

Assessing the role of volunteered geographic information in enhancing Iraqi land administration systems



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Abstract

This thesis explores the use of volunteer geographic information (VGI) as a potential tool to support the land administration systems in the nation of Iraq. It aims to understand how different approaches and characteristics of VGI suit different socio-economic, cultural and topographic contexts in contemporary Iraq.

Two main research problems motivated this work. The major practical problem facing land administration systems in many countries, is lack of comprehensive coverage: only 25% of nations (mostly industrial countries, 35-50 in total) have a complete land registration system, and 75% of the world's land parcels are not currently registered. A second issue is the limited understanding of the efficacy of VGI in supporting land administration under different contexts. The research described here is further motivated by specific experiences in Iraq, where the land administration system has faced many problems since the US-Led Occupation in 2003.

After a review of the current state of Iraqi land administration, exemplified by the local system in Al-Hillah, Iraq, empirical research was undertaken with nine communities in defined rural, peri-urban and urban areas of the district. Three different technologies of VGI collection (smartphone GPS, iPad, and analogue maps) were tested, after selection and training of a total of 105 volunteers collecting this and supplementary land administration data. Questionnaire surveys, observation of data collection practice and interviews with individuals, community leaders and professionals were also used.

The results confirm the difficulties of current land administration in Iraq and public perception of these. They also extend previous knowledge of VGI, deriving information about its spatial accuracy, completeness, currency and value in a number of ways. Conclusions are presented which emphasise the need for a range of methods and approaches, highlighting which methods of VGI data handling work for different communities and individuals. It is suggested that low tech methods may be more accurate and more acceptable in some situations. The work has demonstrated that VGI can bring valuable, accurate and fit-for-purpose data to support formal systems.

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List of Abbreviations

AOI	Area of Interest
DS-25	Document Sample 25
EPRDF	Ethiopian People Republic Democratic Front
FIG	International Federation of Surveyors
GIS	Geographic Information System
GCPs	Ground Control Points
GPS	Global Positioning System
ID	Identity Card
LAS	Land Administration System
MMPW	Ministry of Municipalities and Public Works
NGOs	Non-Governmental Organizations
NMAs	National Mapping Agencies
OSM	Open Street Map
QGIS	Quantum Geographic Information System
RERD	Real Estate Registration Department
RMSE	Root Mean Square Error
UN-Habitat	United Nations Human Settlements Programme
US	United State
USAID	United States Agency for International Development
VGI	Volunteer Geographic Information

Publications from this Research

During the period of this project, the following publications have been arising from the work presented in this thesis:

1. Al-Bakri, M., Fairbairn, D. and Hameed, M. (2016). Positional Matching of Open Source Map Data and Evaluating Effects on Possible Applications, accepted poster GISRUK, 2016, Greenwich University.
2. Hameed, M., Fairbairn, D., Speak, S. and Al-Bakri, M. (2017) VGI data collection for supplementing official land administration systems, accepted poster, GISRUK, 2017, Manchester University.
3. Al-Ossmi, L.H., Ahmed, V. and Hameed, M. (2017) Land Tenure Security and the Administration: Evidence from Middle Eastern Cases, accepted poster, GISRUK,2017., Manchester University.
4. Hameed, M., Fairbairn, D., and Speak, S. (2017). Experiences with Citizen-Sourced VGI in Challenging Circumstances. *ISPRS International Journal of Geo-Information*, 6(12), 385.
5. Hameed, M., Fairbairn, D., and Speak, S. (2017, July). Determining the Potential Role of VGI in Improving Land Administration Systems in Iraq. In *International Conference on Computational Science and Its Applications* (pp. 525-540). Springer, Cham.
6. Hameed, M., Speak, S. and Fairbairn, D. (forthcoming). Working with the problems: Collecting Volunteer Geographic Information in stressed situations, intended submission to *Habitat International*

Presentations

1. Hameed, M., Fairbairn, D. and Speak, S. (2017) Experiences with VGI in challenging circumstances, presentation in *VGI-Analytics workshop*, Wageningen, Netherlands, May 2017.
2. Hameed, M., Fairbairn, D. and Speak, S. (2017) Determining the potential role of VGI in improving land administration systems in Iraq, presentation at *International Conference on Computer Science and its Applications*, Trieste, Italy, July 2017.

Chapter 1. Introduction

1.1 Overview and background

This research explores the use of volunteer geographic information (VGI) as a potential tool to support the failing land administration system in the city of Al-Hillah, Iraq. It seeks to understand how different approaches to VGI might suit different socio-economic, cultural and topographic contexts and to assess the accuracy of different methods. The work adds to and builds on previous studies of VGI which test the spatial accuracy of VGI (e.g. Al-Bakri and Fairbairn, 2012). However, it is innovative and fills research gaps in a number of ways.

Firstly, the study assesses VGI outputs in comparison to formal land administration data in relation to completeness and currency (e.g. number of land parcels, area of all registered land parcels, data stamp, etc.) and attribute data (e.g. owner, description, land use, type of tenure, etc.).

Secondly, unlike other studies, this research explores the process of VGI collection by assessing the relative usability and accuracy of a range of different methods for data collection amongst different demographic and educational groups, and in different geographical contexts.

Thirdly, it engages with land professionals to understand their perspectives on the use of VGI and fit-for-purpose approaches, which are discussed further in Chapter 5. In doing so, it explores how appropriate VGI is for fit-for-purpose land systems. According to Enemark et al. (2014, p6) fit-for-purpose land administration systems improve land registration and administration, particularly for the urban poor and in the Global South, because they are “flexible, inclusive, participatory, affordable, reliable, attainable, and upgradeable”.

A fit-for-purpose system does not necessarily aim to be highly technically precise, but to begin and support the process of land administration where formal institutional capacity is weak or where no formal system exists. However, the concept of fit-for-purpose requires fuller consideration. This work aims to suggest how to undertake VGI in different contexts and to understand where VGI may be appropriate and where not, depending on what that ‘purpose’ is (e.g. cadastral mapping, land registration, urban planning).

This introductory chapter begins with a discussion of the importance of land administration. Based on that importance, the chapter outlines the research problem, questions, aims and objectives. It then explains what volunteer geographic information is, although this is covered in greater detail in the literature review. The chapter also outlines the thesis structure.

1.2 The importance of land and its management

Land is undoubtedly the most important natural resource and asset in any nation. In most countries land contributes half to three-quarters of the national wealth (Burns et al., 2007). Hence there is a need to manage it in a sustainable and equitable manner.

There are many demands on land, including for farming, industry, forestry, infrastructure and urban development, and in addition claims by indigenous groups and environmental campaigners. It is often difficult to balance such competing demands. Land is thus regularly a cause of social conflict, and much effort has been devoted for designing systems to administer land rights. A land administration system may involve the management of public land, recording and registering private interests in land, assessing its value and determining tax, defining land use, and facilitating applications and approval for development.

Expansion in the relevant technology and use of more sophisticated surveying techniques in formal land administration systems in developed countries allows higher level of security, easy access, and efficient services for the people to record, occupy, use and trade their land. However, in other countries (the majority in the world) still do not have a land administration system and the resident people live with the threat of land seizure and their occupancy is highly insecure.

1.2.1 The professional monopoly over land management

For centuries, the collection and use of spatial data, including data about the land has been restricted to official agencies (Goodchild, 2008). Land administration professionals and surveyors, who collect the data, and planners, who use it, have been perceived as technocratic ‘experts’.

In recent years, especially within planning, that monopoly on knowledge and the data used to support it have been challenged. The importance of public and community participation and indigenous knowledge in issues of land and spatial planning policy has become increasingly recognised in both the developing and more developed countries. The term ‘volunteer geographic information’ (VGI) was introduced by Goodchild (2007), referring to the data that is collected informally by non-experts and the public. There are many successful examples of the use of volunteers in collecting weather data, completing street maps, and in monitoring the spread of epidemic diseases. However, using VGI to supplement the official purposes of land administration is relatively new.

1.3 Research problem and motivation

There are two main research problems which motivate this work. The first is the practical problem of the difficulties facing land administration systems in many countries, including Iraq which are discussed in Chapter 4. The second problem is the fact that the current understanding of VGI is not adequate to suggest that VGI can be the answer to those practical problems. This is explored in Chapter 2 and in the concluding chapter.

1.3.1 Problems of land administration

The motivation for the present research comes from the fact that only 25% of nations (mostly industrial countries; 35-50 in total) have a complete land registration system (Asiama, Bennett, and Zevenbergen, 2017). Lack of finance, institutional capacity and political will mean that 75% of the world's land parcels have not yet been registered. The majority of their occupants are the most vulnerable and the poorest groups in society and they live in threat of expulsion due to a lack of security of tenure (McLaren, 2013).

The research is further motivated by experiences in Iraq, where the land administration system has faced many problems since the US-led occupation in 2003. The first problem is the forgery of Title Deed documents, which started to appear from 2003, causing problems for the formal state land registration department as well as unsuspecting future purchasers of the land who might buy it in good faith. Another contemporary problem is the seizure of public buildings by displaced citizens, who have changed them into their living spaces. Additionally, some people have occupied public land and built their own houses on it, thus violating the rules of any effective formal land registration system and disregarding any existing plans for the use of the land. Given these issues and the current political and economic situation in Iraq, developing a formal, highly accurate system is unlikely to happen in the near future. Therefore, we can say that the formal land administration system in Iraq needs an alternative method and sources of data, both as an interim approach overcoming immediate shortcomings, and as a driver for the future shape of land administration within the country.

Given this situation in Iraq, and the vulnerability of those living on unregistered land around the world, this research is underpinned by the philosophical standpoint that people have the right to register their land for their own protection and economic future, even if they cannot provide absolutely accurate spatial data. That right is not upheld by authorities in many places, who often cite lack of resources and capacity as a justification for ailing registration systems. Furthermore, in some cases it may be to the authorities' benefit to maintain the status quo and not formally register the land of poorer communities, so as to support evictions and city

development. Moreover, VGI might be seen as empowering the community, giving it the evidence to support claims and demands against the authorities, which may be seen as undesirable by those in control. Therefore, the research described here supports the development of what has been called a fit-for-purpose land administration system, which is primarily a system suitable for the securing of tenure rights (Enemark et al., 2014).

1.3.2 Volunteer geographic information (VGI)

VGI has become increasingly popular in the collection of land use and mapping data. This is challenging to authorities who sometimes raise concerns about the quality and validity of the data and the processes used in handling it. Such concerns have a particular resonance when dealing with official land registration data and procedures. Nevertheless, central governments and municipalities, particularly around the developing world, face a growing range of difficulties in maintaining an adequate picture of land ownership and use. Political instability, war or civil unrest, and the ongoing diminution of resources mean that land administration records are either badly out of date or non-existent in many countries. This makes any form of effective spatial planning virtually impossible. It is clear that VGI is worth investigating for its potential to contribute to and improve such practices.

The concerns raised about VGI in governmental circles are repeated in many academic papers which focus on the accuracy and reliability of the data that is collected from different volunteers. Therefore, it is important to study the complete process of volunteer data collection, including enlisting volunteers, developing data collection tools, collecting and validating data, and analysing results, to check the possibility of using this data within the formal land system. According to the literature, two ways of checking the quality and validity of VGI are either to compare it to official data (collected by trained professional surveyors) or to seek confirmation from the people living on or connected to the land. The first approach can be applied when official data is available for the area, while the second may be necessary when there is no official data available or if it is available but out-of-date or difficult to access. Knowing that VGI agrees with and validates formal data, and vice versa, may be helpful. However, identifying cases where VGI does not agree with formal data does not help in understanding which is correct, unless we make the assumption that the formal data is correct and valid. This means that professionals may need to accept ‘crowd-sourcing’ as an acceptable way of validating VGI as being more accurate than formal data. As this research is intended to improve the formal land system, it is important to interview professionals in the land administration system and to investigate the problems they encounter with the current formal land system and whether they consider the use of VGI a good idea to support the current system.

Accordingly, this study is motivated by the above discussion to develop and demonstrate practical mechanisms to investigate whether or not it is possible to effectively enhance official land systems using VGI datasets.

1.4 Aim and objectives

1.4.1 Aim

The overarching aim of this research is to understand the potential role of volunteer geographic information (VGI) in supporting existing formal land administration systems to a fit-for-purpose standard.

1.4.2 Objectives

- i. To examine the range and scope of current land administration systems in developing countries, notably in Iraq, to set the context and assess the potential for VGI to support a fit-for-purpose system.
- ii. To identify the current knowledge and perceptions of VGI and fit-for-purpose land systems amongst land professionals in the case study area, and to identify barriers to professional acceptance.
- iii. To identify difficulties and limitations in the current land administration system for professionals in a case study area, and to identify areas and tasks where VGI might be particularly valuable to professionals.
- iv. To understand how complete, current and accurate VGI compares to more formally collected land data, and to acknowledge the limitations and strengths of VGI.
- v. To identify the current knowledge of the people about the importance of registering their land, and to assess their motivation for engaging in VGI.
- vi. To analyse which methods and data collection tools work best in different contexts and for different individuals.

1.5 Research methodology

A methodology has been developed in order to accomplish the overall aim and objectives of this project. The research methodology can be subdivided into several connected parts:

- A review of the literature and reports for non-governmental organizations such as United Nations Human Settlements Programme (UN-Habitat), United States Agency for International Development (USAID) and International Federation of Surveyors (FIG) was undertaken, to understand current problems with land registration globally and approaches to addressing those problems.
- Different data VGI collection tools were developed to be tested in a range of contexts. Three methods were developed and used: (i) a smartphone with a GPS app uploaded to locate land parcel corners and to attribute the resultant polygon; (ii) portable iPad tablet PCs with the official cadastral map uploaded, and overwriting and annotating capabilities provided through QGIS; and (iii) paper-printed aerial or satellite images, with clipboards and pencils for demarcation and annotation.
- In addition to these tools for collecting spatial data, a survey was developed to collect attribute data from both volunteers and other community members. This survey sought to collect the most current information on issues such as tenure, occupier, use, date of last land/property transaction, and registration of plots or sub divisions.
- Preparing contact with professionals. The surveyors within the land administration department were very keen to be involved in the study. They agreed in advance to provide samples of scanned cadastral maps, aerial images and ownership documents.
- A pilot for the field data collection took place in Newcastle upon Tyne, concentrating on the testing of the positional geometric accuracy of a number of smartphones; this involved the capture, comparison and processing of positional information using software developed by a previous PhD student in Newcastle. Furthermore, it was shown that the scanned mapping sourced from Iraq could be registered and loaded onto a tablet, running QGIS, and data could be captured and inserted in the field by volunteers. This was all fully tested before travelling to Iraq.
- The detailed experimental design included the selection of parties and organisations involved in the fieldwork; the scheduling of fieldwork activities;

the nature of scoping visits; choice of case study areas; and descriptions of each field data collection visit under headings ‘data’, ‘method’, ‘output’, ‘milestones’, ‘risk’, and ‘mitigation’.

- Interviews were conducted with urban professionals, including urban planners, land registration department staff, and land surveyors. The objectives of this element of the research are to understand the operational procedures and limitations of the current land registration system, the current difficulties of the Land Department (e.g. lack of capacity, skills or finance) in effectively mapping and registering land in the Municipal area, the degree to which Al-Hillah Municipality’s land department is aware of VGI and skilled in working with communities to support VGI, the Municipality’s willingness to engage with VGI towards the development of a fit-for-purpose land registration system, and to overcome some of their difficulties and the barriers they foresee in rolling out a VGI-supported fit-for-purpose system.
- Interviews were held with the gatekeepers of all selected communities to explain the purpose and nature of the project and emphasising the confidentiality of the information to assess the possibility of conducting it in their communities.
- Volunteers for data collection were identified, enlisted and trained. At the initial workshops, which attracted many people, the researcher explained the project and demonstrated the use of the different methods of demarcation with the use of GPS smartphone, iPad and tracing on printed aerial image. Then, a representative number (10-15) of volunteer citizens per community were recruited, varying in gender, age and educational level.
- The local communities’ volunteers were interviewed to collect attribute data such as owner, type of tenure, date of last transaction, land use, date of last land use change, for example agriculture to residential, and geometrical data. The geometrical data represent the boundaries of the plot.
- Volunteers were given training and written guidelines to enable them to identify the boundary points of their own plot or others’ properties using the different methods. This prepared volunteers for the subsequent work of using each method in each of the communities and their ability to take accurate measurements was validated.
- The geospatial data collected by the volunteers was examined and analysed to compare the positional accuracy of the three different methods, in relation to the formal official data collected by professional surveyors in the Al-Hillah Real

Estate Registration Department (RERD). Therefore, a significant number of points captured by each volunteer using all technologies was made available and accuracy comparisons could be calculated. Positional accuracies for datasets created using each data collection method were calculated for each of the nine sites. This involved a RMSE analysis of coordinated corner points of land parcels and an assessment of discrepancies between the positions captured using the three methods utilized and the coordinates of those points as shown in the official map records. A customized dashboard tool developed in Matlab for calculating and visualizing the RMSE and other measures was used to quantify the discrepancies between VGI and official data.

- The interviews were analysed using thematic coding to highlight key issues and similarities or differences in people's responses to questions and their open discussions.
- With the aid of the community gatekeepers, the researcher arranged final workshops with each community to verify the information that had been collected from those communities.

Clearly there are many aspects of many different methods employed in this research. This thesis describes each in detail and the work was carried out successfully, as demonstrated in the remainder of this thesis. This research methodology was created to establish an efficient way of addressing the research objectives outlined in Section 1.4.

This methodology is discussed in much greater detail in Chapter 3. It also becomes relevant in Chapter 7 when the difficulties of the process of data collection are discussed.

1.6 Organisation of the thesis

The thesis consists of eight chapters. Chapter 1 introduces the research background, which essentially includes a general overview, the aims and objectives of the research, and also a brief introduction to the methods used in this study.

Chapter 2 presents an understanding of the current state of knowledge about land registration and VGI from the academic literature and official reports. It includes general definitions and components of land administration systems (LASs) and discusses the current state of land registration and cadastres worldwide and illustrates the general issues of land administration systems in developing countries. The interview then focuses on the Iraqi land system. The chapter explores the concept of fit-for-purpose land administration systems and investigates the

factors driving contemporary LASs. A major element of the chapter is an exploration of VGI, including volunteers' and local authorities' motivation to collect and use data. VGI quality considerations are also explained with regards to positional accuracy, attribute accuracy, completeness and currency. The methods used to assess and validate VGI when no other data sets are available are also demonstrated. Experiences of VGI for different purposes around the world are examined, and the chapter concludes by exploring the possible use of VGI in the land administration system. The chapter provides a means to develop the research methods chosen and the process of the field work.

Chapter 3 discusses the methodology used in this thesis. It begins with the sampling of locations for research sites in establishing a VGI project. Then it addresses the development and piloting of tools, including the collection of coordinates using a GPS-enabled Android smartphone, the setting up of iPads for data collection, the application of printed aerial images, and the fieldwork survey for collecting attribute data. The next step is to prepare the contact with appropriate partners in Iraq and data collection in the study area, interviewing professionals and community gatekeepers interviews and holding community workshops. The chapter continues with a description of the output of the fieldwork, and the preparation of data for analysis.

The context of Iraq within which the research was undertaken is presented in Chapter 4. This briefly covers the history of Iraq before exploring issues which are significant in explaining land tenure and record keeping, including demography, including age and gender balances, ethnicity, migration and displacement. The country's more recent political history, associated issues in land registration, and the procedures currently in place for land transfer and reallocation are then addressed.

The implementation of the methodology and its outcomes are considered in Chapter 5. Results are this presented of the thematic coding and discourse analysis of field data to explore volunteers' levels of knowledge of, and concerns about, the current land administration system and their experiences of it.

Chapter 6 first explores the results of the analysis of attribute data collected from volunteers and participants, while the second part presents the results of the analysis of geometrical similarity measurements, completeness and currency between formal and VGI datasets. Chapter 6 is organised on a case-study site-by-site basis. The research outcomes directed the order in which material is presented in this chapter, and each zone (urban, peri-urban and rural) is examined individually and considerations of the relevant factors are discussed. Chapter 7 and 8 deliver a summary of the thesis, with recommendations for future work. The work highlights

the fact that VGI proved to be a valuable solution to enhance the Iraqi land administration system. This included attention to the completion of unmapped areas, updating existing maps, completing ownership records and informing professionals about the current situation of illegal expansion on public or private land. Furthermore, the results of this research investigation have given valuable lessons for other researchers who might consider using VGI in the future. In particular, it suggests that different tools and approaches should be developed which are appropriate for different communities, volunteers and topographic contexts.

Chapter 2. Experiences of land administration and VGI data handling

2.1 Introduction

This chapter examines current issues and concerns related to land administration and volunteer geographic information (VGI). It begins by presenting a picture of current trends in land registration and cadastre development around the world to justify the need for investigation of the different methods of administration, and the possibilities of improvement by adopting different data handling techniques within a LAS. It then explores how different countries have tried to develop cadastres and the difficulties they have encountered. Finally, it focuses on the use of VGI and considers how it can be conceptualized and used for land administration and cadastral purposes. Where possible, the discussion takes both an international view and then focusses more specifically on Iraq or the countries of the Levant in order to identify relevant issues which might inform the study methodology and data collection.

2.2 General definition and components of the land administration system (LAS)

Land administration is considered to be the operations of determining, registering and propagating information about the value, tenure and use of the land when implementing land management policies. It encompasses land registration, cadastral surveying and mapping, fiscal, legal and multi-purpose cadastres and the land information system (UNECE, 1996). Land registration is thus one aspect of the land administration system and involves the procedures used to record all interest in land with regards of ownership, size, location, land use, and value and preparing and structuring such information in a public register (Ituen and Johnson, 2014). Cadastral surveying is a specific term used to describe the process of gathering data about land parcels and recording it. These data include geometrical data such as the size, shape and location of the land parcel (Stuedler, Rajabifard, and Williamson, 2004). A further step in cadastral surveying is cadastral mapping, which uses data produced from cadastral surveying to generate complete maps. The main use for the cadastral map is to produce a title registration system and the title is used to simplify the process of land transactions. A cadastre as defined in Osterberg et al. (1995), is up-to-date information on the land parcel which contains a record of the interests in land such as rights, restrictions and responsibilities. A fiscal cadastre is the cadastre that is organized mainly for fiscal objective such as valuation and fair taxation. The legal cadastre is established mainly for the legal objectives such as conveyancing which assists in using and managing the land and facilitates environmental protection and sustainable development. This

kind of the cadastre thus supports the land market. Multipurpose cadastral systems are established for multiple requirements and to support social, economic and environmental sustainability. Another important element of the land administration system is the land information system which contain information that is essential for decision making and management of the land, such as land size, location, land use, land value, land rights and land ownership (Lwoki, 2011). This research focuses on the current cadastral and registration systems which are responsible for demarcating the plot boundaries and recording information about the land.

2.3 Current state of land registration and cadastral systems

Land is undoubtedly the most important natural resource and asset in any nation. In most countries land contributes half to three-quarters of the national wealth. Hence there is a need to manage it in a sustainable manner. While recent developments in technology and the use of advanced surveying techniques in formal land administration systems in developed countries allows high security, easy access, and efficient services for the people concerning their land, the majority in the world of other countries still do not have a land administration system and the people live with the threat of their land being taken from them and this insecure situation is mostly the case in developing countries.

Studies show that only about 25% of land parcels in the world are registered, and these are typically located in 35-50 countries, most of which are in the industrialised world, which have a complete land registration system. Thus, 75% of land holdings have not yet been registered (McLaren, 2013). The majority of these land parcels are occupied by the most vulnerable and poorest groups in society and they live in threat of expulsion due to a lack of security of tenure. In addition, the proportion of people living in urban areas is expected to increase from 50% of the world population to 60% in 2030, which may lead to serious problems in the security of land tenure in new densely populated areas. As such, the formal land administration system may be unable to cover the excluded 75% of the world population and there is an urgent need for an alternative approach to land administration that guarantees prompt and cheap and support for community needs and services.

2.3.1 Issues with land administration systems in developing countries

There are many difficulties with the formal land administration systems in developing countries which make them inadequate and ineffective so that they do not serve the needs of the majority of communities. Adlington and Tonchovska (2010) argued that one of the main reasons for the inefficiency of official land administration systems is the lack of funding support. This is also

supported by World Bank progress evaluation reports which show that, although a large number of land reform projects in about 30 countries started directly after political change and economic transition from central control to a free market, the progress of these projects is weak, and about 48% suffer from budget deficiencies with 17 projects still to be implemented. Bulgaria is one example of an official cadastral system which is limited, covering only 18% of land parcels, and it has been decommissioned due to a lack of funding (Basiouka and Potsiou, 2012).

Another factor that makes the official system inefficient in covering the cadastral system in many countries is a lack of trained staff. Robin McLaren (2013) has pointed out that the numbers of land professionals world-wide are insufficient even with access to new technologies. Rwanda is an example of this situation, where there are few qualified surveyors in the country (Enemark et al., 2014).

Lemmen (2010) argued that the official tenure system may only consider the legal rights of ownership while neglecting other aspects. This kind of system does not serve millions of people whose tenures are predominantly social rather than legal. For example, in sub-Saharan Africa, one-third of the total land area is considered in the official system. The other two-thirds is owned via other forms of tenure which are social. Furthermore, gross errors may occur during official cadastral field work, due to the fact that official cadastral and registration work may not include or take into account the opinions of land owners about their boundaries. Therefore, the parcel may be delineated in such a way that is totally different from the owner's point of view. For example, an official cadastral project in Tsoukalades, Greece (which is part of the Hellenic cadastre) was repeated four times and did not succeed due to the many errors in the shapes, locations, and boundaries of parcels. In addition, others error in registration were discovered which showed that parcels were registered with unknown owners (Basiouka and Potsiou, 2012).

A recent argument by Alemie, Bennett, and Zevenbergen (2015) suggested that official systems could not cope with changes of regime or the consequences of war. This means that the official system may not be the right solution when a new country emerges following independence or when the formal regime changes following war. In these situations, it is unwise to build a new official system from scratch due to the time and cost needed. In this case an interim land administration system may be required that can serve the needs of the community, or be fit-for-purpose, until an official system is developed.

Zimbabwe is an example of land redistribution. This project was conducted during the period from 1980 to 1996 by the Zimbabwean government due to the situation where a small minority of the population (3%) owned about 75% of the total land area, with the majority of the population owning only 25% (Chitsike, 2003). Another example is Ethiopia, where regimes

have changed across the three epochs from the imperial state, military government, and rule by the Ethiopian People's Republic Democratic Front (EPRDF) (Alemie, Bennett, and Zevenbergen, 2015).

Other factors leading to the inefficiency of an official system might be that it is inaccessible for a majority of people. This situation often appears in developing countries where owners are unable to register their ownership or to conduct formal transactions due to the high taxes imposed for these official services. In this case people may not register their ownership or they may buy or sell their land without recourse to the formal system.

Fairbairn and Al-Bakri (2013) noted that there are shortcomings in official systems even where they do exist. These often relate to the completeness of data. For example, over time data become out of date. Authorities struggle to keep up-to-date records of numbers of plots, and changes of use. Shortcomings can also exist when citizens interact with official systems, for example, the definition and nature of a 'boundary' according to professionals may differ from the interpretation given by the occupier, such as in rural areas.

The shortcomings of official registration systems clearly need significant time and resources to address, and they may not serve the needs of the community. The situation appears to be problematic in many official systems where the processes of the registration and transfer of land are too slow and insufficient resources are directed to them.

2.3.2 Fit-for-purpose land administration

The term 'fit for purpose' appears regularly in the literature on land administration. However, we must acknowledge that the 'purpose' of land administration, and therefore tools used to support it, may differ in different socio-political and economic contexts. The underlying purpose of land administration may be to record the ownership or other tenure and use of land in a country or area and any changes to this. However, concepts of ownership and forms of tenure differ greatly around the world. Therefore, the requirements of a system and the tools used to support it will differ. However, in very many places, the official cadastral system is certainly fundamentally weak or has been damaged by war, or does not exist at all, or does not meet the needs of planning by government. In these situations, the requirements of new or improved systems may differ. In some sub-Saharan countries, where no functioning land administration system exists and there is very limited institutional capacity to develop one, the focus of a fit-for-purpose system may not be to build a highly accurate system but rather to provide a system which can record ownership and provide security of tenure for underprivileged communities (Enemark et al., 2014). In countries where there has very recently been a

functioning system which is now in some disarray owing to war, the system may have reasonably adequate data on the number of plots and their size. However, it may need significant work to identify illegal settlement by squatters and internally displaced people. In countries where customary or tribal land systems operate alongside formal systems, the ‘purpose’ of land administration may be to reconcile the multiple forms of ownership and tenure across the country. For this PhD study, the purpose of the land administration system in Iraq is complex. The country has had an evolving and relatively well functioning system over many decades. However, repeated wars and periods of civil unrest have left that system damaged and out of date and have also significantly affected the institutional capacity to repair and update it. Land data does exist but it requires urgent updating, especially given the degree of corruption, false claims and squatting which the country is currently experiencing. The current purpose of land administration in Iraq, therefore, is to collect attribute data such as ownership and land use, as much as it is to collect spatial data, such as accurate extent and area.

This type of system, which may not be fully concerned with spatial accuracy, involves a few principles that may need to be considered when attempting to introduce it. These principles include firstly the adoption of general boundaries rather than fixed boundaries, which means that the accuracy of the delineation process is not considered to be very precisely determined, especially in the rural and peri-urban areas, but it is expected to be suitable for most land administration purposes. A successful example of the adoption of this approach is the Land Tenure Regularisation in Rwanda introduced in 2009 (Enemark et al., 2014).

In the Rwanda case, the goal was to provide legally valid land registration documents to all those who held land legally. The approach of the programme was to collect data relating to boundaries in a very collaborative and participatory way. Geospatial data was collected using high-resolution orthophotos and satellite imagery. Specially trained teams of locally ‘para-surveyors’ outlined land parcel boundaries on printed images which were then scanned, geo-referenced and digitised. These images printouts of the parcel plan ultimately formed part of the legal ownership document. Attribute data on, for example, owners’ details and rights were collected in a register by legally constituted adjudication committees.

The information from the registers was entered into the Land Tenure Regularisation Support System, from which titles were processed and printed for first issuance. By May 2013 about 10.4 million parcels had been registered and 8.8 million printed land lease certificates had been issued. One of the benefits of the system was its very limited cost, at around 6 USD per parcel. One of the major outcomes hoped for with the system was that Rwanda would improve the social harmony within the country by reducing conflicts over land and improving security of

tenure, leading to increased investment in land and increasing the contribution of land as an economic resource for national development. Rwanda suffered from a severe lack of qualified surveyors. However, there is now an ongoing programme to train Geomatics engineers. The implementation of this programme was a collaborative effort between a wide group of Rwandan and international partners, including Rwanda Natural Resources Authority who took the lead. Others included the United Kingdom's Department for International Development, the Swedish International Development Cooperation, Agency, European Union, Royal Netherlands Embassy and IFAD.

A second principle is to use satellite or aerial imagery rather than traditional land surveys with a total station. This can be three to five times cheaper than an ordinary survey and is suitable for many land administration purposes. A good example of this situation is the use of printed 1:25000 satellite image for volunteers to draw parcel boundaries with ordinary pencil as implemented for land ownership in Tsoukalades, Greece (Basiouka and Potsiou, 2012).

Thirdly, the accuracy of the information input to a fit-for-purpose system should be appropriate for the purpose for which the data is going to be used and finally, the system should be designed in such a way that it can be updated and improved over time. For example, the design and implementation of a pilot fit-for-purpose land administration system in Botswana addressed issues such as database design, including the Social Tenure Domain Model (Enemark and McLaren, 2017), an effective user interface and access to official records through a trust and reputation modelling of individuals' abilities (Morero et al., 2018).

A fit-for-purpose approach builds on some important elements (Enemark, 2013). These include that it is participatory, which means that geospatial data is collected with the aid of the community. Next, it should be inclusive, to cover all tenure types without any exceptions. This element is considered to be crucial because it takes into consideration social tenure which has been neglected in the majority of official land administration systems. A further element is attainability, which means that the system is built depending on available resources and within a short timeframe. Finally, upgradability means that the data can be updated and improved in response to the development of the society. The fit-for-purpose concept as presented by Enemark et al. (2014) was developed with reference to these principles and other practical factors.

It is clear that some of the characteristics of VGI conceptually match the framework of 'fit-for-purpose' land administration systems; but there has been limited investigation in real-world scenarios. Keenja et al. (2012) reported that "to date, limited empirical work has been undertaken in this domain: there remain many unanswered questions regarding the accuracy,

authority, assuredness, availability, and ambiguity of crowdsourced data. Meanwhile, the potential for crowdsourcing to provide a low cost and high-speed solution in areas where cadastral coverage is lacking, is eagerly anticipated". Basiouka, Potsiou, and Bakogiannis (2015) used volunteers to assess the possibility of using OSM for official, cadastral purposes, but the target group was college-educated surveying practitioners, rather than real members of the community. Other researchers, such as Grus and Hogerwerf (2014), have reported on experiences of crowdsourcing in the Netherlands' Kadaster, concentrating on change detection, whilst de Almeida et al. (2014) explored the role of VGI in capturing and utilizing 3D data for property cadastres.

2.3.3 Factors driving contemporary LASs

The variables which drive contemporary land administration systems are themselves disparate and multi-faceted. Firstly, tenure may involve aspects such as occupancy, usufruct (official usage rights without ownership), informal rights, customary rights, and indigenous and nomadic rights, with varying levels of security depending on their level and application. Informal land rights differ from formal ones, but land tenure can migrate from one category to another, be upgraded over time and change towards better levels of security. For example, the informal settler may achieve an improved level of tenure if the government begins to formally recognize certain group rights (Quan and Payne, 2008). Secondly, the legal rights used in land administration may reflect a number of acceptable and practical systems such as tribal rights, or religious rights embedded in the Islamic system, for example, and customary rights. A third variable is accuracy, which reflects the different methods and techniques for collecting cadastral data employed by officials. This recognition of variability could be extended to public participation in collecting VGI, for example by field sketches, satellite imagery, or GPS observations. Volunteers may themselves exhibit useful variability. For example, young amateurs may have technical experience whilst elders possess useful historical information, while young people may prefer to use digital technologies (e.g. iPad or GPS) but older people may prefer to use sketch maps to present their land information to the system of public participation.

Clearly, the factors outlined have a reliance on the stakeholders and societal organisations involved. Such factors should be considered and accommodated in any LAS, but they become particularly important when participatory work is undertaken within the system.

2.4 The nature of public participation in collecting geographic data

The nature of public participation in the collection of geographic data has been addressed by many researchers, and although the main perception for all is nearly the same, the terminology used can vary. Turner (2006) referred to ‘neo-geography’, meaning the use of geographical techniques and tools for personal and community activities, or by non-expert groups of users. Goodchild (2007) proposed the term ‘citizens as sensors’ for those numerous people who participate in collecting information on the weather and predicting catastrophes. Meanwhile the term ‘citizen science’ describes the engagement of amateurs in any experimental and scientific observation (Bonney et al., 2009). In geographic terms, the use of the word ‘crowd-sourcing’ can suggest the process of collecting information by local citizens by means of mobile devices and the geoweb (Niederer and Van Dijck, 2010), although it can also be used to refer to the validation of such data by multiple volunteers who can give a ‘best estimate’ on its trustworthiness and accuracy. For a LAS, a relevant recent term is ‘neo cadastres’, which refer to citizen-built and legitimized land data handling systems maintained by volunteers rather than the government (de Vries et al., 2014). The work described in this project demonstrates the convergence of VGI with neo-cadastres, and the focus is mainly on the definition of VGI and its uses, as well as issues related to quality and the methods used to verify VGI.

2.5 Volunteer geographic information (VGI)

For centuries, the collection and use of spatial data has been reserved for official agencies (Goodchild, 2008). However, VGI offers the public the opportunity to be involved in data collection and use. This is challenging to authorities and they may raise concerns about the data or the process. Within the literature on VGI, several areas of importance for this research which might help to overcome these concerns were found. There are three main aspects that other researchers have explored in relation to participatory mapping projects. These are the motivation for adopting VGI in land administration projects, the quality of the data, and ways of verifying the data contributed by participatory engagement (Seeger, 2008).

2.5.1 Motivation for VGI

The word motivation is a general term which refer to the incentives for doing something. In this research, three levels of motivation are identified:

- Motivation for using VGI technologies in a LAS
- Citizens' motivation for collecting and editing geospatial data for the LAS
- The motivations of the authorities

The motivation for using VGI technologies in LAS

The ineffective nature of many LAS, suggests that there is a need to build fast and inexpensive land administration systems that can activate stagnant land markets; and it may be that such initiatives are much more valuable than building highly accurate systems which may need more time and money (Adlington and Tonchovska, 2010). Associated with this approach, it seems obvious that VGI can form a major part of such initiatives, and that contributions from people who live near to a spatial phenomenon can provide the best knowledge of its characteristics (Bishr and Mantelas, 2008). In terms of specific application, therefore, one motivation to consider is that official cadastral data provided by official expert structures can be completed and up-dated when combined with data that is provided by volunteer geographic information. From a technological perspective, the expansion of internet coverage and its availability around the world together with the development of smartphone technology, allows for easy and quick techniques to be used for collecting, selecting, uploading, correcting and mapping geospatial data by ordinary citizens without depending on GIS experts (Tulloch, 2007).

Citizens' motivation for collecting and editing geospatial data for the LAS

The most important motivation is that of the volunteers without whom no VGI project can succeed. The desire of citizens to participate as volunteers in collecting geospatial data over lengthy periods, and not directly linked to financial gain, has been examined by Tulloch (2007), who identified "achieving a higher level of empowerment" as the main factor that motivated citizens to participate in the OpenStreetMap project (the VGI initiative with the highest profile). Goodchild (2007) has suggested that "self-promotion and personal satisfaction" are also major factors. Coleman (2010) suggested that positive factors might include altruism, professional and personal interest, intellectual stimulation, the protection of personal investment, social rewards, personal reputation, the opportunity for self-expression and, especially in the case of geographic information pride of place. Negative factors include mischief, social, economic or political agendas and malicious intent. Haklay and Budhathoki (2010) cited concepts such as

fun, recognition, money, uniqueness, ethos, reciprocity, and instrumentality to characterise the volunteer experience. Cotfas and Diosteanu (2010) considered volunteer participation as a recreational activity, such that the public does not need to be particularly aware or motivated for their participation. However, Laarakker, Georgiadou and Zevenbergen (2014) have suggested that the focussed recognition of a need for better public services and improved systems for land administration might be a more positive driver for participation than such altruistic reasons. Basiouka and Potsiou (2012), who conducted the first practical cadastral mapping exercise using crowd-sourcing techniques, have emphasised that the main reason for the motivation of their participants was the perceived need to overcome bureaucracy and to open the Greek land market, which had been blocked for more than twelve years. The key opportunities for contribution might therefore be market-driven, such as professional or personal interest at an economic level, or the enhancement of a personal job or project, being part of a large social network and being rewarded for having a strong personal presence online, and a 'fun-factor' in working within a 'trendy' environment, as well as humanitarian and altruistic drivers (Winterbottom and North, 2007; Coleman, Georgiadou and Labonte, 2009; Genovese and Roche, 2010).

The authorities' motivations

Although a project of VGI is created and maintained by ordinary citizens, the role of the authorities in supporting and guiding the crowd-sourced mapping project is considered to be crucial for the successful implementation of such projects. Hence, the motivation for the authorities in offering support is also very important. Such motivations are regarded by McLaren (2013) as being fundamental to designing a VGI pilot project. He suggests that the completion of unmapped areas or the updating of an existing system, traditionally the role of an authoritative national mapping agency, could be undertaken effectively using VGI projects and crowd-sourced mapping.

This situation is very important for the authorities because it helps them in decision making and can serve their purposes. Another consideration that may motivate authorities to support a project is to select a crowd-sourcing project in a highly populated urban slum area with very small plots, where high levels of accuracy in obtaining land boundary data is not so important for the authority. This type of project can supply authorities with essential information relating to land rights and the delineation of boundaries in these areas which can then be used for planning and updating social services and infrastructure, such as in Kibera in Kenya (McLaren, 2013). According to Enemark (2014) the crowd-sourcing project motivates land professionals by expanding their role and allowing them to serve the entire population rather than focusing

only on a small elite. He also pointed out that the role of the professional will be more managerial in relation to managing and using land related data rather than only creating it. Finally, crowd-sourcing is considered to be a new source of fresh data that may enhance the quality and quantity of the information in the hands of professional and decision makers (Seeger, 2008).

2.5.2 VGI quality considerations

Because VGI is provided, in most cases, by people with little or no knowledge of the mapping process (Ciepluch et al., 2010), it is necessary to verify the quality of the data and its potential benefits.

From the literature, it is clear that land administration systems are only as good as the quality of their data. There is common agreement that the quality of data can be thought about in several ways (Morrison, 1995, Veregin, 1999, Shi, Fisher, and Goodchild, 2003, Devillers and Jeansoulin, 2006, Lo and Yeung, 2007, Burrough, McDonnell and Lloyd, 2015):

- Positional accuracy, which is the nearness of coordinate values of a VGI feature (e.g. a point) to its corresponding authoritative equivalent feature based on Euclidian distance (Mullen et al., 2014).
- Thematic /attribute accuracy, which refers to the reliable and reasonable correctness of the attribute attached to the points, lines and polygon features of the spatial database.
- Completeness, which refer to comparison between two different sources of data sets for the same area of interest to find which features are included in or excluded from a dataset.
- Temporal accuracy, which refers to agreement between encoded and the ‘actual’ temporal coordinates (Veregin, 1999).
- Logical consistency, meaning the lack of logical contradictions within a dataset (Hashemi and Abbaspour, 2015).

Goodchild and Hunter (1997) evaluated the accuracy of VGI by using traditional statistical methods (root mean square error, RMSE, and standard error) to describe the spatial error of point features. More recently, Al-Bakri and Fairbairn (2012) have agreed with Goodchild and Hunter’s earlier work in reviewing the spatial accuracy of VGI and government data. They found that the RMSE is quite high for VGI, which they attributed to the low-precision devices used; for example, the personal GPS units and commercial imagery services which are commonly used in VGI collection.

Quality appears to change depending on the location. For example, Zielstra and Zipf (2010) examined differences between VGI and commercial data sources in Germany and found that the quality of VGI data became worse the further it was collected from an urban core.

Completeness is used to assess the difference between what is recorded, for example, numbers of houses or lengths of roads, and what is actually found in the real-world (Brassel et al., 1995). Haklay (2010) suggested that it is possible to rely on a numerical assessment by simply counting the total length of streets in OpenStreetMap (OSM) compared to Ordnance Survey (OS) datasets for London and England. However, Jackson et al. (2013) undertook a study based on schools, firstly by simply counting them which showed similarity across four data sets. However, when they repeated the study basing it on names, and in two cases on addresses, they noted that although the numbers were similar the schools themselves were not the same. Thus, they concluded that simply basing the data collection on numbers was insufficient in assessing completeness.

Using the same datasets of schools, Mullen et al. (2014) included demographic features in their specification such as general population, economic status, educational attainment, and race/ethnicity. However, they failed to identify a clear association or statistically significant correlation between either positional accuracy or completeness with any of the demographic variables.

Clearly, any widespread use of VGI in extensive projects requires careful consideration of data quality, however defined. In the project described in this thesis, data quality will be considered from the viewpoint of attribute accuracy and spatial accuracy.

2.5.3 Methods to assess and validate VGI when no other data sets are available

It is important to also validate the process of data collection, especially where there may be no formal or alternative data sets against which to assess the data. In this situation, we must have confidence that the collection method and collectors are reliable. Since the quality of VGI data depends on the reliability of the information that can be obtained from volunteers, it is crucial to find some way of verifying information gathered using participatory methods where the aim is to serve the needs of the community from rather than to serve the purposes of others who aim to defraud or act in maliciously in the system (Coleman, Georgiadou and Labonte, 2009). These methods of verification depend on some criteria such as the producer's reputation, which means that the volunteered information that someone has provided is evaluated by other users (Maué, 2007). Another method suggested by Bishr and Mantelas (2008) depends on the experience and expertise of the producer, which means that a person has a good record in

checking and editing the work of other volunteer work as well as actively participating with his own volunteer data. Furthermore, Haklay et al. (2010) showed that eliminating errors in participatory mapping can be achieved by using a reasonable number of volunteers per area. Other approaches have emerged recently such as the social approach based on the principle of senior trusted users acting as gate-keepers who check and correct the contribution of others. Furthermore, a crowd-sourcing approach can be identified based on the principle of agreement on the data among a large group of people. The geographic approach is based on the principle of comparing the data collected with existing geographic knowledge; for example, the comparison of VGI data with other sources of data such as public land registration data (Goodchild and Li, 2012).

2.5.4 Experiences of using VGI for many purposes around the world

The three factors outlined above have been influential in volunteer geographic information (VGI) techniques which have been used for many successful tasks around the world. Sometimes VGI is used for purposes not directly related to cadastre systems; for example, in disaster relief. These uses are relevant because they tell us something about the difficulties in or the methods employed in using VGI. The lessons from such widespread use of VGI are discussed. Here the focus is on VGI in land administration and cadastre system.

Examples and lessons from governmental organizations

Volunteer geographic information (VGI) techniques have been successfully used in many tasks around the world. Although some of these uses are not directly related to cadastral systems, they provide this project with experience about the difficulties that may be faced in the use of VGI techniques. One possible use is for creating **new geospatial datasets**: for example, South Sudan is a newly emerging country that gained independence a few years ago and the country is poorly mapped. New cadastral maps have been successfully created, although they are based on remote data capture and editing from satellite imagery, along with information from previous residents who had fled the country during the civil unrest. The project was directed by Google and used their map update software tools, and although it did not involve local citizens, local government agencies in cities such as Juba did contribute (Haklay et al., 2014). In Kibera, Kenya, which is Nairobi's biggest informal settlement, VGI was used to create a basic map of roads, land use and settlement boundaries (Holderness, 2016). Such a base map can be used for further surveys of land administration-related information. Similarly, the mapping of slums in urban areas in India used VGI in aiming to provide up-to-date information about informal settlements (Haklay et al., 2014). The lack of information about such areas means that local

government planning is not appropriate or informed for these settlements: VGI can improve the provision of services and raise awareness of slum zones.

Another use of VGI is to **maintain official data sets**. In this situation, official datasets are available but are out-of-date. For example, the Center for Topographic Information (CTI) in the Canadian national mapping agency has investigated the possibility of integrating VGI to its official data sets for the purpose of correcting and updating topographic maps (Bégin, 2012). A preliminary study concentrated on taking VGI data in the OpenStreetMap dataset and detecting whether it includes new features not yet added to the official database. This study raised a number of important questions:

- Does the nature of the detected change affect its incorporation – for example, is adding data from OSM to gaps in the official dataset more important than deleting data already in the official dataset which does not appear in OSM?
- Is the experience of the OSM contributor important – for example, does the accuracy of a contributor's work increase or remain the same over time? If it evolves, how long does it take before its accuracy is stabilized, if it ever does?
- What is the impact of local knowledge on the accuracy of OSM data – for example, is mapping a neighbourhood directly on the ground better than updating features located in an area far from the contributor?
- What is the most effective model for formally exchanging data between the VGI community and the official organisation? (Bégin, 2012).

The release of Canadian National Mapping Agency data to the OSM website allowed OSM community users to easily interact with it by editing, completing and updating the topographic map. This official decision showed the perceived inability of the agency to maintain its datasets and the increasing trust and belief in VGI data (Haklay et al., 2014).

Another example, updating building footprints and addresses in New York City, USA, was undertaken with the aid of volunteers (Barth, 2013). In 2013 New York City's GIS department decided to open its official data to the public through the web-platform Socrata. The data is made available for download or through APIs (application programming interfaces) that allow software developers to construct mobile and web-based applications that incorporate this information. The city has successfully released 1100 official data sets with the aim to make all these accessible by 2018. The main innovation in this project was the development of software by the company Mapbox allowing the New York City GIS department to receive daily emails detailing changes to OSM building or address information. The GIS team can therefore quickly assess updates in OSM to identify where urban changes which may require updates to the

authoritative city data set. Further, a feedback loop between the city and the OSM VGI community ensures quality control.

The next use of VGI is for **risk management purposes**. In this situation, the use of community mapping is essential to support improvements in governmental disaster plans. For example, a participatory mapping project in Philippines was used to support the local government in predicting the effect of catastrophes and the preparing for quick action to be taken in case they happened (Meyer, 2013). Another successful example is the Haiti disaster response project. The aim of the project was to facilitate disaster response management (Haklay et al., 2014). Different maps and images, including historical data, CIA maps and high-resolution Yahoo imagery, were uploaded into the OSM platform for the purpose of detecting and tracing important features not already existing and changes to the limited data which did exist. In addition, volunteers with paper maps and GPS trackers also participated. The result of this release of data was an improved estimation of the needs for post-disaster relief. The outcomes of the data obtained from the participation of more than 6000 volunteers, within one month, were to identify about 30,000 damage reports to infrastructure, and an improved default basemap for responding organizations and the Haitian government. The success of this project was shorter time responses, lower costs of meeting disaster needs, greater participation of local volunteers and increased trust in such VGI projects.

Furthermore, VGI has been used for **specialist knowledge purposes**. Here, volunteers' data can be used to enhance scientific knowledge in particular disciplines. For example, the US Geological Survey have created a website named "Did you feel it" (DYFI) for local volunteers to report on earthquake activity, by recording their estimation for the strength of tremors they felt, together with their locations (<https://earthquake.usgs.gov/data/dyfi/>). Volunteers successfully submitted, through a specifically-designed web interface form, about 360,000 earthquake events to DYFI and these are accessible online on the website archive section. The data are used by USGS to learn and understand more about earthquake activity, and to inform emergency response planning efforts and budgets needed for disaster relief modelling.

National Biodiversity Data Centre (NBDC), Ireland is another example of using citizens to observe and report data, in this case about different kinds of plants and animals. Volunteers can easily access the NBDC website, to fill online forms about their biodiversity observation, or to send attachments of extensive records captured in the field. This governmental organisation reported in 2014 about 61,000 records submitted since it started collecting data in 2012; now an average of approximately 1600 records are submitted monthly. Data is quickly checked and made available for access and visualisation on an online map (Haklay et al., 2014).

Finally, the use of VGI may apply in **public services tasks**. For example, FixMyStreet is a project which can be used for municipality maintenance information in the UK. It is supported with Government data sets of postcodes, basemap, local authority boundaries, contact details and email addresses of relevant personnel in local authorities. This project was created for the purpose of reporting on problems such as litter, unlit lampposts, graffiti etc. to the local authorities. It has become one of the most popular websites for citizens to report on local issues. It enables both the local community to witness the issues in their area, as well as the local authorities to report on their actions made to solve the problems. This website, which was originally created and administered by a social enterprise called mySociety, is free of charge to the public (Haklay et al., 2014).

It is clear from these examples that VGI is being successfully used, in different locations around the world, in both developed and developing countries, for a range of purposes related to governmental and citizen-based activity. However, reports of these examples do not fully detail the processes employed or quantify the success of the data collection methods. This research seeks to fill that gap in knowledge, by learning from such examples and focussing on a particular governmental activity, land administration, in a specific context, the maintenance of records in a challenging environment.

Examples and lessons from non-governmental organizations (NGOs)

Other successful examples of the adoption of VGI without the intervention of the government include situations where no operational cadastral systems existed or the existing systems did not reflect the community's understanding of their land boundaries and rights. Three examples have been mentioned by de Vries et al. (2014) exemplify a bottom-up approach to the mapping of communities. In the first example participatory mapping practices and associated tenure allocation were practised in communal areas in southern Ghana. Olowu (2003) and Arko-Adjei (2011) described a few cases in Ghana such as in the Ashanti Region and Jisonayilli where residents created and demarcated their own tenure system depending on their own rules and regulations based on their knowledge rather than following the government land administration system. Secondly, a bottom-up boundary mapping process was applied to indigenous land in Canada. This community mapping project may not have followed government rules for a cadastral system; however, it did reflect the community's social, cultural and religious relationship with the land (de Vries et al., 2014). The third example is the Larasita bottom-up land tenure rights project in Indonesia which depended on a community recording and allocation process.

Here VGI is considered as a threat to the authoritative LAS because it depends on a bottom-up approach with the community taking the main role and the mechanisms used for surveying and registration were different from the government one.

2.5.5 Evaluating the use of VGI in land administration systems

In recent years, researchers have tried to evaluate the quality of the data that has been collected using participatory methods. Some consider VGI to represent an opportunity for official land administration systems. For example, de Vries et al. (2014) argued that the use of volunteer spatial data in cadastral systems is an opportunity for the creation and maintenance of geospatial data, which changes the role of ownership of that data from being passive to active. This can provide faster, cheaper and more fit-for-purpose methods of land registration than in traditional processes. Alemie et al. (2015) also considered the importance of using volunteer geographic information data for cadastral purposes as an interim solution that can serve the needs of the community by securing their land rights with different levels of security of tenure. Seeger (2008) supported this argument by referring to the opportunity for the government's cadastral authorities to access a new source of fresh data that may help them in planning and decision making. On the other side of the argument, McHenry (2004), Lanier (2006), Keen (2007) and more recently de Vries et al. (2014) have argued that using VGI in a cadastral system may represent a threat to the official system because the process may conflict with the rules and mechanisms of official organizations and experts .

Goodchild and Li (2012) also suggested that the quality of crowd-sourced data cannot be controlled because of the fact that only a small number of people may be able to verify the correctness of information. For example, only the people who are in touch with a specific land parcel can provide the right boundary information. In addition to the quality control problem, the majority of VGI producers are amateurs who have little or no experience with the mapping process (Mummidi and Krumm, 2008).

Other researchers partially agree with the argument that there is a place for the usage of VGI for specific tasks in land administration. For example, Navratil and Frank (2013) argued that, it is difficult to depend totally on VGI as an alternative option for the official cadastral system because an important part of the land administration system concerns land ownership which can only be verified by a very limited number of people. Nonetheless it still has an important role to play in observing land related data which can be easily collected by the authorities but need time and efforts.

To summarize, the opinions of de Vries et al. (2014) about VGI as representing an opportunity and fit-for-purpose solution seems to be more credible because it can serve the needs of the

community in cases of the weakness or absence of official cadastral systems. However, good methods are needed to check the quality of VGI data.

2.6 Chapter summary

This exploration of the literature describing current knowledge of land administration and VGI has informed the present PhD research in several ways. Firstly, it helped to provide focus for the research questions and to position the work in the debates about the empowerment of citizens. It has helped in clarifying the motivation for this research in that it highlighted the importance of formal tenure for the world's poorer people and also for the researcher's home country of Iraq where recent wars have left the formal system broken and unable to secure land rights for citizens. The literature also emphasises the importance of VGI in that it can offer a low-cost, inclusive approach to the updating of existing records, and thus it has informed the methodology and the tools used to collect VGI in this research. It has also helped the researcher to understand that current formal land systems might actually be used to maintain the status quo and only work for the rich and the government, not the citizens and property owners.

The main value for this research of the review of published studies has been in identifying gap in knowledge. It appears that previous uses of VGI have evaluated spatial data but have not closely examined the completeness or currency of data. This study will do both. Other projects and studies have not offered citizens a range of data collection methods, and so it is suggested that some methods and tools might provide greater motivation or accuracy than others, and some methods may be more easily used by people of different ages or levels of education. This study will analyse data collected using a range of different methods to assess spatial accuracy and usability. This is important for a 'fit-for-purpose' system because it may be that very low-tech approaches, while not as precise or accurate as higher-tech (e.g. GPS) are valid in some situations where cost or skills are problematic.

The idea of fit-for-purpose suggests that there is a role for less technically accurate data. However, these ideas have not been fully explored and do not take account many of the purposes of land administration. Also, what is missing from the literature is a fuller understanding of the concept of a fit-for-purpose system and a specification of such systems. This research helps to identify more precise specifications for a system good enough to satisfy the authorities in the process of registering land plots.

Addressing concerns about the validity of data and conflicts with existing formal systems have also become a focus of this research as a result of the analysis of the existing literature. The study will draw on these suggestions to analyse and validate VGI from fieldwork. In particular,

the case study areas included formally registered locations so that data can be validated against existing official data.

It is made clear in the literature that there is need for better studies of the potential accuracy and quality of VGI in relation to land administration systems. It is interesting that there is agreement that completeness and currency are also measures of quality. Focussing on that, rather than simply on spatial accuracy, represents an important innovation in this research, as discussed in chapter 3.

The review of literature on the motivation of the authorities and of citizens is important for this research for several reasons. It directly helped to develop data collection tools and engagement with both the authorities and communities in the fieldwork. Moreover, once the fieldwork data was analysed, the researcher was able to present the findings to the authorities in the height of published studies, and explained the value of VGI data and approaches to their work.

Chapter 3. A research strategy for investigating land-related issues in Iraq

3.1 Introduction

This chapter sets out the approach taken to the research and the methods used. It begins with a description of the sampling of case study sites and the development of data collection tools. It then goes into detail on the fieldwork undertaken, and the actual process of fieldwork data collection. Finally, it discusses the preparation and analysis of the data that was collected during the fieldwork. The methods presented in this chapter are directly related to the objectives specified in Chapter 1 and were developed to achieve the overall aim of the research project.

3.2 Sampling of the locations of research sites

Wide-ranging efforts were made, including engaging with the relevant authorities and academics, to select sites and set-up fieldwork in Iraq. Initially it was felt that the security situation in Iraq would make undertaking the study too dangerous, and several other countries were considered. However, Iraq offered significant advantages both in terms of the researcher's personal knowledge and connections to land professionals and the applicability of the end results. The uncertain political, economic and social situation in Iraq makes it even more important to undertake research in this topic.

3.2.1 Iraq as the country of study

Iraq was used as a case study country because of the many problems experienced by the official land administration system since the US-led occupation in 2003 (Al-ossmi and Ahmed, 2015). Despite the government's attempts to address these problems, there are still many specific issues that affect everyday land data handling. One of these is the large-scale forgery of title deed documents dating from that period. The dysfunctional nature of official systems has led to the seizure of public buildings by people occupying them as their living spaces, with others illegally squatting on public land and building their own houses on it, bypassing the formal land registration system (USAID, 2005). Internal migration and the displacement of large groups of the Iraqi population have exacerbated property ownership uncertainty and occupation disputes, and rebel political and military groups have established alternative governance in many areas (Riordan, 2016).

Current political and economic circumstances have led to a failure to invest in manpower or technology and have not brought any improvements to the inefficient and sometimes corrupt nature of the current land administration system in the country (Yousif, 2016). This suggests that an alternative method based on informal data sources, whilst problematic, may be valuable as an approach to improvement. However, a wide-ranging set of cultural, political, economic and technical issues may affect the possible impact of VGI in difficult situations. These issues are experienced in many other countries have been discussed in Section 2.4. Thus the present work has broader implications.

3.2.2 Selecting the city of Al-Hillah for the establishment of a VGI project

A project was set up to test the applicability and value of VGI in enhancing the land administration system in a province in central Iraq and the practical procedures employed to handle the VGI. The governorate of Babel was chosen, and fieldwork was conducted in the region of its capital city, Al-Hillah, which is 100 km due south of Baghdad.

Al-Hillah was chosen for three main reasons. Firstly, the Municipality has had many problems with its land administration system, including several well-documented cases of land fraud which involved forgery and illegal building. In this respect, Al-Hillah presents many of the typical problems experienced in other provincial cities in Iraq. Second, the researcher has a good working relationship with the local municipal land administration department making it easier to access documents and elicit support. Thirdly, but most importantly, the researcher is from that city and it was safer, given the current security situation, for him to work and stay there.

3.2.3 Selecting areas for fieldwork

Within the Municipality of Al-Hillah three types of locality – rural, peri-urban and urban – were identified. These three different types of location were selected specifically to provide a range of different social, economic, cultural and topographical contexts within which to test the effectiveness and acceptability of different data collection methods, the ways in which the data was recorded, official records might vary in different places and the variability in groups of volunteers. In addition, the coverage of formal land records and maps obtained from official LAS professionals was different for each site. As will be seen in Chapter 6, the study identified many situations where the nature of different locations had an effect on the validity of data or the ease of use of different data collection methods.

For each type of area, several specific study locations were chosen as indicated in Figure 3.1 below, giving a total of nine specific study sites (4 urban, 3 peri-urban and 2 rural). In these locations, the local communities were contacted through gatekeepers (typically the gatekeeper was an elected official, or somebody trusted by the local mosque or somebody who has run a business in the area for a long period) identified in collaboration with the local land administration office.

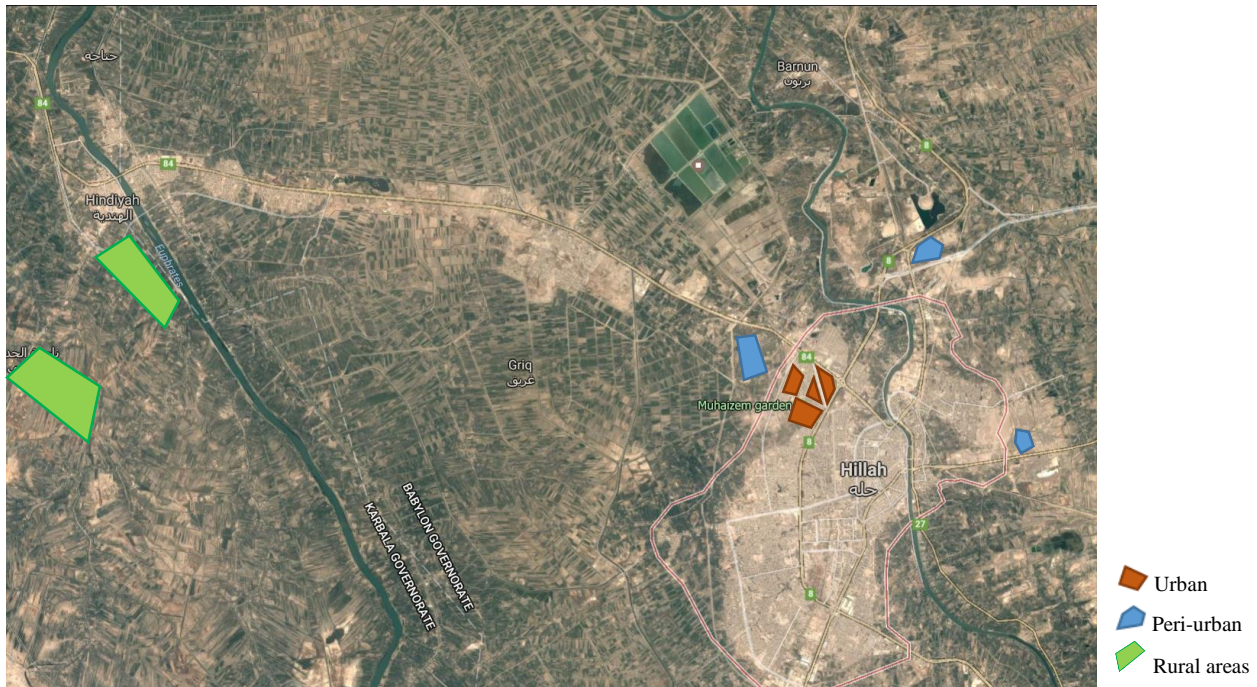


Figure 3.1 Study site locations, Al-Hillah, Iraq (Google Maps, 2016)

3.3 Development of tools for data collection

A key objective of the study was to identify which VGI data collection tools and procedures were most effective for different groups of volunteers in the different case study areas chosen, based on their different educational levels, ages and genders. However, it was felt important that all data collection tools for use in VGI should be free or inexpensive to acquire and use, making it easier for communities to do such work themselves in the future.

Therefore, four different tools for VGI data collection were developed for this study, ranging from higher to lower degrees of technical sophistication and cost arranged from the most expensive and technical (GPS software on a smartphone) to less expensive or technical (iPad for editing maps by uploading QGIS 2.8 software) to the cheapest and least technical (a series of printed aerial images of the study sites suitable for identification of the land parcels and key landscape or topographical features). The tools were each tested in Newcastle upon Tyne prior to the fieldwork and are described in detail. It was important to test the ability of the tools to

allow the collection of the required coordinate and attribute data so that confidence could be expressed about the quality of the data which is investigated further in Chapter 6:

3.3.1 Collection of coordinates using a GPS-enabled Android smart phone

A range of open-source, free application software packages were piloted that can be used on an Android smartphone operating system for the collection of coordinate data. These apps - GPS Test, GPS Coordinate, Latitude Longitude, GPS Location and GPS Essential - were tested during the piloting phase in Newcastle. Although all of the applications offered some benefits, some had poor user interfaces which would make them more difficult to use, especially for the general public or for those with little experience of computers and digital technology or limited education.

Therefore, it was decided to use GPS Essential, as shown in Figure 3.2 below, because of its well-designed dashboard which allowed volunteers to effectively capture their information, which included the coordinates of plot boundaries, attributes and features.

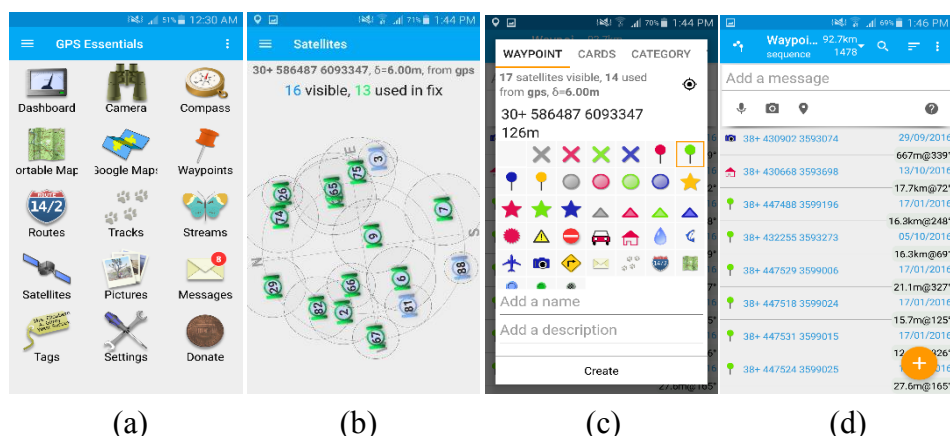


Figure 3.2 GPS Essential: (a) the first screen seen when opening the; (b) number of visible and used satellite, (c) creation of a waypoint and (d) points saved during the work.

Three different Android mobile phones were piloted by the researcher: The Nexus 6, Galaxy s5 and Galaxy s4 were tested to decide which mobile phones have better specifications. The Galaxy Note 4 was chosen based on its better positional accuracy as demonstrated during the pilot study. This smartphone also has a suitable size of screen. It was then prepared to be used by volunteers to collect GPS point data for individual plots and buildings, as shown in Figure 3.3 below.



Figure 3.3 A peri-urban volunteer using a smartphone to select GPS points for the corner of the plots.

3.3.2 Setting up the iPad for data collection

An iPad was prepared with a vector layer of the cadastral maps. The vector layer of the official cadastral map is important because it allows the boundaries of plots to be edited. ArcGIS software was tested for manipulating the maps. The system was piloted in Newcastle prior to undertaking the fieldwork. The manipulation actions included geo-referencing, rectification, reclassification and vectorization.

Raster data was obtained from Al-Hillah land administration authorities by scanning maps. These scanned map datasets do not contain spatial reference information and may have no grid or coordinate information (see Figure 3.4 below). Thus, to use these maps in Arc GIS in conjunction with aerial images, they need to be aligned or georeferenced to an image coordinate system.

When georeferencing, well-defined objects should be chosen which are visible on both the map and the image to be referenced, such as road intersections or parcel corners. In some cases, a ground visit might be necessary to identify the tie-point, especially if the area was not fully built up or if the image was not current. For example, in Wardia, which is one of the peri-urban areas many of the parcels defined on the map supplied by the municipality had not actually been developed and therefore the imagery did not show parcel corners. After identifying common points or ground control points (GCPs), the next step was therefore to align the map with the aerial image that holds the correct coordinate system. GCPs are locations that can be accurately identified in real-world coordinates on the raster dataset and on the unreferenced cadastral map.

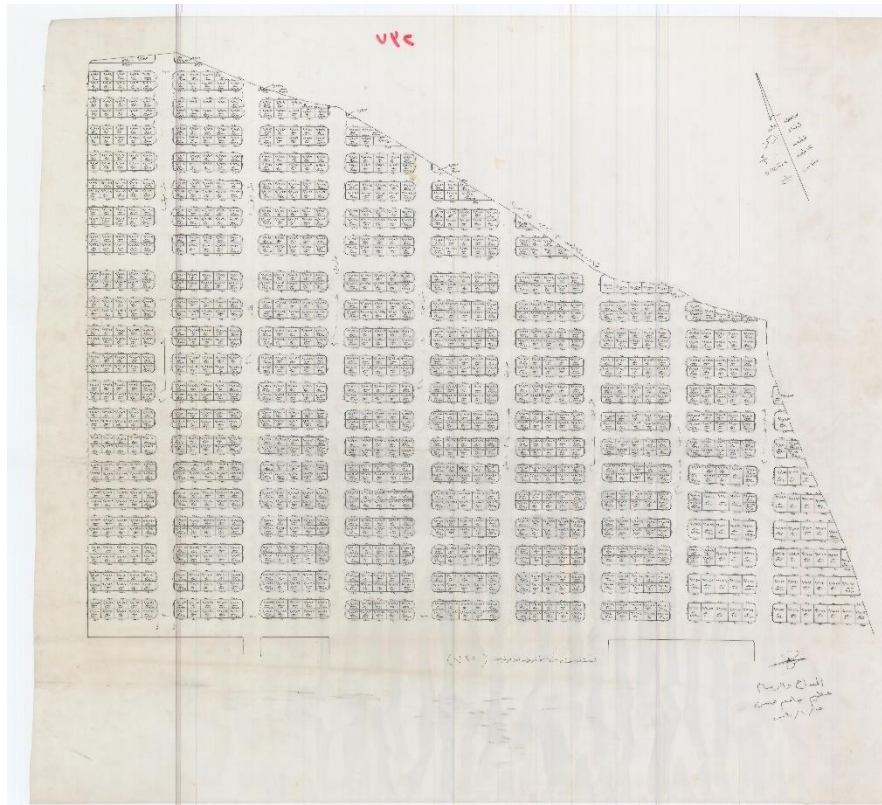


Figure 3.4 Sample of scanned official cadastral map for an urban area obtained from Al-Hillah land administration system.

The matching of the GCPs with the map was undertaken using the image and map handling software. The GCPs were used to build a polynomial transformation that presents the scanned maps in the correct spatial location. The connection between one control point on the maps and the corresponding control point on the aligned target data (aerial image) is a link.

An associated link is the line joining the control points. The links were distributed over the entire raster dataset with at least one link near each corner of the map.

After creating sufficient tie points and links, the map dataset was transformed/warped to match the spatial reference of the aerial image (see Figure 3.5 below).

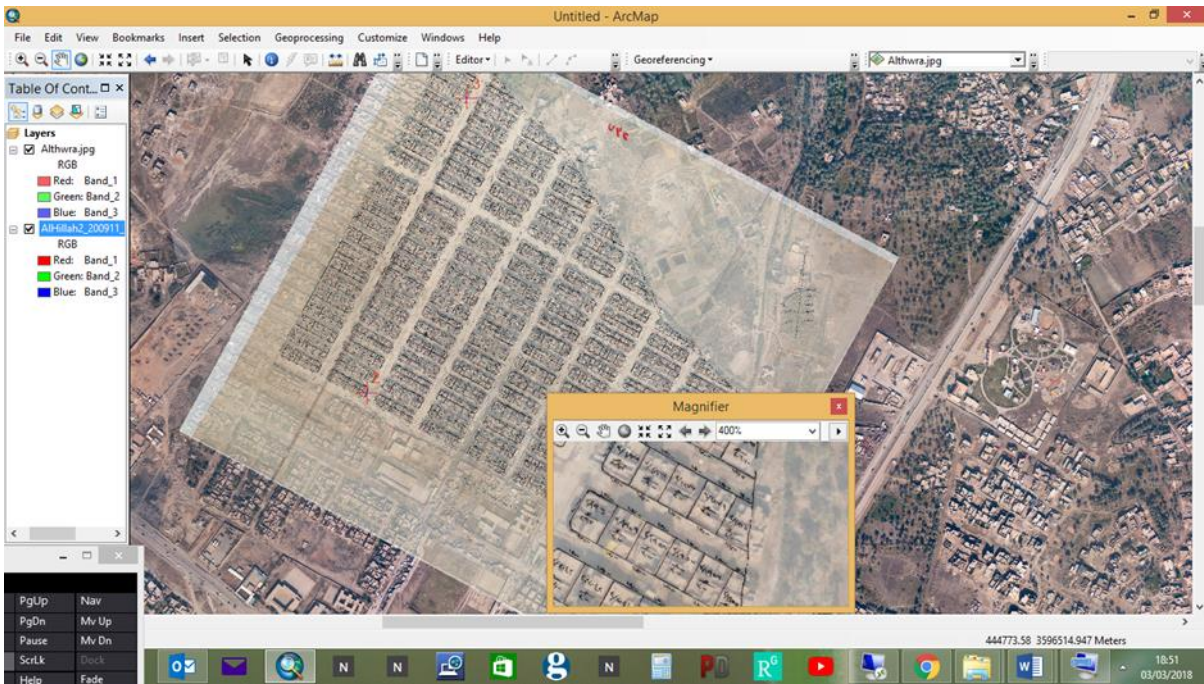


Figure 3.5 Manual georeferencing using control points

Then, the next step was to fix the transformation of the map using the rectify command on the Georeferencing toolbar in ArcMap. The rectified map can be saved in a range of formats supported by ArcMap. The next stage was to convert the rectified map from its raster format to vector format so that it could be edited by volunteers.

The Raster reclassification 3D analysis tool was used to classify the raster map cells into two classes, which were saved in TIFF format. The subsequent step was to create a line shapefile and to start editing, which led to the activation of button Generate Feature Inside Area button. Finally, the whole map was selected and a vector layer was automatically generated. The vector layer of the official cadastral map is important because it allows the boundaries of plots to be edited.

Vector layers for all nine study sites were created and uploaded to the iPad to be ready for the volunteers to edit boundaries according to the current situation on the ground. The map files were held as shapefiles and were presented on the iPad using the QGIS software. This software was mounted on the iPad to ensure that there was no need to purchase, licence and install expensive software such as ArcGIS on multiple devices for use in the field (see Figure 3.6 below).

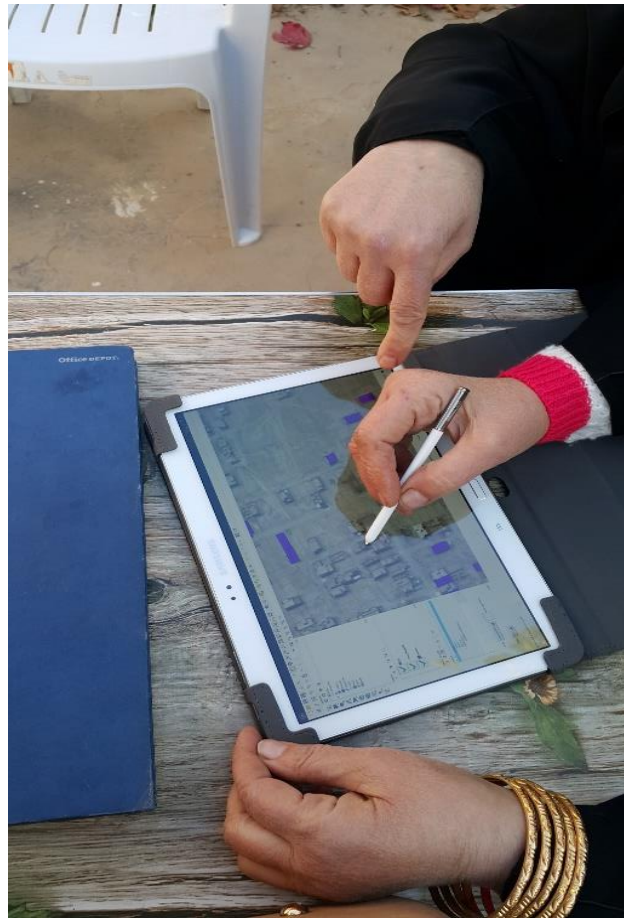


Figure 3.6 Urban volunteer women using the iPad to identify plot boundaries together with attribute data.

3.3.3 Printed aerial images

The least technical approach used was a series of printed aerial images of the study sites at 1:1500 scale which proved suitable for the identification of land parcels and key landscape or topographical features. For this method, Ultimate Maps Downloader and Global Mapper open source interfaces were used to download aerial imagery and to map the case study areas. The images were sourced from Bing Satellite Images which is free to download and use. Those images were successfully used by the volunteers to identify and demarcate the boundaries of their and others' plots (see Figure 3.7 below). This is paper-mapping so that people can annotate it in the field and at data collection meetings. The maps were printed using a large colour printer, and the quality was sufficient for people to identify their property on the images.



Figure 3.7 Urban volunteers using aerial images to identify plot boundaries together with attribute data.

3.3.4 Survey for attribute data

In addition to these tools for collecting spatial data, a questionnaire survey was developed to collect attribute data from both the trained volunteers and the participants whose knowledge was collected in more informal ways. This survey sought to collect the most current information on issues such as tenure, occupier, use, date of last land/property transaction, and registration of plot or sub-divisions. It also elicited the volunteers' personal information, such as their knowledge of the systems, personal data, information about their own plot, documentation about the study project itself, and experience of collecting VGI data for the project (see Appendix 4).

Each survey began with details of the parcel code, owner's age, gender level of education, occupation, and length of residency at the plot. This data was valuable to develop an understanding of how these factors might influence the validity of data collected or the perceptions of the plot holder regarding the current land administration system. For example, if the owner was relatively young or new, they may not have had much experience with the land administration department or system, whilst older people may have. Likewise, family names

reveal ethnic origins, which, as will be discussed in Chapter 6, can be very important in assessing the validity of data about ownership

3.4 Preparation of the contacts in Iraq

Prior to the fieldwork, a significant working relationship was established with a few senior members of the Al-Hillah land administration department who have established contact with the Municipality in Al Hillah.

Professionals within the department were very keen to be involved in the study. Most of them had many years of experience in land administration and some of them were trained at university level. Despite working hard, they often have difficulties in engaging with the public. However, they are part of the community themselves, so they have direct experience with some of the problems in land registration. The professionals offered significant assistance to this research work, and they agreed in advance to provide samples of scanned cadastral maps, aerial images and ownership documents, specifically for an initial pilot project in Iraq. The access to this data is extremely important for others undertaking VGI. However, it must be acknowledged that in many situations around the world such formal data may not be available or access to it may be restricted.

Municipal land department professionals also helped to identify suitable study sites, went with the researcher on initial visits to these sites and introduced him to community gatekeepers. These gatekeepers eventually helped the researcher develop teams of volunteers.

3.5 Data collection in the study area

This section of the chapter describes all of the different forms of data collection undertaken in Iraq, both qualitative and quantitative, with communities or with professionals. Before detailing the process of the fieldwork it is important to clarify two terms used throughout this thesis:

- **Volunteers:** The term ‘volunteers’ refers to those individuals who volunteered to collect VGI data from communities and were trained in the use of the three data collection methods of the smartphone; iPad and aerial images. They also worked with the researcher in workshops to identify valid local study sites. The study’s main aim was to understand the volunteers’ experience of using the different data collection tools and of collecting data from individuals and households.

- Participants: The term ‘participants’ refers to all other household members, community members and gatekeepers or professional individuals who took part in the study by giving their knowledge and information both about their specific plots and more generally about their understanding of the importance of land registration and engagement with the land administration system.

The fieldwork process involved a series of events as follows:

- Interviews with professionals were conducted within the Al-Hillah Municipality, primarily within the Land Administration department.
- Meetings with community gatekeepers were arranged to gain access to communities and permission to hold workshops.
- Workshops with community members were run to identify volunteers and to train them in the use of the different data collection tools.
- Data collection sessions were held in nine different study sites across urban, peri-urban and rural areas.

The fieldwork began with an initial visit in January 2016. During this visit the researcher examined several peri-urban communities. The second fieldwork session was in April 2016 and addressed urban communities and the third visit was in September 2016 examining rural communities. The fieldwork involved interviewing professionals, accessing data, engaging with the community through gatekeepers, training volunteers to capture geometric and attribute data, observing and supporting volunteers’ data collection activities, and assessing the data captured. These fieldwork tasks are discussed next in greater detail.

3.5.1 Interviewing professionals

During the first visit to Al-Hillah land administration development, January 2016 there was a key stakeholder mapping exercise was conducted with the senior surveyor. Following that, meetings were held with stakeholders within the municipality, including urban planners, surveyors and land administrators, to explain the project and to confirm their support. Then, a series of formal, semi-structured, open-ended interviews were arranged with relevant professionals according to an agreed meeting timetable. Suitable methods for recording the interviews were agreed with the professional, which were mainly voice recordings or written notes and these were acceptable for the capture of their answers. These interviews were guided by an interview format of focussed questions about the land registration procedure, costs, difficulties, and institutional capacity, what difficulties the current land administration system poses for professionals, and what the current knowledge and perceptions of VGI and fit-for-

purpose land systems are amongst land professionals in the case study area. An example of a transcribed interview with a surveyor from the Al-Hillah RERD can be found in Appendix 1.

In total, governmental institutions were involved in this stage, with a total of 31 male and female professional participants. This engagement with professionals provided data on many issues as detailed in Table 3.1 below.

Table 3.1 Characteristics of professionals who participated in the study

Government body	Number of professionals		Position
	Male	Female	
Al-Hillah land registration	6	3	Surveyors
	1	2	Employee responsible for keeping registration files
	1	0	Director of Al-Hillah land registration department
Al-Hillah Municipality	2	3	Surveyors
Al-Hillah Urban Planning Department	2	2	Surveyors employed in GIS unit
Al-Hillah Agriculture Department	3	4	Surveyors
General Directorate of Surveyor in Baghdad	2	0	Surveyors

The outcomes of those interviews were recorded interviews or annotated interview notes providing an in-depth understanding of the perceptions of professionals of the current system and of the validity of the present PhD study; the names and locations of nine field study sites (four urban, three peri-urban and two rural) identified on the map, a spreadsheet of details of communities and gatekeeper, and land registry records for use in analysis and to develop fieldwork data collection tools, including aerial images, and maps .

The land administration agency in Al-Hillah retains official records in both textual and map form. Unfortunately, there are very few records which offer up-to-date information, and the vast majority of maps were produced before 2003 and are typically hand-drawn on paper. These show parcel boundaries but little other topographic detail, and are generally limited to drainage and highways. The scale of such maps is typically 1:1,000 for urban areas and 1: 2,500 for rural areas, and the name of the surveyor and date of the survey are shown. One of the nine areas chosen had mapping produced in 1951, with others dating from the 1970s. Such documents are accurate in terms of survey detail, although attribute information such as the owner's name and land use can be hugely out-of-date, and some environments have also changed significantly.

For example, in one rural area a new irrigation scheme has radically transformed the layout and quantity of land parcels.

Unfortunately, most of the maps have no visible coordinate reference system or grid associated with them, but the availability of accurate and contemporary aerial orthophotos has allowed for the georeferencing of the maps to take place, and for comparisons to be made between coordinates collected by volunteers on the ground and the records held on official mapping. In urban areas, information about the coordinate system and an overlaid grid appear on some maps, but in peri-urban and rural areas all the maps needed to be spatially matched with georeferenced aerial orthophotos using well-chosen reference points on the imagery.

3.5.2 Gatekeepers' interviews

Gatekeepers from the selected communities were approached and the purpose and nature of the project were explained and the confidentiality of the information stressed. Then, the gatekeepers were asked about their opinions of the project and the possibility of conducting it in their community. After gaining agreement from the gatekeepers, formal interviews were conducted with them (see one transcribed interview with a gatekeeper of an urban community in Appendix 2). Then the researcher, together with the gatekeepers, walked around those communities to make initial assessments of the suitability of the site (e.g. testing the GPS signal) and randomly met residents to identify their willingness to be volunteers in such a project. A first workshop with each community was established. Within the selected communities, the process was as follows.

3.5.3 Community workshops

A series of workshops to initiate data collection were held in each community. A first community workshop was conducted in each of the selected communities. This initial workshop was to select, interview and train volunteers in each chosen study areas. The workshops were mainly held in the homes of community gatekeepers.

The process for initial selection and training workshops and for all the subsequent data collection by the volunteers is described below.

First workshop: explaining the project and identifying and training volunteers

At the initial workshops, which attracted many people, the researcher explained the project and demonstrated the use of the different methods of demarcation with the use of the GPS smartphone, iPad and tracing on the printed aerial image. Finally, a representative number of

10-15 volunteer citizens per community were recruited, varying in gender, age and educational level (see Table 3.2). Volunteers were asked to register their names and also to sign a “volunteer consent form” (see an example of a transcribed consent form in Appendix 3), and to fill in initial data about themselves to aid in the final analysis, including their gender, age, and education level.

Table 3.2 Characteristics of volunteers who mapped case study areas

	Gender		Age			Education level		
	Male	Female	<30	30-50	>50	Uneducated	School	University
Urban Communities (4 sample areas)	23 (56%)	18 (44%)	15 (37%)	19 (46%)	7 (17%)	6 (15%)	18 (44%)	17 (41%)
Peri-urban Communities (3 sample areas)	29 (78%)	8 (22%)	11 (30%)	14 (38%)	12 (32%)	10 (27%)	17 (46%)	10 (27%)
Rural Communities (2 sample areas)	27 (100%)	0 (0%)	4 (15%)	10 (37%)	13 (48)	14 (52)	9 (33%)	4 (15%)

After each workshop, the volunteers were interviewed individually about their understanding and perception of the formal or informal land registration system. They also completed a survey and collected semantic/attribute data about their own plot. This survey used a standard form for each volunteer’s land-holding collecting basic attribute data such as: owner, type of tenure, date of last transaction, land use, and date of last land use change. This exercise helped to train volunteers in how to use the survey to collect data from other households and plot-holders in their area.

Then the volunteers were asked to identify and measure their own plots by using the three different techniques which the researcher had developed as described above the smartphone with a GPS app; portable iPad tablet with the official cadastral map uploaded, and paper-printed aerial or satellite images, with clipboard and pencil for demarcation and annotation. They had been taught how to use these in advance. The main idea behind this exercise was to train the volunteers in the use of these data collection methods so that they could use them to collect data for their communities. The testing of the equipment was also undertaken at this time, and an indication gained of the utility of the data.

Then, the volunteers and the researcher studied an image or map provided by the authority to identify any change such as in the direction of a river, loss of ground cover, loss of, or arrival of buildings on the image or map provided by the authority. The purpose of this was to highlight if the images and maps used by the authority were current or out-of-date.

After this exercise, volunteers were asked to specify an area of interest (AOI) in their community for the collection of attribute and geometric data. The suggested size of the AOI for data collection was, for rural areas, 250m x 250m [maximum 100 agricultural plots], for peri-urban areas 150m x 150m [maximum 100 land parcels], and urban areas 150m x 150m [maximum 6 city blocks, perhaps including high-rise buildings]. These limitations helped to make the fieldwork manageable.

Following training and instruction, volunteers demarcated their precise data collection area of interest using the map on the iPad or the paper image. Then the researcher divided the selected area of interest into sub-areas and distributed them among the volunteers according to their preferences.

The main outputs of the initial workshops in each study location were recorded and transcribed interviews or annotated interview notes with each volunteer, geometrical data resulting from each volunteer's use of three data collection methods to identify his/her own plot, recorded and transcribed workshop/focus group activities, photographs, a list of volunteers, aerial images with the agreed AOI demarcated. Finally, the date and time for the second workshop were agreed.

Second workshop for collection of VGI data

The researcher prepared in advance for the second workshop by printing aerial images at a suitable scale of 1:5,000 for rural areas. However, a larger scale of 1: 1,500 allowed for more detailed interpretation and identification in the urban and peri-urban areas. It shows sub-divided sections of the AOI map used in the previous workshop and individual maps of each of the sub sections printed on A4 paper. The attribute data questionnaire was also printed based on the Municipality's format, GPS apps were uploaded onto the mobile smartphone, and the Tablet was loaded with cadastral maps and training instructions on the use of the technology were printed.

The second workshop in each location was mainly held for volunteers to collect VGI for each specific area of interest (AOI). Volunteers went in pairs to count and demarcate the boundaries of all plots within each sub-section of the AOI on the aerial image or cadastral map. The main purpose of this was to find the real number of plots within each sub-divided section of the AOI in comparison to the formal cadastral map and to update them according to the VGI data.

Volunteers also collected a random sample of geometrical data by demarcating the plots using the three methods of demarcation via smartphone, iPad and paper printed aerial images from up to 20% of the plots in their sub-area. Finally, the volunteers also collected a sample survey

of attribute data (e.g. owner; type of tenure; date of last transaction; land use; date of last land use change (e.g. agriculture to residential)) from up to 20% of the plots in their sub-area, which were selected randomly, using the same survey that they completed in the first workshop.

The analysis of the results of these tasks will contribute towards answering the following questions:

- How complete is VGI compared to more formally collected land data
- Which methods and data collection tools work best in different contexts and for different individuals
- How current and accurate is VGI compared to more formally collected land data.

The main output of the second workshops were data on the total number of plots within the selected AOIs, and sample surveys were collected for approximately 20% of the plots in each area with the precise demarcation of these plots. At the end of this process, the fieldwork data collection for the urban communities was completed.

Following the fieldwork process of workshops and volunteer data collection activities in each study location, the researcher contacted the community gatekeepers again to arrange with them a date and time for a verification workshop, as discussed below.

In total, nine communities were explored, with a total of 105 volunteers (79 males and 26 females) collecting data on 402 plots, as detailed in Table 3.3 below:

Table 3.3 Number of volunteers and plots in all nine selected communities

Communities		Number of volunteers		Total number of plots	Number of plots with precise demarcation and survey
		Male	Female		
Urban communities	Jawahry	6	4	356	51
	Moharbeen	5	5	381	60
	Zahawy	7	3	651	61
	Fatima	5	6	745	81
Peri-urban	Imhazim	10	3	103	17
	Mahkama	8	2	27	15
	Wardia	11	3	156	45
Rural	Dloaa	19	0	522	58
	Aries	8	0	206	14

Third workshop - Verifying collected VGI data

With the aid of the community gatekeepers, the researcher arranged a last workshop with each community. The purpose of this workshop was to verify the information that had been collected from the community. The researcher presented the VGI data to all in attendance to allow open discussion. The discussions were recorded and notes were made on the opinions of those in attendance on the reliability of the VGI data.

The same process of data workshops, training and data collection and verification was repeated for all the selected communities. However, there were some differences in data collection due to cultural and religious issues. For example, in some communities no women came forwards as volunteers. This is discussed in subsequent chapters.

3.6 Output of fieldwork

Three types of data were collected:

- Data from Interviews with professionals, volunteers and other participants
- Data from Questionnaires
- Spatial data

Each of these data types required a different form of analysis and was analysed for a different purpose as discussed below.

3.6.1 Data from interviews and workshops with professionals and volunteers

Data from interviews and workshops came from volunteers and professionals. All of the interview data was qualitative in nature. This data took the form of voice recordings of interviews and written notes from workshops and field data collection sessions. The interviews were analysed using thematic coding to highlight key issues and similarities or differences in people's responses to questions and their open discussions.

Interview data from volunteers and community households included discourse relating to the interviewees' perceptions and understandings of the land administration system and of VGI and their involvement in it. It also includes discourse from professionals relating to the current state of the LAS.

This qualitative interview data was valuable in addressing the objectives to identify the current knowledge and perceptions of VGI and fit-for-purpose land systems amongst land professionals in the case study area, and to identify barriers to professional acceptance. It also served to address the objective of identifying difficulties and limitations in the current land administration

system for professionals in a case study area, and to identify areas and tasks where VGI might be particularly valuable to professionals. Qualitative data from volunteers and communities was valuable in identifying the current knowledge among the people about the importance of registering their land, and to assess their motivation for engaging in VGI.

3.6.2 Data from questionnaire survey of volunteers and households

Data was collected using a structured questionnaire. This questionnaire was designed to collect data from participating households. However, it was originally used with volunteers during their training, as they were themselves community members. Subsequently, the same questionnaire was used with the participating community households who offered their data.

The questionnaire data collected was largely qualitative with some quantitative responses. The administration of the questionnaire began by collecting household identification data to aid in the analysis, such as plot number and respondent gender, age, and occupation). Qualitative data were then collected on the attributes of properties, including who the occupier was, their type of tenure, and what the property was used for. Quantitative data collected from the questionnaire included, for example, length of residence and date of most recent transaction.

However, although the majority of data from the questionnaire was qualitative, it was analysed both quantitatively and qualitatively. The qualitative analysis was based on thematic coding, done manually.

The quantitative analysis was undertaken using an Excel spreadsheet and it produced a statistical understanding of the percentage of people having, for example, a particular type of property or having the same opinions. This data was used to address the objectives of understanding how complete, current and accurate VGI compares to more formally collected land data, and to acknowledge the limitations and strengths of VGI and to analyse which methods and data collection tools work best in collecting spatial data in different contexts and by different individuals.

3.6.3 Spatial data

The accuracy of spatial data was analysed using a custom-designed software dashboard via which coordinate data can be input and investigated, datasets compared, and statistics of positional and directional deviations derived. This tool was developed for the purpose of testing the accuracy of multiple datasets, including VGI data, in a previous research project (Al Bakri, 2012).

The data was firstly prepared in an Excel file with 5 columns: the first (A) is the index number of the observation; columns B and C represent (X, Y) coordinate data obtained from VGI; the last two columns (D and E) represent the (X, Y) coordinate data for the identical location from official records.

The Excel data is saved as a CSV text file to be imported using a standard Matlab function. Two scripts were developed by Al Bakri (2012) employing the graphical functionality offered by Matlab, for the purpose of statistical testing and visualisation. The first script contains the functions for statistical calculations, while the second file develops the dashboard. The scripts are run within Matlab, calling the data file that contains the official and VGI coordinates that need to be compared.

Running the scripts automatically displays the dashboard. This visually shows, on the left-hand side, positional, descriptive and directional statistics. The right-hand side is divided into two, with the upper part displaying arrow vectors that represent differences between the tested datasets. The lower part shows a summary of the vector error (see Figure 3.8 below) and its mean direction and value. The use of this tool is demonstrated in Sections 6.7.3, 6.8.3 and 6.9.3 for the three selected types of urban, peri-urban and rural areas.

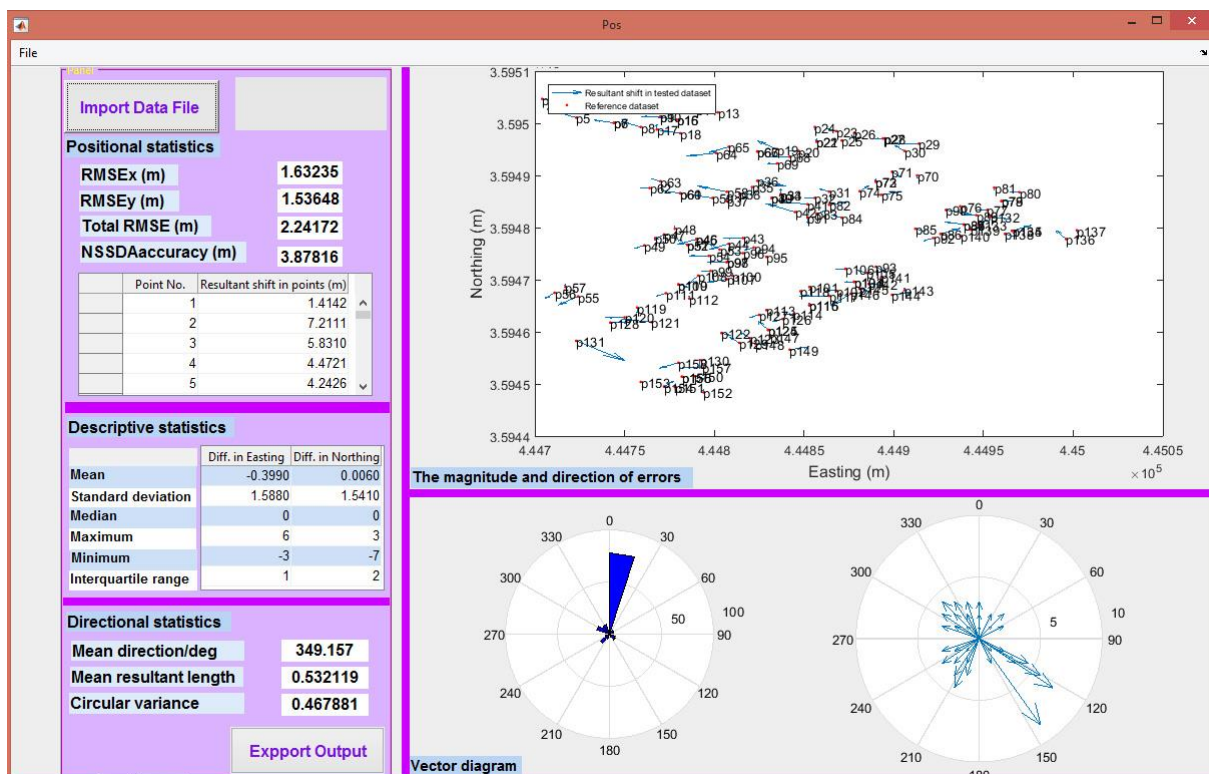


Figure 3.8 Calculation and visualization tool for RMSE (VGI points captured by Satellite image, compared to parcel coordinates from official mapping, Jawahry urban area, Al-Hillah).

3.7 Preparation of data for analysis

The preparation and analysis of the data took place in stages to produce layers of maps from both formal and VGI data: Firstly, a layering of the data was created with a multi-layered GIS mapping of the plots by uploading all the plot coordinates collected by GPS into the GIS software using a memory stick or connection cable. The other form of paper maps that had been created over satellite/aerial images or topographic maps were uploaded into the computer and then to GIS software to conduct the analysis. For this purpose, either on-screen digitizing or scanning techniques were used. The initial method is simple and can be conducted by copying manually all land boundaries previously created by the volunteers during the fieldwork directly onto the image. This method was recommended by Forrester and Cinderby (2014) as the image do not need any pre-processing and the vector layer is created directly. The second method of uploading volunteer maps into the GIS involved scanning the transparencies where the top layer on the satellite image or topographic map which shows the participatory plot demarcation. The annotations of satellite or aerial imagery or topographic maps are then digitised.

Secondly, an attribute file was created for each plot surveyed with varying types of attribute such as the name of the owner, occupant (if different), land use, and recent changes). Thirdly, the formal land administration data was uploaded. This involved whatever form of data the authority used. For example, cadastral maps, as well as formal attribute data. As described in Chapter 6, the geometric and positional data captured by VGI were tested against reference surveys, existing mapping or imagery, but the attribute data were validated by crowd-sourcing. This was because official records of ownership are confidential and could not be accessed or the sub-division had a complicated ownership structure or contemporary information was required. Further attribute data reflecting environmental changes was also recorded by the volunteers – change of river course, building demolition or construction, notifications of heritage status, or changes in land use. Such information allowed for tests of completeness and currency to be undertaken later, and comparisons made between the official records and the VGI.

3.8 Chapter summary

This chapter has detailed the approach to the research, the refining of research questions, the sampling of locations, the development of data collection tools and their use in fieldwork. It has also explained the ways in which data was gathered, what that data consisted of, how it was verified and analysed.

The designing and development of the methodology for this study has altered the researcher's understanding of what is possible in fieldwork in a stressful and challenging context such as Iraq. New skills and understanding were needed and a more robust approach to research design, data collection and analysis was developed.

A great deal was learned during the development of the methodology and data collection tools which prepared the present author for the fieldwork and analysis and, ultimately, improved his research skills more generally. Nevertheless, despite all the preparation described here, problems were encountered at several stages of the work which needed to be worked through, reflected on and accommodated in the fieldwork. From the start, war, civil unrest and insurgency delayed the final choice of study country and location. As there was some doubt that the work could be done in Iraq, other countries were considered. Many connections and contacts were made, especially in Egypt, to allow the work to take place there. This was stressful and delayed the work to a considerable degree in the early days. However, eventually the first choice of country, Iraq, was accepted. Nevertheless, the security situation in Iraq still meant that the work could have been interrupted at any point and that it may have been difficult to access and engage communities. This taught the researcher the importance of very careful planning and the need for good gatekeepers.

Considerable openness and adaptation was required once the work was underway, especially in the field. For example, from the very early stages of engaging volunteers and training them, the researcher needed to learn to adopt a different attitude to his role, accepting that, despite being a professional and studying for a PhD, he was not the expert in this situation. This adjustment helped him to manage the volunteers, to elicit their support and local knowledge, and to recognise when and how to adapt to different situations on the ground, such as the lack of female involvement in rural areas.

Although the workshops were considered carefully during the preparation, improvements in people- and data-handling became evident with each succeeding workshop. Similarly, understanding the need to engage diverse communities is not the same as knowing how to respond to and work with these communities until the work is underway. For example, it was not anticipated that the influence of cultural norms would limit women's involvement in rural areas. This was a specific challenge, but overcoming it was rewarding, and the researcher learned a great many skills in research design, data collection, management and analysis, and working in stressed contexts, which will be invaluable in his career and any further research.

Chapter 4. The social and administrative context of Iraq

4.1 Introduction - history of Iraq

This chapter presents the context of Iraq within which the research was undertaken. It begins with a brief demographic and socio-economic overview of Iraq, as issues of age, ethnicity, gender and education proved relevant to people's willingness to engage with VGI and the robustness of the data collected by or from them. It is important, therefore, that others seeking to use VGI should take account of these issues. The chapter then discusses the recent history and the wars, civil unrest and political difficulties that the country has experienced because many, if not most, of the problems of the land registration system stem from this. Finally, the chapter discusses the ways in which the land and real-estate administration systems are currently designed to work and some of their problems. This represents a basis for understanding the current inefficiency of the system as described by volunteers and participants (see Chapter 5). It also helps to understand the fact that, when working in Iraq, one is working in a country which has had many centuries of formal land management, even if the system is currently not working. In this context, when considering VGI as a tool for developing fit-for-purpose land administration (Enemark et al., 2014), the purpose is to support and improve land administration, rather than to develop a system from scratch as may be the case in some other countries.

4.2 Demographic overview of Iraq

Given the current security situation and disruption in Iraq it is impossible to provide reliable demographic information for individual cities. Therefore, this section details information for the country as a whole to give some indication of the types of people who were involved in the study. However, it also to explain how the experience of the VGI project might be transferable to other countries or cities where similar socio-economic or demographic contexts exist.

4.2.1 Age

Iraq has a very young population, with 39.4% of its citizens being 14 years or younger and only 7.45% over the age of 55 years. As will become clear in later chapters, this age distribution is both helpful and problematic. Young people were very eager to be involved and to use more technical methods of data collection. However, much community knowledge about settlements and plot boundaries is held by older people. As they die, the information will disappear with

them. Recent age statistics both for male and female Iraqis were obtained from the CIA World Factbook (2017) as presented below:

0-14 years: 39.46% (15,464,727)

15-24 years: 19.25% (7,543,562)

25-54 years: 33.84% (13,262,309)

55-64 years: 3.99% (1,565,281)

65 years and over: 3.46% (1,356,232) (2017 est.)

Although children were not officially involved in the study as volunteers, many did want to take part. It was heartening to watch older people working happily with children and discussing the work. These experiences suggest that VGI can become something which bridges generational divides, bringing entire communities together (see Figure 4.1)



Figure 4.1 Teenagers helping volunteers during VGI data collection

These statistics confirm that Iraq is a young country. This is important for this study because one of the aims was to understand what data collection tools worked best for different groups of people. As shown in Chapter 6, age did have an influence on who chose which tools, and the experiences of working with citizens from different generations are considered in Chapter 7.

4.2.2 Gender

An understanding of the gender ratio is important for VGI, as male and female volunteers approached the work slightly differently as discussed in Chapter 7. The 2016 estimated overall gender ratio in Iraq 1.02 males/females (CIA World Factbook, 2017). However, the ratio is somewhat different across the age ranges, with more women than men aged over 55 years.

0-14 years: 1.04 male/female

15-24 years: 1.04 male/female

25-54 years: 1.02 male/female

55-64 years: 0.91 male/female

65 years and over: 0.8 male/female

Gender imbalances can have an effect on property ownership across the country, in general, but may also have an impact on the selection of volunteers for the test studies undertaken in this research.

4.2.3 Education and literacy

One of the objectives of this work was to understand what methods different people could use and the validity of the data collected using those methods. For this reason, both more and less technical methods were chosen to accommodate different levels of education and literacy. Data on levels of education were not available nationally. Recent civil unrest and war means that education was interrupted for many people, and there are no reliable statistics on levels of education in Iraq. However, data from the participants showed that general levels of education are lower in rural areas than in urban areas.

For this study, therefore, it was decided to focus on levels of literacy as a marker of how well different people might be able to use more or less technical methods. In Iraq, almost 80% of the population is literate (defined as those aged 15 and over who can read and write). However, the rate differs between men at 85.7% and women at 73.7% (2015 estimate).

As Chapter 7 shows, it is important to develop tools appropriate for the specific characteristics of volunteers and other participants. It is, therefore, important to consider literacy levels, if not broader levels of education, in designing data collection tools and in the training of volunteers.

4.2.4 Ethnicity, migration and displacement

Although the people of Iraq are overwhelmingly of Arab ethnicity (75-80%), the country has several other ethnic groups. These include a Kurdish population of 15-20% and another 5% composed of people of Turkmen, Yezidi, Shabak, Kaka'i, Bedouin, Romani, Assyrian, Circassian, Sabaeen-Mandaean and Persian origins (CIA World Factbook, 2017).

Iraqis are largely an urban population (69.7% of the total population in 2017). Importantly the rate of urbanization is almost 3%. Much of this change has been driven by migration and

internal displacement. Many were displaced by the US invasion in 2003. However, following the fall of Saddam Hussain, and the emergence of several insurgent or militia groups, many more fled their cities for security reasons. The Refugees International organisation suggests that the country has one of the worst displacement crises in the world with over 5 million Iraqis displaced of whom 2.7 million have been internally displaced (Stigall, 2013). This displacement has led to the proliferation of informal, unregistered settlements in and around Al-Hillah and other cities, meaning that the formal land registry is overwhelmed by many new plots and dwellings. Displacement also helps to set up an environment of fear and suspicion within which the work had to be undertaken, which undoubtedly influenced what information people were prepared to disclose, as shown in Chapter 6.

It is also useful to consider tribalism in terms of ethnicity, as many land disputes, and particularly those in rural areas, have traditionally been dealt with by tribal leaders. In Iraq, the term 'tribe' can be thought of as a very large extended family. A town or city may have several 'tribes' within it. In Al-Hillah, for example there are about 25 tribes. In many if not most cases, members of a tribe will live in close proximity to each other. Therefore, entire areas of a town or village will 'belong' to one tribe. The tribal elders will often be approached about land issues, even before the authorities are consulted.

4.3 Recent political history

The politics of Saddam Husain and the Baathist party were dominant for many years from 1968 to 2003. Under this domination, some areas were kept short of resources and some ethnicities were exiled, restricted to particular areas, or killed. The Gulf War of 1990-91 was brought about when the Iraqi military invaded Kuwait in 1990. Following the liberation of Kuwait in April the following year there were many anti-Hussain protests and uprisings as well as atrocities against ethnic minorities, including the slaughter of many Kurdish people and Marsh Arabs. These and other subsequent ethnic clashes are pertinent to this work, as they have led to an environment of suspicion and fear around disclosing religious and ethnic origins, seen in Chapter 7

Subsequently, a combination of factors, including a desire for regime change and the fear that Hussain had stockpiled weapons of mass destruction, prompted the US invasion of Iraq on March 20th 2003 (Guo et al., 2015). The invasion ultimately removed Hussain from power but left a void which was quickly filled by conflicting opposition parties and para-military groups. This led to a protracted period of civil unrest and political and economic instability which continued with the arrival of the Islamic State group.

The resulting civil conflict, unrest and fear have left an administrative system in chaos and a population who are fearful and suspicious. Many millions of people have fled the country or were displaced internally, having left their homes to avoid conflict. Internal migration has led to people flocking to cities which are unable to accommodate or house them. Some people squat on vacant land, while others have taken possession of houses abandoned by others who have themselves fled to other parts of the country or, indeed, been killed in the wars. It is against this backdrop that this chapter now tries to explain the way in which the land administration system is intended to operate, and to identify the major problems with the system.

4.4 Land administration in Iraq

Iraq has a long history of formal land administration. However, the formal systems have frequently been manipulated to serve the needs of the ruling party, which generally diminished the people's land rights. For example, a year after the British occupation of Iraq in 1917, Declaration No. 15 (1918) was announced by the Commanding General, which stated that the people who have title deeds for their possessions of *Ameriya* (State) lands are considered to be tenants of these lands and not owners as had previously been the case (USAID, 2005). Institutions were to be established to examine those title deeds. Simultaneously, the lands were distributed by the British authority to some feudalists and tribal leaders who had supported the British occupation. However, the British Government, under their mandate, realized the necessity for clear land registration and created Proclamation Number 24 in 1920. Two directorates for land registration in Babylon and Diyala provinces were established under this declaration. Other directorates were to be established; however, after the Iraq uprising of 1920 broke out these were abandoned. Thereafter, the Iraqi Government began to play a role in this process of land allocation and administration.

However, even under the control of an independent Iraqi Government, the land administration system has been manipulated and has been unfair to many people. For that reason, the next sections now explore land administration, firstly prior to the fall of Saddam Hussain in 2003 and secondly during the more recent years of the new Iraqi government.

4.4.1 Land registration problems under the Baathist regime (before 2003)

During the Hussain regime many people were forced out of Iraq, or out of their original cities as internally displaced people, and their land was taken by other citizens illegally or given to them by the state. An example of the forced eviction policy was conducted against thousands of those who are known as the *Tabaiya*, people of Persian origin who have lived in Iraq for

generations and who speak Arabic. These people were accused of supporting Iran during the Iran-Iraq war in the 1980s. After eviction their properties were sold cheaply, mainly to those supporting the Ba'athists, who later resold them at a profit. These ethnic Persians were found in many cities, but mostly in the south near Karbala, Najaf, Al-Hillah, and, to some extent, in what is now known Sadr City District in Baghdad. Since the USA war in 2003, many of those expelled have returned to reclaim their homes and land (USAID, 2005).

Another example of internal displacement can be seen in the policy of "Arabization". This forced non-Arab inhabitants, mainly Assyrians, Kurds, and Turkmen, to leave their cities, mainly Kirkuk and surrounding areas, replacing them with Arabic people from different Iraqi cities. This aimed to reinforce the control of the Baathist regime over the oil fields and large tracts of fertile land in those areas (Isser and Van der Auweraert, 2009).

The previous regime distributed many of the country's lands to enrich Ba'ath Party loyalists, especially before the USA invasion. These distributions were accomplished in a hurry, causing great stress for the land administration officers who had to prepare ownership documents for the government's land so as to satisfy the need of Baath supporters. Much of the work was undertaken even without proper surveys of the land, which then caused many problems after the fall of the regime. Nevertheless, despite its misuse by government, in many ways the land administration system was working well, at least for the Government, because the regime was strong and nobody would dare to break the law, or conduct development illegally, at that time.

4.4.2 Land registration problems after 2003

The year 2003 saw the fall of the Baathist party and the start of the US-led occupation of Iraq. After the fall of the Baathist regime, many problems started to appear. Some of those problems were inherited from the previous regime while others appeared due to the new Iraqi Government's inability, or unwillingness, to address the malfunctioning land registration system. Some of the issues with the system are discussed below.

The post-war forced displacement from property was mainly caused when those displaced by the previous regime returned and reclaimed their land and property. For example, the returning Kurds who had been exiled by the Baathist regime expelled tens of thousands of Arab settlers, who had lived on the land for decades. Some of these Arab settlers were new property buyers or owners who had no knowledge of the plight of the Kurds and, therefore, no expectation that they would ever be displaced themselves. For example, in Khanaqin, 54,000 Arab settlers were expelled from 2003 onwards.

A period of further displacement resulted from sectarian violence. This started in February 2006

after the bombing of the Al-Askari mosque, a famous mosque for Shias Muslims located in the Saladin Governorate (Isser and Van der Auweraert, 2009). After this incident, sectarian violence increased rapidly and became uncontrollable. Following that a new wave of forced displacement happened, mostly in the areas near Baghdad in which lived a mixture of Shia and Sunni inhabitants. Accordingly, around one and half million Iraqi had become displaced by late 2007 (Isser and Van der Auweraert, 2009). Displacement resulting from the rise of Daesh (ISIS) occurred in the latest period of displacement, starting a few years ago and continuing until now. This happened when the terrorist group, ISIS, attacked and took violent control of several cities in the north-west of Iraq including, Mosul, Ramadi, Tikrit and Fallujah. This is seen as responsible for the highest levels of displacement in Iraq, both internally to different Iraqi cities and externally to different countries. This piled further pressure on a land administration system which is unable to secure people's properties in ISIS-occupied cities or to provide temporary dwellings for migrant people. During the course of this PhD, progress has been made in defeating ISIS and recapturing lands.

The phenomenon of rigging title deeds and falsely changing the ownership of the land appeared as a result of the multiple problems facing the post-war regime, including the loss of records during the war, general lawlessness, lack of resources and the poor state of the existing paper based system. This happened especially in relation to lands that belonged to members of the Baathist party who fled the city or country after the fall of the regime. It also affected the lands of those internally displaced people who had fled to safety. It has caused many problems for the government's land administration system which has established a new and more complicated policy to address the problem. The seizing of public buildings also began to appear after the fall of the previous regime. People without houses or displaced families appropriated many public buildings and changed them into their living spaces. For example, Salhiya, a famous area in the centre of Baghdad used to house senior army officers from Saddam's Republican Guard, but is now currently occupied by homeless families and individuals (Isser and Van der Auweraert, 2009). Some people have occupied public land and built their own houses on it, thus violating the rules of any effective formal land registration system (USAID, 2005), and making it difficult for any previous formal land use plans to be implemented.

Infringement on orchards and the use of agricultural land within cities increased rapidly after the fall of the previous regime. This was encouraged by the financial benefits derived from the exploitation of these areas for residential rather than agricultural purposes. This fragmentation led to the unplanned development of cities, decreases in green zones, and the inability of the government to provide services such as sanitation (Istabraq et al., 2016).

Subdividing single plots into a few sub-plots has become common. The main reason for this is the shortage of housing in Iraq, that was estimated by the United Nations and the World Bank to be about 3 million housing units (Shaikley, 2013). Parcels believed by the authorities to be a single plot have very often actually been sub-divided into several or many small plots with very small area and complex ownership structures.

From all these problems, we can say that the formal land administration system cannot cope with the different waves of displacements that resulted from previous regime's eviction policy, sectarian violence and the control of ISIS. A further issue is that a land administration system may be out-of-date and it may change when a new Government comes in, which has an effect on policy but also on the working methods used. Therefore, it is proposed that the engagement of the community and their participation in the land administration system can address these and other problems.

4.5 The current formal land registration system

The land registration system, known as 'Tapu' until 1974, was derived from Ottoman law related to the permanent transfer of state-owned land to farmers. The ownership document was called the Permanent Title, which is a hand-written copy of the original registration document that was saved in the Tapu system. In 1974, the old Ottoman permanent Title Deed was replaced by a new Real Estate Registration Law. However, the same original record book documents were saved in the registration offices and the hand-written copies given to owners as the only proof of ownership.

The main information recorded on the Title Deed document includes the full name of the owner or owners, the property category or use (agriculture, residential, plot of land, industrial and commercial) and the property type which is divided into three kinds:

- 1 Public estate, which belong to the state and are divided into two kinds: (a) governmental estates which entrusted to the Real Estate Registration Department (RERD) and (b) properties given by Allzimh, which are agricultural land that belongs to the government but where the individual has the right of cultivation. In both types of ownership this asserted that the government is a partner-owner with the individual granted some degree or period of use.

- 2 Private estates, which are estates, land or properties that are owned by individual private owners whose names are registered in the Title Deed documents with no other partner.

3 Inheritance property, which is property registered and protected by the Endowment Department until such time as the inheritor is able to take ownership.

In some cases, the owner of private land makes a contract with a person who would like to construct a building on his land. Both the owner and investor agree on a specific period for the contract, and at the end of the contract the building will be given to the owner of the land. This type of agreement is known as “Al Mosataha” and the building should be registered at the land registration department.

4.5.1 The process of transferring plots

In Iraq the procedure for buying or selling plots is the same in all cities (USAID, 2005). Both the buyer and the seller go together to the Real Estate Registration Department (RERD). The seller proves his legal ownership to the plot by presenting the Title Deed document. The RERD office examines the real estate file and its registry to assure that the plot belongs to the seller and is unencumbered by any loan or mortgage. The sell-buy process will not happen if the plot is sequestered or mortgaged.

Then, the seller will be given a sales application form (*Fath Bayan*) to be completed by all parties concerned (see the application form in Figure 4.3). This form is provided with a charge made by the RERD, where information about the seller, buyer, property, and type of transaction (sale, purchase, donation, etc.) is recorded in order to complete the transaction of sale until the property is registered in the name of the new owner. Then, this form needs to be submitted to the RERD to be checked by a specialist professional, familiar with the relevant plot location. If all of the information above is found to be correct, the process continues.

The next step is to verify the identity (ID) card of the seller by sending the application file from the RERD to the local Department of Civil Affairs, which is the government department that is responsible for the identification cards of Iraqi citizens. All personal information included in the ID card is checked, including the name of the person, hair and eye colour, complexion, any identifying marks, mother’s and father’s names, last name, date and place of birth, marital status, and a personal photo. The name of the wife or husband should be included as well. Any change in marital status is also registered in the ID card (i.e., married, divorced, or widowed).

Next, the category of the real estate being sold (land, house, building, etc.) and the land use type (residential, industrial, etc.) should be confirmed by the Monitoring Committee (comprising engineers and surveyors). Subsequently, an evaluation of the plot is performed. This step can be avoided if the transaction is between a willing seller and buyer who both agree

on the price. In such a situation the value is set according to their agreement. However, an evaluation by the committee is obligatory if there is any legal restriction on the real estate, such as a mortgage or inheritance. The evaluation committee consists of a specialist who is not an employee of the RERD and a judge from the Civil Court. The specialist might be an engineer or a mediator with good experience who is considered to be trustworthy by the court. Sometimes the committee may include representatives from both parties to the legal issue.

The selling application form has to be signed by the seller and buyer, after filling in all the personal information from the official ID cards (civil identity card, Iraqi nationality card). The signatures and official papers are verified against those submitted previously by the specialized deputy of the RERD.

If the real estate is valued at more than 20 million Iraqi dinars (approximately 10000 pounds), all documents associated with the process are sent to the local General Taxes Department in the area where the plot is situated for approval. Approval is obtained if there are no tax liens owed on the property. After this check, the Department of General Taxes has to stamp the application to prove that there are no outstanding taxes.

The final step in this process is conducted at the local Municipal Directorate in the area where the property is situated. This directorate also checks the process. Consequently, the transfer has to be ratified by three official bodies. If the property is estimated to be worth less than 20 million Iraqi dinars, then the Department of General Taxes may not be involved.

The procedure at the land registration office is finished when the tax for the “Transfer of Ownership of Immovable Property is paid”. Then, both the buyer and sales have to sign the selling form, which the specialized deputy and the employee in charge of registration must also sign. The application is registered at the Permanent Land Registry, where the buyer and seller also have to sign. The Monitoring Committee of engineers and surveyors then confirms that everything has been performed legally and no steps have been omitted. After obtaining the committee’s decision, a new Title Deed can be created certifying that the named buyer has become the legal owner of the property. A copy of this registration is sent back to the Monitoring Committee to be examined, for them to confirm that the registration is correct and legal. A stamp from this committee is also needed on the application and its registration form and these documents are sent to the General Land Registry and a second copy of the originals is made. If the Monitoring Committee discovers any error or deficiency in these documents, they are sent back to the branch to be corrected (see process diagram in Figure 4.2 below).

The sell-buy process is a long and rather complex procedure that takes place at the RERD and this deters some people from doing it legally. It is also considered to be costly, because the transaction includes notary, registration, survey, and property transfer fees (USAID, 2005).

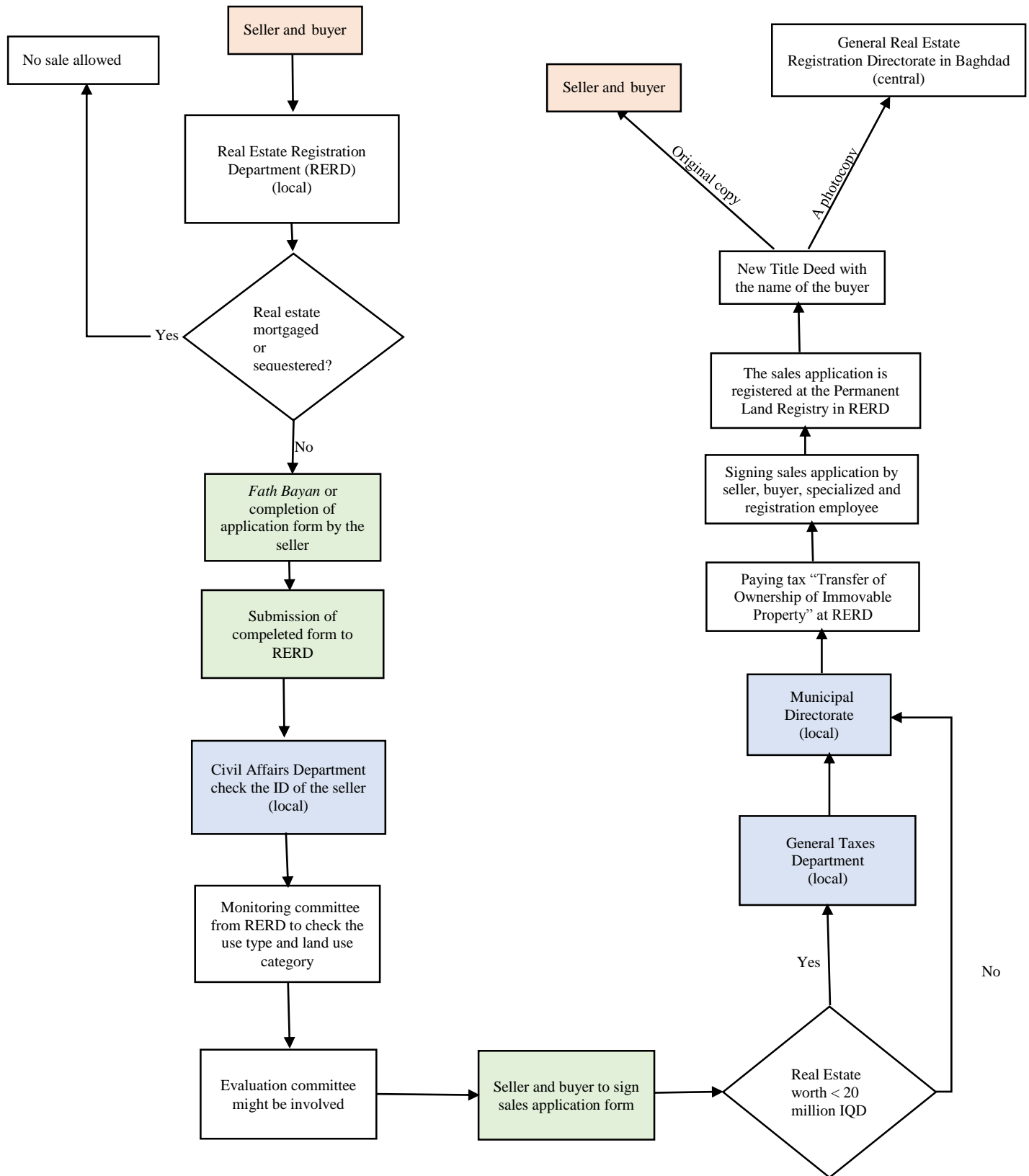


Figure 4.2 The process of transferring plots

The Republic of Iraq									
The Ministry of Justice Real Estate Registration Land Registration / Hillah									
Description of the Current Permanent Real Estate Registration			Governorate	District (Qada')	Sub-district (Nahiya)	Street	Floor no.	Apartment no.	
No.	Date	Cover no.							
Description of the Permanent Real Estate Registration transferred from			Real Estate order	Quarter	Door no.	Plot no.	Province no.	Province name	
No.	Date	Cover no.							
The owner or the authorized person instead and his origin:							Real Estate Category:		
							Additional Residential Buildings		
<i>Borders</i> North East: North West: South East: South West:							Type of Real Estate		
							Easement rights:		
Area	Sq. meter	Owlk (Measurement unit)	Dunam (1000 m ²)	Title deed type		Description of the Permanent Real Estate Registry transferred to			
						No	Date	Cover no.	
Type of the Registration and its Documents:						Signs of sequential assurances and registry locations:			
The real price		The actual money paid		The sum of money under taxation		This is a photocopy of the real estate registration issued according to a request from..... The tax money that is.....is paid according to taxes registry no.....dated..... Signature..... Head of Directory signature..... Employee name and signature..... The Real Estate Directory Registration Date:			
ID	Iraqi cent	ID	Iraqi cent	ID	Iraqi cent				
Official Stamp									

Figure 4.3 Translated reproduction of sample Application Form of the Permanent Real Estate Registry (USAID, 2005 p22)

4.5.2 Changing the use of a property

Alteration in a property's use category are determined by laws and regulations issued by the Ministry of Municipalities and Public Works (MMPW) and the local Municipality Directorate. For example, if the *Amanat* (Baghdad Mayoralty), designates a street as commercial, a residential real estate owner there may apply to change the category of his property to commercial use.

The procedure for such a change is fully described by USAID (2005) as follows:

- “The owner applies to the local Municipal Directorate in the appropriate region, asking its approval for the category change.
- A committee from the *Amanat* (usually consisting of an engineer and a surveyor) is established to examine the real estate and to determine whether or not the application is legitimate.
- After the committee approves the application, it is sent back to the *Amanat* through the local Municipal Directorate.
- The *Amanat* requests that the Real Estate Registration Office should ensure that the Title Deed is legitimate.
- A private engineering firm deemed reliable by the *Amanat* designs a set of new commercial building sketches. If the sketches are approved as suitable for the relevant conditions, then an examining committee (again, consisting of engineers and surveyors) is established.
- Approval from the Water and Electricity Departments must be obtained to confirm the adequacy of the new building.
- A certificate from the Tax Directorate should be obtained to confirm that the property is not mortgaged or sequestered.
- Approval from the Ministry of Municipality and Public Works (MMPW) is needed to confirm soil analysis and groundwater adequacy (see the process of changing land use property in Figure 4.4). The following form is used to apply for new construction or to change the usage category of a property” (see Figure 4.5).

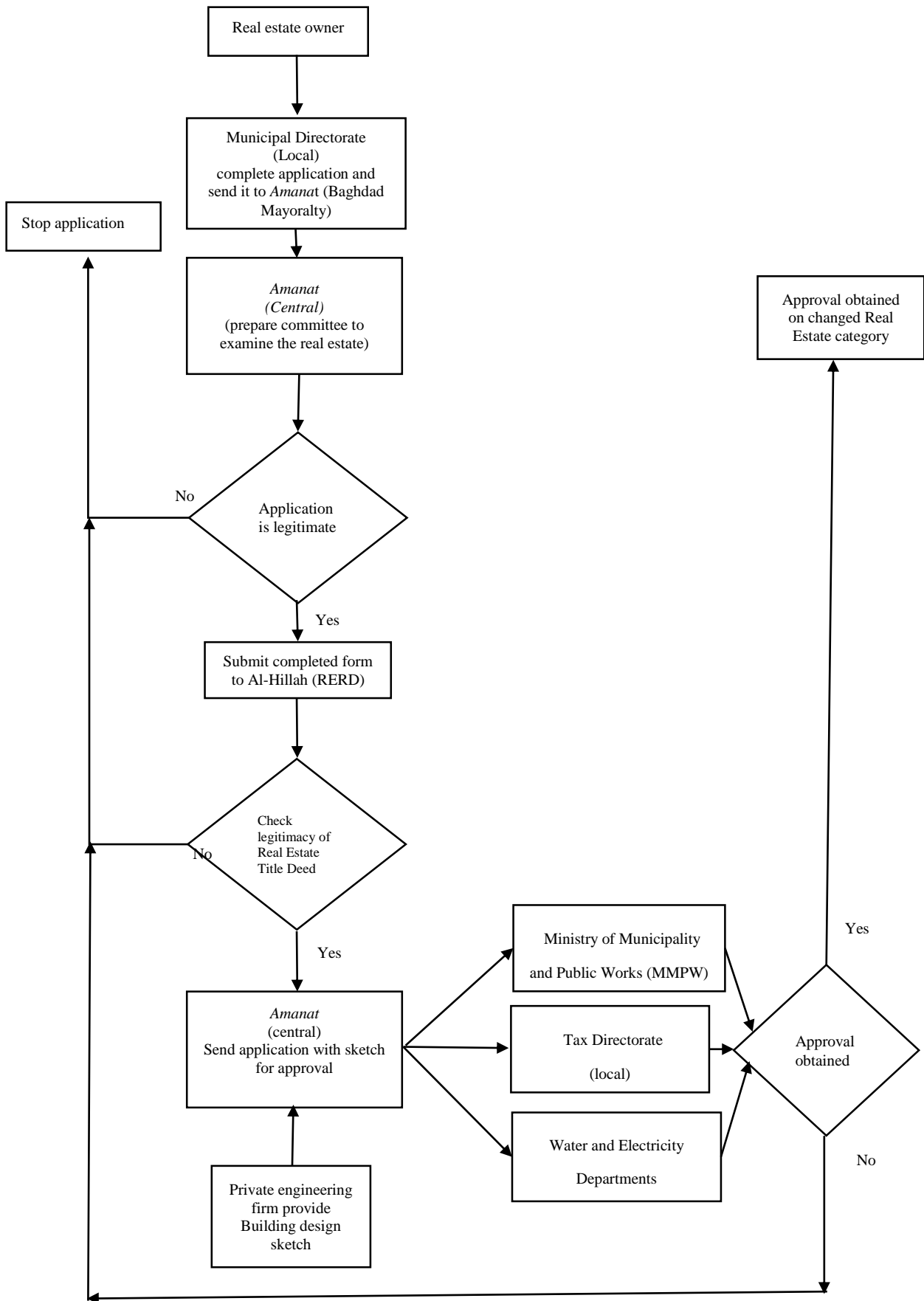


Figure 4.4 Changing the use of a property

The Republic of Iraq
A Building License

Amanat

Central Statistics Institution

Municipality Unit- 7th April

Central Statistics Directory

1. Governorate	2. District	3. Sub-district		
4. Full name of the license ownership				
5. Address of the license ownership				Mobile no.:
Name of engineer or architect ID no.: Address:				
a.				
b.				
c.				
6. Sketch details:	No. of bill	Date	Iraqi cent	Iraqi dinar
a. Building sketch				
b. Pavement sketch				
c. Stamp tax				
d. Parking tax				
e. Additional building tax				
f. Sidewalk occupancy tax				
g. Others				
7. Taxes are paid, Signature				
Accountant Signature				
8. The real estate relation to resolution no. (37)		9. The license is renewed and money in the amount of		
Altered	was paid according to the bill no.....		
Not altered		Dated.....		
Employee in charge of resolution (37)		Accountant		
		Engineer in charge of licenses		
10. No. of the real estate:				
11. No. of the property: District no. Street no.: Building no.:				
12. Use:		13. I have given the measurements and at the location just with the starting of the project.		
Signature				
Geometrical drawer				

		Signature Surveyor	
14. Type of building and use: 1) new building, 2) building addition, 3) building alteration, 4) repair, 5) fence, 6) reconstruction, 7) a house, 8) a residential building, 9) commercial shops, 10) a factory, 11) classified hotel, 12) a commercial building, 13) a workshop, 14) official buildings, 15) others Building material: 16) brick, 17) block, 18) Thermostone, 19) stone, 20) others			
15. Area of the real estate	Built area		Fence length
16. No. of floors	No. of apartments	No. of rooms	No. of shops
17. Title Deed no.:		18. No. of the Real Estate Registration sketch:	
19. Text of the license: Pulling down a part of the house. Reconstructing a building of two floors. The ground floor is for shops no.....The first floor is for commercial offices no.....with a guard room. Additional building to the original house with a room behind the house. The real estate has been built since 1969 according to the General Taxes Institution certificate no..... Dated.....It has the order of occupancy for 6 months starting fromto.....with the approval of the communication directorate, and water, and electricity according to certificates no.....dated.....			
License no.:		License Date:	
Signature: Licensed Engineer Engineering Department Deputy Unit Manager			

Figure 4.5 Translated reproduction of sample Application Form for new construction or to change the usage category of a property (USAID, 2005 p13)

4.6 Chapter summary

This chapter has highlighted a number of issues relating to Iraq and its recent history which have proved important to this research and which have helped to determine the nature of the data collected and the ease of undertaking VGI. The relevance of these issues will become clear in later chapters (especially Chapters 5, 6 and 7). Importantly, the way in which these demographic and political issues have influenced this work highlights why it is vital that anyone undertaking VGI projects should ensure that the approach and data collection methods are designed for the specific context.

A full account of these issues is important for this research in three ways. First, it has helped to explain the motivation for this study. An understanding of these issues convinced the researcher of the importance of maintaining formal tenure systems for the world's poorer people, and particularly for Iraq where recent wars have left the formal system broken so that citizens are unable to secure land rights. Also, because cost and time are barriers to registering land, this work seeks to establish that VGI can offer a low-cost, inclusive approach to updating existing records. The research seeks to understand how to make the formal land administration system more efficient and for it to meet the needs of the community, thus making the system more fit-for-purpose. Third, there is a need to constantly maintain the completeness of attribute data, including the highly detailed information collected on the forms shown as well as spatial data, and this is a valuable focus of this research.

Chapter 5. Knowledge and experiences of and issues with the current Iraqi land administration system

5.1 Introduction

This chapter draws on the qualitative and quantitative data gathered from interviews and questionnaires conducted with the volunteers and professionals who participated in the study. It explores the volunteers' levels of knowledge of, and concerns about, the current land administration system and their experiences of it. It also presents data and discussion on the volunteers' motivation to take part in the study. In doing so it supports the work in two ways.

Firstly, this chapter helps to address research questions that are linked to the study's objectives, such as '*What difficulties does the current land administration system pose for professionals in a case study area*' and '*What is the current knowledge of the people about the registering their land*'. By bringing together the concerns of the professionals and volunteers it presents a picture of the land administration system in Iraq within the current security and financial context. This is in itself valuable, since similar difficulties are being experienced around the world. It can also be seen that there is a shared awareness and agreement about the problems of the land administration system.

Secondly, by highlighting how the volunteers experienced the current system and the problems they have identified, the findings of this chapter help to justify the need to extend, enhance, and improve the methods of data collection used, whether employing VGI or other approaches, in order to supplement and validate formal land registration systems.

5.2 Engaging with land professionals

One of the earliest activities in the fieldwork was to interview land professionals to ascertain their understanding of VGI and their perceptions of the current land administration system in Al-Hillah. This section details their responses to questions regarding their daily work.

Interviews began by asking professional surveyors in Al-Hillah how much land they could survey in order to understand the limitations in capturing data in the field. The majority of interviewees claimed that they were able to survey an average of 3 to 4 parcels per day in the urban or peri-urban areas. However, in the rural areas the figure was less because of the long distances to travel and the more encountered problems in extensive agricultural areas. Surveyors were asked about the methods they used to identify boundaries. They responded that they commonly used a measuring tape to set the boundaries of individual parcels in urban and

peri-urban communities. However, for rural communities they usually used a GPS to identify land parcel boundaries. Initial survey of a complete block of plots is done by municipality surveyors using theodolites and total stations. For dividing the block into small plots, by the RERD surveyors, the measuring tape was adequate. The majority of the surveyors indicated that the time needed to fix the boundary of a single parcel, using a tape measure or GPS, varied depending on the location of the parcel, the nature of the surrounding area, and the surveyor's familiarity with the district. On average fixing the boundaries of one land parcel takes an hour in the urban and peri-urban communities, with a longer time needed for rural area.

It was clear from the interviews that the professionals faced many difficulties. For example, surveyors claimed that the tapes not so accurate in the Iraqi environment; specifically, because plastic tapes may increase in length in high temperatures during the summer. Further, the RERD surveyors explained that they experienced difficulties when fixing boundaries of a single land parcel if the outer boundaries of the whole block (Thaia) are not surveyed accurately by the municipality surveyors.

The expansion of illegal settlements also caused problems for RERD surveyors. After the surveyors have mapped a settlement, the government may decide to change its use from agricultural to residential. Surveyors are sent to check and map the area and map any illegal plots. However, after dividing the area into small plots and registering them to new owners, when the surveyors then go to fix the boundaries of each single parcel, in some cases they find that an illegal settler had occupied plots and built on them.

More generally, surveyors claimed that the main problems in their land administration system are the lack of resources; the old way of storing of data in paper archives; shortage of surveyors, out-of-date maps, increased illegal occupancy of land due to the human displacement; and forgeries in title deed documents. The consensus among professionals was that there was an urgent need for a robust procedure to control illegal occupancy of government and private land and to control sub-divisions, and to update land owner data, as well as for better data storage.

The majority of the surveyors knew about VGI but they did not use it because they thought that people would not do volunteer work, or if they did that they would not be accurate or able to collect geometrical or attribute data. Furthermore, they felt that people would give false information about boundaries and ownership which would cause serious problems. However, the professionals suggested that if the information given by volunteers is agreed by the community or verified, it might be valuable for the system. Interestingly, they already used a kind of VGI to check with neighbours on the claimed ownership: professionals are willing to

interview land owners about the claims of neighbours where official information is lacking due to loss of records during periods of war or civil unrest.

5.3 Volunteers' knowledge and experience of the land administration system

Work with the volunteers began by trying to understand how much involvement people had with the land administration department, what they believed their levels of knowledge were and whether such knowledge differed in varying locations. This is important as differing levels of understanding may influence the willingness and ability of volunteers to engage with VGI and may also affect the authority's willingness to accept VGI data.

Participants were asked if they had personal experience of registering land with the authorities. The results show that in urban communities 59% and in peri-urban communities 62% of interviewees had experience of formally registering land, while only 33% of those in rural communities had experience of land registration.

This may be because the land market is more active in urban and peri-urban areas and, thus, people who live in those areas are more frequent visitors to the land administration office than the people who live far from the centre. An alternative reason might be the effect on rural residential transactions of the tribal land system, which is much stronger than the official one. The higher levels of education in urban and peri-urban areas may also play a part.

It is difficult to verify the accuracy of volunteers' knowledge and understanding about the land administration system, mainly because the system itself is in such disarray and formal statistics from the system do not necessarily present a true picture. However, as a proxy participants were asked *'Do you know how much of the land in this settlement is formally registered with the Municipality and how do you know'* The results are shown in the table below, although the answers to the second part of this question were not standardised or suitable for summarising.

Table 5.1 Percentage of land that has formally been registered with the municipality according to the volunteers' views across the three different area types

Communities	All	Most	> Half	Little	None	Don't know
Urban	5%	15%	53%	0%	0%	27%
Peri-urban	0%	11%	70%	3%	0%	16%
Rural	6%	0%	15%	68%	0%	11%

The results show that the majority of the volunteers interviewed in urban (53%) and peri-urban (70%) areas believed that the proportion of land formally registered with the land administration system was just over half. However, the majority of volunteers in the rural communities (68%)

claimed that only a little of the land in their settlements was formally registered. However, this does not mean that they are correct. The differences between what these people believe and the picture presented by the formal system's data and professionals are discussed in Chapter 6.

Across all three communities, the percentage of people who admitted that they didn't know was different. Interestingly, as levels of education increased (in urban and peri-urban areas) people were more willing to admit that they didn't know. This could be important for VGI, as it will influence the validity of data. Where people are less willing to admit lack of knowledge, they may be more inclined to 'invent' an answer (Lynch, 2000). From above the results, we can see that the majority of people concluded that the official system does not cover all the parcels.

The degree to which the volunteers have been involved with the formal land registry is important, as it helps us to understand what their perceptions are based on. It particularly underpins later discussions about volunteers' confidence in the formal system. The participants were asked '*Have you had any experience of registering land with the authority?*' As Table 5.2 shows, across all three area types, only just over 50% of all respondents had personal experience of registering land with the authority.

Table 5.2 Percentage of participants who have experience in registering land with the authorities against others who have not

Communities	Yes	No
Urban	59%	41%
Peri-urban	62%	38%
Rural	33%	67%
Total	~50%	~50%

However, the responses differed between areas. In peri-urban areas 62% of people did have personal experience and only 38% did not, while that ratio was reversed in rural areas, with only 33% having experience and 67% not. This is important because differing levels of real experience begin to hint at where public perceptions may be based on greater knowledge and also where there may be stronger willingness to become involved with citizen-led approaches.

5.4 Perceived problems of the land administration system

Regardless of the level of personal experience, participants did have strong opinions about the current state of land administration in Al-Hillah, identifying several problems. Those problems are explored in the following section. Where possible, the perceptions of the volunteers were validated through discussions with the land administration professionals or by the researcher's own personal investigations through the analysis of social media, videos, and newspaper

reports. Along with agreement on some fundamental problems in land administration, in some cases there were varying opinions about the issues presented in this section.

5.4.1 Inefficient map storage.

Much land administration data was lost during the Gulf Wars and in subsequent civil unrest, as has been noted in other countries (Zevenbergen, de Vries, and Bennett, 2015). Notwithstanding war damage, even basic secure storage for records and maps is lacking, as shown in the photographs in Figure 5.1 below of the land registration office in Al-Hillah.



Figure 5.1 Examples of map and file storage in the Al-Hillah land administration office

On many occasions, the land administration departments have lost documents of the landowners. This problem causes delays in development and transactions, and was cited by more than one volunteer in the community. On this matter, one volunteer said that:

“I went to transfer the ownership of my land to the buyer. After completing the long routine procedure, they informed me that my documents were lost and I do need to wait until they search for them or they ask for them from the General Directorate for recording real estate which also needs a long time for such a procedure”.

Another householder noted that:

“From my previous experience with the land administration system a few years ago, I visited the land registration system to change the category of my parcel. However, I was shocked when I saw that the file was full of dust and in a very bad condition and a few papers were lost which they said they would search for. I was very depressed and angry because some documents were lost in a place where we expected them to be safe”

A report from the Al-Nazaha committee, which is an independent governmental committee responsible for monitoring and reporting on public integrity and corruption, has revealed that

the situation of missing registration books and ownership documents has become worse and needs an urgent solution. The committee also noted that, when documents are submitted, the receiving officer often does not sign for them and there is no way to trace the employee responsible for amending them. In the case of retirement or changes in of position among employees, it becomes very difficult to trace the person who has dealt with lost ownership documents and enquiries (Al-Nazaha, 2016).

The researcher asked an employee who is responsible for storing the records and files of land owners in Al-Hillah land administration system about the loss of some landowners' documents. She admitted that this situation happens frequently because of high workloads and old-fashioned document storage. In some cases, they will need to ask the owners to re-submit the land transaction documentation, including the owner's own copy of the Title Deed, or to ask the central Land Registry Directorate in Baghdad for replacement documents. This is a cause of much delay in the process. She suggested that:

“To solve such problems, we need either to computerize all of whole land registration records and make it easier for us and faster for the landowners or we simply need more lockers to store the owners' documents properly”.

Both the volunteers and the land administration officers felt that a system in such disarray is very difficult to update, vulnerable to corruption, very slow and requires more effort from the professionals who work on it. Importantly, this was felt to be one reason for some landowners avoiding registering their land parcels or even buying or selling property without recourse to the official system. For example, one volunteer noted that:

“The main difficulties of the current land system are the long process of the land administration system and the old ways of storing data. You know that after the war in 1990 many records in the land administration offices were burned which caused disputes between people.”

This inefficient way of storing documents was believed by the professionals to be one reason behind the increased numbers of cases of the forgery of ownership data. A case was reported in Al-Hillah in 2013 where 14 official employees in Al-Hillah land administration system were accused of forging title deeds for many parcels (Al-khabar, 2013). Another case was reported by television news reporter Haider Salih

“One of the largest counterfeiting operations in Iraq captured a group of mafia fraudsters relating to 7,000 piece of real estate or residential land belonging to citizens and officers from the former regime and pieces of land belonging to the state. After

arrest, the gang confessed that they belonged to a political party able to influence decisions” (Haider Salih, 2013)

There have even been cases of criminal vandalism since the war, where registration files have been lost owing to arson at land registration offices (Al-khabar, 2013). Al-Iraqia news has published on-line cases of a number of residential property owners who have expressed their dismay and condemnation at not being provided with title deeds of ownership and renewal for the current year. One of these property owners said that:

“I have ownership since 1995 in Al-Nidaa district in Al-Najaf governorate. However, the Land Registry Department in Najaf declined to provide me with the required title deed and claimed that the reason was a fire in the building of the real estate registry office which led to the burning of records of ownership”

The same report by Al-Iraqia online news presented interviews with some officials in Al-Najaf real estate registry office about the reason for not providing or renewing title deeds for owners in Al-Nedaa district. The officials noted that the reason for not renewing or initiating some title deeds is that the general directorate of real estate registration in Baghdad did not send copies of the records of ownership of those residents, so they were unable to do anything for them.

5.4.2 Outdated information

Where land registration records do still exist, many volunteers claimed that they are very old for some areas. Some noted that ownership certificates were registered with a person who passed away many years or generations ago. This situation was more common in rural areas where the majority of current owners do not have an ownership document with their name on (see Chapter 6, Table 6.27). This comes about due to the unregistered inheritance of land over many generations so that each land parcel may have hundreds of inheritors. A parcel may be inherited by several sons when their father dies, but none of them actually sub-divides and re-registers their portion.

This was confirmed by a land administration officer, who noted that:

“Most of the land in the rural areas still formally belongs to the owners who passed away many years ago because the inheritors do not usually come to update their records. This leads to hundreds of inheritors who share ownership. For example, in Abo Dloaa, a very big land area was registered in the name of Shaker, who passed away 70 years ago, and now many of his inheritors live on it and consider themselves as owners but they are not registered themselves on the formal records. They may also sell parts

to others without any formal documents. Such situations need to be solved by encouraging the people to update their records”

5.4.3 Insufficient numbers of professional surveyors

During the interviews, many volunteers across urban, per-urban and rural emphasised the problem of the insufficient number of official surveyors. It was recognised that there were too few professionals to address the current land registration problems. For example, as discussed in Chapter 4, the uncontrolled, illegal expansion of cities, the increase in migrant people who have occupied government land, and the problems of illegal sub-division and changing usage from agricultural to residential land, all require the constant updating of land records, which current staffing levels cannot cope with. One volunteer noted that:

“There are too many disputes between landowners on their boundaries. The reason is that the surveyors are unable to deal with a large number of illegal settlements which make it very difficult or impossible to control or register them”.

This issue of insufficient numbers of land professionals to undertake the required work, especially in relation to informal or illegal settlements, presents several dilemmas. Firstly, how can the Government or the Municipality begin to understand the scale of the housing crisis if there is no record of the current quality and quantity of informal housing?

Secondly, should the existing professionals be using valuable time recording existing illegal properties and settlements when they could be updating the records of legal properties and plots so that subsequent transactions are clear?

Thirdly, does recording illegal or informal property imply some form of *de facto* tenure? Or does it set up false hope of formalisation and upgrading amongst the settlers? Finally, if it does not suggest a future upgrading or formalising of tenure, what should the authority do with the residents? These dilemmas are discussed in Chapter 8.

Long waiting times were clearly a problem (Figure 5.2), which resulted in people sub-dividing illegally as this man from an urban settlement reported that:

“When I went to subdivide my land parcel and sell it to one of my relatives, the authorities imposed many obstacles and they put me in very long queue which exceeded one month. Then I decided to sub-divide the land parcel into two parts using a private surveyor and to sell one to my relative. So, all of the parcel is formally registered only in my name. However, we divided it privately into two parcels”.

Another householder noted that:

“If you want to book a surveyor to come and survey your land parcel, then you need to wait for a long period until your turn comes. I think giving money to private surveyors are much better than being on the waiting list”.

This was not, however, simply the perceptions of the volunteers. The General Director of the land administration system substantiated these concerns. During an interview for the Al- Naeem satellite TV channel he confirmed that the numbers of professional surveyors in the land administration system are unable to fulfil current responsibilities, causing much delay in the completion of basic tasks of land administration (Al-Naeem channel, 2015).



Figure 5.2 People feel frustrated about long waiting times in Al-Hillah Land administration office (Commission of Integrity, 2014)

5.4.4 Lack of resources in the official land administration system

There was a general concern about the lack of financial resources for the land administration system. In particular, some of the volunteers mentioned that the department was unable to create a computerized system. This was substantiated by surveyors. A senior land administration officer confirmed this problem, saying that:

“the main problem of the land administration system is the lack of financial support which makes us unable to develop the system and make it more complete and computer-based ... [and] most of the official system offices were rented from other ministries or from private companies”.

However, a lack of resource does not only limit the development of technical systems but the general training and professional development of staff. The majority of volunteers noted that

they believed official surveyors and land administration professionals seemed incapable of surveying the land plots effectively. A volunteer from a peri-urban area commented:

“I went to the real estate registration office to ask for the fixing of the boundaries of a new parcel in a newly opened area that the government gave me. Then as part of the formal procedure, I booked an appointment with an official surveyor who to lay out the boundaries of my plot from the cadastral map to the ground. Unfortunately, the young surveyor was confused and was unable to identify the boundary of my parcel the first time, and then two other experienced surveyors came twice later until they found it accurately.”

Another added that:

“The surveyor is not always accurate. They may do the work more than once, especially in the new residential area.”

Some people felt that the professional surveyors actually made the problems worse, as a volunteer from a peri-urban community noted:

“I witnessed many problems in the community after surveyors did their work. For example, my friend bought a land parcel and asked the professional surveyors to fix it for him. After fixing his boundaries, he built his house on it. After three years, a new person bought a land parcel and also asked an official surveyor to fix it for him. However, they found that my friend has actually built his house in the wrong position. The main problem was that my friend’s official parcel is worth less the land he occupied in mistake. After that, conflicts started to occur between them until their tribes intervened to solve the problem between them without going to the court.”

Some volunteers even resorted to paying private surveyors to re-survey their land parcels:

“The private surveyor checked my parcel (described on the Title Deed as occupying 300 square metres) and found that it is 298.5 square metres. This is 1.50 square metres less than what it should be. The error was due to the official surveyor who had done the surveying previously for the community” (parcel No. 4386).

In interviews with some of the professional surveyors, the researcher raised these concerns and cited the mistakes. In some cases, the surveyors were candid about how mistakes were made. One acknowledged that one reason might originate from the first stages of the process, when the surveyors from the municipality do surveying for the outer boundaries of a new residential area, but they may not be accurate. He noted that the solution to this initial error was to distribute the error equally among all the plots when they go to fix the boundaries of each individual plot.

Another reason for errors in individual plot data is that some of the surveyors themselves, both official and private, fix the boundaries of each single parcel depending on the nearest neighbour without thoroughly checking from both sides of the block. They then divide the error on all the parcels within the block, which cause shortages in the area identified in the last parcel. Other surveyors explained that, in rare cases, surveyors may have difficulties if they are not familiar with the area.

However, one surveyor refuted such accusations, saying that the problem comes from the people themselves because they may shift the pegs accidentally or intentionally after fixing their boundaries. Alternatively, he suggested that landowners might leave the boundary unmarked for a long time before they start building on their parcel. In such cases, the boundary may be disturbed.

However, there was a general consensus among surveyors that they are still human beings and do make mistakes. They also noted that the number of mistakes has increased since the fall of the previous regime because of the pressure of increased work and the fact that new surveyors are not familiar with the problems that result from the actions of the previous regime.

5.4.5 Failure to control illegal urban expansion.

Many volunteers described the current situation of illegal expansion on government and private lands and the changing use of land as uncontrolled and very dangerous (Figure 5.3 below). Since the fall of the previous regime, illegal occupiers who have built large communities of informal dwellings have put stress on the local government which is unable to deal with illegal urban expansion.



Figure 5.3 The situation of the illegal settlements (Alhurra, 2015)

An urban volunteer who was working as a lawyer noted that:

“Due to the shortage of houses, the increasing population, the inability of the government to build new communities and the problems of ISIS, which has caused a huge immigration of people from some cities to others, the number of homeless people is increasing leading them to occupying and building irregular houses on land which belongs to the government or to people who live outside Iraq” (Parcel No. 3/657)

One surveyor estimated the illegal occupancy of lands to represent about 25% of the total Iraqi tenured land and acknowledged that this proportion is increasing rapidly:

“The government admitted in its report last year that we do need at least 10 years to control the current illegal situation”.

On this matter, most of the surveyors confirmed the problem. One noted that:

“Most of the government-owned areas such as green parks, military training institutions of the previous regime or even sites for services such as hospitals and schools were occupied illegally after 2003 and this causes many problems for the government. One of the problems is halting some of the projects that were planned in advance. For example, there was a peri-urban area in the north of our city which was specified to be a university site before 2003 and the design for it was completed. However, because of the war at that time, the government did not start the project. Then, in 2012 it agreed to start working on it again. However, when we visited the area we found that hundreds of houses were built illegally in the area which was specified for the project, and the people were very angry about us visiting and talking about the project. Finally, we stopped the project again until the government could find a solution for those people, which probably will not be solved for decades”.

The Director of Al-Hillah Municipality has confirmed this situation during a formal interview on radio Al Mirbad, saying that:

“The encroachment upon state properties have increased significantly in the recent period due to the weakness of the government which has encouraged people to occupy government land illegally. Most of those lands were specified for building schools, children’s playgrounds and health centres. I have raised this problem and warned the authorities in the state that many of our projects are going to be abandoned if they do not remove those illegal settlements. As a result of not taking action against those illegal settlements, the project of Al-Hillah central park has stopped. For the same reason, the city has been prevented from implementing Road 30, which was designed to be 5

kilometres long and is considered to be a very important project to solve the problem of congestion in the city of Al-Hillah. Furthermore, there are more than 450 plots which have been occupied illegally which were planned to be used for residential buildings with many floors to settle people in need of housing”

Increasing migration and internal displacement between cities, as people search for a safe location, was seen as the main driver behind illegal urban expansion. The researcher met some of those migrants who were occupying land parcels and had built their own homes on it without having formal tenure of the land. One of those occupiers noted that:

“I came as a migrant, from Al-Mosul running away from the terrorist groups ISIS who occupied and destroyed my area, to here and I do not have any place to live. I have moved with my family (5 daughters and wife) to live in Al-Hillah where we can be safe from ISIS. At the beginning, I rented a Moshtamal for a few months until I have no money left to pay rent. My relatives informed me that there is a space in their area which belongs to the government and it was designed as a garage. I came here and built, with the aid of kind people, who built a small moshtamal for me. I wish for the government to register me as owner of this moshtamal because I do not have any place to live.”

Urban areas are not only expanding but becoming denser as plots are sub-divided. Indeed, understanding the increasing phenomenon of sub-dividing large plots into small parts (Moshtamals) is one area where VGI may be most valuable. Many volunteers referred to this situation. They agreed that, due to the very high levels of immigration from unsafe cities to safer ones such as Al-Hillah, original residents or landowners had begun to subdivide and sell their parcels illegally (See Chapter 6, Table 6.4). The majority of the plots in the urban community were subdivided into two or more sub-parcels which were then sold or rented without being formally registered as separate land parcels. For example, a volunteer described his situation by saying that:

“I owned the parcel whose total area is 400 square metres and I have about 100 square metres free (garden), and then I decided to divide it and sell it without returning to the land administration system because the government will not allow me to do so. Then I have done this myself with the aid of my children and sold it.”

Another common approach is to demolish the whole house and subdivide the land into small parcels and build on it as a small, irregular sub-plot. An example of this was given by an urban settler who was, a retired employee of Moharbeen district who remembered his old house with pain and said that:

“I had enjoyed a 200 square metre house that included three bedrooms and a garden until I decided to pull it down and divide the land parcel into four sections and re-build them as 4 separate Moshtamals with fifty square metres each and no more garden. I live in one, gave two of them to my two sons to get married and rented the remaining one to get an extra monthly income that helps me with the presently expensive life. I blame the state who do not care for its citizens and do not offer cheap loans with easy conditions that can encourage people to build new houses” (Parcel No. 3/365).

The researcher asked this man if he thought that those Moshtamals of 50 square metres were acceptable to the urban planning department? He replied by saying that:

“I know that it is unacceptable to the urban planning department. However, I do not care about that because I do not have another choice”

In another situation is where inheritors decide to divide their father’s house and live together. This was the situation of one of the volunteers who said that:

“After my father's death, we had to distribute the inheritance, which is a house in the Al-Bayaa district. Being three married brothers, we have divided the house into three housing units instead of renting houses or living in places far from where we work” (Parcel No.73/169).

On other occasions, when migrants do not have enough money to buy property in safe cities, they illegally occupy land which belongs to the government, or to an individual who lives outside the country or someone who lives in the country but neglects his parcel because the area is not provided with services.

When this was discussed with surveyors, one of the important points raised was that the city of Al-Hillah has increased to about three times the size in term with the number of parcels as a result of sub-dividing large plots into many smaller ones. This causes many problems, such as increasing numbers of disputes between residents, changes in the aesthetics of the city with very small irregular plots, and increasing pressure on services.

However, the problems of illegal settlement and sub-division were not entirely caused by an influx of immigrants. The high prices of land parcels were also seen as a problem. There was an agreement among the volunteers who lived in the urban area that another reason for the illegal occupancy or illegal sub-division of land parcels is the price of land plots. This was felt most strongly in the urban areas, where plots are not only sub-divided but may also be rebuilt as multistory houses on small plots or as blocks of flats, rather than individual houses (see Figure 5.4 below which shows a very small dwelling built on a sub-divided plot).



Figure 5.4 Moshtamal with 33m² space in Al-Moharbeen urban district

However, participants who lived in the peri-urban area considered that the prices of plots were not an important factor in their community. They rather preferred to attribute the illegal expansion in the community to the nature of the human beings who want to occupy areas for free when they find land which is not so important for the government or other developers, and where they feel confident that the government is not going to ask them to leave the place for at least a decade.

Changing land use from agriculture to residential was also perceived as a problem. This situation is very common in Iraq, especially after the fall of the previous regime that was strongly opposed to such a phenomenon.

5.4.6 Lack of trust and confidence in the land registration department

The difficulties discussed above have led to a lack of trust and confidence in the accuracy of the formal land and real estate registration system. This is important because, where there is a lack of confidence, people may be more inclined to disregard the formal system and more inclined to be involved with a citizen-led or supported system using VGI. Again, the responses to questions about the formal system differed between the three different area types. Table 5.3 below highlights that fewer people responded that they did have confidence than did not have confidence in the system.

Table 5.3 Percentages of volunteers who responded to the question of whether or not they had confidence in the current LAS.

Communities	Yes	No	Don't know
Urban	34%	44%	22%
Peri-urban	62%	24%	14%
Rural	15%	67%	18%

There was a noticeable difference of opinion in rural areas, with the majority (67%) having no confidence in the formal system for collecting data about their land parcels, recording and storing that information, or allowing access to the data for land transactions.

This problem is common with many institutions of the Iraqi government where the employees working with the general public or with businesses will not do work or will be very slow or place obstacles in the process unless money is offered. A lawyer in the al-Hillah court said that:

"the routine of work in Iraqi governmental departments is obstructed by some of the staff who put obstacles so as to force citizens to pay bribes or reliance on the Moaakib, a person whose job is to perform or complete any task related to the real estate registration office for the citizens and who earns large amounts of money and he then gives a percentage of the money earned to those employees.

Then he added that: *Despite the alerts and warnings about punishment for venal and corrupt employees in government departments, some state department staff whose jobs involve direct contact with citizens still deal by bribery or invent obstacles that frustrate the citizens. This leads them to leave and resort to the Moaakib who can do the tasks easily and quickly because he is sharing the money with employees inside the Real Estate Registration Department."*

Another volunteer described his experience in one of the real estate registry offices as follows:

"When I was living in Baghdad, I went to the real estate registration office there to transfer ownership. I did not listen to my friends who told me that I should be hiring a Moaakib to avoid wasting effort and time with such government departments. However, I decided to go with the routine procedure of land transaction myself. After strenuous effort and expense, many revisions, going to and coming from, many institutions associated with the real estate register office, finally my file reached an employee responsible for calculating the municipal taxes on the property. This employee intentionally put obstacles in the way to delay the completion of the transaction. I became angry and when a verbal altercation was just about to happen, a wise man

intervened in the matter. Finally, I decided to give authorization to a Moaakib who informed me that he was going to finish the task by giving some money to the employee as a gift to complete the transaction” (Parcel, 3/334).

The director of the statistics department in the Commission of Integrity said that:

“Real estate registration offices are the governmental institutions that we receive a lot of complaints from people about, so that the Commission of Integrity paid more attention to collect survey data on it. This attention stems from our keenness to support the citizens and make them feel that we try our best to solve their problems. As a general average, the Commission of Integrity carries out monthly surveys on about 35 real estate offices. The first category in our monthly survey, using a standard Commission of Integrity form for checking most Iraqi institutions, shows the rate of general bribery. In the real estate registration sector, the usual results of the monthly survey reveal that around 20 of these offices score the highest for general bribery compared to all the other government institutions. For example, the average rate of general bribery may be 2.5% for one month, across all the institutions that the Commission of Integrity has done surveys on, including the 35 real estate registry offices. Then we usually find that half of those real estate offices get a rate of bribery higher than the general rate.”



Figure 5.5 Women consulting Moaakib about land related issues

On the other hand, some *Moaakib* described themselves as ‘good helpers’ (Figure 5.5 above). One of them argued that:

“Citizens are seeking to pay us money to complete their transactions or any other land problems because of their inability, it is hard for them to come from other cities or they may have more important jobs to do than standing for many hours in queues in government departments. They use Moaakibs as a way to carry the burden of their inability to complete transactions. We do not force anyone to come to us and the money that they pay us is not considered as a bribe or extortion. We take the right decision by doing the transaction in addition to enduring the humiliation of some employees of the departments of state”.

However, trust has been eroded further by cases of fraud or forgery among officials. A well-publicised event in October 2013 saw the closing of the official Al-Hillah land administration office after fourteen employees were caught forging a large number of title deeds to control government lands and land owned by people living outside Iraq.

A volunteer from the urban community said that:

“I bought a 300 square metre plot in 2011 in Karama district and left Iraq. After a few years, I came back to Iraq and decided to sell my parcel. I went to the area and found that my parcel, for which I have a formal deed in my name, had been sold three times after I bought it. In addition, I found that the empty parcel that I bought at that time is being built on already with a nearly complete house. I made a formal complaint; however, I got nothing”.

This concern was shared by land administration professionals, and a surveyor from the land administration system agreed, saying that:

“Fraud happens frequently especially when some bad employees change the owner’s documents. For example, they may change the picture of the person who owns the parcel. They also put new documents in his file and then it will be very difficult to find the real owner. All those problems happen because of the way that we store the registration data. if it was a computer-based system, this situation will not happen.”

The lack of trust in the land administration system did not only stem from fraud and impropriety. People were also concerned about a general lack of care or ability on the part of land professionals or other government bodies. For example, the land administration system gives title deed certificates for some areas that the government owns to people without checking the area in advance to ensure that there is no illegal occupier. One woman from the urban area

explained that the government allocated a piece of land for her and other people whose sons or husbands had died while fighting against ISIS. However, when the surveyor of the land administration office went with her to fix the boundary of her parcel he found that the land was already occupied illegally and a house had been built on it. She said that the surveyor asked her to complain to the court. However, despite the making the complaint, the situation was not resolved.

The researcher asked the official surveyor about the reason for such situations. The surveyor attributed it the urgent orders of the Prime Minister, or other high authorities, who want this procedure of giving land parcels to people in need or to martyrs of the army and volunteers, to be completed very rapidly. For this reason, a title deed is given to the owner without formally surveying the land to check if there is any illegal occupancy.

Another explanation came from other surveyors who attributed this situation for two reasons. Firstly, an error may be made by the municipality surveyors themselves, who supply the land administration department with data on the boundaries of the whole area that they wish to subdivide in to parcels and distribute to the people. However, they may not have up-to-date information about recent illegal occupancy. Secondly, the new owners who get a parcel from the government may leave their land for long period because there are no services, no formal roads, or it might still be an agricultural area. This gives the chance to other people to occupy the parcel illegally and build their own homes on it.

5.5 Volunteer involvement in the study: motivation and participation

At the end of the study, volunteers were asked about the reasons for their involvement in the study. In Al- Hillah, as in many other areas of Iraq and, indeed, other countries, the allocation, use, registration, occupancy and transfer of land are extremely contentious issues and any formalised system of administration is open to all manner of professional incompetence as well as fraud and profiteering. It was these issues which appeared to have motivated the volunteers most strongly. Because of the lack of resources and basic inefficiency of the current system, several volunteers had direct experience as landowners of the land administration losing their documents. Even when documents are not lost, volunteers have been dissatisfied, as shown in section 5.4.1. A further motivation for volunteers was to engage with technology. Many volunteers were interested to discover and use technologies to identify and measure plots. Other volunteers were motivated to learn about the administration of land.

5.6 Chapter summary

This chapter has demonstrated and provided evidence of the poor state of the formal system of land administration in Iraq, and why it is not fit-for-purpose. There is a serious lack of adequate data, and existing data is badly managed. The causes of this are shown to be lack of resources, technology and staff, as well as the limited ability of staff in some cases. This supports the argument for the use of VGI, as one of its perceived benefits is the acquisition of more and better data.

It has been shown that people's perceptions and involvement differ between area types and different communities and individuals. Also, this research gathered the opinions of volunteers, how they differed and how this might affect the use of VGI, although it did not investigate why such opinions may differ. For example, it has highlighted that confidence in the formal system in rural areas is lower than in urban areas. The reasons for this are not entirely clear, but it may be due to the fact that illegal occupancy is higher in rural areas. The chapter shows also that some people are critical of the skills of the land surveyors. This may be because those with higher value plots have more to gain, or lose, by errors in boundary identification.

These points go some way to explaining people's motivation to take part in VGI, either as volunteer data collectors, or by giving their data. The chapter highlights that there is a sense in many communities of wanting to make the operation of the system better and to improve land administration in general. This was felt amongst both volunteers and professionals.

The chapter has also confirmed that many, if not most, of the concerns of the communities regarding the formal land administration process are upheld by the professionals themselves. Further, there is evidence that the professionals are accepting of VGI as a means to assist in their work and to begin to rebuild the land administration records.

Concerns shared by both professionals and some communities regarding illegal settlements resulting from displaced people migrating to the cities have also been discussed in this chapter and are discussed further in Chapter 6.

Chapter 6. VGI attribute and spatial accuracy

6.1 Introduction

The previous chapter discussed knowledge, experiences and perceptions of volunteers concerning the land administration system and department, and issues of motivation. It sought to validate this information with data from land professionals. It also sought to understand the acceptability of VGI by the volunteers, communities and authorities. This chapter discusses in more detail the data collected in the field by and from the volunteers and from official sources. It is in two main parts, beginning with a discussion of the nature of the attribute data and then moving on to considering the value of the quantitative and spatial data which was collected.

6.1.1 Definition of terms

This chapter focusses on the data collected in the field by a range of people, as described in the previous chapter. This data collection involved ‘volunteers’, who were people who volunteered to collect VGI data and were trained in doing so by the present author, as well as household representatives and land/plot holders, called ‘community participants’, who gave information about themselves (including personal data, ownership, experiences, opinions), and the ‘professionals’ who manage the official land administration system.

The data collection focussed on several case study areas in the Al-Hillah area allowing the researches to investigate different types of topography and land use. These included dense city-centre urban zones, mixed commercial/residential urban areas, previously extensive but now densely sub-divided plots, suburban housing with open spaces between, newly-built residential developments, open land occupied illegally, planned urban fringe development, rural village settlements, and agricultural fields. Similarly, different socio-economic groups lived in or used the case study areas such as local rural tribes, residents of suburban neighbourhoods, male and female groups, and educated urban professionals, and the volunteers and participants were drawn from each of these communities or groups.

6.2 VGI quality considerations

From the literature review in Chapter 2, it is clear that land administration systems are only as good as the quality of the data held therein. Because VGI is provided, in most cases, by people with little or no knowledge of mapping processes (Ciepluch et al., 2010), it is necessary to verify the quality of their data and balance the potential benefits of this data against any

limitations. Data quality in this context can be examined from a number of different perspectives. **Attribute accuracy** refers to the reliable and reasonable correctness of the semantic information attached to the point, line and polygon features of a spatial database, and **positional accuracy** is the nearness of the coordinate values of a VGI feature such as a captured point to its corresponding authoritative equivalent feature measured in terms of Euclidian distance. The level of **completeness** refers to a comparison between two different sources of data for the same area of interest to find which features are included or excluded from a dataset, and **currency** refers to how up-to-date official data is compared to more recently collected VGI data for the same area.

Each of the parameters of data quality mentioned above needs to be researched in the context of this study, since not only is geospatial accuracy a concern of the volunteers and further end-users, including land administration bodies, but also all of the other data quality variables. The first part of this chapter addresses attribute accuracy, whilst the second part considers positional accuracy, completeness and currency together under the heading ‘spatial accuracy’.

Part one: Attribute accuracy

One aim of the study was to understand if VGI could enhance and improve existing qualitative attribute data relating to plots. Data on the attributes of plots were collected through the use of a formal questionnaire delivered by the volunteers to a sample of community participants in the study areas. The questionnaire asked about ownership, land use, type of tenure and date of last transaction, in order to assess the currency and completeness of the formal land administration data. However, there was a weakness in the quality of data concerning the most recent transaction, because many people could not remember accurately the dates when they bought or sold a plot. Because official attribute data is not up-to-date and is hard to obtain, it would in any case have been difficult to make a comparison to verify the VGI data in this way. Therefore, attribute data was verified through a ‘crowd-sourcing’ method. This process was conducted separately from the VGI data collection undertaken by the volunteers, as it involved the checking of VGI data against the knowledge of others in the community. Experiences with such-crowd sourcing and other aspects of data collection indicated variations in the quality and utility of data. It was noted in Chapter 5 that the type of area concerned influenced the characteristics of data collected, and this was strongly related to the education level and gender of the volunteers. Therefore, further discussion in this section is structured by the type of area involved.

6.3 VGI attribute accuracy for urban areas

Four urban areas were chosen for the research: Jawahry, Moharbeen, Zahawy and Fatima. These areas are mainly in the city centre but vary in levels of development. The attribute data for land parcels collected via volunteers through questionnaires addressed several issues including ownership, land use, tenure, official records, and conflicts. The land parcels sampled were, as determined by the research methodology, those owned or occupied by the volunteers plus other parcels about which the volunteers had some information.

6.3.1 Ownership data

Information about ownership is an important part of attribute data as it shows who the specific plot belongs to. It was difficult to obtain because many people were reluctant to give their names. The reason for this reluctance was primarily that information about the family's name can reveal certain types of information that may lead to people being killed. This risk was particularly high during the sectarian war which arose in Iraq from 2003 onwards. In order to improve the collection of ownership data, the first step was to gain the trust and confidence of the communities about the purpose and possible benefits of applying the project in the community. Furthermore, the community was re-assured that personal data held by the researcher would be kept confidential, and that it was anonymised when reported. Consequently, although some of the volunteers were still not prepared to give ownership details, the majority were willing to do so. The VGI-collected ownership data were verified by crowd-source agreement, by presenting it in front of the community gatekeepers. These were community representatives who had already gained the trust of all community members, had been active in representing community needs, and usually had lived in the community for more than ten years. Other representative members of the community, including older residents with considerable levels of knowledge, who were able to attend a verification workshop after data collection, also contributed to this 'crowd-sourcing'. Table 6.1 shows the results of the use of this crowd-sourcing technique to test the consistency of attribute data collected by VGI. A sample of ~20% of the total number of land parcels surveyed was used for this crowd-sourcing, as well as for further analysis.

Table 6.1 Verification of ownership data by crowd-sourced agreement (random samples presented for verification)

Study area	No. of plots tested	No. of plots with inconsistencies in named owner between volunteer-collected data and crowd sourcing
Jawahry	51	0
Moharbeen	60	3
Zahawy	61	0
Fatima	81	5
Total	253	8

The percentage disagreement in validating ownership data by consensus was low across the four different urban areas. However, there was some variation between the communities. In the two communities Jawahry and Zahawy, there was complete agreement in verifying ownership. The explanation for this situation is that the ownership data were collected by volunteers who had lived in the community for long periods. On the other hand, a few uncertainties found in verifying the ownership data in the communities Moharbeen and Fatima can be explained in terms of the short period of residence in the community of the volunteers (See Table 6.2 below).

Table 6.2 Duration of residence of volunteers in their communities

Urban communities	< 1 year	1-5 years	5-10 years	>10 years	
Jawahry	0	1	3	8	12
Moharbeen	2	5	1	2	10
Zahawy	0	2	2	9	13
Fatima	2	4	2	3	11
Total	4 (9%)	13 (26%)	7 (17%)	22 (48%)	46

The results show that the majority of the volunteers in the urban communities had lived in their communities for more than 5 years. Those volunteers who had lived in their community for more than 10 years were concentrated in Jawahry (8) and Zahawy (9). This could have had an effect on the validity of the ownership data, especially in the Jawahry and Zahawy communities, because these long-term residents probably had a stronger knowledge base to draw on, resulting in complete agreement about plot tenure amongst the volunteers after they had discussed the initial data.

Accordingly, the inconsistencies in the data collected by volunteers who were relatively new to their areas may highlight the importance of using volunteers who have lived in an area for some time. However, as we will see in the peri-urban area, other factors also appear to influence the

validity of data. Also, there is a chance that longer-term residents assume a greater level of knowledge than they actually have. Therefore, additional care should be taken to validate all data from additional sources, in this case by crowd-sourcing.

6.3.2 Land use change

The volunteers surveyed the study areas to identify the number of plots, sub-divisions of plots and changes of use. They then also asked community participants about the kind of property or land they owned and what it was used for. The aim of this question was to discover changes in the categories of plots and land use in different communities, as well as the number of sub-divisions, and the associated problems with these phenomena. This data was compared to official data and to city plans. In some cases, the plots surveyed did not officially exist on any city plan as they had been built illegally on vacant land zoned for other uses.

The urban study areas were all formally planned as residential areas (see the example of the official map of Fatima in Figure 6.1 below). However, although the map, is the most up-to-date official record, it does not reflect current sub-divisions to the planned residential land parcels. By combining the VGI and official maps, and transforming to a common reference system (as described in Chapter 4), an updated version of the situation in Fatima is provided (Figure 6.2).

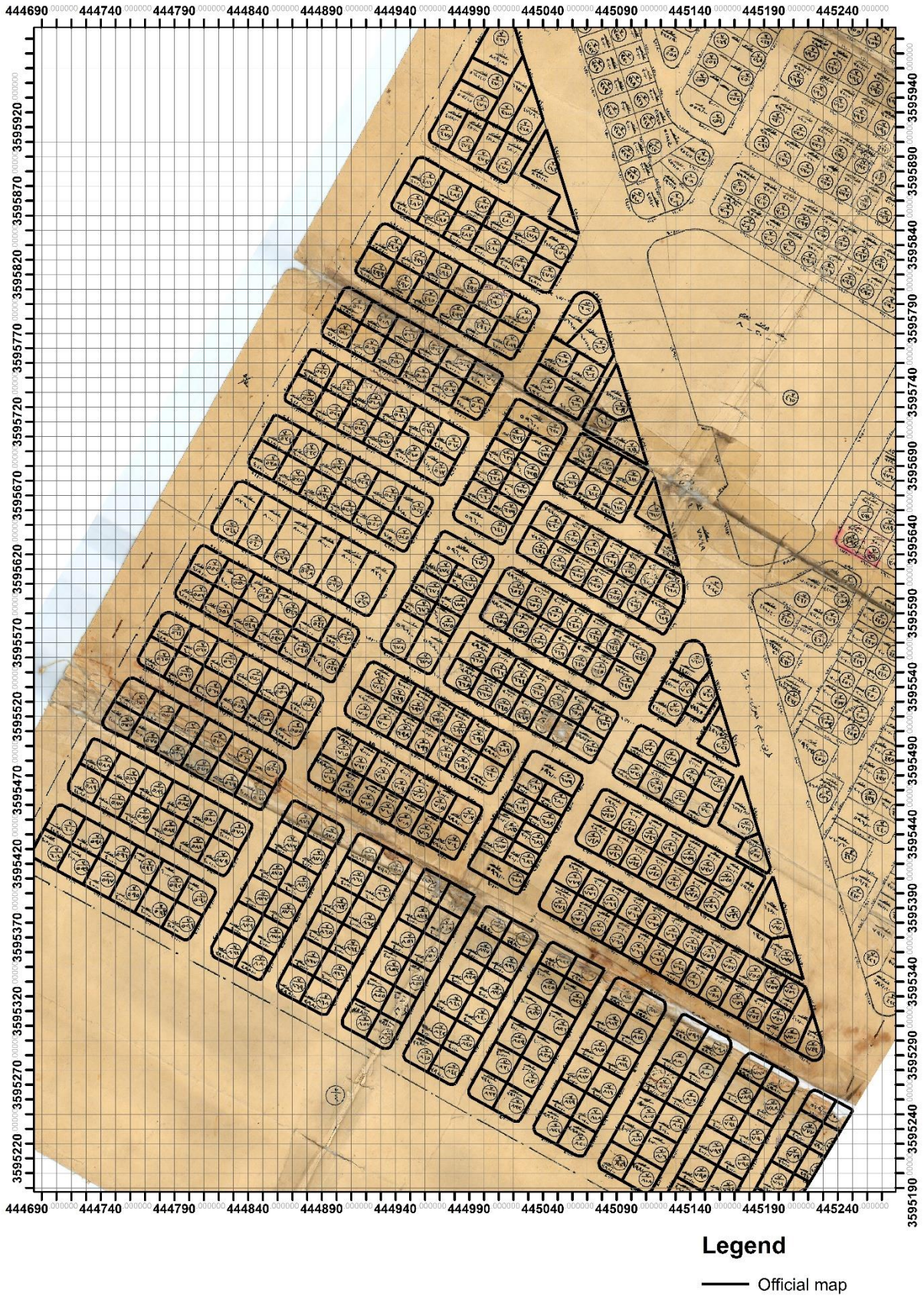


Figure 6.1 Current official Fatima map (Al-Hillah RERD).

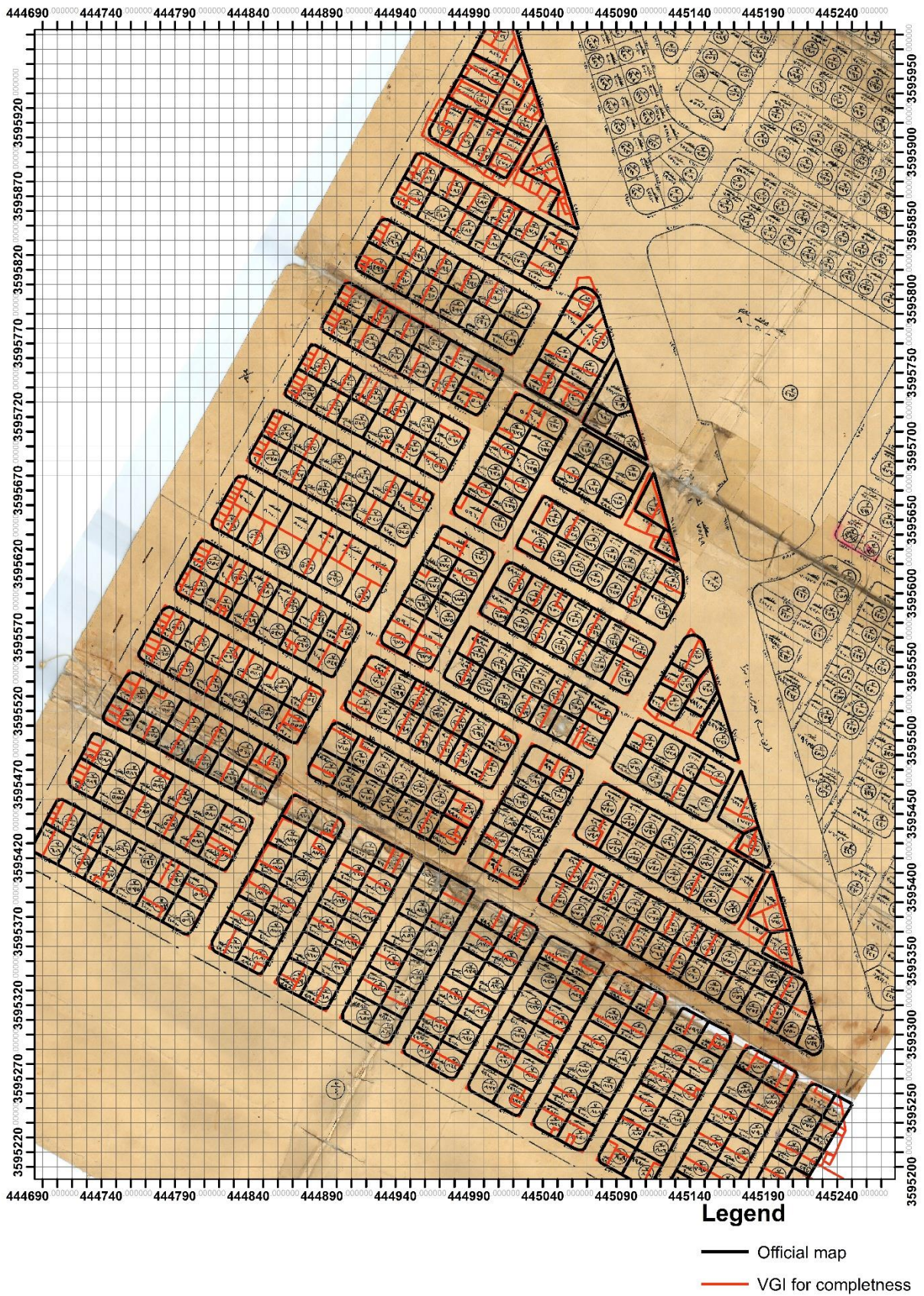


Figure 6.2 Updated Fatima map obtained by adding VGI data to official data.

Across the four urban study areas, the formal plans indicate that there should be 1232 plots for residential dwellings and 2 plots for schools, making a total of 1234 plots. Thus, the formal records suggest that there are only 1234 households living in these areas. However, as seen from Table 6.3 below, the volunteers identified a very different picture, with a total of 2133 ‘units of development’, including sub divisions, shops, flats etc. (Table 6.4)

Table 6.3 The difference between number of plots collected by VGI and the official data

Urban communities	VGI data	Official data	Difference
Jawahry	356	204	152 (74%)
Moharbeen	381	246	135 (55%)
Zahawy	651	388	263 (68%)
Fatima	745	396	349 (88%)
Total	2133	1234*	899 (73%)

* All plots (except 2 for schools) were planned as individual family houses

Table 6.4 Plot categories as collected for the study areas by the volunteers.

Urban communities	Vacant land	Haykel*	Moshtamal**	House	Flat	Shops	School	
Jawahry	8	6	130	135	31	45	1	356
Moharbeen	6	2	156	168	14	35	0	381
Zahawy	17	0	338	218	31	46	1	651
Fatima	14	8	463	172	29	59	0	745
Total	45	16	1087	693	105	185	2	2133

*Haykel = structure/shell of building

** Moshtamal = sub-division of plot or building.

The results reveal that the actual categories of plots, real estate and land use in the urban communities differed greatly from those within the formal plans. The greatest difference in the urban areas was the number of “Moshtamal,” which is an Iraqi term referring to a plot or building which has been sub-divided. Moshtamals can originate from an initial parcel of land divided into small sub-parcels which are then sold separately. Alternatively, as in the majority of cases, the owner of a large house may sell his/her garden to someone who wants to build on it. In most cases the sub-parcel may not meet the requirements for the minimum area of a formal dwelling that have been specified by the government.

Other categories of building which did not conform to the formal data included the number of shops and flats. In both of these categories, the VGI data showed greater numbers than in the formal data. Many of these additional units were formed either by sub-dividing gardens or extending or dividing the original house.

However, if this data is compared with the data held by the land administration department, it is clearly quite different. The official data does not give an accurate picture of the numbers of sub-divisions or the usage categories of the plots. This information is important for several reasons. Firstly, it reflects the very high degree of change made to areas without regard to the official plans or registering changes. Second, it highlights the fact that the real numbers of households, and thus the level of services required, is far greater than the authorities believe. Finally, it emphasises how out-of-date the official data is and how little the authorities actually know about the levels of population and different land uses in their areas. The professionals in the Al-Hillah land administration offices are very interested in the VGI data as it highlights the extent of sub-division into Moshtamals, the majority of which are both illegal in terms of being unplanned sub-divisions and in being smaller than the minimum size requirements. Therefore, the official registration data gives a false impression of the number of households in the city.

6.3.3 Type of tenure and ways of acquiring the land

Community participants were asked about what type of tenure they considered that they had for their property. The main purposes of this question were to evaluate the different types of tenure as well as comparing tenure in the urban areas with the other case study sites. The responses were obtained by volunteers during the semi-structured interviews with participants from the urban communities (Table 6.5).

Table 6.5 The percentage of real estate according to type of tenure

Urban communities	Owned	Rented	Borrowed*	
Jawahry	32	15	4	51
Moharbeen	45	9	6	60
Zahawy	49	12	0	61
Fatima	63	11	7	81
Total	189	47	17	253
Percentage	75%	18%	7%	

* For example, some people were allowed to use the plot owned by a relative who was away. Alternatively, some people who had fled the area due to the civil conflict asked friends or neighbours to occupy their plots for security, until it was safe to return.

The majority of the interviewees considered themselves as land owners with a low percentage of other categories of renters and borrowers. Those who considered themselves to be owners were asked a further question about the process by which they acquired their land. The results shown in Table 6.6 are interesting as they reveal various degrees of precarious or insecure tenure, where properties were subject to eviction by landlords, or were unsafe or involved short-term rental, or were noted to have been acquired by ‘other means’. This is very important in

determining the percentage of plots that were obtained illegally or bought in good faith from someone who did not actually have the right of sale. Most illegal acquisitions of land were perpetrated by those moving into an area and, as noted in Chapter 4, increasing immigration by people displaced from other cities is the main driver behind illegal urban expansion.

In this matter the answers were divided into three different categories of bought or, inherited, other means. The category of ‘other means’ in Table 6.6 below includes people who believed that they had bought a plot in good faith but had actually been defrauded by someone who did not have the right to sell it. It also includes some who can be considered as illegal squatters who had no bill of sale at all and had no legal rights to the plot. The majority of the people in the urban areas claimed that they had acquired their plots by buying them, with a lower percentage acquiring plots through inheritance or other means. The most significant ‘other means’ was squatting.

Table 6.6 Percentage of ‘owned’ plots according to mode of acquisition

Urban communities	Bought	Inherited	Other means	
Jawahry	19	4	9	32
Moharbeen	35	5	5	45
Zahawy	40	4	5	49
Fatima	46	5	12	63
Total	140	18	31	189
Percentage	73%	10%	17%	

A further crowd-sourcing procedure involving asking next-door neighbours followed in an attempt to validate this volunteer-collected data. Importantly, the volunteers themselves often recognised when participants were not telling the complete truth about their tenure, perhaps claiming to have bought it when they had not. Verification of this attribute of land acquisition, therefore, took into consideration when the volunteer data collectors themselves believed the claim to be false, or when the crowd-sourcing via neighbours revealed disagreement (Table 6.7)

Table 6.7 Disagreement on the process of acquiring land as claimed by participants.

Urban communities	Disagreement on the process of acquiring the land
Jawahry	0
Moharbeen	1
Zahawy	0
Fatima	2
Total	3 (out of 189)
Percentage	2%

Three disagreements were revealed, two of which involved falsely claiming that the land had been bought, and one occupier who pretended that he had inherited it. However, all the surrounding neighbours and volunteers agreed that these parcels were in fact occupied illegally.

The official data cannot reveal such situations and it is essential for the authorities to know this so that they can recognize illegal occupiers.

6.3.4 Registration of land with the authority

The community participants were asked a question about whether they had registered their land with the official system. The responses from the participants in urban communities were collected and are shown in Table 6.8.

Table 6.8 Percentage of plots according to registration status (including renters and borrowers)

Urban community	Registered	Not registered	Don't know (rented or borrowed)	
Jawahry	15	26	10	51
Moharbeen	30	18	12	60
Zahawy	24	37	0	61
Fatima	52	29	0	81
Total	121	110	22	253
Percentage	46%	44%	10%	

The results show that the number of the participants who claimed that their plots had been formally registered with the authorities was only slightly higher than those with no registration. To verify the answers, the next-door neighbours were asked. However, most of the neighbours were unable to verify such information because it is personal information and no one knew it except the owner himself or his family. Therefore, we must acknowledge that VGI data on registration status may not be accurate.

The best explanation for the low percentage of registration is that in the urban communities the majority of the plots are categorized as Moshtamals. These are generally illegal unless they conform to specific planning requirements concerning size, type, and location, and would therefore would not be registerable. However, the illegality of Moshtamals may actually hamper the redevelopment of Iraq and mask the true figures of housing need. Then, there is a need to understand whether there are problems between community resident on the boundaries of their parcels.

6.3.5 Conflict with neighbours about plot boundaries

The participants were asked if they had any problems with neighbours about the boundaries of their parcels (Table 6.9). Answers to this question could help in discovering the reasons for conflicts and finding ways to minimize them.

Table 6.9 Percentage of conflicts between land owners over the land boundaries

Urban communities	Conflict	No conflict	
Jawahry	15	36	51
Moharbeen	24	36	60
Zahawy	12	49	61
Fatima	29	52	81
Total	80	173	253
Percentage	32%	68%	

The results show that the majority (68%) of the participants did not have problems with their neighbours in urban communities, but a significant minority clearly did. The best explanation for this situation is that land is very expensive in urban areas, which makes the people who live on it very sensitive to disagreements over even very small areas of land. However, this situation might not be so important for people who live in peri-urban areas where land is considerably cheaper.

This information was not verified because it might reignite conflicts in the community. Instead, the most common reasons for problems with boundaries were investigated. The reasons for such problems were collected and analysed in Chapter 5, and the outcomes were that the shift of a boundary occurred due to surveying error, or intentional error by one owner who may shift the pegs after they were fixed by surveyor.

6.4 VGI attribute accuracy in peri-urban areas

In a similar way to the analysis of the case study zones in the urban areas, data collection and investigation was undertaken in the three peri-urban areas of Imhazim, Mahkama and Wardia, which are respectively in the West, North and East of the Al-Hillah urban centre. The attribute data collected via volunteers through questionnaire are shown below.

6.4.1 Ownership data

The average percentage of disagreement over ownership, which was validated by crowd-sourced consensus, was low across the three different peri-urban areas (see Table 6.10 below). The main reasons for such results were that many of the land parcels were not adjacent to others

but separated by open land and easily identifiable, the numbers of plots were not high, and there was more interaction between people in these communities.

Table 6.10 Verifying ownership data by crowd-sourced agreement

Peri-urban Communities	No. of plots tested	No. of plots with inconsistencies in named owner between volunteer-collected data and crowd sourcing
Imhazim	80	3
Mahkama	27	0
Wardia	116	8
Total	223	11

There are some discrepancies in the results for the three selected peri-urban communities, which are mainly due to the different experiences and characteristics of the volunteers in their communities in terms of length of residency, age, and gender. For example, the highest level of inconsistency occurred in the Wardia community, where the volunteers were overwhelmingly young males in comparison to other areas.

To find the reasons for such differences, the influences of the duration of living in the community was tested as shown in Table 6.11 below:

Table 6.11 Percentage of volunteers according to length of residence in the parcel

Peri-urban communities	< 1 year	1-5 years	5-10 years	>10 years
Imhazim	2	6	3	2
Mahkama	1	5	4	0
Wardia	3	8	3	0
Total	6	19	10	2
Percentage	16%	52%	27%	5%

The majority of the volunteers in the peri-urban communities (52%) had been living in the community for between 1 and 5 years, as the area had only recently been developed and most of the volunteers had built their houses in the previous decade. However, a minority (5%) had been living there for more than 10 years. Accordingly, it is unlikely that the period of living in peri-urban communities is the main reason for the discrepancies in the results of the verification of ownership data between the different areas, as the majority of volunteers were new to the community.

By investigating the characteristics of the volunteers according to their age and gender and the lifestyle, it was found that the majority of volunteers in Wardia were youngsters who spend most of their time working or studying. This is in contrast to the Imhazim and Mahkama communities where the age of volunteers averaged 50 and above. These mostly retired people

were more likely to meet in the community for social occasions. A further reason is that women usually meet with each other more often than men, giving them more in-depth knowledge about their community. Table 6.12 below clarifies the importance of the participation of elderly people and women in volunteering geographical information.

Table 6.12 Percentage of volunteers according to gender and age

Peri-urban Communities	Gender		Age			
	Male	Female	<30	30-50	>50	
Imhazim	9	4	2	3	8	13
Mahkama	7	3	2	3	5	10
Wardia	14	0	10	2	2	14
Total	30	7	14	8	15	37
Percentage	81%	19%	38%	22%	41%	

Accordingly, the ownership data obtained by groups of individuals of a variety of ages and genders is likely to be more accurate and could be fed into the official land administration system without needing to pass through a validation process. This data can eventually contribute to enhanced planning and control of the design of newly developed areas and could prevent any future problems in implementing the basic design of peri-urban areas.

6.4.2 Land use change

Knowing the current use of the plots in peri-urban communities could help official planners and city designers to understand the changing categories of plots and land uses in different communities, as well as the number of sub-divisions and associated problems.

The peri-urban areas studied were all formally planned as residential areas. The volunteers surveyed the study areas to identify the number of plots and sub-divisions of plots and changes in use. Then the community participants were asked about the current use of the plots. This data was compared to official data and city plans. One area, the Wardia community, is explored in detail below before all of the results for the peri-urban areas are discussed.

Figure 6.3 shows the formal plan for the Wardia community area, with residential plots marked. These plots had been given to people by the government. When asked about the area, the land administration department did not know how many plots had actually been built on. However, as seen in Figure 6.4, the VGI data shows that less than 25% of the plots had been built on.



Legend
— Official Map

Figure 6.3 Official map of the Wardia peri-urban community without clear knowledge about current sub-divisions.



Figure 6.4 Current state of development of land parcels in the Wardia peri-urban community

Interestingly, not only did the VGI data identify the actual built plots but it also highlighted that some of these were sub-divided. Figure 6.5 shows this for the Wardia peri-urban community, with a total of 116 plots from the official map having been developed, but 156 plots actually being recognised (each bounded in red). Imhazim and Mahkama were investigated in a similar way. This situation is discussed again below in relation to the overall peri-urban area.



Figure 6.5 Updated map of the Wardia peri-urban community combining VGI and official data

Across the three peri-urban study areas, a total of 223 built plots as recognised on the formal plans are identified, each approved for residential dwellings occupied by one household.

However, as seen from Table 6.13 below, the volunteers identified a different picture, with a total of 286 ‘units of development’, including sub-divisions, Moshtamals, and shops (see Table 6.14)

Table 6.13 Differences between the VGI and official data over the number of plots

Peri-urban communities	VGI data	Official data	Difference
Imhazim	103	80	23 (29%)
Mahkama	27	27	0
Wardia	156	116	40 (34%)
Total	286	223	63 (28%)

- All plots were planned as individual family houses

The difference between the VGI and official sources of data was high in both Imhazim and Wardia. However, the percentage difference in the Mahkama area was zero, and this may be because it has been more recently developed than the other two locations.

Table 6.14 Shows the real usage of plots from data collected for the study areas by the volunteers.

Peri-urban communities	Vacant land	Haykels*	Moshtamals**	Houses	Shops	
Imhazim	10	1	31	59	2	103
Mahkama	0	0	0	27	0	27
Wardia	9	2	55	89	1	156
Total	19	3	86	175	3	286

Table 6. Volunteer data on plots

*Haykel = structure/shell of building

** Moshtamal = sub-division of plot or building.

In the peri-urban communities, the major use is housing which was the original design for the plots. The obvious reason for this is the availability of unbuilt on spaces in the area together with the cheap price of land which would motivate people to build large houses. It is also noticeable that the numbers of Moshtamals (sub-divisions of plots) is low in comparison to urban communities, because there is less pressure on residential plots and therefore people can build big houses with large gardens.

Accordingly, the official data does not give an accurate picture of the number of sub-divisions, the use of the plots nor which plots were actually built on and which were still vacant. This information is important because it reflects the degree of change made to the areas without

regard to the official plans or registration of changes. It also shows that the official plan (Figure 6.3) does not represent what people commonly build.

6.4.3 Type of tenure and ways of acquiring the land

Peri-urban community participants were asked about the type of tenure they considered that they had for their property. The main purposes of this question were to evaluate the level of different types of tenure as well as to compare tenure in the peri-urban areas with the other case study sites. The responses were obtained by volunteers during semi-structured interviews with participants from the peri-urban communities (Table 6.15):

Table 6.15 Percentage of plots according to type of tenure

Peri-urban communities	Owned	Rented	Borrowed	
Imhazim	71	24	8	103
Mahkama	24	3	0	27
Wardia	89	56	11	156
Total	184	83	19	286
Percentage	64%	29%	7%	

The majority of participants considered themselves as land owners with low percentages of the other categories of renters and borrowers. Those who considered themselves as owners were asked a further question on the way they acquired their land. This is a very important question to find out the percentage of plots that were obtained illegally or bought in good faith from someone who did not actually have the right to sell. In this matter the answers were divided into three different categories of bought, inherited, or other means. The results are shown in Table 6.16 and indicate that the majority of participants in the peri-urban areas claimed that they had acquired their plot by buying it, with a lower percentage acquiring through inheritance since most of these areas were newly developed and most of the owners were first-generation, or other means. The most significant ‘other means’ reported was squatting.

Table 6.16 Percentage of plots according to mode of acquisition among participants who claimed that they owned the plot)

Peri-urban communities	Bought	Inherited	Other means	
Imhazim	49	5	17	71
Mahkama	11	3	10	24
Wardia	57	6	26	89
Total	117	14	53	184
Percentage	63%	8%	29%	

The data in Table 6.16 were validated by asking next-door neighbours to confirm the data, and the answers are collected in Table 6.17 below. Importantly, the volunteers recognised when people were not telling the complete truth about their tenure, perhaps claiming to have bought it when they had not. This came to light either because the volunteer data collectors themselves knew the claim to be false or when they sought to verify the data through discussion with neighbours.

Table 6.17 Percentage of disagreement on the process of acquiring land as claimed by participants.

Peri-urban communities	Disagreement on the process of acquiring the land
Imhazim	4
Mahkama	2
Wardia	5
Total	10 (out of 184)
Percentage	5%

The results reveal that there were 10 false claims collected from participants seven of them claimed that they had bought the land and the rest pretended that they had inherited it. However, their neighbours said that none of these claims were true and that the land was occupied illegally during the recent wave of migration in 2014.

The official data cannot reveal this situation and it is essential for the authorities to know this so that they can recognize illegal occupation.

6.4.4 Registration of the land with the authority

Peri-urban community participants were asked a question about whether they had registered their land with the official land system or not. The aim of this is to understand the percentage of the land that had been registered with the authorities. This information can be used to estimate the coverage of the formal system in the different communities and to discover the reasons for not registering with the official land system. The answers to this question were limited to a few choices. The first choice is to be registered, which means that the owner of the plot has a formal deed document. The second answer is to be unregistered, which is followed by another question to specify the reason for this situation. The final choice of ‘don’t know’ occurs either because the person was occupying land that did not belong to him/her or because they had their own

system such as the tribal system. The responses were collected and are shown in Table 6.18 below.

Table 6.18 Percentage of plots according to registration status (including renters and borrowers)

Peri-urban communities	Registered	Not registered	Don't know (rent or borrow)	
Imhazim	80	16	7	103
Mahkama	17	7	3	27
Wardia	89	45	22	156
Total	186	68	32	286
Percentage	65%	24%	11%	

The results show that 65 per cent of participants claimed that their plots had been formally registered with the land authorities. However, 24 per cent of plots were not registered in the peri-urban areas, where land is more plentiful and not as expensive as in the urban areas, meaning that there fewer Moshtamals (sub-divisions) have been created. Those plots which are built on generally have only formally registered houses, without informal divisions or alterations.

To verify the above registration claims, the next-door neighbours were again asked. However, most of the neighbours were unable to verify such information because it is personal and only the owner himself or his family knew. Accordingly, this information may only be verified by conducting interviews with different members of the same household at different times. Then, there is also a need to understand whether or not there are problems between community residents concerning the boundaries of their parcels.

6.4.5 Conflicts with neighbours about plot boundaries

The local participants of the peri-urban communities were asked if they had any conflicts over the boundaries of their land parcels. The main purpose of this question is to understand the level of conflict between neighbours over the boundaries of their land parcels and to discover the reasons for it and ways of solving or minimizing it. Furthermore, it is also a good opportunity to identify perceptions among the community concerning the efficiency of the official surveyors in doing their job. The answers were collected and are shown in Table 6.19 below.

Table 6.19 Percentage of conflicts between land owners over the land boundaries

Peri-urban communities	Presence of conflict		
	Yes	No	
Imhazim	16	87	103
Mahkama	5	22	27
Wardia	11	145	156
Total	32	254	286
Percentage	11%	89%	

The results show that most of the peri-urban community participants (254) answered this question in the negative. However, a minority of 32 participants (11%) claimed that they had conflicts with their neighbours and all blamed the professional surveyors who had fixed their boundaries. They solved such problems either through the court or by asking private surveyors to re-fix the boundaries of their parcels.

As with the urban areas, boundary conflict data in the peri-urban areas were not verified, as the main purpose was to understand possible reasons behind the conflicts. For peri-urban areas these can be summarised as the problems were mainly related to a land owner occupying the wrong parcel, that actually belonged to a neighbour, or extending his parcel onto the neighbours.

6.5 VGI attribute accuracy in rural areas

The two rural areas chosen for the research were Dloaa and Aries in the West of Al-Hillah, the former located near the Euphrates River and the latter closer to the city. The attribute data that were collected via volunteers through questionnaires are shown as follows.

6.5.1 Ownership data

Ownership details were collected, and the percentage disagreement in validating ownership data by consensus was low across the two different rural areas, as shown in Table 6.20 below.

Table 6.20 Verification of ownership data by crowd-sourced agreement

Study area	No. of plots tested (Mainly agricultural)	No. of plots with inconsistencies in named owner between volunteer-collected data and crowd-sourcing
Dloaa	66	2
Aries	14	0
Total	80	2

The results show that there was nearly full agreement (except in two cases) in the ownership data that was collected by groups of volunteers in both rural communities. There were two reasons for this. Firstly, the data were collected by volunteers who had lived in the communities for a long time (see Table 6.21 below). Secondly, most of the rural dwellers belong to tribes who had lived there for a few generations, and so they were well known by the volunteers. It can be concluded that the ownership information obtained from these groups of individuals was correct, and could be used for validation and for informing the official LAS organisation.

Table 6.21 Percentage of volunteers according to duration of residence on the plot

Rural community	< 1 year	1-5 years	>5-10 years	>10 years	
Dloaa	2	2	3	12	19
Aries	0	0	0	8	8
Total	2	2	3	20	27
Percentage	7%	7%	11%	75%	

In the rural communities, the majority of the volunteers had lived in the area for more than 10 years, which also helps to explain the reason for the high percentage of inheritance ownership (see Table 6.25).

6.5.2 Land use change

The local community volunteers in both sites in the rural areas of Dloaa and Aries were asked to walk through the community and describe the current status of 80 selected plots to identify the number of plots and sub-divisions of plots and changes of use. They then asked community participants about the kind of property they owned and what it was used for. The aim of this question was to discover changes in land use in the different communities, as well as the number of sub-divisions and the problems associated with them. The rural areas were all formally

planned as agricultural land (see, for example, of the out-of-date Aries official map in Figure 6.6).

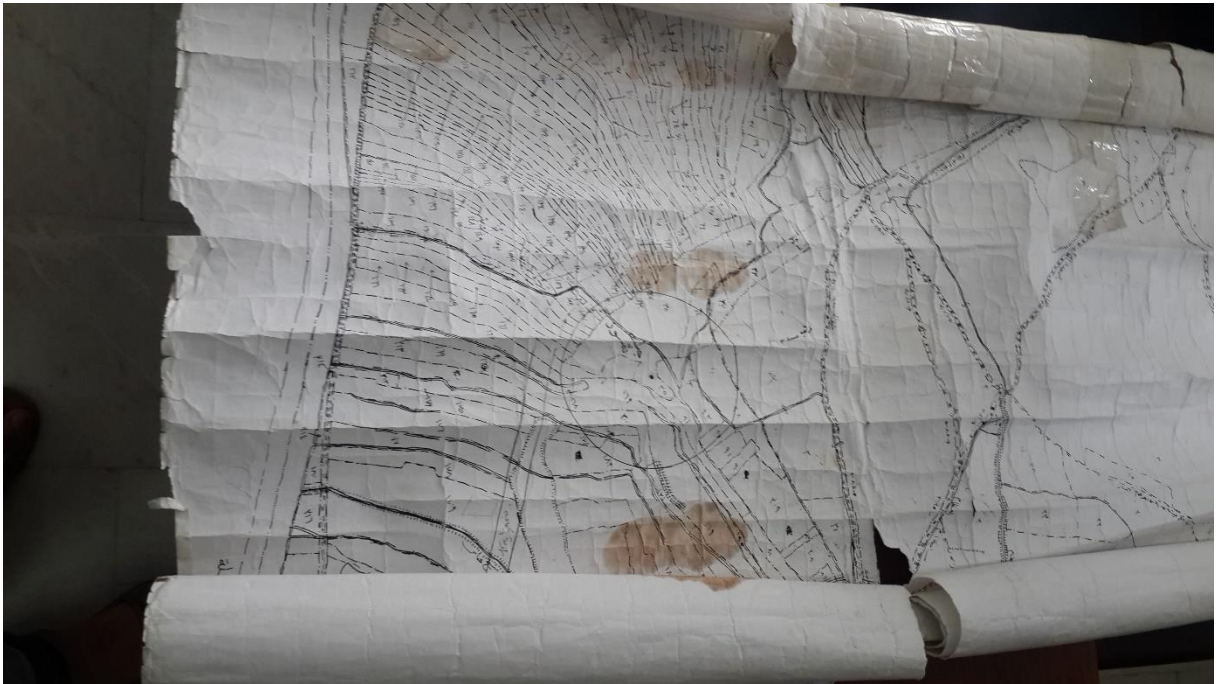


Figure 6.6 Official map of the Aries community without clear knowledge of current subdivisions.

The map shown is an old map for the Aries agricultural area that does not coincide with current developments in the area nor with the aerial image, because the area has witnessed the reclamation of agricultural land which has created a totally new irrigation system. Accordingly, all the traditional agricultural land boundaries were removed and replaced by new channels of irrigation which are not in the same places as the previous boundaries. VGI data collected by the community participants was used to provide an updated version of the Aries community as shown in Figure 6.7.

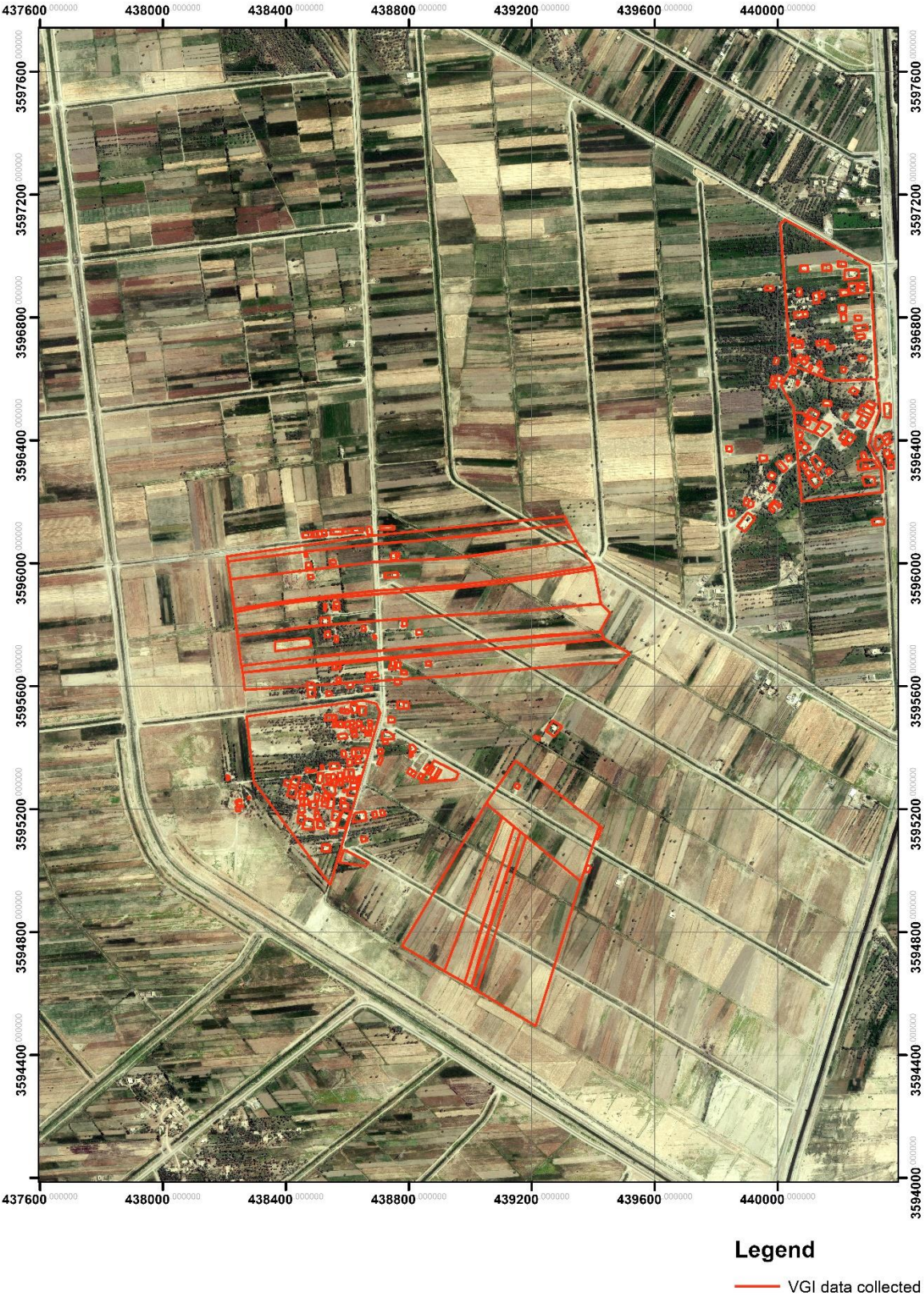


Figure 6.7 Volunteer marking up of land parcel boundaries in the Aries rural community

Across the two study areas the formal plans indicate there should be 80 plots for agricultural activity.

However, as seen in Tables 6.22 and 6.23, the volunteers identified a very different picture, with a total of 728 ‘units of development’, each categorised by volunteers on the ground into types of use.

Table 6.22 Differences between the VGI and official data over the number of plots

Rural communities	VGI data	Official data	Difference
Dloaa	522	66	456
Aries	206	14	192
Total	728	80	648

- All plots were planned as agricultural land for growing crops and associated development such as farmhouses

Table 6.23 Numbers of plots according to categories

Rural communities	Houses	Fish ponds	Poultry fields	Cattle fields	Shops/ storage	Agricultural land	
Dloaa	368	2	5	26	68	53	522
Aries	175	0	2	8	7	14	206
Total	543	2	7	34	75	67	728

The results reveal that the actual categories of plot and land use in the rural communities differ greatly from those within the formal plans. The major differences occurred in 18 agricultural plots which have changed totally or partially (where part of them was still used for growing crops) to become residential areas by dividing the original plot into small parcels and then selling them separately to other people. However, the data held by the land administration department is quite different, and does not give an accurate picture of the number of subdivisions or the usage categories of the plots. This information is important because it reflects the very high degree of change made to the areas without regard to official plans or registration of changes. This emphasises how out-of-date the official data is and how little the authorities know about the population levels and different land uses in these areas. The professionals were very interested in this data as they are trying to control the change land use from agricultural to residential.

6.5.3 Types of tenure and ways of acquiring the land

The local community participants in both rural sites were asked about what type of tenure they considered they had for their plot. The main purpose of this question is to evaluate the different types of tenure as well as comparing tenure in rural areas with the other case study sites. The responses were obtained by volunteers during semi-structured interviews with the participants from the rural communities (Table 6.24)

Table 6.24 Percentage of plots according to type of tenure

Rural communities	Owned	Rented	Borrowed	
Dloaa	52	4	10	66
Aries	12	2	0	14
Total	64	6	10	80
Percentage	80%	8%	12%	

The majority of the interviewees (80 per cent), considered themselves to be land owners with low percentages in the categories of renters and borrowers. The main reason for this situation is that most of the agricultural land owners had inherited their land from their fathers or grandfathers. It was rare to find land sold to strangers in tribal communities.

Those who considered themselves as owners were asked a further question how they had acquired their land. This is very important in identifying the percentage of plots that were obtained illegally or bought in good faith from someone who did not actually have the right to sell. The answers were divided into three different categories of bought, inherent, or other means. The answers are summarised in Table 6.25, showing that the majority of the people in the rural areas claimed that they have acquired their plot by inheriting it with a lower percentage acquiring through buying or other means. The most significant ‘other means’ was squatting.

Table 6.25 The percentage of ownership of plots according to method of acquisition according to participants who claimed that they owned their plots.

Rural communities	Bought	Inherited	Other means	
Dloaa	13	37	2	52
Aries	1	8	3	12
Total	14	45	5	64
Percentage	22%	70%	8%	

The results show that the majority (70 per cent) of participants in the rural areas had inherited their land. This data was validated instantly (Table 6.26 below) by asking neighbours to verify the data.

Table 6.26 Percentage of disagreement on the process of acquiring land as claimed by participants.

Rural communities	Disagreement on the process of acquiring the land
Dloaa	3
Aries	1
Total	4 (out of 64 plots)
Percentage	6%

The results reveal that there were only four cases of disagreement, 2 of which pretended that they had inherited the land and the other 2 pretended that they had bought it. However, all the surrounding neighbours said that this was not true and that there were problems with that land. The official data cannot reveal the means by which land is acquired, yet it is essential for the authorities to know this so that they can recognize illegal occupation.

6.5.4 Registration of land with the authority

The main purpose of investigating the formal registration records was to find out whether people had a good relationship with the land administration authority or if they had used their own system that allowed them to sell and buy without engaging with the authorities (Table 6.27).

Table 6.27 Percentage of plots according to registration status

Rural communities	Registered	Not registered in his/her name	Don't know	
Dloaa	17	42	7	66
Aries	7	5	2	14
Total	24	47	9	80
Percentage	30%	59%	11%	

The percentage of unregistered land was high (59%) in the rural communities. This is because the records indicated owners who had passed away a few generations ago, so that the current inheritors did not own the land formally in their own names.

6.5.5 Conflicts with neighbours concerning boundaries

The local volunteers in the rural communities were asked if they had any current or previous problems with their neighbours concerning the boundaries of their parcels and the reasons for such conflicts if they existed. The main aim of the question was to understand if the current land system adequate and if there were problems between people concerning land boundaries. Their answers are collected in Table 6.28 below

Table 6.28 Percentage of conflicts between land owners over the land boundaries

Rural communities	Yes	No	
Dloaa	42	24	66
Aries	5	9	14
Total	47	33	80
Percentage	59%	41%	

The percentages of conflicts about boundaries were high in the rural areas. The best explanation for this is that the majority of owners were inheritors who always seemed to have problems regarding the boundaries, and eventually they needed to call on the head of the tribe for resolution. The next section of this chapter deals with the spatial accuracy of the data that was collected by volunteers in different communities.

6.6 Reflections on attribute data handling

There were many differences between the formal and VGI data in relation to numbers of plots and households. Therefore, it can be concluded that the understanding among municipal authorities of the level of services needed in their area may be inaccurate. Without accurate land occupancy data, the municipality and central government cannot estimate how many schools or hospitals are required or what the demand for water or energy is now or is likely to be in the future. Urban planners cannot draw up valid planning for the area and transport planning and engineering cannot be based on sound predictions of future demand.

The collection of this attribute data also revealed important points about the practicalities and use of VGI, which are discussed in Chapter 7. Primarily, it is clear that VGI has significant potential to assist in collecting and updating relevant and important attribute information for the purposes of strategic planning as well as maintaining land records.

Part two: Spatial accuracy

Having considered the nature of the attribute data collected and processed by community volunteers and discussed in the first half of this chapter, the next sections aim to assess, and

compare together the other aspects introduced in Section 6.2: positional accuracy, completeness and currency of the spatial data collected by volunteers over large areas. This included assessments of the familiarity of the volunteers with the use of mobile phones, tablet computers and desktop computers before they received training, and finding out how the volunteers felt about using the different data collection tools of smart phone, iPad, and paper-printed aerial images after they received training and written guidelines to enable them to identify the boundary points of their own plot or those of other properties using the different methods.

It became clear during the data collection and analysis, that the specific topography and land use of an area had an effect on the accuracy of the spatial data collected. For that reason, this section is structured according to the type of area, and an attempt is made to link the nature of the environment with the results obtained.

6.7 Spatial accuracy in urban areas

The field data collection activities which were undertaken in the four urban areas of Jawahry, Moharbeen, Zahawy and Fatima also involved the consideration of data related to positional accuracy, completeness and currency. Communities were consulted, volunteers identified, officials interviewed, volunteer data collected, and existing official mapping compared. Examples of the main issues in data collection were identified as follows.

6.7.1 Familiarity of volunteers with technology

Local community volunteers were asked about which of the technologies of mobile phones, tablet computers and desktop computers they had used before. The main aim of this question was to understand their familiarity with the use of the technology. The results helped the researcher to build a framework for the best ways to collect VGI according to the ability of the volunteers and the availability of technologies in different communities (Table 6.29).

Table 6.29 Familiarity of the urban community volunteers with the use of different technologies

Urban areas	Mobile phone	Tablet	Desktop computer	None
Jawahry	7	5	5	2
Moharbeen	7	3	3	3
Zahawy	5	4	5	2
Fatima	10	6	5	0
Total	29	18	18	7

The results reveal that there were differences among the volunteers. Some of them had not used any of the technologies before while others had used one or more than one before.

The majority (29) volunteers across all the urban communities were more familiar with using smartphones. However, a minority of the volunteers (7) in the communities claimed that they had never used any of the technology.

It is clear that this research involves a majority of people who had some familiarity with information technology.

6.7.2 Volunteers' feelings about the methods of demarcation

Before asking volunteers about their feelings toward the data collection methods, they were given training and written guidelines to enable them to carry out a preliminary test exercise in identifying the boundary points of their own plot or other properties using the different methods. The three methods developed and used are described in Section 3.3: firstly a smartphone, with a GPS app uploaded, was used for a) locating land parcel corners in the field, which is potentially a time-consuming and high-profile activity on the streets and b) adding attributes to the resultant polygon. The second method involved a portable iPad tablet PC with the official cadastral map uploaded, with an overwriting and annotating capability provided through QGIS: this method required validation and a visual overview in the field, but no measurement. Finally paper-printed aerial or satellite images were used, with a clipboard and pencil for demarcation and annotation, and this procedure also involved field visits, which often resulted in less detailed data (see Figure 6.8 below).



Figure 6.8 Data collection methods applied in different geographical contexts: (i) smartphone GPS in urban centres; (ii) tablet computer in urban centres; (iii) paper aerial image in rural areas

Then, after completing this exercise, the local community volunteers were asked “which of the methods they found find easiest to use and why. (Table 6.30 below). The main purpose of this question was to identify the easiest way for volunteers to collect geospatial data. Justifications for their choices were been collected from volunteers. The outcomes helped to confirm that each of the three methods were favoured by different people.

Table 6.30 Easiest method of demarcation selected by urban community volunteers

Urban community	GPS / smart phone	Edit map with iPad	Using paper image	
Jawahry	3	6	3	12
Moharbeen	2	3	5	10
Zahawy	3	6	4	13
Fatima	3	5	3	11
Total	11	20	15	46
Percentage	24%	43%	33%	

The results show that the majority of volunteers selected the iPad as their first choice. This device was chosen by most young volunteers, who routinely used iPads in their everyday lives. It was also selected because of the effective interaction with the screen; for example, in zooming in and out of the map. The use of paper images for demarcating land parcels was also popular (33% of responses). This was particularly chosen by older people who were familiar with this traditional way of working and found it enjoyable to do this kind of volunteer work. Uneducated and less technologically aware people also found that the easiest method of demarcation was the analogue way. The least selected choice was to collect coordinate points for the corners of the parcels using smart phone. The main reasons for their choices were that most of the men preferred not to spend time visiting the land parcels in the field and finding GPS points, because they had little free time from their daily jobs. Another reason for the lower popularity of smart phone was that the older people preferred not to spend time collecting data on the street corners and found that their visibility in urban areas using high-technology equipment was unsettling.

6.7.3 Positional accuracy results from VGI of urban areas

Significant outputs from this project include the testing of VGI datasets against the official records. Such testing of accuracy is accomplished by matching land parcel corners and boundaries from the VGI with data in the formal LAS documentation, which may be a map or a list of coordinates. Each of the three technologies was used to capture a dataset in each of the nine areas (with two exceptions, as described in section 6.9.2), and so significant numbers of data points were captured and compared. Values of positional accuracy for the datasets created using each data collection method were calculated for each site. This involved a RMSE analysis of the coordinated corner points of land parcels, assessing the discrepancy between the positions captured using the three methods utilised and the coordinates of those points as shown in the official map records. A customised dashboard tool developed in Matlab for the calculation and visualisation of the RMSE and other measures (Fairbairn and Al-Bakri, 2013) was used to quantify the discrepancies between VGI and official data (Figure 6.9 below).

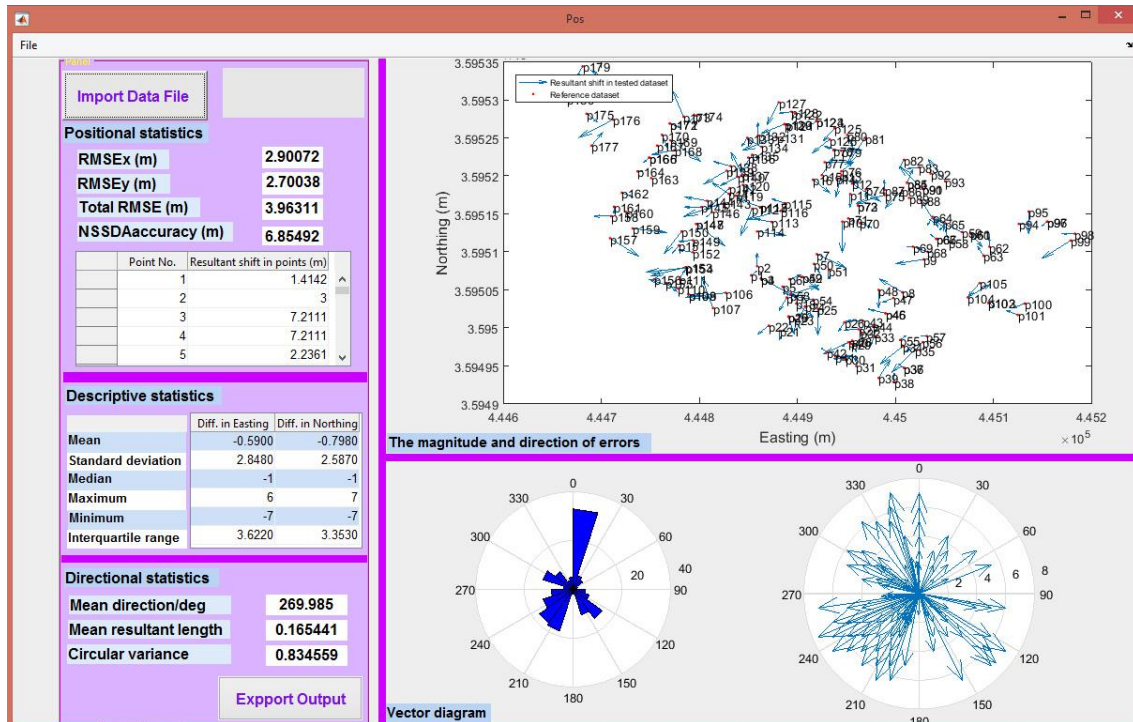


Figure 6.9 Calculation and visualisation tool for accuracy testing of VGI points captured by GPS compared to parcel coordinates from official mapping in the Moharbeen urban area of Al-Hillah

The calculated RMSE values were consistent for each data collection method within each urban zone and across the urban zones, but the summary statistics presented in Table 6.31 do indicate some variation.

Table 6.31 Root mean square error (RMSE) values for parcel corners for datasets compared aggregated by locality.

Urban communities	No. of points tested	RMSE smartphone and official	RMSE iPad and official	RMSE paper photo and official
Jawahry	158	4.046m	1.482m	2.241m
Moharbeen	181	3.963	1.037	1.706
Zahawy	187	4.655	1.249	3.306
Fatima	252	4.599	1.541	2.787
Total	778	4.364	1.357	2.615

The results of the RMSE method in analysing the VGI collected in urban areas reveal that the data collected using iPad to create or update the official maps achieved the best accuracy in comparison with the other tools used for demarcation. The results also appeared to be consistent across all the urban communities with an average accuracy of 1.35m. However, the analogue

and smartphone methods appear to be less accurate, with average accuracy scores of 2.6 m and 4.3 m respectively.

The iPad worked well because of the large, well-lit screen, the ease of use of the digital stylus pen for annotation, and the effectiveness of interaction with the QGIS software loaded to it. Furthermore, it was an attractive tool for most of the youngsters and those experienced with modern technology to show their ability in using the technology.

The smartphone GPS did not work very well in high density urban areas because of limited satellite visibility, especially in the Zahawy and Fatima areas with high buildings where the overall accuracy was found to be a high value of ~ 4.5 metres. Typically, a land parcel corner was measured using only 4 or 5 visible satellites, and accuracy estimates presented on the smartphone by the GPS Essential software indicated the relatively low reliability of the positions captured.

The final method of drawing the boundaries of the parcel using a pen and printed aerial image was also attractive and was appreciated by many of the volunteers in the urban communities. However, there were some differences in accuracy across the four selected urban communities. The most accurate results were found in Moharbeen and Jawahry, with accuracies scores of 1.7 and 2.2 metres respectively. The other communities appeared to have less accurate data, with scores of 3.3 and 2.7 metres for Zahawy and Fatima respectively. The main reasons for such discrepancies in accuracy are differences in the personal characteristics of the volunteers. For example, having difficulty in drawing graphics on paper using a pen, problems in identifying features in the images, care and precision taken in drawing boundaries, misinterpretations of images such as confusing the shadows of walls with the real boundaries of the parcel, and in some cases owners were tempted to expand the boundaries of their properties on the recorded image. The following Figure 6.10 - 6.13 show the three collected VGI layers for each selected urban areas of Jawahry, Moharbeen, Zahawy and Fatima respectively.



Figure 6.10 Three VGI layers for Jawahry urban community



Figure 6.11 Three VGI layers for Moharbeen urban community



Figure 6.12 Three VGI layers for Zahawy urban community



Figure 6.13 Three VGI layers for Fatima urban community

6.7.4 Completeness

Completeness is a property of the land administration system data which has connections to other attributes which have already been discussed, such as land use change, ownership etc., and explained in Section 6.3. It also covers issues related to the capture of land parcel sub-division information, which is the primary data requirement addressed in this chapter.

The total number of plots identified has been compared for each case study site, and a significant difference between the formal data and VGI quantities has been found. Whereas 1235 urban plots are marked on the official map, 2133 plots were observed by the volunteers.

In the urban area there has been a significant increase in plot numbers due to sub-division of plots. For example, one land parcel believed by the authorities to be a single plot was shown to have been sub-divided into three separate plots as shown in Figure 6.14 (1). Two of these were used for housing and the third consisted of several small shop, with a flat above. In another case, one owner of two large individual housing land plots had combined them to produce one plot now containing five houses (2). Other locations highlighted a radical change of use, such as from purely residential to multiple use, including areas where all houses now had shops at the front (3).



Figure 6.14 Sub-divisions of plots in urban areas

6.7.5 Currency of data

Volunteers were asked about their opinions of the official cadastral maps and the difference that they could highlight between the maps and current developments. There was common agreement about some of the main problems, which have been collated and presented in the following points. Firstly, the maps were very old and there were many changes in the sizes of plots, as most of the big plots had been rebuilt as Moshtamals. Secondly, some plots had been used in order to expand roads. For example, there are plots in the Moharbeen district as shown in Figure 6.15b which have been used for this purpose. However, they still appeared to be

parcels on the official cadastral map. Next, the urban areas had been developed and expanded, while the old official maps did not mention such expansion. For example, Figure 6.15c shows that the Jawahry urban community had expanded and many plots were built on, whereas the official cadastral map showed no sign of these changes. Furthermore, spaces that were designed in the communities as garages or vacant land were occupied and used by people to build their own houses illegally. For example, Figure 6.15d shows the open spaces that can be seen next to each block of parcels on the cadastral map of the Fatima urban community, but these are no longer open because people have occupied them.

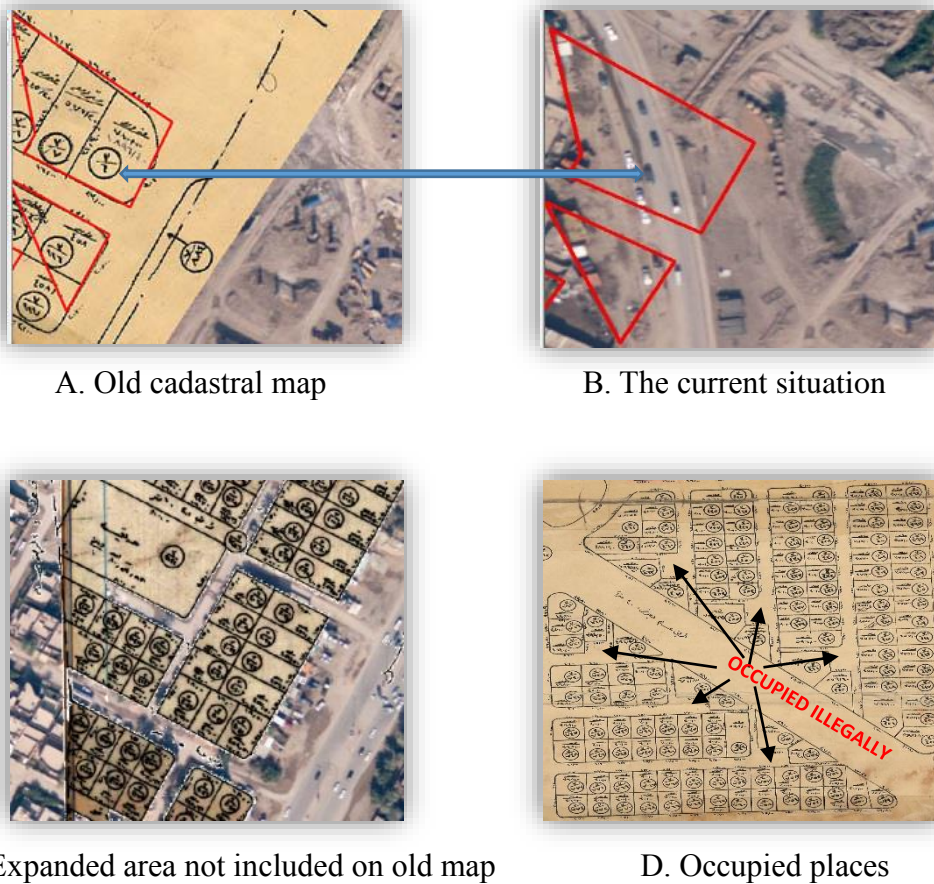


Figure 6.15 Changes/Updates to be applied on official cadastral maps. The red boundary lines in A and B outline plots that were affected by expanding the road. C shows an area developed but not updated on the official map, and D shows the spaces that were occupied

6.8 Spatial accuracy in peri-urban areas

As with the urban areas, issues of technology and accuracy in the peri-urban parts of the city of Al-Hillah were addressed, and similar conclusions were drawn. The field exercises undertaken in Imhazim, Mahkama and Wardia peri-urban areas as described earlier provided data which are discussed below.

6.8.1 Familiarity of volunteers with technology

Peri-urban community local volunteers were asked about whether they had used mobile phones, tablet computers or desktop computers before. Their answers were collected and are presented in Table 6.32 below.

Table 6.32 Familiarity of the peri-urban volunteers with different technology

Peri-urban community	Mobile phone	Tablet	Desktop computer	None
Imhazim	8	2	4	4
Mahkama	7	7	4	2
Wardia	12	5	4	2
Total	27	14	12	8

The results show that, as a result of increased mobile phone usage in the past 10 years, the majority of volunteers were familiar with using them. The other technologies of tablets and desktop computers appeared to be less familiar to them. There were some people who answered that they had not used any of these technologies before.

6.8.2 Volunteers' feelings about the methods of demarcation

Peri-urban local volunteers were asked about their feelings towards using the three methods of demarcation and which they found easier and why. Their answers are summarised in Table 6.33.

Table 6.33 The easiest methods of demarcation as selected by peri-urban community volunteers

Peri-urban community	GPS / smart phone	Edit map with iPad	Using Paper image
Imhazim	6	2	5
Mahkama	5	1	4
Wardia	6	4	4
Total	17	7	13
Percentage	46%	19%	35%

The majority of the local peri-urban community volunteers (46%) felt that using smartphone for the purpose of collecting GPS coordinate was very easy and they would like to use them more in the future. The second most preferred tool (35%) was the traditional way of demarcation with ordinary paper and pens. However, unlike those in the urban areas, volunteers in the peri-urban zone judged the use of the iPad the least preferable method of demarcation.

The main reasons for the volunteers' preferences of mobile phone were the easy access to all of the corner of the parcels because the areas were not fully built on; the good visibility of satellites which minimized the time taken to find GPS points; familiarity with and confidence among most of the volunteers in using smartphones and having fun and the feeling of doing a real surveyor's job in going around the plots to get GPS points.

Demarcation using paper aerial images was also a highly attractive method for the local volunteers: the briefing after data collection led them to feel part of a team. It was also deemed to be suitable for all ages, and especially the elderly, and it was easy to identify the boundaries of their parcels as the areas were in the development stage and were not yet fully built up so that there were spaces between the plots.

The least attractive tool, as described by the volunteers after trying all three of them in the field, was the iPad. This was attractive to only a few volunteers because not many of them were familiar with it. The level of education of those in the peri-urban communities was generally lower than in the urban communities and there was also an influence of preferences.

6.8.3 Positional accuracy results from VGI for peri-urban areas

The geospatial data collected by the volunteers from the three peri-urban areas of Imhazim, Mahkama and Wardia was examined and analysed to compare the positional accuracy of the three different methods in relation to the official data collected by professional surveyors in the Al-Hillah land administration office. A customised dashboard tool developed in Matlab for calculating and visualising the RMSE and other measures was used to quantify the discrepancies between VGI and official data, as shown in Figure 6.16.

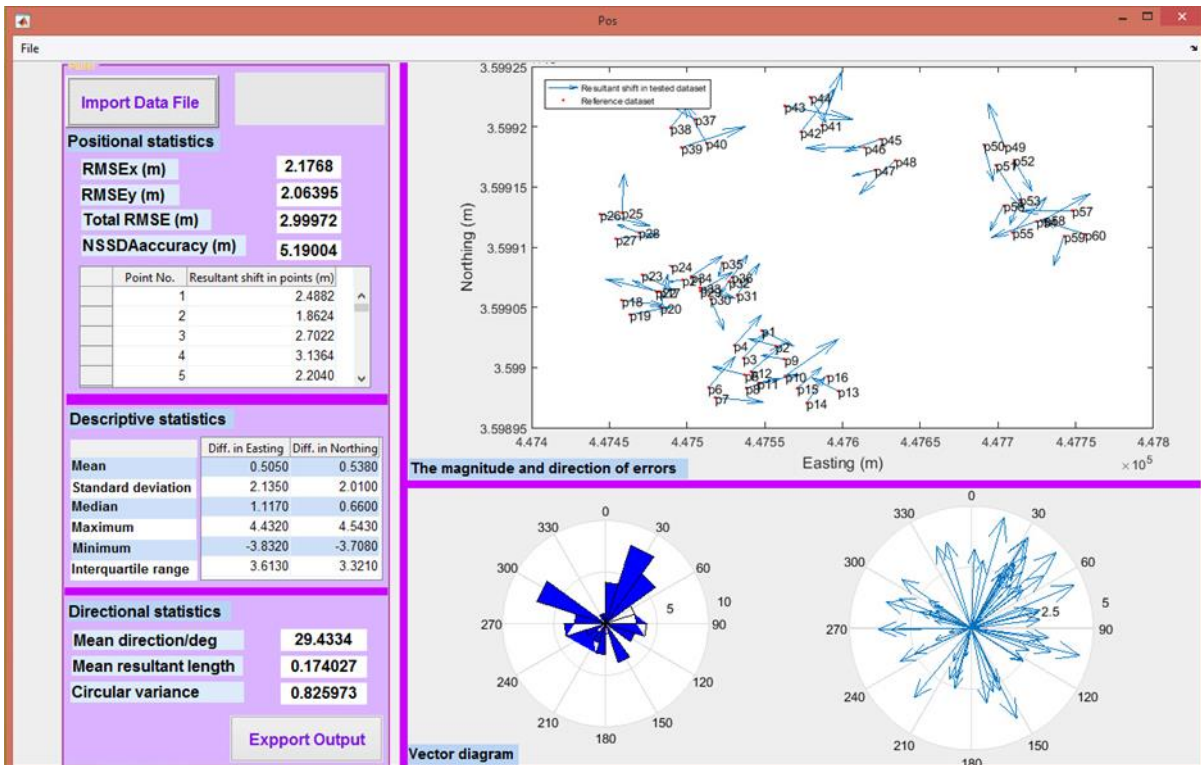


Figure 6.16 Calculation and visualisation tool for RMSE with VGI points captured by GPS compared to parcel coordinates from official mapping in the Mahkama peri-urban area of Al-Hillah

The results of the positional accuracy tests for all peri-urban communities are shown in Table 6.34 below:

Table 6.34 Root mean square error (RMSE) for a sample of peri-urban community plot corners in the datasets compared

Peri-urban community	No. of points tested	RMSE smartphone and official	RMSE iPad and official	RMSE paper photo and official
Imhazim	68	2.710m	1.482m	2.341m
Mahkama	60	2.999	1.337	2.365
Wardia	180	2.992	1.308	2.067
Total	308	2.933	1.354	2.190

According to the RMSE results of the for the three communities, the use of the iPad achieved the best accuracy even though most of the local volunteers were not familiar in using it. The main reasons for this are that the volunteers received effective training and support from the researcher, and the ability to zoom in and out helped people to choose the scale they preferred and they were more careful and precise in following the instructions about demarcation.

The accuracy of the geospatial data collected with pens and paper-printed aerial images scored an average accuracy of about 2 metres, which is acceptable as the scale of the photographs was

about 1:1500; however, the volunteers were a bit faster and less precise in drawing the boundaries.

The least accurate method was the use of the smartphone GPS, which achieved an average accuracy of about 3 metres. This was the best level of accuracy that could be obtained from the smartphone for the peri-urban communities. Although, the accuracy was not high, the measured positions could be used to give approximate locations for the specific plot. The following Figure 6.17-6.19 show the three collected VGI layers for the selected peri-urban areas of Imhazim, Mahkama and Wardia respectively.

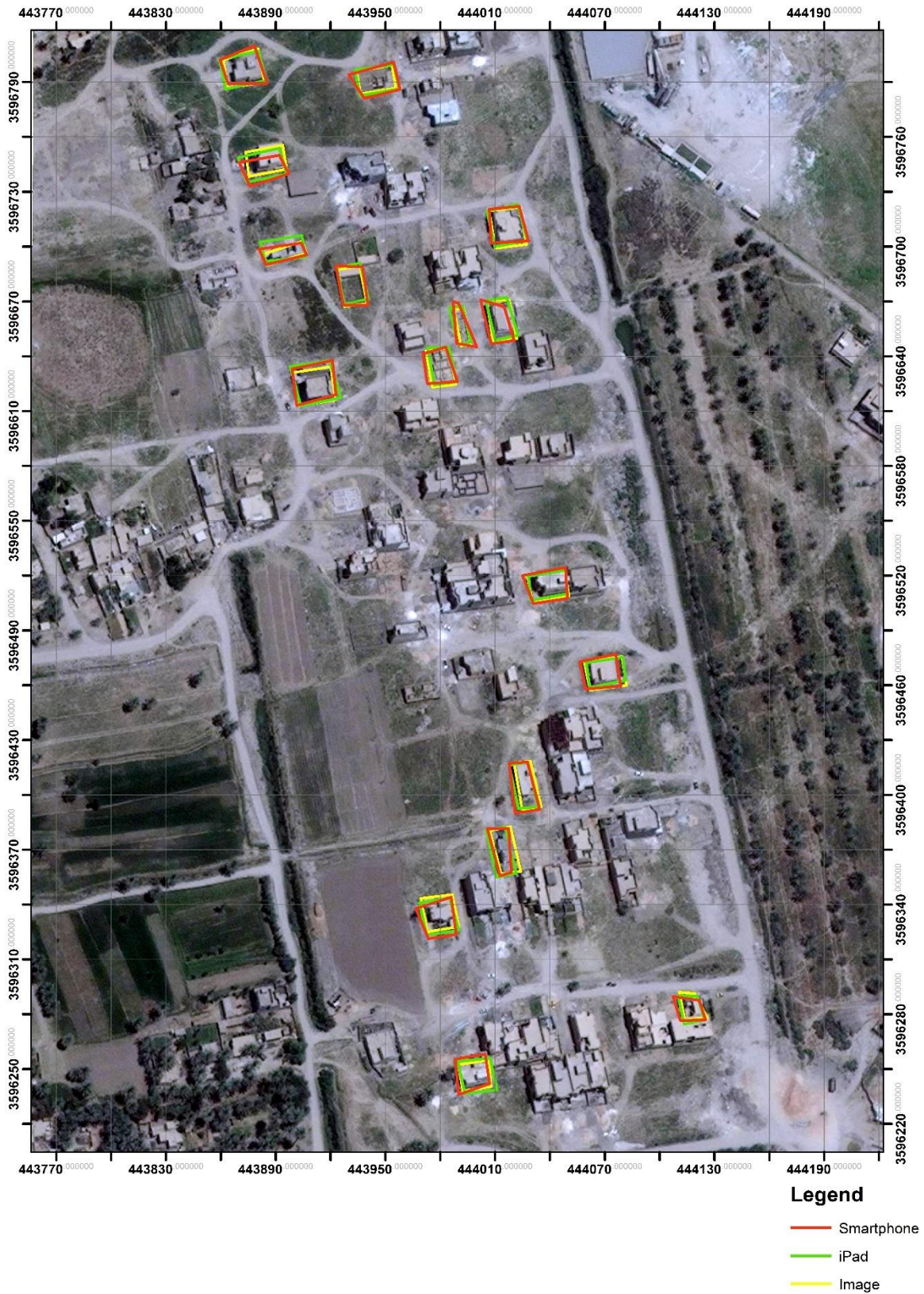


Figure 6.17 Three VGI layers for Imhazim peri-urban community

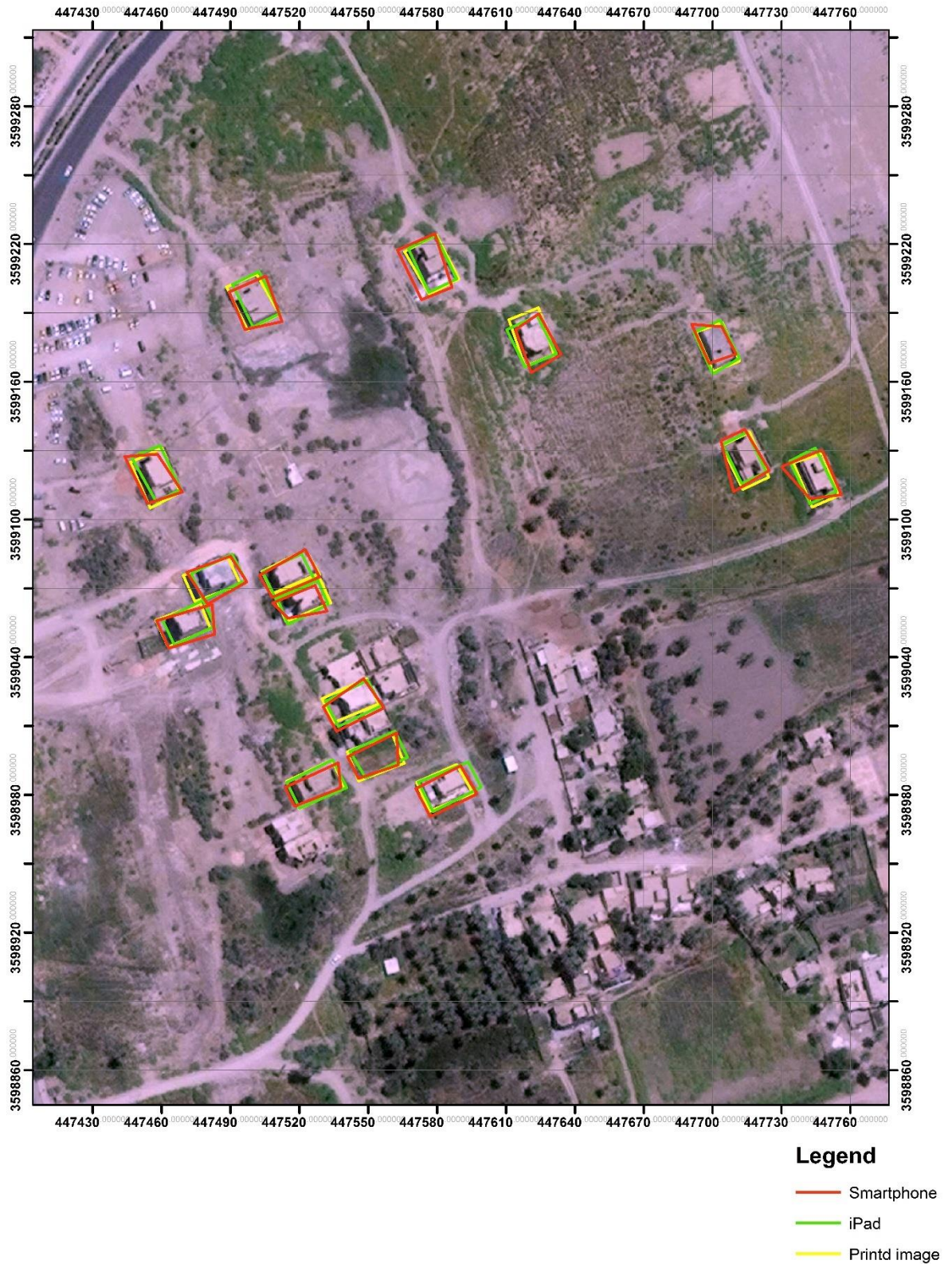


Figure 6.18 Three VGI layers for Mahkama peri-urban community

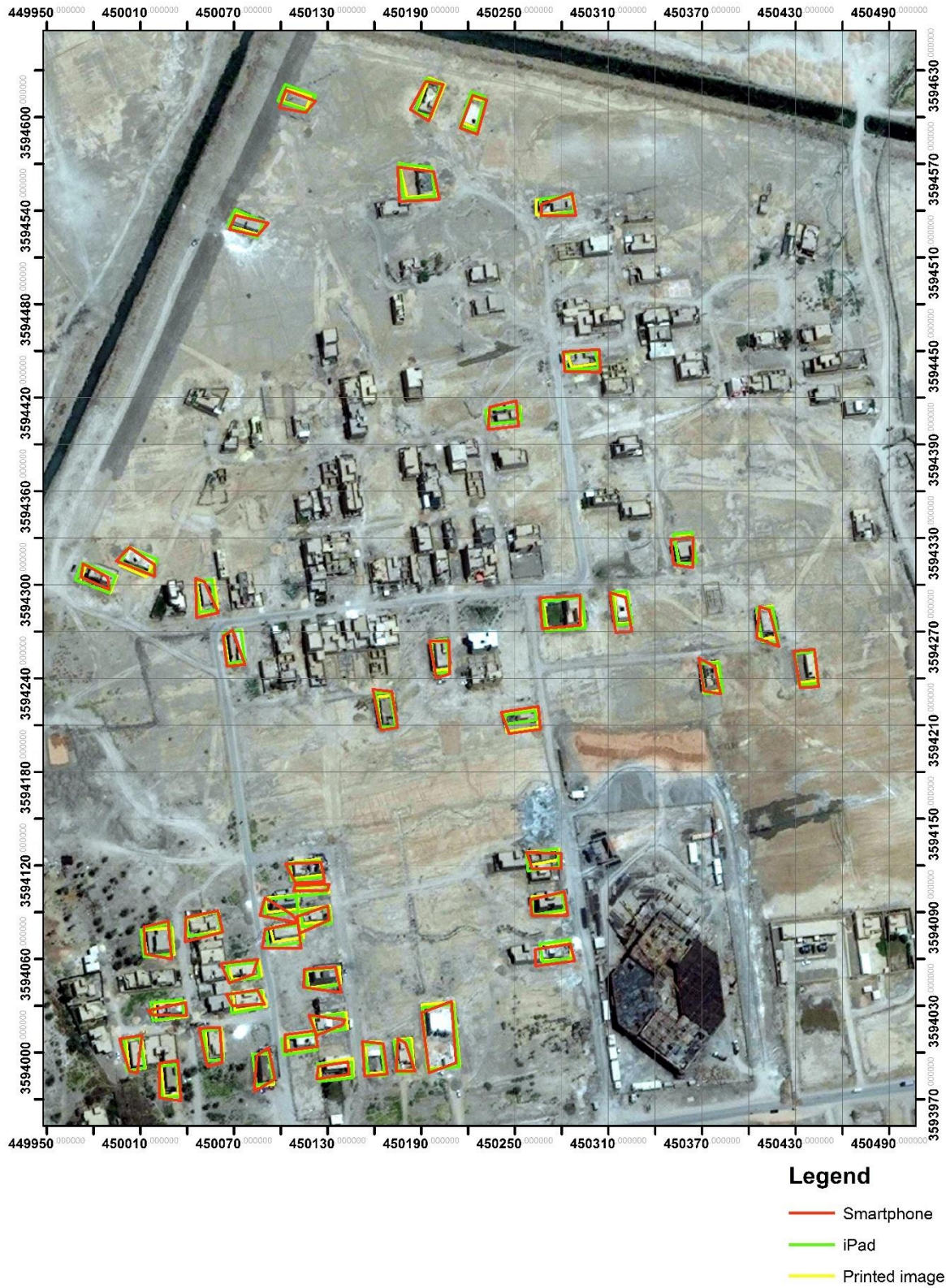


Figure 6.19 Three VGI layers for Wardia peri-urban community

6.8.4 Completeness

The total number of plots identified have been compared for each case study site, and a significant difference between the formal and volunteer quantities has been found in the peri-urban areas, with 223 plots on the official map and 285 plots observed by the volunteers.

The formal data for peri-urban sites was more in line with what volunteers found, and therefore considered to be more complete because these areas exhibit less change than urban areas. This is because of the lower land values, which makes sub division less financially beneficial.

In addition, the population is more settled and stable, with a lower rate of turnover. However, some sub-division does take place. The sub-divisions in peri-urban areas were different from those in urban areas because there is a noticeable lack of vertical sub-divisions: here horizontal (plan-based) sub-divisions were most common (see Figure 6.20 below). This might be due to the abundance of space in these communities and a lower density of built-up plots.



Figure 6.20 Two Moshtamals in Imhazim peri-urban district

The professionals were interested in the data about sub-division in peri-urban areas. They suggested that they may use such data to consider the possibility of changing the minimum size of plots that can be registered in peri-urban areas or they may use this data to plan utilities and roads. They also need accurate data about sub-divisions to help in long-term planning.

The nature and environment of the peri-urban communities were also different from urban areas because of the low numbers of land parcels which were occupied and subdivided compared to the plan (e.g. compare planned Wardia (Figure 6.5) and what was actually built in Wardia (Figure 6.19)).

6.8.5 Currency of data

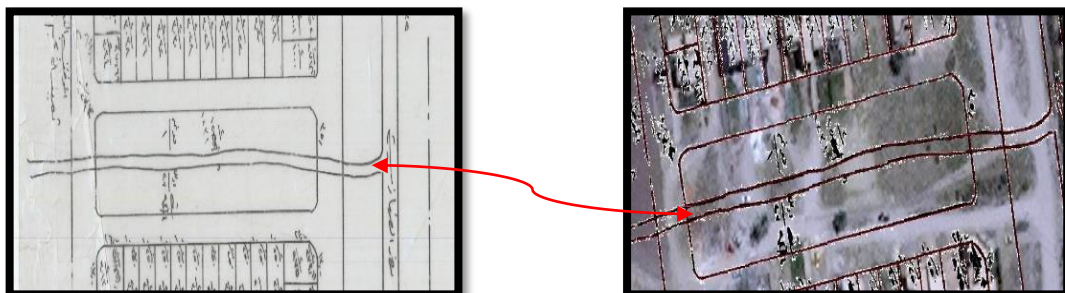
The peri-urban local community volunteers were asked about their opinions of the official cadastral maps of their communities and the differences that they could find between these maps and current developments. There was common agreement between the local residents about some changes that had happened in their communities but where the cadastral maps had not been updated. Their opinions have been collated and are summarised in the following points. The maps were very old and do not represent the current development in the areas. For example, one whole block of parcels in the Al-Mahkama urban community which was considered to be a heritage site where no one was allowed to build on it. However, this block still appears on the official cadastral map (Figure 6.21). Secondly, some land use changes were not updated on the cadastral map. For examples, a small river channel in the peri-urban area of Imhazim had dried up and residents on both sides of the channel had occupied the area and changed it to become their own space (Figure 6.22).



A. On the map

B. Currently as garage and empty land

Figure 6.21 A block of plots that needs to be removed from the official cadastral map



C. The river on the map

D. The river is no longer flow

Figure 6.22 A river that needs to be removed from the official cadastral map

6.9 Spatial accuracy in rural areas

The rural areas consisted of two main communities. The first community is named Abo Dloaa, which is situated to the west of Al- Hillah (between the cities of Babylon city and Karbala). It was mapped during the British colonisation in 1921. It was mostly used as an agriculture area where the major crops were dates, wheat and barley. However, in the last 14 years since the fall of the previous regime much of this land has been sub-divided or changed to residential and sold to hundreds of owners without recourse to the government.

The second rural site is Abo Aries, which has witnessed the reclamation of agricultural land which has created a totally new irrigation system. Accordingly, all of the traditional agricultural land boundaries have been abolished and replaced by new channels for irrigation which might not be in the same places as the previous boundaries. This led the owners of the lands to agree on new boundaries. For this reason, none of the old authoritative maps of this area coincide with the new real boundaries on the ground. Here there was a total dependence on the crowd-sourced data to verify the VGI data collected without comparing it with the authoritative data which is out of date.

During the interviews with the local community volunteers, they were asked about their familiarity with the use of technology and were permitted to choose one, more than one or even no technology at all. The main purpose was to gain a rough idea about the potential success of using different tools for collecting geospatial data in the rural areas for this project and for future projects.

6.9.1 Familiarity of volunteers with technology

The local community volunteers in the two rural communities were asked about their familiarity with the use of mobile phones, tablet computers or desktop computers. The answers were collated and are shown in the following Table 6.35

Table 6.35 Familiarity of the rural community volunteers with the use of different technologies

Rural community	Mobile phone	Tablet	Desktop computer	None
Dloaa	13	2	3	7
Aries	5	3	2	3
Total	18	5	5	10

The results for the first community of Dloaa reveal that most of the volunteers were familiar with smartphones, the use of which has become widespread very rapidly in Iraq in the last 10

years. The volunteers added that they had some idea about how to download apps from the apps store for mobile and were also familiar with YouTube. However, very few of them had used smartphones for the purposes of locating their own places. On the other hand, some of the volunteers mentioned that they were familiar with tablets or desktop computers. Some of them mentioned they did not need to use tablets or desktop computers because the availability of mobile phones with internet services satisfied their needs.

In the other community of Aries one-third of the volunteers mentioned that they were confident in using mobile phones while the others chose the other categories.

The results obtained from these two communities show that the most common technology that people were familiar with is the mobile phone. This led to optimism about their acceptance of using mobile phones in this study. However, the second most frequent category of responses in the two communities was that the people had not used any of the technologies before. These were mainly elders or uneducated people, leading to optimism about their use of the traditional method for the identification of parcel boundaries using aerial images and pens. For this reason, all the possible ways of demarcation were offered and they were asked to first try all the methods of demarcation and then to decide which they prefer to use and why.

6.9.2 Volunteers' feelings about the methods of data collection

At the end of training and the demarcation exercise, the local community volunteers in both rural sites were asked about their experiences of using the three methods of data collection. The answers for this question are summarised in Table 6.36.

Table 6.36 The easiest methods of demarcation as selected by the rural community volunteers

Rural community	GPS / smart phone	Edit map with iPad	Using paper image
Dloaa	3	0	16
Aries	5	0	3
Total	8	0	19
Percentage	30%	0%	70%

The results show that the majority of the volunteers (16) in the first rural community of Dloaa found that using paper images is the easiest method for identifying their land parcels. However, volunteers in the second community preferred smartphone as the easiest method to use to identify the boundaries of their parcels. The iPad was not used in either community because the volunteers did not like it.

6.9.3 Positional accuracy results from VGI for rural areas

The geospatial data collected by the volunteers from the first rural community of Dloaa was analysed to compare the positional accuracy of the two different methods in relation to the official data collected by professional surveyors in the Al-Hillah land administration office. A customised dashboard tool developed in Matlab for the calculation and visualisation of the RMSE and other measures was used to quantify the discrepancies between VGI and official data (Figure 6.23). However, the geospatial data collected from the Aries community was not compared with the official surveying data because the latter was out of date and did not represent the new situation in the area. For this reason, the geospatial data was verified by crowd-sourced agreement on the boundaries.

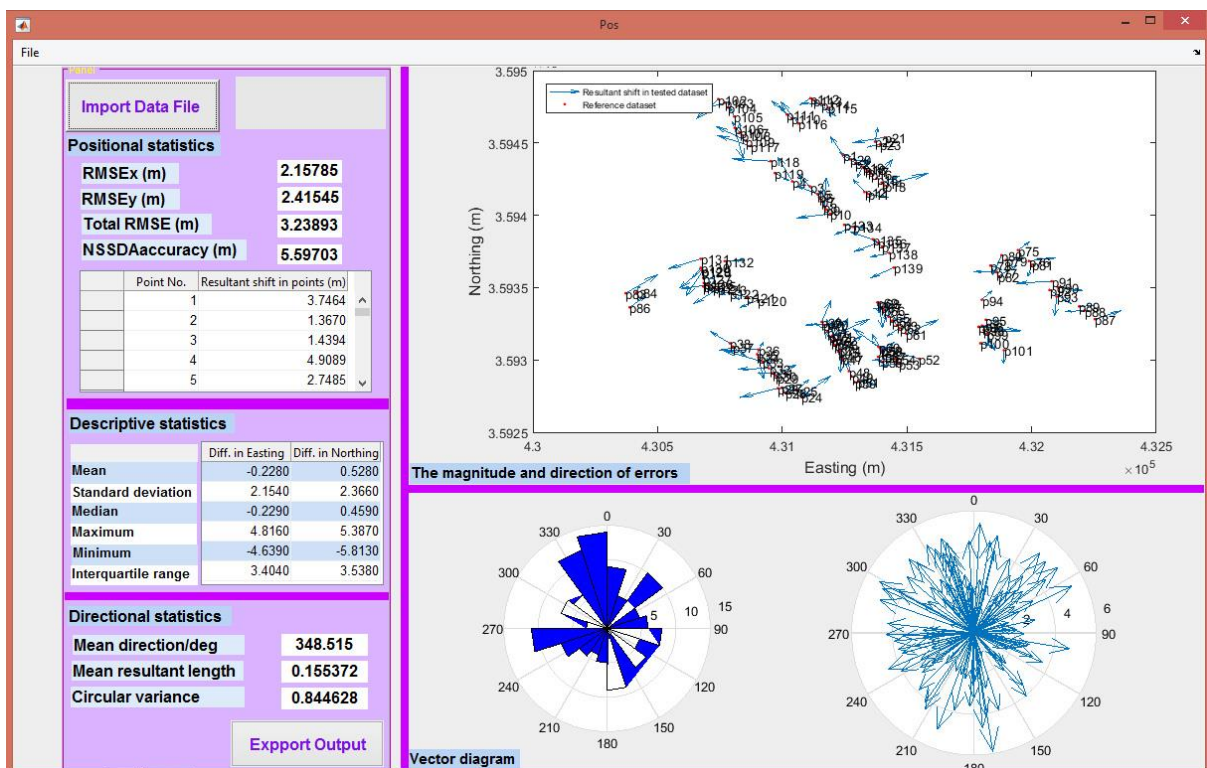


Figure 6.23 Calculation and visualisation tool for RMSE with VGI points captured by GPS and compared to parcel coordinates from official mapping in the Mahkama peri-urban area of Al-Hillah

The results of the positional accuracy testing for the Dloaa rural communities are shown in Table 6.37 below.

Table 6.37 Root mean square error (RMSE) for rural community land corners for the two datasets

Rural community	No. of points tested	RMSE smartphone and official	RMSE iPad and official	RMSE paper photo and official
Dloaa	180	3.23m	-	3.41m

The result for positional accuracy obtained via RMSE values for the Dloaa community reveal that the use of the smartphone for collecting coordinates was slightly better than using pen and paper images. However, there are no iPad results because the local community volunteers were not interested in using this technology. The following Figure 6.24 and 6.25 show the three collected VGI layers for each selected rural area of Aries and Dloaa respectively.

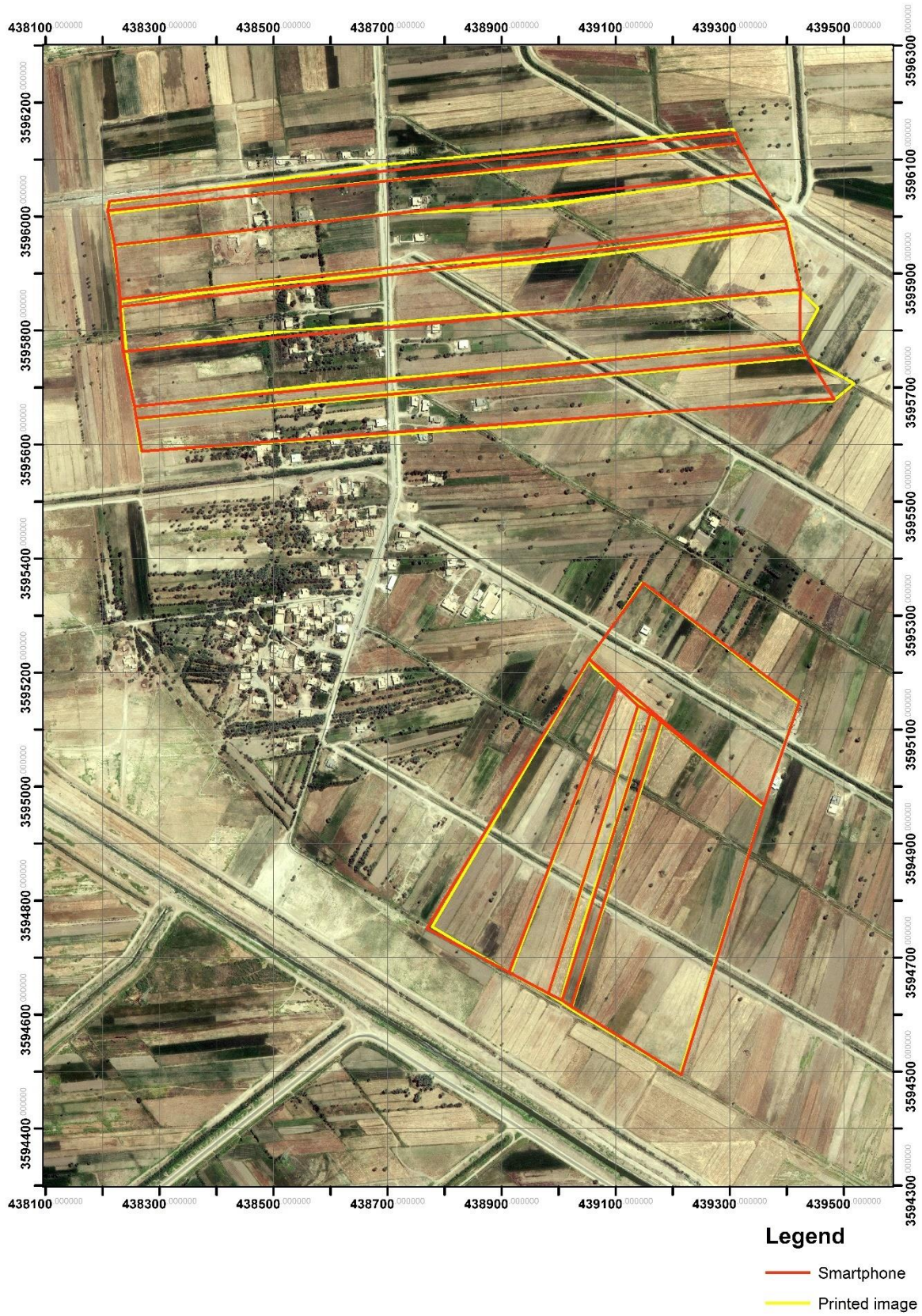


Figure 6.24 Two VGI layers for Aries rural area

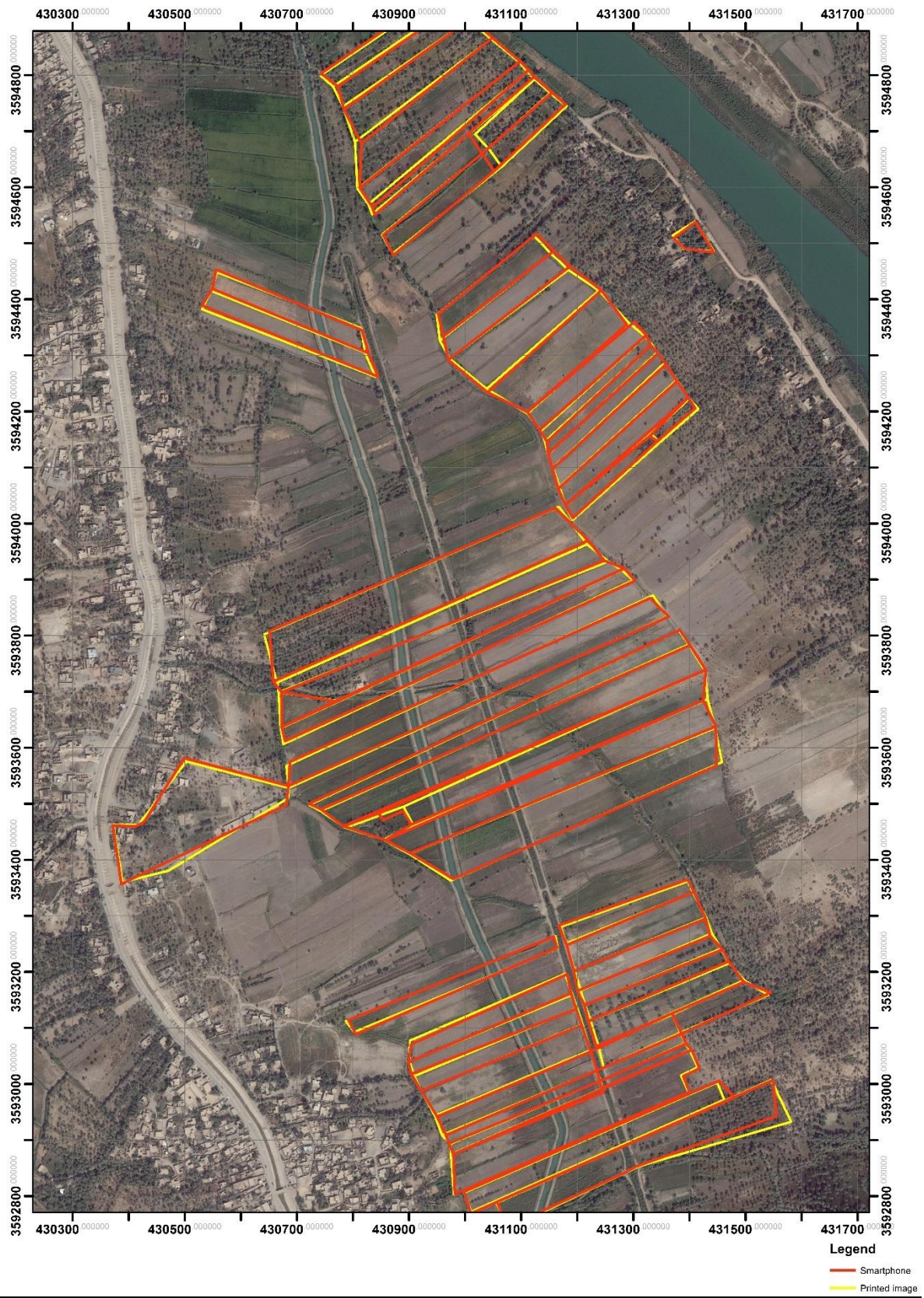


Figure 6.25 Two VGI layers for Dloaa rural community

6.9.4 Completeness

Local community volunteers in the rural areas were trained and asked to go out in pairs to count and demarcate all the plots within a given sub-section of the AOI in the community. The total number of plots identified has been compared with official data for each case study site, and significant differences between the official and VGI quantities have been found, with 80 rural plots on the official map and 728 plots observed by the volunteers.

In the rural areas, some parcels have not changed in occupancy or use for many years, but other locations have changed in land use from agricultural to residential, and numerous housing plots have been created in single fields (see Figure 6.26 below). It is important to identify any changes in rural areas because, where change takes place, it is happening in potentially productive land and changing the very nature of the place from agricultural to residential. This has significant implications for food production and for the municipal services an area needs such as schools, clinics and other infrastructure.

These findings highlight the fact that rural areas are potentially highly dynamic. Thus, incomplete formal data is very problematic. It may be due to the preconceptions of professionals that rural areas are static, or it may simply be a lack of manpower and resources to regularly update data. There may also be a problem related to practices in the rural communities of altering plots without reference to the authorities. However, more data is needed and more emphasis should be placed on engaging with rural communities to encourage them to seek permission to build and then to register changes. Engaging rural communities in VGI might help to bridge the gap between communities and the authorities, educating people in the importance of accurate land registration and, at the same time, providing more complete data.



Figure 6.26 Photographs demonstrating the change from agricultural land to residential areas.

6.9.5 Currency of data

The local volunteers in the rural communities were asked about their opinions of the official cadastral maps of their communities and the difference that they could find between the maps and current developments. There was common agreement about some changes which have been collated and are presented in the following points.

In Aries, the local community volunteers agreed that the current official map dates back to 1950, which was long before the agriculture reform project in the 1980s. This project involved the creation of a full new irrigation system. Accordingly, some clear boundaries that separated plots of agricultural lands were removed. In this case, some of the owners still used the old boundaries while others changed them with the agreement of land owners. For this reason, the geospatial data collected for this area did not match the official records because it is totally different. However, we depended on the crowd-sourced agreement of local community volunteer agreement on the current boundaries and the attribute data.

For the second rural community of Dloaa, the local community volunteers agreed that there had been some changes in the community which did not match the cadastral map, but the general boundaries were deemed to be valid and the original boundaries were still visible on the ground and could be used for the purpose of comparison. These changes indicate that there was an old river shown on the map diminishing to a dry channel over the past 20 years and the boundaries of the land near the river had changed; A new smaller river was created but this did not appear on the map; Some plots had been divided into smaller ones and changed to be residential but

they still appeared as one piece of land on the map and other land had changed from being fertile land with lots of palm trees to barren land, and its status needed to be updated.

6.10 Chapter summary

The results were consistent across each site within each category, verifying that using the iPad for spatial data collection in both urban and peri-urban areas is the best choice in regard to positional accuracy. However, the iPad was not applied in the rural areas, where local people were reluctant to use it. Here, the results for alternative methods of smartphone and analogue mapping were similar to each other.

Several other strands of research have been followed in this project. The gender imbalance in volunteering has been noticeable, particularly in the rural areas where no females volunteered, although as a whole it is not dissimilar to that reported for the OSM project (Glasze and Perkins, 2015). The educational level of the volunteers was directly related to their place of residence, and urban dwellers had a higher level of education and were also happier to use the hi-tech iPad method of data collection.

The potential for VGI within this system is, therefore, worthy of investigation. The analysis has shown the relative accuracy of different data collection methods in different contexts. It can be argued that, in some cases, it may be more important to collect interim data which the community can agree on and take ownership of, even if that means using a slightly less accurate method rather than to focus simply on spatial accuracy. It can be concluded that, in areas of conflict or when official systems are under extreme stress, VGI may be the only realistic method of collecting data. In these cases, it may be more important to encourage people to use a method appropriate to their preference and ability, and to sacrifice some degree of spatial accuracy.

This chapter has, therefore, concentrated on the consideration of different methods of data collection that can suit different types of people in varying geographical contexts. The research provided an opportunity for an encouragingly high number of volunteers to participate, with varying levels of education and experience. The promising levels of accuracy and completeness of the VGI data and its possible inclusion in a fit-for-purpose LAS are of significant interest to the authorities of Al-Hillah.

Chapter 7. Lessons from the process of VGI in stressed and complex situations

7.1 Introduction

This chapter examines the practicalities and processes involved in collecting volunteer geographic information (VGI), to support the development of workable land administration and planning systems in stressed and complex situations. The aim of the chapter is to present findings of direct relevance to the practice of VGI, which may be transferable to other situations. The term 'stressed' is used here to refer to societal situations which are characterised by socio-cultural conflict, economic crisis and household poverty, civil unrest, and limited institutional capacity. In particular, the work seeks to emphasise the way in which these stresses within a community and location can act to help or hinder the collection of VGI. In doing so, it highlights the importance of developing not only the most suitable data collection tools but a process appropriate to the context.

The ideas presented in this chapter are valuable, as VGI has been hailed as something of a panacea for the problems of insufficient or out-of-date data and a key approach for citizens to use in data gathering, especially in relation to land administration. However, it is a relatively new practice. As such, there is perhaps a lack of critical analysis of the difficulties involved in undertaking VGI projects, and the ways in which the problems inherent to localities and communities influence the outcomes. The chapter aims, therefore, to contribute to the debate about how and where VGI can offer valid geographical data, and particularly to highlight issues which might help others undertake VGI projects in situations of stress.

This chapter presents some key lessons from the process of undertaking the fieldwork in the present study. These lessons relate to the importance of certain aspects of the work which others may like to draw on. The next section discusses lessons from the setting up of the work, including engaging with and motivating volunteers, the diversity of volunteers, and their training. The subsequent sections 7.3 and 7.4 draw lessons from the actual undertaking of data collection. This includes the specific issues of the communities' willingness to give information, suspicion about different tools and approaches, the way in which different tools proved more or less effective in different locations, and the accuracy of the data collected. Section 7.5 then considers lessons learned in relation to the difficulties encountered in validating data. The chapter finally discusses the role of local knowledge in more depth, with examples given from the study areas.

7.2 Lessons from the process of setting up the work with volunteers

7.2.1 Engagement and motivation

One of the earliest lessons from the process was about what helps to motivate people. This involved a consideration of varying locations, social situations, citizens' experiences in dealing with land data, and personal preferences. The validity of VGI is primarily dependent on the volunteers undertaking the work and others, for example professionals, who support it. Without either of these groups there can be no VGI. It is important, therefore, to consider what might help or hinder the motivation of all concerned in the process of VGI. Therefore, identifying and tapping into the main factors driving motivation is key to engaging sufficient number of participants.

Ingensand et al. (2016) categorised the motivation to take part in VGI projects as extrinsic motivation, which is the most common category based on reward, and intrinsic motivation based on the volunteers' personal interest, desire to use the technology or wish to contribute to benefit others. In the Al-Hillah study, no reward was offered to any participant, volunteer or professional employed in the administration. However, it was clear that, in many cases, it was the failure of the formal system which motivated both the communities and land professionals to take part in the research. This quotation from one community volunteer expresses a common feeling:

“We [the volunteers] need to be aware of the formal land administration procedures; and also of the current difficulties the professional staff have in managing the system; and we need to be allowed to engage in the existing LAS.”

Another commented that:

‘I feel that I can do something to benefit our country and myself. So, there is nothing better than this feeling.’

However, this sense of interest in the project and the desire to be involved extended to others in the community, and not only to those selected as volunteers. For example, as the volunteers and researcher were going around the study sites, passers-by and community members encountered would often ask what was happening and offer their ideas and knowledge.

Despite the potential for citizen participation to diminish the 'authority' of professionals, in Al-Hillah professionals from the formal land administration departments were exceedingly supportive of the study and well-motivated to take part. They were very well aware of their department's shortcomings, brought about by years of war and lack of investment, as well as

the influence in some cases of fraud and corruption more generally within formal institutions in Iraq.

Several professionals were motivated to take part because they recognised that they could not keep up-to-date records and were unable to control or record the influx of informal settlers, many of whom were appropriating land formally allocated for housing, infrastructure or civic uses. One professional estimated the illegal occupancy of lands to be about 25% of the settled land of Iraq and this has been increasing rapidly through recent internal displacement as described in Section 5.4.5. He commented that:

“The government admitted in its report on recent years that we do need at least 10 years to control the current illegal situation [in land occupancy]”.

A motivation is, therefore, to accelerate the process of controlling illegal occupation. Others were motivated by a desire to start rebuilding a strong base of data. Much of the body of land administration data was lost during the war and in subsequent civil unrest, as noted by Todorovski (2011). Notwithstanding war damage, even basic secure storage for records and maps is lacking, as shown in Figure 7.1 below of the land registration office in Al-Hillah.



Figure 7.1 The storage of maps and files in Al-Hillah land administration system

Both the community respondents and the land administration officers felt that a system in such disarray is very difficult to update, open to fraud and very slow. For example, several volunteers noted that on many occasions the land administration authority had lost the land owner’s documents inside their offices, and this problem caused significant delays in the administration of land.

This indicates that, even in stressed situations, the very problems which point to the need for VGI can act as the motivation for people to accept and undertake it. Therefore, those who wish to undertake such studies or projects should look upon the problems as possible ‘aids’ to the work.

The involvement of the land administration department, at a time when they were under such pressure, was critical to the success of this research project. But although the official staff recognised the problems, the senior management of the land administration department were extremely reluctant to become involved. Managers repeatedly denied any shortcomings in their department and disagreed with the idea that the system was unable to cope with issues such as land invasions and illegal settlements. Those actually involved in the day-to-day running and working of the system were far more open and frank about the problems they faced. Thus, despite the researcher's initial concerns, gaining the involvement of the professionals was far easier than expected. A lesson in this is that, whilst permission may be needed from higher management to engage with formal systems, it is far better to get lower level support first, before approaching management.

Moreover, the involvement of professionals was no deterrent to community engagement and there appeared to be little suspicion or resentment on the part of the community when the professionals introduced the researcher to a community. It was, perhaps, the very fact that the professionals were willing to be involved, and to provide maps and existing formal data, which helped to reduce potential tensions between the authorities and the community.

Engaging the land administration department also helped to lend the final VGI data greater validity and thus it may make it more likely that the authorities will accept it in their formal system. However, although people were quite happy to voice their complaints about the formal land administration system in general, the political tensions which still run through Iraq meant that they were not willing to mention any individuals by name for fear of retribution.

It was clear from the experience gained in this early phase of the work that VGI can tap into a deep desire to pull together and contribute to improving a situation, despite concerns about the failure of the formal system, sensitivities surrounding land and titles, and the stresses of war and civil unrest which plague Iraq. This motivation may also be found in other countries. However, every context will have its own driving issues which will motivate people to take part. It is essential that those developing and directing VGI projects take the time to understand the local context and drivers which might motivate volunteers and other participants.

7.2.2 Diversity of volunteers

It became clear during this project that in VGI it is important to have a diverse group of volunteers. This study took care from the outset to enlist both younger and older volunteers, men and women, and a cross-section of education levels. Despite taking great care to include women in the research, the gender split was not as equal as had been hoped for across all

communities. The percentages of male and female in the urban communities, where women have more independence, generally higher levels of education and may themselves be in employment, was nearly equal (56%: 44%). However, the percentage of women participants was much lower in the peri-urban communities at only 22%. In rural communities the gender bias towards men was greatest, with no women volunteering. There are a number of reasons for this, including the fact that women in the peri-urban and rural communities are less well-educated, and rural culture requires that women focus on caring for their families. In some traditional and devoutly Islamic rural households, women may also not be allowed to travel outside the home and amongst strangers unaccompanied.

The inclusion of women proved to be important as, where women were involved, they were not only equally capable of undertaking VGI but, in some cases, could access areas and data more easily than men. For example, as discussed below, in urban areas there were many sub-divisions of properties and it was necessary to enter a property to collect data in some cases. Men and women also differed in their approaches. Women liked to sit and critically analyse aerial images and cadastral maps. Men tended to be somewhat less accurate when working on maps and images and wanted simply to roughly identify their plot. However, the women were much more precise and detailed, checking and discussing amongst themselves, constantly validating their decisions.

A lesson to be drawn from this study is that, if possible, splitting different tasks between genders may produce more accurate data. However, this idea may not be transferable to other countries, where women are more equal and equally educated. Certainly, the nature of the work involved does not imply that some tasks are 'women's tasks' and others are more appropriate for men. However, gendered roles are not the same in all societies and cultures and those developing and managing VGI projects should consider the gendered nature of the society in which they are working and use its specific strengths in order to improve the work.

The age of volunteers was also important. Right from the start of the work with volunteers, older people were able to make suggestions based on their more in-depth local knowledge. This proved valuable in data validation, as discussed below in section 7.2.3, and in identifying suitable areas for the study based on changes in land use and topography. Younger people proved more likely than older people to understand the technology used and the conceptual underpinning of the study and were faster to learn in training. This may be because younger people are more likely to have had a better education.

7.2.3 Training volunteers and the researcher

If VGI is to be valid and the data robust, volunteers should not be used simply as data collectors. It is important that they are properly trained and fully engaged, and that they feel responsible for and interested in what happens to their data after it has been collected. In this study, volunteers were involved from an early stage in decisions about which areas to collect data from. This early involvement began as part of a two-way process of training.

In training people about the process of VGI and what it entails, it was clear that many, if not most, people had no prior knowledge of it. Some people were a little intimidated by the terminology and technology involved. This is important, because it highlights the fact that others undertaking VGI projects must begin by carefully introducing the concepts underpinning the enterprise before they can train people in the use of the tools involved. Care must be taken to simplify the language and terminology used too, depending on the specific context in terms of, for example, education. Within the training for this study, some volunteers very quickly understood what was required and how to collect the data. Others, however, required much more explanation and time to understand the processes involved. The initial training in this study was based on verbal instruction and discussions between the researcher and volunteers, which took an average of two hours in each community. This was then followed by a practical session, when the volunteers practised data collection on their own plots. However, the duration of training was not perhaps as long as the researcher would choose if the work were to be done again. Depending on the context, other researchers leading VGI projects should consider allowing a longer period to more fully train volunteers.

7.2.4 Learning from the volunteers

During the training period with volunteers it was clear that the researcher was learning as much as the volunteers. This two-way flow of knowledge, ideas and information proved critical to the success of the study. For example, it was not realistic within the time available to assess the completeness of the official data for the entirety of all the study sites. Therefore, during the initial training period, smaller sample areas were selected. However, rather than dictate the precise location of each smaller area for data collection in each community, the volunteers were asked to collectively identify areas of interest (AOIs) themselves and to specify them to the researcher on the official cadastral map and the aerial image. While this would not be appropriate in all VGI projects, it was the approach chosen in this study in order to identify how well communities could recognise discrepancies in the formal land maps being used by the municipality. This approach proved valuable as, in several cases, the volunteers could identify simply by looking at maps significant changes to land use, natural features and topography,

such as changes in the direction of rivers or large areas of illegally occupied land which the authorities were not aware of.

The lesson here is that communities hold excellent local knowledge of changes to their locations and, out of the process of training volunteers, those running a VGI project can gain good local knowledge which they would not otherwise have had access to. Others undertaking VGI projects should be willing to acknowledge the value of local recognise and actively seek it out by, for example, engaging long-term residents and older people as volunteers or advisors

7.3 Lessons from collecting data

A number of lessons were learned about the process of working with communities, the police and the authorities when collecting data which are valuable for others undertaking VGI. These relate mainly to the community's willingness to give information, and the tools suitable for the security context

7.3.1 The community's willingness to give information

First, it was noticeable that most people who were approached by the volunteers were happy to be surveyed and give the attribute details of their plot. Nevertheless, some of those displaced from a long way outside the region, of which there are many thousands across Iraq, refused to answer questions. These were people who had settled on someone else's land or in their dwellings and could not claim *de jure* tenure.

However, a lesson to be learned here comes from the fact that there was a noticeable difference between those who had settled illegally in private property and those who had settled illegally on government land, which was in many cases zoned for specific uses. Even though the latter were equally illegal, they clearly felt much more secure and happy to engage in the project, believing the land to be theirs by virtue of them being Iraqi citizens.

The lesson here is that it is important not to treat all those within a given category of settlers as the same but to recognise the nuances of specific situations. In this case, how illegality might be perceived differently by different people proved to have an influence on the result of the study. This is important because a very great proportion of the world's population is housed 'informally' or 'illegally', but their status is perceived differently both by the settlers themselves and by the authorities in different situations and countries.

The second lesson is connected to the issue of perceptions discussed above and to the difficult security situation in Iraq. While those who did agree to take part in the survey were willing to

give great details about their tenure, length of residency or use of a plot, many were very reluctant to give their last or family name. This is because, in Iraq, one's family name reveals one's place of origin and also religious affiliation. In a deeply sectarian society this can be dangerous. Displaced people were the most reluctant to give their family names. For those who would engage in VGI projects, this raises questions about what might be contentious or problematic in any given area. The lack of a family name to attach to a plot might appear to pose the problem of how to verify ownership, as the VGI data could not be compared to formal records without the owner's name. This is discussed later.

Clearly, then, there are lessons for project managers. Firstly, they need to be mindful of the different sensitivities of settlers and we should not treat all participants in the same way. Secondly, alternative methods of verification should be accepted and established in collaboration with and to the satisfaction of those who might use the VGI data.

Another issue arose when collecting data with volunteers in the community. As already indicated, others in the community, not only the volunteers, expressed interest in the project. For example, as the volunteers and researcher started to explore the study sites, undertake training in the localities and collect data, passers-by and general community members would often ask what was happening and offer their ideas and knowledge (see Figure 7.2). This led to several impromptu discussions about the maps, where members of the community would offer their suggestions and ideas, highlighting the fact that, even under situations of stress and suspicion, VGI can bring communities together. Here, the lesson learned is that those managing VGI projects should not be 'precious' about the details of their structures and research design but should remain flexible and willing to expand their information sources and to reconsider the methodologies applied. Nevertheless, the robustness of the research should also be maintained and we must acknowledge that, just because someone new offers information, it does not make that information true. Therefore, all new information should be validated.



Figure 7.2 Citizens' interaction and participation during VGI data collection in Dloaa rural community

7.3.2 Tools to fit the context

One of the aims of this work was to understand not only which tools worked best, or were more accurate, in which situations, but also what preferences people had for different tools and why. This is important because, in many cases, offering people the tools they prefer to use may be as important to the success of a project as making, or expecting them to use, tools they are uncomfortable with.

For example, older people may feel uncomfortable using highly technological tools and may, therefore, disengage from the project. Thus, the project might lose their important deep local knowledge. In this study there were some very clear preferences.

Younger volunteers were clearly interested in technology and had a desire to learn how to use it. One young man noted that he wanted to volunteer in order,

'...to use the new technology to find the boundaries and let people be able to check themselves their boundaries'.

At the same time, those who were less familiar with technology, generally older people, were not necessarily deterred by it. Nevertheless, some people, despite their excitement and interest, actually found paper maps and pens easiest to use. This is an important lesson for the development of data collection tools.

When choosing the sample of volunteers, care was taken to include both men and women and people of different levels of education and literacy. More technological tools may not suit those with lower levels of literacy, especially where instructions need to be read.

However, the fact that people showed a preference should not be the only factor in deciding which tools to use. It is also important to use the most accurate tools whenever possible. However, this will depend on the specific context. For example, security was a key element in this study. However, the authorities and police were very suspicious about one tool, the hand-held GPS. It seemed that they associated the use of this method with terrorism and the planning of bombing attacks. It was interesting, however, that no security threat seemed to be associated with the use of aerial images or maps, even in such tense locations, although these could equally have been used for illicit purposes. Many areas experiencing security tensions such as those Iraq currently suffers from may need VGI to help rebuild records. In such situations it appears that low-tech methods are seen as less threatening and may, therefore, be easier to establish.

GPS was also less appropriate or useful in recording sub-divisions in urban areas, and lower-tech methods also proved more accurate in some cases. As noted in the introduction to this chapter, the aim of the study was to understand what approaches and data collection tools worked best for different people and in different contexts, rather than simply which produced the most accurate spatial data. The research was initially based on the assumption that the less technically sophisticated methods using maps and printed aerial images were likely to produce less accurate spatial data. However, this proved not to be the case in some situations. In rural and peri-urban areas, the hand-held smartphone with GPS software was more accurate. However, in urban areas this was not the case as buildings interrupted the signals.

In addition, the very high percentage of informal sub-divisions of properties in urban areas also influenced the accuracy and appropriateness of different methods. Referring to the vast number of unregistered dwellings which posed the land administration department significant problems one official noted that: *'The city is three cities, so many sub-divisions, we can't do anything about it.'*

The study collected semantic data for all sub-divided buildings within the sample, including higher buildings. However, it only collected spatial data for sub-divisions of residential houses of 2 storeys but not high-rise buildings. To collect spatial data, it was necessary to explore a sub-divided building in order to identify the many different and unregistered informal sub-dwellings. In high-rise situations, when using GPS on the smartphone, it was only possible to derive the outer points of the building, and then only if the signal was not interrupted by other buildings. In all cases errors occurred using the smartphone and GPS in the spatial data of sub-divisions because of the short distances in the internal dimensions of the sub division and weaker signals. In all cases of sub-divisions, it was generally more accurate for volunteers to use maps and pen and paper to identify additional units.

This situation of mass sub-division is to be found in many cities and towns around the world. Therefore, others seeking to use VGI might benefit from an understanding and acceptance that GPS may not be as effective as less technical methods of data collection in such circumstances.

7.4 Accuracy of different methods

One of the aims of the study was to understand which tools worked best in different locations, not only based on the preferences of the community and volunteers but also on the characteristics of a specific place. The accuracy of different tools in different environments is discussed in this section.

Many people might assume that more highly technological tools, in this case the smart phone using GPS software, would be the most accurate. However, in this research project the smartphone proved not to be very accurate in urban areas (see Chapter 6). Firstly, the high density of the urban area, where individual dwellings were often physically attached to adjoining dwellings, meant that plot corner points could often not be identified or measured. Secondly, because of the height and density of buildings, the GPS signal was not always strong enough in the urban areas to provide sufficient accuracy in coordinate measurements. As urban land is expensive, even an error of 0.5m is problematic and would not be acceptable. In this study, as reported in Chapter 6, the smartphone often produced errors of up to 4 metres. However, the smartphone and GPS did work very well in rural and peri-urban areas. This is because these areas were less dense, with plenty of space between plots. Even where there was an error of up to 3 metres in a plot corner position, this was considered perfectly acceptable by people in the rural areas. However, these results were based on using a relatively affordable smartphone with a free GPS receiver. This was because the study wanted to understand what communities could easily do by themselves at little cost. It must be acknowledged, however, that the use of more expensive GPS applications may have led to different results.

In the urban area the most accurate technology was the iPad, as its use allowed people to edit the boundaries of plots and dwellings on a map. Furthermore, on the iPad there was the possibility of viewing an aerial image as backdrop to assist in identification. In the peri-urban area the iPad was also very accurate as there was more space around and between plots and the map data could be graphically edited on-screen. Unfortunately, no data was collected for the use of the iPad in rural areas, because, even after training, the local volunteers were less happy with this tool. As a key objective of the study was to understand user preferences, their wish not to use the iPad was respected.

The third method tested was the aerial image on printed paper which was accepted by all communities and volunteers. In the urban areas this method was less accurate than the iPad but more accurate than the higher technology method of smartphone and GPS. Even in the peri-urban areas the use of aerial images proved to be slightly more accurate than the smartphone but less accurate than the iPad. In the rural areas the aerial images proved to be only slightly less accurate than the smartphone. As noted above, in the rural areas, people did not use the iPad and therefore the use of aerial images cannot be compared against the iPad for these areas.

The lesson from this experience for others undertaking VGI is that it may be necessary to sacrifice some level of accuracy to either make the data collection affordable for a community or to allow a community to use methods which they are most comfortable with.

7.5 Lessons from the validation process

VGI has been promoted as democratic, a bottom-up approach to informing municipal activities such as land administration. The research described in this thesis adds to the growing number of studies which have proved that communities are willing and able to collect both spatial and attribute data. However, acceptance of the approach by municipalities remains limited and take-up is slow. One reason for this is that there remain some concerns about the robustness and validity of VGI data (Foody et al, 2013; Fonte et al. 2017). VGI data requires validation, generally using official data so that both communities and the municipality are happy to accept it. However, VGI data is most valuable where existing formal data is either missing, incomplete or out of date. This raises questions about how to validate it. In this case of the Al-Hillah study, attribute data was verified by a consensus of community members in specific verification workshops. The value of both community consensus and individual knowledge is discussed below.

The Al-Hillah study originally sought to validate the VGI data against existing formal records of land; however, that proved to be problematic. For example, one of the most important ways of validating ownership was to ensure that the name of the owner was correct and in accordance with formal records. However, when that was tested it raised the issue that people can be known by several different names. They may identify themselves in a survey as, for example “son of Yusuf” or “wife of Mustafa” and this would be culturally accepted. However, their formal record would show a different identification of a formal full name.

Validation was often supported by a form of ‘crowd-sourced’ data. When a precise issue could not be matched to formal data, it was questioned and discussed with the community. This worked well to verify details of ownership, such as name and length of tenure. However, this

approach relies on good local and historical knowledge. Older people were key to this, having years of knowledge and memories of who bought what and when. Indeed, one man of about 90 years old from a rural area was very helpful in identifying both topographic changes to the land and in confirming the ownership of different plots. He could do this from memory, even though he is now blind. His memory and superior local knowledge were accepted and respected by the community (see Figure 7.3).



Figure 7.3 An old man participated in VGI verification workshop and provided valuable information on ownership and land used data.

However, as older community members die, their knowledge dies with them. A younger generation, much of which may be less embedded in the local area owing to migration for work, will not hold that vital informal data on the history of a settlement.

Nevertheless, young people were very motivated and do still have knowledge of the area to offer to VGI projects. In this study they were more commonly found in urban areas than older people who are occupied with work and domestic matters. However, when it came to validating data through community agreement, young people had a lesser voice, especially in the rural areas, as they deferred to their elders. Thus, when validating data with community agreement,

the young found it less easy to disagree with elders about, for example, the ownership of a plot. It is necessary, therefore, for VGI project managers to encourage and facilitate all community representatives to voice their knowledge and not simply to accept the loudest voice.

7.6 Further use of local knowledge

As mentioned above, local knowledge helped in identifying the most suitable areas of interest to focus on in the study and in support of the validation process. However, local knowledge in the process of VGI brought a great deal of added value to the research. Many additional issues were identified which the authorities were completely unaware of, and which the researcher could not have been expected to consider, even though some related directly to land use.

For example, there is a current practice of removing and selling the soil from agricultural land leaving it unsuitable for agricultural activity, as shown in Figure 7.4 below, and with the potential for the area to be flooded.



Figure 7.4 Agricultural land after removal and sale of topsoil layer (up to 75 cm), now unsuitable for growing crops

Another issue noted by many of the volunteers in the rural areas is that some land owners burn the vegetation and crop cover and pretend that this it was accidental. They do this to justify a change of land use from agricultural to residential, thus increasing the land value (Figure 7.5). In this we can see that local knowledge can tell a fuller story of what is happening to land and why than could be told by a more formal survey alone. This further supports the value of VGI in land administration applications.



Figure 7.5 Agricultural land newly burned off and left unsuitable for growing crops

Other local environmental knowledge was used in peri-urban areas, for example, the drying up of a channel which allowed plots to be extended, and in urban areas, where recent heritage classification of potential building plots was known to the community, but not shown on the maps.

7.7 Chapter summary

This chapter has presented lessons from the processes of setting up and undertaking VGI in communities under stress. It highlights points which others undertaking VGI might like to consider in order to strengthen their own projects. It has been shown that others undertaking VGI should consider the very specific context of their location, and the communities and society within which they are working.

In particular, it has demonstrated that, even within a context of poor security, recent civil unrest and failing government, municipalities and the communities are motivated and willing to work together. However, in poor security situations, the methods and tools used to collect data may need to be reassessed. High-tech methods may cause suspicion but, as shown, this does not mean that one must sacrifice accuracy since high-tech tools are not necessarily more accurate than low-tech ones.

Collaboration amongst the community is vital because, as the present work has shown, local knowledge is critical to success. The work has demonstrated that local knowledge comes in

many forms and from all different elements of the community, and therefore the gender and age of volunteers are important factors.

Despite the growing interest in VGI and its role as something of a ‘panacea’ for failing land administration systems, these points have not been fully understood or critically examined before. This chapter has focussed on the practice and process of VGI. However, the project has raised many issues of wider scholarly or philosophical interest. These are discussed in the following chapter.

Chapter 8. Offering to scholarship

8.1 Introduction

This chapter draws on material in the previous chapters to highlight the offering of the thesis to scholarship. It identifies the way in which the work fill gaps in our understanding of the value, accuracy and practical usability of VGI. To do this, identifies how and where the original objectives are addressed. It then draws these discussions together to show how the thesis fulfils its overarching aim of understanding the potential role of volunteer geographic information (VGI) in supporting existing formal land administration systems to a fit-for-purpose standard. It is helpful to remind the reader of the specific objectives of the study, which were to:

- i. Examine the range and scope of current land administration systems in developing countries, and notably in Iraq, to set the context and assess the potential for VGI to support a fit-for-purpose system.
- ii. Identify the current knowledge and perceptions of VGI and fit-for-purpose land systems amongst land professionals in the case study area in order to identify barriers to professional acceptance.
- iii. Identify the difficulties and limitations of the current land administration system for professionals in the case study area, so as to identify areas and tasks where VGI might be particularly valuable to them.
- iv. Understand how complete, current and accurate VGI is compared to more formally collected land data, and to acknowledge the limitations and strengths of VGI.
- v. Identify the current knowledge of people about the importance of registering their land and to assess their motivation for engaging in VGI.
- vi. Analyse which methods and data collection tools work best in different contexts and for different individuals.

8.2 Key issues from the work for scholarship and practice

8.2.1 Contribution to a growing literature

There is a growing body of literature on the range and scope of contemporary land administration systems in developing countries. This work began by seeking to understand that work and to identify the degree to which it was relevant to the Iraqi context. However, there is less work specifically looking at the use of VGI in countries emerging from war and civil unrest, where the internal security context is as complex as it is in Iraq. Chapter 7 highlights how that security context might influence the undertaking and outcomes of VGI.

The work also contributes to existing literature on perceptions of VGI by presenting the situation in Iraq and identifying the level of awareness of VGI amongst both professionals and communities. It also highlights the fact that professionals and communities alike are happy to accept and undertake VGI and that VGI enables communities and professionals to ‘pull together’ to improve land administration

Similarly, there is other work on people’s understanding of the importance of registering their land, and work on their motivation for engaging in VGI. What this study has offered specifically is an understanding of the relationship between communities, volunteer data collectors and professionals. It has highlighted that, even in a context of mistrust and suspicion, communities are willing to give data to volunteers and professionals are willing to support this process.

However, the existing literature does not really demonstrate the influence of war and civil unrest on the practicalities of undertaking VGI projects. Chapter 5 in this thesis seeks to do that specifically. It shows that, despite general support for the work, care must be taken in choosing tools which will be acceptable to communities, volunteers and the security forces and police. This may suggest that the most acceptable tools may not be the most accurate.

8.2.2 Limitations of current land administration

Adding to a more general literature on the problems with land administration systems around the world, this study has shed light on the limitations of the current land administration system in Iraq, following over 15 years of war and civil unrest. In doing so it has shown the dreadful conditions under which professionals in a case study area have to operate. It highlights the lack of resources and institutional capacity and, in some cases, fraudulent behaviour, all of which have produced a failing system and overwhelmed the best efforts of the land administration department to maintain or update records. In identifying this it verifies the types of situation where VGI might be particularly valuable to professionals.

8.3 Contribution to practical knowledge

8.3.1 Comparison of VGI and formal data

The work has presented a clear understanding of how complete, current and accurate VGI data can be, and was, in the study site compared to formally collected land data. However, it also acknowledges the limitations as well as strengths of VGI.

Chapter 6 highlighted that VGI attribute data in the study areas was, in many if not most cases, far more complete, current and accurate compared to more formally collected land data. This is not new, and others studies have had similar findings. However, the present results do help to lend further weight to the growing acceptance of VGI.

8.3.2 Comparison of methods and data collection tools in different contexts and for different individuals

Different VGI data collection tools varied in their accuracy and in the way people preferred to use them in different locations. The second part of Chapter 6 explained the preferences of volunteers and the accuracy of different tools. The iPad was the most spatially accurate tool when used in the urban and peri-urban areas. However, its accuracy in rural areas could not be ascertained as the volunteers there preferred not to use it. Smartphones with GPS app were more accurate when far from the city in peri-urban and rural communities rather than in the urban communities. This was mainly because the GPS signal is stronger in open areas. The use of GPS also appears to make the police suspicious. Finally, aerial images were fully acceptable to most of the volunteers from all communities, and especially the elderly.

8.3.3 Using volunteer geographic information (VGI) to support existing formal land administration systems

Based on the levels of accuracy of the different VGI tools, and the quality of VGI data obtained using them, the land administration professionals were very keen to use and expand such source of data to help the identify sub-divisions, illegal expansion, and land use changes and in updating ownership records. As noted in earlier chapters, the professionals recognised the need for support in improving their systems. They also noted that, in some contexts, it would be extremely difficult for them to collect the amounts of data required because of limited manpower and poor relationships with the communities. This study concludes that VGI as a method of data collection for land administration does have a strong role to play in Iraq. However, systems must be developed which enable the transfer of the data into formal records. Moreover, as be discussed below, VGI is not a 'quick fix' and its use raises many questions and

issues for the land administration profession which need to be addressed in rolling out the approach.

Any proposal for developments and enhancements, whether for Iraq or elsewhere, which is intended to contribute to an existing formal land administration system, should be designed taking into account the needs and limitations of that system and the capacity of the professionals who will ultimately have to use the data. Moreover, such developments should be designed, from the outset, with the community's views, desires and perceptions of important issues, fully taken into account. Conversely, any system designed for informal use, perhaps by communities seeking to collect their own data where no adequate system exists, or as a challenge to a formal system, may need to take into account how the data can be used as the foundation of a formal system. This means that it may need to collect data which the community, at that point in time, does not necessarily feel to be important. It may even be necessary for an informal system to capture data about activity and practices which may be illegal in an official context (e.g. illegitimate occupancy of land).

8.4 Philosophical considerations regarding the use of VGI

Thus far this chapter has considered the data and findings from the literature and fieldwork to identify, as discussed above, what the potential role of VGI might be within land administration in Iraq. However, during the course of the research and analysis, many more philosophical questions began to arise. These related not to whether or not VGI could be accurate enough to be used but to what the ethical implications of its use might be. This final section of the work seeks to present these questions, if not actually answer them.

8.4.1 VGI and the role of the professional

In this work, one man, working with relatively few volunteers in communities previously unknown to him, was able to produce data which the authorities felt was adequate and valid enough to form part of their formal data. A picture of those communities was produced which the professionals working for the Land Administration Department had not been able to acquire through more traditional methods. This raises questions about the capacity, skills, training and methods used by professional land administration teams. Engagement with the Land Administration Department and the experience of VGI in this work suggests that a radical rethink of methods of data collection and of the role of surveyors and other professionals is called for. However, it is not sufficient to simply suggest that existing land professionals use different approaches, including VGI. The training and education of land professionals should

take into account the skills such different approaches might need. Some of these are not technical skills, but the skills needed to engage with the public and communities. This might mean a transformation of the profession similar to the transformation within the planning profession in many countries. What Healey (1993) refers to as the ‘communicative turn’ in planning in the UK saw planners learning to act not as ‘scientists’ or ‘technocrats’, as had been the case, but as collaborators, facilitators and educators, working with and for communities in collaboration with public and private institutions. To accommodate this, planning education had to change.

If such a transformation of the land administration profession was to happen, the education of surveyors and others involved would need to change to ensure that future professionals had the necessary social skills for dealing with citizens in communities. Technologically, the most important is the skill to use a range of tools and methods.

In addition, other less technical skills are needed. For example, in working with the present researcher was required to develop better communication skills and to learn to listen to the ideas and knowledge of the people. Most land professionals are trained to believe in the power of technology and their superior training, rather than to trust in local knowledge and to engage communities.

8.4.2 Accommodating ‘uncomfortable’ data

One of the issues raised during the data collection was how to handle data on illegal developments. The concept of illegal development encompasses a broad range of phenomena. It includes illegal sub divisions of existing property (Moshtamal), which may have not been undertaken to building regulation standards, is contrary to zoning regulations and is not registered, to additional dwellings built on land surrounding a building, unregistered changes of use (such as from dwellings to shops, for example) through to larger-scale illegal development by squatters invading and occupying private or municipal land.

Questions arise about how to treat such illegal developments and what the implications are of covering it in data collection. Should any or all illegal development be identified? If it is, should it be added to the formal land registration system along with legal development? There may be degrees of acceptable or tolerated illegal development which are included in a formal system and others which are not, raising questions of who decides and on what basis.

There are strong political and economic reasons both for including and for not including illegal development in surveys, especially with regard to large-scale squatter settlements. Information is vital if a municipality is to appreciate the true scale of the population and their living

conditions, public health implications and potential levels of demand on services, including schools and hospitals. This information can be used to develop future plans and to negotiate for funding from central government and other sources.

However, to survey is to acknowledge the existence of such illegal development. Having acknowledged its existence, what then should an authority do about it? If it is regularised and made legal, does the authority place conditions on the owner? Does regularising mass illegal development by squatters send out messages to other potential migrants that the city is 'soft' on migrant invasions, effectively inviting others to come? These questions are considered in greater detail elsewhere (Tipple and Speak 2009).

When municipal land use professionals undertake a survey, they can choose to include or exclude certain types of development from the outset. However, when communities are collecting data, they will expect to have a voice about what is or is not acceptable development. However, these opinions are likely to differ depending on the individual's own legal position. These problems are not insurmountable but they do require a more thoughtful approach to the objectives of land administration and the collection of data for it.

8.4.3 Implications of establishing a volunteer system

A major issue to be addressed is the ownership of the data collected. If a community has volunteered to collect VGI data, the data is about them and their properties and they are doing it because the formal system cannot, has not or cannot be trusted. So whose data is it in legal terms? We live in an era where all data has become extremely valuable. The type of data collected for VGI could also be very valuable, as it contains information such as names, addresses, types of land use, and length of residency or ownership. This raises questions about if and how it should be used other than for its original purpose of land administration. It also suggests that protection of the data is important and misuse must be avoided. This leads us to another potential problem, which is corruption.

As has been stated earlier in this work, VGI has come to be considered as something of a panacea for land administration systems in need of repair. This work has shown that the general public are not only willing but perfectly able to collect valid and robust data. In many cases they are more able to do so than professionals. However, while corruption was identified as a theme within the formal system, we should not assume that corruption would not occur in a system of VGI.

In most systems, professionals at least have a code of practice, setting out standards and behaviour to which they should work. The general public have no such code. Moreover, VGI

is offered as a way of collecting data when people mistrust the authorities or where the community will not engage with them and may even threaten professionals. However, socio-cultural issues inform and influence the relationships within a community. They determine who is dominant and strong and who is vulnerable and less strong, and therefore less able to make their voice heard or complain or contradict dominant members. This was shown in the relationship between older and younger members of the community, when young people would not contradict or criticise the opinions of elders. These kinds of relationship can be found in many societies around the world. Who is to say that different community members or groups might not be silenced or dominated by others? Iraq has a history of ethnic and religious dominance of some over others. Therefore, we cannot assume that this would not influence VGI work also.

The name of the process of data collection studied here – volunteer geographic information – highlights the voluntary, and presumably in many cases unpaid, nature of the work. Whilst this work has shown that people are willing to undertake a great deal of work for no payment, it does raise questions about the ethics of tax-paying individuals undertaking the labour which paid professionals should be doing adequately. Should they be paid to undertake work for the municipality? If they were paid, would payment increase the opportunity for corruption, drawing in people who were happy to undertake the work for money rather than for the more ethical reasons of collective responsibility and wanting to pull together to improve their community? This study has shown that the people involved had a deep, intrinsic desire to demonstrate that they could collect accurate and viable data. They took great care to do so with no financial gain to themselves. However, if payment had been offered, it might have attracted people with less ethically sound motivations, who may have little concern for the quality of their work.

8.5 Discussion and Conclusions

This project relied overwhelmingly on the willingness of communities to engage with the collection of VGI and to consider the value of VGI when used within those communities. The identification of ‘gatekeepers’, as representative and authoritative community leaders, was a major factor in successfully carrying out this project.

It was clear from initial interviews with the gatekeepers and with professional stakeholders that the local municipality did not have the capacity to update or maintain the official land administration system. There had been a long-standing recognition of this situation, and an earlier attempt to sub-contract improvements to external consultants failed in 2006.

The potential for VGI within this system is, therefore, worthy of investigation. Analysis has shown the relative accuracy of different data collection methods in different contexts. It is argued here that, in some cases, it may be more important to collect some interim data which the community can agree on and take ownership of, even if that means using a slightly less accurate method, rather than to focus simply on spatial accuracy. It can be concluded that, in areas of conflict or when official systems are under extreme stress, VGI may be the only realistic method of collecting usable data. In these cases, it may be more important to allow volunteers to choose a lower-accuracy method of data capture suited to their preferences and abilities.

Further conclusions relate to the advantages of incorporating VGI into the official land administration system, as follows

1. Speed of data capture: the volunteer groups were able to gather more timely information within a few days than the hard-pressed official agency;
2. Lower costs: the use of basic technologies, including paper images and citizen-sourced annotation, has been shown to be sufficiently accurate for updating records in the official system. Even the more expensive methods, including GPS-enabled mobile phones and hand-held tablets, many already owned by volunteers, are cheaper than investing in agency-wide technologies relying on high-precision GPS or drone mapping programmes;
3. Updated registers of legally-acceptable standards: the speed and low cost of any VGI project of this type will result in significant amounts of valuable, contemporary information. This advantage is more contentious, as the definitive legal status of the VGI has not yet been formally confirmed (although the official agency has been encouraging), and it is also recognised that a more systematic approach to data collection will need to be developed, authorised, and monitored by the formal governmental body; and
4. Engagement of the community: encouraging the citizens and local stakeholders to ‘take ownership’ of the land registration process has significant societal benefits, and the community representatives (gatekeepers) were enthusiastic proponents of this research.

This thesis has exemplified some of the issues involved in capturing VGI in circumstances where official law and order is limited and communities are not functioning in an ideal manner. Thus, in addition to the merits of using VGI, potential problems in enhancing or supplementing the land administration system with citizen-sourced VGI are recognized.

1. Embarking on a programme of data capture which relies on recruiting technically-aware and knowledgeable people representative of a community, can be difficult:

the gatekeepers were relied upon to find a willing cross-section of the local residents and business owners. Problems were encountered, for example, in encouraging female volunteers to use ‘advanced’ technologies. Technical skills in handling technology, training in filling out forms and recording the data required, and conflict resolution in small groups, all needed attention for successful VGI to be compiled;

2. Furthermore, social problems were evident asking contributors to volunteer some of the information requested: questions such as ‘who owns this land parcel?’, ‘is this land occupied illegally?’, and ‘how many people form the household in this property?’ often proved uncomfortable for volunteers to ask;
3. There was also a perception, which was difficult to overcome, that this research was government-initiated, and the hostility of citizens to the authorities took much effort to overcome;
4. The final merging of captured VGI with the official data: in terms of the level of accuracy required, this would not be problematic, but the legal standing of information captured by citizens as opposed to official agencies has not yet been tested.

This research has concentrated on considering different methods of data collection that can suit different types of people, in varying geographical contexts. It has given the opportunity for a diverse sample of citizens, with varying levels of education and experience, to volunteer and participate. The degree of engagement and the promising levels of accuracy and completeness of the VGI data and its possible inclusion in a fit-for-purpose LAS, are of significant interest to the authorities of Al-Hillah. It has been shown that, despite challenging circumstances in engaging with citizens and acquiring good-quality data, there is potential for incorporating VGI into the land administration system of a poorly-documented, yet dynamic area of a country which faces many problems.

This work has presented a detailed review of the literature and identified a number of areas which need further investigation. Through robust fieldwork, it has set out to address that need. The resulting thesis offers careful scholarship both in terms of the practicalities and viability of VGI for fit-for-purpose land administration systems, and also in terms of a deeper critical analysis of ethical considerations relating to VGI.

It has been clearly shown that the use for VGI in the difficult context of post-war Iraq is possible and that the resulting data are viable. It highlights ways in which the very problems of the country act to engage people and how VGI brings people together to improve their situation. It shows that the most accurate tools for the job may not be the most technical or the most

expensive, and that people have strong preferences for what they wish to use. These points are explored in a significant number of publications which have already resulted from this research (see p. xvi).

However, as the work progressed and the author began to think more critically about what had been achieved, the work also raised many ethical and philosophical questions. It is, perhaps, this area of VGI, rather than specific concerns about accuracy, which should be studied more if VGI is to become a common approach to land administration.

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	<p>The tape is not so accurate in our environment (the plastic tape may increase in length in high temperatures during the summer). The GPS may not be accurate in some cases.</p>	
7	<p>What do you think about this system?</p> <ul style="list-style-type: none"> • The system is weak, which is a natural consequences of the wars. • I think the number of the surveyors is not enough to deal with the current issues of the land. • The financial support is very weak due to the wars and the low price of oil. • Most of the maps are very old and need updating 	
8	<p>Do you have any ideas how to improve the system? I have no idea. However, I think there should be an urgent procedure to control the illegal occupancy of government and private lands.</p>	
	<p>Section 2 About Volunteer Geographic Information</p>	
	<p>Yes, No questions:</p>	
	<p>Do you know about Volunteer Geographic Information?</p> <p>No.</p>	
	<p>Do you think that using volunteer geographic information to support land administration systems is a valuable idea?</p>	<p>Yes No</p>
	<p>Give your reasons The people may not be prepared to volunteer. They may not have the ability to use those methods. They may cheat you by giving you the wrong boundaries and ownership details which can cause a serious problem.</p>	

Appendix 2 Example of transcribed interview with a gatekeeper

Possible question	Purpose of the question
Is the land in the community formally registered with the local Municipality?	To know which type of land is formally registered and which is not.
Who owns the land in this community?	To have an initial idea about the types of ownership in the community.
Is there any conflict or difference of opinion between the community and the formal authorities over the ownership and size or location of individual land plots?	To have an initial idea about whether the people are satisfied with the official system or not.
Would you allow me to and support me in engaging with people in this community to collect their own data	To see if there is an opportunity to conduct the project in this community.

Appendix 3 The Consent form for volunteers

consent form	
Name: anonymised Reference No.: 2	contact: anonymised
Reason for participation To help enhance our country's land administration system and to learn new methods of data collection	
I have read and understood the information about the project (see details on information sheet)	✓
I am aware that I can withdraw my participation from the research project at any time and for any reason.	✓
I am aware about my right to ask the researcher question at any point I need clarification	✓
I agree that any information that I provide can be used to support the research project findings.	✓
I agree to appear in any photograph that may capture my image during the fieldwork.	✓
I understand that when the demarcation process starts at the specific time and location, the researcher is responsible for anonymising names and locations by using generic names and grid references for location purposes.	✓
I understand that all the data that I have provided will be fairly used, treated with fully confidentiality, securely stored and, in case the data is used outside the research team, will not be identified as mine.	✓
Signature: anonymised	Date: 07/04/2016

Appendix 4. Transcribed questionnaire with local community volunteers and participants

Parcel code: (715)

Owner Name: anonymized

Contact number/ anonymized email/ None

Gender: M, Age: 51

Highest level of Education: Know how to read and write

What is your job? Taxi driver

Length of time in the settlement:20 years

Section 1 – Knowledge of the systems		
No	Question	Response
1	How much do you know about the current land administration system?	Great deal Enough to understand Very little Nothing
2	Do you know how much of the land in this settlement is formally registered with the Municipality – how do you know? Because many people occupied land without formally owning it. Especially after the fall of Saddam Hussien. You can see the area around the gas pipe in Mahkama or the big piece of land near the centre or many others which belong to either government or people who live outside the country (Some)	All Most Some Little None
3	Have you had any experience of registering land with the authority?	Yes No
4	What was that experience like, what were the difficulties if any? When I went to subdivide my land parcel and sell it to one of relatives, they cited many obstacles and put me in a very long queue. Then I decided to sub-divide the land parcel into two parts using a private surveyor and to sell it to my relative. So, all of the parcel is formally registered in my name only. However, we divided it privately into two parcels.	
5	Do you have confidence in the current formal system being accurate?	Yes No
5a	If No, explain why? Because it is long procedure, expensive, may get more problem that you haven't expect before.	
6	Do you have any ideas for enhancing the official system? Yes, teach us very simple ways as volunteers that can help us to update the system.	
Section 2 About your own plot		
0	Type of parcel	Moshtamal House Parcel Shops
1	Type of ownership	Owned Rented Borrowed
2	How did you acquire the land?	Bought

	If 'other' please specify	Inherited Other
3	Do you remember when was the last transaction? And the previous owner if possible?	Around 1996 Ahmed Sawal
4	For how long you have been living on this plot?	< 1 year 1-5 years >5 years >10 years
5	Do you know if your claim to the land is registered with the authorities?	Registered Not registered Don't know
6	Was there any previous conflict with the neighbour on the boundary of their land?	Yes No
7	<p>Details</p> <p>Due to the inaccurate surveying, my parcel was extended onto my neighbour from the back side. My neighbour informed me about this problem and we brought in a private surveyor to check.</p> <p>The surveyor confirmed the mistake in the surveying of my parcel. Then we checked the price per metre at that time and I have given some money to my neighbour and we solved the problem. However, we kept knowledge of the correction between us without updating the records in LAS due to the long procedure. The reason for such problem is the official surveyor who did not fix it properly.</p>	
Section 3 About helping in this study		
1	<p>What motivates you to be a VGI participant in this study?</p> <p>I am very happy to work as a volunteer for several reasons:</p> <ol style="list-style-type: none"> 1. To learn how the surveyors do their work 2. To use my free time and to help you and other researchers to develop our country. 3. It is interesting to know that I can do some valuable work and I do not need to be an engineer to do it. I always see the surveyors do their work. However, I couldn't understand how they obtained the boundary. With the VGI methods that you have proposed, it is very easy for someone like me who didn't have any experience with surveying to obtain the boundaries of land parcels and be part of the development for the land system. 	
2	Which of these technology you have used before?	Smartphone iPad / tablet computer
Section 4 Experience of collecting VGI data for the project		
1	<p>Which of the methods did you find easiest to use and why?</p> <p>I like to use the paper and pen because it does not need to go around the houses like the GPS and you do not need to have a tablet to update the system. Next, I feel it more suitable for my age to use the paper and pen method of demarcation. Furthermore, the image is very simple and it is easy to identify all the community buildings.</p>	<p>GPS / smart phone</p> <p>Editing boundaries with tablet</p> <p>Using paper map/image</p>
2	<p>Do you think the Municipality should encourage you to collect your own VGI data?</p> <p>Yes, of course, to get fast and up-to-date data. Next, it would help to develop our community, and facilitate land transactions.</p>	<p>Yes</p> <p>No</p>

