TOWARDS A NATIONAL SPATIAL DATA INFRASTRUCTURE (NSDI): INVENTORY AND EVALUATION OF EXISTING GEOSPATIAL DATASETS AND SYSTEMS IN KENYA

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Declaration

This thesis is my original work and has not been submitted for a degree in any other University.

Signed__________ Date 28·04·2004

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This thesis has been submitted for examination with my approval as University supervisor.

Signed__________ Date 28th April 2004

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Abstract

In Kenya there are presently about 50 institutions with GIS installations and it has generally been noted that there are duplications of effort in the production of geospatial data. Again, co-operation among these institutions is minimal. In order to realize an effective, infrastructure-enabled data sharing arrangement, NSDI in Kenya, an inventory of the available geospatial datasets and systems is needed. From such an inventory, it is possible to determine the capabilities and needs of individual institutions and also to identify specific areas for increased co-operation. A study was therefore undertaken to make such an inventory, determine parameters to use to evaluate datasets for suitability and systems for compatibility and to make the evaluations.

Parameters used to evaluate datasets for suitability and systems for compatibility together with the appropriate evaluation criteria were determined. The dataset parameters included: availability, accessibility, form, completeness, format, co-ordinate system, source scale, and positional accuracy among others, while system parameters included: the operating system, GIS software, data interchange formats, database architecture, Database Management System (DBMS), type of network traffic, data transfer rates, search/retrieve protocol and registration system for the SDI servers. In general, the evaluation of systems was not as elaborate as for datasets. Insufficiency of data collected during the survey limited a complete evaluation of datasets on the basis of coverage, currency, positional accuracy, price and logical consistency, while for systems the limitation was in the computer memory and speed, the database architecture, type of network traffic and rate of data transfer.

Based on the evaluation of datasets, it is concluded that Kenya is about halfway ready for NSDI implementation. This is because about half of the datasets were determined as suitable. The study recommends a number of issues among them: Institutions that do not have a catalogue of their datasets to begin documenting their datasets; particular scales (resolutions) be agreed upon for the development of national GIS framework data; datasets not based on the Arc datum 1960 be transformed to this datum; individual institutions to prepare specifications that will guide them in the procurement of interoperable system components; and finally, for a more complete picture, another study on the other parameters be undertaken.

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LIST OF ABBREVIATIONS

ANSI	: American National Standards Institute
ANZLIC	:Australia and New Zealand Land Information Council
BIL	:Band Interleaved by Line, image data storage format
BSQ	:Band sequential, image data storage format
CAD	:Computer Aided Design
CEN	:Comité Europeén de Normalization (European Committee for Standardization)
COM	:Component Object Model
CORBA	:Component Object Request and Broker Architecture
DBMS	:Database Management System
DCW	:Digital Chart of the World
DNS	:Domain Names Service
EIS	:Environmental Information System
ERDAS	:Earth Resource Data Analysis Software
ESRI	:Environmental Systems Research Institute
FDIS	:Final Draft International Standard
FGDC	:Federal Geographic Data Committee
GDI	:Global Data Infrastructure
GIS	:Geospatial/Geographic Information System
GSDI	:Global Spatial Data Infrastructure
ICT	:Information and Communication Technologies
ILWIS	:Integrated Land and Water Information System
ISDN	:Integrated Services Digital Network
ISO	:International Organization for Standardization
KARI	:Kenya Agricultural Research Institute
KEBS	:Kenya Bureau of Standards
LAN	:Local Area Network
NMA	:National Mapping Agency
NSDI	:National Spatial Data Infrastructure
OGC	:Open GIS Consortium

OLE/COM	:Object Linking and Embedding COM
RSDI	:Regional Spatial Data Infrastructure
SDI	:Spatial Data Infrastructure
SFO	:Simple Feature based on OLE/COM
SQL	:Structured Query Language
TCP/IP	:Transmission Control Protocol and Internet Protocol
WAP	:Wireless Application Protocol
WG	:Working Group
WGS84	:World Geodetic System 1984
XML	:eXtensible Markup Language

CHAPTER 1: INTRODUCTION

1.1 Introduction

Information with a location element (with respect to the earth) sometimes referred to as geospatial information is very vital in the discovery, exploitation and management of earth resources. Such information is used for military applications, construction of physical infrastructures, and also in addressing natural resource mismanagement, environmental degradation, food insufficiency and poverty alleviation. Therefore relevant geospatial information is a necessary input in most decision-making processes, and as Ryttersgard (2001) asserts, as much as 80% of public decisions are spatially based.

For a long time geospatial information was presented on analogue maps. Essentially, maps served three functions: store for information, presenting information and findings and analyzing location distributions and spatial patterns (Kiema, 2001). A user of geoinformation ideally needed a map in order to plan and make any decisions, but with the information revolution, users of geoinformation now have developed new demands for digital geospatial information. These demands have to be satisfied by the producers of geospatial information, by producing geospatial information in digital form. These demands can be summarized as follows: people want to have the latest information, want as much as of pertinent information as possible, want to have quick access to information and finally, they want to efficiently process the information.

Digital geospatial information has had widespread application since the beginning of digital mapping. This has been so because digital mapping offers the following benefits: ease of revision, ease of integration, provides greater data compaction capability; access times are improved among others. Alongside the development of digital mapping, was the development of Geospatial (or Geographic) Information Systems (GIS). GIS are different from digital mapping systems both in principle and in practice. Digital mapping systems offer tools for digital drawing but lack data manipulation and data querying capabilities. GIS on the other hand offers tools for manipulation and querying.

The Information and Communication Technologies (ICTs) (together with the benefits of digital mapping) have accelerated the development and establishment of GIS within Kenya and of course in the rest of the world. The accelerated development of these technologies can be attributed to the following reasons among others: increasing prominence of spatial data handling within organizations, robust, easy-to-use and relatively inexpensive tools, data growth, ubiquitous positioning and tracking and navigation capabilities of the Global Positioning System (GPS) as well as the increasing demand for geospatial information. Because of these and other reasons, there is a paradigm shift: from mapping to geoinformation management. The following quotation will probably qualify this observation.

> *"Two thirds of an engineer's time is spent re-entering or recreating information, managing products of plant configurations, searching for information, seeking the record of the design process of what actually occurred"* (Olsen, 2001).

It has also been noted that the producers of geospatial information do not have arrangements to share information in what McLaughlin and Nichols (2001) refer to as a familiar phase that many countries go through in their GIS development. This has led to duplication of efforts. It cannot be gainsaid that achievements have been made in the use of observation data and information management systems within organizations. The main challenge that remains however is how to streamline, integrate and otherwise improve data sharing even as data proliferates and new technologies emerge. The need for streamlining, integrating, sharing information and use of standards particularly for spatial information has come up because of the need to avoid wasteful duplication of efforts, promote effective and economical management of resources. The impetuses for sharing information especially geoinformation came up as a result of the growth of data, the widespread use of GIS and networking technologies. The network or infrastructure for sharing, integrating and streamlining data can be realized within a local authority, a province, a nation, a region or the entire world. Within a nation, a region and the entire globe, such infrastructures are respectively called National, Regional and Global Spatial Data Infrastructures (NSDI, RSDI, GSDI).

The idea of a data infrastructure as a mechanism for providing a more effective access to geospatial data first emerged in the early 1980s in Canada (Groot and McLaughlin 2001). Since then, many countries have established or are in the process of establishing a National Spatial Data Infrastructure (NSDI), for example, the United Kingdom (National Geospatial Data Framework), Australia (Australia Spatial Data Infrastructure) and the USA (American National Spatial Data Infrastructure). In principle, this concept has evolved from earlier data sharing and programme co-ordination efforts to one that encompasses the sources, systems, network linkages, standards and institutional issues involved in delivering spatially related data from many different sources to the widest possible groups of potential users.

1.2 Statement of the problem

"Through the workshop experience, it has become clear that data for NSDI originates from various organizations. There is therefore need of an inventory of the available data and associated information as well as the projects in progress. This would help in linkage and co-ordination of data preparation and avoid duplication of effort".

This is one of the recommendations of the first Kenyan NSDI workshop held at Survey of Kenya on 12th November 2001 (Survey of Kenya, 2001). The need to have co-coordinated geospatial information systems in Kenya was addressed as early as 1992 (KARI, 1992), and organizations, which had installed GIS units included the United Nations Environmental Programme (UNEP) headquarters in Nairobi, the Department of Resource Surveys and Remote Sensing (DRSRS), the Regional Centre for Mapping of Resources for Development (RCMRD), the Kenya Wildlife Services (KWS), with the UNEP as the pioneer organization. Though an operational Kenyan National Spatial Data Infrastructure does not exist as yet, the said NSDI workshop set the stage for its establishment.

In Kenya, there are many players in the geoinformation industry and they all have diverse interests and obligations but unfortunately they are not co-ordinated. As Kiema (2001) rightly indicated, this is mainly because the basic information for planning is lacking or is not yet compiled in a comprehensive, systematic, easily accessible manner. Partnerships between public and private geoinformation sectors are lacking and the level of access to information and communication technologies is still very low.

The best way forward for Kenya therefore is to establish a network for sharing geospatial information and resources but in a systematic manner. The systematic phased approach ensures that the network is developed, tested, implemented and improved. In addition, it ensures that the mistakes experienced in other countries are not repeated (Mulaku, 2000). The basic steps in setting up the infrastructure are as follows (Mulaku, 2002a):

(i) *Setting up an institutional framework.* This entails setting up committees and Working Groups (WG) that will define the policies which will guide the development of NSDI, for example appropriate legislation, standards, education, cost recovery, institutional agreements and relationships. This is the stage at which the structure model and the lead agency of the NSDI are agreed upon. Creation of awareness of the NSDI concept in the government and amongst the stakeholders is necessary when setting up the institutional framework.

(ii) *Doing an inventory of datasets and systems.* This involves determining who has what datasets and what GIS installations and their characteristics such as state, quality and interoperability etc. The inventory of datasets and systems entails making use of existing capabilities such as ISO/DIS 19115-metadata standard to identify datasets. From the inventory it will be possible to identify and recommend advanced capabilities required to implement the full suite of infrastructure capabilities. The identified datasets need to be evaluated to determine whether they can contribute to the framework or later versions of the framework.

(iii) *Building of metadata catalogues.* Metadata (data about data) are built for all the datasets already in the inventory in (ii) above. Metadata includes description of data content, where it is, the areal coverage, its accuracy, currency, restrictions on use etc.

(iv) *Setting up of a clearinghouse*, which should be Internet based. A clearinghouse is a system that facilitates the discovery, evaluation and downloading of digital geospatial data. It consists of a number of interoperable metadata servers set up by all data producers on the Internet. The clearinghouse enables one to discover who has what, a dataset's fitness for use for a given application and how to order for it.

In the first NSDI workshop, the Survey of Kenya (SoK), a department in the Ministry of Lands and Settlement was appointed as the lead agency. In connection with this, a government policy paper on information and technology expected to provide for NSDI is underway (ibid.)*. The problem in this study was therefore to determine what datasets and systems are already available, and secondly, how suitable for inclusion in the NSDI and how compatible these datasets and systems are respectively.

1.3 Objectives of the study

To address these problems, the research was to be guided by the following objectives.

(i) Carry out an inventory of geospatial datasets and significant geoinformation systems in Kenya.

(ii) Determine the parameters that one can use to evaluate the suitability of a data set for inclusion in a NSDI.

(iii) Determine the parameters that can be used to evaluate the compatibility of a system with others in NSDI.

(iv) Evaluate the data collected in (i) in view of (ii) and (iii) above.

(v) Draw conclusions and make appropriate recommendations.

1.4 Organization of the thesis

This thesis is organized in five chapters. The introduction to this thesis is given in chapter one; chapter two presents the literature review relevant to this study. Chapter three outlines the methodology of the study while chapter four gives the results and analysis of the study. The conclusions and recommendations are given in chapter five, the final chapter.

* In the same book, article (previously mentioned)

CHAPTER 2: LITERATURE REVIEW

2.1 The Spatial Data Infrastructure concept

Spatial Data Infrastructure (SDI), alternatively referred to as Geospatial Data Infrastructure (GDI), is a combination of technology, institutional arrangements, policies and people that enable the discovery, evaluation, access and application of geospatial data by all users from all sectors of the economy, plus the general citizenry (Mulaku 2002a).

The term *National Spatial Data Infrastructure* was first coined by Professor John McLaughlin of the University of New Brunswick, Canada, in his conference paper of 1991 (McLaughlin, 1991).

The challenge that users of geospatial information were not aware of the existence of data and that they had no idea whether a certain dataset could meet their application requirements, led to a situation where organizations duplicated other organizations' data collection efforts. Some geospatial data themes for an area were collected again and again at great expense, with possibilities of gaps. This was the basis for the development of the SDI concept. SDI initiatives are intended to remedy this situation. The SDI concept has evolved from earlier data sharing and programme coordination efforts to one that encompasses the sources, systems and network linkages, standards and institutional issues. SDI is a growing data resource to which data producers can contribute, it is therefore envisioned that SDI will continue to evolve and improve. SDI can also help users with various applications, for example, tracking ownership of public land, management of watershed data by a jurisdiction beyond its boundaries, a regional transportation planning project, etc. The SDI capabilities enable documentation of all types of geospatial data such as local scientific or engineering projects, and environmental monitoring.

When SDI is considered at the national level, it is called a National Spatial Data Infrastructure (NSDI), a strategic national resource. If the concept is extended across international boundaries to a region or continent, it results in a Regional Spatial Data Infrastructure (RSDI). Further extension involving the entire globe, it results in a Global Spatial Data Infrastructure

(GSDI) (Mulaku, 2002a). However, GSDI can only be realized by completing NSDI's or RSDI's around the globe (Clarke, 2001).

2.2 Objectives of SDI

SDI is based on the simple fact of taking advantage of available geospatial data as opposed to having to develop the data separately by surveys. However, the choice between the two options will require one (user) to take into account the timeliness, the cost of obtaining and the reliability of the available data. Generally, the primary objective of NSDI is to ensure that users are able *to acquire*, *at the right time*, *complete* and *consistent datasets* of the *highest quality.* The specific objectives of SDI include the following.

(i) Improve planning and decision-making by ensuring availability of geospatial data at the right time and at affordable cost.

(ii) Ensuring adequate, complete and consistent datasets.

(iii) Maximizing the data producers' returns on investment.

(iv) Reducing waste by producing data and using it many times.

The anticipated benefits of SDI (FGDC, 1995) include the following.

- Reduced expenditure on data.
- Increased ease of obtaining and using data collected by others.
- Increased number of customers for data products linked to the SDI, from professionals to the average citizenry.
- Improved recognition of programmes.

The main components of SDI as can be inferred from the definition of SDI, include the following (Douglas, 2001):

1. Data and Metadata
2. Technology
3. Institutional framework
4. Policies
5. People

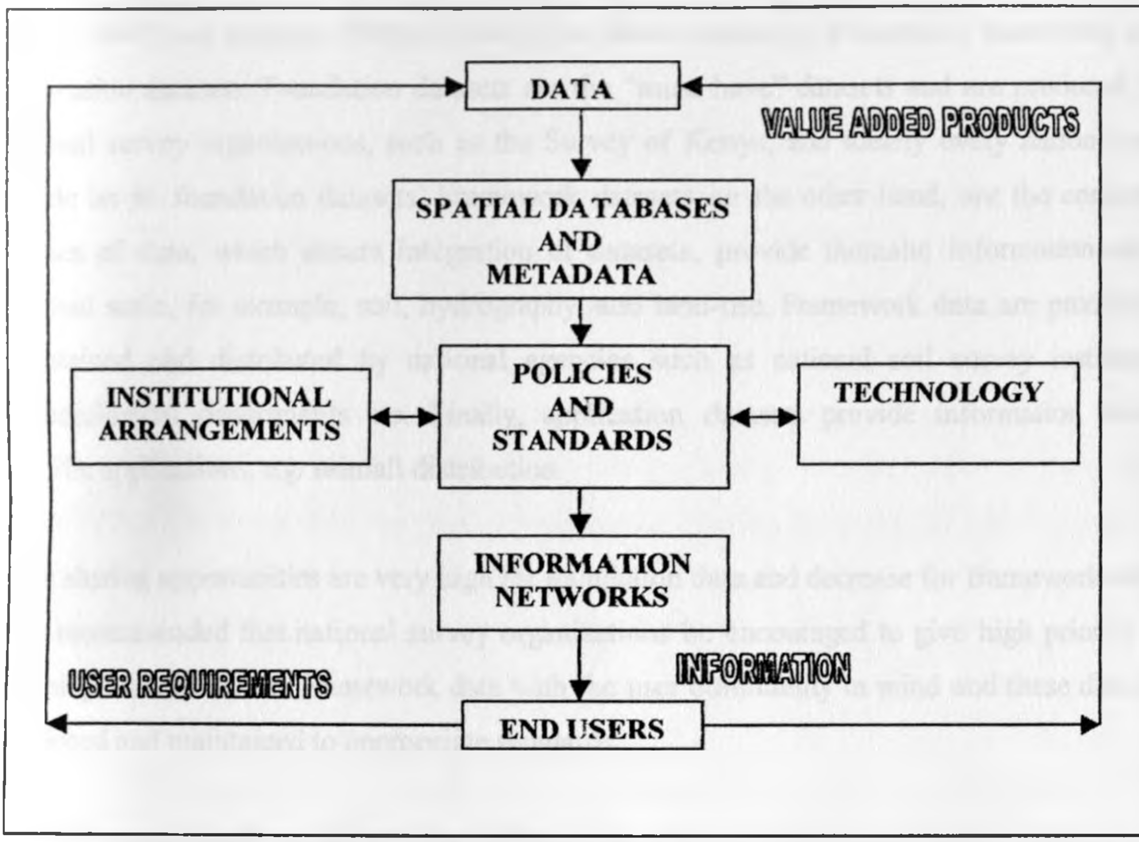

Figure 2-1: Components of a Spatial Data Infrastructure

2.3 Data and Metadata

2.3.1 Data

Data is actually the main subject of the SDI concept. A dataset within the geoinformation industry is considered as a smaller grouping of data, which though limited by some constraints such as spatial extent, or feature type is physically located within a larger dataset. Theoretically, a dataset may be as small as a single feature or feature attribute contained within a larger dataset. A hardcopy map or chart may be considered a dataset (ISO, 2001). Core and framework datasets are basic consistent sets of such digital geospatial data that provide:

(i) A geospatial foundation to which an organization can add detail and attach attribute information.

(ii) A base on which an organization can accurately register and compile other themes of data such as soils, vegetation or geology.

(iii) Orientation and link to results of an application to the landscape.

Groot (1997) and Mulaku (2002a) classify geospatial datasets as foundation, framework and application datasets. Foundation datasets are the "must have" datasets and are produced by national survey organizations, such as the Survey of Kenya, and ideally every nation must decide on its foundation datasets. Framework datasets on the other hand, are the common themes of data, which ensure integration of datasets, provide thematic information on a national scale, for example, soil, hydrography, and land-use. Framework data are produced, maintained and distributed by national agencies such as national soil survey institutes, meteorological departments etc. Finally, application datasets provide information about specific applications, e.g. rainfall distribution.

Data sharing opportunities are very high for foundation data and decrease for framework data. It is recommended that national survey organizations be encouraged to give high priority to defining foundation and framework data with the user community in mind and these data be produced and maintained to appropriate standards.

Overall, the practical benefit of core and framework data is appreciated when updating and sharing of geospatial data with other users. Core data enhances interoperability at different levels: across borders (between different jurisdictions), across sectors (between different sector based applications), across types (between vector and raster data) and overlaps (same features from different sources and processes). To realize such interoperability, it will require technology (technological interoperability), adoption of a common concept of core data (semantic interoperability) and of course, the political support that will help resource the necessary key implementations.

2.3.2 Foundation (core) datasets

The foundation data include the following (Mulaku, 2002a):

- Geodetic control
- Digital Elevation Models (DEM)
- Orthoimagery
- International and administrative boundaries

- Topographic maps
- Gazetteers (official geographic names)

The basic characteristics of foundation data are that they have high re-use value, with the Global Map for GSDI as the best example. Foundation data with defined content and schema specifications enhance interoperability, which in turn enhance the sharing of geospatial data thereby reducing data development costs between users.

To develop core data, various datasets provided by many users such as engineers, urban planners and others must be integrated. At the national level, common spatial data are often defined through community or national agreements on content. In general, the development of core data and indeed the SDI is a collaborative effort. The reasons for developing core data in summary are as follows.

(i) Reducing organizational expenditure on basic geospatial data considering the insatiable need for such data.

(ii) Some organizations cannot afford to collect and develop basic geospatial data.

(iii) Data collected by different organizations are incompatible and information needed to solve cross-jurisdictional problems is often unavailable.

2.3.3 Framework data

In the development of framework data, consensus is required at various levels, which include community, national, regional and global. For example, in Australia, Canada, German, Japan, UK, USA, national framework data have already been selected, of course these vary from country to country. However, candidate national framework data include the following (Douglas, 2001; EIS-Africa, 2001; Mulaku, 2002a).

- Transportation
- Hydrography
- Land cover/ land use
- Cadastral data
- Soils

At national levels, framework data categories may differ, but to enhance interoperable applications across jurisdictions and across disciplines, the datasets must be defined in a common way. Such a definition is necessary because users of geospatial information will of necessity require different classification schemes. If these classification schemes are defined using a consistent set of rules, then the ability to map one classification to another and retain the meaning will be greatly increased. The ISO 19109 (Rules for application schema) is an international abstract model (standard) for defining specific application schemata i.e., developing principles for classifying geographic objects and their relationships and how to map them to an application schemata (ISO/TC 211, 2003).

Even after one conforms to the rules for classifying geographic objects, the actual definition of specific application schemata needs to be standardized within a given application domain. Therefore a methodology for creation of geographic object, attribute and relationship catalogues need to be standardized as well. ISO 19110 (Feature cataloguing methodology) is an abstract model intended to standardize the methodology for creating objects, attributes and relationship catalogue (ibid).

2.3.4 Metadata

The word *metadata* shares the same Greek origin as the word metamorphosis. 'Meta' simply means change and metadata, or data about data describes the origins of and tracks the changes to data. Metadata is the term used to describe the summary information or characteristics of a set of data. This very general definition includes an almost limitless spectrum of possibilities ranging from human-generated textual description of a resource to machine generated data.

The uses of digital geospatial information and geospatial information systems have expanded their application beyond conventional geoscience fields. What is common is that geospatial data continue to be created and stored, but often not well organized and documented. Therefore, there is need to document the data for future use, to be accessible to as a wide public domain as possible and to be evaluated for suitability for particular applications. The following are the significant reasons for documenting data (metadata).

i. Metadata helps organize and maintain an organization's investment in data and provides documentation of existing internal geospatial data resources within an organization (inventory).

ii. Permits structured search and comparison of held geospatial data by others (catalogue).

iii. Provides end-users with adequate information and its use in an appropriate context thus avoiding misuse of the data (documentation).

iv. Collection of data builds upon and enhances the data management procedures of the geospatial community.

v. Reporting of descriptive metadata promotes the availability of geospatial data beyond the traditional geospatial community.

vi. Data providers are able to advertise and promote the availability of their data and potentially link to online (e.g. text reports, image web mapping and e-commerce) that relate to their specific datasets.

Effective use of geospatial data is inhibited by poor knowledge of the existence of the data, poorly documented information about the datasets and data inconsistencies. Once metadata is created, geospatial data can be used by multiple software systems for different purposes.

2.3.5 Levels of metadata

Library catalogues represent an established variety of metadata that has served for decades as collection, management and resource discovery tools. A map legend is one representation of metadata containing information about the publisher of the map, spatial references, and the map scale among other items. Metadata are also those types of descriptive information applied to a digital geospatial file. In some instances, one may need less data and more description about a dataset; this simply means that metadata can exist at different levels of abstraction. These include (ISO, 2001) dataset series level (e.g. map series), dataset level (e.g. describing characteristics of a photographic image), feature type level (e.g. describing attributes and class characteristics of similar objects in a dataset) and finally, instance level (e.g. describing characteristics specific to instances of an object appearing in a database, for example a specific road). Therefore metadata should vary according to the purpose and scope and the distinction between core (discovery), exploration and exploitation metadata, which are the levels of metadata.

Core metadata is the minimum information necessary to provided the users with an effective service and access to datasets. The 'core-metadata' level is usually sufficient for data discovery, high-level evaluation for fitness for purpose and eventual access to the data and/or data provider. Usually the "what, why, when, who, where and how" questions about a dataset are answered. Exploration metadata on the other hand, provides sufficient information to enable the inquirer to ascertain that data fit for a given purpose exists, to evaluate its properties, and to reference some of the contact for more information, while exploitation metadata includes those properties required to access, transfer, load, interpret and apply the data in the end application where it is exploited (Douglas, 2001).

Consistency in metadata content and style is recommended to ensure that comparisons can be made quickly by data users regarding the suitability for different uses. Consistency in content and style can only be realized if the user community adopts similar conventions. This is possible through standardization.

Three main metadata standards exist (or are under development) that are of broad international scope and usage (ibid). They provide detail for all levels of metadata mentioned above. The standards are:

i) The content standard of Digital Geospatial Metadata of the United States of America's Federal Geographic Data Committee adopted in 1994 to support the development of NSDI.

ii) European's CEN (Committee Europeen de Normalization) a pre-standard adopted in 1998. (CEN-TC/287 metadata standard).

iii) The ISO/FDIS 19115 – standard on metadata, in its final stage of development.

Metadata generally provides information on sources, data quality, and spatial extent, general content, production processes and responsibilities. The stated metadata standards define extensive sets of metadata elements; however during implementation, typically only a set of metadata elements is used; it is essential that a basic number of metadata elements is maintained for a dataset, the core metadata.

2.3.6 ISO/DIS 19115 core metadata

A metadata entity set is a set of packages, each of which contains one or more entities. According to ISO/DIS 19115, the core metadata should contain the following packages, which have mandatory (m), conditional (c) and optional (o) entities.

(i) Dataset title (m) e.g. Exploration Licenses for Minerals

(ii) Dataset reference date (m) e.g. 199208 (year, month).

(iii) Dataset responsible party (o) e.g. Dept. of Primary Industries & Resources

(iv) Geospatial location of the dataset (c) e.g. Location name

(v) Dataset language (m) e.g. English,

(vi) Dataset character set (c) e.g. 16 bit Universal Character Set (UCS2)

(vii) Dataset topic category (m) e.g. Environment

(viii) Spatial resolution (o) e.g. equivalent scale 1/5000

(ix) Abstract describing the dataset (m) i.e. the summary

(x) Distribution format (o) e.g. DXF

(xi) Addition extent information for the dataset (o)

(xii) Spatial representation (o) e.g. vector

(xiii) Reference System (o) e.g. WGS84

(xiv) Lineage statement (o) i.e. source data history

(xv) On-line resource (o) e.g. http://www.pir.sa.gov.au

(xvi) Metadata file identifier (o) e.g. XML version 1.0

(xvii) Metadata standard name (o) e.g. ISO 19115

(xviii) Metadata standard version (o) e.g. FDIS

(xix) Metadata language (c) e.g. English

(xx) Metadata character set (c) e.g. UCS2

(xxi) Metadata point of contact (m) e.g. Dept. of Primary Industries & Resources

(xxii) Metadata date stamp (m) e.g. 19920803 (year, month, date)

2.3.7 Implementation of metadata

Creating metadata is like library cataloguing, except that the creator needs to know more of the scientific information behind the dataset in order to properly document them. Each participating organization in the NSDI should generate its own metadata. Initially, this should be informal, unstructured documentation that does not need rigorous fully structured formal metadata. After this, the organizations should consider the use of more complex systems as they realize the benefits of metadata and as they gain greater data holdings and start to provide broader access of their data. This will start with basic audit of their data holdings that will alert them to the vast wealth of data they posses and where it is being replicated or improved across the organization.

Three forms of metadata should be recognized and supported in systems. These are: the implementation formats (within a database or software system), the export or encoding formats (a machine-readable format designed for transfer of metadata between computers) and lastly, presentation formats (format suitable for viewing by human beings). By recognizing the connections between these dispositions of metadata, one can build systems that support mission requirements, standard encoding for exchange, and permit many "report" views of the metadata to satisfy the needs and experience of different user constituencies.

The eXtensible Markup Language (XML) provides two solutions for this metadata problem. First, it includes a capable markup language with structural rules enforced through a control file to validate a document structure. Second, through a companion standard (XML Style Language, or XSL), an XML document may be used along with a style sheet to produce standardized presentations of content, allowing the user to shuffle field order, change tag names, or show only certain fields of information. Used together XML and style sheets allow for a structured exchange format and for flexible presentation. Thus, a metadata entry can be rendered in many ways from the same, single structured encoding (Douglas, 2001).

2.4 Technology

With regard to SDI, technology includes the hardware, software and networks or simply the clearing house and technical standards that make possible the discovery, evaluation, access and application of geospatial data.

The data, people, tools and processes used to build information products are collectively referred to as an information system. In cases where multiple stakeholders are involved, a more precise term used is information network (WCMC, 1996). A clearinghouse as defined by FGDC (1995) is a system of software/hardware and institutions necessary to facilitate the discovery, evaluation and access of digital geospatial data. It consists of a number of servers on the Internet that contain information about the available digital geospatial data. A clearinghouse is an example of a client-server architecture. The server machines hold metadata and clients request information about the available geospatial data by visiting the server nodes, usually through a web browser. In ideal cases, the server not only holds the metadata but also provides a link to the dataset itself. Servers are usually installed at providers, such as National Mapping Agencies (NMA) and private mapping organizations at different organization levels.

Major components of computer networks (Aaron, 1993) are generally grouped as facilities and devices. Facilities are also referred to as communication channels, links or lines. They include telephone lines, coaxial cables, microwave links, satellite channels and optical fibers. Each of these physical media of course has many interesting characteristics in terms of its ability to provide for communication. Devices used to construct a network are often referred to generically as nodes. Sometimes nodes are distinguished by their functions. Network functions include switching, routing, flow control, speed and code conversion, security, back up, failure monitoring and accountability. Data sharing and function sharing are the motivations behind the implementation of a clearinghouse.

Once an organization has documented its data, the next challenge is how to make accessible their datasets and metadata. Whereas the datasets may not be necessarily available because of copyright or for economic reasons, the metadata should be always available because in a way it advertises what geospatial datasets are available. The metadata elements are stored in and served through a user-accessible catalogue. Nowadays a catalogue is a virtual library's critical element to its navigation and use, and so it is for geospatial data. Support of a discovery and access service for geospatial information is known variously within the geospatial community as catalogue services (Open GIS Consortium, OGC), Spatial Data Directory (Australian Spatial Data Infrastructure) and Clearinghouse (US FGDC) (Douglas, 2001).

As a recapitulation, the clearinghouse is based on the principle of distributed systems. A distributed system is a computer system in which resources (in this case, the metadata catalogues) reside in separate units connected by a network, but presents to the user a uniform computing environment. In order to achieve interoperability between these independent metadata catalogues, three things must be put in place and these are (ibid)

(i) Use of common descriptive vocabulary (common metadata standards)
(ii) A common search and retrieval protocol
(iii) A registration system for servers of metadata collections.

2.4.1 Catalogue implementation models

There are several models where catalogue services might be installed within or among organizations. The approaches identified by Douglas (2001) are:

a) *Consortium approach*. Here a single metadata catalogue is built and operated at one location and is shared by multiple organizations with a common discipline or geographic context. This model works well where there are personnel and computer access constraints and therefore a shared service extends outreach. This is recommended for government institutions. This approach encourages collaboration between participants, however the task of managing the complexity in this model is enormous.

b) *Corporate (organizational) approach*. All metadata are forwarded within an organization to a single service at which time the corporate issues of quality, publication, style and content may be evaluated. This model is well suited to organizations that may be restricted to providing a single public access computer for security reasons.

c) *Work group (departmental).* The catalogue service is established at each department within an organization where the data are collected, documented and served. This approach ensures high degree of synchronization between the data and its metadata.

The corporate approach is recommended because this approach places emphasis on individual organizations. This approach also increases capacity for data sharing, improves access to information and there is more informed decision making.

The above approaches assume that access to computers and communication networks is the norm rather than the exception. However, in situations where this is not the case, the following alternative approaches can be implemented.

d) *Paper catalogues,* where organizations and clientele have a limited access to computers or networks. Distribution is through public libraries and organizations interested in using spatial data in decision-making.

e) *"Mirror" catalogues*, where a crawler or harvester program retrieves and indexes metadata from other sites into a regional or replicate index. This approach is handy where Internet services are present and available to the public but network bandwidth within the region in question is limited.

f) *CD-ROM or DVD approach.* The CD ROM or DVD media with searchable metadata (and perhaps data) are used. This approach is suitable in environments where both data providers and clients have access to computers but not to reliable networks.

In the event that (a), (b), (c) are possible, the servers must be directly connected to the Internet and they must be interoperable. Interoperability is only achieved if two obstacles are overcome, and these are technical and semantic non-interoperability (Harrison, 2002). Technical non-interoperability is where different kinds of processing systems from different vendors do not work well together, while semantic non-interoperability is where different data providers (groups) do not define features, structures and their metadata the same way.

2.4.2 Standardization and interoperability

By definition, standards (ISO, 2003) are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose. Standards can be grouped into three broad categories (Mulaku, 2002b); firstly, official standards, created and published by authorized national or international standardization bodies such as the International Organization for Standardization (ISO) and the Kenya Bureau of Standards (KEBS). Secondly, legal standards are created by national or international law, for example, the international law of the sea and cadastral survey standards. Finally, De-facto standards are often created by industry in promotion of commercial interests and are widely adopted by others for example, the DXF (Drawing Interchange Format).

The ISO 10163, also known as ANSI Z39.50 is the search and retrieval protocol used for metadata catalogues. This standard was initially used in the library community for accessing virtual catalogues. Apart from this particular technical standard, SDI standardization is required in the following areas among others: reference systems, data models, data dictionaries, data content, data quality, data transfer and metadata. Standards provide a standardized way of describing geoinformation, and a standardized method for accessing, transferring and updating information, all independent of any specific computer.

Foundation and framework data, systems interoperability and standardization are the key concepts in the integration of various kinds of information stored differently and in different depositories. According to Thanassis (2001), interoperability is absent in spatial data handling because of:

i) Incompatible hardware/software products.
ii) Inadequate data formats.
iii) Semantic misconceptions.
iv) Heterogeneous data models.

Heterogeneous hardware and software products today characterize the computing world and are utilized in distributed systems environments. A distributed system is a computer system in which the resources reside in separate units connected by a network, but which present to the user a uniform computing environment (Lee and Christensen, 1999). Using component technology and well-defined standards is the only way to make this new environment work. Standards that have been defined for implementing object and component solutions include Microsoft's Common Object Model (COM/DCOM/COM+), the Object Management Group's Common Object Request Broker Architecture (CORBA) and Sun's Enterprise Java Beans (EJB) (Kirby, 1999). COM is the widely used component software; it provides reusable, client and server components. COM is not a programming language but a binary-level specification that describe how a series of components, which are possibly written in different programming languages by different vendors can communicate. The ability of disparate components to communicate is referred to as interoperability (Deitel et. al., 1999).

2.5 Policies

SDI policies include official statement of ideas on spatial data management. ANZLIC (Australian and New Zealand Land Information Council) policy statement (ANZLIC, 1999), for example, addresses issues like public access to geospatial information, data privacy and security, copyright, liability, sharing, cost recovery and quality among others. These issues are briefly discussed below.

2.5.1 Privacy and protection of personal data

With the proliferation of information systems, sometimes Geographic Information Systems (GIS) hold personal data. Personal data is any information related to an identifiable or identified person. The information may include tax, land records, data on residence etc. In some cases, this data may be incorrect or revealing a lot of private information, and the individual's right to privacy is a constitutional right. Privacy and protection of personal data is needed for an individual's social and political freedom. It includes confidentiality protection in GIS databases versus enabling public access to spatial data, personal integrity data and politically sensitive data. Policy for restrictive disposal and limited access to spatial data should be implemented. Foote (2000) suggests that the use of encryption like postal codes, to some extent addresses this issue.

2.5.2 Liability, integrity and quality

Geospatial information is sometimes used beyond their original intended purposes and this can cause either social or economic harm (ibid.). The harm could be due to errors, or due to unintended and inappropriate use. Therefore, accountability for the accuracy and reliability for such information as stored in a database, sold or issued to the public (user) must be defined. The use of disclaimers as means of clearing producers of liability in such a circumstance is only limited, therefore liability and the relationship between the data producers and users of value added information must be clearly stated, for example Videnic (2003) suggests that specifications for the reliability of the spatial datasets be expressed in a special contract.

2.5.3 Intellectual property

Intellectual property refers to creations of the mind and is divided into two categories: industrial property and copyright. Industrial property includes inventions (patents), trademarks, industrial designs among others, while copyright is an exclusive right to publication, production and sale of the rights to literary works; it includes literary and artistic works such as novels, poems and plays (WIPO, 2002). Intellectual property rights are rights to financial benefits from and control of distribution of non-tangible property that is as a result of creativity. The complexity of copyright issues is likely to hinder the popular use of geospatial information, even though it can be publicly accessed. Intellectual property rights in geoinformatics can be claimed via the following ways:

a) Computer programs (software) are intellectual works and must therefore be copyright protected. Software piracy affects its authors, producers, end-users and others. Piracy demotivates creativity of authors and makes producers lose due to unrewarded investments in software development process and end-users have to deal with high prices.
b) Databases can be copyright protected if they are original creations and if they represent intellectual work.
c) Licensing say access and use of a database.
d) Patenting hardware products. A patent is an official document giving the holder the sole right to make, use, sell or license a discovery and prevent others from imitating it.

2.5.4 Commercialization of information

Commercialization of public information is a serious issue because government organizations will have unfair competition with their private counterparts. Unfair competition will come about when such public bodies use benefits inherent in their status to compete with private agencies. The competitive advantage may be due to secure public finding, tax exemptions, legal positions and public image (McLaughlin and Nichols, 2001). Commercialization of public information should be addressed because such information has already been paid for. In commercialization, the cost recovery approaches available include:

- Free
- Partial production cost recovery (subsidized)
- Production cost recovery
- Market price (Profit making)

Overall, these and more policy issues must be addressed in the national information policy as the spatial data market expands and within it a culture of information sharing and cooperation should be encouraged.

2.6 Institutional framework

Institutional partnerships are basic to an effective SDI; in fact it is generally acknowledged (WCMC, 1996; EIS, 2001) that the greatest challenges to the development of any information system or SDI for that matter are more institutional rather than technical. Therefore, during the establishment of NSDI questions that must be addressed include:

(i) Who is to be involved?

(ii) How is the NSDI to be organized?

(iii) Can any one body or organization be in "charge" or take a lead role? If so, how is real progress to be realized without continuous 'tacking' to suit the persuasions of individual organizations or groups?

iv) What is the role of the private sector?

v) What are the appropriate measures of success?

The main issues to be addressed under institutional framework include the NSDI organizational structure, co-ordination and capacity building. The NSDI can typically be considered as a 3-tier framework (as in figure 2-2) consisting of the executive committee, the steering committee and the Working Group (Survey of Kenya, 2002).

(i) *The Executive committee*; members are the Directors of the main stakeholders. The main function of this committee is to discuss and authorize what is discussed in the Steering or Operating committee and the Working Groups (WG).

(ii) *The Operating committee*. The members of this committee are heads of sections dealing with SDI issues from each stakeholder. The functions of this committee are: to assign tasks to Working Groups, conclude tasks assigned to Working Groups and report to the executive committee.

(iii) *The Sub-Committees* (or *Working Groups*). These are technical task forces. Membership is drawn from experts in each area from each stakeholder. their main function is to make recommendations on given terms of reference to the steering committee.

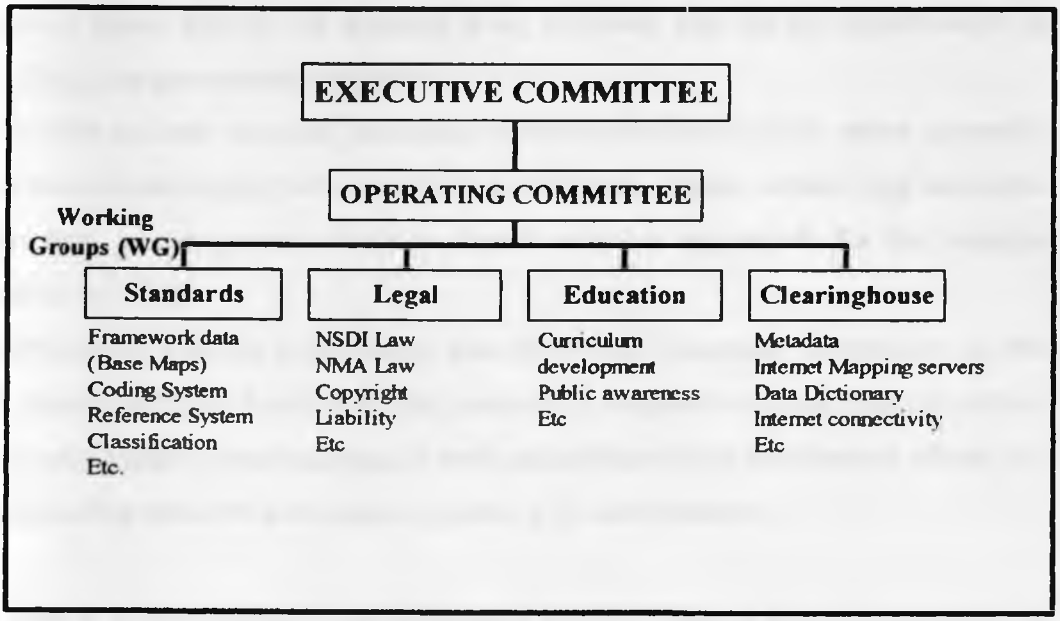

Figure 2-2: A typical NSDI organization structure

Rackham and Rhind have shown that in the development of the UK's NSDI, the National Geospatial Data Framework (NGDF), most of those involved in the board were largely from the public sector with a small number of private sector bodies (Rackham and Rhind, 1999).

2.6.1 NSDI Organization models

Free participation can only be influenced by the kind of NSDI organizational structure selected. Rackham and Rhind suggest four organization models.

(a) NSDI as a commercial body in which those who pay fees control the agenda. This model has the advantage of involving the private sector directly and permits normal contracting of work to be carried out. However, this model restricts membership and undermines the principle of user involvement in the public domain

(b) NSDI composed of primary data producers, for example, government departments and agencies with similar government support. The board members would pay an annual subscription and participate in creating strategic policy. Commercial members would then be drawn from the business community and would be expected to pay an annual subscription. Commercial members' contribution would be at the structural and technical rather than at the strategic level, however, this has the disadvantage of excluding non-government supporters.

(c) NSDI with a single structure, consisting of representatives from the entire geospatial information community, who include data producers, system vendors and end-users. From this, a management board is elected which is responsible for the strategic direction of NSDI.

(d) Identifying an existing organization that deals with geospatial information as the coordinator of NSDI. Funding in this structure is supposed to come from all parties. This would enable commissioning of work rather than relying on voluntary efforts, but this doesn't address the concerns expressed by the user fraternity.

The NSDI with a single structure is recommended because there is direct involvement by representatives from the entire geospatial information community. However, there are other equally successful NSDIs, which are not modeled on the Rackham and Rhind model, for example, the United States of America. Some of the differences are rooted in national differences in government structure, culture and the existing role of the private sector and the status quo (ibid).

2.6.2 Institutional roles

To ensure a robust and well-maintained NSDI, innovative institutional arrangements must be made. The core data as already discussed above must be developed, maintained and integrated by organizations that produce and use data for a particular area. Besides, there is need to guarantee that geospatial units of core data can be integrated to support applications for different or large areas. To accommodate these needs, six institutional roles must be fulfilled and can be carried out by many different organizations (FGDC, 1995). The roles are:

i. Policy establishment; to provide overall guidance for the NSDI. Policies are necessary because of the distributed nature of the responsibilities. The responsibilities include: approving standards, identifying necessary resources, obtaining funding, initiating pilot studies, concepts and implementation strategies, creating awareness, encouraging partnerships, resolving issues caused by different and competing ideas about the operation and advancement of the framework etc.

ii. Theme expertise; to guide the development of the NSDI to meet the new trends, this is necessary because of the changing needs, which include accommodating new standards and techniques.

iii. Framework management; to provide continuing, operational support for the framework. Some of the responsibilities include, for example, managing the production of a theme of data, creating and maintaining framework data for those areas not covered by certified data producers, developing and recommending technical standards that describe the essential characteristics of the theme data and rules and processes for data generalization, and maintaining these standards.

iv. Area integration; to incorporate contributions of data producers into the framework for a geographic area within and among themes. An area integrator implements the technical standards, updates the framework from contributions, and provides guidance to ensure that data producers integrate their data among themes and geographical areas, among other duties.

v. Data production: to generate data used to build and maintain the framework data to standard. The duties include: encoding required metadata, performing and reporting the results of the required data quality tests, encoding data, including feature identification codes, to framework standards and to provide data and metadata without restriction to area integrators.

vi. Data distribution; to provide framework data to users, this is because the distributor may not be the same agency that produces or integrates the data. There may be many data distributors, but only one will be responsible for holding the official distribution copy.

2.7 People

People in SDI include the people who acquire, process, store, distribute and use geospatial information or who are involved in the running of SDI. The development of data and metadata, the setting up of the clearinghouse and technical standards, the establishment of policies and institutional arrangements require human resources, which is why capacity building in NSDI is very important. Development of human resources can be realized through short-term technical assistance and training focusing on technology transfer and further development of practical activities to ensure that operational activities continue.

Groot and McLaughlin (2001) identify three significant categories (see Figure 2-3) of specialized organization and process management skills required to facilitate the development and implementation of NSDI. Naturally, very few individuals will posses talents and interests focused in just one of the categories. Therefore the people in NSDI should have a blend of these skills or the individuals be drawn from these categories, which include:

a) Skills in geographic information science and application development: the individuals here focus on technologies, processes, operations and dataset integration considerations necessary to acquire and build large geospatial databases, assess their overall reliability, create special-purpose geospatial models and analyses.

b) Skills in computer science, telemetry and system development: individuals here have strong interest in the development and smooth operation of large databases and corporate information systems within an organization.

c) Skills in management and policy implementation: individuals here examine the managerial aspects of implementing new technologies, including issues such as standards and network implementation, organization and policy requirements, legal and economic consideration and information technology course evaluation.

To achieve this, will require input from other disciplines such as law, business administration, industrial engineering, telemetry and others.

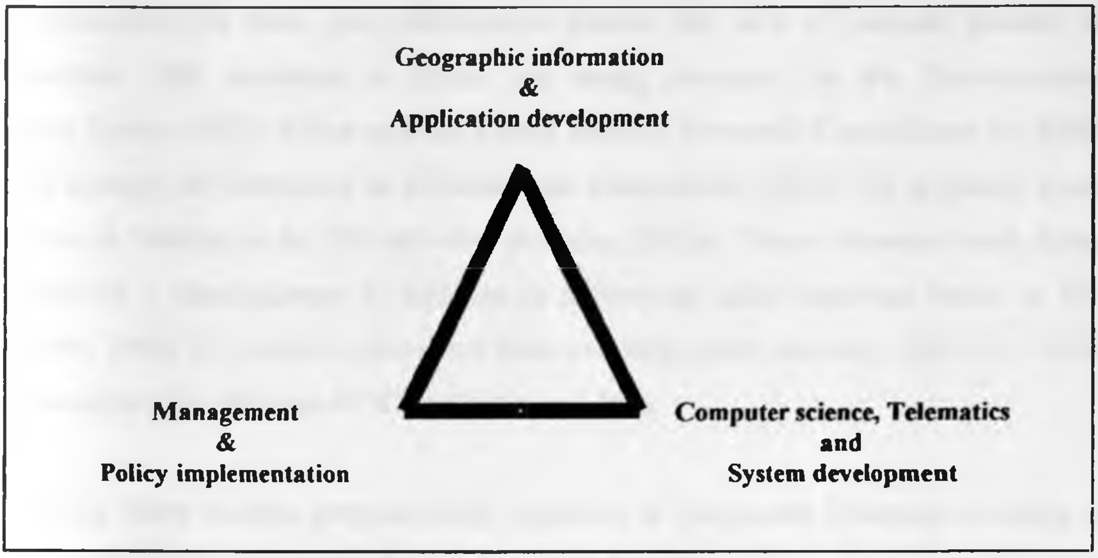

Figure 2-3: Education and skills framework for individuals working in NSDI

2.8 The current SDI situation in Kenya, Africa and the World

Globally, many countries, especially in Europe, America, Asia and Oceania are well on their way to achieving NSDIs and it is estimated that there are over 250 geospatial metadata clearinghouse nodes internationally, of which about 20% provide links to the actual data online (Mulaku, 2002a).

The successful realization of the Global Spatial Data Infrastructure hinges on the successful implementation of RSDIs and NSDIs. A GSDI initiative to co-ordinate these SDIs has so far seen six GSDI conferences being held. A global survey on the status of SDI activities indicated that only seven developing countries responded, and six African countries were actively engaged in NSDI activities (Clarke, 2001). The international conference on spatial information for sustainable development held in Nairobi, Kenya in October 2001 resulted in the Nairobi statement on spatial information for sustainable development, which recommended the practical way forward in creating NSDIs to support sustainable development. The recommendations had national, regional and global perspectives on SDI development (FIG, 2002).

In Africa however the major constraints to SDI development as postulated by Mulaku (2002a) include: poor telecommunication infrastructure, poor mapping infrastructure, poor scientific/research skill base, poor information market and lack of national policies on geoinformation. SDI activities in Africa are being advanced by the Environmental Information System (EIS)- Africa and the United Nations Economic Commission for Africa (UNECA) through its Committee on Development Information (CODI). On a country basis, South Africa is leading in the SDI activities (Mulaku, 2002a). This is because South Africa has established a clearinghouse in addition to addressing other important issues in SDI development. Table 2-1, which is abstracted from a country report summary (UNECA, 2003), shows in summary the situation of SDI activities in Africa.

In East Africa, there is some progress being registered in Kenya and Tanzania according to UNECA country summary report, while in the report no information is given about Uganda's situation. The SDI activities in Uganda are however limited to environmental issues and the National Environmental Management Authority (NEMA) is facilitating the activities (EIS, 2001).

Of the 250 GSDI metadata clearinghouse nodes, three are from Kenya: UNEP and ILRI nodes are active, while the IGAD node is inactive. It is however worth noting that these nodes are established on international mandates and are therefore not true national nodes. In Kenya, there are about 50 institutions with GIS installations, over 70% of which are data producers. Co-operation and data sharing among the respective institutions is minimal. Towards its NSDI development, an inventory of these institutions, their geospatial datasets, and systems and partnerships is required. From such an inventory, it is possible to determine the capabilities and needs of individual institutions and also to identify specific areas for increased co-operation.

So far, two NSDI workshops have been held with the objectives of creating awareness and defining the NSDI structure. Tangible efforts include the establishment of the NSDI secretariat with Survey of Kenya as the lead agency, which has held two meeting of the standards Working Group, conducted a study for the establishing Kenyan standards for NSDI and the opening of the Kenyan NSDI web page, http://kism.icconnect.co.ke (Mbaria, 2003). An on-going donor funded project "*The study for the establishment of the Spatial Data Framework for the city of Nairobi*" promises to generate many large-scale datasets for the city of Nairobi, which will be an important input into the NSDI.

Element	**Status**	**Country**
Status of NSDI	Government has established	Algeria, Botswana, Gambia Gabon, Kenya, Mali, South Africa,
	Government has not established	Zambia
	Concept under discussion	Morocco
	Government has established and under discussion	Benin, Burundi, Congo, Ethiopia, Ghana, Rwanda, Senegal, Tanzania, Swaziland, Zimbabwe
National policy on (GI) Geospatial Information	Approved and operational	Gambia, Mali, South Africa, Tanzania
	Policy on Consultation	Gabon, Kenya
	Draft produced	Algeria, Congo, Morocco, Rwanda, Senegal, Swaziland, Zambia
	Not considered	Ethiopia, Zimbabwe
Status of fundamental datasets	Data available in digital form	Morocco
	Digitization in progress	Ghana, Benin, Gambia, Kenya, Algeria
	Data in analogue form	South Africa, Gabon, Congo, Senegal, Swaziland
	Issue under discussion	Botswana, Burundi, Rwanda, Zambia
	Issue not yet addressed	Ethiopia, Tanzania
National metadata and clearing house	Use clearing house and has gateway	South Africa
	Metadata on CD	Zambia
	Metadata created but no access	Gabon, Congo, Ghana, Gambia, Botswana, Ethiopia
	Agreed but not started	Mali
	Discussion at national level	Senegal, Swaziland, Kenya, Burundi, Rwanda
	No immediate plan	Moroco, Algeria, Tanzania
Implementation of ITRF and WGS84 datum	Datum to ITRF	Benin, Gabon, South Africa
	Datum aligned to IRRS	Botswana
	Data as a paid consultancy	Algeria
	Definition of datum under discussion	Mali, Senegal, Swaziland, Kenya, Burundi, Rwanda, Zambia, Congo, Ghana, Gambia, Ethiopia, Tanzania

Table 2-1: NSDI country report summary

CHAPTER 3: METHODOLOGY

To achieve the objectives of this study, the data collection methods used were a survey by way of administering interviews, mailed questionnaires to some institutions (for primary data) and use of published literature (for secondary data). Though interviews were the main method of data collection employed, it is however the most expensive method per respondent because of the fatigue and travel expenses involved. The choice of this method was however based on the following reasons (Pamella and Robert, 1995):

(i) It provides the most complete contact with respondents.

(ii) It is easy to win respondent co-operation and hold it for a long time.

(iii) Non-response bias is minimized.

(iv) It is quicker than mail survey for a small geospatially concentrated sample.

For this particular survey, this method was likely to give the interviewer an opportunity to see some of the facilities talked about first hand. Mailed questionnaires were used at the request of some respondents, who were not available at the time scheduled for the interview.

The questionnaire, a sample of which is presented in Appendix 1, contained both closed and open-ended questions and was structured to capture the main information needs. The questionnaire items were grouped into six sections namely:

a) Institutional details (e.g. name, address, physical location, website)
b) Description (information management, core business)
c) Information management (information requirement, quality evaluation)
d) Partnerships (Existing networks, partnerships)
e) Systems (e.g. GIS software)
f) Significant geospatial datasets

3.1 Sample design and sample frame

One of the requirements in a survey research is for the research to be as least biased as possible (ibid.). This is realized if a proper sample design is done. In this particular study, no sampling was done; actually the study intended to involve almost all institutions with GIS and/or digital mapping installations. The institutions were categorized either as government, quasi-government, private or academic. The sample frame, in this case the whole population was drawn up based on the previous knowledge about some of the institutions and also from suggestions from my supervisor and some of the interviewees. The sample frame contained in Table 3-1 to Table 3-5, are the institutions that were sampled by category, indicating those that responded and those that did not.

Institution	Category	Code assigned	Response	
			Yes	No
Survey of Kenya (SoK)	1	101	✓	
Department of Physical Planning (DPP)	1	102	✓	
Ministry of Roads, Public Works and Housing (Roads)	1	103	✓	
Ministry of Roads, Public Works and Housing (Building)	1	104	✓	
Central Bureau of Statistics (CBS)	1	105	✓	
Ministry of Water Development*	1	106	✓	
Department of Resource Surveys and Remote Sensing (DRSRS)	1	107	✓	
Department of Urban Development-Ministry of Local Government (MLG)	1	108	✓	
Kenya Meteorological Department (KMD)	1	109	✓	
Nairobi City Council (NCC)	1	110	✓	

*Partial response (at least one of the forms A or B was not returned)

Table 3-1: Government institutions/departments surveyed

Institution	Category	Code assigned	Response	
			Yes	No
Electoral Commission of Kenya (ECK)	2	201	✓	
Kenya Soil Survey (KSS)	2	202	✓	
National Museums of Kenya (NMK)	2	203	✓	
Kenya Wildlife Services (KWS)	2	204	✓	
Kenya Power and Lighting Company (KPLC)	2	205	✓	
Kenya Forestry Research Institute (KFRI)	2	206	✓	
Telkom Kenya	2	207	✓	
National Housing Corporation (NHC)	2	208	✓	
Laikipia Research Programme	2	209		✓
Kenya Marine and Fisheries Research Institute	2	210		✓
Lake Basin Development Authorities (LBDA)	2	211		✓

Table 3-2: Parastatals surveyed

Institution	Category	Code assigned	Response	
			Yes	No
United Nations Environmental Programme (UNEP)	3	301	✓	
International Livestock Research Institute (ILRI)	3	302	✓	
World AgroForestry Centre (formerly, ICRAF)	3	303	✓	
Regional Centre for Mapping of Resources for Development (RCMRD)	3	304	✓	
International Centre for Insect Physiology and Ecology (ICIPE)	3	305	✓	
United Nations High Commission for Refugees (UNHCR)*	3	306	✓	

*Partial response (at least one of the forms A or B was not returned)

Table 3-3: International/intergovernmental organizations surveyed

Institution	Category	Code assigned	Response	
			Yes	No
Oakar services	4	401	✓	
Geomaps	4	402		✓
Geometer Surveys	4	403	✓	
Highland Surveyors	4	404	✓	
GIBB Africa	4	405	✓	
Gath Management	4	406		✓
Norken (formerly, NorConsult) Engineers	4	407	✓	
Eldoret Water and Sanitation co. (ELDOWAS)	4	408	✓	
Wellcome Trust	4	409	✓	
Ground Water Survey	4	410	✓	
Photomap International	4	411		✓

Table 3-4: Private-sector institutions surveyed

Institution	Category	Code assigned	Response	
			Yes	No
Department of Surveying, University of Nairobi (UON)	5	501	✓	
Department of Geography, University of Nairobi (UON)	5	502	✓	
Kenya Institute of Surveying and Mapping (KISM)	5	503	✓	
Department of Geomatic Engineering, JKUAT	5	504		✓
Department of Geography, Moi University	5	505	✓	

Table 3-5: Academic institutions surveyed

3.2 Determining the parameters to be used to evaluate datasets for suitability

Any geospatial dataset can be included in the NSDI. But considering the primary objective of NSDI: to ensure that users are able *to locate, acquire, at the right time, complete* and *consistent datasets* of the *highest resolution* at *cheaper costs*, first and foremost, a dataset first needs to be evaluated to see if it meets this objective.

For a dataset to be acquired, it is necessary to know about its accessibility. Existence of a catalogue will help one know the availability of a dataset and how to locate it. The dataset's completeness can be determined by its status with regard to its stage of development, so is its completeness in terms of scope. The consistency of a dataset can be indicated by topological consistency, attribute database consistency, domain consistency, and compatibility of a geodetic datum upon which the dataset is based on. The source scale, level of abstraction, resolution and positional accuracy of a dataset give an indication of the resolution of the dataset. Price of a dataset and how to order it will be compared with the cost of any alternatives to determine which is cheaper. These parameters are highlighted below.

(i) Availability of metadata//catalogue

The support of a discovery and access service for geospatial information is known within the geospatial community as 'catalogue services' (Douglas, 2001). Catalogue services can be applied to non-digital collections of map information, small digital catalogues and integrated repositories of data and metadata. Geospatial catalogues are there to help in the identification, discovery and evaluation of information. In addition, it helps in the management of geospatial information in an organization. For proper management of a dataset therefore, it should be included in a catalogue.

(ii) Form

This is the form of representation and is either digital or analogue. The idea of making data easily accessible requires that the data be in digital form.

(iii) Accessibility

This is the most important parameter that will determine whether a dataset can be included in NSDI or not. Accessibility indicates the handling restrictions on a dataset. According to ISO/DIS 19115- ISO standard on metadata, a dataset can have the following restrictions:

(a) Unrestricted (unclassified)- available for general disclosure.

(b) Restricted to some- not for general disclosure.

(c) Restricted to most (confidential)- available for someone who can be entrusted with the information.

(d) Unavailable for external use- kept or meant to be kept private, unknown, or hidden from all but a select group of people

(e) Top secret- of the highest secrecy

Some datasets may not be included in the NSDI, for example, those, which for some reasons of corporate policy or lack of capacity are not physically accessible to external users, for example, the telecommunication area exchange networks, which might be interfered with, if accessible by the general public. In addition, application datasets, which are so specialized, that have little bearing on infrastructure goals may be excluded (WCMC, 1996).

(iv) Completeness

Completeness is an assessment of the extent and range of a dataset with regard to coverage, classification and verification. Completeness indicates the presence or absence of features, their attributes and their relationships in a dataset as described by the scope. Completeness varies significantly with application and is usually defined as including information about selection criteria, definitions used and other relevant mapping rules. It also includes a description of deviations from the standard definitions and interpretations and/or statements on relationships of the objects represented within a dataset.

(v) Status

This is the condition of a dataset with regard to its stage of development. A dataset's status can be said to be complete, on going, underdeveloped or obsolete. Most users will always want to have datasets that are complete or nearing completion as opposed to one that are underdeveloped or obsolete.

(vi) Currency

This parameter tells how up-to-date a dataset is. Comparing this with the frequency of update, one will be able to tell whether the dataset is up-to date or not. Currency of a dataset depends on its application.

(vii) Co-ordinate system

Consistency of positions of different geospatial datasets is a necessary condition for their integration. In normal circumstances different datasets have been spatially referenced using different techniques (different map projections, different ellipsoids). If datasets are based on different data (Plural for datum), they cannot be easily combined. In Kenya two projections are used: Cassini based on the Clarke 1858 ellipsoid and the Universal Transverse Mercator based on the Modified Clarke 1880 ellipsoid (GK, 1989), so most datasets are likely to be based on these systems. Some datasets based on the Global Positioning System (GPS) are likely to be inconsistent with others because there is no clearly defined WGS 84 reference frame in Kenya. Therefore datasets not based on the Arc Datum 1960 should be re-examined to determine their relation with this datum and also with the proposed African Reference Frame (AFREF) (McLaughlin and Nichols, 2001). AFREF is an absolute geodetic reference frame that was proposed at CODI-Geo's 1999 meeting. AFREF could be established with 2 cm precision for all countries to connect via GPS observation. This is in line with similar reference frames established in other continents, for example, the European Reference Frame (EUREF) in Europe.

(viii) Logical consistency

Logical consistency describes the fidelity of relationships in a dataset, the logical rules of structure, and the attribute rules for geospatial data. An assessment of logical consistency includes, for instance, carrying out tests in order to know whether all points are labeled, lines intersect at nodes, lines are labeled, lines overshoot or undershoot, polygon boundaries are closed. Logical consistency can be classified (Groot and McLaughlin, 2001) as:

(a) Topological consistency: whether lines should intersect at nodes, polygons are closed, etc.

(b) Attribute database accuracy.

(c) Domain consistency: whether there is adherence to value domains, e.g. integers.

If a dataset is stored digitally then the test for topological (logical) consistency can be carried out automatically using geographic information software.

(ix) Thematic accuracy / attribute accuracy

This parameter assesses the reliability of values assigned to features in a dataset in relation to their true 'real world' values. Attribute database accuracy is the correctness and accuracy of non-quantitative and quantitative attributes respectively. Ill-defined data can introduce errors in final data, for example, when incomplete definitions of object types result in object being wrongly classified. Accuracy of attributes is verified by comparing data with randomly assigned true values, for example, comparing a field in a database with a corresponding field in another database of a higher accuracy.

(x) Data type (Domain consistency)

This is a specification of the legal value domain and legal operations allowed on values in this domain. Examples of data types include: integer, real, Boolean and character string.

(xi) Format (spatial representation)

In this context the term format should be taken to mean the spatial representation of a dataset rather than the logical structure used to store information in a file. Spatial representation refers to the method used to represent geospatial information in a dataset. The representations can be vector, grid (raster), text table, tin or stereo model.

(xii) Source scale, Resolution and level of abstraction/generalization

Digital geospatial data is scale independent, that is, it can be published at any scale. Scales should be adopted appropriate to the intended uses of the products and therefore the intended level of generalization. Level of generalization is influenced by the constraints of scale. For example, houses in a group may be shown individually on a large-scale map or a single symbol may represent the houses on a small-scale map with less precise resolution. In setting map scales, consideration should be given to equivalent pixel sizes (resolution) for corresponding digital images and raster products. Table 3-6 shows common map scales and their uses.

Scale	Appropriate uses
1:1,000,000	Global scales; equivalent to 1Km pixel size Suitable for climatologically influenced data such as soil moisture, vegetation, agricultural production
1:200,000 – 250,000	Continental/regional scales; equivalent to 30m pixel size Suitable for transnational boundary features such as land cover
1:50 000	National scales; Equivalent to 5m pixel size Suitable for monitoring renewable and non-renewable resources
1:5000 - 10 000	Urban scales; equivalent to 1m pixel size Suitable for urban planning

Table 3-6: Common scales and their uses

(xiii) Positional accuracy

The goal of an accurately georeferenced geospatial data is to locate objects exactly as they are located on the ground, as related to a common co-ordinate system. Positional accuracy is usually reported at ground scale, there is therefore a relationship between map scales and positional accuracy (see table 3-7). Positional accuracy can be considered as horizontal position accuracy and vertical position accuracy. According to National Mapping Agency Standards (NMAS) horizontal positional accuracy, using the Root Mean Square Error (RMSE), is evaluated for x and y-components individually. Generally, the standard require that 90% of well defined points that are tested fall within a specified tolerance (FGDC, 1998; Wolf, 1974);

- For map scales larger than 1:20,000, the horizontal tolerance is 1/30 inch (9mm), measured at publication scale.
- For map scales of 1:20,000 or smaller, horizontal tolerance is 1/50 inch (5mm), measured at publication scale.

On the other hand, the American Society for Photogrammetry and Remote Sensing (ASPRS) accuracy for large scale maps, provide accuracy tolerances for maps at 1:20,000 scales or larger. Accuracy is reported as Class 1, Class 2 or class 3. Class2 applies to maps compiled within limiting RMSE's twice those allowed for Class 1 maps. Similarly, class 3 accuracy applies to maps compiled within limiting RMSE's three times those allowed for class 1 maps.

Class 1 Planimetric Accuracy Limiting RMSE (meters)	Map Scale
0.0125	1:50
0.025	1:100
0.050	1:200
0.125	1:500
0.25	1:1,000
0.50	1:2,000
1.00	1:4,000
1.25	1:5,000
2.50	1:10,000
5.00	1:20,000

Table 3-7: ASPRS Class 1 horizontal Accuracy Standard for Large-scale maps

Equally, for vertical position accuracy, NMAS specifies the maximum allowable vertical tolerance to be one half of the contour interval, at all contour intervals. Vertical map accuracy is defined by the ASPRS Accuracy Standard as the RMSE in terms of the project's elevation datum for well-defined points only. For Class 1 maps according to ASPRS Accuracy Standard, the limiting RMSE is set at one third the contour interval. Spot elevation shall be shown on the map with a limiting RMSE of one-sixth the contour interval or less.

(xiv) Price

This is the fees and terms for retrieving a dataset. It also includes monetary units, for example, US$ and KShs. This parameter lets the user compare costs of alternative datasets or compare the price with cost specifications if any.

(xv) How to order

These are general instructions, terms and services provided by the distributor on how to obtain a dataset.

3.3 How to evaluate datasets

The parameters that were determined in section 3.2 are used to evaluate the suitability of the datasets in the inventory. The criteria for evaluation are given in Table 3-8. A dataset after the evaluations is generally said to be:

- Very suitable: If accessible, in digital form, catalogued, complete or nearing completion, complete in coverage, in Arc Datum 1960.
- Suitable: If a dataset is available (catalogued), in digital form and accessible.
- Unsuitable: If either not available, not in digital form or not accessible.
- Very unsuitable: If neither available, nor in digital form nor accessible.

Parameter	Criteria	Recommendation
Availability of metadata (Catalogue/Metadata)	If No catalogue or metadata (1) Unsuitable	Include dataset in catalogue and build metadata
	If Catalogue/Metadata (2) Suitable	Suitable
Form	If analogue (1) Unsuitable	Dataset should be converted to digital form
	If digital (2) Suitable	Suitable
Accessibility	If Top secret/Unavailable for external use (1) Unsuitable	Restriction should be reviewed
	If Restricted to most (2) Suitable	Suitable
	If Unrestricted/restricted to some (3) Very suitable	Very suitable
Completeness (coverage)	If less than 50% (1) Unsuitable	Dataset coverage should be completed
	If more than 50% (2) Suitable	Suitable
Status	If on-going /underdeveloped/obsolete (1) Unsuitable	The dataset should be completed
	If Nearing completion/Complete (2) Suitable	Suitable
Co-ordinate system	If not Arc Datum 1960 (1) Unsuitable	Should be transformed to Arc Datum 1960
	If datum is Arc Datum 1960 (2) Suitable	Suitable
Logical consistency (Topological	If no topologically consistent (1) Unsuitable	Organize the dataset to some level of topology
	If topologically consistent (2) Suitable	Suitable
Thematic accuracy (Attribute accuracy)	If not consistent (1) Unsuitable	Check accuracy of point, line, polygon labels
	If Consistent (2) Suitable	Suitable
Domain consistency (Data type)	Depends on application	Depends on application
Format	Depends on application	Depends on application
Source scale, Positional accuracy, Level of abstraction/generalizati	Depends on application	Depends on application
Currency	Compare last day of update with intended use	Depends on application
Cost	Compare value with price specifications if available	
How to order	If off-line (1) Suitable	
	If on-line (2) Very suitable	

Table 3-8: Evaluation criteria for datasets

3.4 Determining parameters to use to evaluate systems for compatibility

For a NSDI to function properly, reliable and efficient computing and communication technologies must be in place. Technology in NSDI includes: computer hardware (PCs, gateways and servers), software and networks (LAN, Internet) that enable SDI linkages. Most of the devices in a communication network have many properties, which include cost; availability and compatibility just to name a few.

Considering that devices in a SDI should allow for open access to data, it is necessary that these devices (systems) are compatible. Compatibility in NSDI should be taken to mean the types of traffic (data) and links that a particular server node can handle. A node is a generic term used to refer to devices used to construct a network (Uyless, 1993). Nodes are distinguished by their functions, for example, terminals (PCs, workstations), servers, and gateways. A terminal is a source or destination of low volume traffic, usually serving a single user. A terminal usually includes a keyboard and a monitor and can also include disk drives. A PC, workstation may serve as a terminal. A server on the other hand, is a computer that provides and manages access to resources for other computers in a network. The server is said to be 'serving' others. In a network, various computers can act as print server, file server or database server. A network will typically have servers. For connections with other networks, gateways are used. A gateway is a network device that connects different equipment that don't share even the same routing protocol, that is they perform relay functions between networks. Some devices cannot handle links above certain speeds; also other devices cannot interconnect with others or participate in some network architectures because of the software they are using (and therefore the protocol they support) are not compatible (Aaron, 1993).

Compatibility of systems is only achievable if there is an open systems architecture and if they are interoperable. The Open GIS Consortium (OGC)* is one of the associations that are promoting the joint definition, development and promotion of geoprocessing specifications to support interoperable solutions. Open systems co-operate with each other using standards for access, processing and transfer of data; and they are not hindered by specific architectures. System architectures simply refer to the manner in which computers are organized. Computers may be arranged as individual stand-alone machines or co-operate in networks. File server (single–tier) and client server architectures are examples of network architectures. In a file server architecture, each workstation in the network has access to a central file server where data is stored, while in a client-server architecture, some computers 'serve' others in the network (Lee and Christensen, 1999).

Against this background, compatibility of systems can be considered in two ways; where online communication is possible and where it is not (off-line).

In off-line (in some literature referred to as 'classical') communication, the parameters include the following:

(i) Computer memory (RAM), e.g. 128 MB

(ii) The Operating System (OS), e.g. Window NT, XP, UNIX

(iii) The GIS software, e.g. ArcGIS, ILWIS, IDRISI

(iv) Data interchange formats, e.g. DXF, TIFF

(v) Database Management Systems (DBMS), whether it incorporates the simple feature specifications for the Structured Query Language (SQL).

It is sometimes 'folly' to think that a 'must have' computer should be the latest and the fastest. If one wants a computer for connection to the Internet (to enable SDI linkages), then one does not need the fastest computer or modem or anything very expensive. The reason for this is that Internet access speed is limited mainly by the phone line and what is going on at the server (server node), rather than how fast the processor is.

SDI can be said to make sense even when the services are 'classical' (that is ordering, delivery, payment are off-line and catalogue, visualization are on hardcopy). The ultimate realization of a SDI is one that is infrastructure-based, standards-based and full-functioned (Douglas, 2001). In such a situation, a user with a search user interface fills out a search form. The search request is passed to a gateway, which passes the query to one of the registered servers (each catalogue server manages a collection of metadata entries). Interoperable search across national/international catalogues can be achieved through use of *common descriptive vocabulary* (for metadata), a *common search and retrieve protocol* and a *registration system for servers* of metadata. In on-line/ infrastructure enabled communication, the parameters include:

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* The Open GIS Consortium (OGC) is an international industry consortium of private companies, government agencies and universities, which promotes interoperability by developing and publishing implementation specifications.

(vi) Database architecture, i.e. distributed or centralized

(vii) Registration system for servers

(viii) Search/ Retrieve protocol adopted by server nodes

(ix) The type of traffic the network can handle

(x) Data transfer rates

(i) Computer memory (RAM) and disk space

Sufficient Computer memory is required to ensure compatibility. For optimal solutions appropriate computer memory and disk space should be used for particular operating systems and applications as specified. Different applications have different RAM specifications, for example, 64MB is common.

(ii) The Operating System

The operating system controls the execution of application programs and acts as an interface between software and computer hardware. Operating systems evolve because of hardware upgrades plus the emergence of new hardware. Different geospatial applications require specific operating systems, and these should generally allow for input/output management, file management, distributed computing and above all computer security. The operating system of choice should be one that is most portable, for example, Windows.

(iii) The GIS software

GIS softwares have different capabilities for different applications. Because of this they also support different file formats. If compatibility is of concern, then the proprietary formats must be used outside their native systems, or the GIS software should support at least the common file transfer formats and allow for a distributed computing environment.

(iv) Data interchange formats

The term data format refers to the logical structure used to store information in a GIS file. File formats are important in part because not every GIS software package supports all formats. If one wants to use a dataset, but it isn't available in a format that his GIS supports, then he will have to find a way to transform it, find another dataset or find a GIS that supports that format.

There are many data formats. The formats are for vector, raster and attribute data (hhtp://www.gisdatadepot.com/helpdesk/format.html).

Vector formats:

(i) Arc Export is a transfer format, either ASCII or compressed into binary used to transfer files between different versions of ARC/INFO. It is undocumented and will only work with ESRI products.

(ii) Arc/Info "coverage" is an asset of internal binary file used by Arc/Info. This format is proprietary and is not readily usable by other programs.

(iii) AutoCAD Drawing files (DWG) is the internal proprietary format used in AutoCAD, which is a Computer Aided Design program. AutoCAD can convert any DWG to a DXF file without loss of graphic information.

(iv) AutoDesk's Data Interchange File (DXF) format is the most widely used vector transfer format.

(v) Digital Line Graphs (DLG) is a transfer format used by US Geological survey (USGC).

(vi) MapInfo Data Transfer Files (MIF/MID). This format carries three types of GIS information: position, attribute and display.

(vii) MicroStation Design File (DGN) is the internal format used by Bentley's Microstation, a CAD program. It is well documented and standardized and can therefore be used as a transfer standard.

(viii) Spatial Data Transfer System (SDTS) is a relatively new format developed by the US government, designed to handle all positional data. It is supposed to be the foundation of the US National Spatial Data Infrastructure.

Other formats include Topologically Integrated Geographic Encoding and Referencing Files (TIGER) and Vector Product Format (VPF) formats used by US Census bureau and US mapping agency respectively.

There are three candidate file formats for an online vector file on the World Wide Web (www): the Simple Vector Format, the web Computer Graphics Metafile (CGM) and XML-based encoding (Douglas, 2001).

Raster formats:

(i) Arc Digitized Raster Graphics (ADRG) is used by US military to store raster images of raster maps

(ii) Band Interleaved by Line (BIL), Band Interleaved by Pixel (BIP) and Band Sequential (BSQ) are formats produced by remote sensing systems.

(iii) Digital Elevation Model (DEM) is a raster format used by the USGC to record elevation information.

(iv) PC Paint Brush Exchange (PCX) is a common raster format produced by most scanners.

(v) Tagged Image File Format (TIFF), GeoTIFF (TIFF with georeferencing information tags) and Joint Photographic Expert Group (JPEG) are common raster formats produced by scanners and PC drawing programs.

Raster data is characterized by large file sizes. The limiting Internet bandwidth will automatically require compressed files. That is why compressed raster files predominate web-based portrayals for both vector and raster data. Common web raster formats include GIF, JPEG.

(v) Database Management System (DBMS)

A DBMS is commonly understood to mean the software that manages the attribute data for a set of features. Examples include Ms Access and Oracle. Though there are various DBMS, for interoperability, a DBMS should incorporate Simple Feature (SF) specification for SQL as specified by OGC. Simple feature specification is an OGC specification for open interfaces that enable diverse systems to communicate using simple vector features composed of points, lines and polygons. Three profiles that have been released include SQL, COM-based and CORBA distributed computing platforms (ESRI, 2003).

(vi) Database architecture

Database architecture can either be centralized or distributed. In centralized database (file server) architecture, each workstation in the network has access to a central database, while in distributed (client-server) architecture; some computers store the database, which others in the network can access. For geospatial solutions distributed database architecture is recommended, because of the distributed nature of NSDI; in addition, local autonomy can be exercised, responses are much faster and a high compatibility of systems expected from the on-going standards development efforts.

(vii) Server registration system (server registry)

If a server node is to be recognized in a network it must have a unique name within the network. Therefore, all server nodes in a particular NSDI clearinghouse must be based on same registration scheme (registry). The registry is a searchable catalogue in its own right. The scheme should follow the Domain Names Service (DNS) model of the Internet.

DNS is a service that converts domain names to their corresponding numerical Internet Protocol (IP) addresses (Comer, 1995). Domain names are alphanumeric strings identifying Internet hosts based on a hierarchical naming convention. For example, in domain name *uonbi.ac.ke*, *uonbi* (university of Nairobi) is a domain within a larger domain *ac* (for academic), which is the domain of academic institutions within the major domain *ke* (for Kenya). There are two types of top-level domains: generic and country. Specific generic domains include *com* (for commercial), *org* (for non-profit organizations) and *net* (network providers). Country domains use the ISO 3166 country codes (Groot and McLaughlin, 2001). An IP address is a unique compound number, which is assigned to each computer connected to the Internet. The IP is a 32-bit number, usually expressed as a four single byte values, each in the range 0-255, separated by periods in what is called "dotted quad" notation. For example, in 127.18.53.10 IP address, part of this number addresses the host network, while the rest refers to a single computer in that network.

(viii) Search/ retrieve protocol

For an interoperable search by servers, they need to support and use a common protocol. The following are the common protocols used with digital geospatial data. The Structured Query Language (SQL) for database query; eXtensible Markup Language (XML) for the Internet; Wireless Application Protocol (WAP) for mobile phones; Unified Model Language (UML) for data models and Transmission Control Protocol and Internet Protocol (TCP/IP) for Internet traffic. The Z39.50 is the current metadata catalogue search and retrieve protocol while the OGC catalogue is the future protocol for a fully functioning SDI. Z39.50 offers a variety of search and retrieve facilities suitable for computer database systems.

(ix) Type of traffic

In this time and age, network traffic ranges from voice, text, and graphics to image data, generally referred to as multimedia. A given network should ideally support all multimedia data types. Though guided transmission media such as cables and fibre optics dominates transmission, unguided (or wireless) transmission is achieved by using electromagnetic waves. Only radio and microwaves as well as infrared and visible light are used for transmitting information. The advantage of wireless transmission is that one transmitter can reach many receivers. Depending on the wavelength used, a repeater must be installed at certain distances, for example, for microwave links, which are frequently used; a repeater is required about every 50 Km (Groot and McLaughlin, 2001).

In Kenya, most networks are based on telephone lines, in which case only voice data is transmitted. Despite this limitation however, the Integrated Services Digital Network (ISDN) has made possible the transmission of other forms of data through the analogue telephone network. ISDN is a high-speed digital telephone service that can dramatically increase the speed at which one connects to the Internet or Local Area Network (LAN). ISDN allows digitization of telephone systems and therefore accepts digital data directly with the potential to allow voice, text, fax and video signals.

(x) Data transfer rate

Analogue telephone can reach 28.8Kbps; while with ISDN Speeds of up to 155Mbps are possible (Groot and McLaughlin, 2001). If telephone speeds are still limiting, new possibilities exist within the wireless communication realm.

3.5 How to evaluate systems

Since a system is composed of various components, the evaluation should therefore consider the particular properties of these components as discussed in section 3.4. Table 3-9 highlights the evaluation criteria for the systems.

Parameter	Criteria
Computer processor and memory	Pentium III and above are recommended
Operating System (OS)	How portable the OS is.
GIS Software	Should be object or component based: e.g. COM, CORBA compliance
Data interchange formats	Vector: DXF, XML; Raster: JPEG, GIF, TIF
Data Base Management System	Should incorporate Simple Feature specification for SQL
Database architecture	Preferably, Distributed
Registration system for metadata servers	The Domain Names Service model of the Internet is recommended
Search/retrieve protocol	The protocol the server node is based on: TCP/IP, Z39.50, OGC
Type of traffic	Most types of data should be supported, i.e. voice, text, image, graphic
Data transfer rate	Different communication media allow different rates of data transfer. At least 28.8 kbps

Table 3-9: Evaluation criteria for systems

CHAPTER 4: RESULTS AND ANALYSIS

Identifying potential participants in the NSDI is an important step in the development of Kenya's NSDI. Overall, over 40 institutions were approached, of which 84% responded positively to the interviews. The respondents included 10 government departments, 8 government parastatals, 6 Research/ international institutions, 8 private and 4 academic institutions. More institutions than are listed in Tables 3-1 to 3-5 were approached for example the Kenya Pipeline Corporation (KPC) who appeared suspicious and therefore were omitted from the sample. Figure 4-1 shows the percentage representation of the institutions surveyed.

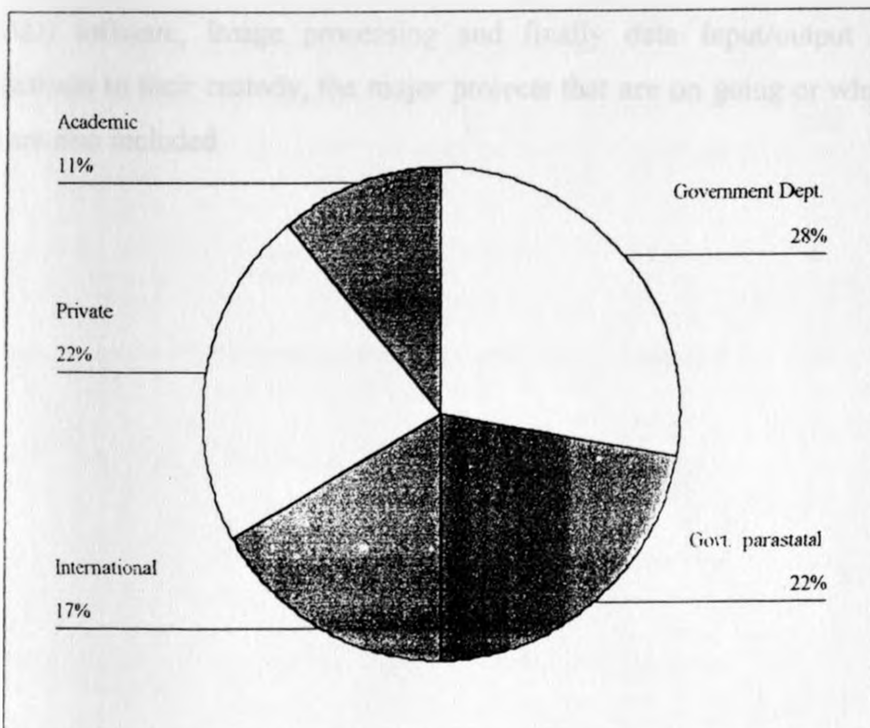

Figure 4-1: Institutions surveyed by category

The list was drawn based on previous knowledge of the institutions and suggestions from my supervisor. Although the description may have been largely determined by the sampling, it nevertheless indicates the general situation in Kenya. Government departments and parastatals represent 50%. What this in effect implies is that the success or failure of NSDI depends on government departments and parastatals. This is because most of geospatial information is in their holding, and this is the information that should be made accessible.

4.1 The Inventory

The inventory as constituted does not contain each and every user and producer of geospatial data in Kenya, but only those that responded in the course of a two and half months survey. Again, a few changes may have occurred since the interviews, for example, the Electoral Commission of Kenya (ECK) has since installed a GIS. Generally, the inventory contains the institutions (by category), their telephone numbers, postal and e-mail addresses, physical location and website. Another section lists the kind of systems used in the institutions. The systems are categorized as GIS software, database management systems, Computer Aided Design (CAD) software, Image processing and finally data input/output devices. The geospatial datasets in their custody, the major projects that are on going or which have been undertaken are also included.

KENYA NSDI INVENTORY

Survey of Kenya (SOK)

ADDRESS: P.O BOX 30046 NAIROBI | TEL: 802241 | FAX:
PHYSICAL LOCATION: Ruaraka | E-MAIL: sok@gt.co.ke | WEBSITE:

GIS SOFTWARE	VERSION
Workstation ArcInfo	7.1
ArcGIS	8.1
Demeter	-

IMAGE PROCESSING

Photoshop suite

DATABASE ARCHITECTURE

CENTRALIZED: No
DISTRIBUTED: Yes

DBMS

Ms Access

CAD

Microstation

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Oce graphics	4
SCANNER:	A0	4
PLOTTER:	HP	4
PRINTER:	HP,Epson	3
INTERNET ACCESS:	Yes	
PC	Yes	6

OPERATING SYSTEM

WINDOWS: 95,98,2000
UNIX: No

ON-GOING/UNDERTAKEN PROJECT: The establishment of the spatial framework data for the city of Nairobi and the development of National spatial datasets at scales of 1:250,000 and 1:50,000

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Kenya administrative	Boundaries	Geodetic and Mapping	Kenya (whole)	Hard copy map	1:1000000	Unrestricted	500	Manual catalogue	Complete
Topographic maps	Imagery/Base maps/Earth cover	Geodetic and mapping	1:50000 and 1:250000	Hardcopy map	1:50000	Restricted to some	500	Digital catalogue	Complete
Cadastral	Planning/cadastre	Cadastral	Kenya (whole)	Hard copy map	1:2500, 1:5000, 1:10000,1:25000	Unrestricted	200	Manual catalogue	Complete
Aerial Photographs	Imagery/Base maps/Earth cover	Geodetic and Mapping	Kenya (whole)	Hard copy	1:12500-1:50000	Restricted to some	500	Manual catalogue	Complete
Kenya Atlas	Imagery/Base maps/Earth cover	Geodetic and Mapping	Kenya (whole)	Hard copy map	Various	Unrestricted	5000	Digital catalogue	Complete
Global map	Imagery/Base maps/Earth cover	Geodetic and Mapping	Kenya (whole)	Digital map	1:1000000	Unrestricted		Digital catalogue	Complete
Topographic maps	Imagery/Base maps/Earth cover	Geodetic and Mapping	Kenya (10%)	Digital map	1:50000	Restricted to some	-	Digital catalogue	Under-developed
Geodetic network	Geosciences	Geodetic	Kenya	Hardcopy map	1:1000000	Restricted to some	-	-	Complete

Department of Buildings

ADDRESS: P.O BOX 30260 NAIROBI | TEL: 723101 | FAX:
PHYSICAL LOCATION: Transcom house | E-MAIL: | WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
		CENTRALIZED:	-	DEVICE	VERSION	NO.
		DISTRIBUTED:	-	DIGITIZING TABLE:		
		DBMS		SCANNER:		
				PLOTTER:		
				PRINTER:		
				INTERNET ACCESS:		
IMAGE PROCESSING		CAD		PC		
				OPERATING SYSTEM		
				WINDOWS:		
				UNIX:		

ON-GOING/UNDERTAKEN PROJECT: Topographic survey for design of government facilities

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Topographic maps	Planning/cadastre	Building		Hardcopy map	Various	Restricted to most		Manual catalogue	Complete

Central Bureau of Statistics (CBS)

ADDRESS: P.O BOX 30266 NAIROBI | TEL: 333970 | FAX: 333030
PHYSICAL LOCATION: Lt. Tumba Avenue | E-MAIL: director@cbs.go.ke | WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
PC ArcInfo	3.5	CENTRALIZED:	Yes	DEVICE	VERSION	NO.
MapInfo	4.0	DISTRIBUTED:		DIGITIZING TABLE:	Calcomp	8
ArcGIS	8.3	DBMS		SCANNER:	Yes	
				PLOTTER:	HP DesignJet 750c	3
				PRINTER:	Yes	
				INTERNET ACCESS:	Yes	
IMAGE PROCESSING		CAD		PC	Yes	
				OPERATING SYSTEM		
				WINDOWS:	3.1,3.11,95,98,2000,	
				UNIX:		

ON-GOING/UNDERTAKEN PROJECT: National Sample and Evaluation Programme (NASSEP), Kenya poverty mapping project

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
District map	Boundaries/Population	Cartography	Kenya (Whole)	Digital map	1:50000,1:250000	Unrestricted	1500	Manual catalogue	Complete

Department of Physical planning

ADDRESS: P.O BOX 45025 NAIROBI
PHYSICAL LOCATION: Ardhi house
TEL: 718050
E-MAIL: dpp@africaonline.co.ke
FAX: -
WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
				DEVICE	VERSION	NO.
PC ArcInfo	-	CENTRALIZED:	No	DIGITIZING TABLE:		2
ArcView	-	DISTRIBUTED:	No	SCANNER:		2
MapInfo	-	**DBMS**		PLOTTER:		2
ArcGIS	-	Ms Access		PRINTER:		3
IDRISI	-	-		INTERNET ACCESS:	Yes	
IMAGE PROCESSING		**CAD**		PC	Yes	10
Yes		Yes		**OPERATING SYSTEM**		
		-		WINDOWS:	95,98,2000,NT	
		-		UNIX:	No	

ON-GOING/UNDERTAKEN PROJECT: Conversion of analogue data to digital format of urban areas

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Regional planning	Planning/cadastre	Physical planning	Kenya (Country-wide)	Digital map	1:2500	Unrestricted	-	None	Complete

Department of Roads- MORPWH

ADDRESS: P.O BOX 30260 NAIROBI
PHYSICAL LOCATION: Transcom house
TEL: 723101
E-MAIL:
FAX: -
WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
				DEVICE	VERSION	NO.
PC ArcInfo	8.2	CENTRALIZED:	-	DIGITIZING TABLE:	(Not in use)	1
	-	DISTRIBUTED:	Yes	SCANNER:		-
	-	**DBMS**		PLOTTER:	HP 450c	2
	-	Ms Access		PRINTER:	HP	2
	-	SQL		INTERNET ACCESS:	Yes	
IMAGE PROCESSING		**CAD**		PC	Yes	8
		AutoCAD		**OPERATING SYSTEM**		
		-		WINDOWS:	98,2000,NT	
		-		UNIX:	No	

ON-GOING/UNDERTAKEN PROJECT: Kenya Road network inventory and condition survey project

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Kenya roads Network	Transportation	Roads	Kenya	Digital document		Restricted to some	-	None	Nearing completion

Kenya map	Boundaries/Population	Cartography	Kenya (Whole)	Digital map	1:50000,1:250000	Unrestricted	1500	Manual catalogue	Complete
Village map	Boundaries/Population	Cartography	Kenya (43 districts)	Hardcopy map	1:2500,1:10000, 1:50000,1:250000	Restricted to some	750	Manual catalogue	Complete
Village map	Boundaries/Population	Cartography	Kenya (26 districts)	Digital map	1:2500,1:10000, 1:50000,1:250000	Restricted to some	1500	Manual catalogue	Nearing completion

Ministry of water

ADDRESS: P.O BOX 30521 NAIROBI
PHYSICAL LOCATION: Maji House
TEL: 716103
E-MAIL: olemiso-dwd@maji.go.ke
FAX: 727622
WEBSITE:

GIS SOFTWARE	VERSION
ArcView	3.2
ILWIS	2.0
-	-
-	-
-	-

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED: Yes
DISTRIBUTED: -

DBMS

Ms Access
Oracle

CAD

AutoCAD
-
-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Yes	-
SCANNER:	Yes	-
PLOTTER:	Yes	-
PRINTER:	Yes	-
INTERNET ACCESS:	Yes	
PC	Yes	

OPERATING SYSTEM

WINDOWS: 98,2000,NT, XP
UNIX: -

ON-GOING/UNDERTAKEN PROJECT:

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
-				-		-		-	-

Dapartment of Resource Surveys and Remote Sensing (DRSRS)

ADDRESS: P.O BOX 47146 NAIROBI **TEL:** 609013 **FAX:** -
PHYSICAL LOCATION: Kapiti road **E-MAIL:** drsrs@meteo.go.ke **WEBSITE:** www.drsrs.meteo.go.ke

GIS SOFTWARE	VERSION
PC ArcInfo	7.0
Workstation ArcInfo	8.1
ArcView	3.2
ArcGIS	8.10
ILWIS	-

IMAGE PROCESSING
ERDAS

DATABASE ARCHITECTURE
CENTRALIZED: Yes
DISTRIBUTED: Yes

DBMS
Ms Access
-

CAD
-
-
-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Calcomp	2
SCANNER:	A4	2
PLOTTER:	HP 6500	1
PRINTER:	Yes	-
INTERNET ACCESS:	Yes	
PC	Yes	13

OPERATING SYSTEM
WINDOWS: 3.1,3.11,95,98,2000,
UNIX: Yes

ON-GOING/UNDERTAKEN PROJECT: Land use/cover and environmental mapping through aerial photography and remote sensing

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Wildlife Distribution maps	Biota(fauna/flora)	GIS section	Kenya(Rangeland districts)	Digital map	Field survey	Unrestricted	50	Digital catalogue	Complete
Landuse/cover	Biota(fauna/flora)	GIS section	Kenya (All Districts)	Digital map	1:250000	Unrestricted	50	Digital catalogue	Complete

Department of Urban Development-MLG

ADDRESS: P.O BOX 30004 NAIROBI **TEL:** 340972 **FAX:** -
PHYSICAL LOCATION: Cianda house **E-MAIL:** **WEBSITE:**

GIS SOFTWARE	VERSION
ArcView	3.2
	-
	-
	-
	-

IMAGE PROCESSING
Photo Impact

DATABASE ARCHITECTURE
CENTRALIZED: Yes
DISTRIBUTED: -

DBMS
Ms Access
-

CAD
AutoCAD
Microstation
LisCAD

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Yes	2
SCANNER:	No	-
PLOTTER:	HP 750c	2
PRINTER:	Yes	-
INTERNET ACCESS:	Yes	
PC	Yes	70

OPERATING SYSTEM
WINDOWS: NT
UNIX: -

ON-GOING/UNDERTAKEN PROJECT: Kenya Urban Transportation Infrastructure (KUTIP) project, Slum upgrading, Nairobi storm water drainage

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS

Local Authorities Topographic maps	Imagery/Base maps/Earth cover	Survey and Planning	Specific towns (26 towns)	Hardcopy map	1:2500	Unavailable for external use	-	Manual catalogue	Complete
Local Authorities Road network	Transportation	Survey and Planning	Specific towns (26 towns)	Digital map	1:2000	Unavailable for external use	-	-	Complete

Kenya Meteorological Department (KMD)

ADDRESS: P.O BOX 30259 NAIROBI **TEL:** 567880 **FAX:** 576955

PHYSICAL LOCATION: Dagorreti corner **E-MAIL:** director@lm.meteo.go.ke **WEBSITE:** www.meteo.go.ke

GIS SOFTWARE	VERSION
IRISI32	132.2
-	-
-	-
-	-
-	-

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED: Yes

DISTRIBUTED: Yes

DBMS

Ms Access

Oracle

CAD

-

-

-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Yes	2
SCANNER:	Yes	10
PLOTTER:	Yes	2
PRINTER:	Yes	30
INTERNET ACCESS:	Yes	
PC	Yes	100

OPERATING SYSTEM

WINDOWS: 3.1,3.11,95,98,2000,

UNIX: Yes

ON-GOING/UNDERTAKEN PROJECT:

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
METEOSAT	Climatology/Meteorology/Atmosphere	KMD	Africa and part of Europe	Digital image	5 Km	Restricted to some		None	Complete
Rainfall	Climatology/Meteorology/Atmosphere	KMD	Kenya (Country-wide)	Digital document		Unrestricted	-	-	-
NOAA	Climatology/Meteorology/Atmosphere	KMD	east Africa, horn of Africa, and part of West Africa	Digital image	1 Km reolution	Restricted to some	-	Manual catalogue	Complete

Nairobi City Council (NCC)

ADDRESS: P O BOX 30075 NAIROBI | TEL: 220067 | FAX: 230640

PHYSICAL LOCATION: City Hall | E-MAIL: | WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE	DATA INPUT/OUPUT DEVICES		
		CENTRALIZED:	**DEVICE**	**VERSION**	**NO.**
		DISTRIBUTED:	DIGITIZING TABLE:		
			SCANNER:	A3	
		DBMS	PLOTTER:	Yes	
		Ms Access	PRINTER:		
			INTERNET ACCESS:	Yes	
IMAGE PROCESSING		**CAD**	PC	Yes	386
Adobe suite		AutoCAD	**OPERATING SYSTEM**		
		ArchiCAD	WINDOWS: 98,2000,XP		
		Corel Draw	UNIX: Yes		

ON-GOING/UNDERTAKEN PROJECT: The establishment of the spatial framework data for the city of Nairobi (Digital mapping of the city of Nairobi),

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Topographical maps	Imagery/Base maps/Earth cover	City Planning	Nairobi (682 Km2)	Hardcopy map	1:2500	Restricted to some		None	
Cadastral	Cadastre/planning	Survey	Nairobi city	Hardcopy map	1:10000	Unrestricted			

Electoral Commission of Kenya (ECK)

ADDRESS: P.O BOX 45371 NAIROBI | TEL: 222072 | FAX: 223998

PHYSICAL LOCATION: Anniversary Towers | E-MAIL: eck@nbnet.co.ke | WEBSITE: www.eck.or.ke

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE	DATA INPUT/OUPUT DEVICES		
ArcGIS	8.3	CENTRALIZED: .	**DEVICE**	**VERSION**	**NO.**
	.	DISTRIBUTED: .	DIGITIZING TABLE:	Yes	2
	.		SCANNER:	Yes	1
	.	**DBMS**	PLOTTER:	Yes	3
	.	Ms Access	PRINTER:	Yes	20
		.	INTERNET ACCESS:	Yes	
IMAGE PROCESSING		**CAD**	PC	Yes	50
		.	**OPERATING SYSTEM**		
		.	WINDOWS: 2000,XP		
		.	UNIX: .		

ON-GOING/UNDERTAKEN PROJECT: Review of constituency and civic wards , Registration of voters

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS

Constituency maps	Cartography		Kenya (Country-wide)	Hardcopy map	1:1000000, 1:250000, 1:100000, 1:50000,	Unrestricted	500	None	

Kenya Soil Survey (KSS)

ADDRESS: P.O BOX 14733 (00800) Westlands NAIRO TEL: 4440903 FAX: 4443376
PHYSICAL LOCATION: Waiyaki way E-MAIL: kss@iconnect.co.ke WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
				DEVICE	VERSION	NO.
PC ArcInfo	3.5	CENTRALIZED:	Yes	DIGITIZING TABLE:	A0,A3	2
ArcView	3.3	DISTRIBUTED:	.	SCANNER:	Yes	.
	.	**DBMS**		PLOTTER:	A0	1
	.	dbase		PRINTER:	Laser jet	2
	.	.		INTERNET ACCESS:	Yes	
IMAGE PROCESSING		**CAD**		PC	Yes	3
		AutoCAD		**OPERATING SYSTEM**		
		.		WINDOWS:	98,2000,NT, XP	
		.		UNIX:	.	

ON-GOING/UNDERTAKEN PROJECT: Kenya Soils and Terrain Database (KENSOTER), Western Kenya ecosystem project and Impacts of re-afforestation and farming technologies to mitigate effects of deforestation

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Kensoter database	Farming	KSS	Kenya	Digital map	1:1000000	Restricted to some	.	Manual catalogue	Complete

National Museums of Kenya (NMK)

ADDRESS: P.O BOX 40658 (00100) NAIROBI TEL: 3742161 FAX: 3741424
PHYSICAL LOCATION: Museum hill E-MAIL: nmk@museums.co.ke WEBSITE: www.museums.co.ke

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
				DEVICE	VERSION	NO.
PC ArcInfo	3.5	CENTRALIZED:	.	DIGITIZING TABLE:	A1Altek A1	1
ArcView	3.2	DISTRIBUTED:	Yes	SCANNER:	HP A4	1
MapInfo	5.5	**DBMS**		PLOTTER:		.
	.	Ms Access		PRINTER:	HP A3	1
	.	File maker		INTERNET ACCESS:	Yes	
IMAGE PROCESSING		**CAD**		PC	Yes	2
Photoshop suite		AutoCAD		**OPERATING SYSTEM**		
		.		WINDOWS:	XP	
		.		UNIX:	.	

ON-GOING/UNDERTAKEN PROJECT: Developing GIS database for archaelogical and palaentological sites

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS

Kenya Geology	Geosciences	Sites and Monument	Kenya	Digital map	1:1000000	Restricted to most		None	Nearing completio n
Arcsites	Cultural features	Sites and Monument	Kenya	Digital map	1:50000	Restricted to some	.	None	Nearing completio n

Kenya Wildlife Service

ADDRESS: P.O BOX 40241 NAIROBI **TEL:** 501081 **FAX:** 603792

PHYSICAL LOCATION: Off-Langata road **E-MAIL:** kws@kws.org **WEBSITE:** www.kws.org

GIS SOFTWARE	VERSION
Workstation ArcInfo	8.1
ArcView	3.2
ArcGIS	-
	-
	-

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED: Yes

DISTRIBUTED: -

DBMS

Ms Access

-

CAD

AutoCAD

-

-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Calcomp and Suma	2
SCANNER:	A4	1
PLOTTER:	HP 750c	1
PRINTER:	A4	2
INTERNET ACCESS:	Yes	
PC	Yes	5

OPERATING SYSTEM

WINDOWS: 95,98,2000

UNIX: -

ON-GOING/UNDERTAKEN PROJECT: Aerial, terrestruial and marine census of animals

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Wildlife protected areas	Biota(fauna/flo ra)	Research	Wildlife protected area (10%)	Digital map	Various	Restricted to some		Digital catalogue	Nearing completio n
Animal counts	Biota(fauna/flo ra)	Research	Kenya (10 Ecosystems)	Digital map	1:50000	Restricted to some	-	None	Complete

Kenya Power and Lighting Company (KPLC)

ADDRESS: P.O BOX 30099 NAIROIBI | TEL: 243366 | FAX: .
PHYSICAL LOCATION: Parklands (Kolobot rd.) | E-MAIL: | WEBSITE: www.kplc.co.ke

GIS SOFTWARE | **VERSION**
SGD .

IMAGE PROCESSING

DATABASE ARCHITECTURE
CENTRALIZED: Yes
DISTRIBUTED: Yes

DBMS
Ms Access
Oracle

CAD
AutoCAD

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Calcomp	3
SCANNER:		.
PLOTTER:	HP 1055cm	4
PRINTER:		.
INTERNET ACCESS:	Yes	
PC	Yes	.

OPERATING SYSTEM
WINDOWS: 98,2000,NT
UNIX: Yes

ON-GOING/UNDERTAKEN PROJECT: Electrical network and base physical network

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Electrical network	Utilities/Communication	IT&T	Kenya(Nairobi and Cost Regions)	Digital map	1:2500	Restricted to some	.	Digital catalogue	.
Cadastral maps	Utilities/Communication	FBD Design	Ngong, Kikuyu-Ruiru Asreas	Hardcopy map	1:2500,1:2000	Unavailable for external use			Complete

Kenya Forestry Research Institute

ADDRESS: P.O BOX 20412 NAIROBI | TEL: 15432891 | FAX: 32844
PHYSICAL LOCATION: Muguga | E-MAIL: kefri@arcc.or.ke | WEBSITE:

GIS SOFTWARE | **VERSION**
MapInfo .

IMAGE PROCESSING

DATABASE ARCHITECTURE
CENTRALIZED: Yes
DISTRIBUTED: .

DBMS
Fox pro

CAD

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:		.
SCANNER:	A4	6
PLOTTER:		.
PRINTER:		.
INTERNET ACCESS:	Yes	
PC	Yes	120

OPERATING SYSTEM
WINDOWS:
UNIX: .

ON-GOING/UNDERTAKEN PROJECT: International Forestry Resources and Institutions project (IFRI), Global Forestry Information System (GFIS)

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS

Indigenous trees	Environment	Forestry department	Kenya	Hardcopy map	1:1000000	Restricted to some	-	Manual catalogue	Complete

Telkom Kenya

ADDRESS: P.O BOX 30301 (00100) NAIROBI | TEL: | FAX: -
PHYSICAL LOCATION: Teleposta | E-MAIL: | WEBSITE: www.telkom.co.ke

GIS SOFTWARE | **VERSION**

-
-
-
-
-

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED: -
DISTRIBUTED: -

DBMS

-
-

CAD

-
-
-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:		-
SCANNER:		-
PLOTTER:		-
PRINTER:		-
INTERNET ACCESS:	Yes	
PC	Yes	-

OPERATING SYSTEM

WINDOWS:
UNIX: -

ON-GOING/UNDERTAKEN PROJECT: To start GIS, Fibre optic network (SDH) and East Africa Digital Link

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Exchange Area Network	Utilities/Communication	Planning and Engineering	Kenya-Exchange Areas	Hardcopy map	1:5000, 1:2500, 1:1250	Unavailable for external use	-	Manual catalogue	Complete
Distribution Network (Cabinet)	Utilities/Communication	Planning and Engineering	Kenya- cabinets	Hardcopy map	NTS (Not To Scale)	Unavailable for external use	-	Manual catalogue	Complete
Transmission and radio links	Utilities/Communication	Planning and Engineering	Kenya	Hardcopy map	1:1000000	Unavailable for external use	-	Manual catalogue	Complete

National Housing Corporation (NHC)

ADDRESS: P.O BOX 30257 NAIROBI TEL.: 331205 FAX: -

PHYSICAL LOCATION: NHC House E-MAIL: WEBSITE:

GIS SOFTWARE	VERSION
	-
	-
	-
	-
	-

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED:

DISTRIBUTED:

DBMS

-

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CAD

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-

-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:		-
SCANNER:		-
PLOTTER:		-
PRINTER:		-
INTERNET ACCESS:	-	
PC	Yes	-

OPERATING SYSTEM

WINDOWS: 95,98,2000

UNIX: -

ON-GOING/UNDERTAKEN PROJECT:

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
	-					-	-	-	-

United Nations Environmental Programme (UNEP)

ADDRESS: P.O BOX 30552 NAIROBI TEL.: 622020 FAX: 624315

PHYSICAL LOCATION: Gigiri E-MAIL: mwangit@unep.org WEBSITE: www.unep.org

GIS SOFTWARE	VERSION
ArcView	3.2
ArcGIS	8.1
IDRISI	132.2
	-
	-

IMAGE PROCESSING

Photoshop suite

Adobe suite

DATABASE ARCHITECTURE

CENTRALIZED: -

DISTRIBUTED: Yes

DBMS

Ms Access

SQL

CAD

-

-

-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:		-
SCANNER:	Calcomp	3
PLOTTER:	HP 1055, 650c	-
PRINTER:	Yes	6
INTERNET ACCESS:	Yes	
PC	Yes	9

OPERATING SYSTEM

WINDOWS: 2000,XP

UNIX: -

ON-GOING/UNDERTAKEN PROJECT: Eastern Africa coastal database and atlas, Mt. Kenya, Mau, Kilimanjaro trend analysis and Africa environment data production

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Desertification	Environment		Kenya/Africa	Digital map	Below 1:1000000	Restricted to some	-	Digital catalogue	-

International Livestock Research Institute (ILRI)

ADDRESS: P.O BOX 30709 (00100) NAIROBI TEL: 630743 FAX: -
PHYSICAL LOCATION: Naivasha road E-MAIL: pam.ochungo@cgiar.org WEBSITE: www.ilri.org

GIS SOFTWARE	VERSION
PC ArcInfo	3.5
Workstation ArcInfo	8.1
ArcView	3.2
MapInfo	-
ArcGIS	-

IMAGE PROCESSING
ERDAS

DATABASE ARCHITECTURE
CENTRALIZED: Yes
DISTRIBUTED: Yes

DBMS
Ms Access
-

CAD
-
-
-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	A0	1
SCANNER:	Yes	-
PLOTTER:		-
PRINTER:	Yes	1
INTERNET ACCESS:	Yes	
PC	Yes	273

OPERATING SYSTEM
WINDOWS: 98,2000,NT
UNIX: Yes

ON-GOING/UNDERTAKEN PROJECT: Use of GIS in Market access studies, Use of GIS in adoption of technology for farmers

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Kenya_ECFdistribution.shp	Farming		Kenya	Digital map		-	Free	Metadata exists	-
Kenya_Provinces.shp	Boundaries		Kenya	Digital map		-	Free	Metadata exists	-
Kenya_locations.shp	Boundaries		Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Ken_elevation	Elevation		Kenya	Digital map	1:250000	-	Free	Metadata exists	-
Kenya_divisions2000.shp	Boundaries		Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_divisions.shp	Boundaries		Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_villages.shp	Society		Kenya (28815 villages)	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_contour.shp	Elevation		Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_outside_boundary.shp	Boundaries		Kenya	Digital map		Unrestricted	Free	Metadata exists	-

Kenya_sublocations.shp	Environment	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_crop/livestock.shp	Biota(fauna/flora)	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_district1998.shp	Boundaries	Kenya	Digital map		-	Free	Metadata exists	-
West_Kenya_rivers.shp	Inland waters	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Highland_roads.shp	Transportation	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_wetlands.shp	Environment	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_Roads.shp	Transportation	Kenya	Digital map	1:50000	-	Free	Metadata exists	-
Kenya_forests.shp	Environment	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_riverbasins.shp	Inland waters	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_protected_areas.shp	Environment	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_major_towns.shp	Cultural features	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_Landuse.shp	Environment	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_Lakes.shp	Inland waters	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_roads WFP.shp	Transportation	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_Rivers.shp	Inland waters	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_rainstations1890-1985.shp	Climatology/Meteorology/Atmosphere	Kenya	Digital map		-	Free	Metadata exists	-

Mki_Access2	Location	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_all_towns.shp	Cultural features	Kenya	Digital map	1:50000,1:250000	.	Free	Metadata exists	-
Kenya_Tree_cover.shp	Environment	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_waterpoints1.shp	Utilities/Communication	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_Aczones.shp	Climatology/Meteorology/Atmosphere	Kenya	Digital map		.	Free	Metadata exists	-
Kenya_tsetsedistribn.shp	Farming	Kenya	Digital map		.	Free	Metadata exists	-
Kenya_Malaria_zones.shp	Society	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_rainstations1991-96.shp	Climatology/Meteorology/Atmosphere	Kenya	Digital map		.	Free	Metadata exists	-
Kentraveltime	Society	Kenya	Digital map		.	Free	Metadata exists	-
Kenya89subloc_cencus.shp	Society/population	Kenya	Digital map		.	Free	Metadata exists	-
Kenya_R_appendiculatus.shp	Farming	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_Aezones.shp	Farming	Kenya	Digital map		-	Free	Metadata exists	-
kenya_Cameldistribution.shp	Farming	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Kenya_mapsheets_catalogue.shp	Imagery/Basemaps/Earth cover	Kenya	Digital map	1:50000	-	Free	Metadata exists	-
Kenya_climate_surface.shp	Climatology/Meteorology/Atmosphere	Kenya	Digital map		-	Free	Metadata exists	-
Kenya79loc_census.shp	Society/population	Kenya	Digital map		-	Free	Metadata exists	-

Kenya_Cattle_density.shp	Farming	Kenya	Digital map		-	Free	Metadata exists	-
Kenya_forest_ranges.shp	Environment	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Wheat_production.shp	Inland waters	Kenya	Digital map	1:1000000	Unrestricted	Free	Metadata exists	-
Sorghum_production.shp	Farming	Kenya	Digital map	1:1000000	Unrestricted	Free	Metadata exists	-
Maize_production.shp	Farming	Kenya	Digital map	1:1000000	Unrestricted	Free	Metadata exists	-
Kenya_Rainfall_distribution.shp	Climatology/Meteorology/Atmosphere	Kenya	Digital map		-	Free	Metadata exists	-
Mkt_Access3	Location	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Mkt_Access1	Location	Kenya	Digital map		Unrestricted	Free	Metadata exists	-
Millet_production.shp	Farming	Kenya	Digital map	1:1000000	Unrestricted	Free	Metadata exists	-
Rice_production.shp	Farming	Kenya	Digital map	1:1000000	Unrestricted	Free	Metadata exists	-

World agroforestry Centre (ICRAF)

ADDRESS: P.O BOX 30677 (00100) NAIROBI   TEL: 524000   FAX: 524001

PHYSICAL LOCATION: UN-Avenue Gigiri   E-MAIL: e.soini@cgiar.org   WEBSITE: www.icraf.org

GIS SOFTWARE	VERSION
Workstation ArcInfo	-
ArcView	3.2
ArcGIS	-
IDRISI	-
	-

IMAGE PROCESSING

ERDAS

ENVI

e-Cognition

DATABASE ARCHITECTURE

CENTRALIZED: Yes

DISTRIBUTED: -

DBMS

Ms Access

-

CAD

-

-

-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Yes	1
SCANNER:	A3	1
PLOTTER:	Yes	1
PRINTER:	A3/A4	3
INTERNET ACCESS:	Yes	
PC	Yes	3

OPERATING SYSTEM

WINDOWS: 2000,NT,XP

UNIX: -

ON-GOING/UNDERTAKEN PROJECT: Reflectance spectrography of soils in L Victoria basin, Spatial information for sustainable development and Baseline survey of land cover of S.W Uganda

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Lake Victoria Basin	Environment	GIS section	Lake Victoria Basin- 33 Districts	Digital map	1:50000	Restricted to some	-	Digital catalogue	Complete

Regional Centre for Mapping of Resources for Development

ADDRESS: P.O BOX 18118 NAIROBI   TEL: 803320   FAX: 802767

PHYSICAL LOCATION: Kasarani   E-MAIL: rcmrd@rcmrd.org   WEBSITE: www.rcmrd.org

GIS SOFTWARE	VERSION
PC ArcInfo	8.1
ArcView	-
ArcGIS	-
ILWIS	-
IDRISI	-

IMAGE PROCESSING

Yes

DATABASE ARCHITECTURE

CENTRALIZED: -

DISTRIBUTED: -

DBMS

Ms Access

-

CAD

Yes

-

-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Yes	-
SCANNER:	Yes	-
PLOTTER:	Yes	-
PRINTER:	Yes	-
INTERNET ACCESS:	Yes	
PC	Yes	-

OPERATING SYSTEM

WINDOWS:

UNIX: -

ON-GOING/UNDERTAKEN PROJECT: Earl warning for food security, Development of Wind Atlas of Kenya and Landuse/land cover mapping of member states

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Satellite imagery	Imagery/Base maps/Earth cover	Remote sensing	Eastern and Southern Africa	Digital image	Depends on satellite and data format	Unrestricted	-	Digital catalogue	-

International Centre for Insect Physiology and Ecology (ICIPE)

ADDRESS: P.O BOX 30772 NAIROBI | TEL: 861680 | FAX: 806330
PHYSICAL LOCATION: Kasarani | E MAIL: icipe@icipe.org | WEBSITE: www.icipe.org

GIS SOFTWARE / **VERSION**

GIS SOFTWARE	VERSION
ArcView	-
ACT	-
	-
	-
	-

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED: Yes
DISTRIBUTED: Yes

DBMS

Ms Access
Postgress

CAD

-
-
-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Yes	-
SCANNER:	Yes	-
PLOTTER:	Yes	-
PRINTER:		-
INTERNET ACCESS:	Yes	
PC	Yes	-

OPERATING SYSTEM

WINDOWS: 3.1,3.11,95,98,2000,
UNIX: -

ON-GOING/UNDERTAKEN PROJECT: Stem borer project (East and Southern Africa)

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Stem borer	Farming		Kenya (Country-wide)	Digital image	1:250000	Unrestricted	-	None	-

United Nations High Commissioner for Refugees, RSAL

ADDRESS: P. O BOX 43801 (00100) NAIROBI | TEL: 254-02-4222748 | FAX: 254-02-4442052
PHYSICAL LOCATION: Westlands | E-MAIL: alspach@unhcr.ch | WEBSITE:

GIS SOFTWARE	VERSION
ArcView	3.2
MapInfo	6.5
	-
	-
	-

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED: -
DISTRIBUTED: -

DBMS

-
-

CAD

-
-
-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:		-
SCANNER:		-
PLOTTER:		-
PRINTER:		-
INTERNET ACCESS:	Yes	
PC	Yes	-

OPERATING SYSTEM

WINDOWS:
UNIX: -

ON-GOING/UNDERTAKEN PROJECT:

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
KEADMIN2_LINE_ADDS and KEADMIN2_	Boundaries	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete

KENYA ADMIN 2 (District)	Boundaries	RSAL	Kenya	Digital map		Unrestricted	Free	Metadata exists	Complete
KEADMIN4_ LINE_ADDS and KEADMIN4_	Boundaries	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
Kenya Contours	Elevation	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KEADMIN5_ LINE_ADDS and KEADMIN5_	Boundaries	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KECONTOURS_LINE and KECONTOU	Elevation	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KESPOTHEIGHTS	Elevation	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KEADMIN1_ LINE_ADDS and KEADMIN1_	Boundaries	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KENYA ADMIN 4 (Locational)	Boundaries	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KEROADS	Transportation	RSAL	Kenya	Digital map		Unrestricted	Free	Metadata exists	Complete
KEADMIN3_ LINE_ADDS and KEADMIN3_	Boundaries	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KEDRAINAGE_LINE and KEDRAINA	Inland waters	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KEGEOLOGY	Geosciences	RSAL	Kenya	Digital map		Unrestricted	Free	Metadata exists	Complete
KERAILWAY	Transportation	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KESETTLEMENTS	Society	RSAL	Kenya	Digital map	1:250000	Unrestricted	Free	Metadata exists	Complete
KENYA ADMIN 3 (Division)	Boundaries	RSAL	Kenya	Digital map	1:1,000,000	Unrestricted	Free	Metadata exists	Complete
KEDRAINAGE_LINE and KEDRAINA	Inland waters	RSAL	Kenya	Digital map	1:1000000	Unrestricted	Free	Metadata exists	Complete

Oakar services

ADDRESS: P O BOX 28844 (00100) NAIROBI — TEL: 715276 — FAX: 721852

PHYSICAL LOCATION: Hurlingham — E-MAIL: tndegwa@africaonline.co.k — WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
				DEVICE	VERSION	NO.
PC ArcInfo	-	CENTRALIZED:	Yes	DIGITIZING TABLE:	Calcomp	2
Workstation ArcInfo	-	DISTRIBUTED:	Yes	SCANNER:		-
ArcView	-	DBMS		PLOTTER:		-
ArcGIS	-	Ms Access		PRINTER:	HP, Epson	4
	-	SQL		INTERNET ACCESS:	Yes	
IMAGE PROCESSING		CAD		PC	Yes	9
ERDAS		-		OPERATING SYSTEM		
		-		WINDOWS: 95,98,2000 server		
		-		UNIX: -		

ON-GOING/UNDERTAKEN PROJECT:

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS

Geometer surveys

ADDRESS: P.O BOX 53387 (00100) NAIROBI — TEL: 311483 — FAX: -

PHYSICAL LOCATION: Tumaini house — E-MAIL: geometer@bidii.com — WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
				DEVICE	VERSION	NO.
ArcView	3.2	CENTRALIZED:		DIGITIZING TABLE:		-
MapInfo	-	DISTRIBUTED:	Yes	SCANNER:		-
	-	DBMS		PLOTTER:		-
	-	Ms Access		PRINTER:		-
	-	-		INTERNET ACCESS:	-	
IMAGE PROCESSING		CAD		PC	Yes	3
Adobe suite		AutoCAD		OPERATING SYSTEM		
		-		WINDOWS: 95,98,2000		
		-		UNIX: -		

ON-GOING/UNDERTAKEN PROJECT: Digital map of Nairobi for petroleum stations, Digital map of potential earthquake sites for Nairobi, Digital tourist map of Kenya

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Digital map of Nairobi	Location	Photogrammetry and Cartography	Nairobi	Digital map		-	-	-	Complete

Highland Surveyors

ADDRESS: P.O BOX 9562 (00100) NAIROBI | TEL: 721726 | FAX: 712092
PHYSICAL LOCATION: Ragati rd. Upper-Hill | E-MAIL: highland@africaonline.co.k | WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
				DEVICE	VERSION	NO.
ArcView	3.2	CENTRALIZED:	-	DIGITIZING TABLE:		
ILWIS	2.1	DISTRIBUTED:	Yes	SCANNER:	A3 and A	2
	-	DBMS		PLOTTER:	HP 450c	1
	-	Ms Access		PRINTER:	HP	1
	-	-		INTERNET ACCESS:	Yes	
IMAGE PROCESSING		CAD		PC	Yes	7
Ulead		-		OPERATING SYSTEM		
		-		WINDOWS:	982,000	
		-		UNIX:	-	

ON-GOING/UNDERTAKEN PROJECT: Mapping as built right of way for Kenya Pipeline Company

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
	-			-		-	-	-	-

GIBB Africa ltd.

ADDRESS: P.O BOX 30020 NAIROBI | TEL: 338992 | FAX: -
PHYSICAL LOCATION: Shell and PB house | E-MAIL: | WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
				DEVICE	VERSION	NO.
PC ArcInfo	3.5	CENTRALIZED:	Yes	DIGITIZING TABLE:		-
ArcView	3.1	DISTRIBUTED:	Yes	SCANNER:	Yes	-
MapInfo	-	DBMS		PLOTTER:	Yes	-
IDRISI	-	Ms Access		PRINTER:	Yes	-
	-	-		INTERNET ACCESS:	No	
IMAGE PROCESSING		CAD		PC	Yes	-
		Yes		OPERATING SYSTEM		
		-		WINDOWS:	95,98,2000	
		-		UNIX:	-	

ON-GOING/UNDERTAKEN PROJECT: Sudan soil classification, Zimbabwe Road network project, Malawi small scale irrigation project

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
				-			-	-	-

Norken ltd

ADDRESS: P.O BOX 9882 (00100) NAIROBI TEL: 337771 FAX: 337757
PHYSICAL LOCATION: Norfolk Towers E-MAIL: norcon@mitsuminet.co WEBSITE:

GIS SOFTWARE	VERSION	DATABASF ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
	.	CENTRALIZED:	Yes	DEVICE	VERSION	NO.
	.	DISTRIBUTED:	.	DIGITIZING TABLE:	Yes	1
	.	**DBMS**		SCANNER:	Yes	1
	.	.		PLOTTER:	Yes	1
	.	.		PRINTER:	Yes	4
				INTERNET ACCESS:	Yes	
IMAGE PROCESSING		**CAD**		PC	Yes	15
		AutoCAD		**OPERATING SYSTEM**		
		Gemini		WINDOWS:	95,98,2000	
		NovaPoint		UNIX:	.	

ON-GOING/UNDERTAKEN PROJECT: Road iventory and condition survey, feasibility study of Rumuruti_Maral road

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Roads	Transportation	Computer	Several Roads	Digital map	Various	.	.	.	.

Eldoret Water and sanitation company (ELDOWAS)

ADDRESS: P.O BOX 8418 ELDORET TEL: FAX: 5363556
PHYSICAL LOCATION: Eldoret Town E-MAIL: eldowas@africaonline.co.ke WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE		DATA INPUT/OUPUT DEVICES		
ArcView	2.1	CENTRALIZED:	.	DEVICE	VERSION	NO.
	.	DISTRIBUTED:	.	DIGITIZING TABLE:	Calcomp	1
	.	**DBMS**		SCANNER:		.
	.	Ms Access		PLOTTER:	HP 220	1
	.	dbase		PRINTER:	Deskjet	2
				INTERNET ACCESS:	Yes	
IMAGE PROCESSING		**CAD**		PC	Yes	.
		AutoCAD		**OPERATING SYSTEM**		
		.		WINDOWS:		
		.		UNIX:	.	

ON-GOING/UNDERTAKEN PROJECT:

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Eldoret Facilities Manager	Utilities/Communication	Technical	Eldoret Municipality	Digital map	1 250000	Restricted to most	.	Manual catalogue	Complete

Wellcome Trust Research Laboratories

ADDRESS: P.O BOX 43640 (00100) NAIROBI | TEL: 715160 | FAX: 711673
PHYSICAL LOCATION: Kenyatta Hospital | E-MAIL: | WEBSITE:

GIS SOFTWARE	VERSION
Workstation ArcInfo	8.1
ArcView	3.2
MapInfo	6.0
IDRISI	3.20

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED: .
DISTRIBUTED: .

DBMS

Ms Access

CAD

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:		.
SCANNER:		.
PLOTTER:	A4	1
PRINTER:	Yes	20
INTERNET ACCESS:	Yes	
PC	Yes	20

OPERATING SYSTEM

WINDOWS: 982,000
UNIX:

ON-GOING/UNDERTAKEN PROJECT: Mapping all health facilities country-wide, Malaria research in Kisii, Gucha, Makueni, Bondo and Kwale

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
	.			.		.	.	.	.

Ground Water survey

ADDRESS: P.O BOX 25069 (00603) NAIROBI | TEL: 573512 | FAX: 573659
PHYSICAL LOCATION: Lavington | E-MAIL: groundwater@kenyaweb.co | WEBSITE:

GIS SOFTWARE	VERSION
ArcView	3.2
MapInfo	5.5
ILWIS	2.1

IMAGE PROCESSING

DATABASE ARCHITECTURE

CENTRALIZED: .
DISTRIBUTED: .

DBMS

CAD

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Yes	1
SCANNER:	Yes	1
PLOTTER:		.
PRINTER:	Yes	1
INTERNET ACCESS:	.	
PC	Yes	.

OPERATING SYSTEM

WINDOWS:
UNIX:

ON-GOING/UNDERTAKEN PROJECT: Water supply projects in Kenya, Tanzania and Sudan

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
	.			.		.	.	.	.

Department of Surveying, UON

ADDRESS: P.O BOX 30197 (00100) NAIROBI **TEL:** 334244 **FAX:** -

PHYSICAL LOCATION: Harry Thuku road **E-MAIL:** **WEBSITE:** www.uonbi.ac.ke

GIS SOFTWARE	VERSION
PC ArcInfo	-
IDRISI	132.2
ArcView	-
ArcGIS	-
ILWIS	-

IMAGE PROCESSING

Yes

DATABASE ARCHITECTURE

CENTRALIZED: -

DISTRIBUTED: -

DBMS

Ms Access

-

CAD

-

-

-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	Calcomp	1
SCANNER:		-
PLOTTER:		-
PRINTER:	HP	2
INTERNET ACCESS:	Yes	
PC	Yes	5

OPERATING SYSTEM

WINDOWS: 98,XP

UNIX: -

ON-GOING/UNDERTAKEN PROJECT: Teaching and Research

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
	-			-		-	-	-	-

Department of Geography, UON

ADDRESS: P.O BOX 30197 (00100) NAIROBI **TEL:** 334244 **FAX:** 336885

PHYSICAL LOCATION: Hyslop Building **E-MAIL:** ianyandega@yahoo.com **WEBSITE:**

GIS SOFTWARE	VERSION
ArcView	3.2
MapInfo	5.0
IDRISI	4.0
	-
	-

IMAGE PROCESSING

IDRISI

DATABASE ARCHITECTURE

CENTRALIZED: -

DISTRIBUTED: -

DBMS

Ms Access

-

CAD

-

-

-

DATA INPUT/OUPUT DEVICES

DEVICE	VERSION	NO.
DIGITIZING TABLE:	A0	1
SCANNER:		-
PLOTTER:		-
PRINTER:	Lase, Ink Jet and do	5
INTERNET ACCESS:	Yes	
PC	Yes	1

OPERATING SYSTEM

WINDOWS: 95,98,2000

UNIX: -

ON-GOING/UNDERTAKEN PROJECT: Nairobi Security Project -INFRA project (NASP) and Nairobi Urban Integration Project (NURIP) INFRA-Faculty of Arts project

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
	-			-		-	-	-	-

Kenya Institute of Surveying and Mapping (KISM)

ADDRESS: P.O BOX 64005 NAIROBI TEL: 861486 FAX: 803575
PHYSICAL LOCATION: Ruaraka off Thika road E-MAIL: kism@iconnect.co.ke WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE	DATA INPUT/OUPUT DEVICES		
			DEVICE	VERSION	NO.
Workstation ArcInfo	-	CENTRALIZED: -	DIGITIZING TABLE:		-
ArcView	-	DISTRIBUTED: -	SCANNER:		-
MapInfo	-	**DBMS**	PLOTTER:		-
ArcGIS	-	Ms Access	PRINTER:		-
ILWIS	-	-	INTERNET ACCESS:	-	
IMAGE PROCESSING		**CAD**	PC	Yes	-
ERDAS		AutoCAD	**OPERATING SYSTEM**		
		Microstation	WINDOWS:		
		-	UNIX: -		

ON-GOING/UNDERTAKEN PROJECT: Third country trainning in GIS for Eastern and Southern Africa, Lake Nakuru mapping project, Digital data for sothern Coast

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
GPS transformation parameters (preliminary)	Geosciences	Land Surveying	Mt. Kenya/Western/ Coastal	Digital document		Unrestricted	Free		
Nairobi National Park	Environment	Cartography	Nairobi National Park	Digital map	1:30000	Unrestricted	-	None	Complete
Nakuru National Park	Environment	Cartography	Nakuru National Park	Digital map	1:25000	Unrestricted	-	None	Nearing completion

Department of Geography, Moi University

ADDRESS: P.O BOX 3900, ELDORET,KENYA | TEL: | FAX: 32143047
PHYSICAL LOCATION: Eldoret Kesses | E-MAIL: | WEBSITE:

GIS SOFTWARE	VERSION	DATABASE ARCHITECTURE	DATA INPUT/OUPUT DEVICES		
			DEVICE	**VERSION**	**NO.**
ArcView	3.3	CENTRALIZED:	DIGITIZING TABLE:	Yes	-
MapInfo	4.5	DISTRIBUTED:	SCANNER:	Yes	-
ArcGIS	8.1	**DBMS**	PLOTTER:		-
IDRISI	3.20	Ms Access	PRINTER:		-
ILWIS	-	-	INTERNET ACCESS:	-	
IMAGE PROCESSING		**CAD**	PC	Yes	-
		Yes	**OPERATING SYSTEM**		
		-	WINDOWS:		
		-	UNIX:	-	

ON-GOING/UNDERTAKEN PROJECT:

TITLE	THEME	DEPARTMENT	COVERAGE	FORM	SOURCE SCALE	ACCESSIBILITY	COST (Ksh)	CATALOGUE	STATUS
Inforsat	Climatology/Meteorology/Atmosphere	Geography		Digital map	1:50000	Restricted to most	-	None	-

According to institutional categories, government departments represent 28%, parastatals (22%), international/intergovernmental (17%), private (22%) and academic (11%). Additionally, from the inventory one can tell:

(i) How many and which institutions have, which data input and output facilities. For example, 92% of institutions have computers for handling geospatial data and information. Table 4-1 gives in summary the hardware items owned by the institutions (in percentages).

Facility	Number	Percentage
Computers (PC)	33	92
Digitizing table	13	36
Scanner	15	42
Plotter	16	44
Printer	33	92
Internet Access point	26	72

Table 4-1: Institutional availability of GIS hardware items

(ii) Which GIS software, DBMS, image processing and CAD software are being used, by which organizations and if they are compatible. For example the dominant GIS software is Arc View with 67% followed by ArcGIS and Arc/Info all from ESRI. This is probably because the regional distributor for ESRI software is based in Kenya. For image processing, ERDAS, Photoshop and Adobe suite were the ones identified. Some GIS software like IDRISI and ILWIS have image-processing modules but they cannot be classified as purely image processing software. AutoCAD from AutoDesk dominates the category of CAD software, while Microsoft Access is the dominant database management software. Table 4-2 shows the software that were identified and the percentage of institutions that have them.

(iii) Which datasets as identified in the inventory are suitable for inclusion in NSDI, and which ones can contribute to the development of core and framework datasets.

	Number	Percentage
GIS software		
PC ArcInfo	11	31
Workstation Arc Info	9	25
Arc View	24	67
MapInfo	13	36
SGD	1	3
ArcGIS	13	36
ILWIS	8	22
ACT	1	3
IDRISI	8	22
Database Management System (DBMS)		
Ms Access	25	69
Dbase	2	6
Fox pro	1	3
Oracle	3	8
Postgress	1	3
File maker	1	3
Image processing software		
ERDAS	5	14
Photoshop	2	8
Photo Impact	1	3
Adobe suite	2	6
Ulead	1	3
IDRISI	1	3
ENVI	1	3
e-Cognition	1	3
Computer Aided Design (CAD) software		
AutoCAD	11	31
Micro station	2	6
Gemini	1	3
LisCAD	1	3
Nova Point	1	3

Table 4-2: Institutional availability of GIS and other related software

(iv) Which on-going (or already undertaken) projects can contribute to the development of new datasets, and projects that are possibly duplicates of others. For example, the Kenya Urban Transportation Infrastructure Project (KUTIP) undertaken by the Department of Urban Development, Ministry of Local Government (MLG), produced geospatial datasets in digital form for 26 towns. If projects similar to the on-going digital mapping of Nairobi will be done for all other town councils, then this definitely will be duplication because the data partly exists.

4.2 Demand for datasets

The NSDI has its foundation on core and framework datasets. These are datasets, which have common-use and are of national and trans-national importance. The respondents were required to choose a number ranging from 1 to 5, with 1 indicating not fundamental and 5, extremely fundamental. Using the responses of the five categories of institutions to determine the demand for various core and framework datasets, Government departments' response (mean demand) for the geospatial framework data is presented in Figure 4-2, while Table 4-4 gives the demand of datasets across institutions.

Each of these categories has its own order of demand, which is different from the rest. This is because of the different emphases in their missions. This item was meant to determine the representative national demand for geospatial data.

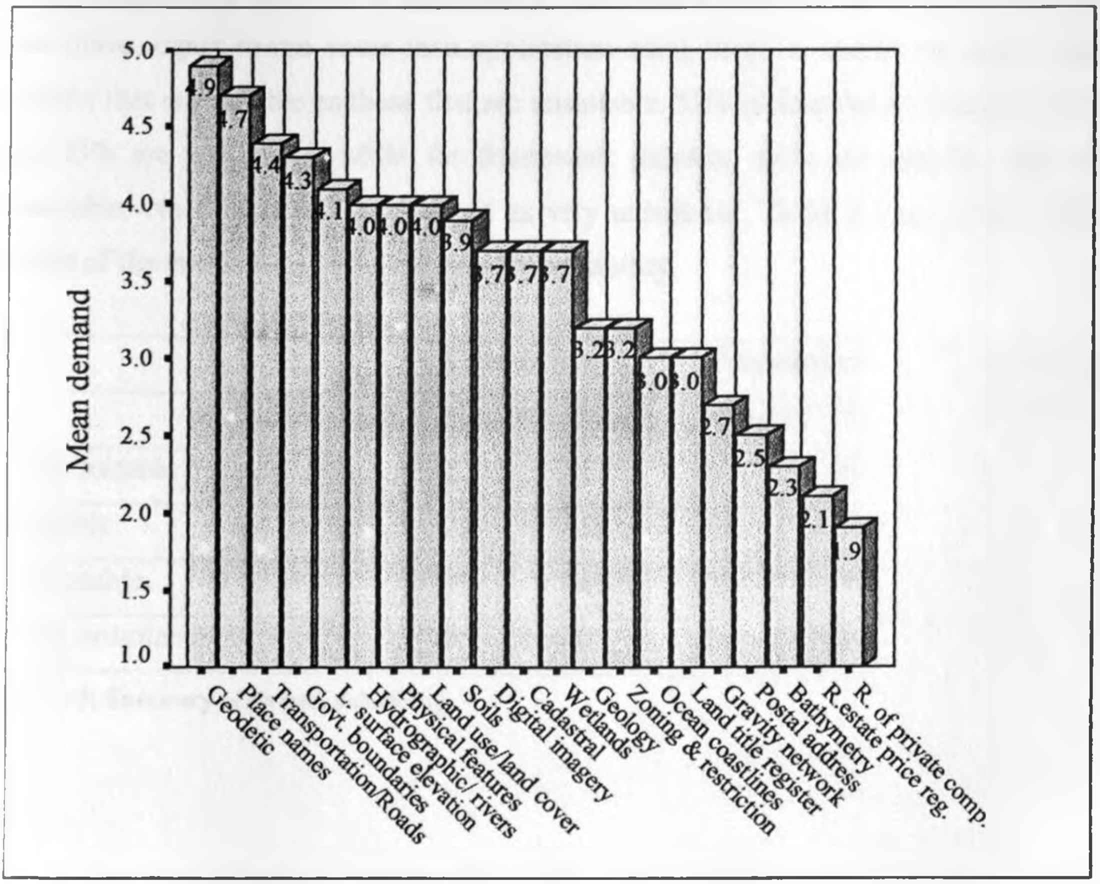

Figure 4-2: Demand for geospatial data across institutions

Government departments' demand for geospatial information has the highest number of candidate core and framework datasets, it is therefore suggested that the government departments be used to determine the true national demand. Government parastatals may have some bias considering that they are mission specific. International/regional institutions' column may indicate a regional /international demand, which may not necessarily reflect the national demand, for instance cadastral information is rated 2. Private institutions might only indicate demand for datasets that they have handled. Finally the academic institutions as expected demand almost all the datasets.

4.3 Evaluation of datasets

The datasets contained in the inventory are evaluated in the light of the criteria established in section 3.3. Out of 115 datasets identified in the survey, 38% were categorized as foundation, 21% as framework and 41% as application. Considering only the foundation and framework data (have higher re-use value than application data), there is almost an equal number of datasets that are suitable as those that are unsuitable. 52% of foundation datasets are suitable and 43% are unsuitable, while for framework datasets, 46% are suitable and 53% are unsuitable. No dataset was determined as very unsuitable. Table 4-5 to Table 4-7 give the results of the evaluations of the datasets for suitability.

	Foundation		**Framework**		**Application**	
	Number	%	Number	%	Number	%
Very suitable	2	5	0	0	2	4
Suitable	23	52	11	46	17	36
Unsuitable	19	43	13	54	28	60
Very unsuitable	0	0	0	0	0	0

Table 4-3: Summary of dataset suitability

Type of dataset	Government departments	Government Parastatals	International/ Regional	Private	Academic
Geodetic	5	5	5	5	5
Land surface elevation/topographic	4	4	5	4	5
Digital imagery (orthoimagery)	4	4	4	3	5
Government boundaries/administrative boundaries (Government units)	4	4	5	4	5
Transportation/Roads	5	5	5	3	5
Cadastral /land ownership	4	4	2	4	5
Hydrographic/rivers and lakes	4	5	4	3	5
Ocean coastlines	3	3	3	2	5
Bathymetry	2	2	2	3	4
Physical features/buildings	4	5	3	3	5
Place names	5	5	5	4	5
Land use/land cover/vegetation	4	4	5	3	5
Geology	3	4	3	3	4
Real estate price register/ Land valuation	3	2	2	2	2
Land title register	2	4	2	4	2
Postal address	2	3	2	3	2
Wetlands	3	5	4	3	5
Soils	4	4	5	3	5
Register of private companies	2	2	1	3	2
Gravity network	2	2	2	4	5
Zoning and restrictions	3	3	3	4	5

Table 4-4: Mean demand for geospatial data across institutions

Table 4-5: Dataset suitability results for foundational datasets

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Topographic maps	Survey of Kenya (SOK)	Suitable	Convert to digital form	Suitable	Establish % coverage	Suitable	Suitable	Build topology if possible	1:50000	500	-	-	Unsuitable
Geodetic network	Survey of Kenya (SOK)	Include in Catalogue and build metadata	Convert to digital form	Suitable	Establish % coverage	Suitable	Suitable	Build topology if possible	1:1000000	-	-	-	Unsuitable
Topographic maps	Survey of Kenya (SOK)	Suitable	Suitable	Suitable	Suitable	Unsuitable	Suitable	Build topology if possible	1:50000	-	-	-	Suitable
Global map	Survey of Kenya (SOK)	Suitable	Suitable	Suitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000				Suitable
Kenya Atlas	Survey of Kenya (SOK)	Suitable	Convert to digital form	Suitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	Various	5000			Unsuitable
Aerial Photographs	Survey of Kenya (SOK)	Suitable	Convert to digital form	Suitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:12500-1:50000	500			Unsuitable
Kenya administrative	Survey of Kenya (SOK)	Suitable	Convert to digital form	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	500			Unsuitable
Regional planning	Department of Physical planning	Include in Catalogue and build metadata	Suitable	Suitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology and confirm consistency	1:2500	-	1996	Vector	Unsuitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Topographic maps	Department of Buildings	Suitable	Convert to digital form	Unsuitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Confirm consistency	Various	-	-	Vector	Unsuitable
Village map	Central Bureau of Statistics (CBS)	Suitable	Convert to digital form	Suitable	Suitable	Suitable	Suitable	Build topology if possible	1:2500,1:10 000,1:50000 ,1:250000	750	1997		Unsuitable
Village map	Central Bureau of Statistics (CBS)	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Build topology if possible	1:2500,1:10 000,1:50000 ,1:250000	1500	1997	Vector	Very suitable
District map	Central Bureau of Statistics (CBS)	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Build topology if possible	1:50000,1:2 50000	1500	1997	Vector	Very suitable
Kenya map	Central Bureau of Statistics (CBS)	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Suitable	Build topology if possible	1:50000,1:2 50000	1500	1997	Vector	Suitable
Local Authorities Topographic maps	Department of Urban Development-MLG	Suitable	Convert to digital form	Unsuitable	Suitable	Suitable	Suitable	Build topology and confirm consistency	1:2500	-	1992	-	Unsuitable
Local Authorities Road network	Department of Urban Development-MLG	Include in Catalogue and build metadata	Suitable	Unsuitable	Establish % coverage	Suitable	Suitable	Build topology and confirm consistency	1:2000	-	-	Vector	Unsuitable
Topographical maps	Nairobi City Council (NCC)	Include in Catalogue and build metadata	Convert to digital form	Suitable	Suitable	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:2500				Unsuitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Constituency maps	Electoral Commission of Kenya (ECK)	Include in Catalogue and build metadata	Convert to digital form	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000, 1:250000, 1:100000, 1:50000,	500	-	-	Unsuitable
Kenya_contour.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_districts98.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_divisions.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_divisions2000.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Ken_elevation	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:250000	Free	-	Raster	Unsuitable
Kenya_locations.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_outside_boundary.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Kenya_Provinces.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_sublocations.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_villages.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
West_Kenya_rivers shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	-	Suitable
Satellite imagery	Regional Centre for Mapping of Resources for Development	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	Depends on satellite and data format	-	1972	Raster	Suitable
Kenya Contours	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1993	Vector	Suitable
KEADMIN4_LINE_ADDS and KEADMIN4_	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1996	Vector	Suitable
KEADMIN5_LINE_ADDS and KEADMIN5_	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1996	Vector	Suitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
KECONTOURS_LINE and KECONTOU	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1993	Vector	Suitable
KESPOTHEIGHTS	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1993	Vector	Suitable
KENYA ADMIN 2 (District)	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	1996	Vector	Suitable
KENYA ADMIN 3 (Division)	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1996	Vector	Suitable
KENYA ADMIN 4 (Locational)	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1996	Vector	Suitable
KEADMIN1_LINE_ADDS and KEADMIN1_	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1996	Vector	Suitable
KEADMIN2_LINE_ADDS and KEADMIN2_	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1996	Vector	Suitable
KEADMIN3_LINE_ADDS and KEADMIN3_	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1996	Vector	Suitable

Dataset title	*Custodian*	*Availability*	*Form*	*Accessibility*	*Completeness*	*Status*	*Co-ordinate system*	*Topological consistency*	*Source scale*	*Price (KSh.)*	*Last date of update*	*Format*	*Remark*
Digital map of Nairobi	Geometer surveys	Include in Catalogue and build metadata	Suitable	Review restriction	Establish % coverage	Suitable	Suitable	Build topology if possible		-	2001	Vector	Unsuitable
GPS transformation parameters (preliminary)	Kenya Institute of Surveying and Mapping (KISM)	Include in Catalogue and build metadata	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free			Unsuitable
Nairobi National Park	Kenya Institute of Surveying and Mapping (KISM)	Include in Catalogue and build metadata	Suitable	Suitable	Establish % coverage	Suitable	Suitable	Build topology if possible	1:30000	-	1996	Vector	Unsuitable
Nakuru National Park	Kenya Institute of Surveying and Mapping (KISM)	Include in Catalogue and build metadata	Suitable	Suitable	Establish % coverage	Suitable	Suitable	Build topology if possible	1:25000	-	1999	Tin & Vector	Unsuitable

Table 4-6: Dataset suitability results for framework datasets

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Cadastral	Survey of Kenya (SOK)	Suitable	Convert to digital form	Suitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:2500, 1:5000, 1:10000,1:25000	200			Unsuitable
Kenya roads Network	Department of Roads-MORPWH	Include in Catalogue and build metadata	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible		-	2001	Vector	Unsuitable
Landuse/cover	Department of Resource Surveys and Remote Sensing	Suitable	Suitable	Suitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:250000	50	1977	Vector	Suitable
Cadastral	Nairobi City Council (NCC)	Include in Catalogue and build metadata	Convert to digital form	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:10000				Unsuitable
Kenya Geology	National Museums of Kenya (NMK)	Include in Catalogue and build metadata	Suitable	Unsuitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	-	2002	Vector	Unsuitable
Highland_roads.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_forests.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_Lakes.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Kenya_Landuse.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_major_towns.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_protected_areas.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_riverbasins.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_Rivers.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_Roads.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:50000	Free	-	Vector	Unsuitable
Kenya_roadsWFP.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_wetlands.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Kenya_all_to wns.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:50000,1:2 50000	Free		Vector	Unsuitable
Lake Victoria Basin	World agroforestry Centre (ICRAF)	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:50000		2003	Vector	Suitable
KEDRAINA GE_LINE and KEDRAINA	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1993	Vector	Suitable
KEGEOLOG Y	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	19990629	Vector	Suitable
KERAILWA Y	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1,000,000	Free	1993	Vector	Suitable
KEDRAINA GE_LINE and KEDRAINA	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	Free	1993	Vector	Suitable
KEROADS	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	1993	Vector	Suitable
Roads	Norken ltd	Include in Catalogue and build metadata	Suitable	Review restriction	Suitable	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	Various				Unsuitable

Table 4-7: Dataset suitability results for application datasets

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Wildlife Distribution maps	Department of Resource Surveys and Remote Sensing	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Build topology if possible	Field survey	50	1977	Vector	Very suitable
NOAA	Kenya Meteorological Department (KMD)	Suitable	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1 Km reolution	-	1989	Raster	Suitable
METEOSAT	Kenya Meteorological Department (KMD)	Include in Catalogue and build metadata	Suitable	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	5 Km		1990	Raster	Unsuitable
Rainfall	Kenya Meteorological Department (KMD)	Include in Catalogue and build metadata	Suitable	Suitable	Suitable	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		-	-	Textual	Unsuitable
Kensoter database	Kenya Soil Survey (KSS)	Suitable	Suitable	Suitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology and confirm consistency	1:1000000	-	1971	Vector	Suitable
Arcsites	National Museums of Kenya (NMK)	Include in Catalogue and build metadata	Suitable	Suitable	Suitable	Suitable	Suitable	Build topology if possible	1:50000	-	2000	Vector	Unsuitable
Animal counts	Kenya Wildlife Service	Include in Catalogue and build metadata	Suitable	Suitable	Suitable	Suitable	Suitable	Confirm consistency	1:50000	-	1990	Vector	Unsuitable
Wildlife protected areas	Kenya Wildlife Service	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Build topology if possible	Various		1994	Vector	Very suitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Cadastral maps	Kenya Power and Lighting Company (KPLC)	Include in Catalogue and build metadata	Convert to digital form	Unsuitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:2500,1:2000				Unsuitable
Electrical network	Kenya Power and Lighting Company (KPLC)	Suitable	Suitable	Suitable	Suitable	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:2500	-	-	Vector	Suitable
Indigeneous forests	Kenya Forestry Research Institute	Suitable	Convert to digital form	Suitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	-	1992	-	Unsuitable
Exchange Area Network	Telkom Kenya	Suitable	Convert to digital form	Unsuitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:5000, 1:2500, 1:1250	-	-	-	Unsuitable
Distribution Network (Cabinet)	Telkom Kenya	Suitable	Convert to digital form	Unsuitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	NTS (Not To Scale)	-	-	-	Unsuitable
Transmission and radio links	Telkom Kenya	Suitable	Convert to digital form	Unsuitable	Establish % coverage	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	-	1973	-	Unsuitable
Desertfication	United Nations Environmental Programme (UNEP)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	Below 1:1000000	-	-	-	Suitable
Kenya_crop/livestock.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable

Dataset title	*Custodian*	*Availability*	*Form*	*Accessibility*	*Completeness*	*Status*	*Co-ordinate system*	*Topological consistency*	*Source scale*	*Price (KSh.)*	*Last date of update*	*Format*	*Remark*
Kenya_ECFdistribution.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_forest_ranges.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_Malaria_zones.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Suitable
Kenya_R_appendiculatus.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_Rainfall_distribution.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kentraveltime	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Raster	Unsuitable
Kenya_rainstations1890-1985.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_rainstations1991-96.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Kenya_Tree_cover.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Raster	Suitable
Kenya_tsetsedistribn.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Vector	Unsuitable
Kenya_Aczones.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Vector	Unsuitable
Kenya_waterpoints1.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Vector	Suitable
Kenya79loc_census.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Vector	Unsuitable
Kenya89subloc_cencus.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Vector	Unsuitable
Maize_production.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	Free	.	Vector	Suitable
Millet_production.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	Free	.	Vector	Suitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Mkt_Access1	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Raster	Suitable
Mkt_Access2	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Vector	Unsuitable
Mkt_Access3	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Raster	Suitable
Kenya_Aezones.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Vector	Unsuitable
Rice_production.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	Free	.	Vector	Suitable
Sorghum_production.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	Free	.	Vector	Suitable
Wheat_production.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:1000000	Free	.	Vector	Suitable
kenya_Camel distribution.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	.	Vector	Suitable

Dataset title	Custodian	Availability	Form	Accessibility	Completeness	Status	Co-ordinate system	Topological consistency	Source scale	Price (KSh.)	Last date of update	Format	Remark
Kenya_Cattle_density.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_climate_surface.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible		Free	-	Vector	Unsuitable
Kenya_mapsheets_catalogue.shp	International Livestock Research Institute (ILRI)	Suitable	Suitable	Review restriction	Suitable	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:50000	Free	-	Vector	Unsuitable
Stem borer	International Centre for Insect Physiology and Ecology	Include in Catalogue and build metadata	Suitable	Suitable	Establish % coverage	Establish the status	Transform to Arc Datum 1960 if possible	Build topology if possible	1:250000	-	2003	-	Unsuitable
KESETTLEMENTS	United Nations High Commissioner for Refugees, RSAL	Suitable	Suitable	Suitable	Suitable	Suitable	Transform to Arc Datum 1960 if possible	Build topology if possible	1:250000	Free	20001107	Vector	Suitable
Eldoret Facilities Manager	Eldoret Water and sanitation company (ELDOWAS)	Suitable	Suitable	Unsuitable	Establish % coverage	Suitable	Suitable	Build topology if possible	1:250000	-	-	Vector	Unsuitable
Inforsat	Department of Geography, Moi University	Include in Catalogue and build metadata	Suitable	Unsuitable	Suitable	Establish the status	Transform to Arc Datum 1960 if possible	Build topology and confirm consistency	1:50000	-	2000	Vector	Unsuitable

4.4 Evaluation of systems for compatibility

(i) Computer memory and speed.

Computers offer platforms for manipulation and processing of digital data. Since the invention of digital computers, a lot of developments in computer speed and memory have been realized. The responses indicated that 95% of the institutions in the sample have computers ranging from 386 to Pentium IV. However, details of computer memory and speed were not given. This is probably because the purchase of the computers was based on various specifications, which were not availed at the time of the interview.

(ii) Operating System.

The dominant operating system identified in the survey was Windows 95/98/2000 with a 91 % represent UNIX with 11 %, Macintosh with 9 %. The main concern with operating systems is their portability, i.e., the ability of the operating system to run on different computer models from different vendors. UNIX portability has not been fully realized because of the proliferation of many UNIX varieties (Groot and McLaughlin, 2001), and this is probably the reason why Windows appear to challenge UNIX's popularity.

(iii) Database Management System.

Ms access, a relational database management system was dominant with a 70%, while Fox pro, an object-oriented database management system has a 3% representation.

(iv) The GIS software.

The main issue with GIS software is their compatibility. Compatibility of these systems can be determined by Knowing:

- The data formats the software support.
- If software is compliant to any object/component specification.

Table 4-8 gives the GIS software identified in the study, the formats they support, and compliance with any object/component specification (obtained from the respective software documentation).

GIS software	Data formats																							Database management System (DBMS)								Object/ Component compliant specification
	Vector formats											Raster formats												Database						Query		
	ArcView .shp	ArcInfo coverage	MapInfo (MIF)	ArcGIS geodatabase	IDRIS vct	DXF	CGM	XML	DWG (AutoCAD)	DGN (MicroStation)	Intergraph	Erdas ERD/LAN/GIS	TIF/GeoTIF	JPEG	TGA	Arcinfo Grid/Arc Raster	GIF	BMP	BIL	ARDG	BSQ	PCX	Idrisi .rst	Ms Access	db III/IV	Ascii	Lotus	Ms Excel		SQL		
Arc View (3.2)	x	x				x	x		x	x		x	x	x		x		x	x	x	x				x					x		
Arc View (3.3)	x	x				x			x	x		x	x	x		x		x							x					x		
Arc Info		x														x																
Arc Info		x														x																
ArcGIS (8.1)		x		x		x								x																		SFO1.1*
AcGIS (8.3)		x		x		x								x																		
MapInfo (4.5)																																
MapInfo (5.0)																																
MapInfo (5.5)	x	x	x			x				x	x			x	x		x		x					x	x	x						
MapInfo (6.0)																																
IDRISI32		x			x	x						x	x					x						x	x							COM compliant
ILWIS (2.1)																	x								x							
ILWIS (3.1)	x	x				x						x	x	x			x						x		x							COM compliant
SGD						x			x																							

Table 4-8: File formats supported by GIS software identified in the study

* SFO1.1 : Simple Feature Access for OLE/COM 1.0, an OGC specification

(vi) Internet access point (server node)

About 72 % of the institutions in the sample frame have access to the Internet. This means that communication (data sharing) between the institutions is possible. But for a fully functional, standard-based NSDI to be realized, these institutions must have server nodes (depending on the model as discussed in section 2.6.1). For the server node to be considered to belong to a particular network (clearinghouse) and therefore compatible, two issues that must be addressed are:

- The search/retrieval protocol (implemented in the server software)
- The server registration system

Of the 250 GSDI metadata clearinghouse nodes, three are from Kenya: UNEP and ILRI, nodes, which are active and the IGAD node, which is inactive. An example of server node information is in appendix 2.

(vii) Data transfer rates and type of traffic the network supports

The connections to the Internet are largely through the analogue telephone system. Definitely this medium has some restrictions on the bandwidth and rate of data transfer. However, with the Integrated Services Digital Network (ISDN), higher transfer rates are possible. Additionally, the ISDN has made it possible to transmit other forms of data (text, graphic and image) apart from voice, except that the limiting bandwidth will mean that compressed file formats are used. During the survey, another medium of data communication identified is the microwave link between the Kenya Meteorological Department (KMD) and the Department of Resource Surveys and Remote Sensing (DRSRS). This medium offers faster rates, and broader bandwidth.

As opposed to an elaborate evaluate of datasets, which can be evaluated singly against all the parameters, on the other hand, only system components can be evaluated independently. In this respect, for systems, only the GIS software were evaluated in a more elaborate way. For the other system parameters: the operating system, the Database management system and Internet access, only the percentage of institutions that have/use them were determined, while the computer memory and speed, the database architecture, type of network traffic and rate of data transfer, the data that was collected during the survey was not sufficient to allow for a more elaborate evaluation.

In general, the evaluation of systems was not as elaborate as for datasets. Insufficiency of data collected during the survey as well limited a complete evaluation of datasets on the basis of coverage, currency, positional accuracy, price and logical consistency, while for systems the limitation was in the computer memory and speed, the database architecture, type of network traffic and rate of data transfer.

4.5 Observations from the study

During the study the following observations were made:

(i) Most respondents did not understand what the definition of a geospatial dataset is and it was only after they were given the definition that they were able to state datasets that they held, this was especially so for those institutions that do not have a catalogue of their geospatial datasets.

(ii) 26% of the datasets are accessible while the rest are unavailable for external use and for some others, their access restrictions were not specified. Therefore for those datasets that were indicated as unavailable for external use, the restrictions should be reviewed. For example, datasets in the custody of the Department of Urban Development, Ministry of Local government.

(iii) The Survey of Kenya in an on-going programme of developing national spatial datasets is converting all its smaller scale (1:50,000 and 1:250,000) topographic maps to digital form. This can be considered duplication of effort given that the Central Bureau of Statistics (CBS) has digitized some of these maps. For large-scale applications (>1:10,000), most of the available datasets may not be suitable because their source scales range from 1:50,000 to 1:1,000,000. The on-going project for the establishment of the spatial data framework for the city of Nairobi is one instance of large-scale data framework and the first of a kind. Therefore for the other towns, the datasets in digital form for 26 towns held by the Department of Urban Development should be used to develop the foundational and framework datasets for these towns, without doing a new survey like the case of Nairobi; otherwise this is a sure case of duplication. Another case of possible duplication is by the Department of Physical Planning in the Ministry of Lands, which in its on-going programme is converting analogue data to digital format, for urban areas.

(iv) Though a greater percentage (84%) of datasets are in digital form, they were prepared for the purpose of producing (publishing) topographic maps, and therefore most of them could contain a lot of feature symbols. Therefore, for these datasets to be used widely, they need to be prepared into GIS framework, that is by representing features with their feature primitives (points, lines and polygons) and to ensure that they are topologically consistent.

(v) Most respondents could only respond that datasets were topologically and thematically consistent without providing consistency check report. Institutions should therefore be encouraged to carry out logical consistency checks automatically and include the results in the metadata.

(vi) Most datasets are in vector format and referenced using plane co-ordinates. The co-ordinate systems identified include UTM, Cassini and local. However, not all datasets in UTM are based on the modified Clarke 1880, others are based on the WGS84 ellipsoid. In these circumstances positions are likely to differ by as much as 300m. Transforming all datasets to Arc Datum 1960 should clear this mixture.

(vii) Price was only given for 8% of the datasets. It is suspected that geospatial data are sold and bought to an extent that some institutions have taken advantage of the ignorance of their customers about the actual prices of digital data to charge exorbitant prices. It is therefore recommended that a study be undertaken to determine price specification for geospatial data and products.

(viii) It was observed that most datasets unless modified (on the basis of need) by the organizations, their currency would be taken as the date they were originally prepared as basic datasets or extracted from the basic datasets. In this regard, currency (last day of up-date) was indicated for only 36% of the datasets.

(ix) ArcGIS 8.1, ILWIS 3.1 and IDRISI32 I32.2 GIS software were found to be suitable on the basis that they are COM compliant (based on Microsoft component technology), and therefore expected to offer higher interoperability, in addition to supporting the common file formats, e.g. DXF and TIFF.

(x) Windows was identified as the dominant operating system with a 91% representation, UNIX (11%) and Macintosh 9%. On this basis, it can be argued that Windows is more portable (ability to run on different computer models from different vendors) than the rest. In fact Groot and McLaughlin have indicated that UNIX's portability has not been fully realized because of the proliferation of many UNIX varieties (Groot and McLaughlin, 2001).

(xi) Off-line and on-line data sharing are possible given that 72% of the institutions have access to the Internet. Infrastructure-enabled data sharing is however not possible as yet because only three metadata servers exist, the UNEP and ILRI, which however are established on international mandate.

(xii) The connection to the Internet is largely through the analogue telephone system, where data transfer rates of up to 28kbps are achievable. But with ISDN higher rates are possible and to transmit multimedia data. To accommodate large data files, larger bandwidths are required. For example, the microwave link between the Kenya Meteorological Department (KMD) and the Department of Resource Surveys and Remote Sensing (DRSRS), rates of up to 1Mbps are realized. It is therefore recommended that data transfer rates be at least 28kbps.

(xiii) 92% of the institutions use computers to handle their geospatial data and information, although the respondents did not give information about the speed and memory. Therefore individual organizations should prepare specifications that will guide the procurement of systems that are interoperable with others in the NSDI

(xiv) The government in its National Development Plan has incorporated in its policy paper on Information and Communication Technologies (ICT), an action plan to establish a National Spatial Data Infrastructure (NSDI) for an efficient management geospatial information (National Development Plan, 2002-2008). Towards the Government's policy paper on ICT, a national communications secretariat has been established and has received over 50 submissions for consideration. So far, the secretariat is working on a draft, which is not available to the public as yet.

(xv) Most institutions (80%) indicated their willingness to co-operate by indicating what their contributions towards the realization of the NSDI would be. The contributions include: provision of framework data, setting up of standards, to provide data portals and links to facilitate exchange of data. However, some private sector organizations showed some unwillingness to indicate what datasets they are holding. This was even to the extent that one private-sector institution did not respond at all by indicating that some questionnaire items were asking for company information that they are not allowed to give out and that some questionnaire items were irrelevant. The willingness of private-sector institutions to co-operate can only be boosted if they can see what their stake in NSDI is. Interoperable data, a dedicated and regularly updated network, more collaborations and specifications of core and framework geospatial datasets are some of the expectations about the NSDI. These expectations show that there are more than enough potential users.

(xvi) Generally, the human capacity to run NSDI seems not sufficient. This is because 86% of the institutions indicated that they need either more staff with geospatial expertise or more training for existing staff or both.

(xvii) More government institutions are aware and are involved in NSDI development than private-sector institutions.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

The study had the following objectives to meet:

(i) Carry out an inventory of existing geospatial datasets and significant geoinformation systems in Kenya.

(ii) Determine the parameters that one can use to evaluate the suitability of a data set for inclusion in a NSDI.

(iii) Determine the parameters that can be used to evaluate the compatibility of a system with others in NSDI.

(iv) Evaluate the data collected in (i) in view of (ii) and (iii) above.

(v) Draw conclusions and make appropriate recommendations.

Based on the evaluated datasets, it is concluded that Kenya is about halfway towards its NSDI implementation. This is because about half of the datasets were evaluated as suitable. Whereas almost all categories of foundation datasets (as discussed) in section 2.3.2) were identified, none was identified as consisting purely of a gazetteer. Therefore an official gazetteer should be prepared. Overall, about 57% of foundation datasets were determined as suitable; therefore the parameters that are wanting in the other datasets should be addressed. The framework datasets identified fall in 8 framework data categories: transportation, hydrography (rivers and lakes), land use/land cover, cadastral, soils, geology, zoning and restrictions and wetlands. These are recommended as the candidate national framework datasets. In general, the evaluation of systems was not as elaborate as for datasets, because of insufficiency of data on systems collected during the survey.

From the study, the following recommendations are made.

- The datasets whose coverage were not supplied, coverage should be determined so that gaps and duplications in coverage can be determined, in addition, logical consistency should also be determined, in order to guarantee consistent GIS framework data. This can be achieved easily if institutions that do not have catalogues for their datasets as yet, would start to document all their geospatial datasets.

- Particular organizations should be mandated to develop particular national framework datasets at particular scales (resolution) and if necessary, be allowed to outsource datasets from other organizations.
- Though majority of the organizations have Internet connections, it was however observed that these institutions are concentrated in urban areas. Therefore for these institutions to establish infrastructure-enabled data sharing, they should be encouraged to prepare specifications that will guide them in the procurement of interoperable system components.
- Government institutions should take a leading role in NSDI development, this is because private-sector institutions, it appears that they can co-operate if only they see what their stake in NSDI is.
- Some cultural and attitude changes must be accepted in the institutions in order to ensure the success of NSDI are as recommended below.

  a) *Academic institutions*
    - Liaise with industry.
    - Broaden curriculum.
    - Equip GIS Labs.
    - Structure and standardize GIS training.
    - Consider offering geospatial training to practicing professionals.

  b) *Government*
    - Consider and guide policy framework for NSDI.
    - Reduce bureaucracy.

  c) *Private sector*
    - Interact more with other organizations
    - Arrange for GIS fora
    - Open up
    - Be transparent

Finally, for a more complete picture, another study on other components, for example, on policies (e.g. pricing), on people (e.g. certification of NSDI personnel) should be undertaken.

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APPENDIX 1: SAMPLE QUESTIONNAIRE

SAMPLE QUESTIONNAIRE

Form A

INSTITUTIONAL DETAILS

Name of organization______________________________

Full address______________________________

Telephone Number(s)______________________________ **Fax**______________________

Physical location____________________ **Website**________________ **E-mail**____________________

Contact person____________________ **Designation**____________

DESCRIPTION

1. **When was your organization set up?**
2. **What is the total number of employees in your organization?**
3. **What is the number of staff working with spatial data?**
4. **Who are the users of your organization's products?**

5. **Which of the following best describes your organization?**

Government Private Profit Semi-governmental Non-governmental

Non-profit Local Authority Charity Other (specify)

6. **At what level does your organization operate?**

International Regional National Local Community Other (specify)

7. **What is the core business of your organization?**

Trade Co-ordination Policy Research Industry Law

Education Regulation Service Administration Consultancy Lobbying

Environmental protection Resource management Other (specify)

8. **State major programmes/projects that you have undertaken or are on going**

INFORMATION MANAGEMENT

9. **Indicate how you consider the following types of data to be fundamental for any of your applications.**

Choose a number ranging from 1 to 5, with 1 indicating not fundamental and 5, extremely fundamental

TYPE OF DATA	1	2	3	4	5
Geodetic					
Land surface elevation/topographic					
Digital imagery (orthoimagery)					
Government boundaries/administrative boundaries (Government units)					
Transportation/Roads					
Cadastral /land ownership					
Hydrographic/rivers and lakes					
Ocean coastlines					
Bathymetry					
Physical features/buildings					
Place names					
Land use/land cover/vegetation					
Geology					
Real estate price register/ Land valuation					
Land title register					
Postal address					
Wetlands					
Soils					
Register of private companies					
Gravity network					
Zoning and restrictions					

10. **Do you use any specifications (standards) for the following items? If so, indicate the specifications.**

	Yes	No	Specification
Data collection and compilation			
Content specification			
Geospatial data format			
Data coding			
Data exchange			
Map design			
Map symbology			
Spatial referencing			
Geospatial metadata			
Catalogue			
Fee schedule for products and services			
Qualification and certification of personnel			
Quality evaluation			

11. **Indicate with a tick (√) in the following, which quality elements you use and those that you test your data for.**

Quality element	Use	Test
Non-quantitative quality element	———	———
Purpose		
Usage		
Lineage	———	———
• *Source*		
• *Process step*		
• *Producer organization*		
• *User guide*		
Quantitative quality elements	———	———
Completeness	———	———
• *Omission*		
• *Commission*		
• *User guide*		
Logical consistency	———	———
• *Topological consistency*		
• *Domain, Geometric, semantic consistence*		
• *User guide*		
Positional accuracy	———	———
• *Absolute accuracy*		
• *Relative accuracy*		
• *Relative horizontal accuracy*		
• *Relative vertical accuracy*		
• *Raster data positional accuracy*		
• *User guide*		
Temporal accuracy	———	———
• *Last updated*		
• *Temporal validity*		
Thematic accuracy	———	———
• Quantitative and qualitative Classification correctness		
• Accuracy of spelling		
• Likely misclassification		

12. **Do you deliver your products with quality results?**

PARTNERSHIPS

13. Please provide details of the most important networks/ steering committees or groups with which your organization is involved. In addition indicate the kind of involvement (whether coordination, facilitation, participation or support)

14. Estimate how many organizations regularly provide and receive data from your organization, specifying whether it is through formal agreements or informal arrangements.

	Number	Arrangement
Provide		
Receive		

15. Please state any partnerships, which are being planned in the near future.

16. How could your organization contribute most effectively to NSDI?

17. What could you expect from such a network?

18. Are more staff needed with geospatial expertise, or do existing staff need more training (or both).

19. Have you experienced changes in workforce of geospatial personnel in your organization?

20. What changes do you expect (in approach and attitude) at the following levels to enhance the use of spatial data by decision makers and the public?

    I. Your organization

    II. Educational institutions

    III. Private sector organizations

    IV. Telecommunications

    V. Government

    VI. Non-Government groups

    VII. Foreign aid agencies

SYSTEMS

Indicate whether the following facilities are used in your organization and also state their number

	Yes	Type/Version	Number
Communications Telephone Fax Local Area Network Email accounts Internet access points Other (specify)	=========	=========	=========
Computers (speed and memory) PC-386 MHz or lower Pentium I Pentium II Pentium III Pentium Iv UNIX workstation Other (specify)	=========	=========	=========
Operating system DOS Windows 3.1/3.11/95/98/2000/NT UNIX Macintosh Other (specify)	=========	=========	=========
Database Centralized Distributed Other(specify)	=========	=========	=========
Geographic Information System Software PC ARC/INFO Workstation ARC/INFO Arc View MapInfo ArcGIS ILWIS IDRISI Other (specify)	=========	=========	=========
Database Management System Access Oracle Other (specify)	=========	=========	=========
Related software Image processing CAD software Other (specify)	=========	=========	=========
Data input/output Digitizing tables Scanners Plotters Printers Other (specify)	=========	=========	=========

Form B (DATASETS)

(One copy of this form per dataset is to be filled depending on the number of datasets within a given organization)

A dataset may be a smaller grouping of data, which though limited by some constraint such as spatial extent, or feature type is physically located within a larger dataset. A hardcopy map or chart is considered a dataset

Title of dataset__________________________________**Department**______________

Contact person__________________________________**Designation**______________

Telephone number____

DESCRIPTION

1. State where required or underline the most appropriate item pertaining to this dataset.

Parameter/Characteristic	**State or underline the most appropriate**
Topic	Farming; Biota (fauna/flora); Boundaries Climatology/Meteorology/Atmosphere; Economy; Elevation Environment; Geosciences; Health Imagery/Base maps/Earth cover; Intelligence/Military; Inland waters Location; Oceans; Planning/Cadastre Society; Cultural features; Transportation Utilities/ communication
Coverage	**Area name** **Area in Km^2**
Form	Digital image; Hardcopy image; Digital document; Hardcopy document Digital map; Hardcopy map; Digital model; Hardcopy model Digital profile; Hardcopy profile; Digital table; Hardcopy table Digital video; Hardcopy video; Audio-visual; Mixture
Source scale	
Role of organization	Resource provider; Custodian; Owner; User; Distributor Originator; Point of contact; Principal investigator; Processor; Publisher
Accessibility	Unrestricted; Restricted to some; Restricted to most; Unavailable for external use Top secret
Kind of restriction	Copyright; Patent right; Patent pending; Trademark License; Intellectual property; Other restrictions?
Terms of accessibility	Free; Free to most; Free to some; Charged
Charge methodology	Cost recovery; Cost plus overhead; Market value; Not defined
Cost	
Media (if accessible)	Hard copy; Floppy disk; CD-ROM; Online Private network; DVD; Satellite; Telephone link
Original source	Remotely sensed data; Paper map; Digital maps; Field survey
Last update	
Positional accuracy	
Vertical accuracy	
Resolution	
Precision	
Topology	Only geometry; Full planar graph; 3D topology; Abstract
Completeness	
Status	Complete; Nearing completion; Under-developed; Early stages of development
Life expectancy	Everlasting; >10 Years; >5 Years >1 Year; >Less than six months; Immediate future only

Year development began	
Frequency of update	Continually Daily Weekly Fortnightly Monthly Quarterly Biannually annually as needed irregular not planned unknown
Catalogue	Manual catalogue Digital catalogue None
Format/Representation	Vector Raster Textual Tin Stereo model Video
Geocoding system	Plane co-ordinates Geodetic Coordinates Street addresses Land Parcel addresses
Projection	UTM Cassini None Other (specify)
Reference ellipsoid	
Datum	
Original purpose	
Uses it has been put to	
Unwise/Improper uses	
Limitations in the dataset	
Standards used	

2. Does the age of the dataset limit its usefulness? If so elaborate.

3. Do you need newer versions of the same data?

4. Has the dataset been documented for external use?

5. Where access is provided, describe the recommended access procedure.

6. Why do you use GIS?

7. State any other significant geospatial information that you manage or use.

APPENDIX 2: SAMPLE SERVER NODE DESCRIPTION

Server Description	
Title:	International Livestock Research Institute
Short Title:	ILRI
Abstract:	Over the last ten years, research at the International Livestock Research Institute (ILRI) has generated an extensive range of spatial data layers. A number of these layers are related to livestock distribution and livestock health and production. Others cover more general topics such as population density, climate and infrastructure. The database published here is a result of a major effort to collect and catalogue these GIS layers. So far, the main focus has been on collecting all that is available for Kenya. But the work is ongoing and data layers for other countries within Africa as well as coverage with a continental or global extent will be forthcoming.
Cost:	free
Active Status:	True
Categories:	Agriculture and Farming, Atmospheric and Climatic Data, Biologic and Ecologic Information, Administrative and Political Boundaries, Earth Surface Characteristics and Land Cover, Elevation and Derived Products, Geologic and Geophysical Information, Health and Disease, Cultural and Demographic Information, Transportation Networks and Models, Base Maps, Scanned Maps and Charts
Server Host Information	
Host Name:	www.ilri.cgiar.org
Host IP:	64.95.130.4
Port:	210
DB Name:	ilri
Software Implementation:	CNIDR zserver v2.07i-NT
Software Version:	2.07i-NT
Platform:	Windows 2000
Website URL:	http://www.ilri.cgiar.org/gis
Server Latitude:	-1.2 Decimal Degrees
Server Longitude:	36.5 Decimal Degrees
Data Coverage:	Kenya

Predominant Geographic Extent of Data Served

Max latitude	
5.5	
min longitude	**max longitude**
33.8	**42**
min latitude	
-4.8	

Server Contact Information	
Name:	Russ Kruska
Organization:	International Livestock Research Institute
Address:	P.O. Box 30709
City:	Nairobi
State:	Nairobi
Postal Code:	0000
Country:	Kenya
E-mail address:	r.kruska@cgiar.org
User Support Hours:	9:00 AM - 5:00 PM E.Africa Standard Time
Telephone:	+254 2 630743
Fax:	+254 2 631499