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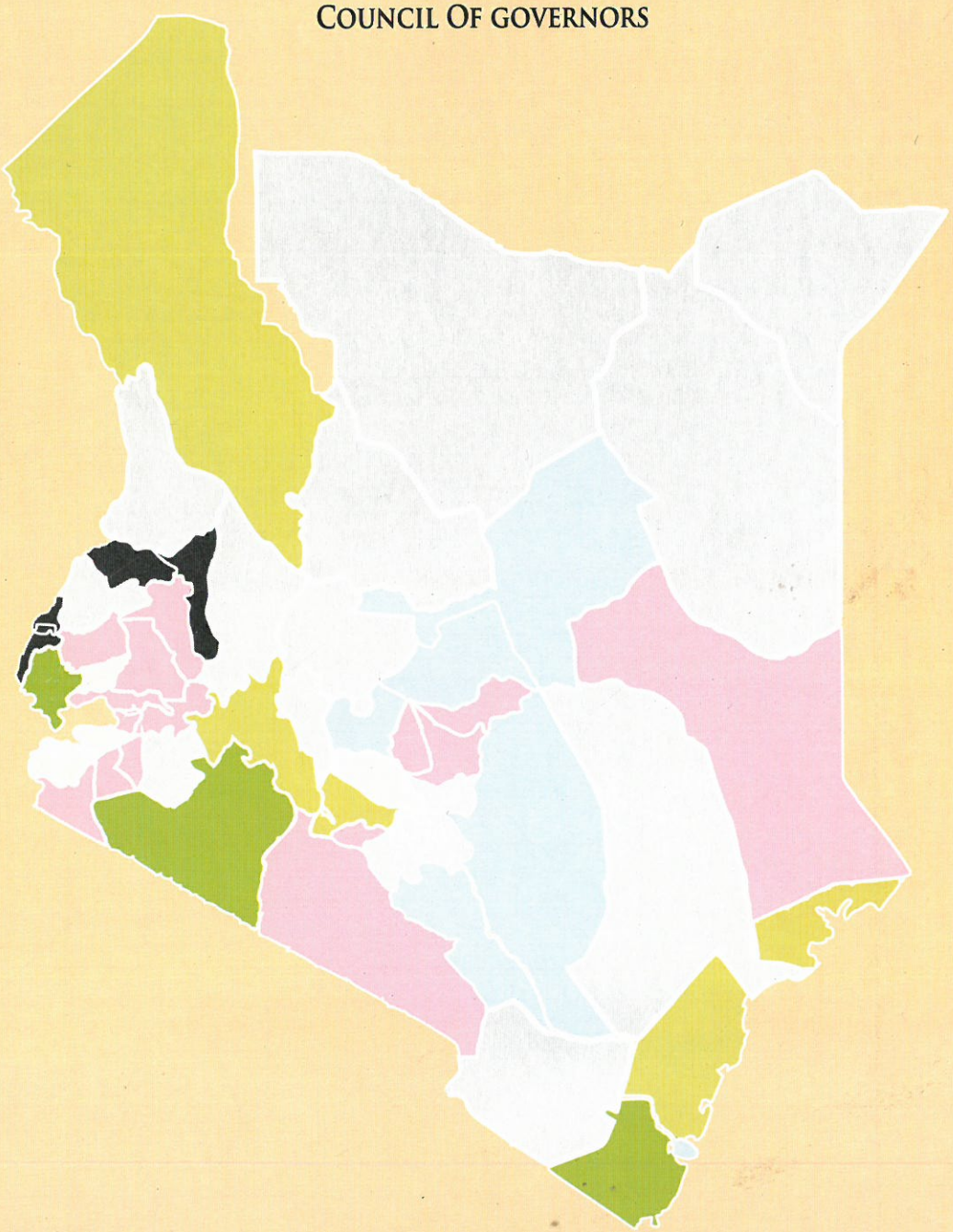

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GIS NEEDS ASSESSMENT IN KENYA

A County and National Level Analysis on the State of GIS and its Application for Spatial Planning in Kenya

July, 2017

GIS Needs Assessment in Kenya

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July 2017

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This assessment was implemented by the Council of Governors (CoG) with financial support from the Department for International Development (DfID) through the United Nations Development Programme (UNDP)

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ACKNOWLEDGEMENTS

The production of this report is the culmination of good collaboration between many actors, all of whom we are grateful to. We would like to acknowledge all those who supported us whether directly or indirectly, most of whom we cannot appreciate by name.

We sincerely thank all members of the Urban Committee at the Council of Governors (CoG) for their continuous support and great coordination throughout the data collection phase, and their timely feedback on the draft versions of the report. For this, we are particularly grateful to Mr. Nicodemus Mbwika and Ms Lenah Mulyungi. We also greatly appreciate Ms Sylvia Kerubo for her coordination with counties during the data collection phase.
The contribution of the UNDP team throughout the assessment is also greatly appreciated. In particular, we thank Mr. Raphael Mutitu and Mr. Geoffrey Omedo for their direct involvement in the data collection and providing feedback at various levels of reporting. The logistical support the UNDP team offered in coordination with CoG is highly appreciated.

We are deeply indebted to all the County Executive Committee Members (CECs) and the Chief Officers (COs) in charge of Land, Survey and Planning ministries, the heads of various departments as well as all the technical officers who created time off their busy schedule to answer our questions. The interest in the assessment, unrivalled knowledge of the subject matter and professionalism which they demonstrated reflects a better future in the adoption of GIS structures for spatial planning in the 30 counties.

Further, our gratitude goes to the 12 national institutions which accepted to be part of the survey, and that comprised a mix of governmental and inter-governmental agencies, parastatals, learning institutions and private companies. In particular, we would like to thank the following institutions for creating time to discuss GIS issues with the consulting team, and for giving invaluable advise to counties as presented in section 47.5 of this report: the Ministry of Land (Department of Physical Planning), Directorate of Resource Surveys and Remote Sensing (DRSRS), National Land Commission (NLC), Independent Electoral and Boundaries Commission (IEBC), Regional Centre for Mapping of Resource for Development (RCMRD), National Environment Management Authority (NEMA), Kenya Power Company, GeoMaps Africa, Esri Eastern Africa (ESRI), University of Nairobi (UoN), and the Technical University of Kenya (TUK). While we cannot thank everyone from these institutions by name, we acknowledge the contribution of the relevant directors/ heads of departments and all the technical staff we interviewed.

Finally, we would like to pass our special thanks to Mr. Maithya Mutyauvyu of Advanced Geospatial Solutions (AGS) for his invaluable support throughout the assessment. Our special thanks also go to Faith Lagat for text editing the final report.

To all those we have not mentioned by name, kindly receive our appreciation.

EXECUTIVE SUMMARY

Pursuant to Section 107 of the County Government Act, 2012, County Governments are obliged to prepare a ten year GIS based spatial plan which shall be a component part of the county integrated development Plan (CIDP). Geographic information system (GIS) is an expanding and evolving technology that has become an essential tool in planning. GIS can determine and address planning needs and bridge the gap between the current situation and the desired future. It can be an appropriate tool to clarify problems and identify interventions for spatial planning. However, for counties to establish efficient GIS labs, a proper needs assessment is essential to guide on some key areas of intervention.

In this regard, the Council of Governors is spearheading the institutionalization of the County Spatial Plan Framework through the Kenya Devolution Support Programme (KDSP). KDSP is a four-year project funded by the Department for International Development (DfID) through the United Nations Development Programme (UNDP) whose main objective is to support counties to put in place long term development strategies.

The main goal of this project was to support the Council of Governors in conducting a GIS needs assessment in relation to spatial planning in Kenya by assessing GIS resources (hardware, software, human resources and data) against the existing legislation; and to make recommendations for suitable interventions to enhance spatial planning activities.

METHODOLOGY

The assessment covered a total of 30 counties identified through a systematic random sampling procedure, which was informed by the level of urbanization of each of Kenya's 47 counties. Since the focus of the project was to undertake a GIS needs assessment within the framework of County Spatial Planning, the interest departments in each county were those in charge of physical planning, land and survey matters. A total of 12 purposively sampled national level institutions whose day to day activities include GIS or urban planning related activities were also interviewed. To achieve diversity, these institutions included governmental and non-governmental agencies, parastatals, learning institutions and private companies. Data from the counties and national level institutions was collected using various quantitative and qualitative tools, which were structured around the four components of a GIS (hardware, software, data and human resource). While data collection in the counties focused on both key informants and professionals who use GIS on a day to day basis or have basic GIS knowledge, national level interviews were conducted with key informants.

KEY FINDINGS

COUNTY LEVEL FINDINGS

In the context of the assessment, the definition of a GIS lab was used to casually define two types of GIS setups: a) functional GIS setups, and b) non-functional GIS setups. A functional setup was defined by presence of a dedicated physical space/office complete with hardware (such as computers, plotters, and scanners), GIS software (eg ArcGIS, QGIS, etc), personnel/staff and GIS compatible/usable data. A non-functional setup on the other hand is one that satisfied one of the following conditions

1. Had a space designated as a GIS lab, complete with hardware and software but did not have personnel/ staff utilizing the equipment, either because there were no qualified people or people designated to do GIS work were fully occupied in other duties
2. Had a space designated as a GIS lab, a few computers, software and staff who could use them even if the computers were not yet set up
3. Had a space designated as a GIS lab, several pieces of hardware and software, data and a few people knowledgeable on GIS systems, even if the equipment was not located within a physical lab space.
4. Had a space designated as a GIS lab, with a few pieces of hardware, data and staff who could use the setup but software was missing.

Use of GIS in counties varied widely, both in terms of adoption, application, intensity and structural setup. Table 1 provides a summary of the GIS setups in the 30 counties

Table 1. Stage of GIS development in Counties

Stage in GIS development	Description of stage	Counties in Stage
Lab has been set up	This includes counties which have a functional GIS lab even if no GIS experts or avid GIS users from other professions exist and/or are using the lab at the moment. It also includes counties where all the systems are operational but are not being used	Siaya, Narok, Kisumu, Kwale
Advanced stage of development	This includes counties which have a space designated as a GIS lab, a few computers, software and staff who can use them even if equipment is not yet set up.	Lamu, Turkana
	This includes counties with space designated as a GIS lab, GIS data, software and a few people knowledgeable on GIS systems; but does not have computers dedicated to the lab, even if other hardware such as scanners and plotters exist	Kiambu
	This includes counties with space designated as a GIS lab, hardware, data, staff who can use the setup but software is missing. It also includes counties where other services such as networking is missing	Nakuru, Kilifi
Initial stages of development	This includes counties which have already allocated a budget for setting up the lab in the current or next financial year (whether directly or through the consultant formulating the CSP), and/or which have already procured and received a few pieces of hardware but can't use it because some components are missing	Mombasa, Isiolo, Meru, Uasin Gishu, Kericho, Kitui, Nyeri
	This includes counties with GIS software, a few non-computer hardware but no lab space and no dedicated GIS computers	Makueni
Being considered	This includes counties which are at the initial stages of formulating strategy for setting up the labs. It includes counties which are still negotiating for funds allocation and approval from the county assembly, and those negotiating with consultants for award of CSP contracts and for which setting up of a lab will be a deliverable	Tharaka-Nithi, Garissa, Nyamira, Kisii, Kakamega, Kajiado, Nandi, Kirinyaga, Embu, Migori
Not present and not being considered	This includes counties for which discussions on setting up a lab are yet to commence	Trans –Nzoia, Elgeyo Marakwet, Busia

Use of GIS in Counties

Regardless of the stage counties were in setting up a lab, 70% (21) were using GIS for some of their work. This was informed by two main factors:

◊ 86.7% (26 counties) contracted out GIS services to external entities whether they had a lab or not. About 90% of counties without GIS labs and 80% of counties with labs had contracted out GIS related work. The contracted work was mostly related to formulation of County Spatial Plans (CSP) and was contracted to private firms and public entities such as universities.

◊ Presence of internal GIS setups did not necessarily mean that the counties used them for substantive spatial analysis work.

Absence of in-house systems and capacity limitations among staff have narrowed the scope of GIS related activities that counties can undertake, with majority of GIS work (including basic operations such as exporting maps for reports) delegated to consultants. As a result of capacity limitations for example, three out of the six counties with GIS labs (Kisumu, Kwale and Makueni) use the setups mostly to view data presented to them by consultants.The facilities in the sixth county (Narok) are still not being used because most staff are still at basic level in GIS training.

Hardware and software

Hardware and software are the top GIS needs by counties. 20 out of the 30 surveyed counties identified the two as their number one priority for development of a GIS lab, 8 counties prioritized human capacity development and only 2 counties identified software as their number one priority.

All the 30 counties visited have various kinds of hardware, although only a few counties have hardware dedicated to GIS and related systems. Likewise, while some counties may not have dedicated hardware currently, they have procured the facilities either through budgetary allocations, partnerships or as part of ongoing county spatial plan preparation contracts. Majority of the hardware that is existing or being procured comprises of computers, plotters, scanners and servers. Other hardware components that the counties have or are procuring include space and lab furniture.

The trend by counties to allocate resources for hardware acquisition is however not accompanied by a similar effort to acquire software. Equally, counties which have outsourced the services of contractors working on CSPs to set up their labs do not seem to have clear guidelines either on the GIS software they desire or the nature of software licensing (where applicable). This situation, which is largely a result of unclear CSP formulation guidelines on the area of hardware and software is a major loophole now and into the future, and may greatly compromise the functionality of GIS labs in different counties. Nonetheless, various forms of software exist in several counties, which range from open source to licensed and pirated copies of commercial software installed in both official and personal computers.

Human resource

Capacity development, and hiring the correct staff is the second most urgent GIS need by counties. 8 of the 30 interviewed counties identified human resource development as their number one GIS priority/need, while 28 counties identified it as their second most urgent need. Lack of adequate technical staff, as well as their limited capacity to undertake activities such as GIS data generation and management, and to formulate spatial plans were identified by counties as some of the key reasons for contracting out these services.

While all counties visited had at least one person who was knowledgeable in GIS systems , only Nakuru had hired a GIS expert, who has worked on various projects over the years, and is overseeing the establishment of the county GIS lab. Kisumu County on the other hand had a GIS manager whose background is ICT with basic skills in GIS, although the county planner and surveyors have basic knowledge in GIS. In all other counties, including those which had set up GIS labs or were at an advanced stage in setting them up, staff who are knowledgeable in GIS are those employed to perform other duties; particularly surveyors, planners, cartographers.

GIS relevant capacity development at the county level is limited, both in terms of taking relevant GIS courses and direct engagement of staff in consultancies which could enhance their work capabilities.

30 counties (50%) visited have facilitated GIS training for their staff, either by sending them for short training courses (eg at RCMRD) or organizing for county based trainings for the staff. These findings were consistent with professional interview results, in which 48% of the interviewees had taken a GIS related course outside their formal university/ college education. There was a strong positive correlation between staff attendance of county sponsored GIS courses and the presence of partnerships between counties and GIS training institutions ($r=0.668$). This implies that there is a very high likelihood that counties which partner with institutions that offer GIS services (e.g RCMRD, universities, Esri Kenya) are more likely to have trained staff than counties which do not create such partnerships. The lesson from this finding is that counties should leverage the available partnership opportunities such as the fast growing universities and colleges within their jurisdictions as a way of enhancing the capacity of their staff on GIS.

A major gap in staff capacity building exists in all counties, particularly with regards to engaging technical staff in ongoing activities by contractors. While for example 86.7% (26) counties have contracted GIS and planning related activities, only 29% of the interviewed professionals indicated that they have engaged with contractors in activities directly relevant to their work. While this may seem biased due to the fact that not all county staff were interviewed, discussions with the key informants identified that contractors often work

independently, and that most interaction with the county staff is during activity progress meetings and briefings. This is despite the fact that all staff who had indicated that they were directly engaged with ongoing work by contractors had gained a lot of hands-on experience in their fields; and that they understood the ongoing processes better and could perform them independently in future.

Data

Land parcel information maps (eg registry index diagrams, cadastral maps) and Development plans of various kinds (eg land use plans, zonings plans, market plans etc) are the most common forms of map data available in counties, with all counties indicating that they have at least a few of such maps. For most counties, these maps only covered small parts of the counties, with near universal coverage concentrated in the urban areas. Topographic maps and imagery are the second most readily available/used maps in counties, with 26 of the 30 counties visited indicating that they had such maps.

Majority (62.3 %) of all the maps available in counties are in hardcopy format. Only, 19.5% were in digital GIS format, and 16.2% were both in hardcopy and digital GIS format. Other map formats included digital non-referenced format (0.6%) and both digital non-referenced and digital GIS formats (1.3%). 11 out of the 30 counties had their map information only in hardcopy format, implying that they neither had scanned maps nor georeferenced maps.

NATIONAL LEVEL FINDINGS

Hardware and Software

The available hardware and software varied widely across the national institutions, with hardware ranging from basic items such as desktop computers to high end systems such as aero planes and LIDAR imaging platforms. Eleven of the 12 institutions had basic guidelines which define the nature of hardware, software and networking to be used in various departments. These guidelines define the minimum requirements of a functional setup within the institution. Each institution had a different set of indicators which they use to group the systems, which are based on their core mandate and processing power/functionality requirements. DRSRS for example, owing to their high processing needs use high end server based hardware and also have a wide diversity of software as compared to an institution like NEMA and IEBC.

Despite the higher level of development in both hardware and software in national institutions as compared to county governments, these institutions face a myriad of challenges, which range from limited facilities and rapidly changing technologies to budgetary limitations and long procurement procedures.

Human resource

The total number of staff in the core GIS departments varied widely, ranging from only three personnel in NEMA to 30 in RCMRD and more than 300 in the Survey of Kenya. DRSRS had 12 staff while IEBC had 8 staff working on core GIS aspects. The high number of staff in survey of Kenya was informed by the fact that, the institution had staff in all counties distributed in four main departments – cartography, photogrammetry, land survey, geospatial and hydrology. The recorded numbers were directly related to the intensity of GIS related activities within the institutions, with institutions which undertake high level GIS functionality having more staff than those whose core mandate is not GIS work. While basic training found in the counties easily relates with what emerged from the national institutions, there is more specialization in the latter, implying maturity of the organizations on GIS related recruitment and capacity development. Outside the learning institutions where attainment of high education levels is a requirement, the two institutions whose main mandate is GIS related services (RCMRD and DRSRS) have highly trained professionals.

The broad implication of the national level human resource structure, and in turn the lesson for counties is that, hiring of staff should be based on the long term intensity of activity, and should consider specialization (as informed by field and level of training) for attainment of functional GIS setups. Consideration should also be made for balancing of the professionals based on available resources, such as one which is lean on top (with highly qualified managers) and wider at the bottom (with more technical people who hold degrees and diplomas).

Data and data sharing

The assessed national institutions have a large data pool, which is both wide in scope (cuts across many sectors) and high resolution in nature (disaggregated into small units) than what was available within the counties. Just like in the counties, land use information was the most common form of data in the 12 national institutions. However, unlike in the counties where majority of data was only available in hardcopy format (62%) most of the data available in national institutions was in digital referenced map format (56%), and only 4% was in hard copy format.

Just like the counties which depicted a high level of data sharing (80% sharing within departments and 86% with other external agencies), all interviewed national institutions share their data with other organizations. The main beneficiaries of data sharing from these institutions include county governments, government agencies, non governmental organizations and private companies. While only half of the national institutions charge for the data, most of the other institutions have costs associated with data which are paid by partner or donor organizations.

Unlike the county level analysis where there are limited or no restrictions to data sharing and/or re-sharing (only 30% of counties indicated that there were restrictions to usage/re-sharing of received data) , 75% (9) of the national institutions which share GIS data impose restrictions, majority being conditions on the kind of data that can be shared and/or re-shared and provisions on acknowledging data sources.

The challenges which national institutions face in terms of data are very closely related to those faced by the counties, particularly those on budgetary limitations and poor data sharing culture among agencies.

Partnerships and work in counties

Other than KPLC and the IEBC, all the other national institutions are undertaking GIS related and/or support work in counties. IEBC however has direct dealings with counties, in which it sells GIS data and maps to them. Outside the survey of Kenya which works in all the 47 counties, there are a total of 17 counties in which the other 11institutions are undertaking or supporting GIS and planning related work, with the counties of Murang'a, Uasin Gishu and Kisumu having the highest number of national institutions supporting their activities (4 institutions per county), followed by Nairobi county (3 institutions).

The major services offered by the national institutions to counties include capacity development (trainings), management of data for revenue collection, resource mapping/ participatory mapping, spatial plan development and supply of data/ maps.

The major challenges faced by national institutions in the management of partnerships include individualization of projects by partners (where partners prioritize their personal projects at the expense of collaborative ones), and lack of follow up on GIS related trainings.

Recommendations

The general findings from the assessment reflect critical GIS needs across the four aspects of hardware, software, human resource and data in the counties, which have to be addressed if counties are going to enjoy the benefits of GIS informed spatial planning. The following are some of the recommendations proposed to address the emerging challenges

- Investment in GIS structures in Counties must focus on all four components of a GIS as opposed to only concentrating around hardware acquisition
- Counties must allocate resources to hire and support continuous training of GIS professionals
- There is need to establish a system through which national institutions can collaborate with counties for data standardization and sharing, as well as knowledge transfer
- Capacity building is the key to successful adoption of GIS in the counties
- GIS Guidelines and a GIS centre at CoG are needed
- Provision of generic GIS lab structure guideline is urgent
- Pervasive partnerships are key to success

LIST OF ACRONYMS

CEC	County Executive Committee Member
CoG	Council of Governors
CIDP	County Integrated Development Plan
CSP	County Spatial Plan
CURI	Center for Urban Research and Innnovations
DfID	Department for International Development
DRSRS	Directorate of Resource Surveys and Remote Sensing
ESRI-EA	Esri Eastern Africa
GIS	Geographic Information System
IEBC	Independent Electoral and Boundaries Commission
ILRI	International Livestock Research Institute
KETRACO	Kenya Electricity Transmission Company
KNBS	Kenya National Bureau of Statistics
KNSDI	Kenya National Spatial Data Infrastructure
KURA	Kenya Urban Roads Authority
KWS	Kenya Wildlife Service
NEMA	National Environment Management Authority
NLC	National Land Commission
RCMRD	Regional Centre for Mapping of Resources for Development
SIDA	Swedish International Development Cooperation Agency
SoK	Survey of Kenya
TUK	Technical University of Kenya
UNDP	United Nations Development Programme
UoN	University of Nairobi
WWF	World Wildlife Foundation

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INTRODUCTION

INTRODUCTION

1.0 Project Background

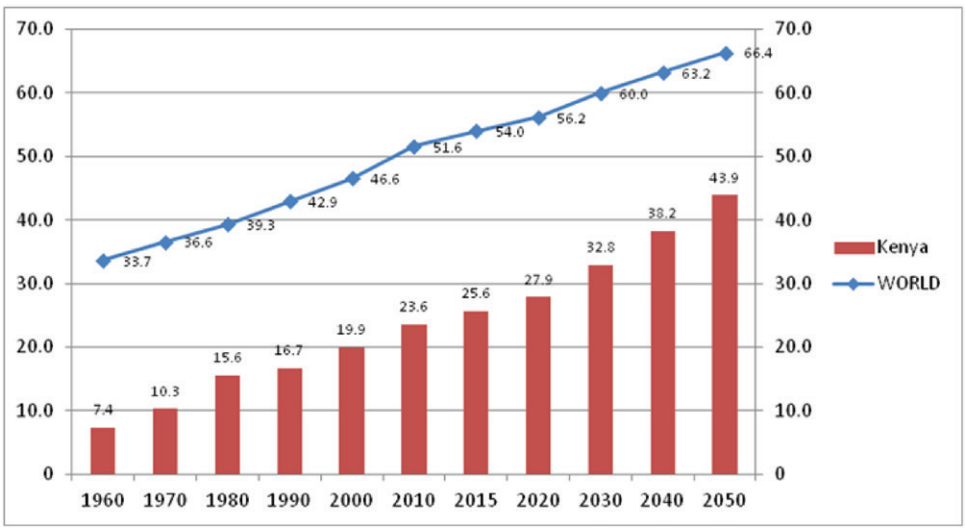
Kenya is among the world's least urbanized areas, yet one of the fast urbanizing countries. Between 1960 and 2015, the percentage of people living in urban areas in the country increased from just 7.4% to 25.6% [1]. Whereas this indicates a general positive growth, the numbers are less than half of the global urban population, which is estimated at 33.7% in 1960 and 54% in 2015. By 2030, the evaluation year for the Kenya vision 2030, the country will be 32.8% urbanized against the world's urbanization level of 60%; a number that will further increase to 43.9% against a global average of 66.4% by 2050 [1] (Figure 1). While most of the urban growth traditionally happened within the two major cities of Nairobi and Mombasa (largely resulting in primacy of Nairobi city), smaller cities continued to experience relatively high levels of growth owing to their importance as regional growth centres within their largely rural hinterlands.

Devolution, which came into the fore with a change in the country's constitution in 2010 created a new growth trend, which is today shaping Kenya's urbanization. The 2010 constitution created 47 county governments, which would act as independent governance and development units within the larger country. The ascension of the constitution, which has largely been touted to have been boosted by huge regional inequalities, has not only created new opportunities for equitable regional growth but also set up a unique platform for the growth of new towns (and expansion of previously smaller towns) spread throughout the county. While data is currently inexistent to measure the actual level of urbanization associated with the shift into a county governance system, there is consensus among scholars and development agencies that today, urbanization is happening everywhere in the country, albeit at varying levels [2]. This, it is projected will in the near future create many well developed and interlinked urban systems, which will act as important economic growth hubs for the counties and the nation as a whole.

This anticipated growth brings both massive opportunities and challenges for the future. While urbanization and its associated growth dynamics (economic and otherwise) in the counties is a much needed change to help reduce poverty and transition the country into a middle income country as indicated in the Kenya vision 2030, lack of proper planning of these emerging towns is likely to create many informal cities, which are greatly associated with inefficiencies and massive economic losses. In this regard, pro-active planning needs to be adopted for all the counties, so as to ensure sustainable growth into the future.

Data is a key pre-requisite to planning. Without data, no city can make informed decision making. This is a dilemma that many African cities have encountered over the years, in which, policy-makers base decisions either on virtual realities or hugely misrepresented facts. While huge amounts of data are generated in Kenya every day, this data is often kept in shelves for years, and rarely used to make informed decisions [3]. Equally, there are many aspects for which data has not been generated over the decades, owing to both lack of appropriate technologies and skilled personnel to generate it. The use of spatial analysis technologies and methodologies has for example been one the least utilized approaches to data generation in the country, following years of the sector's under development in the country [3]. Modern advances in geo-information science have however been changing the data science arena over the past few years, particularly with the advent of cheap and open source software and imagery, and a huge repository of knowledge on the data extraction

Figure 1.1 Percentage of Population Residing in Urban Areas (Data source [1])



and interpretation. Inspite of this, Kenya still remains behind in adopting such technologies to enhance its decision making.

It is against this background that various policy interventions in the recent past have been developed, with a particular emphasis on using Geographic Information Systems (GIS) to enhance the creation of sustainable settlements. For example, recently enforced laws such as the county governments act and the towns and cities act have created a legal basis upon which the country can utilize emerging GIS technologies for spatial planning. Section 107 of the County Government Act, 2012, obliges County Governments are to prepare ten year GIS based spatial plans which shall be a component part of the county integrated development Plan (CIDP). This provision not only opens new avenues for utilization of emerging technologies, but also creates a platform for enhancing the capacity of newly developing urban areas to generate, store and continuously update their spatial data – with the ultimate goal of tracking and monitoring development. However, to effectively achieve this, counties have to establish GIS labs, which would be the homes of all GIS and spatial analysis related activities. The establishment of these GIS labs is itself an intensive exercise, which requires a proper understanding of the county needs and resources for effective functioning of the labs. This calls for GIS needs assessment to identify the entry point for assistance by various entities.

It is on this basis that the Council of Governors is spearheading the institutionalization of the County Spatial Plan Framework through the Kenya Devolution Support Programme (KDSP). KDSP is a four-year project funded by DFID through UNDP whose main objective is to support counties put in place long term development strategies. To achieve the goals of KDSP, the Council of Governors contracted two consultants to undertake a GIS needs assessment in Kenya, both at the national and county levels, in order to create a baseline for the project's intervention. This report is an outcome of the needs assessment survey carried out in 31 counties and 14 national level institutions, two learning institutions (universities) and two private company involved in county related GIS consultancies.

The report is divided into 5 chapters. Chapter one gives an overall background of the project; chapter two creates the analytical framework as defined by existing literature and policy and institutional setup; chapter three discusses the adopted methodology; chapter four is dedicated to analysis of the study results and chapter five makes conclusions and recommendations based on the findings.

1.1 Goal and objectives of the needs assessment

The main goal of the project was to support the Council of Governors in conducting a GIS needs assessment in relation to spatial planning in Kenya by assessing GIS resources (hardware, software, human resources and data) against the existing legislation; and to make recommendations for suitable interventions to enhance spatial planning activities. The project objectives included to;

- Assess the current GIS needs at both the National and County Level including but not limited to hardware, software data and human resource
- Review existing policy documents on GIS at both National and County Levels
- Assess current status in the use of GIS for spatial planning both at the National and County Levels
- Identify gaps and opportunities in the use of GIS to guide Spatial Planning both at the National and County Levels
- Assess current GIS and other existing systems (data management, storage and retrieval) at the National and County Level that may support GIS
- Review current regional and international trends in the use of GIS for spatial planning
- Make recommendations on appropriate interventions by the project based on the assessment findings

1.2 Project Scope

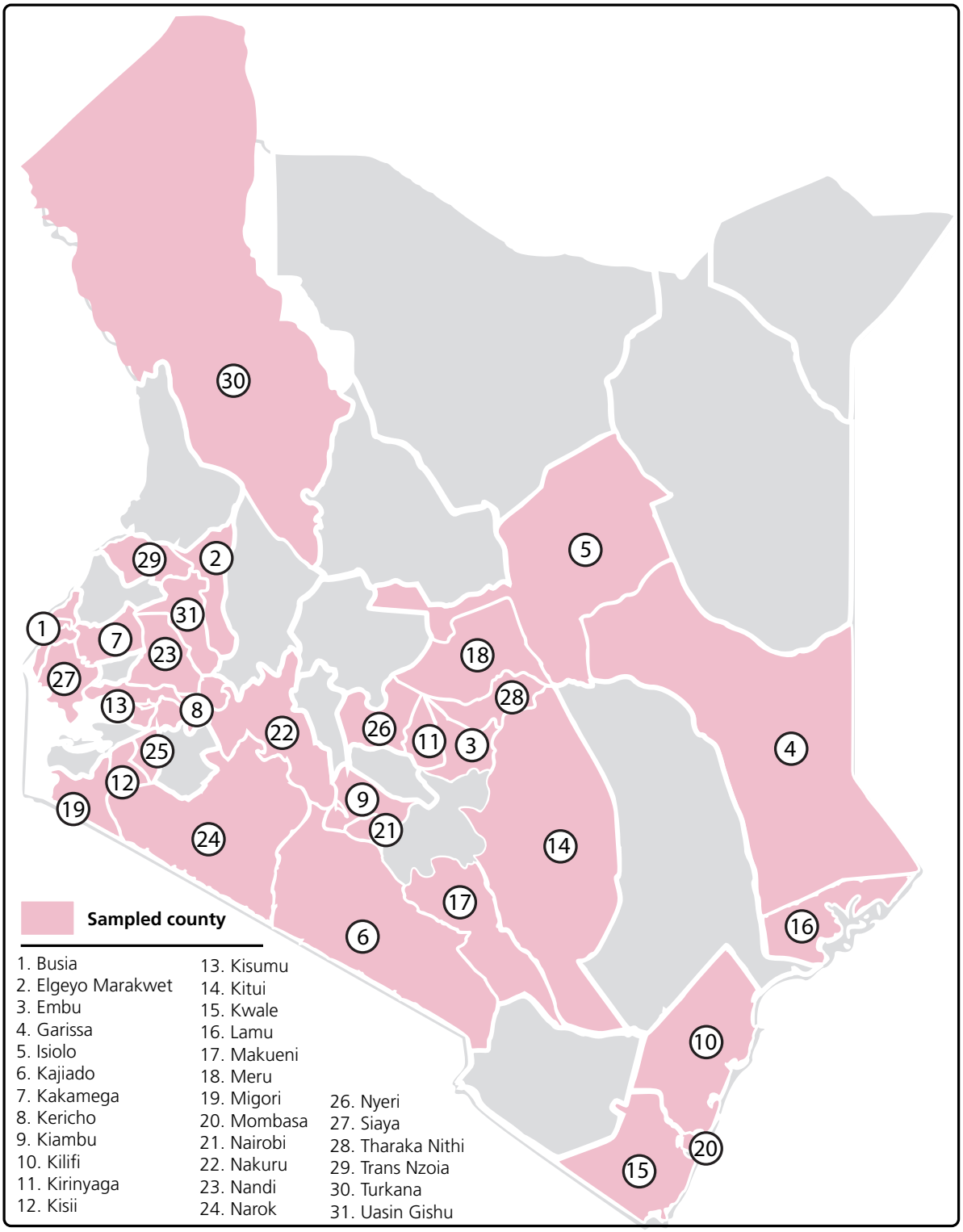
The spatial scope of the GIS needs assessment included 31 counties distributed throughout Kenya (Figure 1.2), 14 national government institutions which are involved in both planning and GIS data generation and use, two higher learning institutions (involved in both training of experts and partnering with counties to undertake GIS related work) and two private consulting firm which is directly involved in GIS and spatial planning work in counties.

The analytical scope of the study included four key aspects

1. Compiling detailed information on the GIS and spatial data needs, GIS resources

(hardware, software, human resource), and existing GIS work flows in the various counties,
2. Determining the most critical GIS needs among counties for enhanced planning,
3. Analyzing national level institutional set ups, GIS resource capabilities and existence of guidelines and standards on GIS; and
4. Recommending on the most suitable course of action for advancing the use of GIS in spatial planning across counties

Figure 1.2. Project Spatial Scope and Coverage: Assessed Counties



LITERATURE REVIEW

LITERATURE REVIEW

2.0 Introduction

Geographic information science is an area that has gained popularity globally in the last 50 years, having started in the early 1960s. In Kenya, while the science is still at an early stage of development, it has received a lot of attention in the last decade. In the last few years, GIS has received growing attention on all aspects of development, particularly those related to planning and development related activities. This, coupled with high value systems and reducing costs of the systems, together with global best practice on the use of GIS which has proven to enhance system efficiency have boosted usability of the systems in the country.

As a result, the last five years have seen a revolution in the adoption of the systems by government based entities, largely resulting in embodiment of the systems into law. For example, it is now a legal requirement under the County Governments Act and the Urban Areas and Cities Act 2015 to use GIS in plan formulation processes, and to develop sharable GIS databases as the platform for planning in the county. This has created massive opportunities for sustainable planning and monitoring of growth.

In this section, we summarize the various applications of GIS in spatial planning, review industry-best practices on the use of GIS for planning, and summarize the legal and policy framework within Kenya for the adoption and development of GIS – both at the national and county levels. Additionally, we also summarize the activities/responsibilities of counties with regards to spatial planning.

2.1 Defining a Geographic Information System (GIS)

A geographic information system is generally defined as a collection of digital information technologies capable of capturing, storing, manipulating, analyzing, managing, and presenting data related to positions on Earth's surface [4].
Geographic Information Systems were developed in the 1960s but their adoption in the early years was limited by high costs associated with their hardware, and the limited capabilities of software [5]. The systems have however experienced dramatic advances over the last two decades, which has greatly enhanced their adoption and usability at all levels of governance. Key advances are related to several trends, the key ones being [6];

- advances in hardware, such as improvements in GPS receivers and rangefinder devices
- an increased sophistication in the methods used to analyze geospatial information, which is partly enabled by the greater standardization of data and databases
- maturation of open-source software, to make data more accessible to a broader group of people
- an increase in the accuracy of data used to pinpoint locations
- a sharp rise in the amount of geospatial information available through smartphones, social media, Google, and other sources
- a sharp increase in GIS knowledge and expertise among various professions

The fall in prices of hardware, computer storage, and peripherals, accompanied by improvement in the performance of hardware and software (particularly the speed of computer processors), and advances in the data structures and related algorithms of vector-based GIS, has made GIS more affordable, less time consuming and more workable. As a result, the 1980s marked an increase in the installation of GIS in different levels (of government and private sector realms) in the developed countries. A further decrease in the price of computer hardware and software recorded in the 1990s further enhanced use of the systems in the developed countries [5]. Today, GIS is an important development tool across all sectors (and professions), a factor that is further enhancing their adoption and increased interest in their science. Since an estimated 80% of all information contains a direct or indirect spatial link/reference [7], the relevance of GIS across all development areas will further continue to grow, further enhancing their adoption.

2.2 The structure and elements of a GIS

A GIS structure follows the principles of an information system, wherein a set of procedures is applied to various components working together to generate information that supports decision making. A GIS is comprised of five key components;

- **Hardware** – which covers all physical aspects that support data input, storage, processing, output and presentation. Examples of these include computers, disk drives, network elements, keyboards, plotters, scanners etc. This also includes other peripheral data capture units such as surveying equipment.
- **Software** – which consists of the non-physical components of a data collection and processing environment, mostly comprising of programs. These are components through which a set of commands and instructions can be issued to undertake various analytical processes and applications which support data storage, transformation and management. Examples are databases, operating systems, programming languages, graphic applications etc.
- **Data** – this constitutes a combination of geometric (spatial) and thematic (descriptive) information which is either generated using hardware and software or keyed in to a GIS system, and which the software is used to manipulate, analyse and present in formats usable for decision making. GIS data is stored in a database system, which is part of the GIS software.
- **People** – represents the GIS system operators and data users; who are in charge of identifying GIS uses, data needs, feeding data into the system and undertaking data analysis.
- **Processes** – represents the combination of steps and commands used to manage the system, enter data, carry out analysis and all other related activities.

The strength of GIS system is on its ability to integrate all the five elements into an efficient system that can analyse spatial data, perform complex functions and produce accurate results which can be used to explain phenomena and make informed decisions [7].

2.3 Applications of GIS in Spatial Planning and Disaster Risk Reduction

Since GIS was developed in the 1960s, it has found application in almost all aspects of development, such as spatial planning, disaster risk reduction and climate change modelling, engineering, environmental and natural resources management, natural resource exploration, market area analysis and logistics management (commercial applications), facilities management, and land information systems – taxation, zoning, and use, land acquisition etc. This section focuses only on the application of GIS in spatial planning, and disaster risk reduction and climate change integration. It also highlights some specific case studies in which GIS has been used to enhance efficiency of service delivery in the two areas.

2.3.1 GIS application in Spatial Planning

The application of GIS in spatial planning spans across all development sectors. Today, GIS is used to perform activities such as [8]

- **Land Use Planning** – in which the systems are used for activities such as preparation of base maps, real time data collection on land uses and land cover, plan preparation – including scenario modelling. They are also used to interpret and formulate land use policy, in which various policy interventions are modelled in a GIS interface to see the likely impacts of various actions. The results of the modelling can be presented as maps, statistics and summary tables and used to discuss the changes, and make changes to policy where necessary. The predicted changes can also be used as a basis for undertaking "proposed action impact assessment". GIS is also used to estimate urban population, where up to data is missing, for more informed planning interventions.
- **Monitoring growth and detecting change in development areas** – in which a combination of remote sensing and spatial techniques are employed to detect change over time. The applications in this area include monitoring developments, land use change, urban sprawl/urban spatial growth among others. This helps planners to understand the dynamics of urban/rural growth and to set forth better and practical development goals. The use of remote sensing makes it possible to both monitor large areas without having to physically visit them, and also to monitor changes in difficult to reach areas. Mapping of land use and multi-temporal land use change dynamics aid to show how settlement systems evolve; as well as to show the demarcation between activities (eg rural vs urban,

commercial vs residential) and how they contribute to appropriation of space. Within the context of the counties in Kenya, adoption of GIS systems would create a good platform to understand the impact of devolution in local spatial and economic growth.

• **Development monitoring, & conducting suitability and feasibility studies** – in planning GIS has been used to help in site selection based on a range of indicators which are fed into the system. This helps to select the most suitable activities for an area. This can also be related to identifying compatible land uses within a planning area and identifying suitability of land for various uses, which are also critical in the discipline of environmental management. GIS can also be used as a tool to monitor progress in development as provided by city guidelines and/or development approval terms and conditions. This makes them very useful tools for development control.

• **Applications in land managemen**t – wherein GIS is used in such applications as land information management systems where all properties are mapped and linked to their attribute data, which information is used to monitor land use. For example, parcel information in a town can be digitized into a GIS system and all the land ownership details added into a database, the property tax rates, together with existing, ongoing or approved developments. This system acts both as a way of monitoring development/development control, and as a way of enhancing property tax collection.

• **Applications in documentation, development review process, and front counter service** – The development review process ensures that plans for development adhere to existing legal requirements as well as protect citizens from environmental or public safety hazards and support progressive economic development. Many planning agencies are today integrating GIS solutions as a central component in the development application review process, through which submission of development applications and the review process can be tracked.

• **GIS is a tool for Participatory Planning and information dissemination** - planners are today using GIS as a tool for citizen participation, through which information can be disseminated to the public in easy to understand formats; and used to discuss proposed actions. Maps can also act as a means for suggesting required change in the area of development, and as tools for public information dissemination on location of various social services.

• **Applications in natural resource mapping, and environmental planning and assessment** - GIS can be used to develop natural resource inventory which shows the locations and current uses of different resources. They can also be used to assess environmental constraints, to identify environmental assets which need protection (eg wetlands and water sources), and to select sites for various sensitive land applications such as sewer treatment plans. They can also be used to model the effects of various actions on the environment, which in turn informs formulation of environmental management plans.

• **Applications in public Works** – where the systems are used in urban infrastructure and utilities mapping and management, such as in effective traffic management, service outage mapping, infrastructure distribution analysis among others

• **Applications in Urban governance** - E-government is using the Internet and GIS to create more effective government. The combination of readily available Internet access and maps lets governments provide a new level of service to both businesses and the public. For example, GIS-enabled Web sites today provide services such as online mapping, fee payment, and application submission that were not previously available. This is helping to both enhance the ease and efficiency of urban governance.

Ultimately, GIS is a tool for collecting, storing and collating spatial information which is crucial in undertaking all planning related activities. A combination of GIS and remote sensing technologies help planners to collect physical data both quickly and with precision, to analyze it and do modelling where necessary – which are key steps in the planning process. The platform also helps to integrate physical (spatial) data with other socio-economic data, providing key linkages on

the planning process and making the process more effective and meaningful [8]. Further, the analytical capabilities of GIS to visualize complex relationships helps planners and other decision makers to understand complexities in the real world, and in turn contributes to making workable recommendations for future development. In general, GIS contributes to the development of planning options; selection of the options which generate the biggest positive impacts; to monitor the plan implementation process; to monitor and evaluate the plan implementation process; and as a platform for updating plans.

2.3.2 GIS application in DRR and Climate Change

The main application of GIS in climate change is through land cover change monitoring, in which a combination of remote sensing and spatial analysis techniques are employed the effects of different climate phenomena (both natural and man-made) to the environment. An example of such

Box 1: Using GIS to improve land use mapping accuracy and efficiency: Case Study—Richmond, Virginia

The Division of Land Use Administration for the city of Richmond, Virginia, replaced a cumbersome manual process with automated GIS-based map production. Adopting GIS has not only made the process more efficient but also more accurate. As part of the Department of Community Development, the division is responsible for amending the zoning ordinance and supporting the Board of Zoning Appeals and the Planning Commission. Until recently, a drafting technician created zoning, land use, and Master Plan maps by accessing data kept in filing cabinets, outdated paper maps, and legacy mainframes. Before GIS was implemented, property maps were compiled by an outside vendor and delivered in paper format. Property maps, copied from the Assessor's keycards, were made at different scales. Because each city block was recorded on a separate page, a drafting technician had to assemble, copy, and scale a number of pages to map an area.

The process for creating zoning maps was equally onerous. The zoning maps, printed on Mylar, had to be sent out for large size duplication on paper. These paper copies were hand colored to indicate zoning. If a property was located at or near the edge of a zoning sheet, additional sheets would have to be printed, scaled, and colored. The resulting sheets would be pieced together manually. Before GIS was used, staff members researched land use coding values assigned by the Assessor's Office by locating properties on a paper map, checking property locations by referencing property descriptions stored on a mainframe, and then cross-referencing coded values with a more generalized scheme kept in a notebook. Finally, each property was hand colored according to existing land use. The city's Master Plan maps were created using a graphics program so the technician had to photograph the pertinent Master Plan map to create slides for zoning board meeting presentations. Because Special Use Permits were not noted on zoning maps, this information had to be researched using the division's card catalog.
With GIS, the drafting technician can query for a specific address, zoom to a desired geographical extent, and quickly create a site, zoning, existing land use, or Master Plan land use map with a date and scale bar. Layers were developed for parcel, zoning, Master Plan land use, transportation, surface parking lots, and the existing land use.

The parcel layer is powerful because its features are directly linked to the Assessor's Office and Central Address databases. Address, ownership, property values, and land use information can be accessed directly by clicking on a parcel without any time-consuming research. The drafting technician can now query a complete, citywide representation of property boundaries. After labeling streets and properties, the drafting technician simply turns on the zoning, existing land use, or Master Plan land use layers and prints any of these maps. Before GIS, producing a series of site, zoning, existing land use, and Master Plan land use maps took between five and seven hours. With GIS, it now takes less than 30 minutes. GIS has reduced the time needed to complete mapping tasks by more than 90 percent, and the result is a better product.

Adapted from: ESRI 2006, GIS Solutions for Urban and Regional Planning: Designing and Mapping the Future of Your Community with GIS.

applications is the

- Monitoring of increasing global temperatures on ice melting in the poles over time. Other applications include
- Monitoring sea level changes- This is is through collecting data sea level rise and climate change from Earth observation satellites
- Pollution Modelling- Mapping carbon dioxide emissions, changes in forest cover (and in turn effects on greenhouse gas sequestration) and their impacts on the environment and people among others.
- Desertification – Studying inappropriate agricultural practices, deforestation and drought.
- Vegetation Indices – Using Remote Sensing vegetation indices like NDVI (Normalized Difference Vegetation Index) to monitor vegetation changes throughout time.

In the field of disaster risk management, GIS is used in all stages of the disaster cycle, which include prevention, mitigation, preparedness, vulnerability reduction, reduction and relief. Some specific examples on the areas of GIS application include;

- Development of disaster risk maps, which show areas which are most prone to various disasters. These maps help to create response strategies, such as safe zones where people can be seek refuge in the event of a disaster
- Creation of natural hazards and vulnerability atlases
- Creation of disaster evacuation maps
- Creating a repository for all major disaster management related data
- Damage Assessment, forecasting and generation of reports
- Creation of Multi-Hazard Risk Assessment and Multi-Hazard Early Warning systems
- Decision Support System
- Generation of shoreline exposure maps
- Tropical storm tracking
- Development of wind field and Rainfall distribution maps

2.4 Challenges of adoption of GIS in developing countries

Both lack of basic data and lack of up-to date data are two key hindrances in the use of GIS across all sectors of development. As a type of information system, GIS needs graphic and textual data in order to function. While a

Box 2: GIS use for Hazards Mapping in New York

Planners in New York City use the Hazards US tool(HAZUS) , developed by the Army Corps of Engineers and the Federal Emergency Management Agency, to identify geographic areas and buildings at risk of flooding, as well as the potential economic loss from such damage. They incorporate this information into investment decisions on climate-change initiatives. Through the tool, the city is divided into grids, which are categorized by 35-40 different building types. Flood analyses determine which areas are at risk of flooding and how high the water could be to identify buildings at risk. For each building type, HAZUS has damage curves which show the expected damage to building based on depth of flooding and time building is inundated. The analysis can be done for different mitigation scenarios (e.g. flood proofing, levies) to quantify avoided costs and identify the most appropriate countermeasure.

Planners and developers can then use the system to estimate the cost of damage that could result if a disaster happens. These costs include the charges associated with repair. The system also estimates the quantity and type of debris in each grid.

Adapted from: McKinsey Center for Government, 2013. Transforming cities through GIS technology and geospatial analytics

reasonable amount of geographical data is available in the developed countries which makes the establishment of GIS setups relatively easy (even if sometimes expensive), data is not so readily available in the developing countries. The most readily available data are those from remote sensing which means that they are restricted largely to land cover information from which a very limited amount of information about land use can be extracted. Because socioeconomic data is also generally lacking and often limited only to population census data, most developing countries are largely limited in their spatial planning endeavors, particularly since it is also expensive and time consuming to generate socio-economic data necessary for such activities [5].

Lack of standardization on data collected is another major challenge in developing countries like Kenya, which makes it difficult to link textual data to spatial data. The quality of the data collected at most levels is also limiting, both in terms of its authenticity (which is related to the nature of organizations collecting it) and its relevance (most data is often outdated). These two are fueled by a lack of proper institutional arrangements to standardize and coordinate data collection, and monitor the frequency of its updating. This is particularly a major challenge in Kenya, where an attempt to standardize spatial data collection through the Kenya National Spatial Data Infrastructure collapsed mid-way mostly due to institutional in-fighting. Equally, in most developing countries a large amount of data used for planning is collected by agencies over which the planning agency has little control. Lack of procedures for verifying the quality of the data further compounds this problem [5], often making most of the data unreliable.

Another major challenge in developing countries is that the state-of-the-art in planning has not advanced much in comparison to GIS. Whereas there has been massive shifts towards adoption of GIS in planning in these countries, the skills of planners and the planning systems are not yet fully ready to utilize the data and functions provided by GIS. This is partly a challenge related to the fact that planning authorities spend less resources in building the capacity of their staff, compared to those spend in generating data which is often never used for making planning decisions.

Other challenges which are limiting the adoption of GIS in countries like Kenya include financial and institutional setups such as [8]

- Inadequate funds to acquire and upgrade periodically the hardware and software.
- Absence of provision for repair and maintenance service due to which upkeep of hardware suffers.
- Inability to procure digital data products and carry out surveys for collection of attributed data.
- Lack of staffing and/or absence of a dedicated team that would continue for a reasonable period to establish GIS database.
- Tendency to hold on to information due to which GIS database creation cost is not shared (poor collaboration between and within institutions)
- Lack of support and mentorship to young GIS professionals
- Rigidity in work culture that does not encourage experimentation that is so vital for GIS implementation.

2.5 Legal and Policy Framework on the Institutionalization of Spatial Planning and adoption of GIS in planning in Counties and National Level in Kenya

2.5.1 Constitution of Kenya

The Constitution of Kenya 2010 is the overarching legal framework on all spatial planning and environment related issues in the country. As the ultimate law in the country, the constitution establishes the two planning levels for which spatial planning should be undertaken – the national level and the county level. The constitution gives the responsibility of monitoring and oversight of land use planning throughout the country to the national government, and establishes the counties as the planning units within their jurisdictions. In particular, the Fourth schedule of the Constitution confers the following roles to the National Government:

- General principles of land planning and the co-ordination of planning by the counties;
- Protection of the environment and natural resources with a view to establishing a durable and sustainable system of development;
- Disaster management; and

- Capacity building and technical assistance to the counties.

The functions of counties, outlined in the fourth Schedule include, inter alia:

- County planning and development, including—statistics; land survey and mapping; boundaries and fencing; and housing; amongst others;
- Implementation of specific national government policies on natural resources and environmental conservation;
- Disaster management.

The operationalization of these functions at both the national and county levels is the Physical Planning Act Cap 286 (2010), the Physical Planning Bill 2015 (draft) and the County Governments Act 2012

2.5.2 County Governments Act No. 17 of 2012

The use of GIS in spatial planning in counties in Kenya, as well as a requirement for county government to formulate various kinds of development plans is embedded in law through the County Governments Act No. 17 of 2012. Among other things, the act sets the framework for planning in counties, establishes the setup for integrating national and county planning, makes provisions for the establishment of a county planning unit, sets out the objectives and principles of county planning, defines the roles of various actors in county planning, including those of plan preparation, approval, implementation, monitoring and evaluation, and also sets the framework for public participation.

Section 107 of the act defines the types and purposes of four types of county plans (a) county integrated development plan; (b) county sectoral plans; (c) county spatial plan; and (d) cities and urban.

Section 110 of the act sets out the purpose and framework for the establishment of 10 year GIS database based spatial plans for counties. It states that,

> 110 (1) There shall be a ten year county GIS based database system spatial plan for each county, which shall be a component part of the county integrated development plan providing—
>
> a. a spatial depiction of the social and economic development programme of the county as articulated in the integrated county development plan;
> b. clear statements of how the spatial plan is linked to the regional, national and other county plans; and
> c. Clear clarifications on the anticipated sustainable development outcomes of the spatial plan.

According to the act, a "GIS based database system" means a geographical information management system that integrates hardware, software and data for capturing, managing, analyzing and displaying forms of geographically referenced information.

The other three development plans defined by the Act also have a GIS basis, as set out in sections 108 and 113.

Section 108 (3) states that, an integrated development plan shall—

> (a) have attached to it maps, statistics and other appropriate documents; or
> (b) refer to maps, statistics and other appropriate documents that are not attached but held in a GIS based database system

2.5.3 Urban Areas and Cities Act NO. 13 of 2011

This law provides for the classification, governance and management of urban areas and cities; sets the criteria of establishing urban areas; and establishes structures for participation of residents in planning exercises. The act also establishes the framework for sharing information and for publicity, including information management at the administration level, the terms for requesting information by the public and conditions on sharing it; as well as the conditions under which the relevant authority may decline to issue requested information

Section 36 to 42 of the act establishes the integrated development plans for urban areas and cities by setting their objectives, defining the framework for aligning the plans with county government plans, the procedures for preparing the plans including their content and review, and the structure for their approval and adoption.

Section 36 provides for the establishment of city or

municipality GIS systems. It establishes that, 36 (1) (d) (vii) Every city and municipality established under this Act shall operate within the framework of integrated development planning which shall be the basis for the preparation of a geographic information system for a city or municipality. Section 40 further makes provisions for development of land use management systems for cities and municipalities as part of the spatial development framework. The section further articulates that integrated city and urban area development plans should reflect applicable disaster management plans.

The requirement for annual review of the development plans (section 42) makes the use of GIS to monitor progress in implementation of the plans very crucial.

2.5.4 Physical Planning Act 2010

The Physical planning Act 2010 (cap 286) revised edition 2012 spells out details of preparation of various physical development plans and related matters. Because the act preceded the enactment of the Kenya constitution 2010, it does not articulate the procedure and processes to be adopted in preparation of County Spatial Plans. The Act is being revised through the Physical Planning Bill to align with provisions of the constitution and the institutional setups established therein.

2.5.5 Urban land use planning: monitoring and oversight guidelines (National Land Commission)

The guidelines seek to guide and systematize the practice of preparing, implementing and reviewing Urban Land Use Plans in the country. Just like the county spatial planning monitoring and oversight guidelines, these guidelines create the planning, oversight and monitoring framework for urban areas as a way of operationalizing the urban areas and cities act.

In particular, the guidelines offer guidance on the stages, purpose, outputs of the urban planning process and the recommended timelines for each activity (including the qualifications of professionals to prepare the plans). They also identify areas in the planning process under which GIS and disaster risk reduction issues should be addressed. For example, one of the key outputs of the plan proposal/ strategy formulation stage of the planning process under which various development scenarios are addressed is the development of a GIS database for city/municipality/urban areas – which itself contributes to the scenario creation and other stages of the plan preparation process. The final city/ municipal/urban area land use plan is also presented as a written statement and as maps, which are in a prescribed (GIS geodatabase) format.

Under the situation analysis stage, GIS plays a critical role in the collection, compilation, description, analysis and interpretation of data on prevailing situations in the planning area; and creation of base maps and layered thematic maps on such issues as Physical, social, political, cultural, economic, sociological or any other development aspects. GIS is further used in the development of maps on proposed plans. The plans themselves should be GIS-based, implying that all layers must have their associated attribute information i.e. area, name and dimensions among others. The generated layers should form part of what will go into the geodatabase, which itself needs capability to store geospatial aspects of the features be designed. The guidelines recommend that the geodatabase must have the following features: ability to; store geospatial information; be queried; be updated; create visual maps which can be printed and ensure that security of the data is enhanced.

Further, the guidelines provide for the scale in which various maps and plans should be presented in, the colours to be used in the maps and plan, the legend contents (e.g. symbols to be used, land use categories, summary of land uses, details of preparing authority etc.), and the presentation specifications (format of the maps e.g. as geodatabases, plan layout and paper size,). They further provide guidance on plan packaging, in which they state that the plan should be presented in such a way that it can be accessed using a GIS software, whereby querying and analysis is possible.

In terms of plan implementation, the guidelines create the regulation of land use/development control framework, including the creation of various sections to manage and regulate various aspects of land use. Recommended sections include a policy section, a land information section. The guidelines also define the qualifications of people to be hired within the sections as well as the duties to be performed by the sections. The land information section for example is

charged with such responsibilities as creating and updating land information systems, facilitating efficient and accurate access to information and sharing real time information with other sections for effective dispute resolutions.

The guidelines also recommend various sources of geospatial data and give indicative costing for various steps in the plan formulation process, including costs associated with spatial data collection and digital mapping, spatial data processing, map production, establishment of a GIS lab and costs of ensuring data security.

2.5.6 County Spatial Planning: Monitoring and Oversight Guidelines (National Land Commission)

These guidelines were formulated by the National Land commission (in partnership with counties and other authorities) to guide and standardize the practice of preparing, and implementing County Spatial Plans in the country. They are based on requirements by the County Governments Act 2012 for counties to prepare, approve and implement county spatial plans; and the constitution of Kenya 2010 and the National Land Commission Act No.5 of 2012 which gives the National Land Commission a mandate to monitor and oversee land use planning throughout the country. The guidelines thus provide a basis for engagement between the County Governments as planning authorities and the National Land Commission as a monitoring and oversight agency over land use planning.

The guidelines identify specific activities to be undertaken during the planning process and indicate areas where GIS should be used. They further set out the stage in the planning process in which county GIS labs should be set up; identify 5 basic requirements of a working GIS lab - hardware, software, people, data and approaches; and articulate the specific roles of GIS in counties as: mapping of existing situations, storing planning data as GIS databases and helping to present planning proposals in form of maps

Further, the guidelines identify 9 key stages of the County Spatial Plan (CSP) preparation process: 1) pre-planning 2) visioning and objective setting 3) research and mapping 4) situation analysis 5) developing scenarios 6) formulation of plan proposals 7) presenting, packaging and publishing 8) approval and 9) launching and dissemination. Under each stage, they identify specific activities, deliverables, and their implementation timelines. For example, while GIS plays a key role in each stage of the planning process, matters such as setting up a GIS lab, digital mapping and development of GIS databases fall under stage 3 of the planning process. As per the guidelines, key GIS relevant deliverables in the spatial planning process include establishment of a GIS database; preparation of basemap, thematic maps, a GIS informed scenario plan and digital maps; and setting up of a GIS lab.

The guidelines also contain an overarching structure showing costs associated with various stages of the CSP process, including those associated with the establishment of GIS labs and digital mapping. With regard to specific guidance associated with GIS set ups, the guidelines are limited in scope and only state that the cost of a lab should include costs of 3 components: hardware, software, expert, training and a plotter. This is despite the fact that the key deliverables under the policy include such aspects as Office Space/Lab, GIS Server, Power backup, Backup System, Air conditioning, at least 3 PCs with minimum 20' screen, GIS Software (ESRI for desktops, Open Source for Server), At least 5 Handheld GPS receivers, Plotter (Minimum 42'), Scanner (Minimum 42'), and a Printer. Further, they do not highlight alternatives for acquiring these services, or how county governments can use partnerships to reduce cost of acquiring the systems.

2.5.7 The Spatial Planning Guidelines for Kenya: preparation and implementation of county spatial plans draft guidelines, Draft Guidelines February 2017 (Council of Governors, Department of Physical Planning)

These guidelines are designed to act as a reference frame to guide planning by National, Regional, County, City and Urban Authorities. They outline methodological considerations, legal and policy framework for spatial plans formulation, public and stakeholder participation setup, the principles of the CSP, procedures and steps to be followed during the CSP process, indicative timelines and work schedules. They also identify the key actors in the plan formulation process and their responsibilities. It also identifies the qualifications of planning expert team developing the CSP, and sets out the structure for engagement.

The guidelines define four interlinked project components: a) Stakeholder engagement, b) situational analysis, c) plan formulation, and d) Institutional capacity building for plan implementation. They further identify five major steps in the plan formulation process: a) Preparatory Phase b) Project Activation Phase c) Process Roll-out phase d) Project Consolidation e) Follow-up Activities. GIS related activities such as generation of basemaps from satellite imagery analysis, digital topographic mapping and overlaying of other forms of data into an editable database, using data to formulate and design alternative development strategies, are identified as key in each of the identified components and steps of the planning process. The final CSP would include both a plan and a GIS platform as identified in the CGA.

The guidelines also define the structure for mainstreaming into the spatial planning process three key cross cutting issues: 1. Climate Change and Disaster Risk, Reduction, 2. Gender, Youth and Disability and, 3. Poverty Alleviation and Safeguarding Livelihoods.

According to the guidelines, the spatial planning process culminates in two key products and deliverables, which are GIS based;

1. **Situational Analysis Report containing;**

   a. Base maps and analytical maps that depict topographic and geographic realities. This may be presented in the form of a GIS- database system

   b. Data sets touching on various factors that impinge on the county development dynamic such as county demographics, resource endowments, environmental variables, etc

   c. A conclusive report that provides a synthesis of the existing spatial structure and summarizes the performance key development sectors

2. **The Spatial Plan - a perspective on the desired future development of the County.** This is as communicated through;

   a. A graphic and schematic representation of a spatial concept and strategy for the organization of the entire county, area based strategies, and strategies for locating and aligning key components of the county structure such as landscape, infrastructure, settlements,

   b. An explanatory memorandum elucidating the plan's policies, strategies and programmes

2.5.8 The Kenya National Spatial Data Infrastructure Policy (Draft)

The draft policy establishes a framework for the collection, integration, distribution, use and sharing of geospatial information and services by the public, private and civil society organizations in Kenya. The main goal of the policy is to provide a national infrastructure for access and use of geospatial information in decision making at local, regional and national levels for sustainable development.

The policy has five key objectives;

- To develop national policy, institutional framework and administrative arrangements that provide mechanisms for data sharing and coordination of the development of geospatial datasets
- To eliminate wastage of resources and duplication in the production of geospatial information
- To develop acceptable standards for data, production and distribution
- To develop a solution for easy discovery and access of geospatial data
- To promote and coordinate national participation in international initiatives on the development of regional and global spatial data infrastructures

According to the policy, a National Spatial Data Infrastructure (NSDI) constitutes the technology, policies, standards and institutional arrangements that facilitate the availability of and access to spatial data. It promotes geospatial data sharing throughout all levels of government, the academia and the private sectors, thus enabling effective use of geospatial data for decision making and development.

While the policy articulates key issues related to standardization of GIS data collection and sharing, its formulation has stalled since the second draft was drafted in May 2016, resulting in the challenge of the legality of its provisions. Some of the policy's provisions are however referenced in the recommendations chapter as good practice indicators to attainment of county GIS setups.

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METHODOLOGY

METHODOLOGY

3.0 Introduction

The methodology used for this study adopted a mixed methods approach for collection, collation and presentation of qualitative and quantitative data. Generally, the study was implemented in three main steps

- **Preliminaries** - which included review of all relevant documents and project briefs, development of data needs and collection guidelines and preparation of an inception report detailing the study methodology and approach
- **Data collection and fieldwork** - this was implemented at two levels, a) a desk review of literature on GIS and its application in spatial planning, and b) field data collection. The latter included collection of data through key informant and professional GIS user interviews, and physical verification of county GIS assets (hardware and software).
- **Situational analysis and reporting** - which included analysis of collected data and collating it with international norms and standards, and compiling it into this report, which includes recommendations on how to enhance GIS usability in the counties for enhanced spatial planning.

3.1 Survey Design

The survey began by a reviewing all the relevant documents which helped contextualize the assessment. It also reviewed the existing legal and institutional setting for institutionalization of GIS into county planning structures.

The understanding of the GIS needs of various counties required a detailed analysis of four key components of a GIS system: the hardware, the software, the data, and the human resource. These four components defined the survey design and sampling frame. The required information on the four components was achieved through administration of questionnaires and key informant interviews the county level.

- **Hardware** - data was collected by undertaking key informant interviews to identify such aspects like the presence of various equipment for operationalization of the GIS lab, and through physical verification of such equipment (Annex 7)
- **Software** - data collected through physical verification of available resources by visiting the county GIS labs and verifying the available resources (Annex 8)
- **Data** - this entailed the understanding of both the available data in the county, as well as the data needs for various functions. This was achieved by administering key informant interviews with various members of the county, particularly those directly responsible for spatial planning aspects (Annex 5)
- **Human resource** - which comprised the available capacities within the county to utilize the hardware, software and data to understand simple and complex development aspects of the county and to generate, edit, and manipulate data to solve local problems. This data was collected at two levels: the first level sought to understand the overall ministry/GIS department set-up (number of employees, qualifications etc), and the second level sought to understand the capacity of the GIS staff to use the available resources for planning purposes. (Annex 6)

3.1.1 Sampling

The GIS needs assessment was a rapid exercise conducted over a period of 90 days, during which the study was conceptualized, tools developed, data collected and analysed and a report produced. While it would have been ideal to undertake the study in all the 47 counties, both the available time and the amount of resources required to undertake a total population survey made it impractical to visit all the counties, making sampling the most practical approach.

While a 30% sample size is most popular in academic surveys, it would be limiting in this case to sample 30% of the 47 counties, both because the representativeness of the sample was based on independent governance entities which would signify higher levels of heterogeneity, and because the level of urbanization in each county was different. Learning from previous studies was equally not helpful in developing the sampling frame, largely because GIS needs assessments are often done for individual cities/county governments.

In this regard, the proposed sample size was 50% of the 47 counties - which the consultants believed would create a balance between academic research sampling alternatives and enhanced representativeness for the hugely heterogeneous counties. The proposed sampling frame was a combination of clustered random sampling and purposeful sampling. In the former, all 47 counties were grouped into clusters based on their level of urbanization, and then counties to be interviewed were picked randomly through a randomizing tool. For the latter, purposive sampling was done for the four urban counties of Nairobi, Mombasa, Kisumu and Nakuru. Purposive sampling of these counties was however only based on their not being picked during the cluster based randomization; and included re-randomization of the clusters in which the four counties were placed in until they were all picked. This would achieve a fully random sample, as opposed to where they would be purposively picked. The rationale for this was that, there was a higher likelihood that these counties had more developed GIS and related data systems, since they have historically experienced faster growth owing to their higher levels of urbanization, and various development driven initiatives by various actors. For example, Nairobi has a history of developing master plans, which have generated massive GIS related data, thus creating a justification to study it further. Nakuru has also been a key interest town for planners and planning organizations, and has seen development of several development plans since the 1980s.

Within the county, only key informants who are directly in charge of spatial planning and GIS related workflows were interviewed. Random sampling of the GIS staff/professionals was proposed as the method of picking the professional respondents, but this was not possible since majority of the counties had not hired GIS professionals. This meant that professional respondents were purposively picked, using information provided by the heads of units in the departments of lands, survey and physical planning, in which the key informant interviews focused on.

3.1.2 Achieved Sample Size and distribution

Using the above described rationale, the proposed sample size for the study was 24 counties, four of which included Nairobi, Mombasa, Kisumu and Nakuru. In order to pick the sample distribution, all the 47 counties in Kenya were grouped into five clusters based on their levels of urbanization

Table 2.1: Proportion of people living in urban areas by county, 2009

%urban population (7-13%)		% urban population (14-20%)				% urban population (21-34%)		% urban population (35-62%)		% urban population (63-100%)	
County	**% Urban**	**County**	**% Urban**	**County**	**% Urban**	**County**	**% Urban**	**County**	**% Urban**	**County**	**% Urban**
Makueni	11.4	Kirinyaga	15.5	Wajir	13.7	Nyeri	24	Kiambu	62.2	Nairobi	100
Meru	7.7	Murang'a	14.1	Homa Bay	14.2	Kilifi	25.3	Isiolo	43.6	Mombasa	100
Nyamira	12.9	Nyandarua	19.2	Kisii	19.8	Marsabit	22	Machakos	51.6		
Siaya	10.6	Kwale	17.7	Elgeyo Marakwet	14.1	Tharaka Nithi	22	Kisumu	51.8		
Baringo	11.4	Lamu	19.5	Laikipia	19.8	Garissa	22.6	Kajiado	41.1		
Bomet	11.3	Taita Taveta	17.1	Nandi	13.6	Migori	33.6	Kericho	38.3		
Narok	6.6	Tana River	14.9	Samburu	16.7	Vihiga	31.3	Nakuru	45.1		
Turkana	11.8	Embu	15.9	Trans Nzoia	19.6			Uasin Gishu	38.5		
West Pokot	8.1	Kitui	13.6	Bungoma	15.4						
Busia	11.1	Mandera	17.4	Kakamega	14						

(% of total population living in urban areas) as measured during the 2009 Kenya population census (table 2.1). The use of percentage of people living in urban areas per county was informed by the fact that the level of organization/ disorganization, and thus the urgency for planning and in turn GIS data and analytical capability is determined by the level of urbanization of each county. The adopted clustering was based on a distribution pattern around the national average proportion of urban population (25%), which has also been adopted by previous reports by the Kenya National Bureau of Statistics [2].

Since Nairobi and Mombasa were purposefully selected, randomization was done for the four other groups. Each of the counties within these individual clusters was given a unique identifier, which was entered into an online randomizing tool (https://www.randomizer.org/) to get the final random sample for counties to be interviewed (Table 2.2).

Table 2.2: Achieved Sample Size

% urban population 7-13%	% urban population 14-20%	% urban population 21-34%	% urban population 35-62%	% urban population 63-100%
Makueni	Kirinyaga	Nyeri	Kiambu	Nairobi
Siaya	Kwale	Kilifi	Isiolo	Mombasa
Baringo	Lamu	Tharaka Nithi	Kisumu	
Turkana	Elgeyo Marakwet	Garissa	Kericho	
Busia	Samburu	Migori	Nakuru	
	Trans Nzoia			
	Kakamega			

Plotting these counties into a map indicated that they were regionally representative, and thus this was the adopted sampling frame. Field complications which included prevailing insecurity at the time of data collection (March – April 2017) however made it impossible to visit the two counties of Baringo and Samburu. In consultations with the Council of Governors, these two counties were replaced with other counties within the same cluster, which were also picked randomly using the randomizing tool. Baringo was thus replaced with Narok, and Samburu replaced with Embu. At the time of writing this first draft of the report, Nairobi County had not given a date for the evaluation interviews.

A high level of cooperation by counties made it possible to include seven more counties to the original sample size, for a total sample of 31 counties. The additional counties were randomly sampled proportionate to the total number of counties within each cluster. The additional counties included Uasin Gishu, Kitui, Nyamira, Kisii, Nandi, Kajiado and Meru.

At the national level, 14 institutions which are directly involved in GIS related work were purposively sampled, based on their experience in spatial planning, GIS systems, GIS and spatial planning related research and training, as well as their involvement in spatial data generation and analysis. Table 2.3 presents the sampled national institutions.

Table 2.3 List of National agencies sampled

Name of Institution	Type of Institution
Department Of Lands	State Department
Department Of Physical Planning	State Department
Department Of Survey (SOK)	State Department
National Environment Management Authority (NEMA)	Parastatal
Directorate Of Resource Surveys And Remote Sensing (DRSRS)	State Department
National Land Commission (NLC)	Commission
Independent Electoral and Boundaries Commission (IEBC)	Commission
Regional Centre For Mapping Of Resources For Development (RCMRD)	Inter-governmental
Kenya National Bureau of Statistics (KNBS)	Parastatal
Kenya Power	Parastatal
Universities (Technical University of Kenya, University of Nairobi)	Academia
ISK (Institution of Surveyors of Kenya) Geographic Information Systems Chapter	National Professional Organization
ICT Authority	State department
ESRI	Private company

3.2 Data collection

Primary data was collected from the sampled counties by teams, each comprising one of the two consultants and two representatives from the Council of Governors and UNDP. Each team visited the county offices, particularly the ministry in charge of spatial planning (ministry of lands, surveying and physical planning in most counties), where the GIS related functions were also housed.

Data from the national level was collected through key informant interviews with key personnel from the 14 purposively sampled institutions. The focus of the national institution interviews was on organizational setup and lessons which can be learned and transferred to the counties; how data generated at the national level is, and/or can be shared with the counties; and what kind of support including capacity building the national institutions are, and/or can offer to the counties as they establish their GIS labs.

3.3 Data analysis and presentation

The collected data was analysed through a combination of qualitative and quantitative analytical techniques. All data from both the key informant interviews and verification checklists was coded and keyed into an SPSS frame, then analysed both through descriptive statistics and cross-tabulations. Narratives were used to explain qualitative data, which also compounded the descriptive statistics. The results are presented in form of charts, graphs, tables and descriptive text in chapter 4 of this report.

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RESULTS AND ANALYSIS

RESULTS AND ANALYSIS

4.0 Introduction

The results presented in this chapter are from 30 counties visited over a period of one and half months. While the study aimed to evaluate Nairobi County alongside other counties, efforts to set up a meeting with the county officials were futile. Since the focus of the project was to undertake a GIS needs assessment within the framework of County Spatial Planning, the interest departments in each county were those in charge of physical planning, land and survey matters. In all counties, the interviews were undertaken at three levels;

a) Key informant level – wherein a discussion was held between the consultants and a technical panel consisting of senior staff, mostly the department chief officer, directors of various units, county planners, surveyors and land officers, and other staff in charge of specific programmes (eg heads of GIS labs where applicable).The consultants first briefed the County Executive Committee Member (CEC) in charge of the relevant department, and got his/her overall views on the key discussion aspects before meeting the technical panel. In some counties, the CEC participated in the technical panel discussion.

The aim of this level of analysis was to get information on any existing county GIS setups, and how their presence/absence was influencing county spatial planning and development related activities. The interviews were guided by a key informant questionnaire, which is appended to this report as annex 5.

b) Professional level – which consisted of individual interviews with GIS users within the visited counties. GIS users in the context of the survey consisted of staff hired to do GIS work, and staff who had basic or advanced knowledge on GIS regardless of whether or not they were using the systems for their day to day work. This level of assessment aimed at getting information on the prevailing human capacity within counties, particularly on their competence in use of GIS, the challenges they face in delivery of their duties, as well as how GIS can enhance their efficiency. In each county, respondent professionals were identified by the senior staff interviewed during the key informant discussion and filled in the questionnaire in annex 6. A total of 89 professionals from 27 counties were interviewed. No professional interviews were conducted in the counties of Kiambu, Kajiado and Busia, either because the professionals were not available during the team's visit and could not submit their responses later; or because there was no GIS user in the county who could fill in the questionnaire.

c) Documenting of existing GIS hardware and Software – which was effected by physically viewing the existing systems and filling in their technical information into checklists in annex 5 and 6.

The findings from these three levels of data collection are presented in the subsequent sub-sections of this chapter. Depending on the interest component, the results are presented as comparisons between counties, or as county specific discussions.

In the context of this assessment, the definition of a GIS lab is used to casually define two types of GIS setups: a) functional GIS setups, and b) non-functional GIS setups. A functional setup is defined by presence of a dedicated physical space/office complete with hardware (such as computers, plotters, and scanners), GIS software (e.g. ArcGIS, QGIS, etc.), personnel/staff and GIS compatible/usable data. A non-functional setup on the other hand is one that satisfies one of the following conditions

1. Has a space designated as a GIS lab, complete with hardware and software but does not have personnel/staff utilizing the equipment, either because there are no qualified people or people designated to do GIS work are fully occupied in other duties (e.g. survey or planning work).
2. Has a space designated as a GIS lab, a few computers, software and staff who can use them even if the computers are not yet set up.
3. Has a space designated as a GIS lab, has several pieces of hardware and software, data and a few people knowledgeable on GIS systems, even if the equipment is not located within the physical lab space.
4. Has a space designated as a GIS lab, with a few

pieces of hardware, data, staff who can use the setup but software is missing.

4.1 Presence of GIS Setups in counties

Use of GIS in counties varies widely, both in terms of adoption, application, intensity and structural setup. Out of the 30 counties visited, only 4 had a section which was dedicated to GIS related activities and had set up a lab, and 5 were at an advanced stage in setting up a GIS lab. Six more counties are in the initial stages of setting up their labs and another 10 are considering starting the process. Only 3 counties are yet to consider setting up labs, as presented in table 4.1.

Assessment session with CEC & Directors in department of land, housing & envivonment, Kilifi County. Photo: © Dennis Mwaniki, 2017

Table 4.1. Stage of GIS development in Counties

Stage in GIS development	Description of stage	Counties in Stage
Lab has been set up	This includes counties which have a functional GIS lab even if no GIS experts or avid GIS users from other professions exist and/or are using the lab at the moment. It also includes counties where all the systems are operational but are not being used	Siaya, Narok, Kisumu, Kwale
Advanced stage of development	This includes counties which have a space designated as a GIS lab, a few computers, software and staff who can use them even if equipment is not yet set up	Lamu, Turkana
	This includes counties with space designated as a GIS lab, GIS data, software and a few people knowledgeable on GIS systems; but does not have computers dedicated to the lab, even if other hardware such as scanners and plotters exist	Kiambu
	This includes counties with space designated as a GIS lab, hardware, data, staff who can use the setup but software is missing. It also includes counties where other services such as networking is missing	Nakuru, Kilifi
Initial stages of development	This includes counties which have already allocated a budget for setting up the lab in the current or next financial year (whether directly or through the consultant formulating the CSP), and/or which have already procured and received a few pieces of hardware but can't use it because some components are missing	Mombasa, Isiolo, Meru, Uasin Gishu, Kericho, Kitui, Nyeri
	This includes counties with GIS software, a few non-computer hardware but no lab space and no dedicated GIS computers	Makueni
Being considered	This includes counties which are at the initial stages of formulating strategy for setting up the labs. It includes counties which are still negotiating for funds allocation and approval from the county assembly, and those negotiating with consultants for award of CSP contracts and for which setting up of a lab will be a deliverable	Tharaka-Nithi, Garissa, Nyamira, Kisii, Kakamega, Kajiado, Nandi, Kirinyaga, Embu, Migori
Not present and not being considered	This includes counties for which discussions on setting up a lab are yet to commence	Trans –Nzoia, Elgeyo Marakwet, Busia

**GIS savvy staff in most counties however have unlicensed versions of commercial GIS software on their personal computers which they use to view data presented by consultants and perform basic spatial analysis*

4.3 Use of GIS in Counties

Regardless of the stage counties were in setting up a lab, 70% (21) were using GIS for some of their work. This was informed by two main factors:

- Majority of counties (86.7% equivalent to 26 counties) contracted out GIS services to external entities whether they had a lab or not. About 90% of counties without GIS labs and 80% of counties with labs had contracted out GIS related work. The contracted work was mostly related to formulation of County Spatial Plans (CSP) and was contracted to private firms and public entities such as universities.
- Presence of internal GIS setups did not necessarily mean that the counties used them for substantive spatial analysis work. With the exception of Siaya and Kitui Counties, all counties which had GIS labs had contracted GIS work to external entities, a fact that was itself largely informed by two key things;
  - ◊ The counties lacked capacity and resources (human and infrastructural) to collect, analyze and manipulate large amount of data required to both set up functional GIS systems and in turn prepare plans such as the CSP. Due to the limited capacity, majority of the counties were unable to even manipulate data presented to them by consultants, and only used their existing systems to view it.
  - ◊ Setting up of GIS labs in most counties is contracted out to external entities, mostly as part of the CSP formulation contract

The case of Kiambu was however different, in the sense that the county contracted individual GIS experts, land valuers and planners to digitize land records, and to undertake data collection on such aspects as land use and property values. The data generated is being used by in-house experts for various purposes, such as preparation of the CSP. This is the opposite of the approach adopted by all other counties who contracted public or private institutions to carry out the entire plan formulation exercise.

The major activities for which counties use GISs include planning (as identified by 36.7% of respondents), development control (22.4%), land management (24.5%), infrastructure monitoring (12.2%) and monitoring development (4.1%). This scope of usage could however be limited by the fact that interviews were done with representatives from the departments of lands, physical planning, surveying and related functions.

The lack of in-house systems and capacity limitations among staff have also narrowed the scope of GIS related activities that counties can undertake, with majority of GIS work (including basic operations such as exporting maps for reports) delegated to consultants (figure 4.1). For example, two out of the four counties with GIS labs (Kisumu and Kwale) use the setups mostly to view data presented to them by consultants, while the facilities in the third county (Narok) are still not being used because most staff are at basic level of GIS training. Among counties without a GIS lab, GIS knowledgeable staff are also able to view data generated by consultants (and presented in GIS compliant formats) using a diversity of software – either open source or pirated ArcGIS software installed on individual on personal computers.

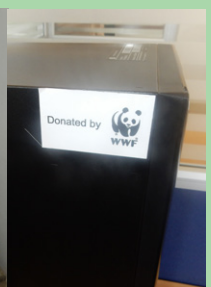
Kiambu County is however using their in-house system, with

Box 4.1: GIS lab Set Up Status in Narok County

Through a partnership with the World Wildlife Federation (WWF), Narok County has set up a GIS lab which constitutes 4 work stations, 4 desktop computers, a server and server switch, and ArcGIS software version 10.4 with lifetime license. Both the hardware and software were supplied by WWF (zero cost for the county government), which also facilitated a two week GIS training for 10 county staff. One of these staff (with IT background) is currently in charge of maintaining the lab. Massive amounts of data is available to the county through the partnership with WWF and other learning institutions conducting surveys on the natural resource rich county. At the time of the survey, the lab was not being used due to lack of the server software, and limited capability of the staff to use the available equipment.

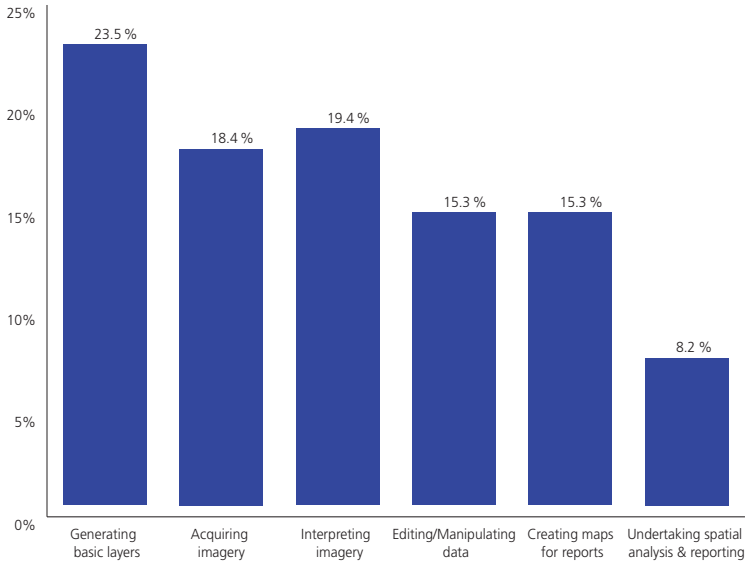






the help of individual consultants to generate and manage data, as well as to undertake analysis and make maps for reports. The county is further building structures to help them to model situations in the future, especially those related to development and growth in difficult to reach areas such as informal settlements. It is however important to note that due to lack of adequate hardware, the hired consultants work from their individual laptops, and data is transferred offline through a hard disk. This creates a data safety challenge for the county, particularly in the handling of sensitive and restricted data.

Figure 4.1: GIS related activities contractors are hired to undertake



The delegation of core GIS functions (as well as other plan preparation exercises) to contracting firms, and the costs associated with such services is an issue that received mixed views fromcounties. When asked to rate the cost of consultancy services, 9.1% of the counties identified the cost as being very cheap, 18.2% identified them as cheap, 40.9% said it was fair, 22.7% said it was high and 9.1% said it was very high. The high number of respondents identifying the cost as fair was informed by such factors as:

- Lack of necessary equipment to undertake the required activities
- Lack of adequate personnel to undertake the tasks
- Lack of capacity among staff to undertake the tasks
- Lack of standards to define costing of various services, leaving counties with the freedom to negotiate with service providers

Private companies form the bulk of contractors undertaking planning and GIS related work in counties (as contracted by 19 counties -73.1%), followed by public entities, particularly universities (in 4 counties -15.4%). Only 3 counties (11.5%) had hired individual contractors to perform different GIS related tasks.

Box 4.2: GIS lab Set Up Status in Kiambu County

Kiambu County is pioneering digital advancement in all development sectors. The county is a pioneer in the electronic development application management system (E-DAMS), which is a digital system that has streamlined development approval processes. The county is also undertaking very innovative GIS activities. Faced with limitations in basic GIS infrastructure (hardware and software), data and human resource, the county opted to hire individual consultants (casuals) to both digitize land records and generate spatial planning relevant data (particularly a basemap and valuation rolls). A total of 30 casuals were hired for a period of three months to perform these tasks. A main pre-condition for the casuals was knowledge on GIS, use of digital data collection tools (e.g. GPSs, smartphones) and ownership of a laptop computer. Work was done in the personal computers by the casuals and transferred to a hard drive owned by the county, which was then used to transfer the data to a server for storage. the data is being used for decision making and in the preparation of the county spatial plan and will be transferred to the GIS lab when it is fully set up. Data generation was still ongoing at the time of the assessment, with 60% digitization of land parcels having been attained, and collection of parcel information (attributes) estimated at 40%. For now, only a space exists, with several non-computer hardware (plotters, scanners, map storage cabinets) also present. The data can be viewed at the office of the director, land, surveys and geomatics department, where two desktop computers installed with ArcGIS 10.3 exist. The county also has 10 ArcGIS 10.3 licenses, of which 8 are not in use due to lack of computers. A server is also being set up at the county offices in Kiambu town.

4.4 Existing County GIS Resources and Needs

4.4.1 Hardware and Software

Hardware and software are the top GIS needs by counties. 20 of the 30 surveyed counties identified the two as their number one priority for development of a GIS lab, 8 counties prioritized human capacity development and only 2 counties identified software as their number one priority.

All the 30 counties visited have various kinds of hardware, although only a few have hardware dedicated to GIS and related systems. Since the focus of this study was on GIS needs, the focus of the data collection was only on hardware that is currently being used for, or will in the near future be mostly used for GIS related tasks. Likewise, while some counties may not have dedicated hardware currently, they have procured the facilities either through budgetary allocations, partnerships or as part of ongoing county spatial plan preparation contracts. Majority of the hardware that is existing or being procured comprises of computers, plotters, scanners and servers. Other hardware components that the counties have or are procuring include space and lab furniture. Annex 2 summarizes the various GIS dedicated hardware available in counties.

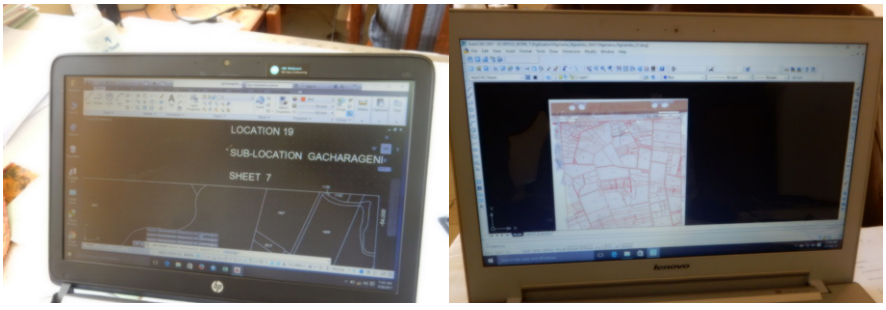
The trend by counties to allocate resources for hardware acquisition is however not accompanied by a similar effort to acquire software. Equally, counties which have outsourced the services of contractors working on CSPs to set up their labs do not seem to have clear guidelines either on the GIS software they desire or the nature of software licensing (where applicable). This situation, which is largely a result of lack of clarity in the CSP formulation guidelines on the area of hardware and software is a major loophole now and into the future, and may greatly compromise the functionality of GIS labs in different counties. Nonetheless, various forms of software exist in several counties, which range from open source to licensed and pirated copies of commercial software installed in both official and personal computers.

Annex 3 presents the GIS software installed in official computers in the visited counties. The assessment, while it appreciated the availability of software in personal computers, did not document the existing alternatives. Professional response analysis presented in section 4.4.2.1 however depicts an orientation by individual professionals to commercial GIS software, particularly ArcGIS. Other than in Makueni where the county government bought ArcGIS software which is installed in personal computers, it was noted that majority of the ArcGIS software installed on personal computers in the other counties was unlicensed. Box 4.3 outlines specific county based findings on prevailing software scenarios and challenges.

Some County hardware & software resources

NAKURU

NYERI



Staff attached to the Directorate of Survey are currently digitizing land records using AutoCad

Box 4.3. Some key findings on the status of software in select counties and emerging challenges

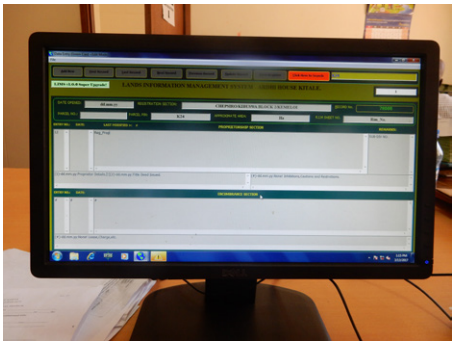
- In **Kilifi** County, while 5 computers exist, the GIS software supplied by the CSP contractors was server based. After an incident during which the server operating system was stolen, the GIS software was rendered unusable and the computers are now either lying idle or being used for other purposes.
- In **Nakuru**, the county has been using lifetime GIS software license supplied through a partnership with UN-Habitat in the early 2000s. Whereas the license still exists, the software version is old and the number of computers the software can support has been attained. Six computers bought for the county GIS lab do not have software currently, and the cost of purchasing commercial software has proven prohibitive, largely slowing down the process of launching the lab.
- **Narok and Lamu** counties received computers and the latest ArcGIS software through a partnership with the World Wildlife Fund (WWF). While the desktop version software had a lifetime software license, the extensions require annual renewal. Despite this, Lamu County had not yet set up the computers (since 2014) due to lack of space for a GIS lab.
- In **Embu**, re-designation of the GIS expert to Survey of Kenya (SoK) in 2014 signaled the end of GIS software capability, since the expert had ArcGIS software installed in his personal computer through a training at the Regional Centre for Mapping of Resources for Development (RCMRD) funded by the county government. While the county subsequently made efforts to procure a computer with high processing power in preparation for setting up of a GIS lab, it has not been able to procure commercial software. The county planner has opted to install open source software on the computer to view GIS outputs presented by consultants.
- **Makueni** County has procured 3 license ArcGIS software through ESRI - EA, but does not have GIS dedicated computers. The software has been installed on staff's personal computers . ESRI offered basic GIS training to the staff
- **In Kiambu**, while a lot of work has been done on GIS such as digitizing all land records, mapping of land uses, mapping of land values, etc.; and while the county has already created space for a lab, the lab is not yet equipped with computers. The GIS data is stored in an external drive and a server located in Thika town. Since the county office headquarters in Kiambu town are not networked, the only access the county offices have access to the data is through the hard disk, and two computers located within the office of the director of land, survey and Geoinformatics – which are installed with ArcGIS version 10.3. While the county has 10 ArcGIS licenses, only two are being used since there are not computers to install the other eight.
- **Kisumu** is supported by French development bank and a data center has been set up with full ESRI licenses. The GIS officer has been trained. The challenge is harmonizing the support initially limited to the municipality with the county needs

Some County hardware & software resources

UASIN-GISHU

KILIFI

TRANS-NZOIA



Trans-Nzoia county is developing a digital land management system internally (which is not spatial based) to help in land searches and ease processing of land related activities

Counties are procuring for/purchasing GIS hardware increamentally using their small budgetary allocations, or as part of the County Spatial Plan prepartion process

4.4.2 Human resource

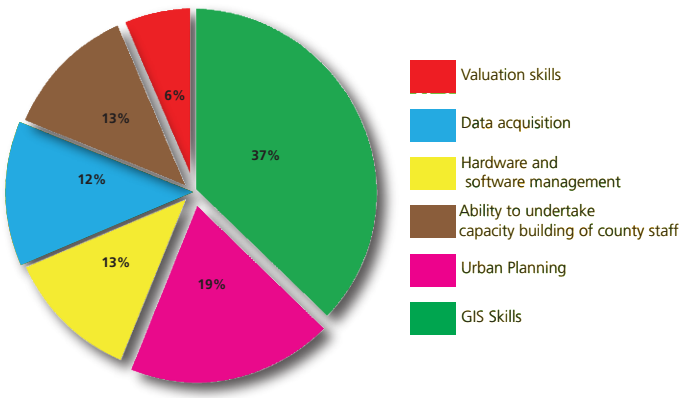
Capacity development, and hiring the correct staff is the second most urgent GIS need by counties. 8 of the 30 interviewed counties identified human resource development as their number one GIS priority/need, while 28 counties identified it as their second most urgent need.

Lack of adequate technical staff, as well as their limited capacity to undertake activities such as GIS data generation and management, as well as to formulate spatial plans were identified by counties as some of the key reasons for contracting out these services. The major forms of expertise sought by the 26 counties which contracted out work included skills in GIS, urban planning, and ability to undertake/conduct capacity building of county staff as shown in figure 4.2

While all counties visited had at least one person who was knowledgeable in GIS systems , only Nakuru had hired one GIS expert, who has worked on various projects over the years, and is overseeing the establishment of the county GIS lab. Kisumu County on the other hand had a GIS manager whose background is ICT with basic skills in GIS, although the county planner and surveyors have basic knowledge in GIS. In all other counties, including those which had set up GIS labs or were at an advanced stage in setting them up, staff who are knowledgeable in GIS are those employed to perform other duties; particularly surveyors, planners, cartographers.

In Lamu, Kiambu and Turkana for example, while the GIS labs are not yet operational, the two people per county who will be assigned to the GIS labs are cartographers and surveyors, with basic training in GIS. Mombasa, Makueni and Kitui counties had the highest numbers of staff knowledgeable in GIS, and who use the systems frequently, as represented by at least 10, 5 and 4 staff respectively. These numbers consist of a mix of surveyors, cartographers and planners who use various GIS platforms to perform their day to day duties. The high number of GIS knowledgeable professionals in Mombasa is related to two things: a) existence of a GIS lab prior to devolution in 2013 (which was supported by the national government and staff were re-designated to other duties after 2013), and b) recent training under the CSP formulation process, through which the contractor (GeoDev) took staff through rigorous training. The staff also received all data generated for the planning process in GIS format, which they are using to perform day to day activities. Currently, most of the county staff are accessing the provided data from their personal computers, which are installed with open source or pirated GIS software. In Siaya, where a GIS lab exists, complete with hardware and software, the process of recruiting a GIS expert/manager is at an advanced stage. Kilifi does not have any person designated to the non-functional GIS lab, although about five staff (mostly surveyors) were trained on GIS under a partnership with the Technical University of Kenya (which is also formulating the CSP). A second round of training, which will involve about 10 staff is underway.

Figure 4.2: Major skills sought by counties contracting GIS & Planning related services



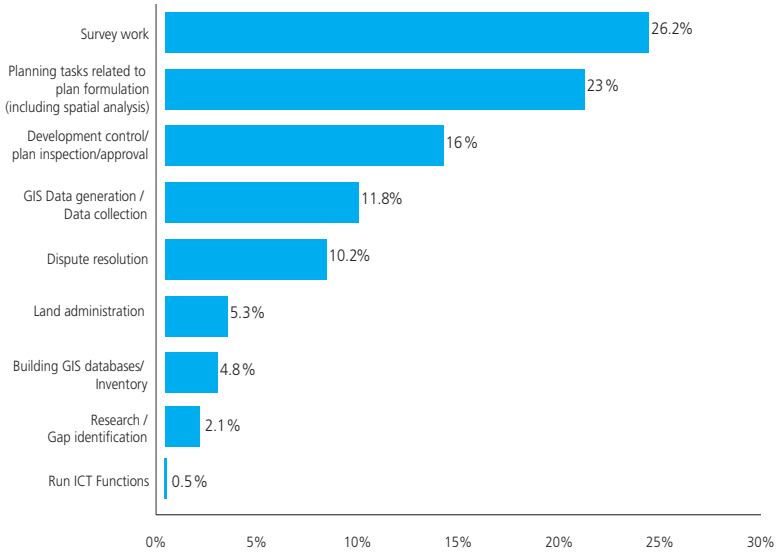
4.4.2.1 Human resource capacity from professional interviews

In order to understand the human capacity on GIS in counties, the needs assessment survey administered a professional interview questionnaire to county personnel working in the department of lands, survey and physical planning. As discussed in section 4.0, the professional questionnaires were administered in 27 counties. Purposive sampling was used to interview staff who were knowledgeable in GIS, whether or not they used the systems in their day to day activities.

Majority of the respondents, and in turn people with basic understanding and/or background in GIS were staff engaged

in survey work, plan formulation activities, development control GIS data generation, and GIS database development as shown in figure 4.3.

Figure 4.3: Activities undertaken on a day to day basis by respondent professionals



ESRI's ArcGIS software is the most popular software among the interviewed professionals, with 53% of the respondents identifying that they use the software. QGIS is the second most popular software (17.4%), followed by global mapper (9.6%) and Erdas Imagine (7%). Other software include ILWIS, ENVI, MapInfo, Pythagoras, surfer, MicroDEM and IDRISI Kilimanjaro. When GIS and remote sensing software are considered seperately, 71% of the respondents use ArcGIS, 23% use QGIS, and 5% use MapInfo softwares. Majority of the respondents are using a crack version of ArcGIS, and identified the software's easy interface and high functionality as the main reasons for preferring it.

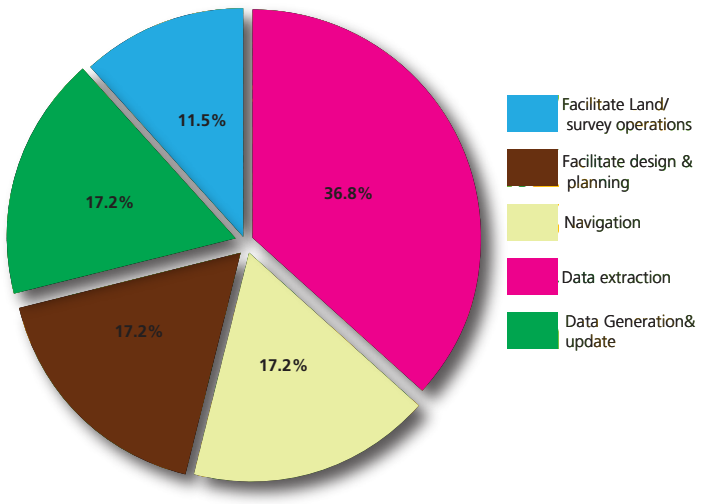
4.4.2.2 Knowledge and use of Open source GIS data platforms as a measure of human resource capacity

The competence of GIS professionals may be assessed by their understanding and use of various GIS open data platforms, since these platforms often form a good basis for understanding an area of interest. 80% of the interviewed professionals reported that they were familiar with one or several platforms. Since multiple respondents were interviewed per county, there was at least one respondent from each of the 27 counties who was familiar with an open data platform. Google earth is the most widely known and used open data platform, with 42.3% of the professionals indicating that they were familiar with it. Other platforms included OpenData Kenya (10.2%), Open Source Boundary Maps (18.2%) USGS/Landsat free imagery (9.5%), Open Street Map (8.8%), ILRI open source data (4.4) and ESRI (2.2%). GitHub, Glovis, DEM Aster, KNBS, virtual Kenya and survey computation were also identified as sources of free data by 0.7% of respondents each).

The respondents mostly use the platforms for navigation (eg google earth), to extract GIS data (downloading datasets – shapefiles and images), to generate or update datasets, to facilitate planning and design (eg as basemaps and design templates) and to facilitate various land/survey related activities (eg sourcing for land parcels coordinates).

The significance of these findings is that, county professionals are knowledgeable on existing data platforms both globally and locally, and are using them to enhance their work. With proper support, such as provision of hardware, software and enhanced training (and where county budgets allow hiring of dedicated GIS experts), counties can use their existing structures as a starting point for building their GIS labs.

Figure 4.4 Major uses of Open source data platforms



4.4.2.3 Relevant GIS training and capacity development as a measure of human resource capacity

GIS relevant capacity development at the county level is limited, both in terms of taking relevant GIS courses and direct engagement of staff in consultancies which could enhance their work capabilities.

Fifteen counties (50%) visited have facilitated GIS training for their staff, either by sending them for short training courses (eg at RCMRD) or organizing for county based trainings. These findings were consistent with professional interview results, in which 48% of the interviewees had taken a GIS related course outside their formal university/college education.

There was a strong positive correlation between staff attendance of county sponsored GIS courses and the presence of partnerships between counties and GIS training institutions (r=0.668). This implies that there is a very high likelihood that counties which partner with institutions which offer GIS services (e.g RCMRD, universities, Esri Kenya) are more likely to have trained staff than counties which do not create such partnerships. For example, out of the 14 counties that had partnered with an organization that offers GIS services (see annex 1), only staff in two counties, Kirinyaga and Isiolo had not attained on-the-job training. On the other hand, of the 16 counties which had not partnered with any institution, only Kitui and Makueni had their staff trained on the job. The lesson from this finding is that counties should leverage the available partnership opportunities such as the fast growing universities and colleges within their jurisdictions as a way of enhancing the capacity of their staff on GIS.

A major gap in staff capacity building exists in all counties, particularly with regards to engaging technical staff in ongoing activities by contractors. While for example 86.7% (26) counties have contracted GIS and planning related activities, only 29% of the interviewed professionals indicated that they have engaged with contractors in activities directly relevant to their work. While this may seem biased due to the fact that not all county staff were interviewed, discussions with the key informants identified that contractors often work independently, and that most interaction with the county staff is during activity progress meetings and briefings. This is despite the fact that all staff who had indicated that they were directly engaged with ongoing work by contractors had gained a lot of hands-on experience in their fields; and that they understood the ongoing processes better and could perform them independently in future.

This illustrates a break down in capacity building for the technical staff, who would ideally learn a lot by engaging directly with contractors throughout the project cycle. This approach is however also limited by few members of staff, who are often in charge of other county activities during the times the contractors are undertaking the technical work.

4.4.3 Data

Data forms part of the core GIS system infrastructure and is often the backbone of all planning related activities. The needs assessment survey sought to understand the kinds of GIS related data counties already have, the format it is in, as well as their most urgent data needs. Within the context of the survey, data largely comprised of planning relevant information, which was either in map or non-map format, but which has been and/or could be used to build a GIS database. Whereas majority of the counties identified data as their least urgent need at the moment, they also identified that access to data was key to building GIS databases, which would in turn inform their spatial planning activities. Land parcel information maps (e.g. registry index diagrams, cadastral maps) and Development plans of various kinds (e.g. land use plans, zonings plans, market plans etc.) are the most common forms of map data available in counties, with all counties indicating that they have at least a few of such maps (Table 4.2). For most counties, these maps only covered small parts of their jurisdictions, with near universal coverage concentrated in the urban areas.

Topographic maps and imagery (aerial photos and/or satellite imagery) are the second most readily available/used maps in counties, with 26 of the 30 counties visited indicating that they had such maps (Table 4.2). The 4 counties which did not have topographic maps (Makueni, Busia, Kisumu and Turkana) indicated that they could easily access them from

the Survey of Kenya. Majority of the topo maps are however old (mostly from the 1980s and 1990s) and in hard copy, although counties identified that they were equally useful and act as reliable basemap since physical features have largely remained unchanged within their jurisdictions.

Other available map information in counties included water and sanitation maps, transportation maps, facilities maps and boundaries maps as indicated in table 4.2.

Table 4.2 Available map information in counties

	Land parcel maps (e.g RIMS, Survey maps)	Development plans (land use plans)	Topographic map	Utilities data (e.g Water maps)	Transport maps - roads, wayleaves	Satellite Imagery/ aerial photos	Natural resource maps	Boundaries Maps
Mombasa	x	x	x			x	x	
Kwale	x	x	x			x		x
Kilifi	x	x	x			x	x	
Lamu	x	x	x	x		x		x
Garissa	x	x	x			x		
Isiolo	x	x	x					
Meru	x	x	x			x		x
Tharaka-Nithi	x	x	x			x		x
Embu	x	x	x			x		
Kitui	x	x	x		x	x		
Makueni	x	x				x	x	x
Nyeri	x	x	x			x		
Kirinyaga	x	x	x					
Kiambu	x	x	x					
Turkana	x	x				x		
Trans-Nzoia	x	x	x		x	x		x
Uasin Gishu	x	x	x			x		
Elgeyo Marakwet	x	x	x			x	x	
Nandi	x	x	x			x		
Nakuru	x	x	x	x	x	x		x
Narok	x	x	x			x	x	
Kajiado	x	x	x					
Kericho	x	x	x			x		
Kakamega	x	x	x			x		x
Busia		x				x		
Siaya	x	x	x	x	x	x		
Kisumu	x	x		x	x	x	x	
Migori	x	x	x			x		x
Kisii	x	x	x			x		
Nyamira	x	x	x			x		x

**Nakuru and Kisumu counties also had maps on social facilities (education, health, etc.)*

Majority (62.3 %) of all the maps available in counties are in hardcopy format. of these only, 19.5% were in digital GIS format, and 16.2% were both in hardcopy and digital GIS format. Other map formats included digital non-referenced format (0.6%) and both digital non-referenced and digital GIS formats (1.3%). 11 out of the 30 counties had their map information only in hardcopy format, implying that they neither had scanned nor georeferenced maps. This however depicts the situation in the departments interviewed during the survey, only for the maps identified per county, and may not be the overall county situation. The counties which had hardcopy maps only include Garissa, Isiolo, Meru, Nyeri, Kirinyaga, Uasin Gishu, Nandi, Busia, Kisumu, Migori, and Kisii.

Other than the four counties which did not have imagery (Isiolo, Kirinyaga, Kiambu and Kajiado) all imagery in the other counties is in digital geo-referenced format and has been supplied by various partner organizations (eg WWF for Narok and Lamu) or contractors working on the CSP and other development plans. Only 3 of the 21 counties that responded to a question on the source of their images had adopted the use of free imagery, of which two were using google earth (Kakamega and Migori), and one was using free Landsat imagery (Turkana). Three other counties had received their imagery through donations (Kwale, Lamu, Nyeri). Most of these images however cover small sections of the counties, particularly the urban centres.

Majority of the available imagery has a spatial resolution equal to, or less than 50 centimeters (60% of imagery), 26.7% of images have a resolution of between 1.5 – 5m, and only 6.7% have a resolution of 25m. A further 6.7% of counties did not know the resolution of their imagery. The overall implication of this is that, despite the small spatial coverage, most counties have high resolution images, which can be used for data generation at various levels, as well as for various planning purposes.

Land ownership records are the most common map related information (non-map data) available in counties. Of the interviewed counties, only Turkana and Nakuru indicated that they did not have access to land records. In Turkana, the lack of these records is associated with the fact that land is largely owned by the community, for which individual ownership is not broadly registered (except for a few individual titles in existence). In Nakuru, the lack of land records is associated with the fact that, all land records within the county are under the custodianship of the department of lands at the national level. The records are however available at request by the county.

It is important however to note that several counties raised a concern that, while the county land registry section deals with land matters, land ownership and related transactions are often handled by the national government. The lack of an integrated system on land matters between the national and county governments was largely blamed for the slow pace in resolving land related issues, as well as a major impediment to county efforts to digitize their records. In Kiambu and Mombasa for example where a lot of digitization of land parcel information has happened in the past five years, there have been many cases where land records at the department of lands are outdated, and do not reflect existing land ownership structures. In Mombasa, where the entire county uses cadastral maps, the fact that there is no system of updating the maps at the national level has limited formalization of land records digitization. While specific GIS users within the county can update the maps from their personal computers, the lack of a centralized system to regularize the process has proven to be counterproductive.

Development control records are the second most common map related information, with 17 counties indicating that they had such records. Other forms of available data included valuation rolls, land rates registers, site inspection reports, and records on public land (table 4.3). In all counties, Information

Old hardcopy land parcel maps and harcopy non-map information are common in counties. Photo: Some maps in the lands registry Nyeri County | © Dennis Mwaniki, 2017

on issues such as population and utilities data (e.g. water) was readily available at request from the county departments dealing with such matters.

While majority of counties have made attempts to digitize their non-map information, or at least have a hybrid system with some data in digital format and some in hardcopy format, 12 of the 30 counties still have their data only in hardcopy format. These counties include Mombasa, Embu, Nyeri, Kirinyaga, Turkana, Elgeyo Marakwet, Nandi, Kericho, Kakamega, Busia, Migori, and Nyamira. As earlier indicated, this information is only specific to map-relevant information and does not mean that digital versions of data do not exist for other kinds of activities, or that map relevant data does not exist in in other county departments.

Table 4.3 available non-map information per county

	Land ownership records	Development control records	Public land records	Non-spatial planning data	Rates registers	Valuation rolls
Mombasa	x	x				
Kwale	x					x
Kilifi	x	x				x
Lamu	x	x				x
Garissa	x	x	x	x		
Isiolo	x	x		x		
Meru	x		x	x	x	x
Tharaka-Nithi	x	x			x	
Embu	x		x	x	x	
Kitui	x	x				
Makueni	x	x			x	
Nyeri	x	x			x	
Kirinyaga	x	x		x		x
Kiambu	x	x		x		x
Turkana			x		x	
Trans -NZoia	x	x				
Uasin Gishu	x			x	x	
Elgeyo Marakwet	x				x	
Nandi	x	x		x		
Nakuru				x	x	
Narok	x			x		
Kajiado	x	x				
Kericho	x				x	
Kakamega	x			x		
Busia	x	x				
Siaya	x		x			
Kisumu	x				x	x
Migori	x	x			x	x
Kisii	x					
Nyamira	x	x				

**Kisumu county also had information such as Site inspection reports, GIS based address systems and a record of issued business permits*

The findings on available data were consistent with those from professional interviews, in which individual data users (staff) were asked to identify the types of datasets they use frequently. 36.5% indicated that they use land parcel data and 40.8% use planning related data (land use, transport, utilities, and social facilities data). Other frequently used forms of data by the professionals include topographical data (hydrology and elevation data), natural resources data, population data and imagery as shown in figure 4.5.

Professionals used data to carry out duties directly related to their appointment, with most data being used for spatial planning and land information management as shown in figure 4.6.

4.4.3.1 Data sharing

Data is shared among various departments and units, with 80% (24) of the interviewed counties identifying that they shared their data with other departments. A further 77.8% of counties received data from other departments. Beyond data sharing among county departments, 86.2% (25) counties identified that they share their data with other organizations and people outside the county, and 79.3% (23) counties receive data from other organizations, including partner agencies, consultants, and individual developers among others.

Data shared between county-departments is mostly free of charge, as indicated by 78.3% of counties. Only 21.7% of counties were charged for every data received. Equally, 61.5% of counties identified that they were not charged for data they received from other organizations (which are not county departments and include contractors, partners, NGOs etc.), against 23.1% who were charged for data shared .A further 15.4% of the responding counties (interviewed persons) did not know whether there were costs associated with received data. Regardless of where the data was received from, 80% of the counties identified that

Figure 4.5: Frequently used datasets by County Professionals

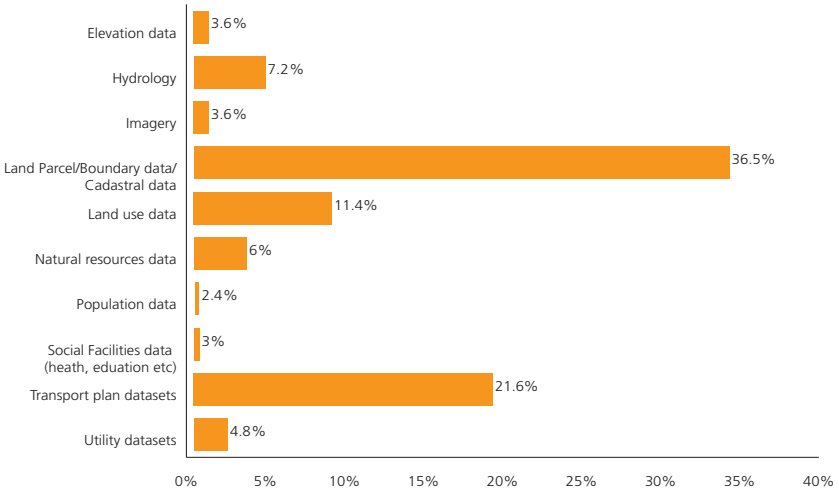
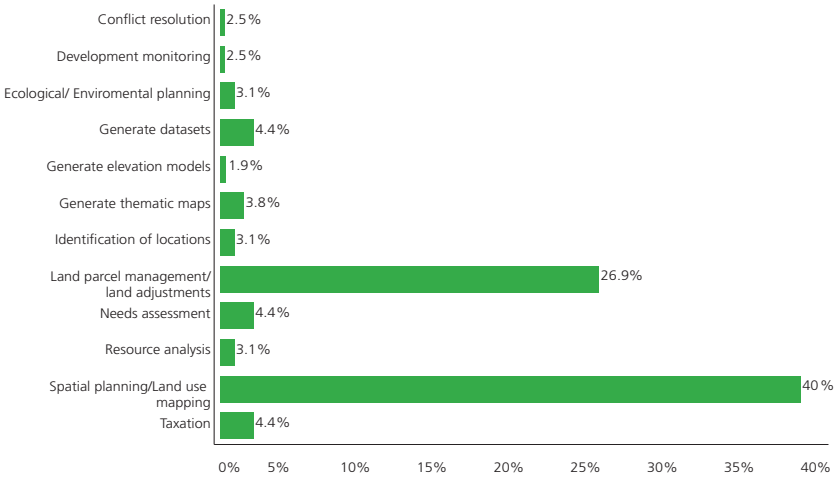


Figure4.6: main uses of data by professionals



there were no restrictions to its usage, implying that the data could be used and re-shared within the departments.

There were more counties charging for the data shared with external organizations (46.2% - 12 counties) than those charging for inter-departmental sharing. On the contrary, there were more counties which did not pay for data received from external entities (63.6% - 14) than those paying for inter-departmental data sharing. This could be explained by the fact that most data the counties are receiving is from hired contractors and partners with whom the counties are engaging in different planning activities. Just like for the interdepartmental data sharing structure, there are no major restrictions on the usage of incoming and outgoing data among counties, as identified by more than 70% of counties.

Across all platforms, data is shared on an as-is basis, indicating that required data is requested from specific department or institution and shared accordingly. Most of the data sharing is done offline. Nakuru had

until 2015 shared various mapping information through NakInfo, a web based service hosted and maintained by the Swiss Center for Development Network when the website was pulled down for maintenance. The county is planning to update the data in NakInfo before the platform is put back online. Kiambu on the other hand is still at the initial stages of developing its GIS database, and plans to avail select information to the public in the next few years once the right structures are put in place.

4.4.3.2 County Data needs

The major county data needs span across all development aspects, with a high preference by all counties to get support in acquiring updated and high resolution data (data disaggregated to the lowest governance levels) on such aspects as land management and land use, utilities and transportation, economic activities, population distribution and environmental resources.

For each of the counties visited, it was difficult to pinpoint the most urgent data needs, as the emphasis was on the fact that the establishment of GIS structures, and in turn using data for planning purposes requires access to information on all sectoral and thematic aspects of development.

However, since most interviews were done with people from the department of land, survey and planning, there was a slight orientation towards the urgency of data on such issues as land parcels, land use distribution and zoning, as well as on distribution of settlements and basic infrastructure services. Up to date Land records were particularly identified as a major need by all counties, since it is the root of most conflicts the department deals with; and also because it is only through a clear understanding of the land structure in the counties that other GIS datasets and operations relevant for planning purposes and development can be sustainably integrated.

When individual data users (professionals) were asked to identify their most urgent data needs, parcel/survey data was in most demand as identified by 32.7% of the respondents, followed by transport network data (24.5%) and land use information (14.5%). Other data needs included topographical data (14.1%), utilities information (4.1%), population data (3.6%) social facilities data (2.3%), imagery (3.6%) and economic data (0.5%). These data needs, while consistent with the general trend of data usage in counties is also informed by the kind of work each individual respondent was engaged in.

4.5 County budgetary allocations for GIS and Spatial Planning related activities

25 out of the 30 counties visited had allocated a budget for various planning and GIS related activities over the past five years, with county budgets ranging from 35 to 300 million shillings. Most of the money allocated was however spend on outsourcing planning services, and associated activities such as image acquisition and data generation.

It was difficult to distinguish how much money counties spend in setting up GIS labs since outsourced planning services, particularly the preparation of the County Spatial Plan had a component on setting up of a GIS lab. Each county has a different set of requirements for its lab, some of which were defined by the CSP contractors themselves, making it difficult to make general conclusions.

This points to a need for development of guidelines and standards on the basic requirements of a GIS lab setup, which would guide counties in the procurement process. While the National Land Commission guidelines "County Spatial Planning: Monitoring and Oversight Guidelines" have made an attempt to define the number of basic required equipment (3 computers, a plotter, scanner, software), the guidelines do not provide counties with much information on the specifications of the equipment.

Through analysis of the setups used in 12 institutions in Kenya which undertake GIS related work, and by directly asking these institutions for advise on the route counties should take, section 4.8 of his report creates a platform for developing more detailed standards and specifications on GIS setups in counties.

4.6 Challenges facing counties

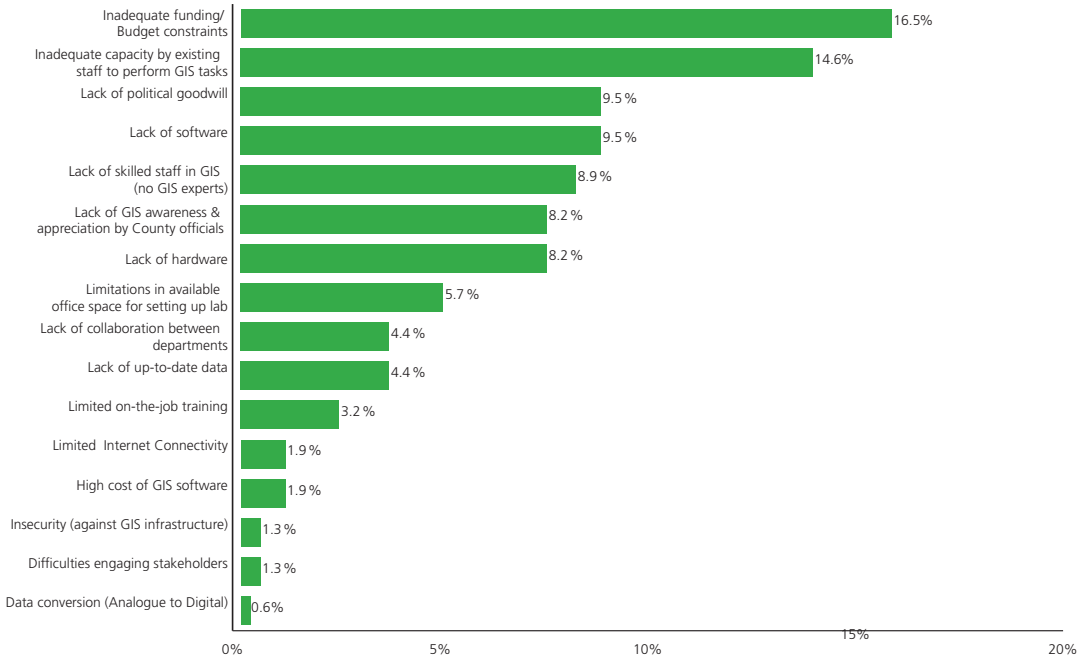
Counties are facing different challenges, which cover both soft issues (those related to limitations at the policy and budgetary allocation levels) and hard issues (limitations in physical infrastructure and human capacity). Equally, these challenges are felt at both the county level and the individual professional level, and are experienced in all the 30 counties.

Adoption of new technologies in any level of governance requires commitment at both the administrative and operational levels. While commitment at the administrative level builds the capacity of both political and technical staff to understand and appreciate emerging technologies (and in turn creates political good will), commitment at the operational level necessitates actual development of systems, formation of partnerships, hiring of knowledgeable staff, and enhances lobbying for the right support at the administrative level. The combined commitment at these two levels eases the adoption of new technologies, and in turn boosts efficiency in the entire service delivery structure.

The 30 counties visited during the assessment have experienced, at varying levels, limitations at both the administrative and operational setups, which have hindered their pace of adopting various GIS technologies. Figure 4.7 presents the range of challenges counties have experienced in their bid to adopt GIS technologies and also to set up their GIS labs, which challenges fall under four main categories

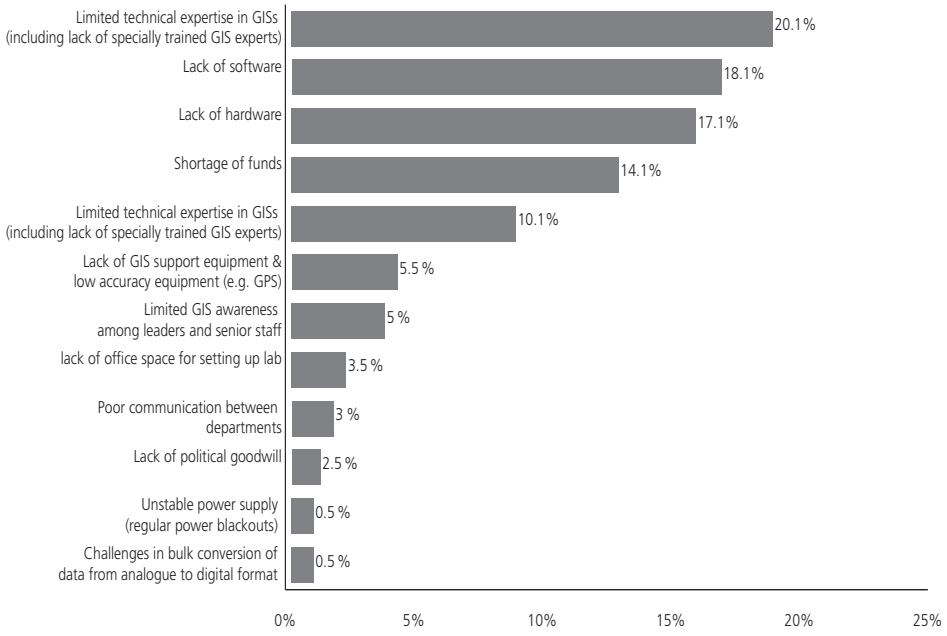
- ***Human capacity related challenges*** – which include both lack of GIS professionals and limited capacity among professionals in other sectors (e.g. planning, survey) to effectively perform GIS tasks. This also includes limitations of lack of on-the-job training among county staff
- Challenges related to ***awareness on the usefulness of GIS in county development***, which also translate into lack of political good will. These limitations apply to both the political level and senior management within the county executive setup
- Challenges related to ***budgetary allocations*** for GIS systems setup
- ***Hardware and software*** related challenges,
- ***Data*** related challenges – which include lack of up to date data and challenges of converting analogue data to digital formats, and
- ***Managerial*** challenges – which include lack of collaboration between departments and difficulties in engaging stakeholders

Figure 4.7 Challenges facing counties in adopting GIS technologies and setting up of GIS labs



When individual GIS users (professionals) were asked to identify the challenges that have limited the adoption of GIS in counties, issues similar to those raised by the key informants emerged; with limited technical expertise, lack of hardware and software being the most experienced challenges as shown in figure 4.8

Figure 4.8: challenges in adoption of GIS technologies by professionals



In order to solve the challenges identified above, there is need by counties to create an environment that promotes development of GIS, and through which staff would have interest to adopt the emerging technologies to undertake their day to day work. This will entail specific interventions for each of the identified challenges, and the order of importance should be determined by specific county needs and their order of prioritization. For example, the general consensus in counties was that hardware, software and capacity development (including both in-house training and hiring GIS experts) were the most urgent priorities and the areas where support would yield the highest results.

Similar sentiments were shared by the professionals interviewed during the assessment;, who identified capacity development as the most urgent intervention (figure 4.9). The rationale for this was that, if the capacity of staff is built to effectively utilize emerging GIS technologies, and if this is supported by the proper hardware and software, then the county staff would easily generate massive amounts of data which would enhance efficiency in service delivery, while also cutting the high costs associated with contracting out of the services. This in-house high volume data generation would also be compounded by a large pool of open source data freely available at various operational scopes.

Further, the counties believe that once basic operational levels are attained and minimum county GIS operational standards defined, data sharing between departments will be enhanced. The ultimate result will be a rapid development of county wide GIS databases, which will boost planning activities and attract investment and growth.

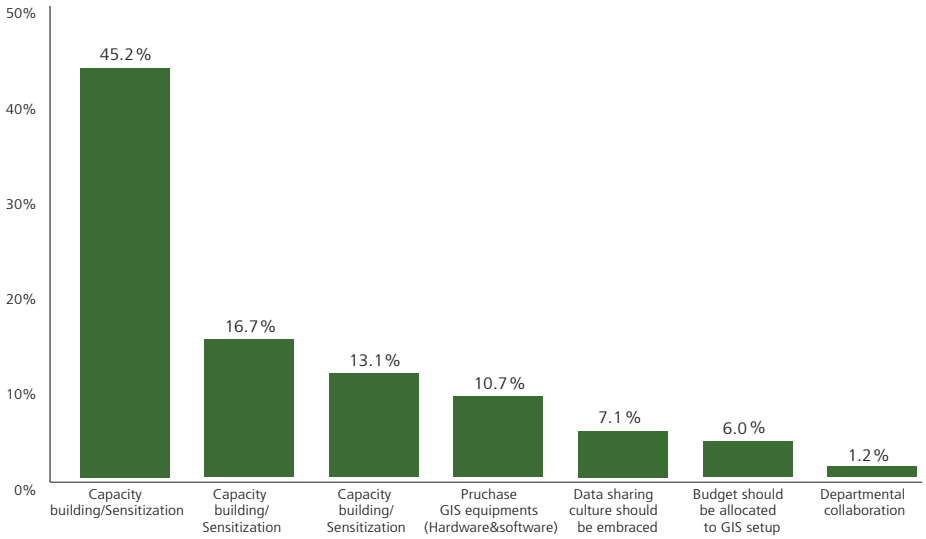
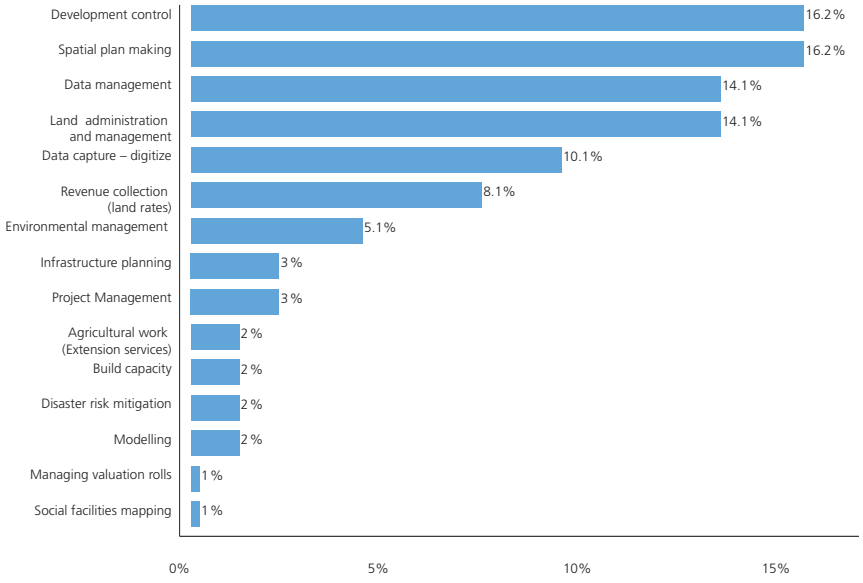


Figure 4.9: required intervention to enhance GIS use in counties

Once the identified challenges and GIS needs are solved, counties intend to use emerging structures for such activities as preparation of the County Spatial Plans, digital data capture, to ease management of large data held in different and far spread departments, land administration and management among other uses as presented in figure 4.10.

Figure 4.10. Major county activities GIS will be used in when labs are operational



4.7 National level findings

At the national level, the project aimed to assess 14 institutions which are directly involved in GIS related work. These institutions had been purposively sampled based on their experience in spatial planning, GIS systems, GIS and spatial planning related research and training, as well as their involvement in spatial data generation and analysis. Logistical challenges which largely included lack of confirmation of appointments by various institutions resulted in a sample of only 12 institutions. The day to day activities of the 12 institutions included physical planning, land survey, land administration and management, resource mapping, map information management, GIS services consultancy, environmental management, infrastructure service delivery, training, sale of GIS software and physical planning services consultancy (Table 4.4)

Table 4.4 Assessed National Institutions

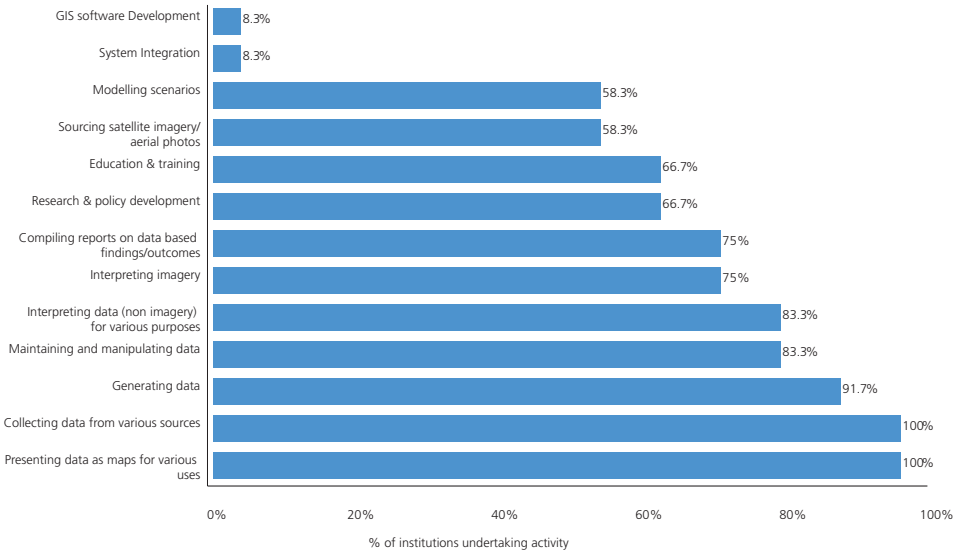
Name of Institution/ organization	Type of institution	Main activities undertaken by institution	Institution operational scope
Ministry of Land (Department of Physical Planning)	Government	Making spatial plans, Capacity building, Supervision of project implementation	National collective, National disaggregated into sub-regions
Directorate of Resource Surveys and Remote Sensing (DRSRS)	Government	Resource mapping (Land cover, natural resource, livestock)	National collective, National disaggregated into sub-regions
Survey of Kenya (SoK)	Government	Land administration and information management, survey work, resource mapping	National collective, National disaggregated into sub-regions
National Land Commission (NLC)	Government	Public Land administration and information management, Research, Monitoring land use	National collective
Independent Electoral and Boundaries Commission (IEBC)	Government	Mapping electoral units and polling stations	National collective, National disaggregated into sub-regions
Regional Centre for Mapping of Resource for Development (RCMRD)	Inter-governmental	Training, Consultancy - GIS services, Resource mapping (Land cover, natural resource, livestock)	International
National Environment Management Authority (NEMA)	Parastatal	Environmental management	National collective, National disaggregated into sub-regions
Kenya Power Company	Parastatal	Power distribution & Optic Fibre	National collective, National disaggregated into sub-regions
GeoMaps Africa	Private	Consultancy - GIS services, Resource mapping (Land cover, natural resource)	International
Esri Eastern Africa (ESRI)	Private	Sale of GIS software, Training, Consultancy - GIS services	International
University of Nairobi (UoN)	Learning	Training, Research, Consultancy - GIS services	National collective
Technical University of Kenya (TUK)	Learning	Training, Research, Consultancy - GIS services	National collective

These institutions were purposively sampled from a list of 50 organizations involved in various GIS related activities. Figure 4.11 provides a summary of the GIS related activities the interviewed institutions undertake.

The findings from these institutions are discussed under five themes:

a) Hardware and software
b) Human resource
c) Data and data sharing
d) Partnerships
e) Lessons for counties from National level analysis

Figure 4.11 Main GIS related activities in the organization



Under each thematic area, the prevailing conditions, opportunities and challenges are discussed, and some lessons for the counties profiled.

4.7.1 Hardware and Software

The available hardware and software varied widely across the national institutions, with hardware ranging from basic items such as desktop computers to high level systems such as aero planes and LIDAR imaging platforms.

Eleven of the 12 institutions had basic guidelines which define the nature of hardware, software and networking to be used in various departments. These guidelines define the minimum requirements of a functional setup within the institution, and often consist of basic properties for a low level system, a moderate system and a high performance setup. Each institution had a different set of indicators which they use to group the systems, which are based on their core mandate and processing power/functionality requirements. For example, in terms of computers (hardware), a high performance system for TUK is equivalent to a basic system at NEMA and DRSRS, while a high performance system at NEMA is equivalent to a moderate system in DRSRS as shown in table 4.5.

The huge difference in the performance rating of computers among various institutions is informed by their processing requirements. DRSRS for example handles large volumes of data which also require high-level processing functionalities (e.g image processing), while an institution like TUK handles light forms of data (e.g shapefiles) and mostly undertakes end-user processing operations.

Table 4.5 Guidelines on computer processing power and system rating in select institutions

	Basic system	Moderate system	High Performance system
DRSRS	Basic systems used by administrators (not for technical work)	1TB, 8GB RAM, multiple quad-cores, NETWORKED	Very high speed server based system
NEMA	500GB, 5GB, COREi3	1TB, 16GB RAM, COREi7	1TB, >16 GB, >7 CORES
TUK	RAM 1GB, Storage 80GB, Processor 2.0GHz	RAM 2GB; Storage 160GB; Processor 3 cores	RAM 4GB, Storage 500GB, Processor core i5

A similar trend was observed in software preference and usage, wherein DRSRS had the widest variety of GIS software, with five different softwares being the most popular/common.

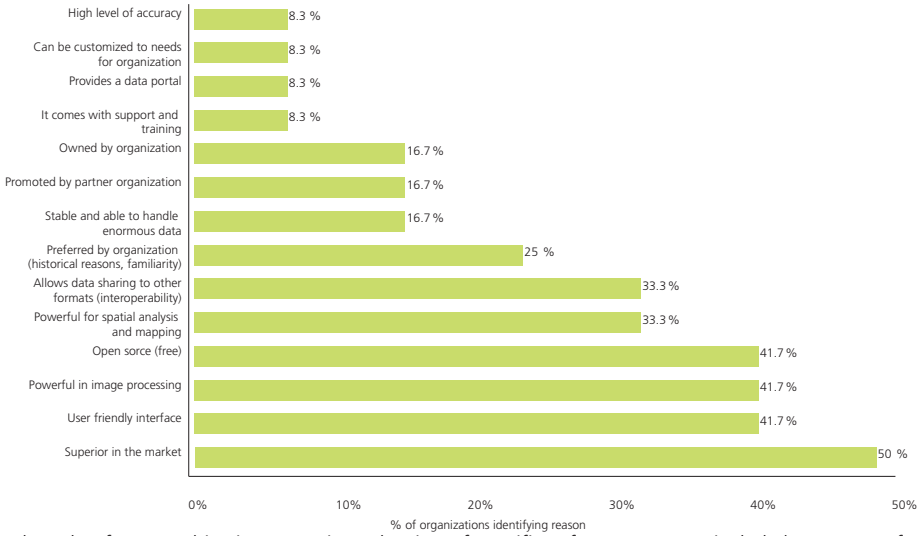
In line with their nature of their GIS related activities, training institutions such as TUK and the University of Nairobi also use a diversity of software (five and four respectively). Equally, four kinds of software are popular in RCMRD, which also handles large amount of data and offers professional training courses. The Survey of Kenya, NEMA and the IEBC on the other hand use only one form of GIS software (annex 4).

Similar to the findings at the county level analysis, ESRI's Arcmap/ArcGIS, QGIS and Erdas Imagine are the three most popular GIS software, with 92% (11) of the national institutions using ArcGIS and 42% (5) using both QGIS and Erdas Imagine (figure 4.12). Of particular mention is the fact that unlike other high data processing/ handling institutions (eg DRSRS, RCMRD) which use a combination of softwares which include open source alternatives, the survey of Kenya largely relies on Esri's ArcGIS for its operations.

The major reasons informing the selection and preference of a GIS software among national level institutions include aspects such as superiority and adequate functionality to perform complex processes, user friendliness, free/ open usage, and ability to convert data into various formats (Figure 4.13)

The type of software license used by these institutions range from free and open source options to commercial/ paid standalone and networked alternatives and student versions. Collectively, commercial software is the most popular among the national institutions, and accounts for 77.1% of all licensing alternatives. Some institutions are also using cracked software versions. The high level of usage of network based licensing is related both to the presence of high performance server based systems in several institutions, and the need for cloud sharing of software among learning institutions. The fact that all the institutions visited are networked could explain the high preference for this setup. 50% of the institutions are networked through a combination of local area network (LAN) and wireless, 25% use LAN alone, 8.3% use a combination of wide area network and wireless and another 8.3% use LAN, wide area network and wireless setups.

Figure 4.13 Reasons for software preference among national institutions



**the role of partnerships in promoting adoption of specific software was particularly key reasons for adoption of ArcGIS by the University of Nairobi and ESRI*

Figure 4.12 Most Popular GIS Software

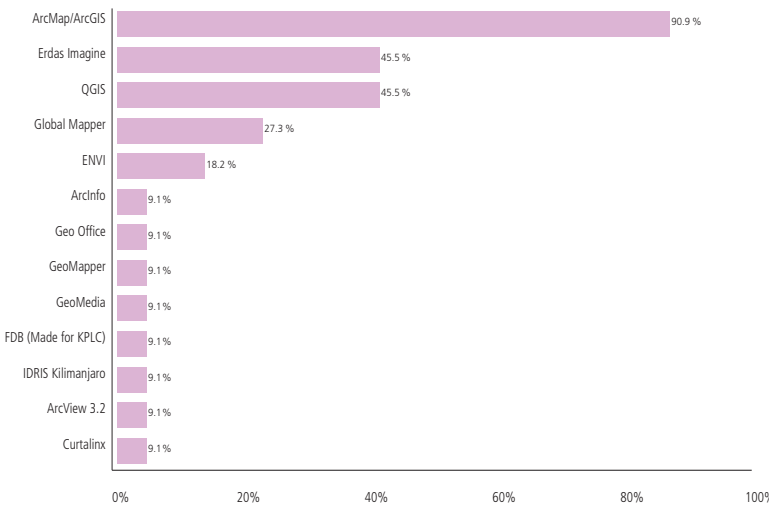
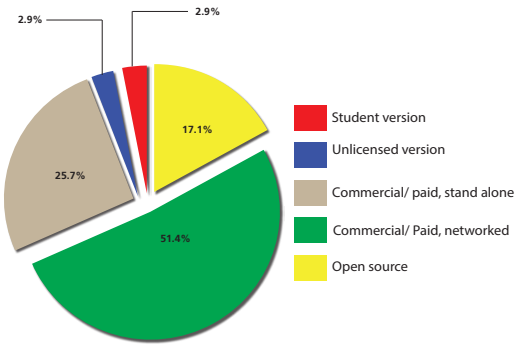
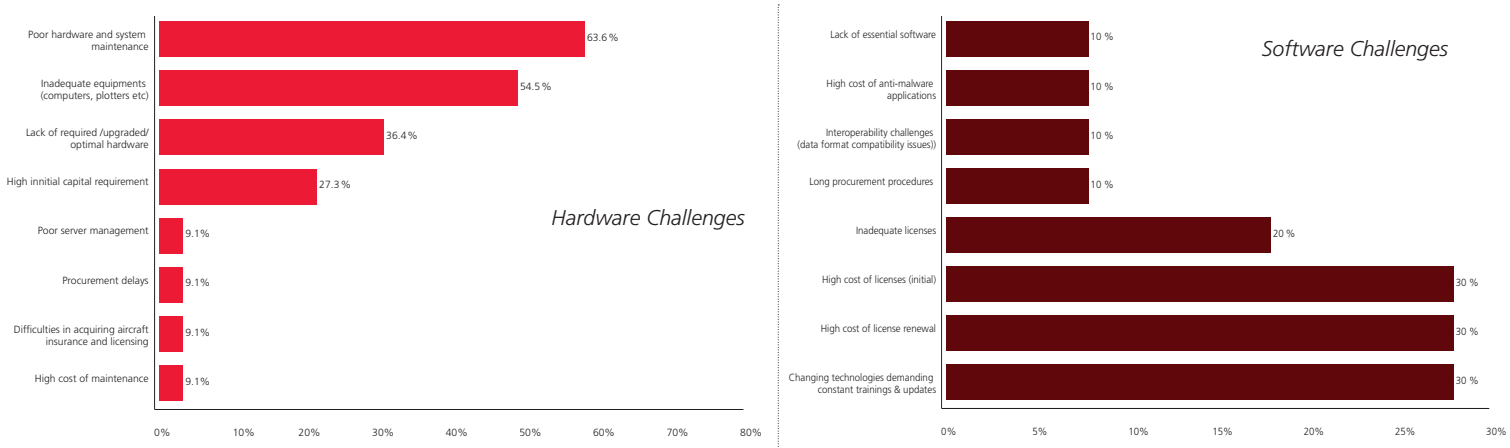


Figure 4.14 Most common license types among national institutions



Despite the higher level of development in both hardware and software in national institutions as compared to county governments, these institutions face a myriad of challenges, which range from limited facilities and rapidly changing technologies to budgetary limitations and long procurement procedures as shown in figure 4.15.

Figure 4.15 Hardware and Software challenges facing National Institutions



The lesson for counties from the national level analysis is that, the determination of hardware and software needs should be based on the long term requirements of each county, and that counties have a multiplicity of options from which they can choose their hardware and software. More detailed studies are however proposed for the determination of basic, intermediate and advanced systems which would be workable for counties at different levels of development.

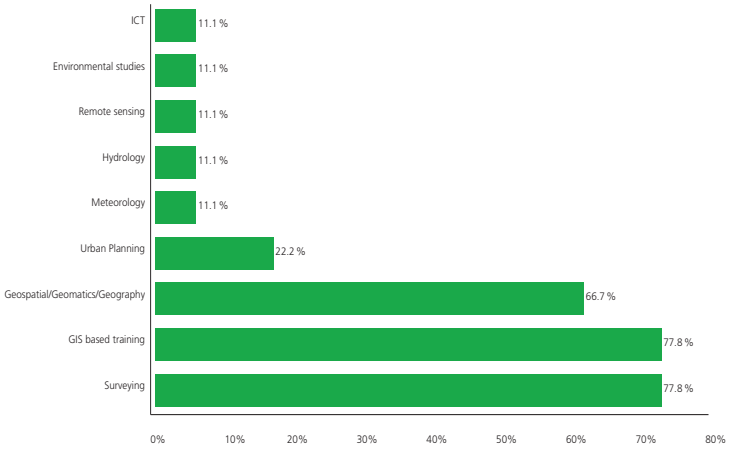
4.7.2 Human resource

National institution interviews targeted departments within the institutions dealing with GIS and related activities, as well as GIS support services such as ICT where server based systems were in use. The total number of staff in the core GIS departments varied widely, ranging from only three personnel in NEMA to 30 in RCMRD and 344 in the Survey of Kenya. The high number of staff in survey of Kenya was informed by the fact that, the institution had staff in all counties distributed in four main departments – cartography (121 staff), photogrammetry (31), land survey (140), geospatial (45) and hydrology (7). DRSRS had 12 staff while IEBC had 8 staff working on core GIS aspects. The recorded numbers were directly related to the intensity of GIS related activities within the institutions, with institutions which undertake high level GIS functionality having more staff than those whose core mandate is not GIS work.

The major training backgrounds for staff in the national institutions included GIS based training, surveying and Geospatial Engineering-related courses (figure 4.16).

While basic training found in the counties easily relates with what emerged from the national institutions, there is more specialization in the latter, implying maturity of the organizations on GIS related recruitment and capacity development. A major variation between the counties and national government institutions is the level of training achieved by their staff. Outside the learning institutions where attainment of high education levels is a requirement, the two institutions whose main mandate is GIS related services (RCMRD and DRSRS) have highly trained professionals. RCMRD has five staff who hold PhD's and 15 with Master's degrees, while DRSRS has 3 master's holders – all of which are GIS related specializations. A major challenge for DRSRS was retaining highly trained staff (e.g Ph.D. holders), who often move to other jobs after completing their training (which is sometimes attained through the institution's sponsorship). Interestingly, both institutions do not have any technical staff who only holds a certificate, although DRSRS has five diploma holders who work as technical officers. On the contrary, while the Survey of Kenya has two PhD holders, 70% (240) of its other staff hold diplomas and another 25% (85) are degree holders. This high number of diploma holders is related to the largely surveying field based activities that the institution handles. The broad implication of the national level human resource structure, and in turn the lesson for counties is that, hiring of staff should be based on the long term intensity

Figure 4.16 Professional backgrounds of national institutions GIS department staff



of activity, and should consider specialization (as informed by field and level of training) for attainment of functional GIS setups. Consideration should also be made for balancing of the professionals based on available resources, such as one which is lean on top (with highly qualified managers) and wider at the bottom (with more technical people who hold degrees and diplomas).

4.7.3 Data and data sharing

The assessed national institutions have a large data pool, which is both wide in scope (cuts across many sectors) and high resolution in nature (disaggregated into small units) than what was available within the counties. Just like in the counties, land use information was the most common form of data in the 12 national institutions (Table 4.6).

Unlike in the counties where majority of data was only available in hardcopy format (62.3 %) most of the data available in national institutions was in digital referenced map format (56%), and only 4% was in hard copy format.

Figure 4.17 Map data formats in national institutions

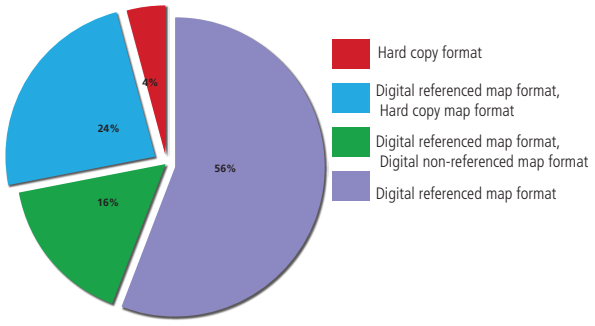
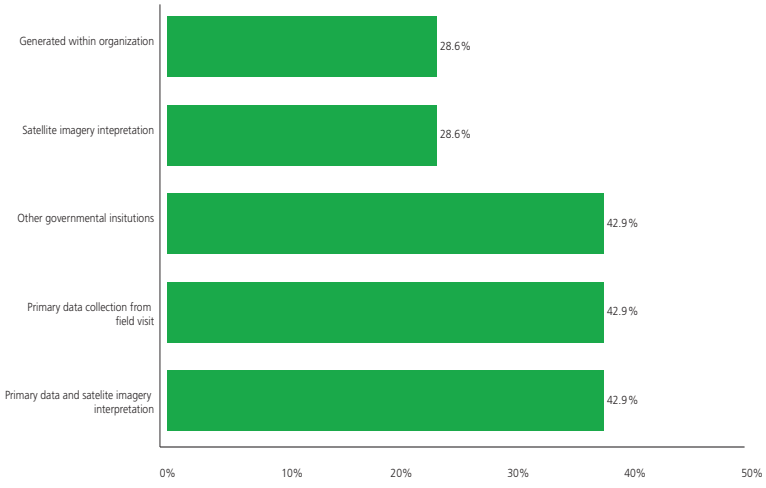


Table 4.6 Types of data available in national institutions

Main data Category	Description of data	% availability
Utility data	Power distribution networks	11.1%
Transport data	Street data (street layers, names, classification etc)	22.2%
Economic data	Location of urban centres/ markets	33.3%
	Major economic activities per area	22.2%
	Formal/ informal economic activities	11.1%
Land and land use data	Land parcel data (location, LR number, ownership info)	55.6%
	Land use information /Land cover data	77.8%
	Topography	22.2%
Environment related data	Location of environmental resources e.g. forests, swamps, wetlands etc	55.6%
	Climate change related data e.g. changing land cover patterns	22.2%
	Disaster prone areas	22.2%
	Disaster risk reduction and mitigation related data	11.1%

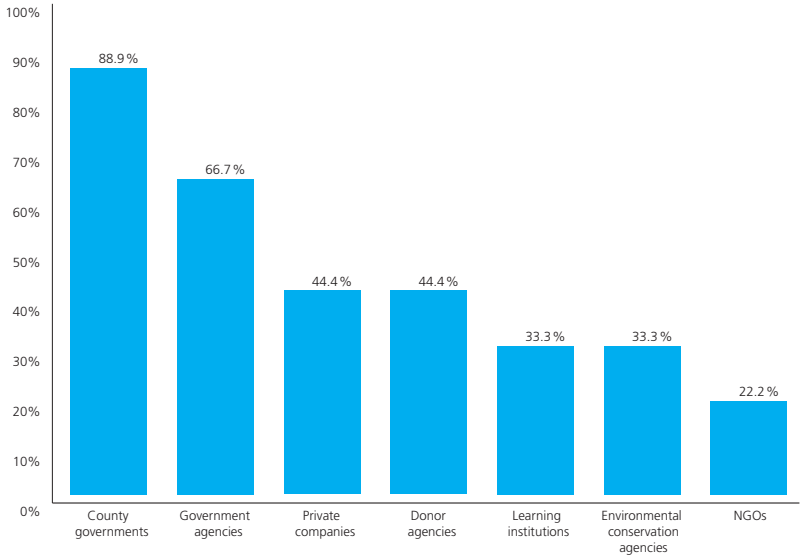
Majority of the data available at the 12 institutions has a scope of both national and county levels (64.7%), 17.6% is available only at the national level and a further 17.6% is available at only the county level. Majority of the data is acquired through primary data collection (both from field visits and through satellite image interpretation) and through compilation of data available in governmental institutions.

Figure 4.18 Sources of data available at national institutions



Just like the counties which depicted a high level of data sharing (80% sharing within departments and 86% with other external agencies), all interviewed national institutions share their data with other organizations. The main beneficiaries of data sharing from these institutions include county governments, government agencies, non-governmental organizations and private companies (Figure 4.19). While only half of the national institutions charge for the data (DRSRS, GeoMaps Africa, IEBC, ESRI-EA, RCMRD), most of the other institutions have costs associated with data which are paid by partner or donor organizations. This finding is in line with county level assessment, which identified that 23.1% of the counties were charged for data received from various institutions.

Figure 4.19 Organizations with which data is shared with



Unlike the county level analysis where there are limited or no restrictions to data sharing and/or re-sharing (only 30% of counties indicated that there were restrictions to usage/re-sharing of received data), 75% (9) of the national institutions which share GIS data impose restrictions, majority being conditions on the kind of data that can be shared and/or re-shared and provisions on acknowledging data sources. Some institution specific restrictions include;

- *"Sensitive data such as that from the department of defense cannot be shared "* – which applies to both the Ministry of Land (Dpt of Physical Planning) and DRSRS
- *"Data sources need to be acknowledged"* – which applies to data from DRSRS and NLC
- *"Data is copyrighted"* – which applies to the Survey of Kenya
- *"Shared data cannot be re-sold/ not for commercial use"* – which applies to data from NLC and ESRI - EA
- "Data sharing at the institution must be approved by director general or other relevant approving authority" – which applies to data from NEMA and GeoMaps Africa
- *"Data can only be viewed and not manipulated"* – which is applicable for data from the Kenya Power Company.

Only three institutions did not have restrictions to data sharing, IEBC, RCMRD and the University of Nairobi. For IEBC, the lack of restrictions could be related to the fact that the institution largely sells printed maps to organizations, and rarely share data in digital geo-referenced format. Non-restricted sharing of information by the University of Nairobi could be related to the fact that most data is both generated in collaboration with other partners who in turn receive it under common license, and that its generation and use is meant to enhance research and learning and can thus be used freely (with acknowledgement as other academic material). The Technical University of Kenya did not have any data of its own for sharing, but rather worked collaboratively with different institutions and counties to generate specific forms of information which was largely owned by the partner organizations.

The national institutions indicated that that the cost of data acquisition in Kenya was expensive (75%) as compared to only 16.6% who said it was cheap.

Interestingly, RCMRD, an organization that generates and

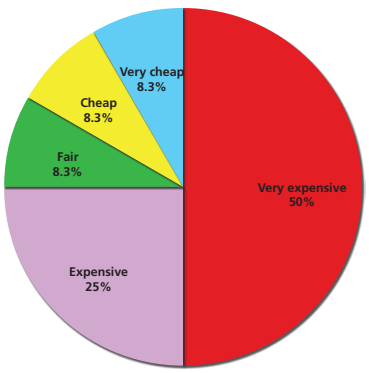


Figure 4.20 Perception on Cost of data in Kenya

sells data was the only institution to identify the cost of data in Kenya as cheap. While this observation was not shared by other data generating institutions like Survey of Kenya, DRSRS and ESRI (who identified costs as very expensive and expensive respectively), RCMRD could have been comparing the national costs to those of international benchmarks, particularly in other parts of Africa. GeoMaps Africa identified the cost as fair, something that could be justified by the fact that the organization generates and sells data at market rates using applicable business models. The two learning institutions (UoN, TUK), the department of physical planning and NLC indicated that the cost was very expensive, while NEMA and Kenya power noted that it was expensive. This ranking among the data users is in line with findings from the counties, which indicated the data costs as either expensive or very expensive. IEBC on the other hand indicated that the cost was cheap.

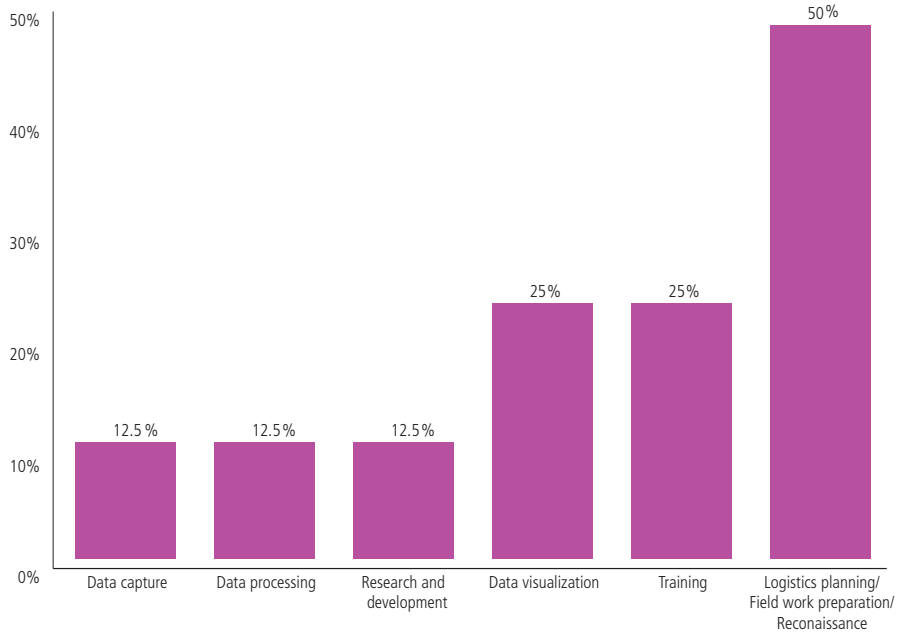
Generally, while the cost of data varies between the organizations, the key factors that influence cost include type of data (image versus shapefile), the spatial scope (physical expanse of data), the temporal scope (year of capture and single year versus time series data) as well as the data resolution (e.g high resolution imagery or shapefile data disaggregated into very small units). Table 4.7 summarizes some indicative costs for various kinds of data.

Table 4.7 Indicative data costs per institution

DRSRS	SoK	NEMA	UoN	IEBC	ESRI EA	Kenya Power Company	TUK
1 Sq Km of aerial photo @ Ksh. 15000; and Satellite image @ 20 USD/ SqKm	1 sq km of satellite imagery @ USD 28; cost per layer of vector data @ Ksh.3000	Kes. 500,000 for primary data collection in urban area	1 sq km of satellite imagery costs USD 25	Print version map size A0 and A1 image costs Ksh 2000; A2 and A3 image costs Ksh 1000; A4 image costs Ksh 500	1 sq km of old imagery at 0.5m resolution costs USD 10	Company pays average of Ksh 6000 to collect data for 1 km of network; To collect customer meter data costs Ksh 58	1 sq km of satellite imagery costs USD35; 1sq Km of aerial photo costs Ksh 10,000

Closely associated with the used forms of data and their costing is adoption and use of open source data platforms for various activities. 75% (9) National institutions use various open data platforms, particularly Google Earth (33.3%), Open Street Map (22.2%), Open Data Kenya (16.7%), Google Maps (11.1%), and ESRI City Engine and Landsat free data (5.6% each). Only the Survey of Kenya, NEMA and GeoMaps Africa were not using any of the identified platforms. Majority of these platforms are used for field work reconnaissance/ planning, training and data visualization.

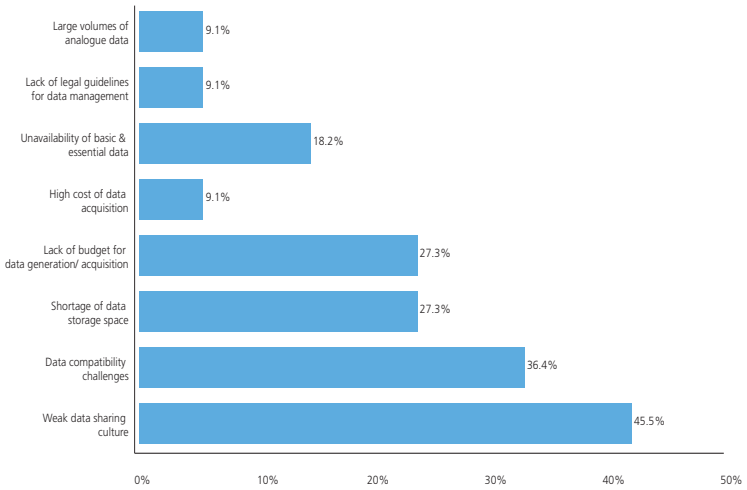
Figure 4.21 Major uses of open data platforms among national institutions



The challenges which national institutions face in terms of data are very closely related to those faced by the counties, particularly those on budgetary limitations and poor data sharing culture among agencies (Figure 4.22).

Poor sharing of data among institutions is specifically an issue of grave concern, particularly because the seamless flow of information within and between national organizations, and between these organizations and county governments is a key prerequisite for informed planning and development. This challenge, and the lack of clear guidelines on data generation and management at all levels in the country is what the KNSDI aimed to address. The collapse of the policy formulation process mid-way still leaves a lot to be desired, particularly in the era of devolution, when data sharing and standardization of collection procedures is crucial for regional development.

Figure 4.22 Challenges in data, data management and sharing in national institutions



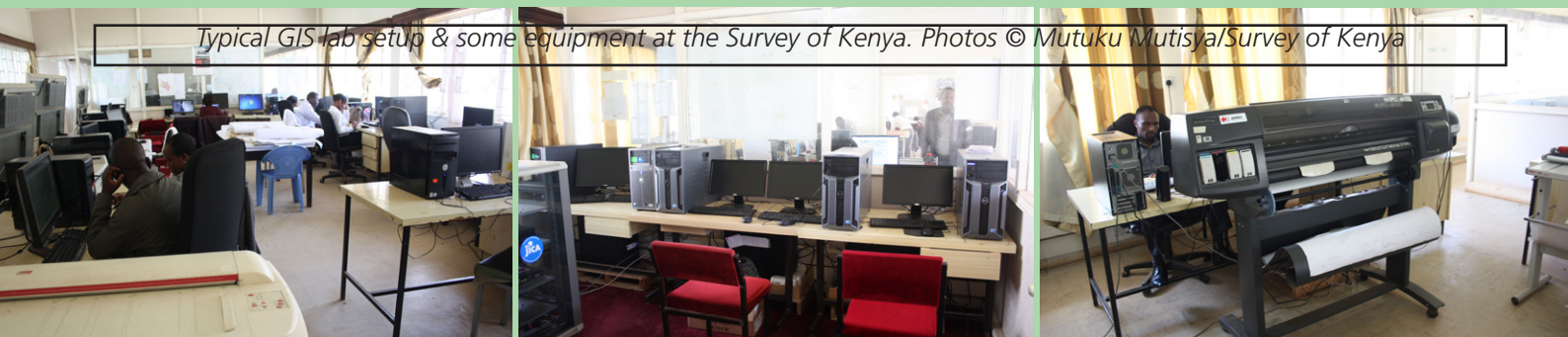
Box 4.4: Some findings from the Survey of Kenya

The Department of Surveys, commonly known as Survey of Kenya (SoK), is the official agency of the government of Kenya on all matters affecting land surveys and mapping. It has been in existence since 1903 and is one of the oldest Departments in the country. The department is responsible for national surveying and mapping. It is also the national focal point of GIS and Remote Sensing. As a pioneer institution in GIS and remote sensing, SoK has invested heavily on these as evidenced by the existence of a fully-pledged department of Geodetic and Geographical Information System (GIS).

SOK has been the primary reference of spatial data in Kenya and continues to be so for all cadastral records for fixed boundary survey. The institution has immense expertise in Survey, mapping and GIS and has partnered with county governments, international institutions and academia to advance the state of GIS use in Kenya. SoK is also the core pillar of the proposed Kenya National Spatial Data Infrastructure (KNSDI). SOK is one of the very-well equipped institutions in Human resources (>50 GIS experts), GIS and Remote sensing hardware/software with more than 300 Desktop PCs, about 10 plotters and more than 30 GPS units

SoK has recently partnered with Kiambu County for digitization of survey and parcel records within the County. It is a mutually-beneficial partnership in which SoK is providing overall quality assurance of data produced by GIS experts hired by the county government. The organization has also provided quality control services in the digitization and quality control of locally produced data in other counties, such as Nairobi, Mombasa, Isiolo and Kilifi.

SoK provides data to county governments, and the general public in both hardcopy and digital formats at a nominal fee which is dependent on the required dataset and scope. For instance, a digital GIS layer of roads features would cost about Ksh. 3,000 per layer. Under special circumstances this price can be considerably reduced, such as in cases where partnerships exist with county governments (e.g the case of Kiambu, Nairobi). In order to speed up data digitization and standardization, there is an urgent need to expand the partnership between the institution and all county governments, something that can be facilitated through the Council of Governors.



Typical GIS lab setUp & some equipment at the Survey of Kenya. Photos © Mutuku Mutisya/Survey of Kenya

4.7.4 Partnerships and work in counties

While only 14 of 30 visited counties had partnered with an institution that offers GIS services (including those which generate GIS usable data), all the 12 national institutions had partnered with at least one governmental agency, parastatal, learning institution, private company, county government, professional organization, inter-governmental agency or international agency. Table 4.8 summarises the major partnering organizations and the partnership aspects for the 12 national institutions.

Assessment session with executive and technical staff in Trans Nzoia County

Table 4.8 National institution partner organizations and partnership purpose

Governmental Agencies		**Parastatals**		**Learning institutions**		**Private companies**	
Name	Purpose	Name	Purpose	Name	purpose	Name	purpose
Kenya National Bureau of Statistics	Data capture, acquisition, collection	NEMA	Data capture, acquisition, collection	University of Nairobi	Data capture, acquisition, collection	Ramani	Data capture, acquisition, collection
Kenya Wildlife Service	Data sharing and integration	KWS	Data sharing and integration	JKUAT	Training and capacity building	GeoMaps	Training and capacity building
Kenya Forest Service	Research	WWF	Training and capacity building	DeKUT	Research	Laikipia Wildlife Forum	Professional support/ consultancy
Survey of Kenya	Boundary delimitation	KURA	Professional support/ consultancy	University of Pretoria; Technical university of Berlin; ETH Zurich	Land administration	Oakar Services	Land administration
KALRO*		CURI	Address system development	ITLS 4 LAND*	Develop planning guidelines/ plan making	Esri	Develop planning guidelines/ plan making
Office of the President	Resource mapping	KETRACO	Expansion of electricity networks	Technical University of Mombasa	Offer internship	CoreTec	Software licensing and management
Ministry of Environment		Nairobi Metropolitan	Resource mapping			Habitat Planners	
		Rural Electrification Authority					

Table 4.8 National institution partner organizations and partnership purpose

County governments		**Professional bodies**		**International organizations**	
Name	Purpose	Name	Purpose	Name	Purpose
Mombasa	Data capture, acquisition, collection	SIDA	Data capture, acquisition, collection	ILRI	Land administration
Kwale	Training and capacity building	Institute of Surveyors of Kenya	Research	Eastern Africa Land Administration Network (ELAN)	
Marsabit	Develop planning guidelines/ plan making	Kenya Institute of Planners	Professional support/ consultancy		
Nyeri, Murang'a, Uasin Gishu, Bungoma, Kisumu, Nyamira		EIK	Develop planning guidelines/ plan making		
Council of Governors		FIG	Environmental conservation		
			Regulation of professional bodies/experts		

Other than KPLC and the IEBC, all the other national institutions are undertaking GIS related and/or support work in counties. IEBC however has direct dealings with counties, in which it sells GIS data and maps to them. Only the Survey of Kenya, NLC, NEMA, IEBC and Kenya Power Company have county based offices. Besides Survey of Kenya which works in all the 47 counties, there are a total of 17 counties in which the other 11 institutions are undertaking or supporting GIS and planning related work, with the counties of Murang'a, Uasin Gishu and Kisumu having the highest number of national institutions supporting their activities or undertaking work within their jurisdictions (4 institutions per county), followed by Nairobi county (3 institutions).

Table 4.9 Existing partnerships between national institutions and county governments

	Dpt. of Physical Planning	**DRSRS**	**NLC**	**NEMA**	**GeoMaps Africa**	**ESRI - EA**	**RCMRD**	**TUK**
Kwale	x	x						
Makueni						x		
Nyeri			x					
Kirinyaga								x
Murang'a			x		x		x	
Kiambu						x		
Turkana					x			
Uasin Gishu	x			x		x		
Nakuru					x			
Narok	x							
Kajiado					x			
Bomet	x							
Kakamega						x		
Bungoma	x							
Kisumu				x		x		x
Nyamira				x				
Nairobi					x	x		
The survey of Kenya undertakes work in all 47 counties where it is involved in the creation of geospatial basemaps								

The major services offered by the national institutions to counties include creation of geospatial basemaps, capacity development (trainings), management of data for revenue collection, resource mapping/ participatory mapping, spatial plan development and supply of data/ maps as summarized in table 4.10.

Table 4.10 Major GIS support activities national institutions offer county governments

Kind of support offered	Dpt of Physical Planning	DRSRS	SoK	NLC	NEMA	GeoMaps Africa	UoN	IEBC	ESRI EA	RCMRD	TUK
Creation of geospatial basemaps			x								
Quality control services (eg. data standards, calibration of survey equipment)			x								
Parcel Data Management/ Development of LIMS									x		
Supervise GIS related activities	x										
System integration									x		
Manage data for revenue collection		x							x		
Aerial photography		x									
Land cover classification		x									
Offer equipment support				x							
Resource mapping/ participatory mapping				x					x		
Spatial plan development					x	x					
Draft policy documents					x						
Offer Trainings				x			x			x	
Sell data/Maps to counties								x		x	
Spatial data acquisition											x

The major challenges faced by national institutions in the management of partnerships include individualization of projects by partners (where partners prioritize their personal projects at the expense of collaborative ones), and lack of follow up on GIS related trainings (table 4.11).

Table 4.11 Challenges faced by national institutions in managing partnerships

Challenge	% institutions facing challenge
Insufficient funding for joint activities	20.0%
Bureaucracy	20.0%
Data sharing complications	20.0%
Difficulties sustaining partnerships/ partners not honouring terms of engagements	20.0%
Licensing delays	20.0%
Format incompatibility of data from partners	20.0%
Delayed payment by county governments	20.0%
Individualization of project/ partners prioritize their own projects	40.0%
Lack of follow up by partners after training	40.0%

Despite the many activities the interviewed national institutions are undertaking at the international, national, and county/local levels, they are not focused on developing geospatial policy as a way of setting an enabling environment for their operations. Only two institutions, Ministry of Land (department of Physical Planning) and DRSRS have been contributing to the development of geospatial policies in Kenya. This has largely been through such activities as providing support/advise in the development of the NLC's data standards and the national land information management system, land use management; participation in technical committees for KNSDI; contributing to the development of the Kenya National Air Service Agency; assisting counties in formulating their County Integrated Development Plans; and using data to advise on workable and sustainable development policies.

8.7.5 Lessons for counties from National level analysis

Each of the 11 national institutions were requested to provide advice to counties as they work towards developing their GIS setups. The provided advice was based on each institution's experience in designing, developing, operationalizing and updating/upgrading their GIS structures, and was grouped into the four evaluation aspects of hardware, software, staffing (human resource) and data. Table 4.23 summarizes the key emerging lessons for counties.

Table 4.12 Key lessons for counties on the development of GIS setups

Lessons on Hardware	Lessons on Software
-Adopt incremental acquisition of appropriate hardware -Procure high performance computers, plotters, and scanners -Procure GIS support equipment especially GPS units -Network computers (particularly to LAN and Wireless networks) -consider procurement of server and/or cloud storage	- Consider use of open-source software where the cost of commercial is prohibitive -Start with few licenses for commercial GIS software -Use licensed software for enhanced functionality e.g ESRI software -Partner with universities for support -Embrace the Use web-based GIS -Acquire remote sensing software only when and if necessary
Lessons on Staffing	**Lessons on Data**
-Hire GIS savvy Planners and surveyors -Hire experienced GIS managers -Hire qualified staff -Hire staff with appropriate professional backgrounds -Allocate sufficient budget for staffing -Clearly delineate the roles of each staff in GIS development -define and implement management structure as Manager (top); Mid-level staff (with Msc, and Bsc); and technical staff (with Diplomas)) -Train GIS personnel continuously	-Use open data platform and explore existing data options before venturing in new data generation; then generate your own data based on relevance -Create partnership with organization offering good quality data e.g. RCMRD -Develop data standards based on county needs -Embrace data sharing and/or to avoid duplicating efforts; use web services for data exchange/sharing -Train staff on data handling -Start small in data storage and management -Acquire good quality resolution imagery -Embrace research -Digitize and convert social and economic data into GISs

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

The general findings from the assessment reflect critical GIS needs across the four aspects of hardware, software, human resource and data in the counties, which have to be addressed if counties are going to enjoy the benefits of GIS informed spatial planning. With the appreciation of ongoing efforts to set up GIS labs, and by acknowledging the limitations facing them, we propose the following actions which should be implemented simultaneously;

5.1 Investment in GIS structures in Counties must focus on all four components of a GIS

A general finding from the evaluation in counties was that there is a trend to allocate resources for hardware acquisition which is not accompanied by a similar effort to acquire software, or to hire GIS professionals or build the capacity of their staff at the least. While the former results in dysfunctional GIS setups, the latter has greatly limited counties' capacity to effectively develop terms of references for various GIS related consultancies, as well as to effectively oversee the kinds of output produced by the consultants, effectively translating into gaps in the final product. The development of GIS labs by counties should consider investment in all four components of a GIS, as opposed to only the physical attributes.

On investment in software, counties should consider a mix of both commercial and open source software depending on the intensity of GIS use, and the desired functionalities. Investment in human capacity should not only be limited to training of existing staff with basic or advanced knowledge on GIS, but also recruiting fully fledged GIS professionals with analytical knowledge of complex phenomena such as disaster risk management and climate change.

5.2 Counties must allocate resources to hire and/ or train GIS professionals

A major impediment to operational structures in counties is lack of qualified personnel who can spearhead GIS work. This is partly a result of budgetary limitations to both recruit and hire such professionals. If counties are to achieve workable structures, they must allocate adequate financial resources to both hire qualified GIS staff, and facilitate their continuous capacity development in line with county needs and global trends.

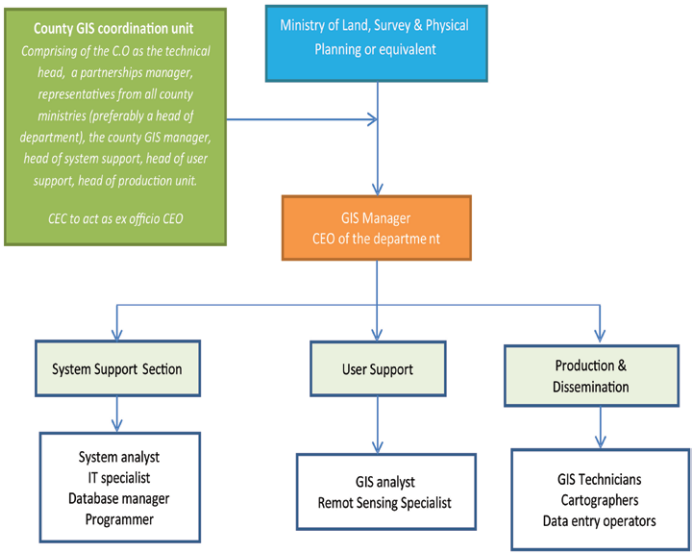
5.3 There is need to establish a system through which national institutions can collaborate with counties for data standardization and sharing, and knowledge transfer

A major observation from the assessment was that there is a lot of data and knowledge that exists at the national institutions, and which is not readily available to counties. Equally, there is a general lack of standards on data collection and dissemination, which makes a lot of the available data incompatible. Since survey of Kenya is the custodian of a lot of spatial data in the country, and given that most of the interviewed institutions (and many more others) are constantly generating spatial data, there is an urgent need for the Council of Governors as the representative of counties to engage these institution(s) to facilitate both data standardization and sharing with the counties. This would effectively promote data availability in the counties, and in turn ease spatial planning activities, and ensure informed decision making on all matters of (spatial) development.

5.4 Capacity building is the key to successful adoption of GIS in the counties

As discussed throughout this report, the challenge of building capacity of county executives to appreciate GIS and its role in enhancing long term growth and its monitoring needs urgent attention. The Council of Governors should thus prioritize this issue, and develop various capacity building programmes, some targeting Members of County Assemblies (MCAs) and others targeting technical staff in the counties. Further, intensive short courses should be developed between the academia, local and regional institutions and the counties through the council of governors should be developed and implemented in all counties. This will fill gaps in awareness, basic capacity on data capture, management and manipulation as well as basic reporting based on GIS data. It is also recommended for expansion of long term strategic investments on higher education (GIS) by the academia and continuous training at the counties.

Figure 22 Proposed GIS setup structure for counties



5.5 GIS Guidelines and a GIS centre at the Council of Governors are needed

The lack of operational guidelines which would standardize GIS data generation and sharing is also a major challenge at both the county and national levels. While attempts to attain operational guidelines were made through the national KNSDI policy, whose formulation collapsed midway, the Council of Governors needs to either lobby for the continuation of the policy formulation process, or commence its own efforts to standardize county data structure. An option that could help achieve data standards at the counties, while also leveraging the sharing of data from the data-rich national institutions is creation of a GIS centre at the council. The centre would act as a one stop centre for all GIS needs for counties, wherein they would get advise on basic properties of GIS system requirements, acquire software at a discounted rate through the centre partnerships, and also be able to explore existing datasets collated at the centre servers before commencing new data collection activities. The centre would also provide guidelines on charges associated with various GIS services, as well as keep a database of reliable consultants on related activities. This would ideally solve the prevailing county challenges in access to data, and reduce the high costs associated with its acquisition.

5.6 Provision of generic GIS lab structure guideline is urgent

The lack of an overarching structure under which counties can develop their GIS labs is a key concern as observed in the county level analysis. This, combined with technical limitations on what is required for different operational aspects among county staff has largely resulted in the reliance of consultants working on the county spatial plans to develop their own terms of reference, particularly on which GIS infrastructure to deliver. This also includes generation of data which only the consultants can update since capacity building activities are rammed into a few days. This approach is completely unsustainable and needs to be checked. The proposed alternative to this is for counties to delegate some of their technical staff to work with the consultants throughout the process, and learn the necessary skills first hand. This proposal appreciates major limitations in county staffing, which would make it impossible to delegate core staff to work for which they have paid to be done. In counties with high levels of understaffing, a counter-proposal is the inclusion of a requirement for continuous capacity building for staff in consultancies, particularly those which engage the staff in actual/practical activities as opposed to the prevailing classroom approach to capacity building.

On the aspect of a GIS lab setup guidelines, we propose the following structure, which borrows from the GIS setups in national institutions , and that is based on the existing county governance systems which largely domicile GIS matters to the ministry in charge of lands, surveying and physical planning.

On the issue of staffing, it is recommended that hiring of GIS staff at the counties should be based on the long term intensity of activities, and should consider specialization (as informed by field and level of training) for attainment of functional GIS setups. Consideration should also be made for balancing of the professionals based on available resources, such as one which is lean on top (with highly qualified managers) and wider at the bottom (with more technical people who hold degrees and diplomas).

Whereas this report gives some indications of basic hardware which counties require based on their needs, we propose that more detailed studies be undertaken to determine the basic, intermediate and advanced systems which would be most

workable for counties at different levels of development.

5.7 Pervasive partnerships are key to success

One major opportunity that counties face today is that of partnerships, which have proven to significantly reduce the costs of GIS related services and also to boost the capacity of county staff to perform GIS related activities. Recent expansion of training institutions (eg universities) to counties offers a unique opportunity for mutually beneficial partnerships, where for example the counties can offer internship opportunities while the universities can undertake practical training within the counties (e.g planning studios) through which they can collect policy and development relevant data.

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ANNEXES

ANNEXES

Annex 1: Basic County profiles

County	Stage in GIS development	Has any staff from department attended a government sponsored training?	Has the county partnered in GIS activities with any organization?
Mombasa	Initial stages of development	x	x
Kwale	Lab has been set up	x	x
Kilifi	Advanced stage of development (level 3)	x	x
Lamu	Advanced stage of development (level 1)	x	x
Garissa	Being considered		
Isiolo	Initial stages of development		x
Meru	Initial stages of development	x	x
Tharaka-Nithi	Being considered		
Embu	Being considered	x	x
Kitui	Initial stages of development	x	
Makueni	Initial stages of development	x	
Nyeri	Being considered		
Kirinyaga	Being considered		x
Kiambu	Advanced stage of development (level 2)	x	x
Turkana	Advanced stage of development (level 1)	x	x
Trans -NZoia	Not present and not being considered		
Uasin Gishu	Initial stages of development		
Elgeyo Marakwet	Not present and not being considered		
Nandi	Being considered		
Nakuru	Advanced stage of development (level 3)	x	x
Narok	Lab has been set up	x	x
Kajiado	Being considered		
Kericho	Initial stages of development	x	x
Kakamega	Being considered		
Busia	Not present and not being considered		
Siaya	Lab has been set up	x	
Kisumu	Lab has been set up	x	x
Migori	Being considered		
Kisii	Being considered		
Nyamira	Being considered		

Annex 2: Major Hardware in Counties

County	Dedicated GIS computers (including recent purchases)	GPS units/ mobile mappers	Server & server switch	Plotter (for large maps)	Other equipment
Kwale	5 laptops; 1 desktop Laptops – Core i7, 1TB Storage, 16 GB RAM	4 handheld; 1 RTK	1 server still at DRSRS (to be deployed to county)	1 (Sakano 825)	1 A4 printer, HP; 1 A0 large format scanner & copier
Kilifi	1 desktop; 1 laptop core i3, 4GB RAM, 500 GB storage (1 computer was stolen together with server software)	5 Garmin GPS Map 62	1 server & switch (server software was stolen)	1 Canon image PROGRAF iPF785	
Lamu	2 Desktop computers core i5, 4GB RAM , 500GB storage (donated by WWF in 2016 but not yet set up due to lack of space)	2 mobile mapper 20 spectra precision	1 server and 1 server switch (donated by WWF butnot yet set up)	1 HP Design Jet T790 (not yet set up)	
Garissa		5 Garmin,	1 hp	1 hp T1100ps	Ammonia Machine
Isiolo		1 Garmin	1 server - HP		4 A4 HP printers
Meru		10 Garmin-	1 server HP	1	5 A4 HP printers
Tharaka-Nithi		4 Garmin Etrex	1 HP		5 normal printers (A4 paper size) – 3 Hp, 2 Samsung
Kitui		10 Garmin	1 server (not working due to connection problem)	1 HP 530	2 A4 printers HP 1 trimmer 1 scanner Contex
Makueni		6 Garmin	1 Server HPG9, G8, 3G9	2 (1RicohFW770; 1 Epson T5000)	1 A4 HP lasterjet pro printer; 1 Trimfast Trimmer
Nyeri				2 HP DesignJet T3100 PostScript printers; 1 large format scanner HP Design Jet SD pro 1 AO Ricoh FW 780 (delivered to county 3 years ago from Survey of Kenya – not working because it has no catridge)	Die line printers – 1 Super Diazo 3 NeoLT, 2 Techno Diazo 3 (all from Survey of Kenya) (used by survey department to scan maps which they then digitize in AutoCAD) (the printers & scanner were supplied by Oaker services in May 2017 & purchase was supported by NLC)
Kiambu	2 hp pro i3 – 3500 Series MT,			2 HP T2500	
Turkana	4 laptops (core i3, 64 bit, 4GB RAM, 500GB); 5 desktops (core i3, 64 bit, 4GB RAM, 500gb)	6 Garmin	1 (not fully set up)	1 hp	RTK 2pcs, Rentax
Nandi	1 old computer				1 Total Station- Leica; 1 A4 HP LaserJet colour printer; GPS receivers

County	Dedicated GIS computers (including recent purchases)	GPS units/ mobile mappers	Server & server switch	Plotter (for large maps)	Other equipment
Uasin Gishu		1		1 HP Designjet T2500 (purchased in 2016 but has not yet been set up) 1 A0 colour plotter Ricoh FW780 (purchased in 2013 but does not work due to lack of replacement catridge/ink)	NeoLT Die line printers (2); A0 paper trimmer
Nakuru	6 desktops Dell core i5, , 8GB RAM, 1TB storage; 3 LAPTOPS LENOVO CORE i5, , 6 GB RAM, 500GB storage.	4 TRIMBLE 3D	1 server ; 1 Server switch (not yet set up)	1 NeoLT (old model, not working)	1 large format scanner Contex SD 4430 (bought in 2009 but not working due to lack of software) 1 Die Line printer - Superdiaz03 neolt Italy
Narok	3 HP pro Desk 400 G2MT Core i5; 4 GB RAM, 500 GB storage (donated by WWF)	1	1 server, 1 server switch (donated by WWF in 2017 but not working due to lack of software)	1	3 Uninterrupted power supply (UPS) for computers; 4 batteries acting as backup power for server
Kakamega	7 desktops : 3 Dell core I7, 4 GB, 500GB; 2 HP dual core, 1GB, 500GB; 2 HP 512 MB, 500GB. 3 Laptops: core i7, 8GB, 1TB	5 handheld, Garmin	1- To be procured		1 A4 printer, HP
Siaya	5 desktops: core i7, 8GB RAM, 500 GB. 2014 6 Laptops: core i7, 8 GB, 1 TB.	18 handheld	1	1	20 Samsung J7 phones for mapping/ data collection for CSP
Kisumu	3 Desktops, core i7, 8GB, 1TB	2 trimble	1 blade hp server	1 A0 HP plotter	1 A4 HP printer
Nyamira		6 Garmin	1 HP G9,G8,	2:Ricoh FW 770; EPSON T 5000	1 Trimmer
Counties without dedicated GIS hardware: Busia, Embu, Mombasa (procurement ongoing), Kirinyaga, Migori, Kisii, Trans –Nzoia, Elgeyo Marakwet, Kajiado*, Kericho,					

Annex 3: Major Softwares in Counties

County	Software Name (incl DBMS software)	VERSION	LICENSE(Open source/paid subscription)	Installed date/year	Expiry date	Operating system in computer
Kwale	ArcGIS; Arcpad	Advanced(1)	Pre-installed			Windows
Kilifi	ArcGIS	10.2	Network based but not working since server software was stolen			Windows
Lamu	ArcGIS	10.4	Four user license(lifetime license)	not yet installed since computers have not been set up		Windows 7
Kiambu	ArcGIS	10.3	10 user license (only two licenses are being used)	2014	Annual license renewal	Windows 7
Makueni,	ArcGIS	10.2	3 user licenses installed on personal computers due to lack of dedicated GIS computers	2014		Windows 7
Turkana	ArcGIS AutoCAD Global Mapper	-- 10.3 2016	-- From RCMRD From RCMRD	2013 -- --		Windows
Nakuru	Arcpad (for GPS units) ArcView (old model supplied through collaboration with UN-Habitat with lifetime license)	10.3		2016	lifetime	windows
Narok	ArcGIS	10.4.1	Paid lifetime License (extensions require annual renewal)	2017 feb	Extensions expiring in April 2017	Windows7
Kakamega	ArcGIS QGIS CAD (Aoutocad, topocad, land developer)	10.2 2007		2011 2014 2011		Windows 10,7,8
Siaya	ArcGIS QGIS Google earth	10.1	Network based license (ArcGIS)	2014 2013	2015(yet to be renewed)	Windows 7
Kisumu	ArcGIS	10.3	Paid	2017	2018	Windows 10
Nyamira	ArcGIS	10.2	3 user license paid	2014		Windows7
Nyeri	No dedicated computers but the survey department is digitizing maps in AutoCAD					
Counties without software: Garissa, Isiolo, Meru, Tharaka-Nithi, Embu, Kitui, Kirinyaga, Mombasa ,, Busia, Migori, Kisii, Kajiado*, Kericho, Trans –Nzoia, Uasin Gishu, Elgeyo Marakwet, Nandi						

Annex 4 Most common GIS software among national institutions

	Dpt of Physical Planning	DRSRS	Survey of Kenya	NLC	NEMA	GeoMaps Africa	UoN	IEBC	ESRI - EA	Kenya Power Company	RCMRD	TUK
ArcMap/ ArcGIS	x	x	x	x	x	x	x	x	x		x	x
Erdas Imagine	x			x			x				x	x
ArcInfo		x										
Geo Office		x										
Global Mapper		x				x				x		
QGIS		x		x			x				x	x
GeoMapper						x						
GeoMedia							x					
ENVI									x		x	
FDB (Made for KPLC)										x		
IDRIS Kilimanjaro												x
ArcView 3.2												x
Curtalinx												x

Annex 5: Key Informant Interview Schedule

COUNCIL OF GOVERNORS

GIS Needs Assessment Survey

A1. Key informant Questionnaire

The Council of Governors in conducting a GIS needs assessment on the status of GIS use at both the National and County Levels. This is being done by profiling the existing policy, GIS infrastructure (hardware, software and data) and human resources to utilize emerging GIS technologies for enhanced analysis and understanding of key developmental issues. The information provided in this interview guide will form the framework for intervention by the Council and its partners on issues related to adoption of GIS technologies for enhanced spatial planning at the national and county levels.

County …….. Name of ministry/ department ……..

Respondent name …… Position in department ……..

Basic Department Profile

Primary responsibilities of department or ministry?

Spatial planning	Land allotment/ sub-division/ registration/ management	Environmental monitoring & management	Research
Development control	Infrastructure development/ monitoring/ maintenance	Housing	Disaster risk management

How many people are employed in your ministry and department? …….

GIS Availability & Use

1. Does your organization currently use GIS for some of its work? a)Yes b) No (if no, skip to question 7)
2. When did your department start using GIS? ……..
3. Which GIS related activities does the department undertake? A) Create data using applications b) analyse data c) maintain and edit data d) presenting data in various formats e) Modelling situations f) others …….
4. On which programmatic areas does the department use GIS? a) Planning b) Development control c) Land management d) Infrastructure monitoring e) Other …….
5. Do you have a section dedicated to GIS activities? a)Yes b) No
6. How is GIS currently staffed in your department?

No. of full time staff	No. of part time staff	No. of interns/ students	No. of contractors/ service provider	No. of IT staff

7. Whether your department uses or does not use GIS, what stage of implementation is GIS in your department? a) Not present and not being considered b) Being Considered c) Initial Stages of Development d) Few Users & Applications e) Extensive Use f) Few Users g) Extensive Use h) Many users

Impacts of GIS in County Operations

8. Do you think that GIS could positively contribute to the work of your organization? a)Yes b) No
9. If you were to get a GIS department, which are the two most important components you would want provided

a) Hardware (computers, GPS devices etc) b) Software c) Capacity development for staff d) GIS data e) Others ……

10. If you were to create a GIS department, on which activities would your department utilize GIS technologies?

GIS Data Availability, Sharing & Data Needs

11. Please list any maps commonly used by your department and indicate if they are in digital or hardcopy format

Description (land use maps, parcel data, topo maps)	Hardcopy	Digital non-referenced	Digital GIS format

12. Please indicate any non-map information commonly used in your department that includes a reference to a geographic location (eg development approvals by location with physical location description)

Description of information (e.g, list of approved developments by location)	Digital	Hardcopy

13. Does your department share any of this data with other organizations? a) Yes b) No c) Unknown (if no go to question 16)

14. If yes, does your department/division charge for this data? a) Yes b) Sometimes c) No d) unknown

15. Are there restrictions to usage of the shared data? a) Yes b) Sometimes c) No d) unknown

16. Does your department receive GIS data from other organizations? a) Yes b) No c) Unknown (if no go to question 20)

17. If yes, is your department/division charged for this data? a) Yes b) Sometimes c) No d) unknown

18. Are there restrictions to usage of the received data? a) Yes b) Sometimes c) No d) unknown

19. How frequently does your department exchange GIS data? a) Hourly b)Daily c) weekly d) annually e) as needed/periodically f) never

20. Does your department have a web site? a) Yes b) No

21. Does your department provide any forms of maps on the website? a) Yes b) No

22. Does your department/division use aerial photography in its GIS? a)Yes b) No (if no go to question 25)

23. If Yes, what resolution of aerial photography do you use? (define all resolutions that apply) ……

24. Where does your organization get the imagery from? a) Purchase from …… b) Google Earth c) Donations by organization …….. d) Free Landsat imagery …… e) other ……..

GIS Data Needs

25. In addition the various maps you have in your department, which kinds of data do you need to ease your operations (pick/identify the 5 most urgent data needs)

Spatially disaggregated Demographic data	Population per sub-location	Gender	Age-sex distribution			
Utility data	Water distribution	Sanitation facilities	Power distribution	Mobile phone coverage		
Transportation data	Distribution of transport networks	Street addresses				
Economic Data	Location of markets	Major towns & urban centres				
Land & land use	Land Parcel data	Zoning data	Land use distribution	Land cover	topography	Settlement patterns
Other						

Contracting External Entities to undertake GIS Work

26. Has your department/division ever contracted out any GIS work to outside entities (to non-county staff including companies & individual contractors to undertake specific tasks)? a)Yes b) No

27. If yes, for which aspects did/do you engage contractors? a) generating basic layers b) Acquiring imagery c) Interpreting imagery d) editing/manipulating data e) creating maps for reports f) Undertaking spatial analysis and writing reports on related interpretations g) others …….

28. Which was the nature of the contracted entities a) Public Entities (eg universities) b) Private companies c) Individuals d) All

29. Kindly list all the public entities and private companies that your department has ever contracted to undertake GIS work ……

30. Kindly list the specific expertise that contracted individuals had/have (eg urban planning, image extraction & analysis etc) ……..

31. In your view, how would you rate the cost incurred from such contracting, if any a) very high b) high c) Fair d) cheap e) very cheap

Budget allocations for GIS Activities

32. Over the past 5 years, did the county government allocate any resources that were used for the development of GIS aspects? a)Yes b) No

33. Over the past year, how much money from the departmental/county budget was dedicated to GIS related activities (including for hiring personnel, hardware, software, GIS services outsourcing) ……..

34. What proportion of this budget was spend on various components over the last year (% or actual no.)

35. Of this budget, what proportion was used to pay for outsourced services (including hiring of external entities to perform duties, purchasing data etc) …….

Hardware	software	Human resource development	Data acquisition

County Human Resource Development

36. Has your department/ county organized or facilitated any GIS training for its staff? a)Yes b) No

37. Has any member of the GIS team/department attended any training with support from the county government? a)Yes b) No

38. Has the county partnered with any GIS organization for any activity? a)Yes b) No

39. If yes, which organization and what was the aim of the partnership .....

40. Would your department/ministry/county be willing to support an inter-county GIS training in any of the following ways? a) hosting training b) Facilitating staff to attend c) exhibiting in event d) making presentations e) volunteering trainers f) financial sponsorship g) other

41. Is there interest within your department/ministry to build or enhance GIS capacity in its employees in the future? a)Yes b) No

Future GIS Desires

42. Whether you are using or not using GIS currently, which GIS technologies and activities would you be interested to adopt in the future? a) Mobile technology b) web technology c) big data d) automated data collection and inventory e) advanced training for staff f) other ……..

Challenges in Implementation of GIS

43. What have been your major challenges to using GIS technologies in your department …….

44. What have been your major challenges in your department when creating a GIS lab in your department?

Annex 6: Professional Interview Schedule

COUNCIL OF GOVERNORS

GIS Needs Assessment Survey

A2. GIS Professional Interview Schedule

County …….. Name of ministry/ department ……..

Respondent name …… Job Title ……..

Academic Qualifications ……

1. Kindly describe the activities you undertake on a day to day basis …….
2. How long have you been a GIS professional? ……..
3. Have you always worked in this department? a) Yes b) No
4. If no, where did you transfer from? . ……..
5. Which GIS soft wares are you comfortable with (list softwares and level of competence – professional, basic, etc)

Software Name	Can use with difficulty	Basic competence – can use to view data	Confident– can use to edit and present data	Competent – can use to create, edit, present data	Professional – can use to create, edit, present data and to do modelling

6. Which datasets do you use on a day to day basis (frequently)

Dataset (eg land parcels, roads, etc)	Main use

7. Which open GIS data platforms are you familiar with (eg opendata.co.ke, google earth, landsat imagery, openstreetmap, boundaries maps etc) ……

8. Which of these platforms have you used in the past and for what purpose

Name of open data platform	Main use

9. What datasets would you like to have (rank them per importance)

Dataset (eg land parcels, roads, etc)	1 - important	2 – Very important	3 – Extremely Important

10. have you undertaken on-the-job training courses (seminars, online courses etc)? a) Yes b) No
11. If Yes, kindly list courses you have taken, what they entailed and their relevance to your work

Name course	Summary & relevance to your work

12. Have you worked with other members of county departments on GIS related assignments? a) Yes b) No
13. If yes, describe the collaborating departments and the nature of assignments

Department	Purpose of collaboration

14. Have you worked with external contractors on GIS related projects for the county? a) Yes b) No
15. If yes, describe the consultant types and names, the assignments you worked on, and impacts on your department operation

Name of contractor (for companies and public entities, include name; for individual consultant indicate individual)	Assignment undertaken eg data generation for CIDP	Impacts for your department & lessons learnt eg capacity building for staff

16. What are the major challenges you face in performing your duties …….
17. What are the opportunities for enhancing GIS usability in your department
18. Any extra comments on GIS related issues?

Annex 7: Hardware Checklist

COUNCIL OF GOVERNORS

GIS Needs Assessment Survey

A3. Hardware Checklist

1. Your organization may or may not have an established GIS department/office. However, does your organization have any of the following supplies or hardware? (if yes, how many)

	How Many pieces	Models, Yom (for all items other than GIS computers)	Are the hardware supplies currently working/in use? (1 Yes 2 No)	If not in use, why? (1 No Power connection 2 Broken down 3 they have not yet been set up 4 inherited from a previous office/ administration in non-working condition)
Dedicated GIS computers (including recent purchases)				
GPS units				
Normal Printer (indicate paper max paper size it can print)				
Replacement ink for printer				
Server Computer				
Plotter (for large maps)				
Plotter replacement ink				
Rolls of paper for plotter				
Mobile mapper				
Other equipment (include GIS compatible equipment – incorporating compatible surveying hardware)				

2. Kindly provide the following technical information on the dedicated GIS computers

Computer No.	Computer properties (RAM, storage space,)	Year Purchased	Connected to network? Which kind of network (LAN, wireless)	Additional processing hardware (eg media card)

Annex 8: Software Checklist

COUNCIL OF GOVERNORS
GIS Needs Assessment Survey
A4. Software Checklist

1. How is your department/division networked? A) Not Networked, b) Local Area Network, c) Wide Area Network, d) Wireless, e) others …..
2. How is your department/division connected to the Internet? A) Not connected b) broadband cable c) wireless network d) dial-up connection e) ….
3. Kindly provide the following information for the computers you are using to implement GIS duties

Computer No.	Software Name (include multiple softwares per machine – i.e GIS software, database management systems eg MS Access)	Version	License (open source/paid subscription)	Installed date/year	Expiry Date	Operating System in computer

Annex 9: Key informant Questionnaire - Institutions

COUNCIL OF GOVERNORS

GIS Needs Assessment Survey

Key informant Questionnaire - Institutions

The Council of Governors in conducting a GIS needs assessment on the status of GIS use at both the National and County Levels. This is being done by profiling the existing policy, GIS infrastructure (hardware, software and data) and human resources to utilize emerging GIS technologies for enhanced analysis and understanding of key developmental issues. The information provided in this interview guide will form the framework for intervention by the Council and its partners on issues related to adoption of GIS technologies for enhanced spatial planning at the national and county levels.

Name of Institution/Agency ……

Type of Institution/Agency (Government, Parastatal, Private, NGO) ……..

Organization operational scope (National collective, national disaggregated into sub-regions, urban areas only, counties)

Main activities undertaken by institution ……

Data

1. Which are the main GIS related activities organization is involved with? 1. Collecting data from various sources 2. interpreting data (non imagery) for various purposes 3. generating data 4. Maintaining and manipulating data 5. Sourcing satellite imagery/aerial photos 6. Interpreting imagery 7. Modelling scenarios 8. Presenting data as maps for various uses 9. Compiling reports on data based findings/outcomes 10. Research & policy development 10. Education & training 11. Other (Specify) ……

2. Which forms of data/datasets does the institution have/use? (Kindly Refer to CODES FOR QUESTION 2 appended for general dataset types)

Kind of data/ datasets	Format 1. Digital Referenced map format, 2. Digital Non-referenced map format 3. Hardcopy map format 4. Digital non map format	Scope of data coverage/ disaggregation 1. Global, 2. Regional/ continental, 3. National, 4. County, 5. Sub-county, 6. ward, 7. sub-location, 8. village, 9. Urban areas (kindly specify if data covers only small parts of Kenya)	Main sources of data 1. Generated within organization, 2. open source platforms, 3. other governmental institutions, 4. NGOs, 5. primary data collection from field visits, 6. satellite imagery interpretation	Is data shared with other organizations? 1. Yes 2. No

3. If data is shared, which are the major institutions? 1. Gvt agency 2. Private companies 3. County Govts 4. learning institutions 5. NGOs 6. Envt conservation agencies 7.Donor agencies 8. Other …

4. If yes, what are the terms of sharing:

4a. Are there charges associated with data? 1. Yes 2. No

4b. If yes, what are the guidelines for data pricing? (eg Kshs. X for layer y) ……

4c. Are there restrictions to shared data use (eg re-sharing)? 1. Yes 2. No

4d. If yes, what are the key restrictions? ……

5. In our opinion, how would you describe the cost of data acquisition in Kenya (1. very expensive, 2. Expensive 3. Fair 4. Cheap, 5. Very cheap).

6b. Can you give some examples of specific costs associated with data acquisition? eg the average cost of acquiring one square meter of imagery, cost of processing/generating GIS layers etc?

6. Is institution using open data platforms to undertake any of its work? 1. Yes 2. No

6b. if yes, which Open Data Planforms do you use?

6c. What are the major uses of open data data? …..… ……

Organizational setup and Human Capacity

7. How is your organization structured for efficient delivery of services? (In the space provided below, kindly describe/ sketch the structure of the organization, particularly defining the main departments, their functional roles and the number of staff employed in each department. Please provide an organizational structure/flowchart if available)

8. For the technical staff working on GIS related activities, kindly fill the table below indicating the numbers and general competencies (kindly also include the composition of the ICT department)

Department (Include technical departments/ sections working on GIS work. Kindly also include the ICT department if in existence)	No. of staff (permanent, part time, consultants)	No. with PhDs	No. with MSc/ MAs	NO. with degrees	No. with Dips.	No. with Certs	Which are the most common training backgrounds of staff in department (1. Geospatial/ geomatics/ Geography 2. GIS based trainings, 3. Surveying, 4. Urban planning, 5. ICT, 6. Environmental studies, 7. Engineering). If possible/known, indicate in brackets number of staff in each training or indicate share of staff with various trainings

Hardware and software

9. Does the institution have guidelines on hardware, software and networking to be used? 1. Yes 2. No (indicate if guidelines exist for only one component and ask to get a copy)

10. Whether guidelines exist or not, the organization might have a range of hardware ranging from basic to advanced performance. With regards to computers and other key hardware, kindly describe the properties which the institution uses to rank hardware (as basic, optimal/moderate & high performance). E.g basic computers have RAM of less than 1GB, storage of less than 500GB, and processor less than 2GHz)

Properties of basic systems (e.g 500GB, 4GB RAM, Corei3)	Properties of moderate systems (e.g 1TB, 16GB RAM, Corei7)	Properties of high performance systems (e.g 1PB, 162GB RAM, 200 cores)

11. Which forms of hardware does the institution have to enable it to undertake its work (only for technical departments including ICT)

	Total No. of items available in technical depts.	No. of basic	No. of optimal	No. of high
Desktop computers				
Laptops				
Plotters				
Servers				
Handheld GPS units				
Mobile Mappers				
Scanners				
Drones				
Aero plane/ Helicopter				
other				

12. What are the most commonly used GIS sofwares in your institution, what is their nature of license and why do you prefer to use them?

Software (Name & versions)	License type (open source vs paid; networked vs standalone)	Reasons for preferring identified software

13. Is the institution networked? 1. Yes 2. No

14. What type of networking is used in the institution? 1. Local Area Network, 2. Wide Area Network 4. Wireless 5. Others

Partnerships

15. Has institution partnered with any other organizations for delivery of its work 1. Yes 2 No

16. If yes, which are the key partners for the organization?

Partner (tick which apply)	Egs of key partners	Major aspects partnerships are based on (research, data acquisition, data sharing/ dissemination)
Governmental agency (eg KNBS)		
Parastatals dealing with GIS related work		
Learning Institutions		
Private companies		
County governments		
Professional organizations (both global & local, e.g ISK		

Work in counties

17. Is institution undertaking any GIS support work in counties? 1. Yes 2 No

18. If yes, which counties is institution working in and what are they activities being undertaken? Does institution have county based offices? 1. Yes 2 No

19. If yes, how are institution activities interlinked to those of the county government?

Climate change related work

20. Does institution undertake any climate change integration related activities? 1. Yes 2 No

If yes, which activities? …..……

……..……

Contribution of agency/institution to GIS policy and framework development

21. Is the institution contributing in any way to the development of geospatial policies or other operational framework in Kenya 1. Yes 2 No

22. If yes, what are the areas of interventions/ what is the institution doing towards this goal?

Challenges & recommendations

23. What are the challenges your institution faces in terms of:

23a. Hardware ……..……

……..

23b. Software ……..……

……..

23c. Human resource ……..……

……..

23d. Data ……..……

……..

23e. Managing partnerships ……

……

24. Based on your experience, what is the advise you can give to an institution that is starting up a GIS lab in terms of:

24a. Staffing (basic background of staff to hire (train other professional vs hire GIS trained personnel, number of staff per workload)

24b. Hardware (types of hardware (computers, plotters, scanners etc), few high performance computers versus many low processing power computers, recommended processing power etc)

24c. Software (e.g do you recommend use of open source licensed software)

25d. Data (e.g would you recommend use of available data platforms or generation of data or formation of partnerships with data generation etc) ……..…… ……..

Annex 10: List of Interviewed Key Informants

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Annex 11: TORs

COUNCIL OF GOVERNORS
TERMS OF REFERENCE FOR A CONSULTANT FOR THE COUNCIL OF GOVERNORS
GIS NEEDS ASSESSMENT

1.0 Background

The Council of Governors is established under Section 19 of the Intergovernmental Relations Act 2012 and is mandated to provide a mechanism for consultation amongst national and County Governments and share information on performance of the counties in execution of their functions among other roles (Section 20).

Spatial planning in Kenya is a public function that is jointly shared by the National and County Governments for purposes of management of space and development. It aims to create a more rational organization of land uses and the linkages between them, to balance demands for development with the need to protect the environment and to achieve social and economic objectives. Spatial planning comprises measures to coordinate and improve the spatial impacts of other sectorial policies so as to achieve a more even distribution of economic development within a given jurisdiction. Thus, its primary role is to draw up a framework that identifies and apportions space within the County for different and most effective future spatial development and integration of multiple uses. Spatial planning is therefore an important lever for promoting sustainable development and improving the quality of life. Consequently, there is need to use spatial planning as a means of integrating adaptation and mitigation to climate change and disaster risk reduction in all the 47 Counties.

Spatial planning has a key role in providing a long-term framework for development and coordinating policies across sectors. It can provide a vision and common direction for policies and programmes and identify priorities for policy implementation, it can help to avoid duplication of effort by different departments and spheres of national and county governments and can assist in the coordination of sectoral policies. Furthermore, due to rapid growth in the development, the demands upon infrastructure and provision of services are on the increase. The high rate of urbanization being witnessed in most of the counties and which is expected to increase in the foreseeable future is a worrisome phenomenon. Consequently, the need for spatial planning is particularly important in all the 47 Counties

2.0. Spatial planning and Geographical Information System

Pursuant to Section 107 of the County Government Act, 2012, County Governments are obliged to prepare a ten year GIS based spatial plan which shall be a component part of the county integrated development Plan (CIDP). Geographic information system (GIS) is an expanding and evolving technology that has become an essential tool in planning. GIS can determine and address planning needs bridge the gap between the current situation and the desired future. It can be an appropriate tool to clarify problems and identify interventions for spatial planning. However, for counties to establish efficient GIS labs, a proper needs assessment is essential to guide on some key areas of intervention.

In this regard, the Council of Governors is spearheading the institutionalization of the County Spatial Plan Framework through the Kenya Devolution Support Programme (KDSP) . KDSP is a four-year project funded by DFID through UNDP whose main objective is to support counties put in place long term development strategies.

3.0. Objective of the assignment

The objective of the assignment is to support the Council of Governors in conducting a GIS needs assessment on the existing policy frameworks on GIS at both the National and County Levels, GIS resources including hardware, software, human resources and data at both National and County Levels and recommend a suitable interventions for the project based on the needs assessment. .

4.0 Scope of Assignment

The following are the itemized deliverables that will contribute to the full scope of the assignment:

1. Review existing policy documents on GIS at both National and County Levels.
2. Assess the current GIS needs at both the National and County Level including but not limited to hardware, software data and human resource.
3. Assess current status in the use of GIS for spatial planning both at the National and County Levels.
4. Identify gaps and opportunities in the use of GIS to guide Spatial Planning both at the National and County Levels.
5. To assess current GIS and other existing systems (data management, storage and retrieval) at the National and County Level that may support GIS
6. Review current regional and international trends in the use of GIS for spatial planning
7. Make recommendations on appropriate interventions by the project based on the assessment findings

5.0. Deliverables

During the assignment, the Consultant will deliver:

- An inception report which includes a work methodology, assessment tools, work plan and budget.
- An assessment report clearly defining the current status with regard to the use of GIS to inform spatial planning at both National and County Level and clear recommendations on the key areas of intervention by project.
- Facilitate work sessions/workshops related to the assignment, to the Council of Governors on a need basis.

6.0 Management of the Assignment

The Assignment will be managed by the Council of Governors Secretariat.

7.0. Duration

It is estimated that the consultant will require a maximum of 90 days to undertake the assignment over a three -month period. The table below summarizes the schedule of activities

Activity	PAYMENT SCHEDULE
Inception Report	20%
Draft Report	40%
Submission & acceptance of the final report	40 %

Travel

- The consultants will be responsible for travel within Nairobi. Travel to undertake county level work will be met by the Project.