INTRODUCTION

1.1 BACKGROUND

More than ever before, there is real need for various institutions (government, private) to share geospatial information so as to increase their efficiency and effectiveness in their operations. This means that institutions will focus more on their main objectives by obtaining their geospatial information needs from other institutions without need for initiating an independent data collection exercise. In this way duplication of data collection efforts are minimized as far as possible and business activities for geospatial information and services will be induced. This sharing of geospatial information should involve as many institutions as possible including government departments, private institutions, the academia and the entire citizenry. The primary objective of a National Spatial Data Infrastructure (NSDI) is to ensure that users are able to acquire, at the right time, adequate, complete and consistent datasets.

However, for NSDI to be realized, a number of issues must be addressed. The issues are quite varied but we have grouped them for the sake of this report as institutional, legal and political, technical and finally socio-cultural.

Institutional issues are generally believed to pose the greatest challenge to the development of NSDI (WCMC, 1996; EIS-AFRICA, 2001). Institutional issues include determining who (institutions) to be involved, how the NSDI is to be organized (i.e. the organization structure), who is to be “in-charge”; how appropriate the measures of success are.

The legal and policy issues to be addressed in establishing NSDI include the legal status and political backing of NSDI, public access to government-held information, commercialization of public geospatial information, privacy and protection of personal information, liability, integrity of the geospatial information, copyright and others.

Data sharing between institutions is not only hindered by institutional constraints but also by technical constraints. To have efficient data sharing within the NSDI, two obstacles must be overcome; Technical non-interoperability and semantic non-interoperability (Harrison, 2002).

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Technology with regard to NSDI includes the hardware, software or simply the networks that make possible the discovery and evaluation of geospatial data. Therefore technical non-interoperability is where different kinds of processing systems and different processing systems do not work well together while semantic non-interoperability is where different groups do not define features, structures and their metadata the same way. Interoperability is defined as the ability of a system or components of a system to provide information sharing and inter-application co-operative process control (Groot and McLaughlin, 2001). Interoperability therefore is a key concept for integrating the various kinds of information stored in different and differing repositories.

Apart from technical issues, the success or failure of NSDI depends also on socio-cultural conditions in a given country. Socio-cultural issues include for example the willingness to share information, and more generally the social acceptability of geospatial technologies or NSDI for that matter. The cultural acceptability relates to functionalities such as communication and information sharing, strategic planning, operational planning and management and monitoring and evaluation (ibid). In general therefore the way each country perceives the NSDI concept and how it believes its citizens may restrict the acceptance, desirability and economic traffic of government-held information. Therefore because of diversity in cultures, Kenya cannot afford to just copy NSDI applications from elsewhere, instead the establishment of NSDI should consider the prevailing and anticipated cultural conditions.

Over and above, there are other challenges that countries in Africa must contend with. As espoused by Mulaku (2002), they include low teledensity, lack of sufficient funds among others.

1.2 GEOSPATIAL STANDARDS

In actual practice (especially in Kenya), interoperability is absent in spatial data handling due to incompatible software products, inadequate data formats, semantic misconceptions and heterogeneous data models. This according to Thannasis makes interoperability a dream for users and a nightmare for system developers (Thannasis et al, 2000).

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It is now common knowledge that standards facilitate sharing of information and computer resources within and between organizations and in that regard standards have become popular in geospatial information because of the need to share information and resources. However, standards are not an end in themselves but the foundation to help information systems and databases easier to use and maintain (Groot and McLaughlin, 2001). Therefore legislation and policy recommendations are not suitable for imposition of standards. The reasons for embracing a standard as stated by Thannassis (2000) are:

i) It exists and it is complete across the area of interest.
ii) It is simple to access and use.
iii) It does the job.

Standards generally solve particular problems such as how to represent data efficiently. They are important for various reasons (ESRI, 2001) they facilitate the following:

i) The exchange of information (portability).
ii) Comparison of similar measurements.
iii) Analysis of information across disciplines.
iv) Reduce life cycle expenses.

Standards can generally be grouped as independent and de-facto standards. Independent standards are formally approved by a recognized body through a well-defined consensus setting, in which multiple interested parties have participated. For example, standards approved by the International Standards Organization (ISO), the American National Standards Institute (ANSI), the British Standards Institute (BSI) and the Kenya Bureau of Standards (KEBS) fall in this category. De-facto standards on the other hand, are those standards that become accepted because of their broad popularity and use, but are not necessarily accompanied by formal approval by an independent standards organization. In most cases de-facto standards arise from the I.T industry, in other words, the development of digital geospatial technologies and I.T. has awakened the need for standards. For De-facto standards, one company or group of companies may develop specifications or standards associated with

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a set of products and with sufficient market share, these standards are accepted by a large segment of the user community.

Efforts at developing standards for digital geospatial data have been made and will continue to be made through national, international and industry efforts. Some of the countries that have developed standards include the United States of America (USA), the United Kingdom (UK) and Japan, just to name a few. Besides the country level, internationally, a lot of comprehensive work has been undertaken in this field. In 1992, a decision was made to establish a committee, the Comite′ Europe′en de Normalization (CEN). The committee is referred to as CEN Technical Committee (CEN/TC 287) on Geographic Information (EIS Africa-2001). In 1994, ISO/TC 211, was formed under the International Standards Organization to oversee the development of standards for digital geospatial data.

The internationally recognized standards for digital geospatial data that are of broad international scope as already mentioned are the CEN/TC 287 and ISO/TC 211. ISO/TC 211 was formerly ISO 15046.

1.3 THE ISO STANDARDS

The International Standardization Organization (ISO) is a worldwide federation of national standards bodies from some 140 countries, one from each country. ISO is a non-governmental organization (NGO) established in 1947 and its chief missions are to promote the development of standardization and related activities in the world with a view to facilitating international exchange of goods and services and to develop co-operation in spheres of intellectual, scientific, technological and economic activities (ISO, 2003a). ISO's work results in international agreements, which are published as international standards.

ISO is made up of members divided into three categories namely: member body, correspondent member and subscriber member. A member body is the national body 'most representative of standardization in its country'. Thus only one member in each country may be admitted to membership of ISO. Member bodies are entitled to participate and exercise full

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voting rights on any Technical Committee (TC) and policy committee of ISO. The Kenya Bureau of Standards (KEBS) is Kenya's member body to ISO.

A correspondent member is usually an organization in a country, which does not yet have fully developed national standards activity. Correspondent members do not take an active participation in technical and policy development work, but are entitled to be fully informed about any work of interest to them. Finally, a subscriber member is for countries with small economies. These members pay reduced membership fees that nevertheless allow them to maintain contact with ISO.

1.4 HOW STANDARDS ARE DEVELOPED

ISO standards development is based on three principles namely: consensus, industry-wide and voluntary. ISO standards are developed by Technical Committees (TC) and Sub-Committees (SC) in a six-stage process as here briefly presented. ISO (2003a) gives a detailed procedure.

a) Stage one (Proposal stage)

If an item is needed, it is proposed and submitted for vote by the relevant members of the TC/SC to determine the inclusion of the item in the Working Group (WG) Programme. The proposal is accepted if the majority of the Participating members (P-members) of the TC/SC vote in favour. At this stage, a project leader for the work item is appointed.

b) Stage two (Building expert consensus)

A Work Group of experts is set up by the TC/SC for the preparation of the working drafts. Successive working drafts are considered until the WG is satisfied that it has developed the best technical solution to the problem being addressed. At this stage, the draft is forwarded to the WG's parent committee for consensus building phase.

c) Stage three (Consensus building within TC/SC)

As soon as the first draft is available, it is registered with the ISO central secretariat. It is distributed for comments and if required, voting by the participating members of the TC/SC is done. Successive drafts may be considered until consensus is reached on the technical content.

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Once consensus has been attained, the text is finalized for submission as the Draft International Standard (DIS).

d) Stage four (Enquiry on DIS)

The DIS is circulated to all ISO member bodies by the ISO central secretariat for voting and comment within a period of five months. It is approved for submission as a Final Draft International Standard (FDIS) if 2/3 majorities of the P-members of the TC/SC are in favour and not more than ¼ of the total number of votes cast are negative. If these criteria are not met, the text is returned to the originating TC/SC for further study and a revised document is again circulated for voting and comments as FDIS.

e) Stage five (Formal voting on FDIS)

The FDIS is circulated to all ISO members by the central secretariat for final Yes/No within a period of two months. If technical comments are received within this period, they are no longer considered at this stage, but registered for consideration during a future revision of the standard.

f) Stage six (Publication)

Once the FDIS has been approved, only the minor editorial changes if any and where necessary, are introduced into the final text, which is then sent to the ISO central secretariat, which publishes the international standard. All ISO standards are reviewed at least every five years by the responsible TC/SC. A majority of the P-members of the TC/SC decides whether international standards should be confirmed, revised or reviewed. Any party/person interested in a particular ISO standard can obtain it by ordering for the same through his/her member body.

1.5 THE ISO/TC 211 – Geographic Information/Geomatics

The ISO/TC 211 is a family of standards in the field of digital geospatial information/Geomatics. The technical committee was established in 1994 and so far six International Standards (IS) and two Technical Reports (TR) have been approved, while one, the metadata standard is a FDIS and thirteen others as DIS. This family of standards is

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intended to contain information concerning objects or phenomena that are directly or indirectly associated with a location relative to the earth. The standards may specify for geospatial information, methods, tools and services for data management (including definition and description), acquiring processing, analyzing, accessing, presenting and transferring such data in digital form between different users, systems and locations. This family of standards also links with appropriate standards for information technology and data and also provides a framework for the development of sector specific applications using geospatial data.

The standards in this family include the following (ISO, 2003b)

a) International Standards and Technical Reports (TR)
    i) ISO 6709: 1983 standard representation of latitude, longitude and altitude for geographic point locations
    ii) ISO 19101: 2002 Geographic information-Reference model
    iii) ISO 19105: 2000 Geographic information-conformance and testing
    iv) ISO 19108: 2002 Geographic information-Temporal schema
    v) ISO 19111: 2003 Geographic information-Spatial referencing by coordinates
    vi) ISO 19113: 2002 Geographic information-Quality principles
    vii) ISO/TR 19120: 2001 Geographic information-functional standards
    viii) ISO/TR 19121: 2000 Geographic information-imagery and guide and data

b) Draft International Standards (DIS)
    i) ISO/FDIS 19115: Geographic information-Metadata

c) Draft International Standards (DIS)
    i) ISO/DIS 19104: Geographic information-Terminology
    ii) ISO/DIS 19106: Geographic information-Profiles
    iii) ISO/DIS 19107: Geographic information-Spatial schema
    iv) ISO/DIS 19109: Geographic information-Rules of application of schemata
    v) ISO/DIS 19110: Geographic information-Feature cataloguing methodology

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vi) ISO/DIS 19112: Geographic information-Spatial referencing by geographic identifiers
vii) ISO/DIS 19114: Geographic information-Quality evaluation procedures
viii) ISO/DIS 19116: Geographic information-Positioning services
ix) ISO/DIS 19117: Geographic information-Portrayal
x) ISO/DIS 19118: Geographic information-Encoding
xi) ISO/DIS 19119: Geographic information-Services
xii) ISO/DIS 19125-1: Geographic information- Simple feature access-part 1: Common architecture
xiii) ISO/DIS 19125-2: Geographic information-Simple feature access part-2: SQL option

Standards of importance to geospatial information users range from the details of computer hardware and networks to design of databases and map products. The standards for digital geospatial data and information will generally cover topics such as data quality, data classification, metadata, data transfer and other related topics.

In a country where digital geospatial technology is gaining widespread use such as Kenya, the development of standards is mandatory in order to achieve economics of scale with digital geospatial data. The wisdom in the industry today is that user and producer organizations must adopt standards to deploy and support use, maintenance and sharing of geospatial information. From Sub-Saharan Africa, only South Africa is a participating member of ISO/TC 211, while Zimbabwe and Kenya are Observing members (ISO, 2003b). In the majority of countries little or no work at all on standardization for geoinformation is being carried out.

It is for this reason that this preliminary study to determine the current situation of digital geospatial data in Kenya as regards the level of acceptance of digital geospatial data; the organizations that are involved; accessibility and sharing of geospatial data between organizations; legal issues and sale of geospatial data. And also to determine the statuses of specifications of major geospatial data producers in Kenya.

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1.6 OBJECTIVES OF THE STUDY

The study was commissioned with the objectives as spelt out in the Terms of Reference (TOR) in Annex 1, these are:

1 To collect information on current situation of digital geospatial data production in Kenya in general.
2 To present statuses of specifications of major geospatial data producers in Kenya
3 To analyze the findings and preparation of recommendations for establishing Kenyan standards for geospatial data.
4 Preparation of the final report

Significance of this preliminary study is that status of specifications of major data producers and users will be determined, which will then define the starting point for standards development for digital geospatial data. The development of such standards is invaluable in the NSDI development efforts.

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THE RESEARCH METHODOLOGY

In order to achieve the objectives of this study, a survey of data producers and users was done using a suitable questionnaire. The questionnaire contained both closed and open-ended questions and was structured to obtain information about the institutions and their specifications for geospatial data. The questionnaire was administered by way of interview.

2.1 SAMPLING

The entire population of institutions who produce and use geospatial information in Kenya is quite varied and it was not possible to visit each of them individually. The best possible sampling was therefore done across the government, the private and the academic sectors. Some international/regional institutions that are within Kenya were involved as well. A sample frame of the institutions that were visited is in annex 2. In general 32 institutions responded to the survey, however more than this number were approached, but due to time constraint and lack of co-operation from some of them, no response was forthcoming from the rest. Of the 30, 9 were government departments, 8 government parastatals, 3 educational, 7 private and 5 international/regional.

2.2 QUESTIONNAIRE CONTENT

The questionnaire (with sample in annex 3) was divided into four sections i.e.

(A) Institutional Details

Under this section, the information that was to be captured include

- The name of the institution
- Full address
- Telephone numbers
- Physical location
- Contact person

(B) Description

- When the institution was set up
- Number of employees
- Number of staff working with spatial data
- Opinion regarding use of standards for geospatial data

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- Description of the institution
- Level of operation
- Core business

(C) Information management

- Significant geospatial datasets
- Standards/specifications used
- Quality evaluation

(D) Partnerships

- Data exchange
- Partnerships planned in the near future
- Contribution of the institution toward NSDI
- Benefits from NSDI

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QUESTIONNAIRE RESULTS

The survey responses were analyzed using the Statistical Programme for Social Scientists (SPSS) software.

(i) Description of organizations

Although the institutions surveyed were generally grouped into five categories, the respondents described the institutions in various ways. Figure 1 shows how the respondents described the institutions.

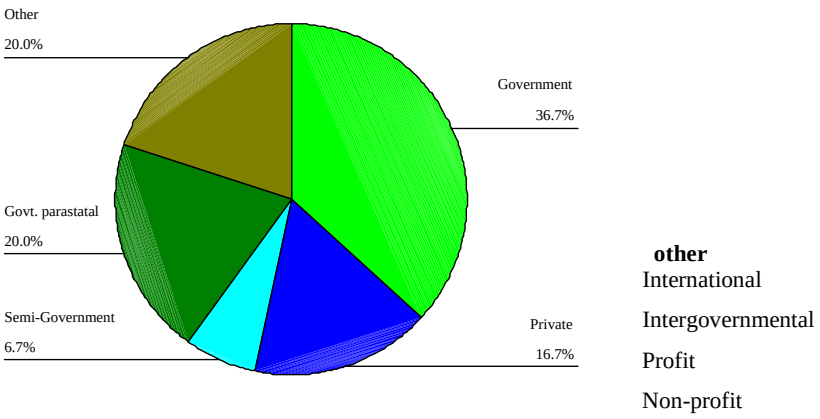

Figure 1: Organizations

In general terms, the organizations indicated who the users of their products are. Although this item was meant to sample the disciplines where geospatial information is being applied, most of them were instead general in their responses. Government departments, parastatals and international institutions responded that their customers are other departments within, other government institutions, learning and private institutions, while the private and the academic institutions have government parastatals and the private sector as their customers.

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(ii) Information management

The NSDI has its foundation on framework datasets. These are datasets, which have common-use and are of national and trans-national importance, Government departments' response (mean demand) for the geospatial framework data is presented in figure 1.

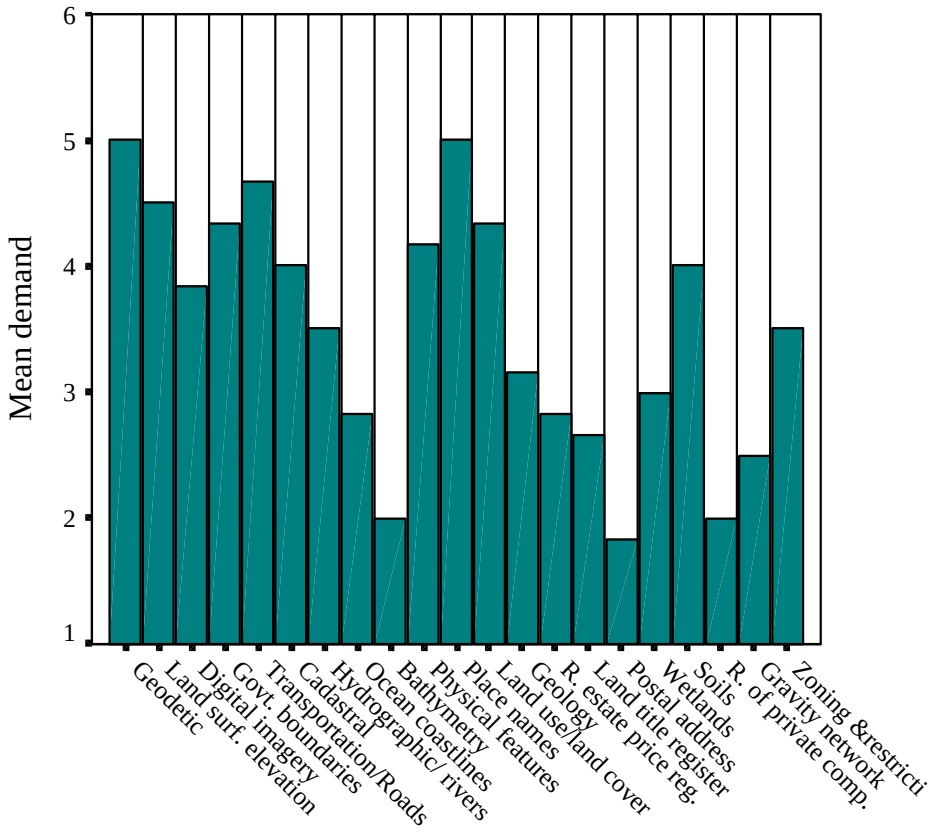

Figure 2: Demand for various geospatial data

This item was meant to determine the representative national demand for geospatial data. In comparison with what has been suggested in various literature (Douglas, 2001; EIS-Africa, 2001), the candidate framework datasets are:

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- Cadastral information
- Geodetic control
- Geographic feature names
- Orthoimagery
- Elevation
- Transportation
- Hydrography
- Government units

The Government demand for geospatial information has the highest number of candidate datasets, followed by the academic institutions. It is therefore suggested that the government departments and the academia be used to determine the true national demand. Government parastatals may have some bias considering that they are mission specific. International/regional institutions may indicate a regional /international demand, which may not reflect the national demand, for instance cadastral information. Private institutions might only indicate demand for datasets that they have handled. Finally the academic institutions as expected indicated almost a uniform demand for all the candidate datasets.

Since the government department will determine the success or failure of NSDI, the demand for framework data by Government departments and academic institutions will indicate generally the national demand. From this analysis, the following are recommended as key framework data for Kenya.

- Geodetic
- Place names (gazetteer)
- Transportation
- Government boundaries
- Land surface elevation
- Physical features
- Land use/land cover
- Cadastral
- Digital imagery
- Hydrographic

(iii) Use of standards/specifications

Generally, there was a very positive response with regard to the establishment and setting up of standards for geospatial data. As shown in figure 2, Out of the 30 responses 87% indicated that they were in strong agreement with the idea, while 13 % indicated that they only agreed,

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none indicated that they either weren't sure, or in disagreement or total disagreement with the idea.

The respondents gave various reasons with respect to the establishment of standards. Some of the reasons advanced include the following:

- Ease of conversion and comparison (to determine reliability) of data sets
- Ease of integration and sharing of data with other organizations
- Standards ensure that all stakeholders develop data sets at acceptable (e.g. quality) and on common reference
- With standards duplication is minimized
- It is a national mandate
- They enhance effectiveness of digital geospatial data.

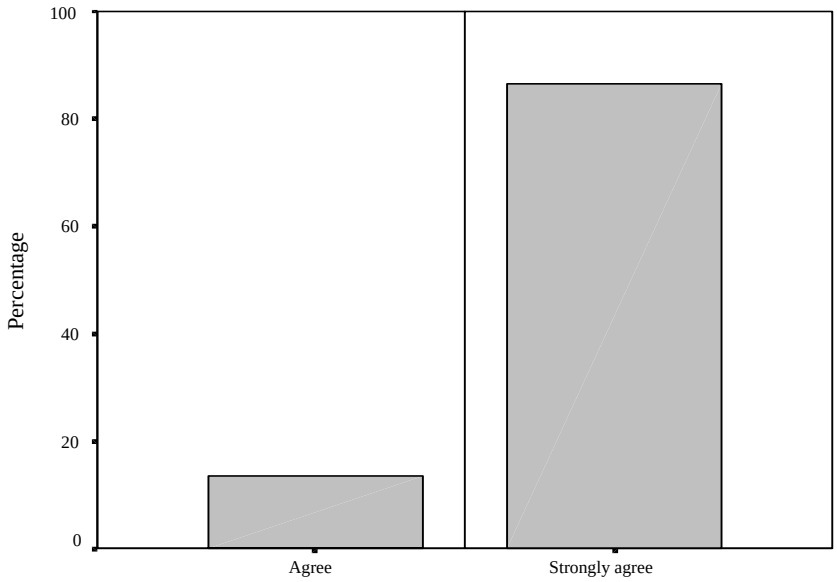

Figure 3: Use of standards

This overwhelming positive response therefore implies that the question to be addressed is not whether to establish or adopt standards for geospatial information but what standards are to be established or adopted?

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Though standards impacting Spatial Data Infrastructure range from hardware and networks to design of databases and map products, this study was more biased towards the high-level standards. These are standards that deal with the development of geospatial information systems, which include among others the design of databases, establishing procedures for data exchange among others.

To determine whether any specifications or standards for geospatial data are used at all, a related item required the respondents to indicate whether they use any specifications for particular items and to indicate the specifications if any. A total of 13 items were under investigation. The items under investigation generally covered five areas: data format, data compilation and update, product presentation, production distribution and certification and qualification of personnel.

Overall, the responses to all these items ranged from 69.0% to 93.1%. With qualification and certification of personnel getting the least response while the catalogue receiving the highest response. Table 1 gives in summary the responses, while Annex 3 contains the comprehensive response on this item.

The items with their percentage responses (percentage of the valid responses) are presented below. Generally the responses are grouped into three categories. The first category (A): those who indicated that they do not use any standards or specifications. The second category (B): those who indicated that they either have some internal specifications, use specifications as required by a given project or limited to what the particular software provides and finally, the third category (C): those who use some national or international standard.

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Item	A	B	C
Geospatial data format (valid response 90.0%)	29.6	66.6	3.7
Data content (valid response 83.3%)	20.0	60.0	20.0
Data coding and classification (valid response 80.0%)	29.2	50.0	20.9
Data exchange (valid response 80%)	37.5	58.3	4.2
Geospatial metadata (valid response 80%)	58.3	33.4	8.3
Data collection and compilation (valid response 90.0%)	22.2	70.3	7.4
Spatial referencing (valid response 86.7%)	23.1	7.6	69.2
Quality evaluation (valid response 86.7%)	30.8	50.0	19.1
Map design (valid response 86.7%)	26.9	34.5	38.4
Map symbology (valid response 90%)	14.8	25.9	59.2
Fees schedule for products and services (valid response 70.0%)	61.9	28.6	9.2
Qualification and certification of personnel (*valid response* 66.7%)	45.0	15.0	40.0

Table 1: response for specifications

A. Data formats:

This includes Geospatial data format, data content, data coding and classification, data exchange, geospatial metadata. What this pattern of response clearly reveals is that for geospatial data formats, producers and users have no option but to depend on what the available software provide for, or what a particular project specifies. The majority of the institutions define their data content dependent on the project together with what the available software provides for. Data coding and classification are in most cases influenced by international organizations such as the World Meteorological Organization (WMO), the Food and Agricultural Organization (FAO). For data exchange most institutions use software options and for vector data, DXF was cited most as the specification for data exchange, but this depends much on the software. Finally, for metadata, majority of organizations do not know what metadata is. To have NSDI that is effective, this is one item that must be taken seriously for it is the one that ideally makes data discoverable and enables evaluation.

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B. Data compilation and update

The items here define the acceptable techniques for capturing and compiling data, accuracy and quality standards. They include data collection and compilation, spatial referencing, quality evaluation. For data collection, the institutions that deal with land survey cited the specifications as provided in the Survey act, while those that deal with soil survey indicated FAO soil survey specifications.

A majority of the respondents use UTM/Geographic co-ordinate system, but the majority of them again obtain basic geoinformation from Survey of Kenya, which are based on UTM/Geographic. GPS was also included in this category, but during the interviews, most respondents expressed the need to have pillars with known WGS84 co-ordinates.

C. Product presentation

This covers specifications for production of standard maps and other output products. Though many organizations do not have map production as their main business, at one point or another, they produce maps. The standards here include accepted map layout (Sheet format, scale, margin and legend designs), standards for accepted point and line symbology and for other products.

For map design, the response is almost uniform, indicating that the design of maps has various specifications. The high response for map symbology ideally refers to International cartographic specifications.

D. Product distribution

This entails any established programmes for external distribution and sale of geospatial data, products and services. Most institutions have no specifications for geospatial products and services. Those who deal with land survey use specifications as provided in the survey act. But for digital geoinformation, unrealistically high fees characterize the industry. This is

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because some institutions will want to benefit as much as possible before digital geoinformation gets widespread use in Kenya.

E. Qualification and certification of personnel

This is one item that may not have gained a lot of popularity in Kenya and generates a lot of interest for discussion. 45% do not have any specifications, 15% and the remaining 40% use internal and GoK scheme of work/ESRI specifications respectively. But one interesting thing is that the way this particular item is addressed will determine the direction the development of geospatial technologies will take.

(iv) Quality evaluation

Since people from many disciplines outside the traditional professions are involved in the production and use of geoinformation, quality of the geoinformation is one item that must be addressed, if the data is to be used effectively and efficiently. Quality of a dataset generally defines the overall fitness or suitability of a data for a specific purpose. Geospatial data quality can be described both by qualitative and quantitative parameters.

This item required respondents to indicate the quality parameters they use and those that they test for. Table 3 summarizes the responses. Use means that the item is only used to indicate quality, while test is validating the element.

Out of 21 elements, 16 of them (with more than 50%) had no response. This item was the most difficult to administer, with most respondents saying that it was too academic. What this pattern of response indicates is that quality evaluation for geoinformation in Kenya has not gained much popularity.

Pertaining to the delivery of products with quality results, 60.0% of the respondents deliver their products with quality results, 10.0% don't, while 30.0% did not respond.

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Quality element	Use %	Test %	Test and use %	No response %
Non-quantitative quality element	═══	═══	═══	═══
Purpose	13.3		13.3	73.3
Usage	16.7		10.0	73.3
Lineage	═══	═══	═══	═══
• *Source*	40.0	3.3	13.3	43.3
• *Process step*	26.7	3.3	16.7	53.3
• *Producer organization*	33.3	3.3	6.7	56.7
• *User guide*	23.3	3.3	23.3	50.5
Quantitative quality elements	═══	═══	═══	═══
Completeness	═══	═══	═══	═══
• *Omission*	26.7	3.3	36.7	33.3
• *Commission*	16.7	3.3	26.7	53.3
• *User guide*	16.7		23.3	60.0
Logical consistency	═══	═══	═══	═══
• *Topological consistency*	16.7	6.7	20.9	56.7
• *User guide*	16.7	16.7		66.7
• *Domain, Geometric, semantic consistency*	16.7	3.3	23.3	56.7
Positional accuracy	═══	═══	═══	═══
• *Absolute accuracy*	23.3	3.3	30.0	43.3
• *Relative accuracy*	20.0	3.3	36.7	40.0
• *Raster data positional accuracy*	3.3	6.7	20.0	70.0
• *User guide*	13.3		16.7	70.0
Temporal accuracy	═══	═══	═══	═══
• *Last updated*	23.3	3.3	13.3	60.0
• *Temporal validity*	16.7	3.3	36.7	43.3
Thematic accuracy	═══	═══	═══	═══
• Accuracy of spelling	20.0	3.2	36.7	40.0
• Likely misclassification	16.7	6.7	26.7	50.0
• Quantitative and qualitative classification correctness	13.3	6.7	26.7	53.3

Table 2 : Quality evaluation

(v) Partnerships

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Apart from the NSDI, other groups/committees with respect to geospatial information identified during the survey include the GIS Kenya, the Land Surveyors Board, International Federation of Surveyors (FIG), Food and Agricultural Organization (FAO), World Meteorological organization (WMO) and Environmental Information System (EIS).

Despite the fact that there is no NSDI already in place, it cannot be denied that there is sharing of geospatial data between organizations. The table 4 shows in summary the arrangements for sharing geoinformation by the institutions surveyed.

Arrangement	Get %	Give %
Formal	43.3	23.3
Informal	6.7	6.7
Formal and informal	26.6	40.0
None	3.3	10.0
No response	20.0	20.0

Table 3: Sharing of geoinformation

(vi) Contributions to and benefits from NSDI

To realize the benefits of NSDI, each of the participating institutions should contribute in one way or another. Annex 5 contains a list of the organizations indicating what their contribution would be. The following is a sample of their responses.

- Provide framework data
- Provide application data
- Planning and implementation
- Setting up of standards
- Preparation and collection of framework data
- Provision of software
- Development of metadata
- Development of clearinghouse
- Provide data portals and links and facilitate data exchange

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- Co-ordination of NSDI for member countries

In the same vein the institutions indicated what they expect of and from the NSDI. The following is a sample of their responses.

- Interoperable data
- A dedicated network updated regularly
- Collaboration
- Specifications of major geospatial data

(vii) Total number of employees and number of people working with geospatial data

Some organizations did not respond to this item, and for those that responded, the figures are largely approximate. Considering the multidisciplinary nature of geospatial information, now more people outside the traditional professions handle geospatial information. Because of this, in some cases the people reported referred to surveyors, cartographers and anyone who could handle geospatial data. The individuals involved in the interview fell in one of these categories.

(viii) Human capacity requirements

Of the 30 organizations visited, their responses on human capacity (personnel dealing with geospatial information) needs were as in figure 4.

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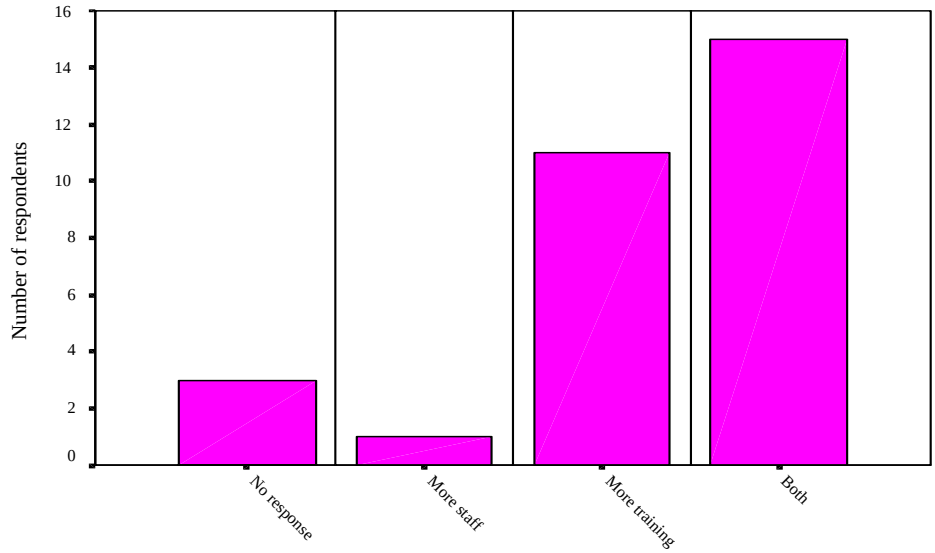

Figure 4: Human capacity requirements

The following are the number of institutions and what they indicated their human capacity requirements are.

14 – more staff plus upgrading (training) the existing staff

11 – indicated that they need training of the existing staff, while

1 – indicated that only need more staff, while

3 – did not respond

In the case of no response the interviewee was not in a position to respond to this item.

Changes in workforce of the geospatial personnel were also investigated. According to table 4, 53.3% of the organizations indicated that they have experienced changes. However, during the interviews most respondents indicated that the changes were largely within the country. On the other hand, 36.7% indicated that they have not experienced any changes while 10.3% did not respond.

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Changes in workforce

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	53.3	59.3	59.3
	No	11	36.7	40.7	100.0
	Total	27	90.0	100.0	
Missing	System	3	10.0		
Total		30	100.0		

Table 4: Staff changes

(ix) Opinions regarding what institutions should do to enhance the management and use of geoinformation.

The following is a collection of opinions regarding what institutions should do.

(a) Your organization

- Make data more available
- Work towards using more digital data
- More staff and additional training
- Sensitize decision makers
- Accept and accommodate change
- More awareness

(b) Educational institutions

- Liaison with the industry
- Offer GIS training to practicing professionals
- Structured and standardized GIS training
- Broaden curriculum to reflect the 21st century needs.
- Equip GIS labs

(c) Private sector organizations

- Interact more with other organizations
- Arrange for GIS fora
- Develop user friendly applications
- Make accessible their data

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- Have partnerships with the government
- Open up
- Need to be transparent

(d) Telecommunications

- Telecommunication facilities should be increased between govt. departments
- Expansion of services to accommodate for example image data
- More teledensity
- Lower tariffs

(e) Government

- Co-ordinate and guide policy framework set up
- Embrace LIS for taxation, revenue collection and in local authority management
- To be sensitized on the need for geospatial data
- Implementation and funding for NSDI
- Change with time and encourage modernization
- Reduce bureaucracy in obtaining geoinformation
- Create conducive environment
- Encourage communal GIS to spread costs of common GIS projects

(f) Non-Government groups

- Open up

(g) Foreign aid agencies

- Assist in acquisition of more hardware and software
- Assist government to develop capacity
- Sponsor projects and support initiatives

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(x) Systems

Systems in this context comprise of the main facilities accessible by organizations to enhance production, publication and distribution of geospatial information. These include communication facilities, computer hardware and software and data input and output devices. Annex 6 contains an inventory of systems in the surveyed organizations. The inventory (in alphabetical order) contains the information as supplied by the respondents. The table below shows the percentages of the institutions with the facilities/ systems.

Communication facilities (telephones, fax, e-mail and internet) have facilitated the exchange of information worldwide but from the opinions of most respondents, there is need to increase their density, reduce tariffs and ensure their availability. At least 80% of the respondents have Internet access points, mainly for Internet communication.

In the NSDI institutions (especially government institutions) will be assigned roles, particularly for collection and development of specific datasets. The institutions will be assigned say duties to develop topographic information, climate information, and soil information, vegetation and land use information etc. these institutions are termed as node in terms of equipment and logistics. These nodes can only be interoperable if the systems are based on common standards say Z39.50 standard. Common specifications will enhance the efficiency of systems.

From the survey, most institutions (63.3%) use ArcView and other related ESRI packages like Arc/Info, ArcGIS. Other GIS packages in use include MapInfo, ILWIS, IDRISI, SGD, GEOVIS, ACT, HalthMapper.

Ms Access is the most common database software used, with 63.3% of the respondents indicating so. Other database software includes dbase, Oracle, Filemaker, Postgress. Dominant image processing software used as it emerged during the interviews was Erdas, but most GIS packages like ILWIS, IDRISI have image processing modules incorporated.

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Facility	Percentage (%)
Telephone	96.7
Fax	96.7
LAN	73.3
E-mail	83.3
Internet access point	80.0
Pentium I-IV	90.0
Windows 3.1/3.11/95/98/2000/NT/XP	100
UNIX	13.3
Macintosh	10.0
Novel NT	3.3
Vax VMS	3.3
Centralized	43.3
Distributed	40.4
PC ArcInfo	30.0
Workstation ArcInfo	36.7
ArcView	63.3
Mapinfo	30.0
ArcGIS	33.3
ILWIS	30.0
IDRISI	23.3
GEOVIS	3.3
SGD	3.3
Healthmapper	3.3
ACT	3.3
Ms Access	63.3
Oracle	16.7
dbase	3.3
Filemaker	3.3
Postgress	6.7
Image processing	40.0
CAD	46.7
Digitizing tables	40.0
Scanner	43.3
Plotters	46.7

Table 5: Facilities

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DISCUSSION AND RECOMMENDATIONS

Since the introduction of digital geospatial technologies in Kenya in 1992 with UNEP as the pioneer institution, a number of institutions have adopted this technology. These institutions were described in various ways. Although the description may have largely been determined by the sampling, it nevertheless indicates the general situation in Kenya that Government departments and parastatals represent a significant portion in the geoinformation industry. What this in effect means is that the success or failure of NSDI will depend much on government departments and parastatals. This is because most of public information is in their custody, and this is the information that should be made accessible as much as possible.

Overall, there is a widespread use of digital geospatial technology in Kenya although most of these are in Nairobi. Though not all the institutions in the sample frame like Telkom Kenya and the Electoral Commission of Kenya (ECK) have GIS installations, they however indicated that they are in the process of putting up such installations. Therefore their inclusion in the study was significant because they will contribute towards the development of the NSDI in one way or another.

Since the government department will determine the success or failure of NSDI, the demand for framework data by Government departments and academic institutions will indicate generally the national demand. From this study, the following are recommended as key framework datasets for Kenya.

- Geodetic
- Place names (gazetteer)
- Transportation
- Government boundaries
- Land surface elevation
- Physical features
- Land use/land cover
- Cadastral
- Digital imagery
- Hydrographic

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Technologically, these institutions have what one might say is sufficient at least for their own GIS operations in both hardware and software. For data sharing with other institutions however, the study revealed that only one or two institutions have purely formal arrangements, while the majority of institutions have a mixture of both informal and formal arrangements.

Some institutions in Kenya participate in the Environmental Information System (EIS)-Africa, which is a forum for data sharing environmental data and their involvement institutions is participatory. The members from these groups are therefore expected to provide expertise during the development of NSDI.

All institutions interviewed are in agreement with the idea of establishing standards so as to facilitate conversion and comparison, integration and sharing, to minimize duplication and more generally to enhance the effectiveness of digital geospatial data. This response leads to a significant challenge: what standards are to be established and adopted?

A survey of specifications used by these institutions indicated that for most items, the majority use internal, project specifications or specifications depending on the software they have and use. This clearly indicates that there are no common specifications between the institutions. It is in spatial referencing that most institutions seemed to have a common specification, UTM and geographic co-ordinate systems. However, the use of the Global Positioning System (GPS), which is based on WGS84, seems to have introduced more confusion. Within the institutions, they depend on what the software provides or what the project requires and indeed minimal internal specifications. This scenario generally reveals that though there could be project specifications, national specifications for digital geospatial data are absent and this is likely to complicate the data sharing between organizations.

In the NSDI policy, the NSDI standards to be developed should have much input where possible from international standards that are already in existence like the content standard for Federal Geographic Data Committee (FGDC) and ISO/TC 211.

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From this study, it is here recommended that a Working Group under NSDI responsible for the establishment of standards be established, and it should be as inclusive as possible to have a wide representation of all the interested parties.

The standards that are of international scope are at generic and at GIS application independent level. Kenya should make use of her ISO membership to benefit from these standards. With this in mind and with the fact that there is no hardware or software development for GIS going on, it is here recommended that for NSDI, much effort be focused on developing standards at application level. This however does not need to be an independent exercise, but borrow experience from other countries.

In very general terms, we further recommend first the establishment of standards for framework datasets for Kenya as determined by demand (figure 2). The focus should be on the development of uniform standard for database construction and should address the following and more aspects.

i) Geospatial data formats
ii) Data exchange formats
iii) Data dictionary/Data content
iv) Geospatial metadata
v) Data coding and classification

For data compilation and quality assurance, the issue to addressed include

vi) Data collection and compilation
vii) Spatial referencing
viii) Quality evaluation (map accuracy)

For product presentation

ix) Map design
x) Map symbology

For product distribution the issues include

xi) Fees schedule for products and services

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Lastly, qualification and certification of personnel should be addressed in order to guarantee integrity in the anticipated NSDI. In their response to human capacity requirement, most institutions indicated that the existing staff needs more training and more staff with geospatial expertise is required. Therefore this is one item that will definitely need special and urgent attention.

From the survey most hardware and software come from other countries, this can be taken to mean that in Kenya there is not much hardware or software development in relation to digital geospatial data. This has the implication that in the meantime, Kenyan institutions may not have much say in the design of the systems, therefore the way forward is for the individual organizations to prepare specifications that will guide the procurement of systems that are interoperable with others in the NSDI. These specifications should include both hardware and software and are to be derived from the NSDI policy.

Over and above, government institutions should be willing to share geoinformation in their custody, if there is a policy framework. However, for private institutions, and some government institutions, as it emerged during the interviews should be encouraged to share. Their reluctance to even indicate what geoinformation they have to some extent indicates lack of clarity of mandates and copyright laws. This must of necessity be addressed in the NSDI policy

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ANNEX 1

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ANNEX 2

SAMPLE FRAME

1. Department of Survey, Ministry of lands and settlement
2. Department of Physical Planning, Ministry of lands and settlement
3. Ministry of Water Development
4. Ministry of Roads and Public Works and Housing –Roads
5. Ministry of Roads and Public Works and Housing -Building
6. Department for Urban Development, Ministry of Local Government
7. Department of Resource Surveys and Remote Sensing (DRSRS)
8. Central Bureau of Statistics (CBS)
9. Electoral Commission of Kenya (ECK)
10. Kenya Wildlife Service (KWS)
11. National Museums of Kenya (NMK)
12. Regional Centre for Mapping of Resources for Development (RCMRD)
13. United Nations Environmental Programme (UNEP)
14. International Livestock Research Institute (ILRI)
15. International Centre for Insect Physiology and Ecology (ICIPE)
16. International Centre for Research in AgroForestry (ICRAF)
17. Kenya Medical Research institute (KEMRI)
18. Kenya Forestry Research Institute (KFRI)
19. Kenya Soil Survey
20. Meteorological Department
21. Kenya Power and Lighting Company
22. Department of Surveying, University of Nairobi
23. Department of Geography, University of Nairobi
24. Kenya Institute of Surveying and Mapping (KISM)
25. Telkom Kenya
26. Norken Kenya Limited
27. GIBB Africa
28. National Housing Corporation (NHC)
29. Highland Surveyors
30. Geometer Surveys
31. Oakar Services
32. Ground Water Survey

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ANNEX 3

SAMPLE QUESTIONNAIRE

Name of organization_____
Full address_____
Telephone Number(s)_____ Fax_____
Physical location_____Website_____ E-mail_____
Contact person_____ Designation_____

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. Please indicate (with a tick) your opinion regarding the establishment and use of standards for geospatial data. Please answer on a scale 1 (strongly disagree with the statement) to 5 (strongly agree)

1(Strongly disagree)……..2(Disagree)……..3(Not sure)……...4(Agree)…….5(Strongly agree)

6. Give a reason/reasons for you choice in 5.

7. Which of the following best describes your organization?

Government Private Profit Semi-governmental Non-governmental
Non-profit Local Authority Charity Other (specify)

8. At what level does your organization operate?

International Regional National Local Community Other (specify)

9. 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)

INFORMATION MANAGEMENT

10. Indicate how you consider the following types of data to be important 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					

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Wetlands						
Soils						
Register of private companies						
Gravity network						
Zoning and restrictions						

11. 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			

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12. Indicate with a tick (√) in the following, which quality elements you use and those that you test your spatial 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,		

13. Do you deliver your products with quality results?

PARTNERSHIPS

14. 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)

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15. 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		

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

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

18. What could you expect from such a network?

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

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

21. 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

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SYSTEMS

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

	Yes	Type/Version	No	Number
Communications Telephone Fax Local Area Network Email accounts Internet access points Other (specify)				
Computers (speed and memory) 386 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 ArcView 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)				

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ANNEX 4

Frequency Tables

Data collection and compilation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	6	20.0	22.2	22.2
	Survey of Kenya	2	6.7	7.4	29.6
	Internal	11	36.7	40.7	70.4
	Project specific	7	23.3	25.9	96.3
	various	1	3.3	3.7	100.0
	Total	27	90.0	100.0	
Missing	System	3	10.0		
Total		30	100.0		

content specification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	5	16.7	20.0	20.0
	Survey of Kenya	2	6.7	8.0	28.0
	Internal	7	23.3	28.0	56.0
	Project specific	8	26.7	32.0	88.0
	International cartographic conventions	2	6.7	8.0	96.0
	GK	1	3.3	4.0	100.0
	Total	25	83.3	100.0	
Missing	System	5	16.7		
Total		30	100.0		

Geospatial data format

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	8	26.7	29.6	29.6
	Internal	3	10.0	11.1	40.7
	Project specific	3	10.0	11.1	51.9
	Depends on software	12	40.0	44.4	96.3
	International	1	3.3	3.7	100.0
	Total	27	90.0	100.0	
Missing	System	3	10.0		
Total		30	100.0		

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data coding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	7	23.3	29.2	29.2
	Internal	7	23.3	29.2	58.3
	Project specific	2	6.7	8.3	66.7
	various	1	3.3	4.2	70.8
	Depends on software	2	6.7	8.3	79.2
	National	1	3.3	4.2	83.3
	International	4	13.3	16.7	100.0
	Total	24	80.0	100.0	
Missing	System	6	20.0		
Total		30	100.0		

Data exchange

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	9	30.0	37.5	37.5
	Project specific	2	6.7	8.3	45.8
	Depends on software	12	40.0	50.0	95.8
	International	1	3.3	4.2	100.0
	Total	24	80.0	100.0	
Missing	System	6	20.0		
Total		30	100.0		

Map design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	6	20.0	23.1	23.1
	Survey of Kenya	7	23.3	26.9	50.0
	Internal	5	16.7	19.2	69.2
	Project specific	3	10.0	11.5	80.8
	Depends on software	1	3.3	3.8	84.6
	International cartographic conventions	3	10.0	11.5	96.2
	None	1	3.3	3.8	100.0
	Total	26	86.7	100.0	
Missing	System	4	13.3		
Total		30	100.0		

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Map symbology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	4	13.3	14.8	14.8
	Survey of Kenya	7	23.3	25.9	40.7
	Internal	4	13.3	14.8	55.6
	Project specific	1	3.3	3.7	59.3
	Depends on software	2	6.7	7.4	66.7
	International	8	26.7	29.6	96.3
	International	1	3.3	3.7	100.0
	Total	27	90.0	100.0	
Missing	System	3	10.0		
Total		30	100.0		

Spatial referencing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	6	20.0	23.1	23.1
	Internal	1	3.3	3.8	26.9
	Project specific	1	3.3	3.8	30.8
	UTM and Geographic	16	53.3	61.5	92.3
	GPS	2	6.7	7.7	100.0
	Total	26	86.7	100.0	
Missing	System	4	13.3		
Total		30	100.0		

Geospatial metadata

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	14	46.7	58.3	58.3
	Internal	6	20.0	25.0	83.3
	Project specific	1	3.3	4.2	87.5
	Depends on software	1	3.3	4.2	91.7
	FGDC	1	3.3	4.2	95.8
	ISO	1	3.3	4.2	100.0
	Total	24	80.0	100.0	
Missing	System	6	20.0		
Total		30	100.0		

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Catalogue

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	10	33.3	37.0	37.0
	Survey of Kenya	1	3.3	3.7	40.7
	Internal/Lists	13	43.3	48.1	88.9
	Depends on software	2	6.7	7.4	96.3
	FGDC	1	3.3	3.7	100.0
	Total	27	90.0	100.0	
Missing	System	3	10.0		
Total		30	100.0		

Fee schedule for products and services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	13	43.3	61.9	61.9
	Survey of Kenya	1	3.3	4.8	66.7
	Internal	6	20.0	28.6	95.2
	Survey of Kenya	1	3.3	4.8	100.0
	Total	21	70.0	100.0	
Missing	System	9	30.0		
Total		30	100.0		

Qualification and certificartion of personnel

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	9	30.0	45.0	45.0
	Internal	3	10.0	15.0	60.0
	GK Sheme of work	6	20.0	30.0	90.0
	ESRI certification	1	3.3	5.0	95.0
	University of Nairobi	1	3.3	5.0	100.0
	Total	20	66.7	100.0	
Missing	System	10	33.3		
Total		30	100.0		

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Quality evaluation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	8	26.7	30.8	30.8
	Survey of Kenya	1	3.3	3.8	34.6
	Internal	12	40.0	46.2	80.8
	Project specific	1	3.3	3.8	84.6
	ISO	1	3.3	3.8	88.5
	International	2	6.7	7.7	96.2
	ESRI certification	1	3.3	3.8	100.0
	Total	26	86.7	100.0	
Missing	System	4	13.3		
Total		30	100.0		

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ANNEX 5

Organization	Contribution
Survey of Kenya (SOK)	Facilitate development of NSDI
Department of Physical planning	Provide framework for planning data
Department of Roads- MORPWH	Provide accurate road network information
Department of Buildings	Paper maps for government facilities which can be scanned
Ministry of water	Provide information on water resources
Dapartment of Resource Suveys and Remote Sensing (DRSRS)	Exchange of information and giving expertise
Department of Urban Development-MLG	We have information of urban centres
Kenya Meteological department	Provide meteorological information
Electoral Commission of Kenya (ECK)	To create a website to be able to share our data (constituency boundaries)
Kenya Soil Survey (KSS)	In standardization
National Museums of Kenya (NMK)	
Kenya Wildlife Service	Provide biodiversity conservation areas information
Kenya Power and Lighting Company (KPLC)	
Kenya Forestry Research Institute	Provide forest information
Telkom Kenya	N/A
National Housing Corporation (NHC)	
United Nations Environmental Programme	Providing central data portals and links, and facilitate data exchange

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(UNEP)	
International Livestock Research Institute (ILRI)	To provide market access data
World Agroforestry Centre (ICRAF)	To data
Regional Centre for Mapping of Resources for Development	Co-ordinate NSDI for member states
Oakar services	Provide software, setting standards, metadata development and gateway/clearinghouse development
Geometer surveys	To collect and analyse data on behalf of other organizations
Highland Surveyors	Data provision
GIBB Africa ltd.	
Norken ltd	Supply ground control undertaken by us
Wellcome Trust Research Laboratories	
Ground Water survey	
Department of Surveying, UON	By participating in the planning and implementation of NSDI
Department of Geography, UON	Training and in quality control
Kenya Institute of Surveying and Mapping	Development of standards and metadata

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