Human Capacity Development for the Application of Geospatial Technologies in Land Administration and Management in Rwanda

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Abstract
Land administration and management are important government functions that must be executed in any nation in order to achieve efficient utilisation of land and land resources. In recent times, geospatial technologies have facilitated and improved the efficiency of land administration and management in developed and developing countries of the world, including Rwanda. However, the effective application of these technologies in the execution of land administration and management functions depends on the availability of competent human resources. This paper examines human capacity development for the application of geospatial technologies in land administration and management in Rwanda. The study utilised secondary data obtained from Rwanda Education Statistics and curricula of universities offering academic programmes in geospatial disciplines in

the country. It found that there is skills gap in the human resources available for the application of geospatial technologies in land administration and management in the country. It advocates for a strong and effective collaboration between the stakeholders and concludes that such cooperation is essential for sustainable capacity building to produce human resources with appropriate skills and competencies needed for efficient land administration and management in the country through the application of geospatial technologies.

Keywords: *Human Capacity Development, Geospatial Technologies, Land, Land Administration, Land Management, Rwanda*

Introduction

Efficient utilisation of land and land resources is required by every country to achieve sustainable economic growth and development. Sustainable development entails meeting the needs of the present without compromising the ability of the future generations to meet their own needs (World Commission on Environment and Development, 1987). In fact, fifteen of the seventeen sustainable development goals (UN, 2015) cannot be achieved without sustainable utilisation of land resources. This is because these goals are interconnected and initiatives necessary to achieve them inevitably require land. Land administration and management are very crucial in achieving sustainable spatial development (Williamson *et al*, 2010; Dawidowicz & Źróbek, 2017). Sustainable spatial development basically involves the use and development of land in a manner that results in economic, social and environmental sustainability.

Land administration and management has evolved since the advent of human civilization. The most significant aspect of this evolution is the application of geospatial technologies, in which land information is collected, stored, processed, retrieved and utilised through geographic and land information systems. No doubt, the application of geospatial technologies in land administration and management requires competent human resources the world over. While the developed countries have built their human capacity to cope with the challenges of contemporary land administration and management such as the application of geospatial technologies, the same cannot be said of the least developed and developing countries.

Due to advances in geographic and land information systems and developments in information and communication technologies, coupled with the forces of globalisation, it is imperative for every country that intends to achieve efficient and sustainable land administration and management to consistently pay attention to the development of human capacity, especially in the application of geospatial technologies.

Rwanda is one of the few emerging economies in Africa with a well-established land administration and management system. As the country progresses towards a knowledge-based economy, the sustenance and efficiency of its land administration system largely depends on the capacity of its human resources. It is on this basis that this paper examines human capacity development for the application of geospatial technologies in land administration and management in the country.

The Concept of Human Capacity Development

According to OECD (2006), capacity is the ability of people, organisations and society as a whole to manage their affairs successfully. Human capacity development (HCD) is very essential for the effective functioning of the private and public sectors of every nation's economy. It must be enshrined into the corporate strategy of an organisation if its goal must be achieved. It is the process through which individuals, organisations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time (UNDP, 2009). This definition has been further modified by the United Nations Economic Commission for Africa (UNECA) in its capacity development strategy document. It defines HCD as the process through which individuals, groups, organisations and societies deploy, adapt, strengthen and maintain the capabilities to define, plan and achieve their own development objectives on an inclusive, participatory and sustainable basis.

Although the drivers of HCD differ across the various sectors of a national economy, the process remains the same. The primary objective of HCD is to produce competent human resources to improve governance and enhance the welfare of the people. The cycle of HCD is shown in Figure 1.

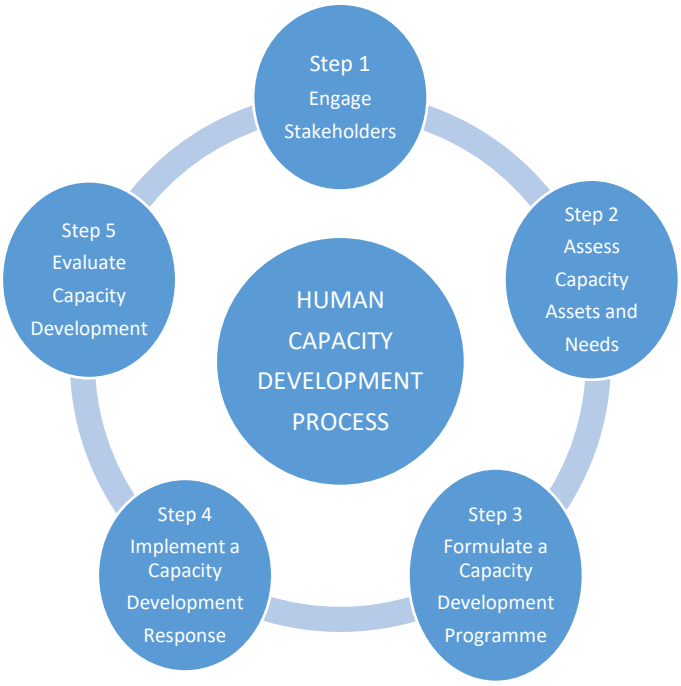

Figure 1: The Cycle of Human Capacity Development

Source: *Adapted from UNDP (2009)*

The cycle of HCD begins with the engagement of relevant stakeholders on capacity development. The goal of such engagement is to identify the needs for capacity development and the capacities necessary to be developed. The second step in the cycle is the assessment of capacity assets and needs identified in the first step. Such assessment will reveal the nature and complexity of the needs for capacity development and provide the framework for the formulation of an appropriate capacity development programme in the third step of the cycle. The fourth step is the implementation of a capacity development response, based on the feedback obtained from the first three steps. The last step is the evaluation of the capacity development programme and the outcome is used to engage the stakeholders again on capacity development and the cycle continues.

Human Capacity Development in Rwanda

HCD in all sectors of the economy has been a major policy objective of the Government of Rwanda in its effort towards achieving sustainable economic growth and development. It is a key priority for achieving the country's socioeconomic transformation agenda envisioned in its Vision 2020 (UNFPA, 2017). In the last two decades, the government has undertaken several programmes and initiatives aimed at building capacity for the country's critical areas of need. The overall goal of these initiatives is to achieve national growth, improved governance and poverty reduction as well as produce sufficient human

resources required to transform the country from low-income to middle-income status (NCBS, n.d).

An important sector of the economy that is very crucial to the HCD efforts of the government is the tertiary education sector. This is because it provides the middle-level and high caliber manpower required for the smooth operation of the economy. Critical reforms have also been carried out in this sector. The most remarkable of these reforms was the consolidation of public universities in the country into a single public university (the University of Rwanda) in 2015 with the mandate to focus extensively on science, technology, engineering and mathematics (STEM) disciplines. However, despite this mandate by the government only a small number of graduates have been produced from these fields for the economy in the past few years as presented in Table 1.

Table 1: Graduates produced by all Tertiary Institutions in Rwanda, 2016 - 2017

Field of Education	2015/2016		2016/2017	
	No. of Graduates [a]	% [b]	No. of Graduates [a]	% [b]
Education	4566	19.3	5010	21.7
Arts and Humanities	212	0.9	440	1.9
Social Sciences, Journalism and Information	1138	4.8	1377	6.0
Business Administration and Law	8688	36.8	6566	28.4
Natural Sciences, Mathematics and Statistics	1367	5.8	1133	4.9
Information and Communication Technologies	2544	10.8	1515	6.6
Engineering, Manufacturing and Construction	903	3.8	2850	12.3
Agriculture, Forestry, Fisheries and Veterinary	948	4.0	931	4.0
Health and Welfare	2153	9.1	2186	9.5
Service	1116	4.7	1092	4.7
Total	23,635	100	23, 100	100

Source: [a] *Ministry of Education (2018)*
[b] *Computed from a*

In 2016 and 2017, the proportions of graduates from STEM to the total number of graduates from all tertiary institutions in the country as indicated in Table 1 were 33.5% and 37.3% respectively. These are far below those from non-STEM disciplines which were 66.55 and 62.7%. respectively. Except significant improvement is made, this scenario will obviously affect the availability of human resources for the application of geospatial technologies in the various sectors of the nation's economy. This is because

the skills needed for the use of geospatial technologies are derived from the knowledge obtained from STEM disciplines. Although progress has been made in HCD for national growth and economic development in the last decade, much needs to be done to improve the quality of human resources in the country.

HCD in Rwanda is based on three fundamental strata namely, individual, organisational and policy environment/institutional levels (Ndashimye, 2015). The trend in human development index (HDI) of Rwanda and those of other countries in East Africa is shown in Figure 2. The HDI of Rwanda has improved progressively in the last two decades. This may be attributed to the various interventions of the government within the period. Nevertheless, the HDI of the country is far lower than those of Sub-Saharan Africa and developing countries as shown in Figure 3, an indication than more HCD initiatives need to be embarked upon. Such initiatives should largely focus on the adaptation of the nation's educational system at all levels (pre-primary, primary, secondary and tertiary) to the development of critical skills needed to drive sustainable economic growth and development, anchored on a competency-based curriculum in which knowledge is created and utilised from science, technology, engineering and mathematics (STEM).

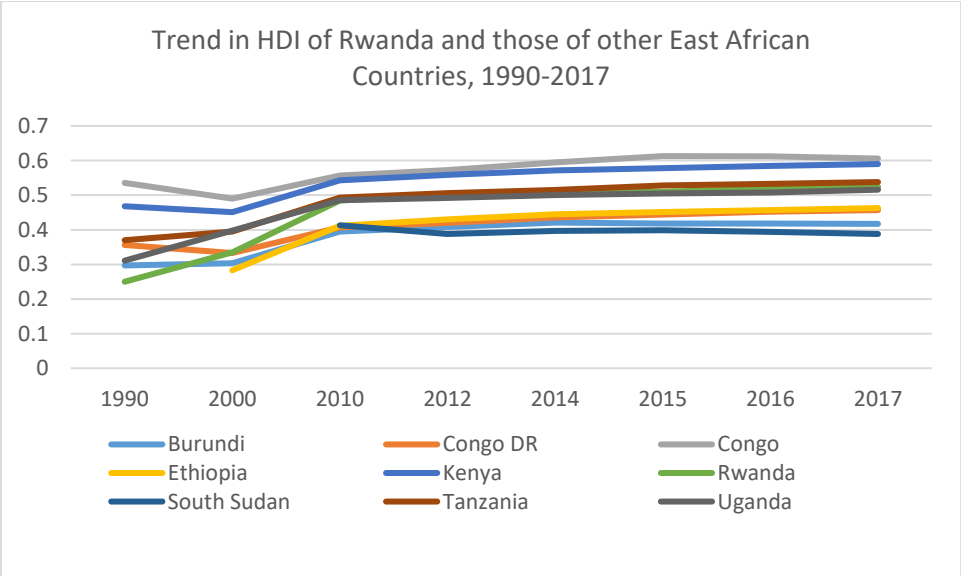

Figure 2: Trend in HDI of Rwanda and those of other East African Countries, 1990 – 2017 based on Data from UNDP (2018)

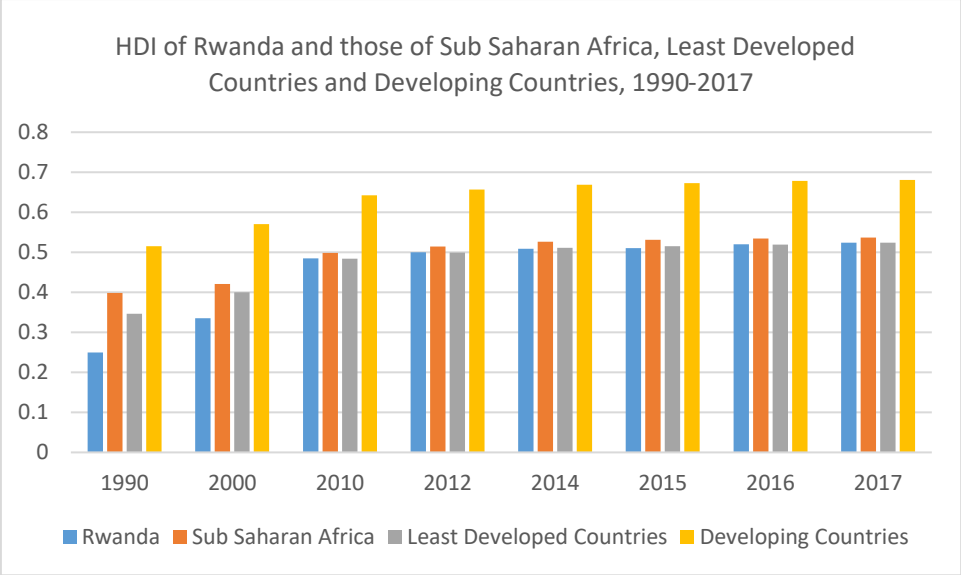

Figure 3: HDI of Rwanda and those of Sub-Saharan Africa, Least Developed Countries and Developing Countries, 1990 – 2017 based on Data from UNDP (2018)

An Overview of Land Administration and Management

Over the years, several scholars and institutions have attempted to provide the definition of land administration that is widely accepted across the globe. The definition provided in the Land Administration Guidelines of the United Nations Economic Commission for Europe (UNECE) appears to be the most adopted definition in the literature in the last two decades. It defines land administration as the processes of determining, recording and disseminating information about the ownership, value and use of land when implementing land management policies. Such processes include the determination (sometimes known as the "*adjudication*") of rights and other attributes of the land, the survey and description of these, their detailed documentation and the provision of relevant information in support of land markets (UNECE, 1996). This definition covers a wide range of issues concerning land administration such land registration, documentation of land transactions, land use planning and development, land valuation, land information management and land dispute resolution.

Similarly, land administration is the way in which the rules of land tenure are applied and made operational (FAO, 2002). It is the management of a system of land rights (Lindsay, 2002). Land administration can be formal or informal in nature. Notwithstanding whether it is formal or informal, it comprises an extensive range of systems and processes to administer land rights, land-use regulation, land valuation and

taxation (UN-GGIM, 2015). Every country's land administration system is established for fiscal, legal or multiple purposes (Arko-Adjei, 2011). In order for any land administration system to achieve its purpose(s), all components of land administration must be implemented in an efficient and sustainable manner. Dale and McLaughlin (1999) identified these components to include land registration, cadastral surveying and mapping, land valuation and land use planning.

Land management is concerned with the activities associated with the management of land as a resource from both an environmental and an economic perspective (UNECE, 1996). It entails sustainable use and development of land to maximize its value, create wealth and enhance economic growth. According to UN-GGIM (2015), land management is the art or science of making informed decisions about the allocation, use and development of the earth's natural and built resources. Economic, social and environmental sustainability cannot be achieved without good land management. Thus, land management covers all activities concerned with the management of physical resources of land, including farming, mineral extraction, property and estate management and physical planning of towns and the countryside (UNECE, 2005). There is a very strong nexus between land management and land administration. While land administration provides the infrastructure for achieving good land management, on the other hand, good land management cannot be achieved without efficient land administration system.

Land management and land administration are interwoven and inevitably inseparable. An essential commodity that links both functions is land information. Land information is simply information about land and land resources. Land information is collected, processed, stored, retrieved, utilised and managed through land information system. It is then used to carry out the basic operational functions of land management namely land tenure regularization, land valuation, land use planning and land development. The response from these functions are thereafter sent to the land administration system and the cycle continues.

Land management covers all activities associated with the management of land and natural resources that are required to fulfill political objectives and achieve sustainable development (Dawidowicz & Źróbek, 2017). Land administration is the main instrument

through which the goal of land management can be achieved. The use of geospatial technologies enhances the generation of land information for the efficient management of land and land resources. To this extent, human capacity development for the application of geospatial technologies in the discharge of both functions is intertwined and inseparable.

A Review of Land Administration and Management in Rwanda

Land and land resources are very crucial to the economic growth and development of Rwanda. It plays an inestimable role in the poverty reduction strategy of the government as well as sustainable economic empowerment of the people. Land is both a physical commodity and an abstract concept in that the rights to own or use it are as much a part of the land as the objects rooted in its soil (UNECE, 1996). In fact, no nation can exist without land as the ultimate resource (UNECE, 2005). Rwanda is an emerging economy heavily dependent on agriculture. Sustainable agriculture particularly in the rural areas cannot be achieved without effective access to land by a larger proportion of the population. The country has one of the highest population density in Sub-Saharan Africa with serious implications on land use intensity. This has made efficient land administration and management system in the country very necessary (RNRA, 2012; Nkurunziza, 2015). In the last two decades, the government has made significant progress in land administration and management in the country. This is examined here based on three aspects namely, legal, spatial and institutional aspects.

Legal Aspect

Land administration is built on policies and laws and further detailed in regulations and guidelines (SIDA, 2008). Laws and regulations are necessary to register land rights capable of being owned or transferred. Several laws and regulations have been enacted to streamline land rights in the country as well as facilitate the land tenure regularization (LTR) programme of the government. Important among these laws are the Constitution of the Republic of Rwanda (2003), the National Land Policy (2004) and the Organic Land Law (2005). While the Constitution recognises state and private property as well as the right of every citizen to private property whether held individually or in association with others (GoR, 2003), the National Land Policy provides the setting for appropriate land administration as the key to the security of land tenure in the country by formalizing land rights and facilitating their registration. Thus, the key elements of the National Land

Policy are ensuring that all Rwandans enjoy same rights of access to land, ensuring that all lands in the country are registered and alienable and ensuring that land registration in the country is based on title-deeds registration system.

The Organic Land Law is the principal legislation that determines the use and management of land in Rwanda (RNRA, 2012). It provides the legal framework for ownership and transfer of rights to land by individuals and the state, forms of land tenure and the requirements (in terms of plot size) for the use of land for agricultural purposes. Other key legislations such as those relating to expropriation in the public interest (2007), mortgages (2009), the valuation profession (2010) and several Presidential and Ministerial Orders have been issued to enhance efficient land administration and management in the country.

Spatial Aspect

No land administration system the world over can function properly without reliable spatial data and an effective spatial data infrastructure (SDI).SDI is the pivot of any land administration system. Spatial data is simply geo-referenced data. It is also known as geospatial data or geographic data (Simbizi, 2007). It can only be collected, stored, processed, retrieved and updated through SDI. The Global Spatial Data Infrastructure Cookbook (GSDI, 2004) states that SDI comprises five major components namely, core spatial data, policies, standards, technologies and institutional arrangement that facilitate the access to geographically-related information.

The Lands and Mapping Department was established in the Rwanda Natural Resources Authority (RNRA) to coordinate the mapping of the country for the purpose of producing cadastral plans of land parcels for registration through the land tenure regularization (LTR) project. The outcome of the LTR is that all the 10.67 million parcels of land in the country have been demarcated and entered into the database of the land administration information system, out of which 9.1 million land parcels have full information on claimants (Nkurunziza, 2015).

Institutional Aspect

No country can maintain stability within its boundaries or sustain economic development unless it has land policies that promote internal confidence among its people and its

commercial enterprises (UNECE, 2015). These policies must be implemented by good land governance institutions in order to achieve good land administration. Also, such institutions must act in accordance with the legal framework for land governance (SIDA, 2008) so as to build a land administration system that is transparent, efficient and positively beneficial to the country's economy and the welfare of the people.

Land governance institutions in Rwanda involved in land administration and management in the country operate a top-bottom administrative structure. At the top of the structure is the Ministry of Natural Resources (MINIRENA) which is responsible for addressing issues of policy, particularly through Ministerial Orders and/or orders that set out laws and procedures for the administration, planning and allocation of land (RNRA, 2012). The effectiveness of these institutions in land administration and management has improved the quality of land administration in the country in the last decade. The quality of land administration in Rwanda and that of the entire Sub-Saharan Africa is presented in Table 2.

Table 2: Quality of Land Administration Index of Rwanda and Sub-Saharan Africa

Key Component	Maximum Point	Rwanda	Sub-Saharan Africa
Reliability of infrastructure	8	8	1.6
Transparency of information	6	1.5	1.8
Geographic coverage	8	8	0.7
Land disputes resolution	8	7.5	4.3
Total Index	30	25	8.4

Source: *Adapted from Deininger et al (2015)*

As indicated in Table 2, Rwanda is far ahead of the entire Sub-Saharan Africa on the basis of the quality of land administration. Based on the key components of the quality of land administration index, the land administration system in the country is efficient in terms of reliability of infrastructure (100%), geographic coverage (100%), land disputes resolution (93.8%), but very deficient in terms of transparency of information (25%). Therefore, greater attention should be focused on access to accurate and reliable land information by all who need such essential resource. In today's digital world, such initiative is not possible without the use of geospatial technologies.

Geospatial Education and Training for Land Administration and Management in Rwanda

Land administration is inherently geographical and good geospatial information is needed to manage geographic elements in a digital world (UN-GGIM, 2015). Geospatial technologies consist of modern tools that aid in the geographic mapping of the earth for a wide range of purposes. Basically, they are technologies relating to the collection or processing of data that is associated with location (AAAS, 2019). They include remote sensing, geographic information systems (GIS), global positioning system (GPS), internet mapping technologies, surveying, geodesy, photogrammetry and global navigation satellite system (Pin-Cheng, 2001; Satapathy, 2008 & AAAS, 2019). In land administration and management, geospatial technologies are very essential for land use planning, land valuation and taxation, land registration, land tenure regularization, cadastral surveying, mapping and land information management,

Effective land information management depends hugely on the soundness of the land information system. Without geospatial technologies, the development of an effective land information system will be extremely difficult. Land information systems consist of human and technical resources which together with appropriate organising procedures are applied to the collection, storage, retrieval, dissemination and use of land-related information (UNECE, 2015). It is imperative to state that human resources are very crucial for the establishment and maintenance of any land information system and human capacity development is inevitable for the sustenance and survival of such system.

Stuart *et al* (2009) carried out a survey of GIS professionals in Africa and found that there is limited human resource capacity, especially lack of trained personnel. They also discovered that this is the most significant factor limiting the wider use of geospatial technologies in the continent. It is also the view of UNCTAD (2012) that the application of geospatial technologies particularly in developing countries is largely hindered by insufficient human resources and challenges to capacity-building. This is further worsened by the limited number of higher learning institutions offering competency-based degree programmes in geospatial disciplines. This is the situation in Rwanda as indicated in Table 3.

Table 3: Number of Tertiary Institutions in Rwanda offering academic programmes in Geospatial Disciplines

Number of private tertiary institutions	29
Number of public tertiary institutions	2
Total number of tertiary institutions	31
Number of tertiary institutions offering programmes in geospatial disciplines	2
Proportion of tertiary institutions offering programmes in geospatial disciplines	6.45%

Source: *Extracted from Higher Education Council of Rwanda (2019)*

As indicated in Table 3, only two tertiary institutions, representing 6.45% of all the tertiary institutions in the country offer academic programmes in geospatial disciplines. This situation has serious implications on the availability of competent human resources for the application of geospatial technologies in the country. In the context of HCD, the curriculum is very vital and should be updated regularly in order to produce professionals that can respond properly to the dynamics of today's digital world in terms of cutting-edge skills and competencies.

According to the Guidelines for the development of Curricula on Land Governance in Africa (UNECA, 2017):

> *Curricula on land governance ought to include training on the development of affordable and accessible Land Information Management Systems (LIMS) responsive to Africa's unique circumstances (Guideline 21).*

It has also been recognized by UNCTAD (2012) that human resource challenges in the field of geospatial science and technology varies from region to region. Consequently, HCD for the application of geospatial technologies should be structured to provide specific solutions to the land administration and management challenges of each country. It should also be a mainstream component of the land administration system and not an "add-on" (Williamson, 2001). In other words, it should be a continuous process of training within the gamut of spatial data infrastructure. The key aspects of geospatial technologies covered by the curricula of geospatial disciplines in tertiary institutions in Rwanda are presented in Table 4.

Table 4: **Key aspects of Geospatial Technologies covered by the Curricula of Geospatial Disciplines in Tertiary Institutions in Rwanda**

Key Component	University of Rwanda			INES
	GEO	CEGE	EMV	LAM
GIS and LIS Applications	✓	✓	✓	✓
Geostatistics	✓	✓		
Cadastral surveying	✓	✓	✓	✓
Remote sensing	✓	✓		✓
Computer programming		✓		
Spatial data infrastructure		✓		✓
Geospatial data mining				
Web-based mapping		✓		
Spatial data visualization		✓		
Digital cartography	✓	✓		
Geodesy and GNSS		✓		✓
Ethics in geospatial technologies application				

Source: *Curricula of Geospatial Disciplines in the Tertiary Institutions under study*

- ✓ In the Table means the key component is available in the curriculum. Others are not available.

Also,

GEO = Geography

CEGE= Civil, Environmental and Geomatics Engineering

EMV = Estate Management and Valuation

INES = Institute of Applied Sciences, Ruhengeri, Muzanze

LAM = Land Administration and Management

As indicated in Table 4, some key components of geospatial technologies are very marginal in the curricular of geospatial disciplines in the country. These are geostatistics, computer programming, geospatial data mining, spatial data infrastructure, web-based mapping and ethics in geospatial technologies applications.

Conclusion

In recent times, geospatial technologies have facilitated and improved the efficiency of land administration and management in developed and developing countries of the world, including Rwanda. However, the effective application of these technologies in the

execution of land administration and management functions depends on the availability of competent human resources. Effective collaboration between the stakeholders is very necessary. Such cooperation is essential for sustainable capacity building to produce human resources with appropriate skills and competencies needed for efficient land administration and management in the country through the application of geospatial technologies.

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