro total area is covered by water. This area makes it the second largest region in Tanzania (the largest is Tabora). Its population is leaded by female 1,125,190 while male being 1,093,302 (URT, 2013b). Figure 3-1 below shows location map of the study areas of Mkambalani and Mikese wards (Figure 3-1 (D)) which can be traced to Morogoro rural (C) Morogoro region (B) in Tanzania (A).

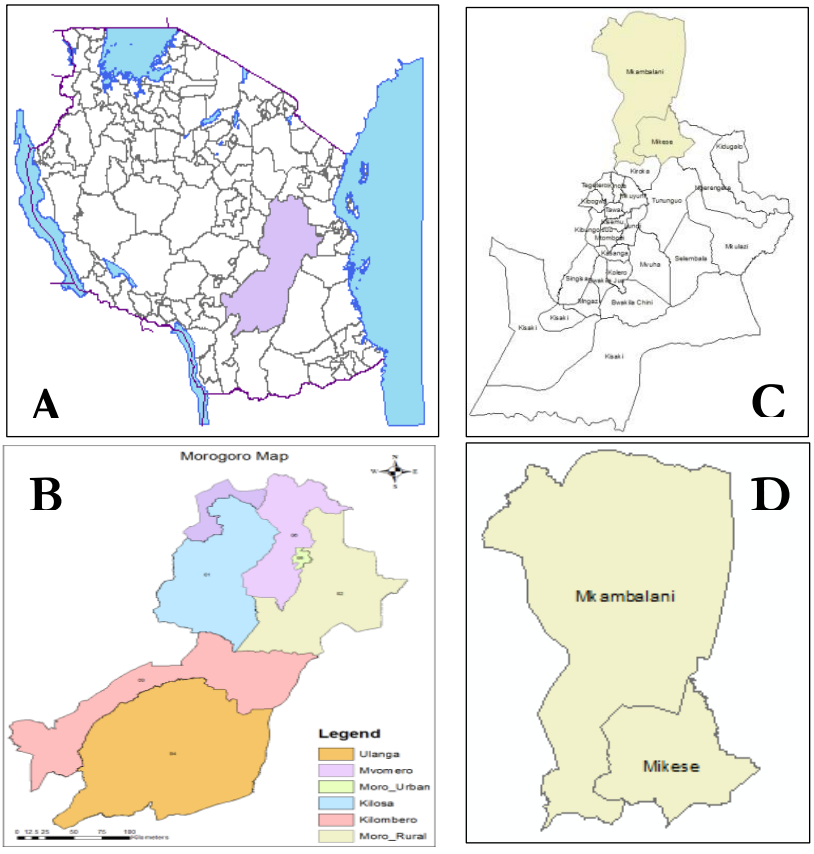

Figure 3-1: The Case study area

3.4. Methods and Techniques for data Collection

This section discussed methods and techniques employed in this research. However, the methods selected for this case study includes focus group discussion, interviews, publications, direct observations and WPMS web pages analysis as shown in figure 3-2 below. All this has been done to get insightful on mechanism being used to update water point mapping information.

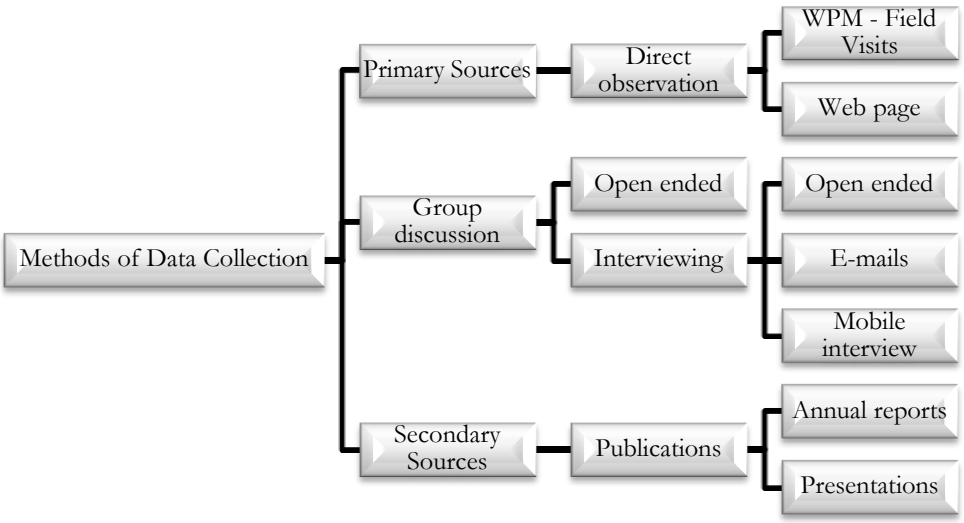

Figure 3-2: Source of data and method of data collection

3.5. Data Collection Goal

The main goal and method used for data collection is to develop an appropriate mechanism for data updating based on water point mapping information, after knowing the various challenges on the mechanism that have been used before, this is also highlighted in literature review. Other goals are:

A: To check for the common software that is being used for data updating in water point mapping information and how the data/information on the WP are being shared among the citizen and other different users in the society, together with the challenges that they face on the used software.

B: To check which tools are being used for data collection, and which are instant ones in providing the information on water points. Moreover, to check the advantage and disadvantage of those tools that is being used in data collection. In this way the result can allow the research to advice on appropriate tools for data collection as well.

C: To check for the challenges that the organization are facing in updating the water point information to their web and how the information will reach to the society such as status coverage and different maps showing the reality on the ground.

D: To check how Government is accountable in providing the relevant information to different stakeholders based on water point mapping information, as well as different actors who are involved in providing information and to which extent do they share the data such as maps, shapefile for boundaries and water mapping data for other development intervention.

3.6. Instruments for data Collection

Data collection aims to investigate goals as elaborated in section 3.5 through various instruments both primary and secondary sources as has already been demonstrated in figure 3-2.

3.6.1. Interview with Respondents

Each interview question was formulated in relation to the research objectives. Thus was done from different actors and respondents from Government, NGO and different users. The aim of interview was to get the in-depth ideas on the mechanism used to update the information on water point mapping. All defined actors were interviewed and it was observed that some of the respondents had little knowledge about WPM and found it difficult to respond to interview questions.

3.6.2. Interview with Key respondents

An in-depth discussion was conducted in a structured manner with individuals who were carefully chosen because of their knowledge about water point mapping. The interviews assisted the researcher to establish a base of the identification of study area and the type of research conducted. These key informants included Ministry officials as in ICT departments, district water engineers and district technicians, different stakeholders as I Wash, SNV and GeoData, lastly different Users. These interviews were conducted through telephone and others as open ended questions, aiming at knowing the reality on WPM data updating mechanism system, because these key informants were believed to have a sufficient knowledge on the subject matter. Figure 3-3 shows interview session conducted with Morogoro technician.

By using telephone calls, messages and email helped to set a timetable to meet with key informants. Twenty (20) interviews were conducted from different respondents, (Ministry – 5, GeoData -5, University of Dar-es-salaam -1, SNV -1, and Wamiruvu 1, iWash -1, COWSO 2, Mappers 2 and Users/Politician 2). Most of the interviews were conducted from 20 – 30 minutes at expected place as it was arranged. Some of the interviews were postponed to other dates because the respondents had other commitments on the scheduled date, example iWash at Morogoro and some from Ministry of Water. All in all open interviews as face-to face were conducted in the office of the respondents within their own organizations and some outside while walking. Most of these interviews were recorded after asking their permission so the respondents were free to remark on the study behind.

The email conversation between researcher and Wash Advisor in SNV Mwanza, ICTU department in MoW Dar es Salaam and RSWN Coordinator in Switzerland, were done purposely with regard to their experience on water point mapping. Furthermore internet search has been valuable tool that were employed in considering relevant information of WPM. Above all annex III show meeting attendance on the training of trainers (TOT) in WPM where by the researcher was able to get insightful idea on how WPMS is working.

Figure 3-3: Interview conducted with Morogoro Rural Technician

3.6.3. Direct Observation

An observation has enabled to gather sufficient information even before interviewing started. It helped much to observe webpage of water point mapping (WPM) and see the current status. Furthermore, the method helped the researcher to examine the importance of WPM to the society after performing certain analysis.

3.6.4. Field Observation

As an act of doing inspection so as to make acceptance on the requirements of doing field, the researcher were able to look on water point physical settings and made contact with water user in rural areas. Consequently, through this method the researcher were able to systematically observe existing situation, in the area of study such that there are newly built WP that are not inserted in the water point mapping database. This proves data updating is still a challenge in Tanzania.

3.6.5. Focus Group Discussion

Two focus group discussions (FGDs) were held involving DWEs and Technicians at Morogoro District and NGO (GeoData). The homogeneous groups of NGO (GeoData), was the optimal institution to provide the in-depth information regarding perception, causes, nature and extent of water point mapping, existing initiatives and/or efforts towards the mechanism of data updating in WPM information. In addition, FGDs with the identified informants helped to provide more and better information.

3.6.6. Data Transcribing

Some of the interviews that were conducted and recorded in Swahili language were later translated in English and saved in the format that will play into different format as mp3. (OALD, 2011) defines transcribing as an act of putting thoughts, speech, or data into written or printed form. In order to simplify work the interviewer was transcribing by using Express Scribe Transcription Software (NCH software), as free source software which helped in increasing the voice and minimizing the talking speed that eased the transcription process. Figure 3-4 shows transcription interface where quoting strategies were used. For instance, when the researcher asks; what mechanism is used for water point information updating? As seen in (Annex III). The respondents answer was "0:00:07.9 - *COSWO is Community Owned Water Supply Organization established and registered to receive their water supply from a common source or one or more water points. Now we are using COWSO as a new approach for data updating because we have seen its works and the incentive of water user is to have water, anybody who went to fetch water in the tap either for drinking, cooking or bathing he/she want to see there is a flow of water, if he/she won't find out will report immediately"*. However, the agreements were first reached with the respondents before conducting the recording.

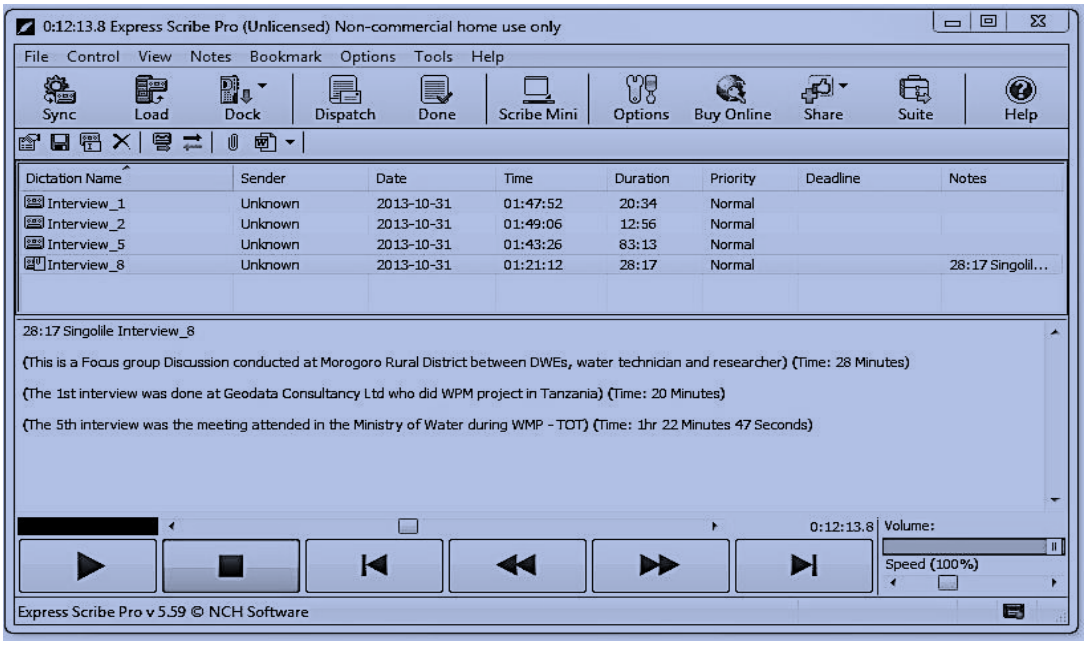

Figure 3-4: Transcription interface

3.7. Instruments for data analysis

Table 3-2 indicates different formula on how data were analysed. According to Ministry of Water in Tanzania, the given formula below from number 1 – 10 clarify how water points data can be calculated in relation to population. Where else, Statistical package for social science (SPSS) version 21 has been used to analyse different variables as seen in formula clarification 11 – 14.

Table 3-2: Matrix table of the formula to calculate Water Point functionality coverage and ANOVA statistics in wards.

No.	Description/Variables	Formula
1	Total Water Point Coverage	(Total Wpts / Population) * 1000
2	Functionality	(Functional Wpts / Total Wpts) * 100
3	Functionality Water Point Coverage	(Functional Wpts / Population) * 1000
4	Percentage of Full Coverage met by functional WP	(Functional Wpts * 250 /Population) * 100
5	Non Function Water Points Coverage	(Non-Function Wpts / Population) * 1000
6	Current shortfall of functional Water Points	(Population / 250 – functional)
7	Difference in density of full Coverage from the mean	(Average Wpts Coverage) – Total Wpts Coverage
8	Difference density to positive for full Coverage	(Difference in densities of Full Coverage from the mean * -1)
9	Difference densities of functional coverage from mean	(Average of Functionality WP coverage - Functionality WP coverage)
10	Difference densities to positive to Functional coverage	(Difference in densities of functional coverage from the mean * - 1)
ANOVA Statistics from WPM Database in making simultaneous comparisons between variables		
11	Water point construction and breakdown year	Boxplot graph
12	Water point actual population and payment	Correlation
13	Water point status and extraction system	Cross tabulation
14	Water point Status and Payments being done	Frequency in descriptive statistics

4. OBSERVATION ON WATER POINT MAPPING IN TANZANIA

4.1. Introduction

I worked as a GIS expert and Water Point Mapper in Tanzania in 2011 and the experience I got pushed me into undertaking the research at hand. In this regard the findings of this research are to a great extent a reflection of my experience then acquired. The findings based on the specific objectives with their questionnaire; the first part deals with experience and observation of WPM and Updating Practice. The second part concentrates on usability of WPM information in the society and finally third part deals with the effectiveness use of WP information.

4.1.1. Experience of Water Point Mapping in Tanzania

Prior to WPM exercise that has been done all over Tanzania, my field work started with an intensive short course. The course aiming to equip the mapper with the knowledge on the proper use of GPS and how right coordinate can be captured. Furthermore, the use of digital camera in taking photography that shows condition of WPT and village office. Finally how the questions should be filled in as seen in (Annex I). Thereafter, we left for the field accompanied with the DWE. The field work lasted for a total of 75 days under this distribution, 40 days for Morogoro rural, 14 days for Morogoro town and 21 days at Biharamulo district in the western side of the country.

The exercise of data collection used to commence at 7:30 am in the morning terminating at 6-7pm in the evening. At some areas locating WP was difficult due to poor logistics especially roads that lay along a hilly land were so muddy and slippery due to rains that were falling then. Unfortunately this exercise took place during a rainy season a condition that lead to a delay in the completion of the task. At some places we encountered floods that made it impossible for us to use our car but had to use a canoe instead. While at other places we had to use a motorbike. Other areas we were compelled to walk on foot for up to eight (8) hours in order to accomplish the task ahead of us.

Filling up the WPM data sheet in GPS as it shown in (annex II) was accompanied by several questions of which several participants were included such as, water technician, village executive officer, water committee, water user/citizens and mapper. For-instance, when we reached to a ward office we were provided with ward population for all villages under it and raw data on the available water point, village registration number and number of private connections, by ward executive officer (WEO) and village executive officer (VEO).

After being given the necessary information, we were directed by VEO to a place where water points are allocated. A picture for every water point was taken by WPM mapper using digital camera as well as to document the status and physical condition; then the right coordinate was taken as well by using handled GPS. During this process, several questions were asked to the water technician; such as type of extraction system because he/she knows and a source type. A water point type can only be observed and filled correctly for example hand pump, play pump, rope pump and standpipe.

Every water point was marked by WPM mapper. For example, a unique identifier that were generated from National Bureau of Statistics (NBS) such us 05023043181WP50 meaning (05 – Region code, 02 – District code, 3043 – LGA code, 181 – Ward code, and WP50 – water point number). To know the status

of water point and hardware problems, a question was posed to a water committee and water user because they are always in use of that particular water point.

In case of water quality, the WPM Mapper used to observe and sometimes tasted it by tongue. The water quantity question was answered by water users and water committee members for they are the recipients of the commodity capable of knowing the volume of it. The answer to the concept of breakdown year and reasons for not functioning was shared by a technician especially on technical part, whereas the non-technical was answered by water committee members.

Finally, WPM form asked on the amount in which a citizen pays as service fee when he/she drew water. The question was normally answered by water committee members and residents as well as to check whether they pay or not. Thereafter a Mapper wrote a general comment on what he saw in every water point mapped.

When the exercise of mapping is done, the mapper downloads data from the GPS and from the Camera onto a laptop; making a folder for every ward/village mapped and a sub folder containing GPS data, shapefile, field photo, excels document folder and word document folder for writing daily report. These files are then sent to the main office ready to be processed and analyzed in order to come up with a map showing the status of water points for each ward. By using Microsoft Excel, the Mapper can be able to correct the spelling error and having uniformity in the data that have been filled in the form. Furthermore, ArcGIS and Arc View are being used by GIS specialist to do analysis and finally providing a map that shows the variation of functional and non-functional water points in a digital form and in the paper as in the size of A0. The provided maps are then taken by the Government to view the reality on the ground and then are presented to other stakeholders for any sectorial review and implementation.

4.2. Observations of Water Point Mapping and Updating Practice

4.2.1. Observations of Water Point Mapping Practice

Based on first place visited (village) we took pictures of the office. Village Executive Officer (VEO) provides data for the number of residents and that of WP available for the area together with a resident who acted as a pilot, taking us to all places where WPT are located at their area as figure 4-1 below shows.

Mkuyuni Water Supply Office and Village in Mkuyuni ward at Morogoro

Sinyauline village Office in Ngerengere ward at Morogoro rural district.

Tununguo Village Office in Tununguo ward at Morogoro rural district.

Figure 4-1: Different capture of Village Office at Morogoro Rural District

It was also observed and confirmed by a member of Village Water Committee (VWC) that, villages where the money was properly kept and used intentionally, the WP were found operating efficiently and rehabilitated when found not working as can be observed through the figure 4-2.

Functional need repair Nira/Tanira shallow well under rehabilitation at Kisaki ward Gomero village in Morogoro rural district.

Functional Tap water from a gravity scheme at Tawa ward in Tawa village at Morogoro rural district.

Non-functional SWN 80 water point from Mvuha ward in Dala village at Morogoro rural district.

Figure 4-2: Different Water Point Captured with different cases

The Morogoro chiefs went to an extent of blocking us from taking photographs or mapping their areas believing that such action will lead to drying up their water points mysteriously. It was also observed here that about five villages that are situated on a mountain tops have no water services completely. The residents on those areas use water from locally constructed wells/ponds and streams.

Some leaders in the village made the exercise of data collection fairly difficult because they dared to give wrong information about the actual number of WP they had in their areas. They gave smaller number against the real number they had. This has been revealed because WEO and Technician were having the previous raw data of the installed WPT in every village. This they did in expectation of being provided with more WPs for they thought that was the mission of our visit.

It was further observed that some villages have completely neglected their WPs such that they were found in the bush covered by forest rotten leaves and bush grass. Figure 4-3 below depicts the reality.

Non Functional Water Point (SWN 80) found around the bushes at Kiroka Ward in Kikundi village in Morogoro rural district.

Non Functional Nira/Tanira found around the bust at Biharamulo ward in Kitutuma village at Biharamulo district.

Non Functional WP found around the bush as it was supposed to be cleared at Kidugalo ward magera village Morogoro rural district.

Figure 4-3: Different Water Point found around bushes

During field work we also encountered a problem of car breakages due to the poor conditions of the roads coupled with heavy rains. At one time we were compelled to spend a night in the forest when our car stuck in mud having no help at hand. We even encountered a very unpleasant observation where we found human excretion scattered on top of one WP base. At another it was witnessed that people were taking a bath right near the WP. At among several WPs we saw groups of school pupils drawing water having abandoned their classes; a sad experience indeed as it shown in figure 4-4 in following page.

LEFT: Children fetched water at functional Nira/Tanira found at Nyantakara ward in Nyantakara village at Biharamulo district.

RIGHT: Functional Nira/Tanira found at Runazi ward in Runazi village at Biharamulo district where children fetched water.

Figure 4-4: Water Point found with children during class hours

During WPM exercise we even observe some wards as Kisaki in Gomero village at Morogoro Rural district that is within the Selous Game Reserve, whereby we were able to see the elephant around water point, as figure 4-5 below shows the reality.

LEFT: The red arrow above point two elephant that were seeking for water around the community at Kisaki ward Gomero village in Morogoro

RIGHT: A Non-functional WP destructed by elephant found at Kisaki Ward Gomero Vilage in Morogoro Rural District.

Figure 4-5: Water Point with Elephant case at Kisaki Wards

Biharamulo is an area that stretches along the border with Rwanda on the western part of the country. Here we were told that due to the location of the area acts of unfaithfulness among the people are very common. This was said to be so because evil people had a big chance of sneaking into another country unnoticed whenever they did any evil act on either of the countries sharing the border. Burglary and banditry are a common experience to the area we were told. We also were told by water technician about the acts of theft of water pipes and water pumping machines, the Nira Tanira type in particular *(Refer to Glossary of terms on Nira/Tanira)*. We observed an illegal connection of water pipes by individual villagers from the main public water pipe. Figure 4-6 below and a map in figure 4-7 reveals the reality.

LEFT: WP with stolen extraction system and broken base found at Ngerengere ward in Matuli village at Morogoro Rural district.

RIGHT: WP with stolen pump found at Nyarubungo ward in Katoke village at Biharamulo district.

Figure 4-6: Water Point found with stolen pump

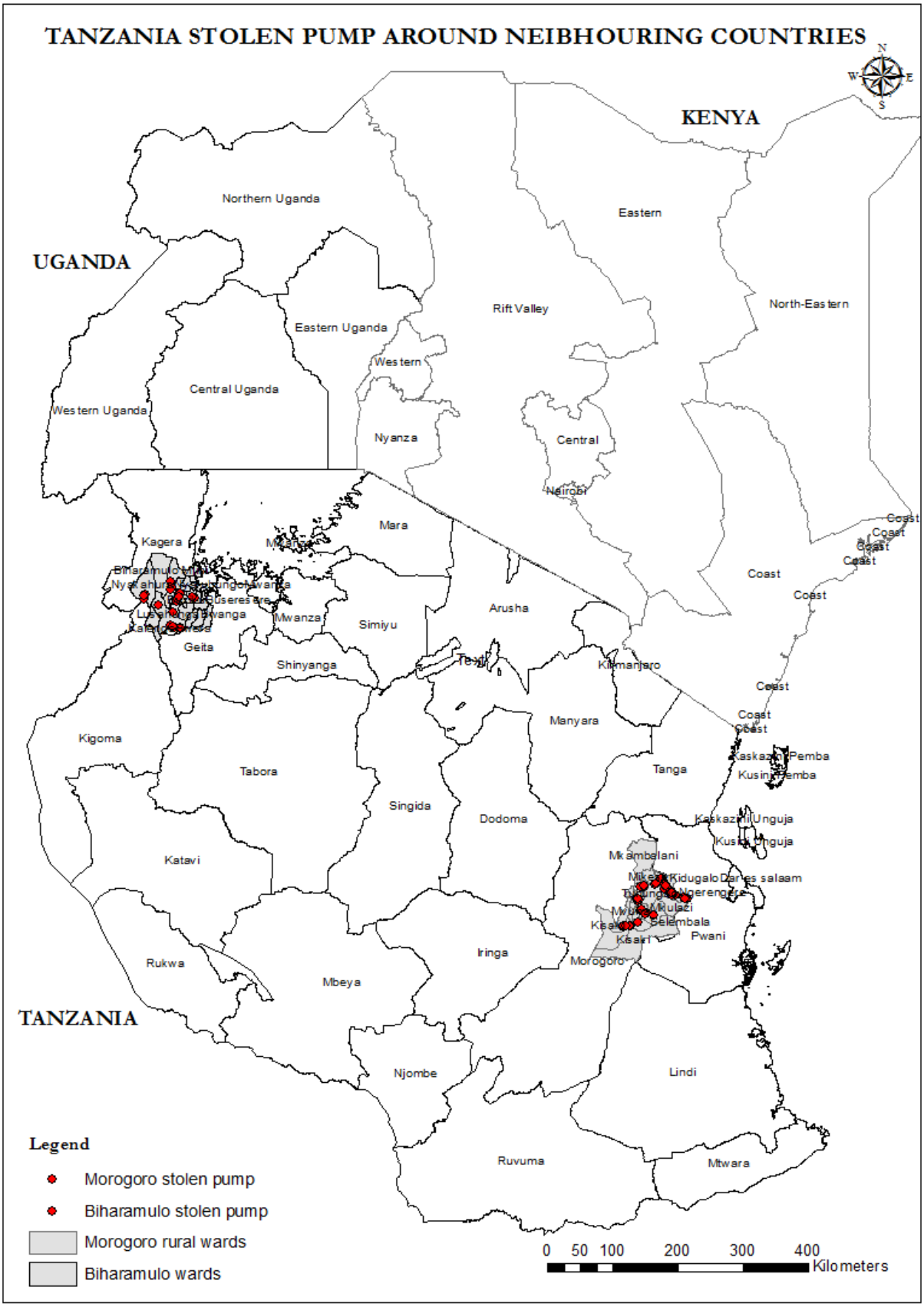

Figure 4-7: Water Point with stolen pump in neighbouring countries

As in many cases where water pump were stolen, the pump type was not recorded in the database, it is difficult to verify whether in border areas more pumps of a specific type (Nira/Tanira) were stolen.

At one area we observed a pond that had been left open being used jointly by man and animals. We were informed by village executive officer that the contractor to the project vanished without accomplishing the work, apparently after being paid fully according to the terms of the contract. In different incidents, a biharamulo technician was quoted saying, *"We have left them with devices – spanners for every Nira/Tanira machine we have installed for them for maintenance whenever minor default occurs to the machines. We have further advised them to report on any major breakdown occurrence in which case our responses will however depend upon the availability of fuel in the office to ferry us to the destination for repair."* This has been said after realizing there is a large number of Non-functional WP in rural areas at Biharamulo district.

According to the form as seen in (Annex I), the answers to the questions about the quantity of water were answered differently by citizen/water user in different places/location we visited and mapped. The user declared that *"Some of WPs have insufficient amount of water to meet the number of people around it, as a result people are compelled to wait for more than four hours (4) in order to get it"*. Others said, *"we only draw water in early mornings and late evenings to allow the well accumulate enough water during the afternoon and night hours, because the well has insufficient water"* others said, *"Certainly our well has insufficient water as a result we have decided to dig another well beside of which we use a bucket to draw water from."* Figure 4-8 below explains.

Multiple standpipe WP showing different time of taping water morning and evening found at Ngerengere wards at Morogoro.

The red arrow above point to the local well that have been drilled by citizen after realizing that the drilled well has no enough water. The left WP found at Runazi ward Migango village while the right WP found at Kabindi ward in kabindi village both at Biharamulo district.

Figure 4-8: Water Point found with extra local well and timetable for water collection

At some areas however were seen to have sufficient water. There were those areas that use tap water, have established water committees that are responsible for the collection of monthly contributions that the villages have agreed upon to pay per each family. Here they have successfully been able to raise a fund that is properly kept and used specifically for maintenance purposes. There are also areas where water is so scarce to an extent that it is only during rainy season that they are able to get enough of it as it shown in the Figure 4-8 here under.

LEFT: WP showing rain water harvest at Kidugalo ward Visaraka village at Morogoro Rural District stores in underground tank.

RIGHT: WP showing rain water harvest rooftop found at Nyarubungo ward in Katahoka village at Biharamulo district.

Figure 4-9: Water Point with rain water harvest tanks

It was observed in figure 4-10 that there are a variety of under qualities and modes of water. There is clear and colour less water. There is milky water. There is also water that is clear when it is in the well but turn grayish whenever you draw and keep it for some minutes. There is also mineral or hard water that has a tendency of causing rust in water pipes and taps that are made of steel.

LEFT: Technician proves the milk water in a small bucket at Nyamigogo village in Nyamigogo village at Bharamulo District.

RIGHT: WP at Morogoro Rural district show how fluoride and rust manage to destruct the pump at Tawa Ward in Kifindike village.

Figure 4-10: Different water point with water quality cases

Year of construction and Break down year variables; some of the observation as it shown in figure 4-11, clearly give an impression on the old/colonial era functional water point against newly water point that is no longer in use.

LEFT: Technicians at Morogoro Rural District explain on functionality of 1962 WP that is durable than the 1990's to date.

RIGHT: WP that built on 2000 is no longer in use, pump stolen and slab broken found at Ngerengere ward Morogoro Rural

Figure 4-11: Water point indicates Construction and Breakdown year

On status variables that concerns the functionality of water points: Tanzanian government regards WP to be functioning when it produces good water through water taps and that the water is clean and safe from cement constructed and covered well. Such that Functional – A WPT is referred to as functional if it yields good quality or safe water with no technical problems. Non – functional – A WPT is regarded non-functioning in the following circumstances, one it is unable to yield water for more than six months of a year and second it is completely dry yielding no water at all. Functional need repair – this is a WP that is functional in use but has in the course accidentally been damaged partially (example; Gate valve breaks, cylinder, pump or cork or water pipe anything alongside is broken) need repair.

During my stay in Morogoro from 25th September to 28th October 2013, I had the opportunity to see several newly constructed WPTs which are not seen in the water point mapping data base, for example those found at Mikese ward. Figure 4-12 below indicates the situation.

LEFT: New India Mark II WP named "Msikitini" found at Mikese ward in Mikese Village at Morogoro Rural District.

RIGHT: New SWN 80 WP named "Kwa Diwani" found at Mikese ward in Fulwe Village at Morogoro Rural District.

Figure 4-12: New Water Point found during field visit

I was also had an opportunity to see a WPT that had no pump yet with enough water that was on use by the residents though unsafe as it has been seen at Mkambalani ward. Figure 4-13 below depicts the reality.

LEFT: Non-functional WP according to MOW is the same WP found functional in 2011 at Morogoro Rural District.

RIGHT: SWN 80 WP found in full operation at year 2011 at Mkambalani ward Morogoro Rural District.

Figure 4-13: Water Point with different functionality status

During the field practise there are some new things that I have never come across before when doing mapping of WP, these things are such as the case of data updating by using different apps and different software. For example MoW in Tanzania applied COWSO, where by SEMA project develop DHIS2 while Wami Ruvu in collaboration to iWASH use ATLAS as their mechanism for data updating and repowering as well. The main different between COWSO is merely paper based while DHIS2 and ATLAS are digital based.

I also had an opportunity to view the database and found certain challenges. The water point mapping database that is online has several mistakes that can disable a person to perform certain analysis. Taking an example of the field/row of funder and installer which many of the names provided are either shortened or they are not related to each other.[6]

4.2.2. Actual Observations of Updating Practice Including problems with Data Arising from Procedure

Water Point Mapping today provides new opportunities to collect and map useful data, and much is still being learned. There are promising examples of the data being used in decision-making, however, the analysis and use of water point mapping data is an area that deserves more attention (Pearce *et al.*, 2012).

The actual water point mapping activity today is based on the created WPMS database, whereby the MoW in Tanzania has developed the webserver on WPM information that has all the data as the main server where all the visualization of map on WPM information can be easily viewed and the report can be generated. Data updating mechanism has been the main activity whereby the Ministry aiming at using COWSO as their new mechanism for data updating. *"WPMS has been installed and being configured into three servers namely; Main Server.* [7] *Backup servers at PMORALG Dodoma and Training and Test site server.*[8] *Apart from having the webserver the main challenge we have is how we can update the data, until today we don't have an appropriate mechanism for data updating, so far we are trying to use COWSO as our mechanism" (ICTU - MoW 2013).*

The WPMS that is being used to update the data from various LGAs is only meant for a few staff in the Ministry as other relevant data that are available in the system must be taken or viewed once a person has an account to that system. So far the database itself has some mistakes taking an example, when doing query basing on "water point for all regions" Arusha Region has 2,830 functional water points, 200 functional need repair and 1,081 not functional which makes the total of **4,111 water points**; whereas the

[6] *http://www.maji.go.tz/userfiles/tanz_wpm_25_04FullData.xls*

[7] *http://wpm.maji.go.tz*

[8] *http://wpm.gaf.de*

same Arusha Region when doing a query for "Water point coverage density in all regions" the figure found are 2,787 for functional water point, 1,064 not functional water point and total water point 4,047 while the roundup figure was supposed to be **3851**, therefore out of 4111 of the first query and 3851 of the second query within the same system 260 water point cannot be traced.[9]

Among problems that have been observed during field attachment noted also is a technological problem especially GIS technology. Tanzania has few experts on GIS technology who are Government employed. This implies that a work that is supposed to be done on GIS basis will cost the Government much money because it has to contract externally. *"Apart from updating being a challenge in the Ministerial level as you can see we are struggling to find the best solution, yet we face another challenge as missing the skilled capacity on GIS expert" (ICTU - MoW 2013)*

4.2.3. Description of Water Point Updating Procedure

According to Pearce *et al.* (2012), a method of regularly updating databases at low-cost should be a common priority, because data updating on water points and sustainability of mapping is the main challenge which should be taken into account so that they can make data obsolete over time. Taking an example from representatives of Water Aid in Southern Africa concurred, claiming continuous updating requires technology for ease of data transmission, but that a suitable institutional setup is required(Pearce *et al.*, 2012).

According to Koroma (2012a), a systems for continued updating would be (GPS + Spread sheet + Google Earth = Updated Map). Whereas in Tanzania, the system used for data updating basing on WPM information, (not formerly commissioned but on trial basis) is COWSO. Some correspondents say; *"In the beginning it was really difficult to acquire data from villages because the VWC were reluctant to send the report, but when COWSO started at least we believe we will get data easily because they are well trained and are able to make reports on time. The reports are sent to WEO, later to DWE and finally to the Ministry. It was wisely suggested that the application of mobile technology through SMS sending would improve efficiency to the whole process of data updating because reporting through SMS takes a short period" (Field Data Collection Morogoro rural Office 2013)*

At ministerial level the updating system has been developed into two terms: short term and long term solution as it has been indicated in Chapter 2 section 2.4 in figure 2-3 even though these systems have not started working properly. The challenge that is seen basing on this new system was mentioned to be as manual work and it is time consuming. *"The first COWSO registered was at Muleba in Kagera followed by Magu in Mwanza as a pilot phase aiming to get an in-depth understanding on how COWSO works, how is it registered, and how will COWSO do so that it could make the updating mechanism and data flow from WP to WPMS easier. The big challenge facing COWSO is a non-standard procedure used to register COWSO" (Field Data Collection GeoData Consultancy Office 2013).*

4.2.4. Issues with Updating Arising from Mapping Procedure

Many issues has been seen after conducting several interview and group discussion to different respondents basing on tools used for data collection and updating the WPM information, Challenges and benefits of those tools, mechanism used in data updating and their consequences, finally challenge that face an organization (MoW) in updating the available online information.

4.2.5. Tools and Software for data Collection and Updating

Identified tools for data collection during water point mapping is Handheld GPS, even though when conducting an interview with other respondents they mentioned other data collection tool as Mobile

[9] *http://wpm.maji.go.tz*

phone. Tool that are used for data updating has been identified as COWSO that the Ministry is trying to apply in different places, Digital ATLAS that is being used by iWASH office in Morogoro. Other identified Data updating software is DHIS2 as it is used for SEMA project. The system was originally developed for Health care.

Digital Atlas is a geospatial information gateway on all sectors connected with water resources, climate and monitoring station, surface water features, water infrastructure, water use, forests, biodiversity, geology, administration, transport, settlement, population demography and vulnerability (Saha, 2013).

The advantage of ATLAS is in bilingual English and Swahili, it can be installed in any Operating System as a self-contained set of vector/raster data and Java environment, the printed map can easily be accessed and lastly an internet connection is not required to use the Atlas. Shapefiles are created using GIS programs such as Arc GIS or Q GIS (Saha, 2013).

The Digital Atlas allows users to zoom into locations such as river stream tributaries, or village streets for a detailed study that is not possible on a printed atlas with static maps displayed at various fixed scales. Furthermore, the user can combine different layers of data, adjust visual styles and labels and create their own maps using the digital product very easily, saving them in various image formats for presentations, reports and publications(Saha, 2013).

DHIS2 is used as national health information systems for data management and analysis purposes, for health program monitoring and evaluation, as facility registries and service availability mapping, for logistics management and for mobile tracking of pregnant mothers in rural communities.[10]

With DHIS2 you can capture data on any type of device, including desktops, laptops, tablets, smartphones and feature phones. A major solution for work-offline is making them ideal to improve reach in locations with poor connectivity. DHIS2 provides a wide range of solutions based on HTML5, SMS and Java.

DHIS2 also supports SMS-based functions. Because SMS is most widely available technology: these features can help you increase the scale of your information system. The SMS features of the system could be deployed as a standalone function, but is more commonly used together with the other mobile clients and the web based interface of the system, as a portfolio of technologies that caters for the specific user context. Some of the use cases that are supported through SMS such as; a simple web based interface for sending SMS to individual or groups that is being send automatically and when the patient respond the reporting data being send to the system and the feedback is been provided, then the desk officer will check for status of a patient's follow-up using SMS.

From DHIS2 system SEMA project develop the mechanism of data updating on their project which seems to work properly as shown in the figure 4-14.

[10] *www.dhis2.org*

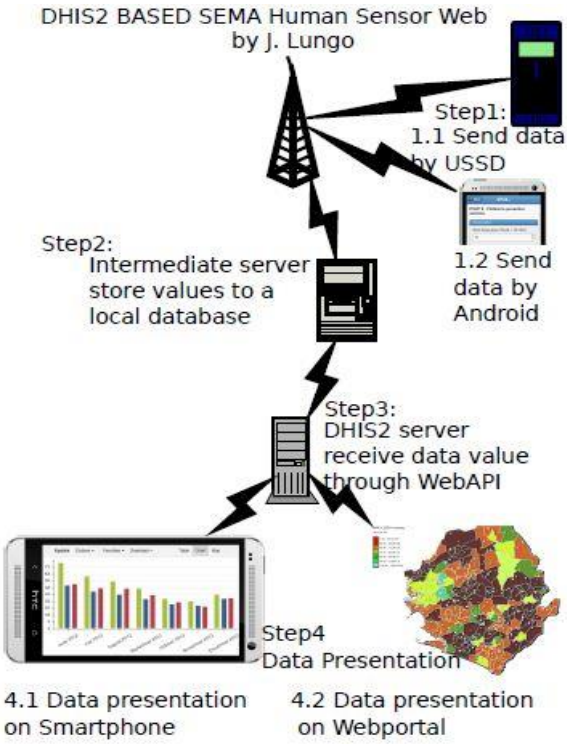

Figure 4-14: New updating mechanism integrated from health

4.2.6. Challenges on tools and software for data collection and updating

Water point updating has been considered as a big challenge for the Ministry and the Government by involving various stakeholders who has tried its best in looking up for the best updating mechanism yet they face many challenges.

After realizing that mobile phone emerged as an easily affordable and preferable device, in several places in the case study area where large cellular network can easily be found, the respondents agreed that the most instant reporting mechanism should be sending messages to water point mapping system (WPMS) in the ministry of water and to district water engineer (DWE). The approach however was seen to have challenges such as; lack of electric power, Lack of credit to recharge the phone and purchase expenses of phone, Lack of security against theft, ignorance of the use of mobile phone. *"I do think the best and suitable method of updating the information/data effectively is via mobile phone due to the fact that the facility of communication is well spread almost throughout the country" (Head of ICT department Geodata Consultants Office 2013).*

4.2.7. Benefits on tools for data collection and updating

Most of the benefits addressed by the respondent basing on the tools for data collection and updating are as follows.

a. Large penetration of cellular network makes it easier for the usability of mobile phone as tool form information transfer from one place to another.
b. When using an android handheld GPS it could be easy as well to update the information because GPS helps in collecting right coordinate ways and elevation and its accuracy being + or – 5m to 10m.
c. Its two way traffic when you send a message to DWE or to the system it is easy to get response from these parts.

   Most people prefer the use of mobile phone for easy communication to the other side. However, one respondent opted for the use of notebook until in the future when he gets solar power.

Training should be conducted to the owners of these tools; this will help to make the transfer of information from the WP to the system much easier. Taking an example from South Korea by Engineer from Morogoro Rural District *"By using GPS that is inserted on a Camera, South Korea has well developed, they used to seat in the office then they plot the system (Water Management Information System - WAMIS). This is a portal system on the internet, built for providing services including water resources information scientifically collected, created and processed for water related organization, and the information that is being searched is consistent.[11] In Tanzania that approach has not yet been practised, however if it develops interest in it through good planning, it can adopt it. The acquired information can be useful to water resources policy planners and decision makers. Nevertheless, it is the argument of the researcher that any strategy related to water resources designed by planners and policy makers should target and involve the public."*

4.2.8. Challenges Facing an Organization in Updating Water Point Mapping Information

The Ministry of Water in Tanzania as an organization that is supposed to update the information on water point mapping has had many challenges towards implementing the better mechanism of data updating. The following challenges are based on the result from the research conducted in Tanzania.

a. Required skills of updating the system especially in local government authorities (LGAs) level, lack of skilled personnel especially in GIS who can deal with database. They had to employ expert from other countries or non-government organization (NGO).
b. Expensive in handling large database and finally lack of working tools as a whole, that's why it is even difficulty to update the current status from time to time.
c. Lack of internet connectivity in some of the rural areas.
d. Insufficient internet bandwidth available for the system requirement.
e. Non availability of accurate and complete spatial datasets or maps (shapefiles) for administrative boundaries (villages, wards, districts) from National Bureau of Statistics and Ministry of Lands.
f. The technology for updating water point's functionality in a real time manner such as using sensor system technology either based on cellular coverage or telemetry.
g. Updating is still a paper work as they use COWSO to write a report to DWE until it reaches to the ministry so it takes a lot of time, moreover COWSO registration is not done all over the country; it operates within few regions until today.
h. Managing the relationship between COWSOs and District Water Engineers (DWE's); and making sure that DWE's are regularly updating the WPM information.

4.2.9. Information Collected on Water Point Mapping in Tanzania

Most of the respondents and actors involved in water point mapping in Tanzania such as the Ministry, Hamlet leaders, LGAs, VEOs, COWSO leaders, said information collected is the status of water points such as Function, Not Function and Function need repair because these are the basic variables/attributes that determine water point. Out of the collected information they integrate that with other variables such as population and boundaries acquired from National Bureau of Statistics (NBS) in digital format, that help them to know exactly that a certain WP serves a certain population within a certain area.

According to Ministry of water, the variables that have been used in water point mapping are the ones which agreed by the Ministry principally together with other beneficiaries so that they might have the common ground once they start collecting WP data. *"After undergoing certain practices with different stake-holders we decided to use by adopting the variables that were being used in Malawi WPM. We found the variable fit for our*

[11] http://www.wamis.go.kr/ENG/overview.aspx

purposes. Basically WPM is defined by looking into one main variable namely status. Other variables help to elaborate more on every WP that is mapped." (ICTU - MoW 2013)

4.3. Usability of Water Point Mapping Information

Respondents stated that the information acquired in WPM is basically used for different purposes such as; planning purposes and operations at local level and national level within the Ministry especially in underpins sector performance. "*The WPM data provide reliable, accurate and up to date information as well as increasing accessibility to information regarding the current coverage of functional and non-functional public rural water points throughout the country with the view of improving decision making and allocation of resources towards improvement of water supply services in rural areas" (ICTU - MoW 2013).*

Second, the availability of information helps to track down the implementation of new schemes and highlights issues of equity, inclusiveness and targeting as far the project is being facilitated by different stakeholder. "*The available information need to be distributed to stakeholders in terms of maps and report because any development strategy need to have a starting point, for-example members of parliament need these information because they are aiming to construct WPTs" (Field Data Collection Morogoro rural Office 2013).*

Third, the information helps to facilitate decision at the ministerial level and LGAs who are the implementers of different projects pertaining to both rural and urban water supply and to the development partners who fund the projects to ensure there is continuity of an inflow of new data to sustain the required progress to the whole process in order to attain the targeted goal of supplying enough clean and safe water to the entire national community. *"We share this data with different reasons, as to facilitate decisions at different levels like LGAs who are the implementers of different projects pertaining rural water supply, development partners who fund the projects" (ICTU - MoW 2013).*

Fourth, the increase of responsibility and accountability to the citizens and authorities from water services and how authorities can better communicate with the citizens to inform and share challenges the authorities face in implementing water projects services to the public. Fifth, the information acquired helps as an indicator in MDGs towards water supply rural coverage which plan to increase access to clean and safe water supply from 58.7% in 2009 to 65% in June 2015 (URT, 2013g). *"This data are required to support local level planning and improve accountability for water sector performance at local and national levels. Also the data of Water Point Mapping (WPM) helps in monitoring the distribution and status of water points and can be used to inform the planning of investments to improve water supply coverage" (ICTU - MoW 2013).*

Other water point mapping usability mentioned by respondents is the provision of visually mapped data as beneficial for monitoring the status of water points. WPM database can be used to be integrated with surveyed data such as population data, as well as road data and other studies. *"The stakeholders provided with visualization for their in-depth understand therefore by making different maps from village level to national level basing on the collected data on WPM through GIS, will definitely help monitoring activities" (Field Data Collection Morogoro rural Office 2013).*

Regarding, the increase in sustainable management of water resources quality and quantity, the Tanzania iWASH declared that, having updated information helps in implementing the water resource management framework in order to understand and sustain water resources and ecosystems upon which human population depends. *"As iWASH we have different constructed well, these are for our beneficiaries in poor rural areas as we would like to see community being served with clean and safe water. Information helps in increasing sustainable management of water sources and points". (Field Data Collection Morogoro at iWASH Office 2013).*

It is noted through Group Discussion conducted in Morogoro that, among the usability of water point mapping information is for rehabilitations of WP projects as well as planning for equity basing on different population around the specific area. *"We have these data from the ministry and use them especially for planning and rehabilitation of our projects so as to insure equitable service distribution because many village lack this water facilitate. It helps us also because we can give the information to other development partner concerning the need for the rural poor people" (Field Data Collection Morogoro District Office 2013).*

From usability of water point mapping data perceptive, what is seen from respondent's responses is the eagerness and readiness to use data in fulfilling different purposeful activities in connection with this exercise, bringing together all stakeholders to co-operate for a common goal.

4.4. Effectiveness of Water Point Mapping Information to the Society

Water point mapping information has a potential power to aid planning in both data processing and decision making. In all levels of the LGAs, this would be reached only if there is good system of data updating, system of sharing information so as to avoid duplication of data. Having the database content that is not complicated, but understandable, easily increases in political support, data accessibility and data accuracy. *"It is better that we have those graphs that help a user to get quick Visio expression of what is all about, so far the use of that map and graph might be for planning purpose, budgeting, monitoring, and resources distribution basing on the population density of the respective areas, but the main challenge is whether the information obtained by the user is for equity purposes." (ICTU - MoW 2013)*

The use of WPM information will help to enhance management in creating accountability and efficiency at work. There are cases already available where the COWSO worker perfectly in managing the water services with the community. Giving an example of Mkambalani COWSO named as Zahanati which has 17million Tshs in their bank account; as contributions collected from daily water services that stand at 20 Tshs Per bucket. At present, Mkambalani villagers are able to pay 100,000 Tshs monthly to COWSO chairman. The monthly collected amount has been used for maintenance of the project and they have bought a motor cycle for daily inspection. Figure 4-15 reveals the reality.

Figure 4-15: Mkambalani COWSO named Zahanati

The effectiveness of WPM information in the society could also be seen in the provision of the maps and graphs that deeply elaborate details of the coverage status of water point within the study area. In that manner, other development partner may use this information for the future development and the related as shown in figure 4-16 to 4 – 19 below.

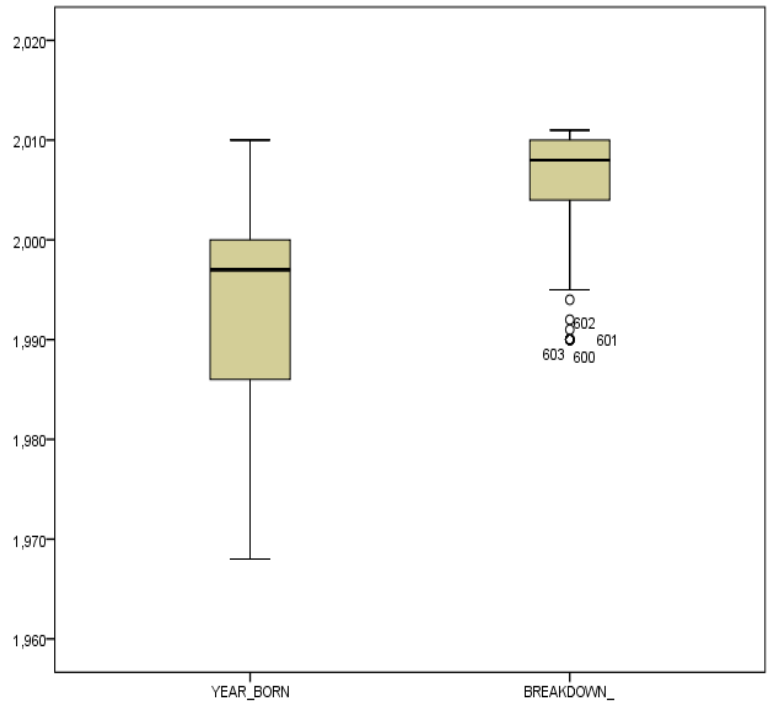

Figure 4-16: WP variation in year born and breakdown

Morogoro Rural WP on different year installed and breakdown, many water points' shows to be installed in between 1990 – 2000 whereby the breakdown was in 2010. (Shorter distance means a quartile is bunched together while long distance meaning quartile is spread out)

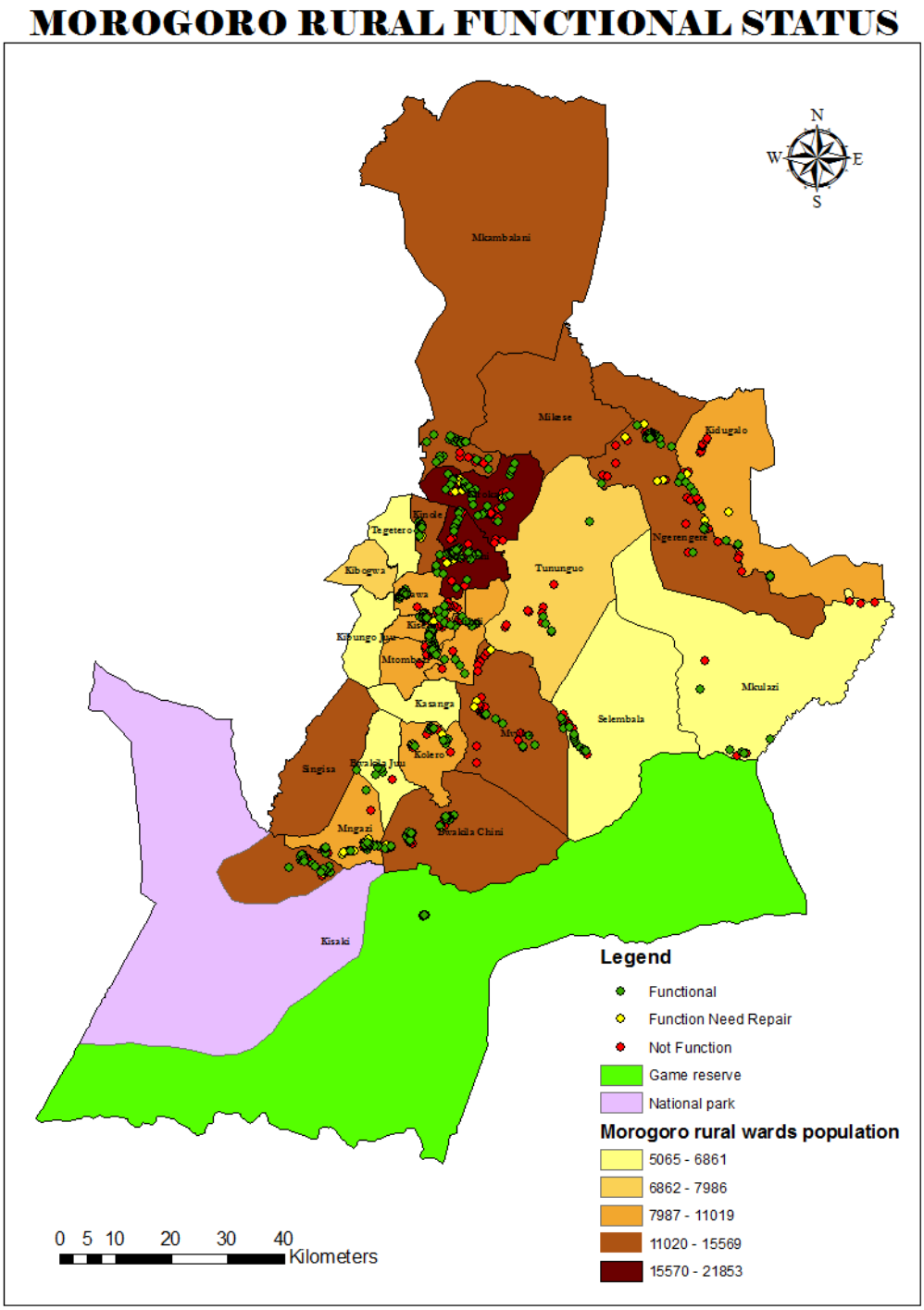

Figure 4-17: Functionality Status of WP for Morogoro Rural District

Figure 4-17 shows the existing situation on functional status of water points in Morogoro rural district, which considers distribution of functional, non-functional and function need repair water points in the wards. The actual water points from ground truthing based on GIS technology have been overlaid with digital spatial data such as district boundaries and population data to gain understanding and variation on the distribution of water point based on the population saved. Unevenly distribution indicated that some wards meets national standards while other not.

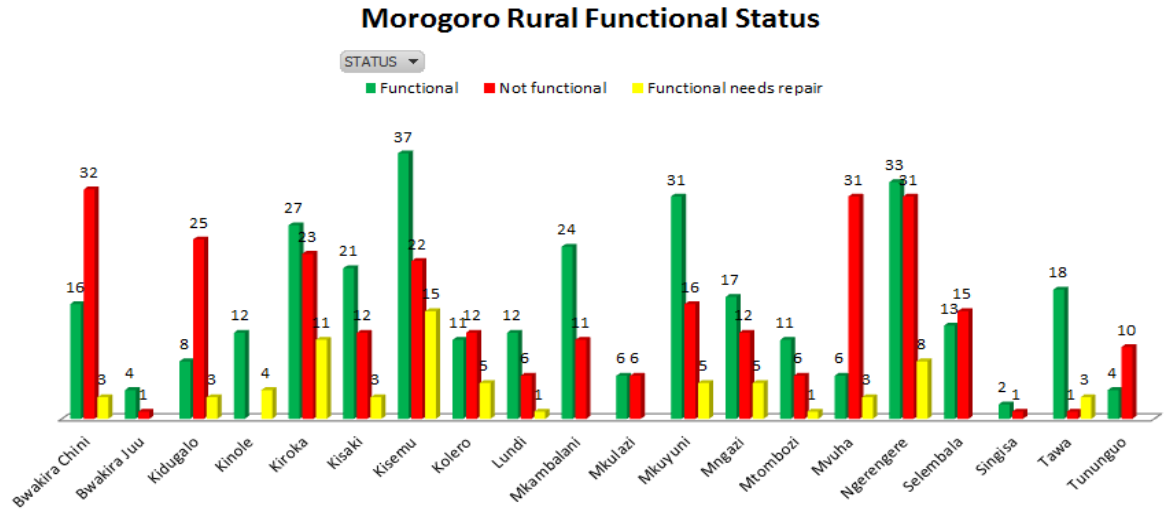

Figure 4-18: Morogoro Rural WP Status in different wards.

The figure above illustrates distribution of an improved community water points in Morogoro rural district wards. Regarding functionality, Kisemu ward leaded with 37 functional water points and 15 functional need repair whereby Bwakira Chini has more of Non-functional water point (32).

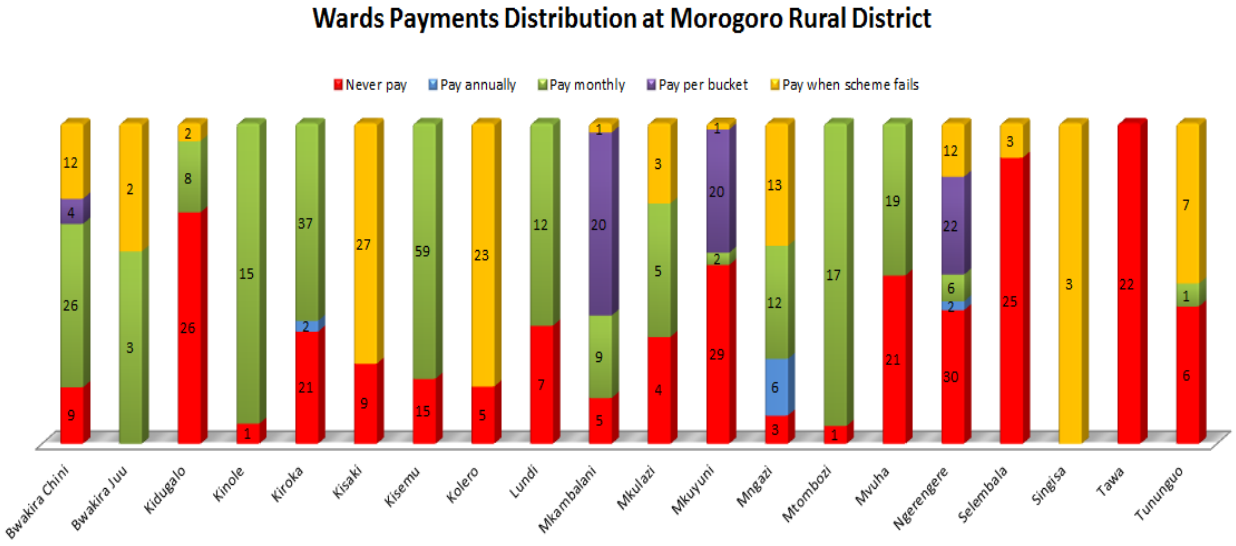

Figure 4-19: Water point payment distribution.

Figure 4-19 demonstrates that 26 counts within Kidugalo wards the water users never pay and few pay when scheme fail. This result corresponds with figure 4-18 whereby Kidugalo ward shows 25 counts of non-functional water point. Generally, many wards never paid and some paid when the scheme fail while few wards pays in annual basis like Mngazi ward with 6 counts.

Among the usefulness of water point mapping information is the comparison between types of pumps and breakdown period that helps to identify the types of pumps/extraction system that live longer as indicated in table 4-1 in the following page. The results clearly shows during 2010 many SWN 80 were found out of use whereby 4 counts were found to Nira/Tanira within the same year the pump which is assumed to be durable.

Table 4-1: Comparison basing on Types of Pumps and Breakdown Year.

		Extraction System									
		Gravity	India Mark II	KSB	Mono	Nira/Tanira	Other	Submersible	SWN 80	SWN 81	**Grand Total**
Breakdown years	1990					7			1		**8**
	1991					1					**1**
	1992					1					**1**
	1994						1		1		**2**
	1995	4				1	1				**6**
	1996	1									**1**
	1997								1		**1**
	1998					5	2		1		**8**
	1999								2		**2**
	2000	3				3		2			**8**
	2001	2				1	2				**5**
	2002					1	1	3	2		**7**
	2003	2						2	10		**14**
	2004	3				1	3				**7**
	2005	2				6	7	1	4		**20**
	2006	6				3	6	1	3		**19**
	2007	3				1	3	1	3		**11**
	2008	11	2		1	6	3	2	15	1	**41**
	2009	5		1		5	3	1	5		**20**
	2010	24			1	4	7	2	28		**66**
	2011	13				3	2	2	5		**25**
	Grand Total	**79**	**2**	**1**	**2**	**49**	**41**	**17**	**81**	**1**	**273**

The observation undertaken at Morogoro Rural District depicted that the presence of stolen pump and broken ones is very high rated to 56 and 79 respectively, where by 66 WP need to be repaired, as shown in figure 4-20. In some cases few water points were found to be functional while the tap were poorly sited and other found with a broken tap.

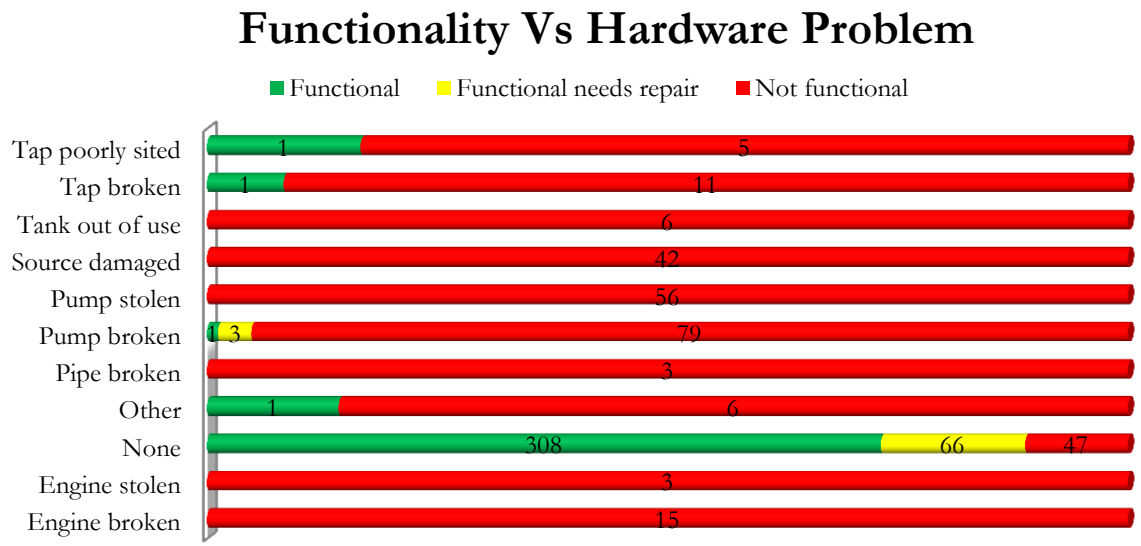

Figure 4-20: Water point Functionality against Hardware Problem

From the observation and key informants interview they confirmed that, there is a correlation within the database which can be viewed via population with other variables such as payments as seen in figure 4-21 and cross tabulation in figure 4-22.

Correlations

		POPULATION	AMOUNT_TSH
POPULATION	Pearson Correlation	1	.034
	Sig. (2-tailed)		.391
	N	656	656
AMOUNT_TSH	Pearson Correlation	.034	1
	Sig. (2-tailed)	.391	
	N	656	656

Figure 4-21: Populations against payment correlation table

The correlation measure the statistical relationship between two comparable variables which are population and water payment. The result indicates that there is no significant correlations between populations and payments which statistically signifies (r= .034 where P = 1 level (2-tailed)). The analysis was done to prove if the water payments collected correspond with the population served. In some cases the payment varies from one place to another ranging from buckets payment, weekly, monthly, annual basis and payment's when scheme fail, there is no fixed amount. In other places payments are done only during rehabilitation time, from this fact there in no correlation between population and payments.

STATUS * EXTRACTION Crosstabulation

			EXTRACTION											
			Afridev	Gravity	India Mark II	KSB	Mono	Nira/Tanira	Other	Other - Play pump	Other - SWN 81	Submersible	SWN 80	Total
STATUS	Functional	Count	2	137	0	0	1	53	1	0	1	23	95	**313**
		% within STATUS	0.6%	43.8%	0.0%	0.0%	0.3%	16.9%	0.3%	0.0%	0.3%	7.3%	30.4%	100.0%
		% within EXTRACTION	100.0%	59.8%	0.0%	0.0%	11.1%	52.0%	1.3%	0.0%	100.0%	56.1%	49.7%	47.7%
		% of Total	0.3%	20.9%	0.0%	0.0%	0.2%	8.1%	0.2%	0.0%	0.2%	3.5%	14.5%	47.7%
	Functional needs repair	Count	0	44	0	0	0	11	0	1	0	0	14	**70**
		% within STATUS	0.0%	62.9%	0.0%	0.0%	0.0%	15.7%	0.0%	1.4%	0.0%	0.0%	20.0%	100.0%
		% within EXTRACTION	0.0%	19.2%	0.0%	0.0%	0.0%	10.8%	0.0%	100.0%	0.0%	0.0%	7.3%	10.7%
		% of Total	0.0%	6.7%	0.0%	0.0%	0.0%	1.7%	0.0%	0.2%	0.0%	0.0%	2.1%	10.7%
	Not functional	Count	0	48	2	1	8	38	76	0	0	18	82	**273**
		% within STATUS	0.0%	17.6%	0.7%	0.4%	2.9%	13.9%	27.8%	0.0%	0.0%	6.6%	30.0%	100.0%
		% within EXTRACTION	0.0%	21.0%	100.0%	100.0%	88.9%	37.3%	98.7%	0.0%	0.0%	43.9%	42.9%	41.6%
		% of Total	0.0%	7.3%	0.3%	0.2%	1.2%	5.8%	11.6%	0.0%	0.0%	2.7%	12.5%	41.6%
Total		Count	**2**	**229**	**2**	**1**	**9**	**102**	**77**	**1**	**1**	**41**	**191**	**656**
		% within STATUS	0.3%	34.9%	0.3%	0.2%	1.4%	15.5%	11.7%	0.2%	0.2%	6.3%	29.1%	100.0%
		% within EXTRACTION	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	0.3%	34.9%	0.3%	0.2%	1.4%	15.5%	11.7%	0.2%	0.2%	6.3%	29.1%	100.0%

Figure 4-22: Status against extraction system cross tabulation table.

As a statistical process cross tabulation helps to join and summarize categorical data, create contingency table and providing a basic picture of the interrelation between status and extraction system in Morogoro rural district. 16.9% of the functional WP belongs to the Nira/Tanira type. 44% of functional WPs are of gravity type, followed by 30% of SWN 80 and Nira/Tanira with 17%. Comparison within the table shows Nira/Tanira as good extraction system compared to other, even though SWN 80 has higher percentage value. This is due to higher number of WP installed.

4.5. Conclusion

Updating the system of water point mapping information is still a challenge in Tanzania. It leads many local government authorities to lack the feedback. Nevertheless, it should be noted that the aim of doing the updating is to utilise the existing structures of WPMS in order to save costs and avoid duplication. This is seen clearly when Welle (2005) says "*The need for updating mapping information is urgent in order to ensure that mapping remains a 'living' and usable tool*". As a way to overcome the existed challenges, training for GIS expertise is a relevant approach in order to equip technicians with the appropriate technology that has to be adapted to meet the challenge. Nevertheless in order for WPMS to be user friendly there is a need to improve governance and accountability sector to create a room that will eventually usher in an atmosphere of integration with other social economic data from other social partners.

5. IMPROVING WATER POINT MAPPING AND UPDATING

5.1. Introduction

The discussions behind this chapter elaborate/validate what has been observed during the WPM exercise in 2011 and the field work conducted during September 28th to 25th October 2013. The discussions are aimed at identifying the mechanisms behind mapping water points and updating the data on water points in Tanzania and suggest some ideas that will bring about relevant improvements to the whole process.

5.1.1. The information collected by water point mapping

In line with Data collection phase, the literature review and the observations gathered in the field, it became evident that, the information collected from the water point mapping contains different aspect such as functionality status, water quality and quantity, payments, constructed and year of breakdown, and problems encountered. *WPM is defined by looking into one variable namely status (functioning, non-functioning and function need repair). Other variables help to elaborate more on every WP that is mapped." (ICTU - MoW 2013).*

Water points are considered functioning even if it produces water seasonally with no defect technically. As seen in figure 4-12, the water points only are functioning according to the community when they can tap water and use it for their daily consumption as cooking, bathing and drinking. At the same time, the different issue raised in accordance to the Ministry of Water in Tanzania that have decreed such water point is not functioning (URT, 2012). Nkonya (2010) pg. 26 emphasized that "For water to be safe, it needs to be free from contamination and acceptable in terms of colour, odour, and taste". The reason behind this is the functioning water point should be covered at the top without dipping any instrument to draw water. Pearce (2013), confirmed that, *"The photo shows an unimproved water source. Whilst this may be useful from an accessibility perspective (reduction in the time somebody may have to walk to fetch water), unprotected sources such as this are not considered improved. This is because the water source is not protected from contamination. The water will become contaminated from the bucket being lowered into the water, or the rope, or by other means because the water is not contained in a sealed and protected area. Therefore, while the community can use this to draw water, it cannot be included as a functioning water point because it does not provide reliably clean water".*

According to information obtained from water point mapping as depicted under figure 4-3, there are some water points that were found abandoned in bush and shrubs. Reaching this destinations was not an easy task but one that subjected us into difficult and hazarders situation of experiencing of either snakes or other poisonous insects bites. We were compelled to clear the bush using cutlasses, hoes and spades and that was costly and time wasting. At one point a very unfortunate observation was experienced that of human excretion being found scattered on top of one WP base. This is attributed not only to lack of education but lack of good manners to be most appropriate. Evenly so were some other villagers who irresponsibly and insensitively turned WP areas for laundry activities and bath rooms. In both incidences people were subjecting themselves to diseases contamination and other health disappointments/failures.

The distribution and population densities of elephants is related to the location of drinking points, and because of their dependence on water, they prefer to be near drinking water points and seasonal river as it has been seen in figure 4-5 (Chamaille'-Jammes *et al.*, 2007; Ngene *et al.*, 2009; Shannon *et al.*, 2008). For this reason communities that are surrounded by National Game Reserves have to protect their WPs against elephants that on several occasions have broken water points to enjoy the flow of water thereafter. This can be done by constructing the concrete fenced around WPs in order to avoid such incidents.

Apart from what is collected in water point mapping, there are certain things which are missing, among of them are; First mapping of the source, it is also important to map the source of water and not only WPT (where citizens fetch water) because the presence of many water point do not indicate the quantity of water therefore demand to water source is necessity. Second, Mapping of dams as other source of water is important because a dam can be used as water reservoirs. Third, is about water quality. There is a need to have water tester equipment's because it is not safe to taste water by using a tongue. Fourth, the syntax of coding should be reflected again in the sense that the codes should bare three digits instead of the variation in two, three and four digits as seen in chapter 4 section 4.1 subsections 4.1.1 because some regions have more than 100 water point in their areas. Therefore to keep the format clean other digits should be standardized as well. Finally, it is important to have in every region and district a digital database in order to make the updating process easier where necessary.

5.1.2. Ways Water Point Mapping is done regarding data capturing, storing, access and sharing

Through observation, mapping at one hand is in digital collection by using a handheld GPS whereby the storage of data in village level is in analogy way. From this perspective sharing of information and storing in village level remains a problem. It's important for the villagers to keep records of their water point as this would help them on rehabilitation period once the donor appears.

To come up with good and reliable data proper training is crucial. Poor reliability of collected data and inadequate combination of different information sources have been viewed by Jiménez and Pérez-Foguet (2010) as a problem in water point mapping. However the case of data storing, access and sharing, as identified in the chapter 4, section 4.2, sub section 4.2.1 shows that in the village level it is difficult to store the data especially to the place where the village office is under the tree shade where villagers are assemble to execute their office activities. In this case, storage of office records is by way of individual officers who are obliged to keep them in their homes subjecting them into misplacements, misuse, destruction and anything along with. At the same time, it has been identified by Morogoro engineer that there is lack of data sharing that is why they lack necessary information from other sources. A study by Prasain (2003) proves that, sharing of data must be agreed upon by stakeholders so as to make user-friendly utilization because the single user entry is not versatile for multiple sharing. For this reason, government information which is beneficial to all citizens shall be open to every official and non-official citizen. This will help in increase accountability to the Government and empowering citizen in their daily activities. Apollos *et al.* (2012), emphasized; information sharing has been improved through website that enables civil society to share documents with citizens and raise awareness, it's also help to avoid duplication and a move towards standardize data reporting by NGO hence increase sector investments.

5.1.3. Correlations within the water point mapping database

In looking for the relation basing on the variables within the database, it was found there is no or less correlations as it was expected. The reason behind is the integrity of the data and many error as well, such that there are many wrong things in a database which make it difficult to do analysis and correlations. For-instance duplication of water points, duplication of water point's codes, mismatch of names for the funder and installer as also identified in chapter 4 section 4.2.1 pg. 34.

Figure 4-21 presents correlation that exists within the dataset. The result indicates that there is no significant correlations between populations and payments which statistically signifies (r= .034 where P = 1 level (2-tailed)). This is due to the fact on different payments in water such as buckets payment, weekly, monthly, annual basis and payment's when scheme fail.

5.1.4. Usefulness of the Information

With the benefits of water point mapping in Tanzania and other Nations that have conducted the same exercise like Malawi, Senegal, Ethiopia and Nepal, it has been identified that, the information obtained from water point mapping are merely used by Government at high level and very few at other local level or other partners. WaterAid (2010), reports that, reliable information on key indicators at local level often lacks, but even when it is available, the uptake for such data by policymakers is, at best, challenging. But if the local user will be given the mandate to report on a wrong happening to WPM they will be in a position to report daily issues and reveal the reality that is on the ground. For example, the case of illegal connection as it has been explained in chapter 4 as well as water tariffs and water leaks. This is in line with Welle (2010b) argument that, TAWASANET used WPM evidence to prepare a yearly equity report and rural WPM can be used to support variety of analysis as equity issues and scheme functionality. A study by Jiménez and Pérez-Foguet (2010) pg. 5 shows that "*the uncontrolled connection to the network affects the functionality of community WPs and threatens the sustainability of the services*".

The information gathered on WPM are used for different purpose as already identified in chapter 4, section 4.3. Furthermore, the information was used in determining the sense of transparency as it can be seen through map visualization. WaterAid (2010), declares that, visual display of information clearly points out priorities for water supply intervention below district level. It is clear that a large amount of citizens cannot make sense of the map unless it has been demonstrated to them in a serious manner that would make them understand as supported by Anokwa (2013). WPM information that is displayed in the Google map or in the Ministry system is not useful to the citizen especially those in the local level, unless otherwise the main target of these information would be for professionals. This case lead to the situation that the maps don't convey any meaning. Therefore it is an important aspect to empower the citizens from local level to high level so that the content of information displayed in the map could be easily visualized.

Other usefulness of information obtained from water point mapping said to be planning purposes, decision making and operations at local level and national level within the Ministry especially in underpinning sector performance. Giné-Garriga *et al.* (2013) pg. (i) articulated that, "*The collected data is finally validated through simple statistical analysis, which in turn produces valuable outputs that might feed into the decision-making process".* It is only proven by United Nations (2012) that if the information will be used as it was planned, the coverage of water point by 2025 will reach the target of 90% to rural areas but if this information will not be used as it was planned it will be difficult to achieve the objective. Moreover, the information helps to track down the implementation of new scheme and highlight issues of equity, inclusiveness and targeting as far the project is being facilitated by different stakeholder.

The intended identified use of water point mapping information was the increase in responsibility and accountability to citizens, the increase of sustainable management of water resources quality and quantity, and for rehabilitations of water point's projects as well as planning for equity basing on different population. (Giné-Garriga *et al.*, 2013; Jiménez & Pérez-Foguet, 2010b; WaterAid, 2010) declared that map provides clear message on who is served and who is not; as they address equity issues and functionality level in districts. The obtained information can be used to inform decentralized government on planning matters and increase water coverage. Therefore, the important thing is to turn this rhetoric into practical reality, and to reject the outdate ideas performing the work without collaboration from local levels because it's the group that is affected with the project. In this way, the Ministry of Water will be able to monitor the impact of its large investments in the urban sub sector.

The continuation of using data for planning and monitoring purposes is said to be hindered by lack of data updating mechanisms and inadequate sector-related institutional framework, (Joint Monitoring

Programme, 2011; World Health Organization, 2012). As observed from the system of updating WPM perspective shows the challenges as discussed in Chapter 4 section 4.2, subsection, 4.2.2 that, the system itself is not stable in case of querying attributes. This means that it is the challenge of in-indeed the struggle for sustainability in various dimensions. Therefore it is important to keep the existing system (WPMS) working by focusing on capital investments for a sustainable updating system and to create a service delivery approach not only for Government officials but to the local level and LGAs as well. In one way or another, this will help to increase progress in functionality coverage hence service equity in the rural areas.

When looking how useful database is in assessing payment, it shows that it's difficult to analyse because of its units. Different units such as bucket, year and even monthly payment are used. At the same time water use differs in needs per person, some use 2 buckets a day while other 10 buckets. It is possible to compare monthly and yearly payments but not to compare buckets and months/year. On the other hand some residents were not prepared to contribute monthly an amount of money that was communally agreed upon to be used for the maintenance of the machine in case of breakages. This reason is stressed by Hambadiahana *et al.* (2012) when taking an example from Bas Congo, where there are many non-functional WPT due to lack of an effective management and water payment mechanism. Haysom (2006), confirmed that poor financial management was correlated non-functionality because the revenue collection was weak. Schoot Uiterkamp (2013), emphasized; the community is responsible for management and maintenance of their water facilities; this is normally done through payment by citizens. URT (2012), on its part stipulated that communities are responsible for full cost recovery in terms of installation, operation and maintenance so as to get clean and safe water. If the situation continues in this way it will lead to communities to turn back into local uses that have unsafe and unclean water and unfortunately having non-functioning water points as seen in figure 4-1 and 4-2.

As Local Government Authorities involved in the provision of basic services through rehabilitation of water infrastructures, planning, implementation and management of service and regulation; it is in this fact that decision making can be fulfilled when there is reliable and up to date information on water service. Therefore the water point mapping data are useful for all stakeholders involved at the local level, in the development or management of water services. In particular, it targets local decision-makers, district technicians, NGOs, consultants, national and regional stakeholders and development partners.[12]

5.1.5. Requirements and Demands for Water Point Data

Water point mapping as a tool for data collection needs to provide accurate data/information to development partners decision-makers, stakeholders, technicians, NGOs, consultants, regional and national that would support the equity analysis as requirements for future targets. Furthermore, engineers at Morogoro rural district decree that keeping mapping data up to date is the foremost requirements, they would have because it helps to address gaps in coverage and challenges that the water sector faces. Number of built water points and their functionality status helps as an indication towards intervention. Data on household's size and wards boundary that are acquired from National bureau of statistic office help to determine and estimate number of beneficiaries per water point as seen in figure 4-17. Upon this reason WPM was seen to be an effective tool for capturing data on coverage status within the LGAs and the information to be used for the user potentiality and the Ministry. Nevertheless, the citizens are left out of active communication during the exercise of Mapping except those who can be around the WP. As a result, these citizens even fail to get feedback on the whole exercise but then others citizens neglect their

[12] http://www.irc.nl/content/download/195309/911823/file/Call%20for%20abstract.pdf

WP not to be mapped due to superstition fearing that when mapping takes place the well will dry up. An effective communication between mapping agency and the citizens will help to provide the reality in a transparency way and in a responsible manner thereby encouraging participatory mapping.

5.1.6. The Way Data Fusion Improve Usability of Water Point Mapping Information

Using water point mapping information in collaboration with other data such as demographic, administrative and physical data (population and boundaries data) help much in understanding which water point is being served at certain location and the population it serves (Jiménez & Pérez-Foguet, 2010a). A work that is being done through analyses performed by GIS technology that positively affect the improvement of decision makings when the information has been displayed using digital maps is by (Welle, 2005). SNV (2010) pg. 8 declared "*The information will provide planners and decision maker with evidence based reference on resource allocation*". However, experts highlighted, there is lack of GIS expert, something which need to be taken account of in the future. Furthermore, there is high incidence of water pumps being stolen or water points being vandalised (SNV, 2010); as also seen in figure 4-19 that shows the relation of stolen pumps with that of broken ones. If these water points are not going to be fixed in short period of time there will be an increase in a number of non-functional water points in the rural area. That will lead communities to turn back into the use of local well that have unprotected and unsafe drinking water, hence decrease the National coverage status of water user as it seem in figure 5-1 below.

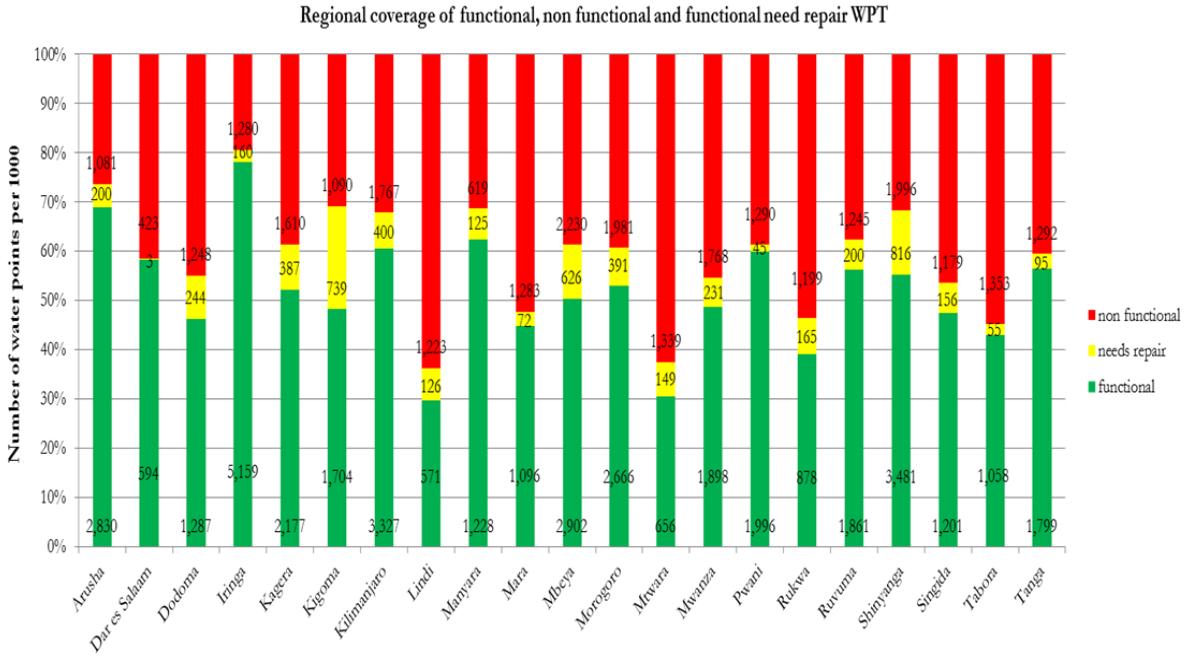

Figure 5-1: Matrix table show regional coverage status of water points in 2013

The figure above illustrates the coverage of water point in every region in rural areas. As Tanzania Government aim to reach its vision 2025 by having 90% of coverage in rural area, some regions coverage status is below 50% such Lindi, Mtwara and Rukwa.

5.2. Tools and Mechanism for water point Mapping and Updating

Updating is essential if the data is meant to keep its value with time. Therefore in order to improve service delivery to the public, data updating and reporting on water point mapping information is crucial. This will help to insure service quality and reliability towards citizens. From this point of view section 5.2.1 to 5.2.5 explain in details tools and mechanism which were used for data updating, improvement to take upon data updating process and identification of the mechanism to be used.

5.2.1. Tools used in water point mapping and updating

The identified tools which were used during WPM are Trimble handheld GPS together with Sonny Digital camera that used to capture water point and village office. DWE was used as a means of data updating although the issue of trust with them remain a critical one because it would be easy to report high rate of functional WPT while in actual situation is not. However, the Hackathon workshop conducted by SEMA (2013) declared that; up-to-date information on water point status is needed for improved water management and this can be done via mobile technology such as smartphones so that the COWSO chairperson can be able to send and receive reports on water point status. According to Welle *et al.* (2013), the built in GPS on smart phone has enabled mapping application, including apples, and nokia as well. Seen from this point several tools have been identifies to be useful in WPM as well as updating. These tools were GPS, Mobile phone through sms sending, androids apps, tablets that will use solar power together with sensor technology system that will be used for updating the system when the drop of water passing through, it will be able to identify/detect that the WP in functioning and vice versa is true.

As mobile phones seems to be more usefully and incredibly powerful in improving data flow Pearce *et al.* (2012), there is yet some challenge that has to be taken care of such as; charging, availability of money for the purchase of air time for sending sms, and the security of the mobile against theft. Coordination among various level within local government need attention for successfully implementation and better usefulness of mobile phone via COWSO representative because they are the ones who collect money as water bills therefore they will definitely have money to buy air time for sending reports to respective places through messages.

5.2.2. Mechanism Used for Water Point Information Updating

In Tanzania context, there is no proper mechanism for data updating yet. Currently they are under the implementation phase of how COWSO as part of updating mechanism should work. COWSO updating constitutes paper work, and this will eventually take a long time for the report to reach to the Ministerial level. Schoot Uiterkamp (2013), pointed out that, the use of mobile phones is to improve information sharing and governance of public services only when citizens are participating and not being as passive users. A study by Pearce *et al.* (2012) shows, 'Smart hand-pumps' as automatic measure that transmit hand-pumps performance data in real-time, at low-cost and in a reliable manner. This proves that communities should use their mobile phones by texting and the results could be linked to a database that can be published so that every user would be able to get feedback instantly.

It is observed that DWE is an intermediary in the channel of communication between COWSO and the Ministry; hence limiting the ability of COWSO to interact directly with the Ministry. A change of this existing system to an interactive feedback mechanism is vital in order to enable the citizens and/or COWSO to report status of water points directly to the ministry without necessary brokering the communication through DWE. Most importantly, the citizens have the right to know what situation they are inn (Meijer, 2005). This will help in managing the relationship between COWSOs and District Water Engineers (DWE's) and making sure that DWE's are regularly updating the WPM information.

The limitations for the role of COWSO in providing the needed information can be the use of analogue system in sending the report since it's a paper work. Other challenges identified by GeoData Consultants are Non-standard procedure for COWSO registration and validation and inquiry process (VIP). The national guidelines do not give mandate to anybody being responsible on the enforcement of law whereby Act No. 12 of 2009 Par 31 gives the mandate to LGAs to formulate and register COWSO. Validation and inquiry process aims to looks upon functionality issues in order to seek an in-depth understanding of the main causative of the situation through participatory approach.

5.2.3. Improvements suggested for updating mechanism

Pearce *et al.* (2013a), pointed out that, mobile data collection tools have increased data reliability; open-source mapping tools such as Google Fusion Tables, QGIS and the Water Point Mapper have been cited as complementing processes as well. In Tanzania context, the valuable data capturing tool that has been used during WPM was handheld Trimble GPS. Through discussion conducted with different respondents it was argued that, it could have been better if there would be a transformation of a way in which data can be captured. For example, through using mobile phone especially by sending sms this will definitely help in the capturing of data and the updates as well within a short period of time. This is because citizens can provide information on WP within their surroundings through mobile phones, and thereafter the results can easily be linked in databases and then published online. Other respondents went further to say that, *"It could be better if we adopt the use of solar tablet because it won't even require electricity"* whilst other claimed *"it is better if we apply the use of an android mobile technology because it has powerfully link to the server"*. Another also said *"the use of GPS is more durable as far as we can easily link to the web server"*.

However, as more attention being based on the analysis and use of water point mapping information, enough funds should be placed to make plans and help implementations of updating mechanism such as improving GIS expertise and supplying funds for sustainable updating of the system. Furthermore, as an improvement towards updating mechanism, citizen/cowso should be allowed to send report via sms, androids and web as well as being provided with feedback loop to keep the report up to date.[13] Finally, standards procedure on COWSO registration should be implemented to insure updating mechanism is made formal and lawful.

According to Welle (2007) pg. 35, "*the process of awareness creation is seen as crucial for the validity of mapping results and updating of existing community list*". This is similar to observation made that; some of the local chiefs denied their water point to be mapped and marked hence causing serious problems and waste of time. Reasons behind this situation is lack of the preliminary information that was supposed to been disseminated to them prior to the mapping exercise commencement at village level so as to keep the community aware of what was about to take place in their community. The provision of education would help them to develop a sense of responsibility and the introduction of a participatory mapping idea within government circles. On the case of transport difficulties, Hirn (2011b), confirmed the road network to be very bad, such that even motorbike cannot move from one village to another thereby delaying the data collection exercise. There were situations a data collector was compelled to spend hours walking or at times was forced to use a canoe to cross crocodile fetched rivers because of floods. As far as the mapping exercise was conducted during rainy season, a canoe and motorbike became an alternative means of transport that at least helped to enable the data collector to accomplish the mapping exercise.

5.2.4. Identification of Data Updating Mechanism

Producing an accurate and up to date mechanism for data updating basing on water point mapping information is one of the most urgent challenges facing the sector of rural water supply infrastructure in Tanzania. Therefore by providing this mechanism it will help the organization to evaluate the potential and implications of new technologies especially mobile phone through SMS sending and minimize the risks associated with delay of an information and plan for the future. Nevertheless this change in mechanism will enable or force significant changes in organizational form and processes thus increasing the accountability and efficiency in the work place. Figure 5-3 represents the regular updating mechanism.

[13] http://www.slideshare.net/markiliffe/taarifa

Data updating mechanism in the context of my study can be defined as the full procedure of water point mapping including people and event in the mapping process with regard to timely recording, updating and sharing of water-point related information such as water points status, hardware problems, water quality and quantity as well as other similar issues on water points in the villages.

Generally, water point mapping information is reported in literature and not digitally, this made the information to be held by genuine user. From this perspective, the study identifies WPM data updating mechanism in a real life situation with regard to five different phases as depicted in figure 5-2 below.

Phase one; Training Session (TS): This is where by mappers are being trained on the basic use of GPS for data capturing and the best use of digital camera that used to picture water point and village office as discussed in chapter 5 section 5.1 subsection 5.1.2.

Phase two; Data Collection (DC): This is the time when the really mapping activities are being conducted in the rural areas. It's as well compiling transport network, infrastructure and people who involved in one way or another. During this process the qualitative and quantitative of data collection should be considered as elaborated in Chapter 5 section 5.1 subsections 5.1.1.

Phase three; Analysis Routine (AR): This phase include action taken during analysis such as using of Microsoft Excel to clean the data. Furthermore, the transformation of data ArcGIS package including data as population and ward boundary which help to make a map of functionality status. Furthermore this phase helps to produce performance indicator such as map on status coverage in certain places as seen in figure 4-17 and elaboration in chapter 5 section 5.1 subsections 5.1.3.

Phase Four; System Creation (SC): The purpose of an updating mechanism is to improve the performance of the system and create awareness to citizens by providing feedback on how will they be able to get report on status and coverage. This system need to have password which identify the correct user.

Phase Five; Updating Mechanism (UM): The moment whereby results are achieved by testing the actual performance of the updating system. Most likely, general variable is stated such as "STATUS". An update mechanism can as well be used to update personnel onset and make them accountable especially the government officials in improving public service as discussed in chapter 5 section 5.2 subsections 5.2.3.

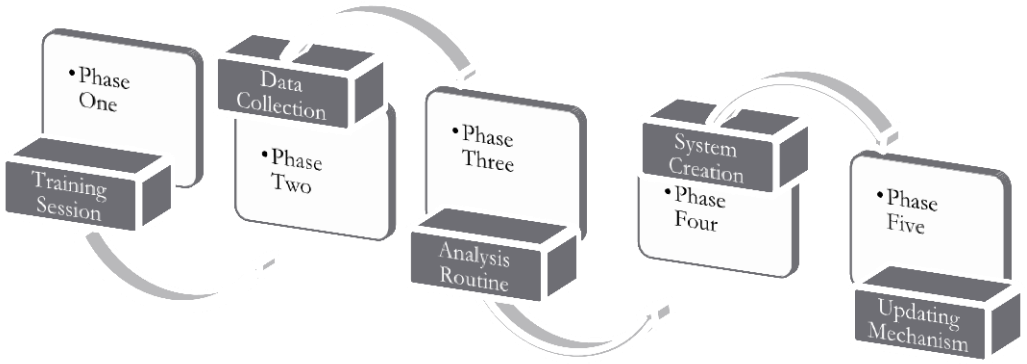

Figure 5-2: Regular Updating Phase.

5.2.5. Suggestion for Regular Updating Mechanism

In updating mechanism, the actors identified are COWSO, Village Executive Officer (WEO), Ministry and District water Engineer. The work of COWSO and VEO is to send a status report of existing WPT

and newly WPT via mobile phone to the desk officer who will definitely treat the sms. Data manger will be responsible for the visualization and analysis of the map and update the database accordingly.

Mapping exercise has already being done throughout the whole country. By this far DWE should be used to the update of the new WPT and send the coordinates to the data manager in the Ministry. Data Manager with cooperation to GIS specialist, the ministry will perform analysis and finally produce maps. Furthermore, the Water sector management and technical staff would be responsible for the maintenance, treatment and reporting on water points.

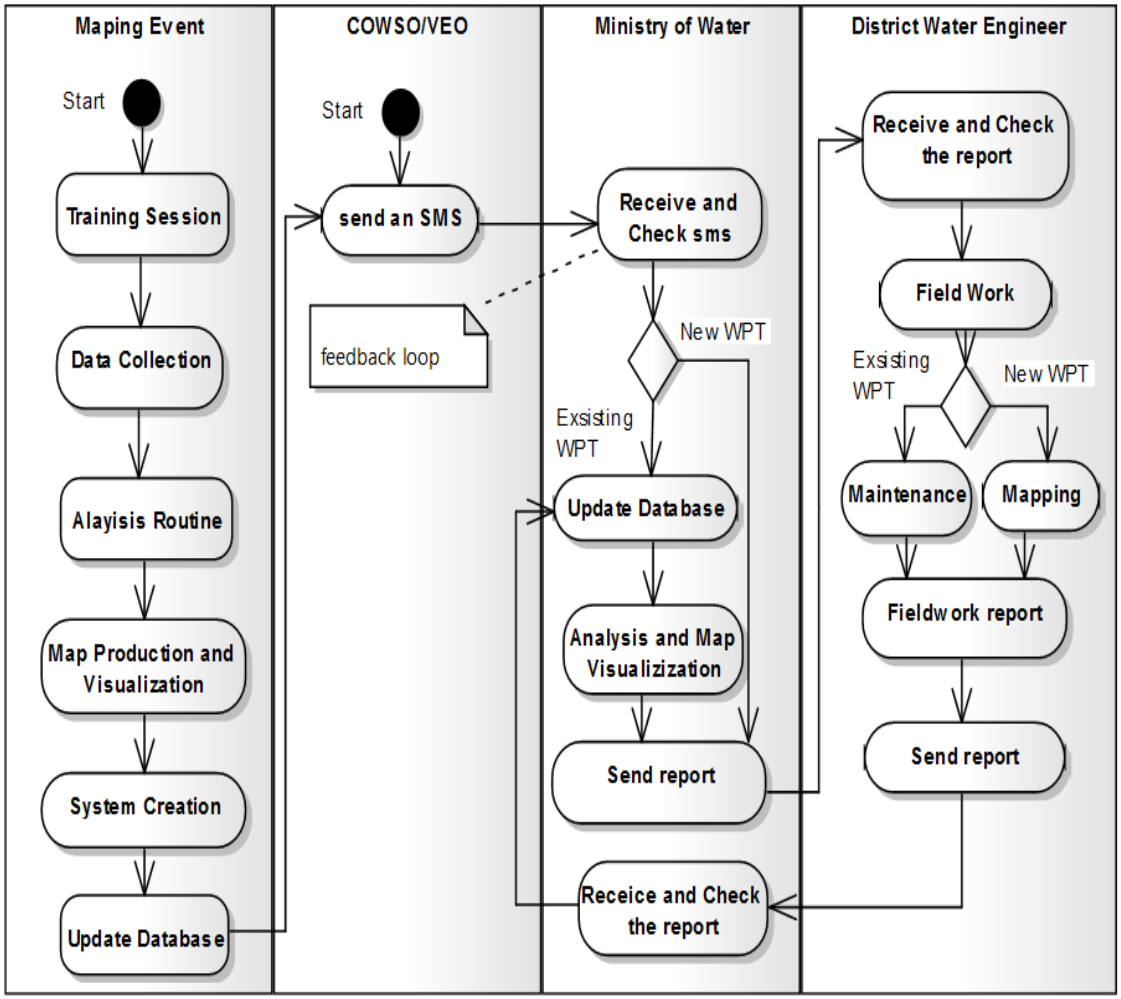

Figure 5-3: General design on Regular Updating Mechanism

The proposed regular updating mechanism is in line with other updating system such as Nepal updating mechanism which used to collect data digitally, enter them, compile and dissemination the same into database system for effective and efficiency information sharing among stakeholders. In the same manner Liberia use AKVO Flow in data collection, management, analysis and visualization. The system use Android Smartphones and Google Map. For the case of Sierra Leone, the gap in coverage on water point mapping information is being filled by their sustaining regular updating mechanism after doing baseline survey, import data to database, doing mapping, performing analysis, doing data assimilation and finally update the database. The failure of updating by using DWE leads MoW in Tanzania to adopt COWSO and regard it as its representative responsible for reporting on WPT status. This process is in analog system that causes citizens to lack feedback. A perceptive digital updating system should take over for easier and accurate updating.

5.3. Conclusion

This chapter looks upon improvements of water point mapping information and updating mechanism procedure. It was found that, the main debate was based on the mechanism for water data updating which will solve the update challenge thereby provide better strategies for updating WPT data and keep the commitment of water point mapping system rolling. The solution developed by government on updating includes COWSO to DWE and from DWE to the Ministry. However, some stakeholder claimed that, the methodology will lead DWE to stay unfaithful by reporting all water point to be functional while is not the case. In order to fulfil these objectives, the use of mobile phone in sending short messages (sms) concerning the status of water points directly to the desk officer in the ministry would be appropriate measures.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion on the summary of achieved Objectives

This research looked at mapping of public rural water service in Tanzania with special emphasis in the mechanism used for data updating.

The selection of two wards was done purposefully because of the time scope of the study at the same time these wards such as Mkambalani and Mikese provided the information to achieve the objectives of the study and the respondents were willing to share the information.

Provision of education and creating awareness to the community is necessary because they are the affected group. Nevertheless, the interactive maps need expertise. On this ground, more GIS expertise with new skills and technicians are needed so as to keep whole mapping exercise smooth.

6.1.1. Information Collected for water point mapping

As seen in annex 1, structured questionnaires helped to collect the necessary information related to water point mapping. Above all, functionality is the general variable used to identify the water point status. Other variables/dimensions are as well related and act as indicators for WPM such as quality, quantity and management.

The study finds no correlations exist within the database. Many variables are wrongly recorded or misspelt. As far provision of accurate information to development partner is essential, then proper data collection is crucial. This helps in sharing of correct information and avoids duplications as already found in the database.

Furthermore the context basing on information storing and access, the study finds that, it is difficult to store and share data in village level because several villages don't have offices. It is therefore necessary to have digital database in every district to easier data storing, access and sharing.

6.1.2. Usability of water point mapping information

Among the study objective is how water point mapping used effectively. This can be seen through data fusion/integration with population and boundary data that help to increase the reality that in dense area it is where you can find a lot of non-functional water point as compared to area with average population. Through these available data it is easier for the Ministry of water and other stakeholder to plan and make decisions.

The identified user for water point information includes, NGO, consultants, ministry, technicians, stakeholders and development partners. However, the intended use of water point information said to be planning, underpinning water sector performance, monitoring and decision making. Water point mapping can be used to support different analysis as already seen in chapter four which will help in strategic plan and priority settings among LGAs (MacDonald *et al.*, 2009). Planning in a local level Map seems to be powerful tool in identifying and targeting the most deprived population. A study by WaterAid (2010) concluded that the use of Map is low for better planning despite of its potential usefulness.

As map can convey massage easily and accurately also illustrate spatial change in time, it can be used for advocacy purposes. Furthermore the representation of it can be used for fund allocation as well used by citizens to pressurize their government to provide quality service (MacDonald *et al.*, 2009).

6.1.3. Identified issues arising in water point updating

The findings of this research reveal that, there is no functional mechanism for data updating till date. The current mechanism that has been put in trial is COWSO. This system by operation is completely a manual work in which COWSO leaders have to write a report and send it to DWE and from DWE to RWE and from RWE to the MoW. This task is not only bulky but time consuming as well. It entails the process of writing and a bureaucratic practice of sending reports from one office to another until it reaches the desired destination to culminate/finalize the process of information updating. In this regard, the aspect of time spending becomes inevitable. With this argument we can conclude that COWSO is currently not an efficient part of the mechanism for water data updating.

The study also attempts to investigate the subject of opinion on preferences regarding more convenient tool/tools that could be used for data updating. On this aspect, the findings from the respondents prefer the use of a mobile phone for an instant reporting and updating via SMS sending. This result corresponds with the idea behind of the SEMA project that used mobile phone to update their data system.

The study also found challenges in an organization that are addressed to increase in the problem of data updating. These challenges are lack of internet connection, lack of GIS skills and lack of working tools as a whole. It is these facts which at most lead to lack of a proper mechanism of WPM information updating system. The more WPM data became outdate the less vital it is in planning process.

6.1.4. Effective use of water point mapping information

Water point mapping information can be used to rank communities based on service level and infrastructure status. This being done by looking at several criteria such as management, quality of water delivered, seasonality of service, and coverage (Jiménez & Pérez-Foguet, 2010). These ranks provide accurate prioritization for future intervention. However, in case of data integrity within database its usefulness is limited.

The functionality to water points through the technology used, construction and breakdown year as well as how water point is being managed, this will help to know the durability of water point and adopt implementation to local government authorities (WaterAid, 2009). Therefore careful analysis of data is required towards mapping and whether there is availability of data. Furthermore the use of mobile data collection helps to create data reliability and awareness.

6.2. Recommendation for Further Research

According to the scope of the study it was difficult to investigate on how the WPM maps are made in relation to other surveyed data and how its visualization can be interactive enough to inform citizens to make decisions and use them for planning purposes as well. From this fact there is a need for further study to be conducted along the same line.

Although the study is based on mechanism for data updating, further studies can be conducted to investigate into what goes on within each of the three elements identified as challenges for data updating by (Welle *et al.*, 2013). Furthermore, it is necessary to conduct the Mapping events during summer. This will definitely help much in reaching easily the water points and reduce the time waste in the field and cost as well.

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ANNEX I

WATER POINT MAPPING – DATA ENTRY FORM 2011:

Date of record

Recording Organization

Region

District

LGA Name

Ward

Village

Village Population

Village Registration No

Village Photo

No. of Private connection

Sub Village

WPT Name

WPT Code

Population Served

WPT Photo ID

Scheme name

Water Permit YES or No

Catchment

Funder

Installer

Year of construction

GPS way point no. Dec°

Dec°

Source type

- ◯ Shallow well
- ◯ Hand Drilled tube well
- ◯ Machine Drilled bore hole
- ◯ Dam
- ◯ River/Lake
- ◯ Spring
- ◯ Rainwater harvest rooftop
- ◯ Rainwater harvest ground
- ◯ Others….

Extraction System

- ◯ None
- ◯ Mono
- ◯ Cemo
- ◯ Climax
- ◯ KSB
- ◯ Surbmersible
- ◯ Gravity
- ◯ Affridave
- ◯ Nira/Tanira

- ◯ SWN 80
- ◯ SWN 81
- ◯ India Mark II
- ◯ India Mark III
- ◯ Walimi
- ◯ Windmill
- ◯ Gravity
- ◯ Others…….

Water point type

- ◯ Hand Pump
- ◯ Communal Standpipe
- ◯ Communal Standpipe multiple
- ◯ Dam
- ◯ Improved Spring
- ◯ Windimill
- ◯ Others……

Status

- ◯ Functional
- ◯ Non Functional
- ◯ Functional need repair
- ◯ Not Functional > 6 months
- ◯ Not Functional < 6 months
- ◯ Not Functional < 3 months

Hardware Problem

- ◯ None
- ◯ Source damaged
- ◯ Pump broken
- ◯ Pump stolen
- ◯ Engine broken
- ◯ Engine Stolen
- ◯ Tank out of use
- ◯ Pipe broken
- ◯ Tap poorly sited
- ◯ Tap broken
- ◯ Under construction
- ◯ On Rehabilitation
- ◯ Other……..

Water quantity

- ◯ Enough
- ◯ Insufficient
- ◯ Seasonal
- ◯ Dry
- ◯ Others….

Water quality

- ◯ Soft
- ◯ Milky
- ◯ Coloured
- ◯ Salty
- ◯ Sallty abandoned
- ◯ Flouride
- ◯ Floured abandone
- ◯ Others……

Breakdown year

Reason for not functioning

Scheme management

- ◯ VWC
- ◯ WUG
- ◯ WUA
- ◯ Company
- ◯ Trust
- ◯ Water board
- ◯ Parastatal
- ◯ Private
- ◯ Other

Wpt Management

- ◯ VWC
- ◯ WUG
- ◯ WUA
- ◯ Company
- ◯ Trust
- ◯ Water board
- ◯ Parastatal
- ◯ Private
- ◯ Other

Water payments

- ◯ Pay per bucket
- ◯ Pay monthly
- ◯ Pay annualy
- ◯ Pay when scheme fail
- ◯ Never pay
- ◯ Other……..

Public meeting

Yes ◯

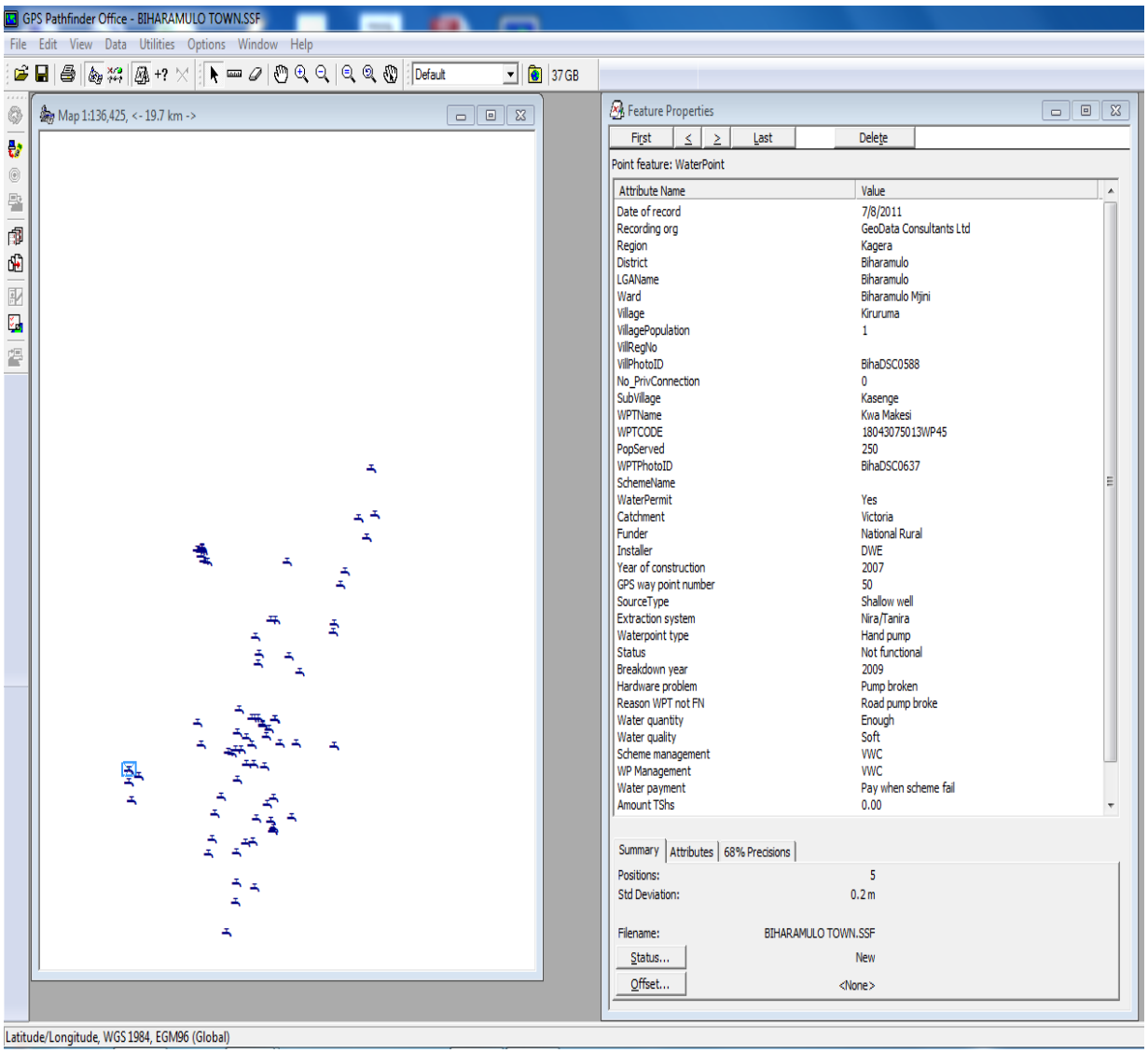
No ◯

Amount Tshs

General Comments

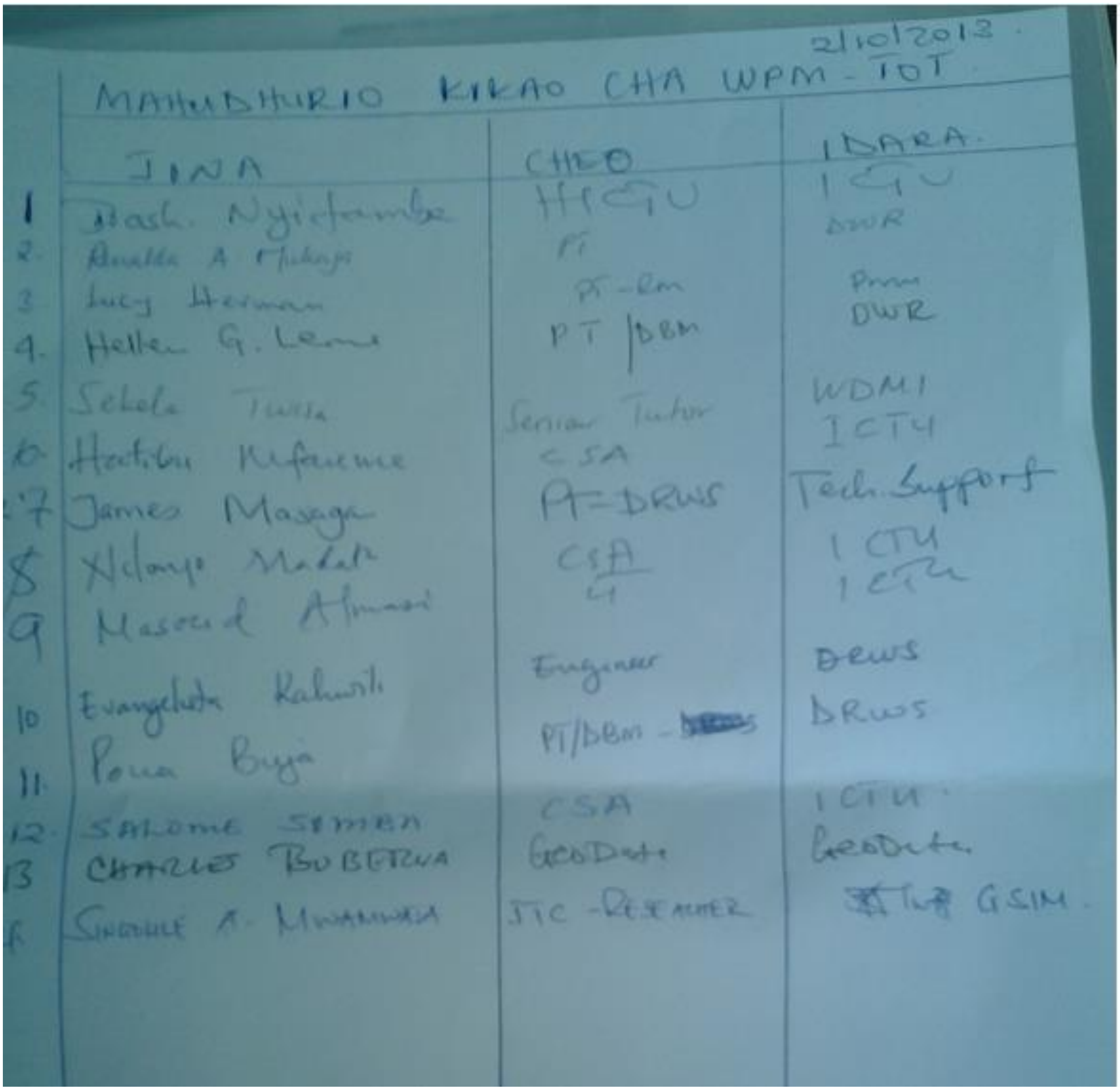
ANNEX II

WATER POINT MAPPING – DATA SHEET



ANNEX III

TRAINING OF TRAINERS (TOT) WATER POINT MAPPING MEETING



21/10/2013.

MAHUDHURIO KIKAO CHA WPM - TOT.

	JINA	CHEO	IDARA.
1	Rash. Nyirfambe	HHGU	IGU / DWR
2.	Renalda A Mtikaja	PT	
3	Lucy Herman	PT - Rm	Prm
4.	Hellen G. Lema	PT / DBM	DWR
5.	Sekela Twisa	Senior Tutor	WDMI
6	Hatibu Kifaruwe	CSA	ICTU
7	James Masaga	PT = DRWS	Tech. Support
8	Ndonyo Makala	CSA / G	I CTU
9	Masoud Almasi		I CTU
		Engineer	DRWS
10	Evangelista Kahwili	PT/DBm - [illegible]s	DRWS
11.	Pona Biya		
12.	SALOME SIMBA	CSA	ICTU.
13	CHARLES BUBERWA	GeoData	GeoData.
ꟻ	SWEDDLE A. MWAMWAJA	JTC - RESEARCHER	[illegible] GSIM.

ANNEX IV

INTERVIEW QUESTIONS TO THE IT PERSON AND TECHNICIANS

I. Introduction

I am **Singolile Abby Mwamwaja** studying MSc degree at the Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente. I am conducting a study on "Mapping for public rural water services in Tanzania: A case in Data Updating"

Therefore this interview is intended to collect data that will help the researcher in understanding the tool and mechanism of data updating and reporting the water point's information in Tanzania and suggest the improvements.

II. Bibliography

Name ……
Organization ……..
Function ……
Gender……

III. Interview Questions

1. Who are the actors involved in providing water point information to the public?
   Mention ……..

2. Which considerations did you make by choosing certain variables/attributes in the water mapping dataset? And WHY?
   ……
   ……
   ……

3. Listed below are some of the commons/basic software for data updating in WPM data
   A. Atlas
   B. Akvo Flow
   c. Human Sensor Web
   d. EpiSurveyor
   Of the four, which one do you use for updating (WPM) data? Which other software do you consider in the future? ……

4. What are the advantages in the software mentioned in question three. Please explain ……..

5. What do you consider as the major constraints in the software mentioned in question three? Please explain ……..

6. Does it involve coding? (YES) or (NO). If the answer is YES how do you do coding? IF NO why? Please Explain …….

7. Please explain what else can/cannot be coded ……

8. What is your opinion on how WPM is updating? / What mechanism is used for WP information updating? Please Explain ……

9. Listed below are some of the possible data collection tools for WPM. Which one do you use for data collection?
   (a) Mobile Phone
   (b) Handled GPS
   (c) IPAD
   (d) Kite Mapping

10. From the listed tools in question 9, which other devices do you use for data collection? Mention ……..

11. Which data do you specifically collect using such devices in WPM?

12. How effective are the tools in collecting WPM data/information?

13. Which device would you prefer the most for instant data reporting? And why?

14. What challenges/problems do you face in using such devices for data collection?

15. Please mention three to five challenges facing the organization in updating the water point information?

16. How often is the content of water point's information updated in a year? And WHY?
    One time …… Two time …… Three time……. Four time……. Etc.

17. How can WPM information be updated effectively?
    Explain …….

INTERVIEW QUESTIONS TO THE MINISTRY OF WATER – RURAL WATER SUPPLY

I. Introduction

I am **Singolile Abby Mwamwaja** studying MSc degree at the Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente. I am conducting a study on "Mapping for public rural water services in Tanzania: A case in Data Updating"

Therefore this interview is intended to collect data that will help the researcher in understanding the tool and mechanism of data updating and reporting the water point's information in Tanzania and suggest the improvements.

II. Bibliography

Name ……
Organization ……..
Function ……
Gender……

III. Interview Questions

1. Give a brief History of WPM in Tanzania.

2. What is the reasons/rationale that you consider for each variables/attributes in the water mapping dataset? And WHY?
   ……
   ……
   ……

3. Why New Data of WPM is required and for what purpose?
   Explain……

4. Do you give WPM related information to citizens/users? (YES) or (NO). If the answer is YES how do you do it? If NO WHY?
   Please explain ……..

5. Do you share Data (Identifiers) with other organization? (YES) or (NO). If the answer is YES can you mention which data do you share? If NO WHY?
   Please explain
   ……..…….

6. Which organizations do you share data with?
   Please
   explain……..……..

7. Why do you share the data?
   Please explain ……..……

8. What do you think will be the benefits of WPM information to the society?

9. What changes do you think the WPM information is likely to bring to the society?

10. Can data fusion/integration improve the usability of water point mapping data?

11. How often is the content of water point information updated in a year? And WHY?
    One time …… Two time …… Three time……. Four time……. Etc.

12. Please mentioned three to five challenges facing the organization in updating the water point information?

13. Who are the actors involved in providing water point information to the public?
    Mention ……..……

14. What should be done by the Government to improve the WPM data updating system?
    a. ……..
    b. ……..
    c. ……..
    d. ……..

15. Any important considerations, challenges, developments or remarks that we did not discuss that is related to data updating and reporting on WPM?
    ……
    ……
    ……
    ……
    ……

INTERVIEW QUESTIONS TO THE DIFFERENT USERS

I. Introduction

I am **Singolile Abby Mwamwaja** studying MSc degree at the Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente. I am conducting a study on "Mapping for public rural water services in Tanzania: A case in Data Updating"

Therefore this interview is intended to collect data that will help the researcher in understanding the tool and mechanism of data updating and reporting the water point's information in Tanzania and suggest the improvements.

II. Bibliography

Name ……
Organization ……..
Function ……
Gender……

III. Interview Questions

1. What do you know about WPM? Shortly explain……
2. Which tool do you use to report the broken/ (dysfunctional) of Water point? Mention ……
3. If by phone which type of mobile phone do you use in reporting the broken pump?
   a. Nokia b. Samsung c. Seaman's d. Others Mentions……
4. Does your mobile phone acquire internet connection? YES/NO. If NO WHY?
5. Did you have any problems in using your device for reporting on dysfunction of WP? YES/NO. If yes what are they like batteries, internet connection or geo-location? Others please mention…….
6. How long does it take for the technician come to fix the problem of broken pump/tap? And WHY?
   a. One week …… Two week …… Three week……. Four weeks……..
7. Do you get feedback from the acquired information of WPM? YES/NO. If yes which information do you get? If NO why?
   Please Explain …….
8. What is the useful of the feedback you get from WPM to your office?
   Please Explain…….
9. How long do you travel to fetch a drinking water in a public tap? And WHY?
10. What is your suggestion on data updating mechanism and reporting of WPM information to the Government? /What more has to be improved in the system? How can we make it better? Please Explain ……