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Application of the Geographic Information System (GIS)
in developing countries: contributions, effectiveness,
sustainability and limitations in development project

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Abbreviations and acronyms

GIS	Geographic Information System
IT	Information Technology
ICT/ICTs	Information and Communication Technology/Technologies
GPS	Global Positioning System
GCP	Ground Control Point
MLGH	Ministry of Local Government and Housing
LCC	Lusaka City Council
LPPA	Lusaka Province Planning Authority
ECZ	Electoral Commission of Zambia
JICA	Japan International Cooperation Agency
RESCAP	Rural Extension Service Capacity Advancement Project
GIZ	Gesellschaft für Internationale Zusammenarbeit
D4D	Decentralisation for Development
DFID	Department for International Development
SIDA	Swedish International Development Cooperation Agency
CIA	Central Intelligence Agency
GDP	Gross Domestic Product
PM	Participatory Mapping
PLA	Participatory Learning and Action
PRA	Participatory Rural Appraisal
PD	Power Distance
UA	Uncertainty Avoidance

Executive Summary

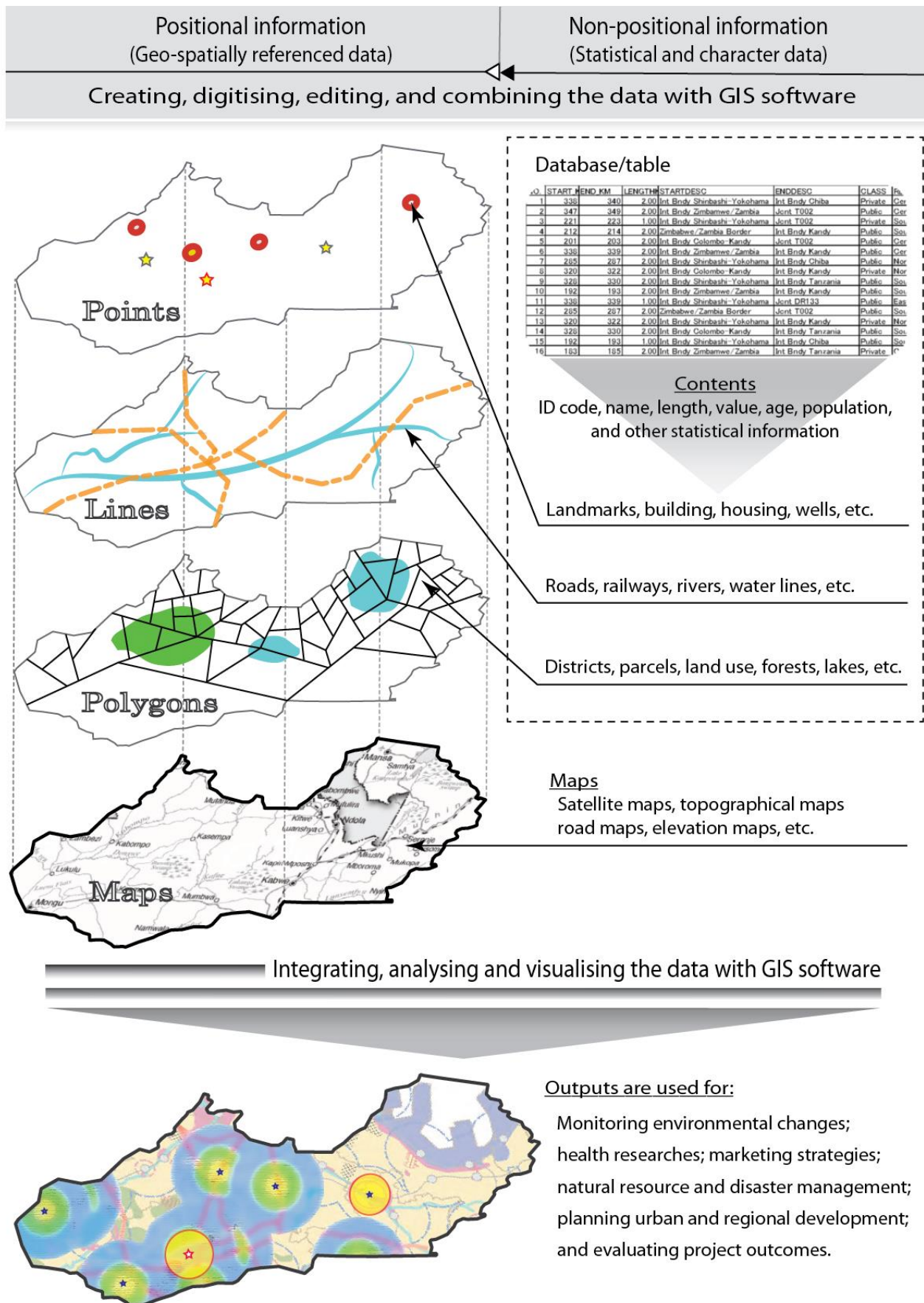
The Geographic Information System (GIS) lets us visualise and analyse complicated information. It is widely believed that there are many ways to use GIS even in developing countries, especially for planning, monitoring, and evaluation. However, appropriate usage of the system requires various conditions; the accuracy and availability of information; the ability to operate software; and fundamental ICT conditions. It is expected that these conditions are unformed in developing countries; therefore, it is quite doubtful that GIS can contribute to developing countries as well as it does to developed countries.

The aim of this study was to examine a practical figure of GIS application in developing countries, including various challenges, achievements, limitations, and roles of each stakeholder. My study focused on government sectors and international organisations through GIS-related projects, and based on reviews of literature and a case study in Zambia.

The adoption processes and influences of GIS are not uniform but diverse, that is why the GIS application in developing countries can be more sensitive, complicated, and challenging. It is important to support operational skills through training and supervision, at the same time, the supervision has to cover a holistic point of view for a lengthy development process, particularly in order to establish desirable conditions for GIS and ICTs. Moreover, fluent and frequent communication among stakeholders should be strongly suggested in order to manage the organisational influence on GIS.

Regarding key findings from my research, the GIS application takes important roles in capacity building and organisational structure reform. The case study illustrated the fact that GIS encourages political and geographical structural reform. Thus, GIS in developing countries should be regarded as not just a simple ICT tool but rather a catalyst that has a massive impact on social reconstruction in multi-dimensional perspectives. In terms of challenges and impediments, my findings focused on data management in particular. Data sharing is essential for GIS-related project; however, this problem is often underestimated, particularly by local government. A solution for this issue will be required from cultural and institutional as well as technical approaches.

Diagram: What is the Geographic Information System?



Chapter 1: Introduction

1-1 Rationales and background of the research

As an example of Information Communication Technologies (ICTs), the Geographic Information System (GIS) has been adopted by many people and facilitated various opportunities throughout the world. It has become popular among developed countries in the past few decades, especially for planning, monitoring and evaluation. As a narrow definition, one of the major GIS software companies, ESRI, states that GIS is an IT system used to create, edit, visualise, question, analyse, interpret, and share various geographic data to understand relationships, patterns, and trends¹. More practically, it enables users to analyse and visualise complicated information, such as quality of life, by means of a combination of geospatially referenced maps and plotted positional data including land use, roads, water lines, buildings, natural resources, and other facilities, with statistical (non-positional) data such as population, age, income level, type of household, and so on. It is generally used for urban/regional planning, evaluations of projects, explanations for external institutions and inhabitants, and collective data management. Hence, GIS has a variety of uses, though the most important contribution would be the increased visibility of complex information.

That is why the GIS has been adopted not only by developed countries but by developing countries as well. It is widely believed that there are many ways to use such ICTs even in developing countries, and this is surely true to a certain extent. However, appropriate usage of the system requires the accuracy and availability of fundamental information above all, in addition to the ability to operate software and manage data. Moreover, there are various desirable conditions for the sustainable use of GIS, for instance, punctual data collection over a long-term period; horizontal cooperation among governmental sectors in order to share information; ensuring the transparency and validity of the information; and accessibility of affordable information resources, including mapping data. It is expected that these conditions are either weak or have collapsed in developing countries. In the

¹ ESRI What is GIS <http://www.esri.com/what-is-gis>, and ESRI Japan <http://www.esrij.com/getting-started/what-is-gis/>

context of developing countries, development policies frequently face a lack of facilities and information, a lack of transparency, and poor management of information resources; furthermore, governmental crises and social instability are also urgent risks. Despite the ICT-adoption trend within the global community, it is quite doubtful that GIS can contribute to developing countries as well as it does to developed countries.

On the other hand, it is assumed that there would be more varieties of the potential uses of GIS in developing countries. One of the typical examples could be poverty reduction; assessment of the poverty level within a region can be visualised precisely with composite information about income levels, forms of livelihood, housing conditions, and accessibility to public services, markets and natural agricultural resources; mapping the water lines and water supply facilities related to a poor residential area can present effective provisions of water and sanitation for them; health conditions can be traced visually and chronologically, which can be used for provisions against infections or diseases. Likewise, disaster management and natural resource management have been supported by GIS, both of which would be in high demand in some developing countries.

1-2 Research questions

This research will examine a practical figure of GIS application in developing countries. It explains various issues, potentials, and limitations of GIS in the context of developing countries, clarifying their differences from developed countries. In particular, I will focus on government sectors and international organisations through GIS-related projects. The main research questions are as follows:

Question 1: What kinds of GIS-related projects have been implemented in developing countries, and what have been their main rationales for GIS adoption?

First, application of GIS in developing countries would have partly different characteristics from the application in developed countries, particularly in terms of its introduction, objectives, expectations, and outcomes. Therefore, it is important to understand the varieties of practical projects and the reasons for GIS adoption.

Question 2: What are the crucial problems of GIS application in developing countries?

During the implementation of GIS-related projects, it is assumed that there would be lots of challenging issues for each stakeholder. For instance, scarcity, such as a lack of skills and facilities needed to operate GIS software, is a typical impediment in developing countries. The collection of information is another serious issue because developing countries often have problems with data accuracy, reliability, availability and coverage. Other common issues in developing countries include a prevalence of informal businesses and activities that are not officially registered, social disorder, and polarisation of political power; these factors negatively affect the application of GIS. In addition, a lack of horizontal cooperation among governmental sectors and some traditional organisations might be crucial impediments. These practical and potential problems will be exemplified through various case studies from literature and field work.

Question 3: What are some alternative methods that can compensate for the disadvantages?

Limited resources and skills are fundamental issues in most developing countries; therefore, policy makers and international communities who plan to adopt GIS must consider how to handle this. GIS experts from the international community may be able to share their operation and management skills to compensate for those disadvantages using several alternative approaches.

Question 4: How does GIS contribute to development issues by each stakeholder?

In the context of international development, GIS may be able to play more important roles in tackling major issues in developing countries. Some must be similar to those in developed countries, such as urban/regional planning, but there are other uses for GIS to facilitate poverty reduction and capacity building. Sustainability and feasibility are also important issues, and the main roles that each international organisation and local government would take should be discussed.

1-3 Limitations

There are some limitations to this research. First, it focuses only on government sectors and international organisations, meaning private sectors have been excluded. Even in developing countries, GIS has been introduced by private companies such as consulting and research firms. However, the influence of these private sectors on local communities will not be discussed in this research. Second, the total number of case studies about the application of GIS in developing countries is still limited. Hence, the findings within a certain region/country may be unclear within the general discussion because a case study of GIS might have been strongly affected by the specific context of the region/country.

1-4 Structure of dissertation

The next chapter will introduce reviews of literature related to the application of GIS within developing countries. In chapter three and four, I will present a case study that I conducted in Zambia, explaining its methodology and analysis and providing further discussion. Subsequently, I will present a conclusion about the application of GIS in developing countries based on the case study and the literature review.

Chapter 2: Reviews of literature

This chapter will discuss various arguments relating to the application and implementation of GIS in developing countries. Many arguments regarding GIS have arisen from academic and practical points of view over the past few decades; however, there have been relatively few discussions on the application of GIS focussing specifically on developing countries. One of the main reasons for this could be that GIS is a relatively new technology that is only used within specific fields in developing countries. Although it is generally believed that GIS is quite flexible and has contributed to various objectives and fields, the requirements of skills, finances and facilities are somewhat higher than other ICT tools such as the internet and mobile phones, which might be one of the factors for its slow progress in academic researches on GIS.

In this literature review, I will basically argue using academic studies about the application of GIS and the implementation of GIS-related projects in developing countries, beginning with a classification of the studies and a review of each discussion.

2-1 Types of literature about GIS studies

Primarily, academic literature is classified into project-based case studies and generic studies. Project-based studies focus on specific programmes in a country or region, and are based on the specific context of the project area and the objectives. On the other hand, generic studies focus on the essential features of GIS itself, based on cases in several countries and regions. As De Man (2002) said, the contexts of arguments relating to GIS are not uniform and therefore project-based study is more popular. Nevertheless, generic study is also important for reflecting the nature and common influence of GIS within the international development field.

The types of arguments are as follows: discussions about the adoption and diffusion process of GIS in developing countries, which often refer to the desirable/essential conditions for that; the technical utilities and the potential usefulness of GIS for the objectives of development programmes; successful elements for the sustainability and feasibility of GIS-related projects; induced changes as a result of the application of GIS and

its compatibility with the current organisation and culture.

2-2 Decision-making for the adoption and diffusion process

2-2-1 Contextual differences in developing countries

The process of diffusion and adoption is the subject of one of the major arguments regarding GIS application in developing countries. This debate is more common than arguments about the actual operation of GIS, which implies that the process of GIS diffusion and adoption in developing countries would be considerably different than it is in developed countries. What we should understand at first is that GIS is not only a simple tool for technological innovations or effective solutions for tasks, but also one constructed within a social structure (De Man, 2002). GIS, in terms of diffusion and adoption, is strongly influenced by the culture and social conditions of a region/nation, and is highly diverse as a result. This could be one of the reasons why a successful technology transfer is harder than originally planned.

Despite the diversity, Mohammed and Plante (2002) outlined four general issues regarding GIS and relevant technologies:

1. Lack of data and information
2. Institutional barriers
3. Lack of expertise and capacity for operation
4. Lack of financial resources

Likewise, most studies have pointed out issues such as finances, skills, legislation, and infrastructures as major impediments. Berisso (2010) claimed that the most essential condition for GIS adoption is accessibility to technology. Adoption of GIS is a part of the process for ICTs, and the utility of GIS is preconditioned on the availability and functionality of ICTs (Berisso, 2010). There is obviously a crucial gap between developed and developing countries in other factors such as educational and financial access. Furthermore, Langmia (2005) researched the roles of ICTs in economic development and reported that information literacy, local languages, and conditions of electricity have been main causes of the digital

divide, especially in rural areas. Those three factors are necessary for the application of GIS for the same reasons.

Moreover, De Man (2002) researched relationships between the application of GIS and the cultural contexts within organisations. This illustrated the different perspectives on the adoption of GIS from a technical point of view, referring to skills and ICT functionalities, which helps us to understand the nature of GIS and further desirable conditions for the application of GIS in new regions with different cultural contexts and circumstances. De Man adopted Hofstede's (1980, 1991) four-dimensional model of culture in order to indicate the desirability and sustainability of GIS adoption using cultural labels as follows (De Man, 2002, p. 56):

1. Power distance (PD): culture's way of accommodating human inequality, whether it is hierarchical or flat within organisations.
2. Uncertainty avoidance (UA): culture's way of accommodating uncertainty. Organisations' behaviours of taking and avoiding risks.
3. Masculinity versus femininity: culture's way of accommodating masculine and feminine values. Masculine cultures focus on achievements and success, and feminine cultures emphasise quality of life and social values.
4. Individualism versus collectivism: culture's way of accommodating the individual and the group.

De Man (2002) suggested that cultural desirability for the adoption of GIS can be assessed by these indicators; moreover, it is reported by De Man (2002) that individualism and PD are inversely correlated, therefore the desirability and feasibility of GIS-supported organisational functions will be assessed by the three factors: PD, UA, and Masculinity versus Femininity (De Man, 2002). This can be adopted to introduce and initiate a GIS-related project, though feasibility can hardly be evaluated without ambiguity because it is associated with GIS-functional properties, objectives of GIS adoption, and technical factors such as skills and resources (De Man, 2002). Overall, the decision to adopt GIS should be considered with these cultural factors in mind as well as the technical and physical points

of view.

2-2-2 Process of decision-making for GIS adoption

In terms of the decision-making process in practise, as De Man (2002) and Berisso (2010) claimed, there is no uniform way for GIS adoption. The concept of innovation is changeable when it is transferred from developed countries into developing countries in particular, therefore there is diversity in terms of the factors of decision-making (Berisso, 2010). Moreover, the model of societal culture mentioned above is also influential: for instance, the decision-making can be organisational, otherwise an individual could make a crucial decision. Furthermore, Langmia suggested that strong governmental leadership is quite important in order to initiate ICT-related programmes for development issues such as poverty reduction (Langmia, 2005).

The types of decision-making processes for the adoption of GIS within an organisation or a nation are diverse, including the public sector and private sector, external organisations or domestic organisations, higher institutions or grassroots, policy-makers or technicians. In general, it derives from organisational interests in many cases, additionally introduced from higher institutions and external organisations, and private consultants (Berisso, 2010). Especially in most public sectors in developing countries, introduction of GIS is project-based (Berisso, 2010), which implies that the adoption decision is generally made by higher institutions and external organisations. GIS introduction is initiated with training and short-term workshops in most cases, and participants learn and increase their interest of GIS with them (Berisso, 2010). These kinds of activities will influence local professionals, particularly draft persons, planners, engineers, and managers, with multiple effects as an organisation starts using GIS; this can take the GIS introduction into other organisations through the individual communication channel (Berisso, 2010). Hence, project-based introduction with training or workshops would be quite convincing and effective; nevertheless, it requires that other arguments such as continuous practise and sustainable use be addressed afterwards.

In addition to the occasional events such as training and workshop, internal and external pressures and requirement of sharing data with other projects often become additional

opportunities for further dissemination of GIS. For instance in Ethiopia, GIS was introduced at several institutions participating in the governmental reform programme, and it became an integrated solution in projects, and secondary dissemination occurred in other institutions (Berisso, 2010). Having said that, support based on the project is not uniform across organisations and regions. Some organisations might receive training, while others were taught by early adopters or may have learned from the internet, or perhaps there was no support at all (Berisso, 2010).

Although diffusion processes and desirable conditions are varied and not uniform within regions and organisations, there are some standard processes in the introduction and initiation of GIS. These findings are suggested by several researchers, but the evidence is limited; hence it still requires continuous empirical research (De Man, 2002).

2-3 Technical usefulness of GIS in practise

Like the ICTs, GIS has supported various organisational functions such as strategic planning, operational planning, monitoring and evaluation (De Man, 2002). More precisely, the major ways GIS can contribute include urban and regional planning, resource management, environmental monitoring, health and disease monitoring, disaster management and agriculture development (Mohammed and Plante, 2002).

Gariba et al. reported on GIS application to environmental education and forest management in Ghana's forest region. They emphasised its effectiveness as an educational tool in terms of demographic tracking; local people visually perceived trends and changes of people and properties over time (Gariba et al., 2003). At the same time, it helped with land border reconciliation as well (Gariba et al., 2003). Furthermore, integrated information and digital data can be used for other projects and researches in the future, so the main purpose of the project was environmental education even though potential achievement can be more than that, extending to modernisation and standardisation of the governmental system. In other words, GIS application should be regarded as not only a complementary or supportive function for current systems but also a way to upgrade traditional systems to the international standard level, especially in terms of the ICTs.

Sugimoto et al. introduced GIS application for health research projects in Bangladesh within the regional context. In that case, the decisive reason for adopting GIS was that the project area was large and required an effective participant tracking system with a geographic component that could spatially relate and display several relevant points (Sugimoto et al., 2007). During the project, local officers had the important task of seeking out all geographical features, such as houses and roads, to verify and upgrade the current information. It is difficult for external officers to search geographic features, especially in rural areas, therefore this task was accomplished by local officers. Consequently, this general process in GIS application is regarded as capacity building to train skilled local field workers in a cost-effective way (Sugimoto et al., 2007).

Furusawa reported in his study on the Solomon Islands that he used GIS in combination with GPS and heart-rate monitors to research fishermen's work activities and overall effectiveness. He successfully visualised the relationship between practical physical stress in participants' daily work and the total amount of fisheries (Furusawa et al., 2011). In addition, he implemented another ecological study on the carrying capacity and sustainability of migratory cultivation in the Solomon Islands. To compare current cultivation areas with past ones, he conducted field surveys with a GPS to locate present areas and specific landscapes, and conducted further interviews and observations to locate past areas (Furusawa et al., 2011). Analysed by ERDAS Imagine, which is remote-sensing software used to create spatial information from geographic images, it illustrated the total forest areas that had been opened within the past 55 years and the annual increase rate, and concluded that the productivity of the land was relatively high, meaning it would not require further deforestation for agriculture if the population remained at its current level (Furusawa et al., 2011).

These studies and projects exemplified that various findings can be depicted in collaboration with fieldwork and remote-sensing analysis with GIS, especially those concerning natural resources and environmental and health issues, which will be used for further planning. Moreover, a lack of infrastructure and information resources can be handled to a certain extent by a skilled GIS expert in order to achieve successful researches and analyses. On the other hand, it is implied that the quality and flexibility of analyses

strongly depend on the capacity of the people involved, in addition to the available data, maps and software.

2-4 Practical procedures of GIS project in developing countries

Several project-based researches introduced practical procedures for using GIS in the project. The implementation of GIS-related projects differs by project; however, most projects follow the same general procedures.

According to Sugimoto et al. in 2007 in Bangladesh, at the first stage of the project, it was necessary to convert conventional paper maps and information into digital data in order to use GIS. Likewise, other projects in developing countries, especially those relating to the environment, disaster management, education and health, are often initiated by creating digital maps. In a technical procedure, it is common to combine several pieces of maps into one base map for a project because there are few cases in which an existing map covers the entire project area. Several adequate available maps and the Ground Control Points (GCPs), which are used as landmarks in order to combine different maps, are required to create the base map.

In terms of collecting and upgrading geospatial information, the approaches used are basically field surveys or aerial maps and satellite maps. Most cases have involved field work as a main approach. In the case of Bangladesh, that task was included in the weekly fieldwork of the local office (Sugimoto et al., 2007). In the field work, they found that some infrastructures such as low-cost housing and natural materials had high rates of turnover; on the other hand, some specific landscapes and intangible things like land boundaries were likely to be unchangeable (Sugimoto et al., 2007). It is expected that there is much housing made of natural materials in poor areas, meaning frequent upgrading is important for effective analysis of GIS; in addition, facilities that have long turnover periods are suitable for GCPs, and may not require frequent upgrading processes. To improve the accuracy and reliability of information in field work, many cases involved individual research using GPS to confirm the geospatial information, which was verified by supervisors from external or higher institutions. The proportion of the supervisors' verification was approximately 1-2% (Sugimoto et al., 2007).

On the other hand, Furusawa (2011) used satellite maps and analysed land use with remote sensing software. He used maps available online, including free resources, quite effectively. Some aerial and satellite maps are available on certain websites, but the availability of maps and data is often limited in terms of years and resolution, and technical processing skills are required for GIS technicians and advisers. High-resolution maps are expensive and difficult to access in general. This might be a main rationale why the field work method is used so often in development projects. In addition, the information collected from field surveys is possessed by field workers involved with the procedure, whereas information analysed with aerial/satellite maps is possessed by technicians. This could be another decisive point in choosing the field survey method in order to collect information for GIS, as the process trains skilled field workers at the grassroots level and uses a bottom-up information flow.

2-5 Potential and conceptual usefulness of GIS

More conceptually, Chambers in 2006 regarded approaches through a mapping process including GIS as a concept of 'Participatory Mapping' (PM), which is a widely adopted participatory development method. Originally, the mapping approach was utilised for rural/regional development methods such as Participatory Rural Appraisal (PRA) and Participatory Learning and Action (PLA) (Chambers, 2006). He enumerated major purposes of PM such as social mapping, health mapping, water and sanitation, education, prevention of crime, and participatory monitoring and evaluation. Participatory monitoring and evaluation are especially important for this concept because they enable farmers to review their own properties: soil, water and sanitation (Chambers, 2006).

Furthermore, in general discussion of ICTs, it is suggested that technological innovations can boost economic development and create new labour forces, and, in addition, increase awareness of education and health (Langmia, 2005). ICTs can suggest 'the alternative path to development' (Langmia, 2005), so GIS would have the same potential as well.

2-6 Induced changes

Benefits and influences brought by GIS into organisations and functions are not only technical solutions for problems but also cultural and organisational changes. Berisso

suggested that the expected induced changes can be classified into the structural and the behavioural. The Ethiopian case study reported that GIS diffusion and increased importance within organisations would bring about changes in tasks and the process of their duty (Berisso, 2010). Structural changes are sometimes intangible, and one of the clearest interventions in that respect is the establishment of a new office such as a GIS unit, creating new job opportunities.

In practise, GIS induces speedy and accurate information which will increase effectiveness in terms of the economy, time management and quality of social management involving various stakeholders (De Man, 2002). Collected and edited information would be stored and shared, and then used for other investigations and analyses. In the case of Ghana's forest region, project objectives focused on the educational impact of environmental management, but drafting borders and combining maps with various types of geospatial information would be instrumental for further projects and planning (Gariba et al., 2003).

2-7 Problems, risks and limitations

Most project reports related to GIS application focus on positive factors and successful points; nevertheless, they point out various kinds of impediments to GIS in developing countries. These often include serious limitations and challenges, besides predictable issues such as a lack of technical skills, resources, finances and infrastructures.

First, frequent updating of information is desirable but too idealistic to maintain. Although the field survey in the Bangladesh case was effective, the systems and overall validity are affected by the supervisor's skills and motivations: top-down organisational decision. "Effective GIS analysis requires geospatial factors and related outcomes which reflect at the same time the outcome that actually occurred" (Sugimoto et al., 2007, p. 443), but in practise, supervisors and technicians have to ponder how to deal with existing information, rather than how new and accurate the information is. Consequently, this will require a higher level of skills and understanding in the operation of GIS.

Second, although GIS has a significant impact on organisations and functions in developing countries if the application succeeds, the achievements are often slower and unplanned. Furthermore, GIS cannot support all the organisational functions, and the benefits are

relatively low (Berisso, 2010). Hence, the impact of GIS in developing countries is often likely to be less than expected. A similar issue is pointed out in the ICTs, as speed of development in many developing countries has been slow despite their ICT prevalence (Langmia, 2005). Langmia enumerated some reasons in the context of the African continent, including embezzlement, bribery, corruption, lawlessness, and lack of accountability, and additionally the problems of bureaucracy, dictatorships, economic stagnation, war, the literacy crisis and cultural importations (Langmia, 2005, p. 153). The same issues can be suggested for GIS.

Third, many cases of GIS adoption are initiated by projects designed for specific purposes. It is pointed out that GIS application often results in project prescriptive, and it is not timely parallel as the induced transformation of organisation (Berisso, 2010). Thus induced organisational changes may not be supported by the projects.

Fourth, I should refer to the digital divides for GIS as a part of the ICTs. Those include computer literacy, accessibility to facilities, electricity, and local languages, and will be crucial impediments to the application of GIS, especially in rural areas.

Finally, software and hardware for the ICTs are mostly imported from developed countries, therefore prevalence of the ICTs into developing countries may increase dependency on the Western community (Langmia, 2005).

Those are the ICT-related issues that are generally adopted in GIS as well. However, some characteristics of GIS differentiate it from the other ICTs, such as the internet and mobile phones. For instance, GIS is introduced to organisational units and not to individuals in general. Moreover, free software such as QGIS² is widely available to everyone. Thus, in terms of GIS, the digital divide and dependency on the West would not be crucial problems, although they are still disadvantages within rural and poor communities.

² QGIS, previously known as Quantum GIS, is a free and open source GIS software available online: <http://qgis.org/>

2-8 Conclusion

Nevertheless, GIS application in developing countries has been not uniform but diverse, and there are some common trends to a certain extent that make it different from developed countries.

First, rationales and objectives of GIS application in developing countries have two dimensions as practical initiatives, such as improvement of the effectiveness of tasks and modernisation/standardisation of organisational systems; another one is creating changes within organisational structures. The latter one should especially be regarded as a major difference from developed countries.

Project-based GIS adoption aims at planning, managing, analysing, and increasing effectiveness, otherwise GIS introduction itself can be an objective. In addition, secondary benefits such as capacity building and education are often reported.

On the other hand, the diffusion process of GIS and its impact on society are still controversial and ambiguous. As De Man suggested, the cultural factors should be assessed carefully, and the relationship between cultural influence and GIS application needs further evidence (De Man, 2002). Moreover, cultural compatibility may not be an essential issue for successful adoption, although it may make the adoption process much smoother. Cultural influences can be either negative or positive, hence we should consider where, what, and how the impact affects rather than whether it is compatible or not.

Furthermore, adoption of GIS can be a catalyst for social reform in a nation, and reform of social or governmental systems will be opportunities offered by GIS adoption. In this perspective, the opportunity of organisational reform in developing countries is strongly correlated with GIS applications. GIS can strengthen local authority (Berisso, 2010), which is why the opportunity of organisational reform would promote GIS adoption, and vice versa.

Overall, researches related to GIS in developing countries illustrate some impediments and obstacles in their specific contexts; however, there are mostly positive perspectives. It requires more evidence, and there is much room for further discussion of the risks and

limitations which decision-makers should consider. For example, Gariba et al. (2003) suggested that GIS is undoubtedly instrumental in environmental management projects, especially from an educational perspective, and it also helps to reconcile land boundary issues in a community. This, in other words, implies that GIS makes the land boundaries clearer, which may forcibly bring unambiguous legitimacy to a culture by accident.

There are some reasons why the negative perspectives have not been argued well: GIS might not bring about any negative impacts, or they might be easily ignored by the society; the number of case studies is quite limited, with not enough to fully discuss it; most programmes related to GIS have not been proceeded to a great enough extent to reflect the negative impact in the societies in developing countries. Hence, the following case study will illustrate and verify factors from literature reviews, and discuss the implications of negative perspectives as well.

Chapter 3: Methodology of the case study

3-1 A main method for the research

This case study was implemented using semi-structural interviews conducted in Zambia, mainly at the capital city of Lusaka in July 2014. The number of interviews conducted during the period was seven, with two brief preliminary discussions for the international organisations. The interviewees were, as shown in Table 3-1, four professional experts on GIS from international organisations and three local government professionals. All the interviews were done in Lusaka at their offices, although some projects were being implemented in regional areas. The interviews were individual face-to-face style, and in some cases their office colleagues also answered the questions.

The questions were listed in semi-structural interview form, thus the research was totally qualitative. In order to make the content of the questions clearer for interviewees, I gave a brief explanation about this dissertation and the background beforehand through discussion and e-mail.

Table 3-1: List of interviewees

Organisation	Position	Project office/area
Local government	Acting Provision Planner	LPPA/Lusaka Province
International/GIZ	GIS Adviser	D4D/Solwezi district
International/GIZ	GIS Adviser	D4D/Lusaka, MLGH GIS Lab
International/JICA	Expert on Rural Development	RESCAP/Northern and Western Provinces
Local government	System Engineer	Electoral commission of Zambia/Lusaka
Local government	Land Surveyor	Lusaka City Council/Lusaka
International/JICA	City Planning Volunteer	LPPA/Lusaka Province

3-2 Limitations of the case study

This research had several limitations. The number of interviewees was limited, and all the questions are qualitative, so there was no quantitative analysis. This is mainly due to time constraints, and the number of GIS projects in the country was limited. Moreover, the research targeted only government-related GIS application cases, which were mostly project-based, so it does not cover private-led application of GIS.

3-3 Criteria to designate places and methods

I selected Zambia for the case study using the following three factors:

- GIS-related projects have been implemented for years there by the government and international organisations: it is desirable that multiple institutions have implemented projects both in the capital city and other regions in order to gain holistic, inclusive, practical perspectives on the use of GIS in the nation.
- Relatively peaceful and stable social conditions: this is important not only because of personal safety during the investigation but also for the stability of the project, sustainability of the GIS operation, and availability of GIS-related data over a period of years. Obviously, a society unstable in peace and governance would be a major risk of maintaining GIS-related properties.
- The country should have the basic capacity for ICT to a certain extent

The number of questions totalled 21, but some might be excluded in case they are not applicable. Semi-structured interviews were appropriate for this case study, because they can manage the difference in each project perspective and each interviewing context quite flexibly; moreover, interviewees can reflect their opinions on the GIS project directly. Although the number of interviewees was limited, all respondents held representative positions in projects and offices, therefore offering clear and responsible ideas on GIS.

Chapter 4: Case study in Zambia

4-1 Statistical information on Zambia

Zambia is rated a lower-middle income country by the World Bank³; its GDP in 2013 was 22.38 billion USD, and its population in 2013 was 14.54 million. It is located in southern Africa, surrounded by Zimbabwe, Angola, the Democratic Republic of Congo, Mozambique, Malawi, and Tanzania. It has a relatively large land area, ranked 39th in the world, but its arable land was only 4.52% in 2011 according to the CIA World Factbook (CIA⁴). Its capital city Lusaka has a population of 1.8 million. The urban population in 2011 was 39.2% of the total population, and it is estimated to be gradually increasing (CIA). The population rate beneath the poverty line in 2010 was 60%, and life expectancy in 2014 (est.) was around 52 years (ranked 216th in the world). The risk of infectious disease was rated 'very high' (CIA). These statistics illustrate that Zambia has been very vulnerable to poverty and poor health conditions.

Despite of the difficult situations, the CIA says that "Zambia's economy has experienced strong growth in recent years, with real GDP growth in 2005-2013 of more than 6% per year", which has been led by its privatised copper mine industry (CIA). More importantly, as several articles have showed, Zambia is known as one of the more peaceful countries in Africa, managing its vulnerabilities of violent conflicts⁵ related to political issues, poverty, and neighbourhood countries.

As for ICT, the condition of communication facilities showed 816,200 internet users in 2009

³ World Bank: Zambia <http://data.worldbank.org/country/zambia>

⁴ CIA World Factbook: Zambia <https://www.cia.gov/library/publications/the-world-factbook/geos/za.html>

⁵ Department for International Development (DFID) (2002) 'Conducting Conflict Assessments: Guidance Notes', and Swedish International Development Cooperation Agency (SIDA) (2006) 'Manual for Conflict Analysis' help us to understand the elements to assess the conflict vulnerability. They enumerate the factors that bring about tensions and conflicts, regarding to ethnicity and natural resource management in addition to security, economic and political issues.

and 10 million mobile phone users in 2012, ranked 105th and 76th in the world, respectively (CIA). According to the CIA World Factbook, "several cellular telephone services are in operation, and network coverage is improving", and "internet service is widely available" (CIA).

4-2 Project background

GIS in Zambia has been instrumental in various projects and organisations. This case study focuses on the government sector in Zambia and the international organisations, and the research addresses mainly GIZ and JICA as major actors in GIS-related development projects. GIS has been used by the government sectors in both head offices and regional offices, and it has been adopted and used by individuals in an office at times. The important key factors of GIS in Zambia in terms of governmental policy should be decentralisation and capacity building. After the presidential election in 2011, the government approved the national decentralisation policy which empowers provincial and regional governments to manage their own development issues, and encourages the participation of local leaders in governance⁶.

The main focus of this research is the Ministry of Local Government and Housing (MLGH) at the head office level, Lusaka, Solwezi and Kasama districts at the district level, and the Lusaka Province Planning Authority (LPPA) at the provincial level.

4-2-1 Government sector

The Ministry of Local Government and Housing (MLGH) was established to "promote a decentralised and democratic local government system and facilitate the provision of efficient and effective delivery of quality housing, infrastructure and social services by local authorities and other stakeholders for sustainable development" (MLGH⁷). Lusaka Province

⁶ Most interviewees mentioned this policy. In order to understand the official perspective of this, I referenced some articles of the online newspaper Lusaka Times on 10 April 2013 and 23 August 2013.

⁷ Quoted from Ministry of Local Government and Housing: About Us: Mission Statement <http://www.mlgh.gov.zm/>

Planning Authority (LPPA) is "a statutory body with delegated powers from the Minister of Local Government and Housing, Early Education and Environmental Protection" (LPPA⁸), and it is responsible for Planning Permission in Lusaka Province. They adopted GIS in their office due to more effective and accurate procedures in planning and assessments.

Another governmental sector that has a specific purpose in the use of GIS is the Electoral Commission of Zambia (ECZ). In order to deliver a credible electoral process, it aims to achieve "the delimitation of constituency, ward and polling district boundaries" as one of its primary goals (ECZ⁹). The delimitation project is now being implemented with GIS by system engineers and some occasional staff members.

4-2-2 GIZ and D4D programmes

The German international organisation, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has funded a large amount of aid support for the Decentralisation for Development (D4D) scheme¹⁰ in Zambia. The D4D programme aims to strengthen authorities in local provincial governments through tangible technical and financial support including their capacity building; the organisation says that "decentralisation has been top of the agenda since the change of government in 2011", "however, there is a lack of personnel and organisational expertise to plan and implement this complex reform process" (GIZ¹¹).

This has been the main project operating with GIS by GIZ with the Zambian government. Some GIS advisers have been allocated into central and regional offices, including the GIS laboratory in MLGH.

⁸ Quoted from a brochure of the Lusaka Province Planning Authority. See Appendix.

⁹ Quoted from Electoral Commission of Zambia (ECZ): About ECZ
http://www.elections.org.zm/about_ecz.php

¹⁰ Detailed information of the programme is available on the GIZ website
<http://www.giz.de/en/worldwide/338.html>

¹¹ Quoted from GIZ: Support of the Zambian Decentralisation Process:
<http://www.giz.de/en/worldwide/20832.html>

4-2-3 JICA and RESCAP

The Japan International Cooperation Agency (JICA) is implementing a technical cooperation project named 'Rural Extension Service Capacity Advancement Project' (RESCAP) from 2009 to 2014 in cooperation with the Ministry of Agriculture and Livestock. It targets local government officers and small-scale farmers in the Northern and Western Provinces. The project aims mainly at assessing rural farmers' needs, collecting information, and providing technical support and capacity building.

In addition, JICA dispatched some volunteer officers in the urban planning section from 2008 to 2013 in the Lusaka and Kasama provinces. Their main duties were technical skill transference to allocated offices and other related offices that would use GIS, planning for urban development, digitising cadastral maps, and other support for effective work tasks.

4-3 Main research questions

The questions mainly focused on characteristics of GIS-related projects implemented in Zambia, the background and rationales for the application of GIS, the crucial issues and impediments to achieving the objectives, and the most successful elements and most challenging issues related to the use of GIS. In addition, the research analysis addressed the data resource management and operation of GIS, and the relationship between international organisations and local governments during the application process of GIS.

4-4 Results and summary of the interviews

The introduction of GIS in Zambia was, according to the case study, initialised in 2002 as SIDA implemented a project for capacity building in Lusaka City Council (LCC) at first, with GIS being gradually disseminated throughout this decade. More recently, district reform and the decentralisation policy issued by presidential order in 2012 became an important point in GIS application in this country. At the same time, the Zambian government is nowadays revising the National Development Plan, which will contain principles for land use and development policy, and the physical planning department and the Ministry of Local Government and Housing (MLGH) are taking the lead to create the Integrated Development Plan (IDP). This political movement is now a major rationale for GIS

application.

Like the other cases referred to in the literature review, the basic flow of GIS introduction is initiated by training and workshops, and digitising various information resources. More precisely, as in many cases in Zambia, organisations have tried to collect digital data in three ways: receive from the other sectors, digitise existing paper information, and create the data by themselves. Particularly for the third one, they have used GPS in fieldwork and also free online resources such as Google Earth to collect spatial information in affordable ways. In addition, some of them can acquire cadastral maps and satellite/aerial maps when they are available and affordable.

Regarding the successful elements, GIS generally has limited tangible achievements, especially in the initial stages of the project; for instance, with GIZ in Solwezi, only nine months have passed since it commenced, meaning most outcomes are not clearly shown. Having said that, the participation of GIS advisers from the very first stage would be quite meaningful to show local officers how to manage GIS software and data that is collected and analysed in the long run.

As a part of the outcome of the training and workshops, the JICA volunteer said that there are multiple effects to understand in the operation of GIS, as local officers teach and train other locals after receiving training from an expert. This reaction was an achievement as a result of a two-year programme.

Another type of achievement was presented in the RESCAP. It has successfully contributed to the effectivity and transparency of work tasks in the local government. Using GPS and Google Earth to calculate the actual travel distance of the agriculture extension officers, the expenditure of fuel for vehicles was reduced. It illustrated that there had been a considerable loss in the expenditure on transportation for the government field officers, which was adjusted properly by a combination of GIS and GPS as a convincing solution for all stakeholders.

In terms of challenging issues, a common opinion among both international organisations and local government officers was the slow progress of their projects. Moreover, it is often reported that the skills transferred from the higher institutions to the other local

organisations after training and workshops were quite limited and less than expected. In addition, many international and local organisations pointed out shortages in equipment, human resources, finances, and data resources. This is a fundamental problem because it is always reported in many other case studies mentioned in Chapter Two.

Furthermore, another serious issue is the availability and validity of information, which would be the most challenging element for GIS in a developing country. First of all, most projects of international organisations face a lack of available maps for the base map¹². Even if there is a map available, it is often not reliable, accurate, or up-to-date. Likewise, the land surveyor in LCC said that paper maps that are digitised are often inaccurate and sometimes partly lost, although there are many stocks of paper resources.

Second, there are many illegal/unregistered housing and land uses, especially in rural areas and some parts of urban areas, which create 'blank space' in the official spatial information. For example, shape file¹³ data of building created by the land surveyor in LCC has accurate and detailed information in it, but some illegal buildings and land uses are not included in the data because the government office has not approved them. It seems reasonable in terms of the legitimacy of the public sector, but those should be filled with the same contents of information for an appropriate analysis. However, then another problem comes up: who will be responsible to do that?

Third, the level of geographical allocation in spatial information is another issue. The national census data would be one of the basic information resources, but GIS advisers and experts have pointed out that the data was not appropriate for their GIS-related tasks because the allocation of geographical area was too large for the analysis. Therefore, they

¹² Sugimoto (2007) explained that digital maps for each local area join into a contiguous map covering the project area for GIS, which is called a 'base map'. I use this word with the same meaning in this research.

¹³ 'Shape file' is a type of the digital data set developed by ESRI, known as a standard data type used for GIS software. For further technical information, see ESRI Shape file Technical Description: An ESRI White Paper (July 1998) www.esri.com/library/whitepapers/pdfs/shapefile.pdf

had to create further detailed data by themselves.

Fourth, the international organisations reported that the application for digital data possessed by the government was sometimes refused by the local government. There might be some sensitive factors and bureaucratic issues that could be serious impediments to transferring data from the government sector to the others, particularly to the international organisations.

Additionally, there is another interesting point about data sharing and transferring. The international organisations consider that this is one of the most serious constraints, and will require significant effort to improve the situation and to establish an appropriate structure. On the other hand, local government officers have recognised the problem, but they consider that the situation will be improved in the future because they have several plans of newly launched projects for that. Thus, there would be a gap in perspective between them, and the local government might have more optimistic views than the international organisations.

There is an important implication suggested by the case study: issues on data sharing are more an organisational than a technical problem. The system engineer in ECZ who is creating accurate data of electoral area boundaries said that they have no restrictions on sharing the data of area boundaries that they have created. However, when it comes to the other data that was created with boundary shape files, such as roads, rivers, and other spatial features, the sector does not have any authority to create and manage it officially, and therefore it is not authorised to share. This means that they have to create their own digital data, such as shape files and base maps, as they need them because there is no available data that can be shared with other offices and projects due to organisational limitations. For these reasons, most of the data created by them will be used only within each organisation.

Moreover, the international organisations suggested two considerable issues which might happen even if the data were collected at a certain place in the government: first, the officer in charge may not hand over the data to the other stakeholders, or he/she may not be authorised to do that. There is a suggestion that this reluctance to share data may be

associated with officers seeking bribes. Second, data management may be insufficient because there is no label or log to describe when the data were created and edited, or who created it, and for what reason it was created, so it cannot be used with validity after all. The JICA expert found that the digital data acquired from the government was often lacking any labels with the file name or property explaining when and by whom it was created, therefore files can sometimes be difficult to use.

Finally, there are several potential risks and threats pointed out in the use of GIS and GIS-related projects. First, skilled officers may be transferred to another office or often leave for higher education. Therefore, training programmes may not be sustainable in this aspect. Second, immature institutional functions in data management may cause exclusive possession of data and unfavourable data exchanges, which are considerable obstacles for GIS and ICTs. It is obvious that development of GIS and ICTs will induce an increased value of data and information, hence the current situation in a local organisation that has not decided who is in charge of data management could easily allow data occupation and unfavourable trade. Third, planning may not reflect analysis of GIS, or it may not be practically effective. Fourth, there is a slight threat that making ambiguous boundaries clear by using digital data may cause irregular conflicts on land use among land owners. Especially in rural areas, if the land boundaries have been decided ambiguously by societal leaders, which can be depicted in a different way from official decisions, then it may be difficult to create a line that is impartial for every stakeholder.

4-5 Analysis and discussion of the case study

4-5-1 Main roles of the international organisations

One of the most important and expected roles for international sectors should be to provide technical advice on GIS, so the allocation of GIS advisers surely has a massive impact on local governments. The advisers and experts have profound knowledge of not only operations of GIS software but also a holistic view of managing GIS-related issues within an organisation. In terms of operation, the roles which the advisers would take are not simple but diverse because the conditions and resources for the operation are quite limited in developing countries, and require various alternative methods to reach the

outcomes. For instance, high-resolution satellite maps are too costly to purchase for most local organisations, so the adviser is required to perform consulting tasks to suggest a solution using affordable/free resources to compensate for the accuracy, which can be a remote-sensing method or a field research, such as participatory mapping. Solutions for the organisational issues are an important duty in addition to the technical advice. Facilitating training and workshops effectively, providing desirable ICT conditions including data management, and other things are often beyond simply technical issues, and are deeply rooted within organisational structures. This means that international organisations in GIS programmes should play a crucial role in government structural reform.

During the implementation of the project, approaches in technical supports are relatively similar among international organisations, whereas policies for physical/financial support are somewhat different with each. Ideally there should be a consensus among organisations about what kinds of facilities and finances will be supported externally and for how much the government has to put into the budget. Otherwise, the aid policies of each international organisation would not be effective, and partiality among organisations would take place, which may result in a negative factor of implementation of projects and an impediment to collaborations with the other organisations. This sort of facilitation in spite of the complexity of each programme might be an additional role for international organisations as well.

4-5-2 Conceptual framework of the projects

International organisations have often emphasised the concepts of sustainability and participation in each project. In terms of sustainability, obviously many challenges exist within developing countries. In addition, the participation of local stakeholders should be treated carefully, especially regarding the time and financial capacity of locals (Chambers, 2006). In Zambia, the international organisations have implemented and proceeded with several projects involving these development concepts; nevertheless, the impediments are deeply rooted in the context of poverty in this country and require much effort to overcome that.

4-5-3 Training and workshops

Training and workshops are the most basic and introductory part of the project led by international organisations. In Zambia, training often has been conducted in collaboration with local and several international organisations, and have achieved successful results to a certain extent. Having said that, there are still several problems pointed out by the officers. First, allowance for participation in workshops should be given by local government, otherwise local officers cannot attend them even if they are interested in doing so. Moreover, there were sometimes lengthy gaps of time between training and practical use. Furthermore, skilled and well-trained officers tend to leave the office due to transference and higher education.

4-5-4 Supportive free/affordable tools for GIS

Most organisations have used free resources such as QGIS as a software programme, Google Earth as a map resource, and GPS as a supportive tool for fieldwork. All of them are undoubtedly quite instrumental, especially in developing countries. On the other hand, many organisations have their own paid licenses for GIS software as well, mainly ArcGIS, and some offices have purchased aerial maps. As the land surveyor in LCC said, they can afford to purchase some materials, but not as many as they need, thus why they use free resources as complementary tools.

4-5-5 Basic facilities for ICT operation

Basically, GIS requires ICT facilities such as relatively high-processing speeds on computers and broadband connections for the internet. According to the interview, in Zambia, broadband conditions in the capital city of Lusaka are not at a desirable level, but are good enough to operate GIS to a certain extent; nevertheless, it is still quite limited. Likewise, computers are good enough to operate GIS software so far, and the international staff often use their own laptops. On the other hand, aside from the capital city, internet and even electricity conditions are quite unstable, so the limitations are more serious.

Another problem is data protection, such as provisions against computer viruses or the frequent back-up of data. Since GIS creates and stocks various kinds of important

information, including rather private and sensitive material, the issues of data protection should be considered above all. According to the interview, the officers and engineers usually back up the data, and stock it in their data servers. In terms of the protection of computers, they have installed software against computer viruses; however, it is reported that software in some offices have expired and have not been upgraded. It seems in general that local governments do care less about this issue than international organisations, and often fail to use free virus protection software properly. As another provision, the land surveyor in LCC uses a stand-alone computer for GIS that is not connected to any networks, and this provision seems quite practical. It implies that protection of computers and data strongly depend on the personal skills and behaviours within an organisation.

4-5-6 Changes of project plans and terms

Several officers pointed out the slow progress of the project in terms of technological diffusion, skill improvement and the process of collecting information. Thus, the project term should be flexibly changed, and the international organisations have planned it to take around two years initially with extensions of up to six years.

Some project objectives can be changed, or launched as part of another project. For example, the JICA expert in RESCAP had aimed at further technology transference of GIS but later focused on capacity building at the grassroots level. He said that map education may be more important than simple diffusion and skill improvement; it must help them understand the essential concepts, meanings, and uses of maps.

In terms of technological diffusion, skill transferring of GIS came up in some offices, but the influence was often limited to within the organisation and not beyond the organisational and district levels. This implies two things: first, the skills that they acquired are not diffused as smoothly or easily as the international officers expected; second, the skills and progress of GIS application are not uniform in each organisation but considerably different.

4-6 Conclusion and suggestions from the case study

The case study showed several important characteristics of GIS in Zambia:

1. One of the ICT tools for integrated information management: GIS-related projects in Zambia at present have been mostly focussing on collecting, creating, and digitising data. This can be regarded as a part of the application process of ICT, moving to standardisation and modernisation in the global community.
2. A catalyst for the process of social reform and governmental decentralisation: one of the dominant rationales in Zambia is the decentralisation policy, and most projects are following this policy to encourage the local authorities. In addition, for revising regional/district boundaries, GIS has significantly contributed to drawing clear boundaries and visualising them.
3. One of the tools and objectives in capacity building: training and workshops are common initial approaches of the application of GIS in Zambia, and are regarded as a part of capacity building for local staff. This involves not only simple technical transferring but also presenting unique alternative solutions using GIS within daily duties to increase effectiveness, as in the case of RESCAP.

It is significantly important to support operational skills through training and supervision; at the same time, the supervision has to cover a holistic point of view throughout whole organisations and stakeholders for a lengthy development process, particularly in order to establish desirable conditions for GIS and ICTs in the process of governmental structure reform. In this sense, application of GIS in this country has been a massive issue combining technology with societal and political organisations.

To manage the whole process, the results of the interviews illustrate that there should be an institutional function as a facilitator of the GIS/ICTs in order to strengthen a communication channel among stakeholders. Crucial issues such as data management should be shared more frequently and more clearly among the institutions. This should be led by the local government with supervision from the international communities, and should not be implemented by a single project of an international organisation with limited

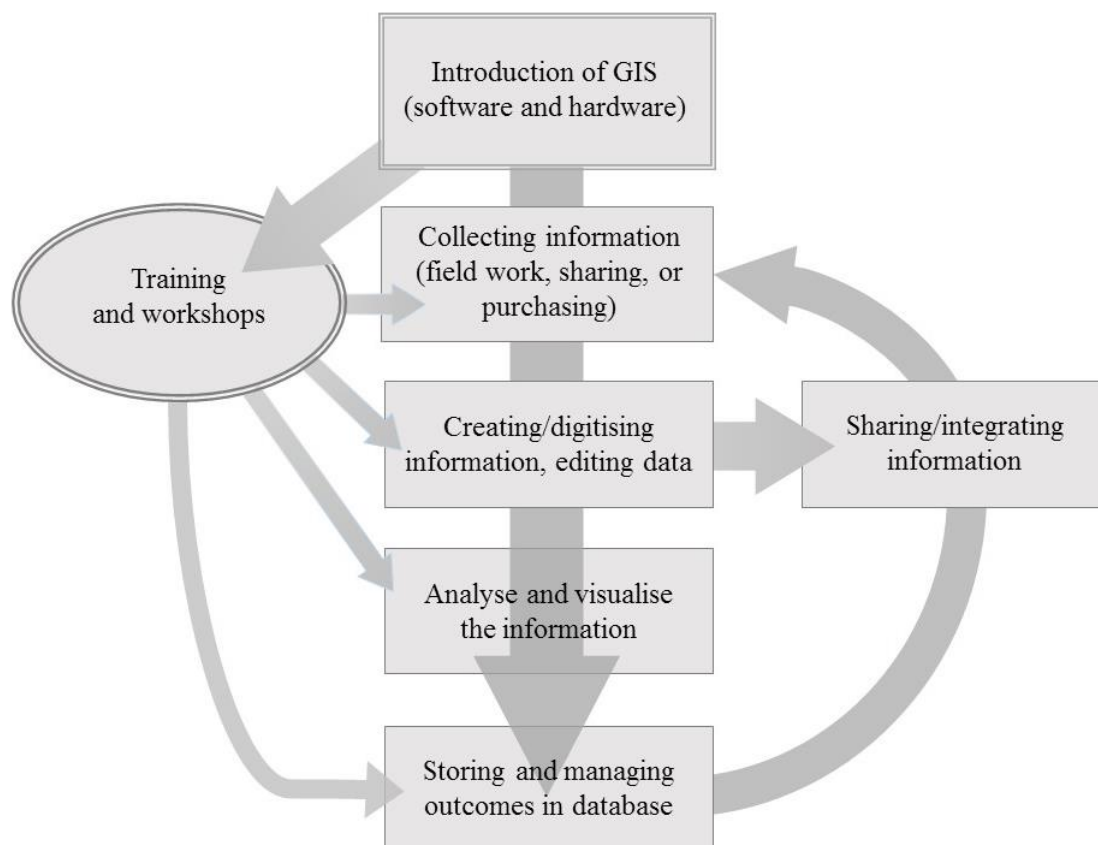
time. As many stakeholders pointed out, the improvement of skills and the entire GIS application process have moved slower than they expected; moreover, there are large gaps in each sector in operational skills and progresses of project procedure, such as digitising information. Hence, if the leading institution does not have enough skill and authority to facilitate the situation, it will limit the dynamism of advanced organisations. On the contrary, the best-skilled and most advanced organisation may become the one to lead this situation, though it may increase the risk of occupation of information.

In terms of organisational changes related to application of GIS, as in the cases of other countries, some projects in Zambia established specialised offices for GIS. For example, GIZ has operated the GIS Laboratory in MLGH, and the ECZ has an office for the operation of GIS for its delimitation project. Despite these establishments, the functional effectivity, skill and authority of GIS institutions are still somewhat debatable. If someone takes a central role as the facilitator of GIS, it should be sustainable for a long-term run, and open to a wide range of stakeholders related to GIS in terms of affordability and accessibility. Thus, it might be still idealistic at present to establish representative institutions of GIS, and, if so, it should be suggested that a more practical way is to organise a high-level conference about organisational functions related to GIS/ICTs in cooperation with local governments, international organisations, and private institutions. Fluent and frequent communication among stakeholders should be strongly suggested in order to manage the organisational influence on GIS.

Chapter 5: Conclusion

This research has detailed the application of GIS in developing countries through the presentation of a case study. Most elements pointed out in the literature were found in the case study in Zambia as well, and the case study exemplified further practical details of them, providing some general implications about the roles of international/local stakeholders, achievements, challenges, problems and risks. Diagram 5-1 illustrates the basic process of GIS application; GIS-related projects generally address some parts of the process.

Diagram 5-1: The general flow of GIS application



While the basic flow can be generalised, there have been various types of objectives and approaches in development projects related to GIS. In particular, GIS is instrumental in planning, monitoring, and evaluating projects. Both in developed and developing countries, GIS is utilised as a strong analysing/visualising tool for health research, education,

environmental and natural resource management, and disaster management¹⁴. Additionally, international organisations have introduced GIS as an important tool for urban planning, regional development, and rural development, including participatory methods. Several projects related to GIS in developing countries have involved the introduction of GIS with initial skill development and support for facilities as part of the main objectives.

In general, the government of a developing country would expect an intervention in order to support technical improvements; at the same time, the intervention sometimes provides physical aid such as computers, plotters and software licenses. Although the policies of what should and should not be supported are differentiated by organisation, those such as GIS adoption and improvement of operation skills are often regarded as high priorities in the initial stages of the project.

The major rationales for the application of GIS in developing countries are as follows:

1. As an ICT tool for solving current problems and achieving project objectives
2. Improving the effectiveness of work tasks
3. Standardising and modernising the process following the trend of the ICTs
4. Capacity building through the practical use of GIS and field works
5. Catalysing changes in organisational structure

Some elements, such as numbers 1 and 2, are quite common in developed countries as well. As the case study exemplified, free resources such as QGIS and Google Earth for

¹⁴ I did not cover a case of disaster management in the interviews of the case study; an GIS adviser of the D4D programme has been allocated into Disaster Management and Mitigation Unit (DMMU) in Zambia; as another example, Hashimoto (2012) suggested that disaster management is one of the main rationales for the application of GIS, and proposed to the public sector in Japan the manual to create a Tsunami Hazard Map by using free resources including QGIS, which is acceptable and affordable for almost all public sectors in the country (Hashimoto, 2012). Although this is the case of a developed country, some proposed skills and concepts can be adopted in other countries.

professional analysis can be implemented even in developing countries despite their various scarcities. Technical advice to compensate for limitations in free software would be one of the important roles for the international sector, as well as basic operational skills. Standardisation and modernisation should be a strong rationale for developing countries in order to follow the trend of ICT in the global community. The more unique figures in GIS in the context of developing countries would be numbers 4 and 5. Capacity building has been one of the major objectives of development projects with GIS; it is based on technical transference through training, field work and supervision by international experts. Furthermore, especially regarding number 5, application of GIS in developing countries would have a significant impact on government, society, and culture, more so than in developed countries.

Since this research has been focussing on government and international organisations, it clearly illustrates the fact that GIS catalyses organisational changes such as the decentralisation policy in Zambia. In the whole process of GIS application, the information has to be updated and digitised into data files. The created data is officially legitimated, and spatial information such as public facilities and district borders is clearly depicted without ambiguity. The other elements, such as capacity building and participatory approaches, will strengthen the local authority with respect to skills and responsibilities. Hence, these factors will strongly encourage political and geographical structural reform.

On the other hand, there are various types of challenges and impediments for further contribution which require multi-dimensional approaches. In terms of the international intervention, continuous support, especially in technical skills and information management, are highly expected. Some typical contexts in developing countries which would be serious impediments for GIS/ICTs include bribery, embezzlement, corruption, problematic bureaucracies, war, and literacy crises (Langmia, 2005); these should be changed for sure, but it would require totally different approaches from a GIS-related project. In this sense, those issues are potential threats for GIS/ICT development. The other negative factors that cause slow progress in ICT, such as economic stagnation, lawlessness, and lack of accountability and transparency (Langmia, 2005), can be partly addressed through the application process of GIS. Furthermore, many stakeholders have pointed out the scarcity

of resources and finances; however, it should be regarded as the fundamental disadvantage of developing countries. Hence, the most important attitude for governments and international communities should be to understand these typical contexts and lead towards development managing the new technology effectively. In terms of risks, the negative influence on GIS is still not clear in this research, and only a few potential threats were suggested in the case study without enough evidence. This should be observed in the progress of GIS diffusion.

In addition to those problems, the most serious challenge that international organisations face in GIS-related projects would be data management. One of the typical findings in this research is about issues of data sharing. After the initial application of GIS in a country, there should be an accumulation of digitised data for GIS which should be shared; however, the project officers have often struggled with serious limitations for using it. This limitation is basically caused by the following: missing data, an issue of institutional authority as to who is in charge of managing and sharing the data, or a certain governmental circumstance such as bribery. Hence, a solution will be required from cultural and institutional as well as technical approaches. The effectiveness and flexibility of GIS strongly depends on the availability of digital information from various perspectives, and if the information were limited to within a few perspectives the outcomes would be ineffective. Therefore, it is not an exaggeration to say that data sharing is a precondition for GIS in both the application process and the sustainability of the project; however, this problem is often underestimated, particularly by local government.

Overall, the influence and impact of the application of GIS are unique in the context of developing countries, especially for the organisational structure and functions. This involves many organisations and policies at the same time. That is why, compared with developed countries, it can be more sensitive, complicated, and challenging in developing countries. In terms of sustainability, creating appropriate institutional functions of GIS in the process of organisational reform should be a main concern in addition to the technical skill improvement in local offices. There should be an active communication channel within organisations in order for them to cooperate with each other and have common understandings on development policy. Thus, GIS in developing countries should be

regarded as not just a simple ICT tool but rather a catalyst that has a massive impact on social reconstruction in multi-dimensional perspectives. The number of GIS-related projects in developing countries will continue to increase, which will make these findings and evidences much clearer.

Appendix

Case study

■ Main question:

Is the intervention for a GIS project appropriate and effective in the country?

■ Research questions:

1. What kind of GIS-related projects have been implemented?

[Objectives, organisations, members, duration]

2. What are some crucial problems and constraints?

[Data accuracy and availability, technical/organisational/cultural problems]

3. What are some alternative methods that can compensate for the disadvantages?

[Adaptation planning, use of free-ware and other tools, original researches]

■ Organisations for interviews

A. Head office: Ministry of Local Government and Housing (MLGH), Disaster Management and Mitigation Unit (DMMU)

B. Regional office

C. International organisations (JICA, GIZ)

■ Types of interviewees:

1. GIS advisers in the international organisations (GIZ/JICA) working at the head office (MLGH/DMMU)

2. Local GIS engineers in the head office (MLGH/DMMU)

3. GIS advisers in the international organisations (GIZ/JICA) in regional offices

4. Local GIS engineers in a regional office

5. International volunteers for GIS operations (if any)

List of questions

About the project

- Q1. Context and background of the project
- Q2. The main objectives, expected outcomes and duration of the GIS project
- Q3. Physical aid support
- Q4. Technical aid support
- Q5. Tools and devices used with GIS (if any)
- Q6. What has been the most successful element of the project?
- Q7. What have been the major challenges and impediments in the project?
- Q8. Assumed potential risk (if any)
- Q9. Collaboration of aid support with other organisations (if any)
- Q10. Considerable changes from the initial plan of the project (if any)

About the office

- Q11. How many local staff members/managers use GIS in practise?
- Q12. How many international staff members/GIS advisers are working on the project?
- Q13. Organisational objectives and decision-making processes in the office
- Q14. Types of GIS software
- Q15. Environment for operating ICTs

About data resource management and operation of GIS

- Q16. How to get appropriate digital map data

Q17. How to get shape files and other geospatial data


Q18. What kind of other information have you used for the GIS analysis? (if any)

Q19. What kinds of free resources have you used in the GIS operation?

Q20. How do you plan to share the information, maps, and shape file data sets?

Q21. Provision for protection of computer and data

A brochure of the Lusaka Province Planning Authority (LPPH)

<p>LUSAKA PROVINCE PLANNING AUTHORITY</p> <p>What is Lusaka Province Planning Authority (LPPA)</p> <p>It is a statutory body with delegated powers from the Minister of Local Government and Housing, Early Education and Environmental Protection, which implements the provisions of the Town and Country Planning Act Cap 283 of the Laws of Zambia. The LPPA Board Membership consists of the Chairperson who is the Provincial Permanent Secretary and other appointed members. The Department of Physical Planning and Housing -Lusaka Province is the Secretariat to the Planning Authority</p> <p>What is Planning Permission?</p> <p>It is a mandatory notification of approval to develop, subdivide, consolidate and rezone land issued by the LPPA. It is a legal document, which benefits the holders in several ways. For example;</p> <ul style="list-style-type: none">• The developer need not fear that their buildings may be demolished without payment or compensation• It is essential to an interested developer in raising a mortgage or other financial assistance from Building Societies, Banks, or other lending institutions• It assists in the sale of property <p>Why is Planning Permission needed?</p> <p>Planning Permission is necessary because</p> <ul style="list-style-type: none">• Legally required under the Town and Country Planning Act, CAP 283• Ensures a beautiful and health environment	 <p>THE REPUBLIC OF ZAMBIA</p> <p>LUSAKA PROVINCE PLANNING AUTHORITY</p> <p>GOVERNMENT ROAD (Opposite Ridgeway Post Office Entrance) P.O BOX 50063 LUSAKA</p> <p>Phone: 0211251505 Fax: 0211251505 E-mail: lppa@yahoo.co.uk</p>
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