

---

February 2021

## GIS use and Land Conflict in Rwanda: Case of Gasabo District

Emmanuel Mushimiyimana

University of Rwanda, mushimiyimana.emmy@gmail.com

Follow this and additional works at: <https://digitalcommons.usf.edu/jacaps>



Part of the [Development Studies Commons](#), [Geographic Information Sciences Commons](#), and the [Peace and Conflict Studies Commons](#)

---

### Recommended Citation

Mushimiyimana, Emmanuel (2021) "GIS use and Land Conflict in Rwanda: Case of Gasabo District," *Journal of African Conflicts and Peace Studies*: Vol. 5: Iss. 1, .  
Available at: <https://digitalcommons.usf.edu/jacaps/vol5/iss1/7>

This Article is brought to you for free and open access by the Open Access Journals at Digital Commons @ University of South Florida. It has been accepted for inclusion in Journal of African Conflicts and Peace Studies by an authorized editor of Digital Commons @ University of South Florida. For more information, please contact [digitalcommons@usf.edu](mailto:digitalcommons@usf.edu).

---

## GIS use and Land Conflict in Rwanda: Case of Gasabo District

### Cover Page Footnote

I would like to acknowledge TWAS-DFG Programme, Gasabo District, the University of Rwanda, School of Governance and the University of Koblenz-Landau, Rwanda Centre and Office for Africa Cooperation. May God remember and bless your work. I would like to acknowledge the contribution of the following persons for field work data collection and inspiration: Mrs. Daniella Peace Gashayija, Mr. Elias Nkundabose, Mr. Schadrack Irakoze, and Mr. David Tumwebaze. I thank you.

## 1. Introduction

Rwanda has been facing land scarcity due to increase of population and land deprivation effect that followed social violence and genocide against Tutsi. Some of the perpetrators of the genocide illegally took over land from the victims who were either dead or displaced as it was the same case in the neighboring Burundi. Land certification was introduced at least as an alternative to stabilize and resolve immediate demarcation conflict (Tchatchoua-Djomo, et al, 2020). In this framework of study, we consider that adoption of Geographic Information System (GIS) is a supplement to the local solution of land demarcation usually done by planting a tree called, *umuyenzi* but in a more codified, digitalized and computed ways. As *umuyenzi* land delimitation system demarcated the land before, so, is GIS and we assess in which way this effectively solve the land dispute in Gasabo District?

Normally, land still posits a serious problem in Rwanda due to the density of population. Gasabo district is particularly as one of the district of the city of Kigali which has a density of population of 1,237/km<sup>2</sup>, in 2012. Land issue is also due to the lack of land dependence substitution such as technology and industrialization and overreliance to agriculture of subsistence. Nowadays, the problem of land conflict among citizens, particularly in Rwanda had increased among other issues that are solved by local institutions, including: *Abunzi* (mediators). As there were no maps and records to prove the ownership, plots of land are intersected to each other, it was a burden to the judges because there were some instances where unfair justice resulting from verbal facts. Rwanda tries to create well-documented land policy legislation and institutions to guarantee equitable land rights through land registration systems (Geographical Information System/Land Information System (GIS/LIS)). As a result, the government of Rwanda introduced GIS which is used in mapping and registering land, and the paper highlights that it has played a great importance in land disputes resolutions to high extent especially after the introduction of Land Information System (LIS). This paper explores in details how it worked by exploring qualitative and quantitative data in Gasabo district since 2019.

## 2. The literature review

Plans or maps help to describe the features that have been measured and drawn in an accurate and practical way and these measurements and presentations are recorded in the form of plans or

maps, be on paper or in a digital form. They constitute the best basis for an accurate inventory of natural resource and help to regulate its use. There are documents that describe the nature, the extent and the location of resources and thus constitute a basis for systematic conservation and development (RDI, 2010). Kamatali (2013) asserts that a series of maps may be used as an adequate recording of information concerning the land. These may be geological information including: information on the depth and movements of water, on temperature and pressure in the air, on the volume and distribution of rainfall, on the distribution of the flora and fauna, and even on the details of human population or other components.

The digital maps can be combined or manipulated in different ways by using GIS. Digital maps and plans help in engineering works, development of agriculture, forestry, exploration of mineral resources, and in urban or rural development planning. Rwanda is modernizing and updating maps of land basing on those components especially in natural resources management, mining, and urban planning especially. Registration of land in Rwanda is progressing with bases of Organic Land Law of 2005, where land registration is an obligation to all citizens. This land registration occurs through use of GIS countrywide to delineate each individual land limits.

GIS provides more different important services. Basing on the main objectives of this study, the focus is on seven: (1) land mapping, (2) land titling, (3) remote sensing, (4) providing accurate land information system (LIS), (5) land sharing, (6) recording and (7) territorial changing. Land Mapping is a central function of GIS. Cadastral maps are important components of land administration in most countries (Ibraheem, 2012).

The computerization of land and geographical information systems has given urgent impetus to a creation of cadastral maps and the digital cadastral data base (DCDB) which provides a visual interpretation of data and hence solve the land disputes. Land maps usually help to determine the location of property by indicating the size and shape of each parcel, and reveal geographic relationships that affect the property value. Maps and map data are important for assessors. Besides, sharing GIS files over an internal or external data network makes parcel maps and related attribute information widely available, and reduces the duplication of effort inherent in separate map systems which in turn reduce land related conflicts (Ibraheem, 2012).

Rwanda has been using the aerial photography (Nkurunziza, 2015). Using airplanes and helicopters, the registry team took detailed photographs of the four cells and identified any visible boundaries (RDI, 2010). Then, the staff followed visiting every household to determine ownership of each parcel. The government adopted the Strategic Roadmap for Land Tenure Reform in Rwanda, based on the results of the pilot projects, since March 2008. Armed with the plan, the National Land Centre recruited and trained 100 permanent employees, 800 contract workers, and more than 5,000 casual labors; developed business processes; and designed the Land Tenure Regularization Support System to digital record ownership information (RDI, 2010).

GIS software applies remote sensing imagery, terrain elevation models, and other digital data layers and these help to visualize the boundaries of land in dispute, the types of resources at risk, affected populations, and other considerations. The rights of land possessions must be adequately documented or recorded to be ready for economics and trades use, including; capital or mortgage for bank loans and share in any local or international investment. Adamu (2016) emphasized that the adoption of GIS technology in European countries potentially led to the development of efficient and organized land markets, guarantee tenure security among land owners, increase revenue generation by government, reduce disputes among land owners as well and fostering prudent land management and efficient administration.

Rwanda as well as Nigeria used modern methods for computerization of land records as well as enhancing the process of land registration. Many countries of Africa adopted GIS/LIS to prevent and overcome land related conflicts. Given the history of violent conflicts, the Constitution of Rwanda, the National Land Policy of 2004, and the Organic Land Law of 2005 mentioned above, incorporated land ownership and GIS/LIS used facilitation to have the formal legal basis (Nkurunziza, 2015).

The progress of providing land titles increased especially since 2017, where 8 million documents were already completed. This goes hand in hand with reduction in the time of spending in the process of acquiring land title. Previously, it had been taking up to one month to process a land title. With the new administration processes in place with GIS/LIS, this elapsed time was reduced in few days or even done just in one week in some cases.

Furthermore, of in these 8 million land title documents, 1.8 percent was officially registered in the financial year 2015-16. To reduce informal sale in the trading of land, the government allowed private surveyors, concomitant with independent land property evaluation companies. The government sets up land weeks to enable local access to land conflict resolution mechanism and land boundary dispute at local level. This allowed quick registration whereby almost 110,000 people registered their land during the period of land week and land dispute diminished from 81% to 47% (Robin, 2017).

Biraro (2015) found that GIS application has many objectives that all rightful landholders in Rwanda receive valid land title documents to minimize disputes. GIS/LIS has been very ambitious but successful systematic land registration program. Nevertheless, in the case of Rwanda, the number of transactions reported in 2016 fell short of the registry's target, indicating that further works laid ahead (Biraro, 2015) and this triggered the need to set up regular mechanism and easy system of land registration at local level. Currently, each sector level of administration has a land officer in charge of this action.

### **3. Research methods**

This study was carried out in Gasabo district which is in capital city of Rwanda. Gasabo District is one of three Districts of Kigali city created by organic law No 29/2005 of 23/12/2005 related to the administrative entities of the Republic of Rwanda. Its capital is in Kacyiru Sector, the suburb neighboring the presidential office and number of Rwanda different ministry offices. The district also includes large areas of the city itself, including Kacyiru, Remera, Nyarutarama and Kimihurura. Gasabo district is divided into 15 sectors including; Bumbogo, Gatsata, Jali, Gikomero, Gisozi, Jabana, Kinyinya, Ndera, Nduba, Rusororo, Rutunga, Kacyiru, Kimihurura, Kimironko and Remera. Its population is approximately 522,561 inhabitants and more than 56,708 households (NISR, 2012). The respondents of this study included 30 respondents (15 land officers and 15 land surveyors). Both male and female were selected to participate in the study to ensure that information from them meet the objectives of the study. The research uses both quantitative and qualitative tools to get relevant information. In all sectors that make up Gasabo District, all 30 respondents are sampled.

Therefore, this study uses purposive sampling because it enables the study to choose those participants who best meet the purpose of the study. The participant is sampled purposefully for their expertise in their respective fields. Fifteen land officers were interviewed in their individual capacity as a knowledgeable source on applicability of GIS to prevent land related conflicts and fifteen land surveyors were reached as ones who use Geographical Information System (GIS) in their daily activities. The interviews and questionnaires were distributed to respondents basing on the appointments agreed upon with land officers and land surveyors. The researcher explained the purpose of the study in its general objective. When the survey started, the population was already informed and aware. The average time taken to respond to questions of interview was 20 minutes per respondent.

## **4. Findings**

### **4.1. Information on improved tenure security in Rwanda and in Gasabo District**

Concerning the kind of land title provided by land surveyors in Gasabo District, 93.4 % of household have leasehold, they own the property but the real owner of land is the state of Rwanda, here as a tenant and gives lease for almost 100 years, renewable (depending on the tenure period). The remaining 6.6% of homesteads have freehold, meaning that they own property, land and space over land. This implies that a big number of respondents hold land through lease and then land holdings registered with certificate of property in a given time. This means that GIS based land tenure is generally used in Gasabo District and therefore land ownership and its demarcation is known. However, this was not enough as the research has to look at the type of conflict that rises from this land tenure and demarcations.

#### **4.1.1. Land Conflict in Rwanda**

There has been association of armed conflict, land governance, and power dynamics in the society with land disputes especially in Rwanda and Burundi – the twin countries (TAKEUCHI, 2014, P. 2). The displacement of people due to civil wars and the genocide against Tutsi in 1994, the power relations in the society and the systemic deprivation of land by government officials after independence and the overall dependance of agriculture of subsistence increased the land dispute in Rwanda and Burundi. In the case of Rwanda, which is the focus of this research, the land disputes after the genocide of Tutsi in 1994 was characterised by the land occupation by

repatriated refugees of 1950s, 1960s and 1970s from neighbouring states with the former owners some who were displaced recently or fled to the Democratic Republic of Congo (DRC) and latter on repatriated as well in 1996 on ward (Takeuchi, 2014, Musahara & Huggins, 2005).

The government decided that people who fled and repatriated should share on equal bases (1/2) with the other population, especially in the East Province except on the houses which would be occupied by their farmer owners. The process was called land sharing (*kugabana/gusaranganya ubutaka*). In the cities where were some occupation of other's houses, in the process called property and local land grabbing (*kubohoza imitungo itimukanwa*) the government obliged to return the houses and land to the owners. Some who were historically marginalised persons (HMPs) whose land were grabbed by other dominant groups were not given new land as compensation but the government built them the houses to the vision village (*imidugudu*).

As the country stabilises until early 21<sup>st</sup> century, the land dispute is no longer on displacement and refugees, but mostly based on ownership, accessibility and commercialisation (Rwanda Development Board, 2021, Republic of Rwanda, 2004). Land in Rwanda is divided into utility. Some reserved for farming and others for residential areas. A land title shows these variabilities of uses in master plan officially communicated by district office of land. In other regions, mostly in swampy land, land use consolidation (*guhuza ubutaka*) policy was put in place for the common agricultural for instance rice, and maize and other cereals. The territories with land consolidation are used by people who own the plots but the uses are mostly controlled by states regulatory bodies or cooperatives. People sometimes claim that they cannot manage their harvest from the land as cooperatives plan for harvest and postharvest processing and selling – this brings newtypes of conflicts over land in Rwanda nowadays.

The research shows that land conflicts in Rwanda are in different types. The findings show that the most and recurrent are inheritance conflicts by 33.3%, this land conflict which is an official occasion to confirm an individual right to land, which constitutes the most important asset for the households in Rwanda. Land conflicts related to boundaries (26.6%) and this conflict arises because of scarce land, people tend to move the boundaries of their land and take the lands of their neighbors. Moreover, Sales of orphans' land and conflict related to political changes are 13.4% for each land conflict. Sales of orphan's land emerged when orphans of the period of 1994 genocide against Tutsi reached adulthood as a result of claiming for their land back.



Additionally, unauthorized sale of common land by 6.6% with the same percent as conflicts related to expropriation by the State organs. Unauthorized sale of common land conflicts: these conflicts occur when some family members sale a piece of land without the permission of all family members. Conflicts related to expropriation by the states are the conflicts between state organs and the population in the case the population is obliged to leave the land without receiving a prior compensation or when they do not agree with the values which they receive as an exchange during expropriation. Basing on the above findings, I argue that inheritance conflicts, boundaries conflicts, conflict related to political changes and sales of orphans' land are the main types or levels of land conflicts that occur in the country generally and in Gasabo district more particularly.

The above findings were also in agreement with Marara's views that it is therefore, quite natural that land disputes tend to occur with families at the time of inheritance especially in case of polygamist families (Marara, 2011:6). MINERENA (Ministry of Natural Resource of Rwanda) reported that the source of boundary disputes is the common source of conflict between neighbors having bordering land in Gasabo district (MINERENA, 2008:72). Therefore, the research highlights the real cause of land conflict in Gasabo District.

#### **4.1.2. Land conflicts in Gasabo District**

Land conflicts in the cities are different from the rural areas due to different values and land use. Currently, there are value differences over price in the city whereby in Kigali the plot of 60 m<sup>2</sup> values between \$15,000 USD to \$150,000 USD, in Gasabo district. Other econdary cities like in Huye, Musanze and Muhanga the same plot cost between \$5,000 USD to \$30,000 USD. This typical price differences increase the conflict whereby people compete to own or cheat the ownership over land in the cities. This competition come in the range of inheritance, buying and selling and also over land use permission in the delivery of construction permit and the relocation process of the people from the zones large or industrial investments – case of 'Bannyahe' slums , formerly knows as Kangondo and Kibiraro, to Busanza model village (Sabiiti, 2019).

The conflict rises from resistance between the people and the state over larger land of investments, issuing construction permit, and forced relocation in Kigali due to modernisation of

the city (BBC, 2022). Beside, it is sometimes linked with local level corruption in issuing land use permits. There is also issues of delays in compensation of the people over land given to investors, and resistance to the type of compensation as the government sometime choose to give them new houses in agreements in model village apartments, instead of paying money. Though apartments are more nice and looks modern, it is still difficult to accommodate this new culture that we see in the Western world for Rwandans, hence creating some resistance of the people. Apart from family inheritance diputes, there are business dispute over land. There have been cases where third party dealers (*abakomisiyoneri*) where involved in conterfeit of land title ownership or confused the land businesses due to the rapid rise of the price over land in the cities and lucrative benefit of land businesses. This happened in underestimationa and overestimation in auction which caused the government to establish new online system of selling property and land through pubic auction – the e-auction system.

Therefore, the main causes of land conflicts in Gasabo district, as asserted by respondents, are demographics, economics and political causes. Land scarcity is the most causes of land conflicts in Gasabo District as it was said by 8 out of 15 respondents (53.3%). The findings agreed with literature that land scarcity is a cause of land conflict in Rwanda, population pressures and inheritance practices have resulted in increasing fragmentation of land parcels (MINIRENA, 2010:12).

Demographic causes (there is insufficient land to meet the needs of the growing population) come to the second place as it was indicated by 4 out of 26.6% respondents, the findings matches well with the literature that based on current population growth in Rwanda and patterns of land use, it is estimated that 82% of all land holdings could be less than one hectare or smaller by 2011. An estimated 38% of all holdings were smaller than 0.275 hectares, (Bigagaza, 2011:19). Further, other causes that were revealed by respondents include political turbulence was asserted by 2 out of 15 respondents (13.3%), poverty among people was revealed by 1 or 13.3% of respondents.

The finding shows that land is the most important assets for production and livelihood of Rwandans. It is not surprising that the loss of land sweep along poverty amongst households, and thus leads to land related conflicts. Political reasons, such as the return of old-case refugees, long

refugee absences or arrests based on the suspicion of genocidal crime, and payment for Gacaca where many old-case returnees came in and acquired land - political factors have become the main causes of land conflicts. Based up on both quantitative data and secondary data, it is worth to assert that the main causes of land conflicts in Gasabo District are land scarcity and overpricing of plots, political turbulence, demographic causes and poverty among people.

Effects of land conflict in Gasabo district has been that the majority of the conflict resolution cases in Gasabo district agents and courts are mainly based on land. Besides, there is (1) increasing resistance of the people over the land use policies in Gasabo district, as mentioned above, the case of “Bannyahe” village (Kangondo and Kibiraro) in Nyarutarama. The resistance of the people to relocate shows growing dissatisfaction of the people to the state policy (Kamuzinzi, 2022), new residential (apartments) plan – different from old culture. There is also (2) speculation and counterfeit over land titles due to rapid increase of the value of land and estate values in Kigali, and eventually (3) loss of affordable land to the citizen with low income in the city of Kigali more specifically in Gasabo district, (4) use of force in land policy implementation, and (5) violence in families due to conflict over land and properties rights.

#### **4.1.3. Land Registration in Gasabo District: type of land titles provided**

The land registration in Gasabo district is done by One Stop Center which is a government agency that issues land titles and other land related services including land dispute resolution. Apart from issuing lease titles they provide a number of land-related services including (1) Single family area construction permit, (2) increasing time for authorisation of construction permit, and (3) Conflict resolution services resulting from the construction of infrastructure. Besides, the office (4) facilitates the payments of investors’ services rendered to the district, (5) authorizes the renewal of the old houses or resuming the previous construction activities, (6) partitioning of the land or plot of land, (7) organising the land use consolidation process, (8) correcting delimitation of land or space of land, (9) changing land titles and updating them, and changing lease title to freehold title. The Office is also in charge of (10) updating the names of owners (persons or organisations) on land title, (11) registering the shares on land property or division of property ownership, (12), registering the part which is co-shared by individuals, (13) transfer of authority and property right from owner to new owner, (14) change of planned land

use to the new type of use – from for instance farming to construction, or to industrial zone. It also contributes to (15) the authorization of the master plan and (16) and solve dispute over land (Republic Of Rwanda, 2023).

The One stop center in short provides leasehold and freehold title and participates in the land use, plan and land conflict resolution process. It may work with other institutions such as *Abunzi* (mediators) who are in local government, the Rwanda Revenue Authority, and Rwanda Development Board to solve land issues, taxes, and determine land use activities, and facilitate the public work and investment.

#### **4.2. Services rendered using GIS to prevent land conflict in Gasabo District**

This section presents and interprets the results or findings related on respondents' view on the use of GIS to prevent land conflict in Gasabo District. Results show that 100 % of land surveyors (Participants in this study) were aware about applicability of GIS/LIS to land-based conflict prevention as all argued that they used it to provide land title in order to prevent land conflicts in Gasabo. Out of 15 respondents, five or 33.3% ascertained that basic land geographic data is one of the main services rendered to customers using GIS in Gasabo district. To add to this, 4 respondents representing 26.6 % affirmed that GIS is applicable for land use planning in order to prevent land conflicts in Gasabo district.

Furthermore, 2 or 13.3 % of land surveyors pointed out that GIS was used to create land prices maps closely followed by 1 or 6.7 % of land surveyors cited that the use of GIS is easy and possible to Sub-divide land and merge them when they share the same boundary. Finally, other services include; land price monitoring, transfer of rights; land transaction and land demarcation are also the service rendered to homesteads using GIS in Gasabo District as it was highlighted by 6.7% land surveyors selected in this study.

#### **4.3. Needs of GIS in land information systems (LIS) to land conflict resolution**

Respondents were asked to point out the reasons behind applicability of GIS in preventing land conflicts in Gasabo District and gave out different views: Mapping the suitable locations of

planned economic activities was the reasons behind applicability of GIS in land related issues in Gasabo District as it was mentioned by 5 or 33.3% respondents followed by the use of GIS in Zoning and land use and Data protection. This was said by 4 out of 15 respondents to mean 26.6%. Findings revealed that 20.0 % or 3 land surveyors replied that GIS is needed to reduce land disputes using boundaries recorded on cadastral maps. Thirteen point three (13.3) of respondents mentioned that GIS is needed in Gasabo district to be used in modeling spatial change of development activities.

There are other 6.7% respondents who confined and pointed out that there are other reasons behind applicability of GIS in land related services in Gasabo district. It is in this framework that other needs of using GIS include provision of data for assessing the value of land and property. It helps in identifying the trend in the land use and valuation, guaranteeing, information about the land ownership through land recording and GIS provides data for assessing the value of land and property. This is for intace the case of taxation or calculating land acquisition compensation as well as reduction of land sharing related claims. In addition to that it helps in planning and management of utilities such as water, sewerage, electricity, telecommunications, and cable television. It also helps in provision of data for defining land transfer, mortgaging, and investment.

The findings further complement those of other researchers for instance considering that the value of property is primarily determined by its location (Pagourtzi, et al, 2003). People realized the importance of GIS techniques (Zeng & Zhou, 2001). GIS provides not only a geo-database to store relevant data with spatial relationships, but also a visual representation of information. Land price research has long recognized GIS as an ideal tool for appraisal processes and spatial analysis (Pagourtzi, et al, 2006) for instance, creating land price maps by using spatial distribution models (Tsutsumi, et al, 2011). For general participants of the land market it is difficult to carry out land price analysis without having access to professional tools (Hu, et al, 2013).

#### **4.4. Applicability of GIS in improving land tenure and prevent land conflicts**

For the question “Did applicability of GIS prevent land conflicts in Gasabo District?”, 93.3 percent (n=14) of land surveyors replied yes while 6.7 percent (n=1) replied no. Thus, the land

surveyors overwhelmingly accredit the applicability of GIS in improving land tenure and prevent land conflict, and claim that it is the best strategy or land policy in land disputes and prevention of unnecessary claims. However, there are great demands for land price information in Gasabo district. It is not an easy task to satisfy these demands by traditional information presentation means, because land price is a kind of special geographical information which varies both spatially and temporally.

All the respondents when asked their rating of the use of GIS to improve land tenure and prevent land conflicts, they unanimously rated it as high. Land surveyors in Gasabo district were aware about the use of GIS because 80% of them rated it as very high, 13.7% of land surveyors rated it as high while 6.7% rated its use as medium. Hence, from the data at hand, Gasabo district as well as other districts in Kigali city put more emphasis on applying GIS in off land related services.

The discrepancy between the extent of land disputes obtained from land officers interview data and those from the Gasabo District Land Office may be attributed to the possible reluctance of respondents to reveal that land scarcity, political turbulence, demographic causes and poverty among people, family land disputes, suspected to be the main causes of land disputes in the study area. This suspicion is confirmed by qualitative data that family disputes and polygamy and inheritance land dispute represented between 38 % and 65% of land disputes in Gasabo District mainly Nduba, Bumbogo, Jali, Jabana, Gisozi, Masaka and Bibare. There are some cases of land disputes related to land sharing mainly in consolidated private state, land called 'paysannat' that were allocated to individuals in 1970s at Kimironko sector, few cases of spouse land disputes and boundary sharing disputes in Gasyata, Kimironko, Ndera and Bumbogo were also recorded. 45 cases of boundaries conflicts arose at Bibare and Nyagatovu. 12 cases of sales of orphans' land at Kabuye in Rutunga sector and two cases of conflicts related to unauthorized sale of common land at Nyamitanga in Jali sector and Ngara cell in Bumbogo sector.

Basing on the secondary data, it is clear that applicability of GIS in improving land tenure in Gasabo District has been quite impactful in solving land administration challenges. For example, the applicability of GIS and LIS solved an average of 61.1% of the total land related disputes. In 2015, 46.3% of the total land disputes were solved, and remaining pending. In 2018, use of GIS in land related services in different sectors and different dates helped up to 3,538 people that had land related problems (311 people with land related disputes cases and 3, 225 with normal land

cases) and resulted in 3,004 cases being dealt (245 land related disputes solved, 2759 normal land cases dealt) and 221 normal land cases not dealt because of different reasons. Moreover, in 2019, the use of GIS and LIS helped up to 2,958 people that had land related problems (291 people with land related disputes cases and 2,667 with normal land cases) and resulted into 2,442 cases being dealt (281 land related disputes solved, 2,161 normal land cases dealt) and 516 normal land cases not dealt because of different reasons.

#### **4.5. Challenges faced in land conflicts resolution using GIS applications**

A higher number of respondents equal to 5 out of 15 with 33.3 % revealed that they faced a challenge of lack of reliable dataset and record to judge on the land disputes. The 4 respondents (26.6 %) say that they were challenged by the inconsistencies between the planning and cadastral data sets that do exist about record encroachments on public land. Closely followed by 3 respondents or 20.0% challenged by the building encroachments, for which no digital information is currently available. There was insufficient understanding of workflow and GIS data layers and manipulation. Besides, there lack installing, troubleshooting, and maintaining GIS for access by multiple users.

#### **4.6. Presentation of qualitative data**

The information secured from interview with land officers revealed that the main types of land conflicts they tried to solve are inheritance conflicts, land conflicts related to land sharing between old-case returnees and original inhabitants. *“Land conflicts here are caused by people who tend to move the boundaries of their land and take the soil of their neighbors, and land conflicts arise as result of expropriation due to public interest”* (interview with land officer). They added that other types of land conflicts exist during the sales of land.

“conflicts occur in the case a family member sales the land or a piece of land without the permission of family members and conflicts related to sell off of the land owned by the orphans as well as ownership conflicts due to lack of land registration and disputes over the distribution of revenue from customary land” (interview with District land officer).

The qualitative results of the field research revealed that the causes of land - conflicts in Gasabo District are the conflicts between parents and their children, poverty, land scarcity, and ignorance of the law related to succession. The overall observation of the findings reveals that there have been family based land conflicts in Rutunga, Kimironko and Bumbogo. These are conflicts between parents and their children, conflicts between brothers and sisters, conflicts between husbands and their wives and conflicts between orphans of the 1994 genocide against Tutsi and their relatives. The causes of these conflicts are poverty, land scarcity, inheritance, polygamy, population pressure and selfish interests. Among these causes, poverty and land scarcity are the cross cutting ones for all family based land conflicts. This is because, despite the effort of the Rwandan government in fighting against poverty, it is still a crucial problem that faces rural households in general and in Gasabo district particularly. This problem is exacerbated by land scarcity that is not enough to feed family members.

The interview with the respondents was confirmatory of quantitative findings that transfer of rights by sale, inheritance, donation, exchange and expropriation is one of the main services rendered using GIS in Ndera, Jabana, Nduba and Kinyinya (mostly transfer by sale), in Nyabikenke (Bumbogo) and Kibenga (Ndera, mostly transfer by inheritance). In addition, first land registration (sporadic registration: register a needy leased parcel that was not registered during the systematic registration) is also provided to people at Ngara, Karuruma and Mukuyu (Ndera) using GIS application. Change in land use, sub-division, and donation, land use planning and creation of land price maps were services done using GIS application in Kibagabaga and Kinnyinya as well as Ruturusu in Remera sector. Merge of parcels and in all sectors of Gasabo was done using GIS. Requisition for unexploited land and change person, appraisal land processes and spatial analysis are also provided to homesteads using GIS. Thus basing on qualitative data, it is a clear evidence to confirm that land transfer, land registration, sub-division, replacement of certificate, replacement of title, change of land use, land use planning and creation of land price maps are the main services rendered using GIS in Gasabo District.

The land officers share the same view saying that needs of geographical information system (GIS) techniques are only a geo-database to store relevant data with spatial relationships, but also a visual representation of information. GIS is needed in creating land price maps by using spatial distribution models. Land officers added that mapping the suitable locations of planned



economic activities; zoning, land use, data protection and boundaries recorded on cadastral maps were the reasons behind applicability of GIS in land related issues in Gasabo District. Furthermore, even if GIS is use of commercial software and open software in the land information systems design, it provided a cost of effective option for data processing provides land title guarantee and land tenure security.

Interview results revealed that pre-implementation of GIS period was characterized by lack of a legal and regulatory framework for land use and ownership. There have been several constraints of physical scarcity. For several decades, secure access meant acquiring and clearing more land and the access to land has been indirectly constrained by lack of access to technology. They added: *“land surveyors in the land market are usually hampered to browse and analyze the land price information due to the lack of information sources and available analysis tools”*.

Post implementation of GIS has come as a response to more critical land issues than negatively skewed land distribution while a service-oriented GIS-based web system was developed to provide a practical solution. The essential data source contains basic geographic elements and benchmark land price (BLP)-related information. Core models for land price analysis were implemented, including; land price index, spatial distribution, and parcel appraisal. The system was developed based on a four-level Browse Server (B/S) architecture using GIS and web service technologies, which enables the publishing, browsing and analysis of the land price information via internet. With effective functionalities, the system has been employed in a project for updating BLP in a case study city located in Gasabo District.

The main advantage of the GIS-based web approach lies in its integration of spatial-temporal analysis models and web GIS technology, which allows more investors and administrators with limited domain knowledge to obtain further understanding on the change pattern and spatial distribution of land price by an online means. Statistically, the applicability of GIS and Land information system solved an average of 61% of the total land related disputes in Gasabo District.

## **5. Conclusion**

The findings of this study matches well with empirical references that in urban areas (Gasabo District inclusive), it is not appropriate to use land price index to reflect the distribution of land

price because land price index is in the form of point data instead of regional or zone data. For different land use types (e.g., commercial, residential, and industrial), characterizing the spatial distribution is essential for understanding the structure of land price and predicting values for those areas without monitoring points (Tsutsumi, et al, 2011). This is a true reflection as portrayed in conceptual framework of this current research. This study found out that the application of GIS improves land tenure through spatial land price distribution.

It is ambitious to argue that this research closed that gap traced by other researchers as all objectives regarding the services rendered using GIS application within land disputes resolution, appraise the need for GIS-based land information systems (LIS) to land conflict resolution and the challenges in land-based conflict resolution using GIS application as well as the use of GIS had reduced land related claims and conflicts. It is clear and evident to argue that GIS application is effective to land conflict resolution in Rwanda at 61% (Gasabo District Land office: 2015-2019).

Findings on the first objective related to the services provided using GIS, the study revealed that Basic Land geographic data, Land use planning, sub-division of land, creating land price maps and merge of parcels are effective for land based conflict resolution and prevention. As far as the needs for GIS applicability in land related services were further found that mapping the suitable locations of planned economic activities thereby analyzing and visualizing spatial changes are the key factors for the applicability of GIS in land Services in Gasabo. Modeling spatial changes of development activities in a city is the main tasks of leaders for instance land surveyors, land officers and physical planners. The study also found out that GIS is needed to reduce land disputes using boundaries recorded on cadastral maps and zones, land use and data protection.

Even though acted as a digital supplement to reinforce traditional demarcation mechanism through planting *umuyenzi* tree, it has been clear that its functioning still have a problem to solve both scientific and technical land problems in Gasabo District. It has been revealed by the findings that land surveyors and land officers were challenged by lack of reliable dataset and records to judge on the land disputes, the inconsistencies between the planning and cadastral data sets as the system was new and record encroachment were not digitalised. In addition to the above, some land officers argued that they have few skills about workflow of GIS data layers

and manipulation (installing, troubleshooting, and maintaining geographic Information Systems for access by multiple users). Lastly, this current study found out that applicability of GIS solved an average of 61.1% of the total land related disputes in Gasabo District during the last six years.

## REFERENCE

1. Adamu, S.J. And Yahaya, I, (2016) "A Review of the African Traditional Perspective on Land and its Resources", International Journal of Social Science and Economics Invention(IJESSI), 5(2), 1 -5.Hu, S.; Cheng, Q.retrieved july 2016.
2. BBC (17.9.2022). "*Kigali: Kangondo na Kibiraro Barimo gusenyerwa no kwimuka, mugihe igihe ntarengwa kegereje* (Kigali: Kangondo na Kibiraro houses are being destroyed and people relocated to new apartment building as the deadline is closer)". Available online at: [Rwanda - Kigali: Aba Kangondo na Kibiraro barimo gusenyerwa no kwimuka, mu gihe igihe ntarengwa cyegereje - BBC News Gahuza](#) . Last consulted on 8<sup>th</sup> June 2023.
3. Biraro, M. et al. (2015) 'Access to the Land Tenure Administration System in Rwanda and the Outcomes of the System on Ordinary Citizens', Journal of Land Administration in Eastern Africa 3(1): 346–52.
4. Ibraheem, A.T., (2012) "Development of Large-Scale Land Information System (LIS) by Using Geographic Information System (GIS) and Field Surveying". January 2012, *Engineering* 04(02):107-118, DOI:[10.4236/eng.2012.42014](#).
5. Kamatali, J. M. (2013). "*State Building in Rwanda*" in "Reconstructing the Authoritarian State in Africa", ed., G.K. Kieh and P.O. Agbese. Abingdon-on-Thames: Routledge.
6. Kamuzinzi, S. (12 Sept 2022) "*Abaturage muri Bannyahe Bagomba kwimuka bitarenze iki cyumweru*"(People from Bannyahe must Relocate in this week). Kigali Today. Available online at: [Abatuye muri 'Bannyahe' bagomba kwimuka bitarenze iki cyumweru - Umujyi wa Kigali - Kigali Today](#) . Last consulted on 8<sup>th</sup> June 2023.
7. Martine, N. (2012) GIS and Multi-Criteria Decision Analysis for Land Use Resource, Planning, May 2012, *Journal of Geographic Information System* 4(04):341-348, DOI:[10.4236/jgis.2012.44039](#).

8. Musahara, H., & Huggins, C. (2005) “Land Refor, Land scarcity and post-conflict reconstruction: a case of study of Rwanda”. In Huggins, C. & Clover, J. (Eds). *From the ground up: Land Rights, Conflict and Peace in Sub-Saharan Africa*. Pretoria: Institute of Security Studies.
9. Nkurunziza, M. (2015). *Land week and Land transaction fees too high, says new survey*, . Kigali-Rwanda : Newtimes Jule 27, 2015.
10. Pagourtzi, E.; Assimakopoulos, V.; Hatzichristos, T.; French, N. (2003). *Real estate appraisal: A review of valuation methods*. J. Prop. Invest. Financ. 2003, 21, 383–401.
11. Pagourtzi, E.; Nikolopoulos, K.; Assimakopoulos, V. (2006) *Architecture for a real estate analysis information system using GIS techniques integrated with fuzzy theory*. J. Prop. Invest. Financ. 2006, 24, 68–78.
12. RDI. (2010). *Assessment of land reform in Rwanda*. Kigali . Land mapping department publisher.
13. Republic of Rwanda (2023). “*Serivisi zitangirwa mu ishami rya one stop center: Serivisi fatizo zitangwa mu Ishami rya One Stop Center kubijyanye n’imyubakire n’imiturire , ibyangombwa by’ubutaka hamwe n’ibikorwa remezo* (Land related services provided by the One Stop Centre). Available online at: [One stop center \(gasabo.gov.rw\)](http://gasabo.gov.rw)
14. Republic Of Rwanda (2004). *National Land Policy*.
15. Rwanda Development Board (RDB), (23.4.2021). *National- Land-Use-Masterplan*.
16. Robin, M. (2017). *Securing land titling work in Rwanda*. University of New Brunnswich publisher.
17. Sabiiti, D. (29.09.2019). “Kigali: 360 Families to be Relocated from ‘Bannyahe’ Slum”. *KT Press*. Available online at: [Kigali: 360 Families to be Relocated from ‘Bannyahe’ Slum – KT PRESS](#).

18. Takeuchi, S. (2014). “Land Conflicts and the State in Rwanda and Burundi”. 2014 *World Bank Conference on Land and Poverty*, The World Bank, Washington DC, March 24-27, 2014.
19. Tchatchoua-Djomo, R., van Leeuwen, M. and van der Haar, G. (2020). “Defusing Land Disputes? The Politics of Land Certification and Dispute Resolution in Burundi”, *Development and Change* 51(6): 1454-1480. DOI:10.1111/dech.12621.
20. Tsutsumi, M.; Shimada, A.; Murakami, D. (2011). *Land price maps of Tokyo metropolitan area*. *Procedia Soc. Behav. Sci.* 2011, 21, 193–202.
21. Zeng, T.Q.; Zhou, Q.M (2001). *Optimal spatial decision making using GIS: A prototype of a real estate geographical information system (REGIS)*. *Int. J. Geogr. Inf. Sci.* 2001, 15, 307–321.