



Using Information Communication Technology (ICT) Tools in Managing Customary Land, Demarcation, Conflict and Tenure Data in Developing Countries: A Case Study of Zambia

Annie Mporokoso¹, Jackson Phiri²

¹Department of Electrical and Electronics, University of Zambia, Zambia

²Department of Computer Science, University of Zambia, Zambia

¹anniemporokoso@yahoo.com; ²jackson.phiri@unza.zm

Abstract - Zambia has in the recent years witnessed domestic and international land boundary conflicts as a result of commercialization, urban-rural migration and high demand for customary land and its consequent translation into monetary values due to improper land demarcation system and partial documentation of customary land parcels. In this study we propose the utilization and integration of Information Communication Technology (ICT) tools such as the Participatory Geographical Information System (PGIS) and the mobile application to be used in the implementation of the customary land management system. This will enable families and community groups to properly demarcate customary land boundaries in order to reduce land conflicts and provide security of tenure. We began by a baseline survey to ascertain the methods and type of information used by chiefs in customary land management. Based on the baseline study, we developed a mobile application using PGIS technologies.

In our baseline study, the results showed that 61% of the residents had their land demarcated using trees, 29.4% had used ant hills and 9.6% used streams. The study also showed the occurrence of land disputes due to inappropriate land demarcation system, with 56% of the residents having experienced family boundary conflicts, 42% experienced selling of land by their leaders and 4% experienced communal land conflicts. Using the results from the baseline study, a mobile customary land management system model was developed. Using this model we developed a prototype which has the capability of harmonising land boundary coordinates for family and communal land and integrate with ownership details thereby reducing land conflicts and ensuring security of customary tenure.

Keywords— land demarcations, PGIS, ICTs, Mobile Application, land allocation, boundary conflicts

I. INTRODUCTION

In sub-Saharan Africa, since human settlement and the birth of civilization, land has been the most valuable asset for a nation or society [1]. As the value of land increases throughout the progress of human civilization, so do conflicts over land. With increasing population growth and consequent demand and exploitation of high-value natural resources, including oil, gas, minerals and timber, conflicts over land has become problematic, especially in less-developed countries where land is still central to production and economic growth [2]. Some African nations, such as Zambia, have experienced a number of conflicts over land. A major contributing factor to these conflicts is the increasing scarcity of land caused by population growth and urban-rural migration coupled with unclear boundary demarcations [3]. Proper land administration and management systems supplemented with latest technology of mapping becomes vital in customary land administration thereby ensuring security of land tenure for the citizenry.

In this paper, we recommend a model for customary land management through use of mobile technologies such as PGIS and GPS. The paper is arranged as follows; Section I gives the Introduction, Section II provides the Literature Review, Section III is Related Works, Section IV is the Methodology, Section V outlines the Implementation Results, Section VI is Discussion and Future Works and Section VII is the Conclusion.

II. LITERATURE REVIEW

ICT has an important role to play in improving the operation of land administration and in making information services more readily available in support of land tenure [4]. The advancement of mapping technology and PGIS has made land administration more accurate and effective in the management of customary land [5]. The section below provides a summary of review of customary land management in developing nations and how ICT is being applied to enhance customary land administration.

A. Customary land management : Developing Countries

In this sub section we look at the management of customary land in developing countries. We begin our analysis with Africa. In Nigeria, there are three types of land tenure systems; communal, individual (private) and public (state). Communal land tenure is established on the inalienable and equal rights of joint ownership of land by every member of the community, with some selected members, usually elders and titled men, given the responsibility to act on behalf of others as custodians of the land. The customary land ownership rights are based on oral traditions and their connection to culturally-significant places such as graveyards to make claims and prove ownership [6] [7]. In Ghana, Customary lands are lands owned and controlled by stools (ethnic groups), clans or families where traditional and customary norms and practices govern their tenures and administration. The customary land sector controls roughly 80% of the land holdings in Ghana. Ownership and management of these lands is vested in traditional institutions headed by chiefs, clan and family heads. The chiefs do not have maps as evidence of lands given out and this has had major challenges because of poor record keeping [8] [9]. In Uganda, [10] states that land is owned by the Ugandan citizens, who may choose to manage the land either individually or communally in accordance with customary norms and practices. Uganda has four main land tenure systems, freehold, leasehold, Mailo and Customary land tenure systems. Customary land tenure system is the dominant land tenure system in which individuals' use of land is subject to regulations and sanctions determined by the community, clan and family. Owners of customary land have no papers as proof of owning the land, but they are still the legal owners of the land [11] [12] [13]. In Malawi, three land tenure types exists; customary, public and private. The predominant tenure is customary tenure, which accounts for about 68%. Customary land is all land held, occupied, or used by community members under customary law. Access to customary land is primarily through the traditional leaders who act as overseers [14] [15]. Subsequently, we look at Asia and South America. In Bolivia, land is held individually by private individuals and communally by families and indigenous people. Ownership of land by indigenous people is based on customary law. Indigenous land rights are unregistered. Registries are poorly maintained, especially in rural areas such that no proper record system exists [16]. In Cambodia, the Cambodia's law recognizes three forms of land ownership: private ownership, state ownership and collective ownership by indigenous communities [17].

B. Application of ICTs in Customary land

This section looks at how ICT tools have been applied in the management of customary land to reduce land disputes and ensure security of tenure. In Nigeria, particularly in Akabor area, [18] designed a web based customary land tenure information system based on the TalkingTitler model to suit the needs of the Akabor community, whose land tenure evidence was based on the oral testimony of land owners and their witnesses. In the Talking Titler system, flexibility in creating relationships between people and between people and their interests in land is the primary design feature. Talking Titler as described by [19] is a land tenure information software system, that allows a great deal of flexibility in the way data relating to people, land and evidentiary media such as titles, deeds, survey plans, descriptive documents, audio records of oral testimonies, videos, photographs, valuation records can be stored and related. In Uganda and Ghana, the Social Tenure Domain Model (STDM) was employed. The STDM is a land administration data modelling application developed as a specialization of the International Federation of Surveyors whose aim is to model the person-land relationship regardless of their formal or legal status. The STDM application provides the ability to put rights into a system, rights which are not registered as well as claims that need to be adjudicated both in terms of the 'who', the 'where' and the 'what type' [20] [21] [22] [23] .

III. RELATED WORKS

Mobile phones have made a bigger difference to the lives of many people, more quickly, than any previous communications technology. Mobile phones are connected to phone networks at higher bandwidths, which has opened real-time access to the Internet and information services. System Engineers and Developers have developed mobile applications with the capability to integrate Global Navigation Satellite System (GNSS)

positioning and GPS to provide citizens with the opportunity to directly get involved in the land registration and cadastral processes [24]. This section presents an overview of some of the mobile applications developed in land administration.

In Tanzania, USAID designed a mobile technology application to crowd-source land rights information at the village level called Mobile Application to Secure Tenure (MAST). MAST is an easy-to-use, open-source smartphone application that captures the information needed to issue formal documentation of land rights. Coupled with a cloud-based data management system to store geospatial and demographic information, the mobile application has lowered the time involved in registering land rights and has made the land registration process more transparent and accessible to local people [25]. The Food and Agriculture Organisation (FAO), Solution for Land Administration (SOLA) Team have recently developed 'Open Tenure' to address the need of people in many developing countries like Ghana, Nepal and Samoa to have their tenure rights recognised at a community level through the use of mobile devices and crowdsourcing techniques. Open Tenure is an open source software application for mobile devices that gives communities and individuals the ability to record tenure rights within their community. SOLA software application addresses tenure recording at the community level outside formal land administration. Open Tenure takes advantage of more affordable technology in the form of mobile devices including tablets and smart phones. In the field, using Open Tenure, land details are collected on the property itself such as name or other identifiers and the land use, ownership including multiple owners and defined shares, images of supporting documents, photos of owners and the property and a map of the property [26] [27]. Computer scientists at the University of Washington [28] have used Android, the open source mobile operating system advocated by Google, to develop an Open Data Kit to turn a mobile phone into a versatile data collection device. It is being used by organisations around the world that need inexpensive ways to gather information in areas with little infrastructure. For example, members of the Surui tribe in Brazil have tested the Open Data Kit as a tool to raise awareness of illegal logging on their lands [28].

IV. METHODOLOGY

A. Baseline Study

Zambia is a landlocked country located in Southern Africa [29]. Zambia has two tenure types namely customary land tenure system and privately or state titled land under the statutory land tenure system. Customary land tenure is the dominant system governing land administration of the major land mass of Zambia. Approximately 64 per cent of Zambian land is currently held as customary land and 36 per cent is held as state land. Customary law, on the other hand, is not written, but it is assumed that the rules and regulations under this system are well known to members of the community [30]. The continuing attrition of customary land management within a context of investor interest has increased the demand for customary land in Zambia, which is already under pressure with rising number of people dependent on it for survival such as farming [31]. Despite the fact that most land is under customary power, there are no resources obtainable to manage the land system. Tenure insecurity continues to destabilize local land rights, especially for women and orphans. Land administration and ownership has proved a major problem for the pre-urban and rural population in Zambia. The failure by government to provide better mechanism of land ownership is considered to be a major factor contributing to the mass relocations and non-preservation of land for future generation [32]. Reports abound of Chiefs and local elites in Zambia, persuading communities of the benefits of releasing their land to investors and even reinterpreting their trusteeship as entailing their due right to sell and benefit from those sales. Communal rights are being grossly interfered with, farming systems upturned, livelihoods decimated and water use and environments changed in ways which are dubiously sustainable [32]. There is therefore a need to make customary tenure more secure than it is now to ensure equal distribution of land to all Zambian citizenry.

The study area selected for this research is Munkonge Chiefdom, situated in the Northern Province of Zambia. The study area is headed by Chief Munkonge and his supported by four (4) village headmen as shown in Table 1.

TABLE I
VILLAGE AND RESPECTIVE HEADPERSON

Village Number	Village Name	Headperson
1	Makonde	Makonde
2	Kalebaila	Kalebaila
3	Nakulukatongo	Nakulukatongo
4	Nsange	Nsange

For this study, a mixed approach of qualitative and quantitative survey methods were conducted. Questions and face to face interviews were also conducted as means of obtaining information from the subjects of the study area. A total of one hundred and two (102) questionnaires were administered, twenty five (25) questionnaires were distributed to the female and male village committee members who are in decision making and seventy seven (77) questionnaires were distributed to the ordinary subjects. The targeted groups were male and female residents that own land from the age of eighteen years to above one hundred years.

B. Customary Land Management Model Design and Implementation

This section looks at the development of the mobile customary land management application. The application will be used by the residents to register for land and the land administrators to accurately demarcate the land boundaries using the GPS enabled mobile device connected to the internet. The system will be implemented using the two tier client-server architecture consisting of the mobile application and the database which will store land related data. The mobile application will be developed using PHP as the frontend application which will capture the client's personal details and the land details. The mobile application will run on Android operating system. The backend system will be developed using SQL and JAVA. The GPS will use the Google API for capturing the land boundary coordinates on the mobile device and later upload the maps into the SQL database server.

IV.B.1 Basic concept and Design

The architecture of the mobile customary land management application is a two tier client-server model. The mobile application will run on the handheld mobile device. The clients will enter their personal details, the land details and later view all land details from the mobile device. The administrator will have full control of the application which will be deployed at the Chiefs palace. His major role will be updating land records, coordinating boundary demarcations and ensuring security of all the land parcels in the database. Fig 1 below shows the basic architecture of the mobile application for customary land management.

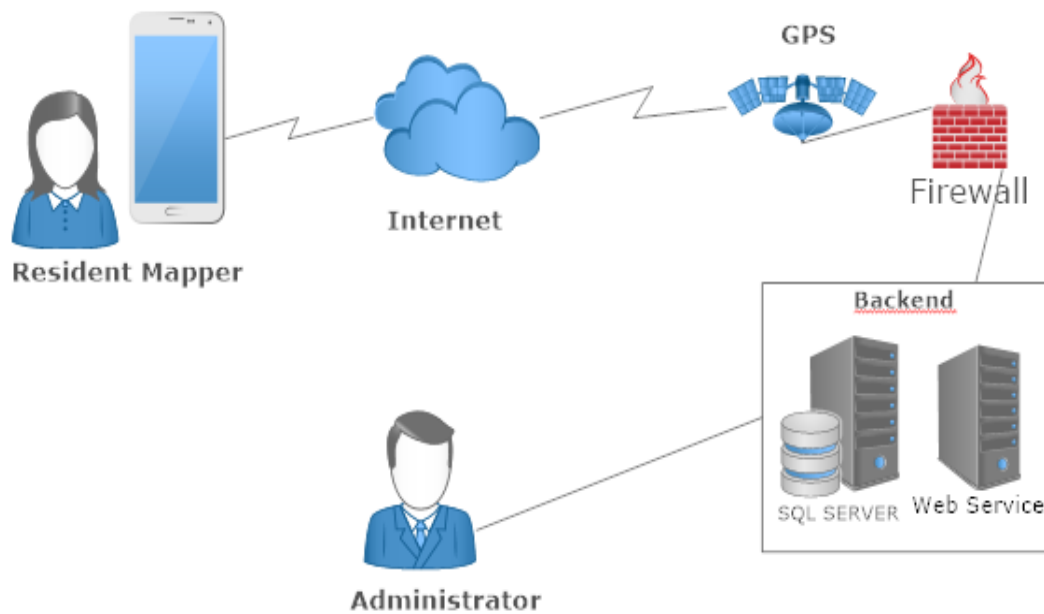


Fig 1 Mobile Application Architecture

B.2 Use Case Diagram for customary land management system

The use case diagrams represent use cases, actors and the relationships between the use cases and the actors. The administrator or chief will perform the following activities in the customary land management system:

- Assign land
- View land details
- Update land details
- Delete land details.

Fig 2 shows the administrators interaction with the system

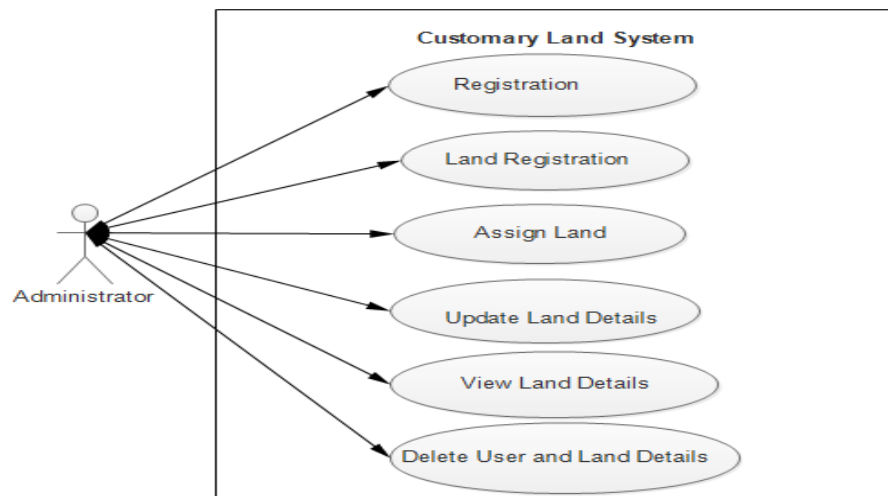


Fig. 2 Administrator’s Use Case diagram

B.4 Entity Relationship Diagram

Fig 3 below is the customary land management Entity Relationship Diagram (ERD) comprising of the property entities and their attributes as well as the User entities.

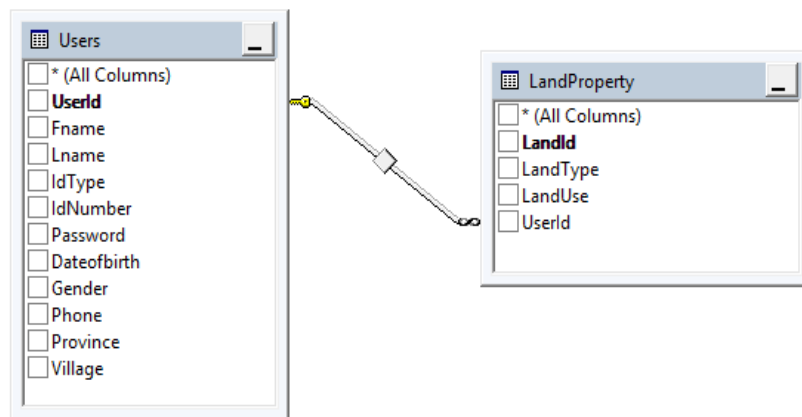


Fig 3 Entity Relationship Diagram

V. RESULTS

This segment looks at the findings of the study based on the questionnaires and face to face interviews that were conducted. The findings below provide answers to the research questions of the study.

A. Baseline study

V.A.1 Respondents’ period of stay

The land history and land administration is believed to be kept by people who have lived longer in the chiefdom. It is important to know how long the respondents have lived in the study area as this will afford an opportunity to understand how historical land information is passed on to the future generation. Fig 4 shows that 66.3% male respondents have outlived the female respondents between forty (40) years to sixty (60) years.

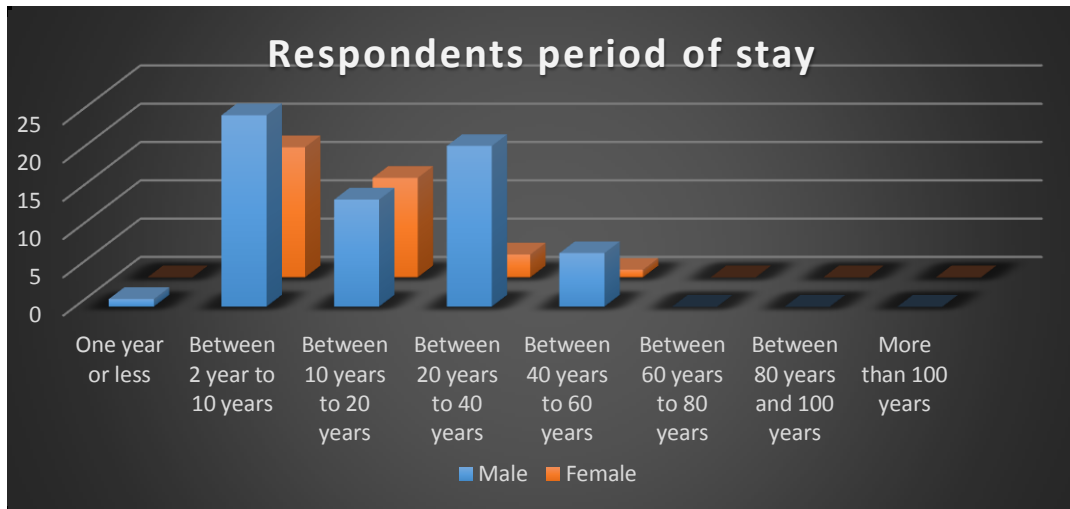


Fig. 4 Respondents period of stay

V.A.2 Land allocation

Land is an important asset for the residents of the study area which is also treated as sacred. The residents of the study area occupy land ranging from two (2) hectares and sixty (60) hectares with 66.7% being dominated by males while 33.3% is allocated to female residents as shown in Fig 5.

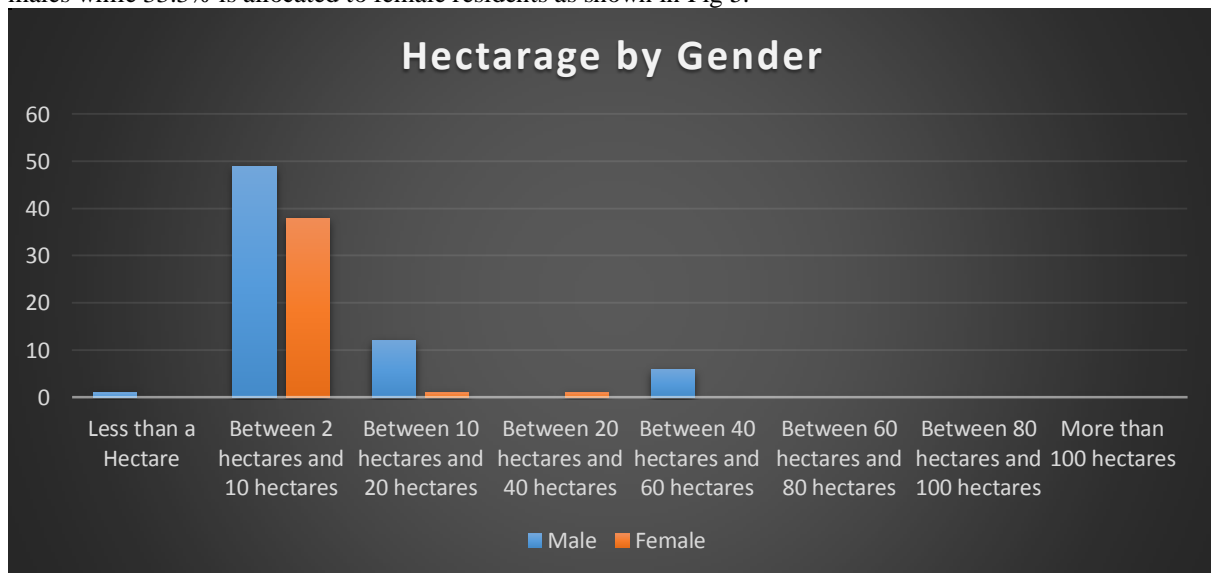


Fig. 5 Hectares Owned by gender

V.A.3 Demarcation type

The village headman and the residents of the study area demarcate the family land boundaries and communal land using ancient trees, streams and ant hills. The study reveals that 61% of the residents confirms that the land is demarcated by ancient trees, while 29.4% attest land being demarcated using ant hills and 11.8% residents confirms the demarcation of the land through use of streams as shown in Fig 6.

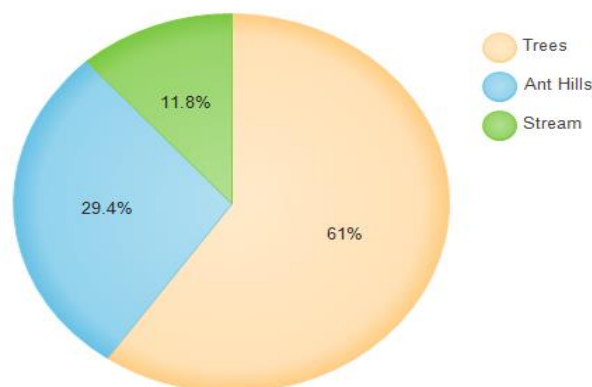


Fig 6 Land demarcation types

V.A.4 Causes of land disputes

The study area encounters land disputes ranging from family boundary disputes, communal boundaries disputes and selling of land by chiefs and headmen. Fig 7 shows that 54.9% residents have had family disputes, 41.2% residents affirm to selling of communal land by chief or headmen and 3.9% experienced communal land disputes.

The family boundary disputes are rampant because of a non coordinated and systematic land demarcation system supported with proper land ownership evidence.

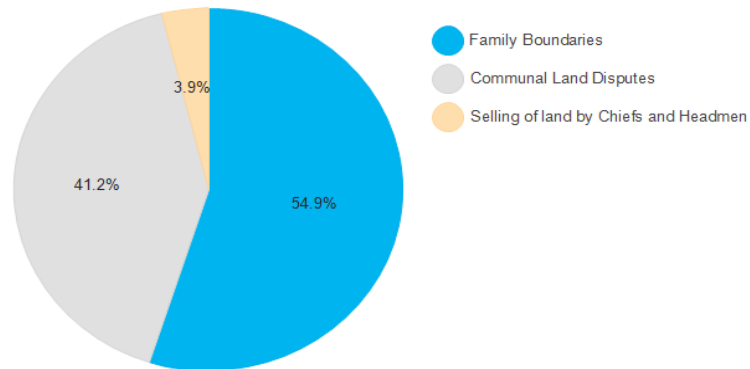


Fig 7 Causes of land disputes

B. Model Implementation Results

V.B.1 Registration Window

Fig 8 below is the registration window for the residents to register.



Fig. 8 Mobile Registration window

V.B.2 Land Registration window

Fig 9 depicts the land information details which the residents will need to enter.

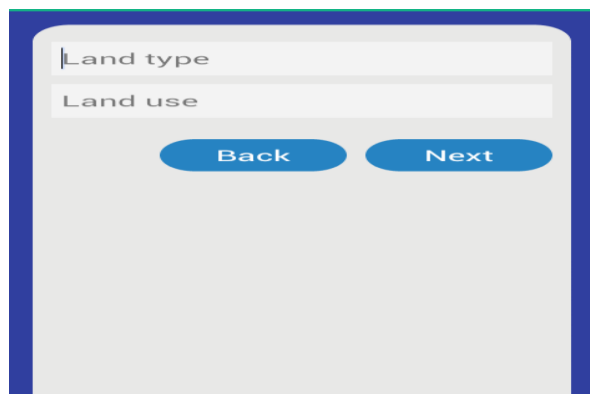


Fig 9 Land Registration window

V.B. 3 Land Demarcation process

Fig 10 shows a piece of land that has been demarcated using the mobile application.

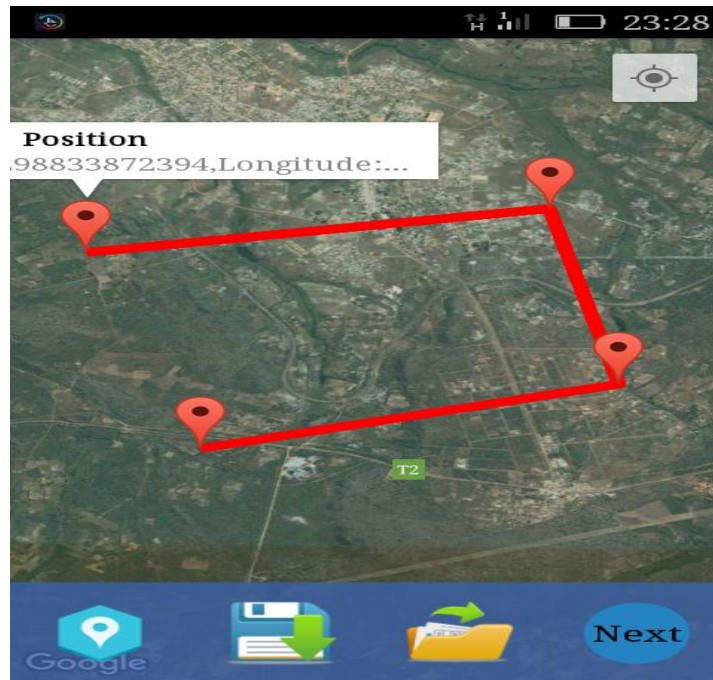


Fig 10 Mobile Land demarcation

VI. DISCUSSION AND FUTURE WORK

After conducting a successful research survey to establish the methods and type of information used by headmen and the Chief in the management of customary land in Zambia, the results shows that the residents of the study area own substantial amount of land, with 66.7% male residents and 33.3% female residents occupying land measuring between two (2) to sixty (60) hectares and 65.6% male residents and 34.4% female residents practice subsistence farming as a means of supporting their families. The survey also looked at how land demarcated are done, the results indicate that 67.6% of land demarcations are done by the village headmen and 32.4% land demarcations are done by the villagers themselves. Land is demarcated through use of big trees, ant hills and streams. The study also looked at the documentation of land ownership records. The results show that only the personal details such as the name, age, identity cards are recorded in the membership book and no record of land ownership such as area size is documented. As such, there is no proper evidence to prove that a particular piece of land is owned by an individual. The study also looked at the occurrence of land disputes such as family boundary disputes, communal boundaries disputes and selling of land by chiefs and headmen. The results indicated that 54.9% of the residents have had family disputes, 41.2% experienced selling of communal land by chief and the headmen and 3.9% conflicts arise from communal land disputes. The resolution of the land disputes is done by the village headmen, the village committee members and in some cases, both the village headmen and the village committee. The results indicate that 56.9% of the disputes are resolved by the village headman, 26.5% of the disputes are resolved by the village committee and 16.7 % of the disputes are resolved by the village headmen and the village committee.

The study also looked at how ICT tools such as PGIS, mobile application and GPS could be used to effectively establish customary land boundaries and document land parcels in order to improve customary land management, thereby reducing land conflicts. A mobile application tool for the management of customary land was designed and developed with the following capabilities:

- Ability to register land
- Ability to allocate land
- Ability to properly demarcate land through use of GPS.
- Ability to attach any form of media to the land documents

The aim of the mobile based customary land management system is to automate the existing customary tenure data for enhancement of security of tenure for the residents of the study area.

VII CONCLUSION

In this paper, we conducted a study on customary land administration and management in Zambia. It is evident that there is lack of proper demarcation and ownership documentation of customary land and this has led to land disputes such as family boundary conflicts and communal land boundary disputes. To ensure security of tenure for customary land, utilisation of ICT tools such as mobile application and PGIS are fundamental as these will help in land demarcation and documentation of the customary land. This study therefore aims at developing a

mobile customary land management system that will be used for land demarcation and ensure proper documentation of customary records

REFERENCES

- [1] E. Nyadimo, "The role of private sector in land adjudication in Kenya," XXIII FIG Congress, Munich, 2009.
- [2] A. Grzybowski, "Land and Conflict: Toolkit and guidance for preventing and managing land and natural resources conflict," UN department of political affairs., 2012.
- [3] F. Nlerum, "Security Implications of land and Chieftaincy Disputes," 2011.
- [4] R. A. V. MCLAREN, "ICT FOR LAND ADMINISTRATION AND MANAGEMENT," [Online]. Available: http://www.ictinagriculture.org/sites/ictinagriculture.org/files/final_Module14.pdf. [Accessed 19 March 2016].
- [5] D. M. Barry, "Land tenure administration and GIS: trends and challenges," SASGI Proceedings, University of Calgary, 2013.
- [6] I. Osita, "An Analysis of Igbo Traditional Land Tenure System in Amawbia (Amobia), Awka South Local Government Area of Anambra State"," *International Journal of Engineering Science Invention*, vol. 3, no. 1, pp. 25-30, 2014.
- [7] N. B. Udoekanem, D. O. Adoga and V. O. Onwumere, "Land Ownership in Nigeria: Historical Development, Current Issues and Future Expectations," *Journal of Environment and Earth Science*, vol. IV, no. 21, pp. 182-188, 2014.
- [8] "Analysing the role of customary land secretariats in effective land administration," [Online]. Available: <http://geospatialworld.net/Regions/ArticleView.aspx?aid=31129>. [Accessed 6 October 2015].
- [9] M. E. FIADZIGBEY, "Customary Land Administrator in Ghana – Challenges and Prospects," XXIII FIG Congress, Munich, 2006.
- [10] H. M. Ravnborg, B. Bashaasha and R. H. P. a. R. Spichiger, "Uganda's new land policy and development in Uganda," Copenhagen, 2013.
- [11] F. Conor, "A Guide to Property Law in Uganda," United Nations Human Settlements Programme, Nairobi, 2007.
- [12] F. Mwesigye, T. Matsumoto and K. Otsuka, "Population Pressure, Rural-to-Rural Migration and Evolution of Land Tenure Institutions: The Case of Uganda," National Graduate Institute for Policy Studies (GRIPS), Tokyo, 2014.
- [13] M. O. L. H. A. U. DEVELOPMENT, "THE UGANDA NATIONAL LAND POLICY," Kampala, 2013.
- [14] P. Jere, "IMPROVING LAND SECTOR GOVERNANCE IN MALAWI," 2012.
- [15] P. Jere, "IMPROVING LAND SECTOR GOVERNANCE INIMPROVING LAND SECTOR GOVERNANCE IN MALAWI," Lilongwe, 2012.
- [16] USAID, "PROPERTY RIGHTS AND RESOURCE GOVERNANCE BOLIVIA," USAID, [Online]. Available: http://www.usaidlandtenure.net/sites/default/files/country-profiles/full-reports/USAID_Land_Tenure_Bolivia_Profile.pdf. [Accessed 16 03 2016].
- [17] USAID, "PROPERTY RIGHTS AND RESOURCE GOVERNANCE CAMBODIA," USAID, 2012.
- [18] I. F. Egbulefu, "Designing a Technical Solution for Managing Land Tenure Data in a Customary Setting," CALGARY, ALBERTA, 2015.
- [19] U. o. Calgary, "Talking Titler," Land Tenure and Cadastral Systems Group, [Online]. Available: <http://www.ucalgary.ca/mikebarry/TalkingTitler>. [Accessed 19 september 2015].
- [20] C. LEMMEN, C. AUGUSTINUS and P. a. M. OOSTEROM, "The Social Tenure Domain Model – Design of a First Draft Model," FIG Working Week, Hong Kong SAR, 2007.
- [21] C. Lemmen, "The Social Tenure Domain Model A Pro-Poor Land Tool," International Federation of Surveyors (FIG), Copenhagen, 2010.
- [22] D. ANTONIO, "The Social Tenure Domain Model: A Specialisation of LADM Towards Bridging The Information Divide," International FIG Workshop on the Land Administration Domain Model, Kuala Lumpur, 2013.
- [23] C. Lemmen, "The Social Tenure Domain Model A Pro-Poor Land Tool," International Federation of Surveyors (FIG), Copenhagen,, 2010.
- [24] R. MCLAREN, "Can the Innovative Use of Mobile Phones Support More Effective Land," FIG Congress, United Kingdom, 2010.

- [25] USAID, "Mobile Application to Secure Tenure: Tanzania," USAID, 2015-2016. [Online]. Available: http://www.usaidlandtenure.net/sites/default/files/USAID_Land_Tenure_MAST_Brochure.pdf. [Accessed 15 March 2016].
- [26] N. Pullar, A. McDowell and M. Rizzo, "Enabling Technology for Citizen and Community Tenure Rights Protection," Food and Agriculture Organization of the United Nations, Rome, 2015.
- [27] F. A. A. Organisation, "FAO," FAO, 2015. [Online]. Available: http://www.fao.org/fileadmin/user_upload/nr/land_tenure/OPEN_TENURE.pdf. [Accessed 16 03 2016].
- [28] R. MCLAREN, "Can the Innovative Use of Mobile Phones Support More Effective Land Administration Services," FIG Congress, Sydney, 2010.
- [29] F. Sichone, "The System of Land Alienation," [Online]. Available: <http://dspace.unza.zm:8080/xmlui/bitstream/handle/123456789/1910/Main%20Document.pdf?sequence=2>. [Accessed 15 12 2015].
- [30] I. Crabtree-Condor and L. Casey., "LAY OF THE LAND Improving land governance to stop land grabs," Actionaid, 2012.
- [31] M. M. MUDENDA, "The Challenges of Customary Land Tenure in Zambia," Munich, 2006.
- [32] S. Msune, "A comparison of customary and leasehold tenure: agriculture and development in Zambia," Ministry of Lands, [Online]. Available: <http://www.fao.org/docrep/x1372T/x1372t07.htm>. [Accessed 18 01 2016].