Guidelines for the implementation of national spatial data infrastructure in African countries

"Strengthening the capacities of African countries to develop geospatial information services in support of the implementation and monitoring of the Sustainable Development Goals"

Developed with the support of the 2030 Agenda for Sustainable Development Sub-Fund of the United Nations Peace and Development Fund

United Nations
Economic Commission for Africa

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I. Introduction

The motto of United Nations Global Geospatial Information Management (UN-GGIM) is "everything happens somewhere", showing that location has become a critical component of information. According to current estimates, more than 80 per cent of all data and information used in all forms of planning and decision-making are related to geographic space, typically involving georeferenced positional data or geospatial information.

Geospatial information is now recognized everywhere as key in virtually all programmes and projects across all economic, social and environmental development sectors, including health, education, agriculture, planning and management of infrastructure, planning and management of urban centres, planning and management of utilities and resources, planning and management of environmental protection, land use, etc. As a result, it can and does play an increasingly important role in supporting evidence-based, effective decision-making to address issues related to the three pillars of sustainable development: the economic, the social and the environmental.

The significance of geospatial information in the planning, monitoring and evaluation of sustainable development was recognized by the United Nations when it adopted the 2030 Agenda for Sustainable Development, the transformative plan of action based on 17 Sustainable Development Goals and 169 targets: it emphasized that the follow-up and review processes of the Sustainable Development Goals at all levels would be guided by a set of principles, rigorous and evidence-based, informed by country-led evaluations and high-quality, accessible, timely and reliable data disaggregated, among others, by geographic location, relevant in national contexts.

It has been almost two decades since the Economic Commission for Africa (ECA) also recognized the important role of geospatial information in the drive for sustainable development in African countries, based on the growing awareness that it was essential information for evidence-based decision-making. ECA has been working to build capacity in geospatial data collection and management, improve access to available geospatial data and promote its reuse in African countries. It was in this connection that ECA initiated the effort to promote the implementation of national spatial data infrastructure in African countries.

As its name implies, national spatial data infrastructure is infrastructure that promotes the concept of a reliable, supportive environment, analogous to the road and telecommunications networks of a country. But it also facilitates the availability of and access to geospatial data, and provides a basis for geospatial data discovery, evaluation, sharing, and application for users and providers at all levels of government, in the private sector, non-governmental organizations and academia, and by citizens in general.

To achieve this, ECA has taken the initiative of preparing these guidelines on implementation of national spatial data infrastructure in African countries.

The guidelines are intended to provide a framework for the step-by-step implementation of national spatial data infrastructure based on the current and specific condition of African countries.

II. Use and objectives of the national spatial data infrastructure implementation guidelines

A. Why new guidelines?

Several attempts have been made to produce national spatial data infrastructure implementation guidelines, the most relevant, in particular to African countries, being *Developing Spatial Data Infrastructure: The SDI Cookbook*, published in 2001 by the Global Spatial Data Infrastructure Association (GSDI Association), and *SDI Africa: An Implementation Guide*, compiled and published in 2003 as a cooperative effort by ECA, the GSDI Association and the Network for the Cooperative Management of Environmental Information in Africa (EIS-Africa), with the collaboration of the University of Twente Faculty of Geoinformation Science and Earth Observation (ITC).

Despite these efforts, national spatial data infrastructure implementation in developing countries, including African countries, has lagged behind, widening the geospatial digital divide. The main reason for this is the bottom-up approach taken in the previous studies, which focused mainly on geospatial information organizations and professionals attempting to take the lead in implementation. This resulted in a situation in which geospatial information organizations and professionals largely talked only to one another, instead of involving high-level decision-making political organs of government from the outset.

The objective of compiling these guidelines is therefore to assist African countries to change course and follow the top-down approach by involving and engaging high-level policy decision makers from the start, in addition to the bottom-up approach so far pursued. Nonetheless, great care has been taken to avoid repeating or duplicating previous efforts and instead to build upon and add value to them.

B. Use and objectives

These guidelines are intended to be of assistance to African countries as they plan and implement a national spatial data infrastructure initiative in their respective countries. They are primarily addressed to the organizations and people responsible for such planning and implementation, mainly decision makers at the highest level involved in seeking political support for national spatial data infrastructure initiatives, national mapping and geospatial information agencies or equivalent organizations and other stakeholders involved in the initiative as a result of their engagement in the production, analysis, use and distribution of spatial data.

In the preparation of this document, extensive use has been made of existing reference material, including spatial data infrastructure manuals from other regions and countries. Further information about them can be found by consulting the material in the list of references.

The document guides users through the successive steps involved in planning, implementing and promoting the adoption of a national spatial data infrastructure initiative and measuring and monitoring its performance.

These guidelines should be adapted to the specific country circumstances of individual African countries. It is expected that this will be a living document, upgraded and improved over time with the addition of more material from ECA member States as they proceed further with national spatial data infrastructure planning and implementation.

The objectives of the guidelines are fourfold:

- To provide guidance on planning for and implementing national spatial data infrastructure in African countries.
- To share international good practices in national spatial data infrastructure implementation.
- To integrate the implementation of national spatial data infrastructure with the Integrated Geospatial Information Framework.
- To enable African countries to learn from one another's experiences.

III. Geospatial information and sustainable development in African countries: the missing link

A. Urgent need for sustainable development in Africa

Although sustainable development has meant different things to different people (Scott and Rajabifard, 2017), these guidelines adopt the most commonly accepted definition, expounded in the *Report of the World Commission on Environment and Development: Our Common Future* (United Nations, 1987), that sustainable development means ensuring that development meets the needs of the present without compromising the ability of future generations to meet their own needs.

On the basis of this definition, economic development, social development, and environmental protection are considered the three pillars of sustainable development, and there is universal recognition of the need to advance and strengthen these interdependent and mutually reinforcing pillars at local, national, regional and global levels.

In this respect, the major objective of development is understood to be the satisfaction of basic human needs and aspirations, such as nutrition, clean water, clothing, and shelter. In Africa, however, a significant proportion of the population does not have access to means of satisfying these basic human needs. This is because Africa is by far the poorest continent on the planet, being home to 33 (70 per cent) of the world's 47 least developed countries. According to World Bank estimates in 2015, 413 million of the 736 million extremely poor people in the world (56 per cent) were Africans.

A continent with such rampant poverty will always be prone to environmental and other crises. It was to avert such impending risk that African Heads of State and Government adopted the African Union Agenda 2063: The Africa We Want (African Union, 2015) in which they expressed their determination to eradicate poverty in one generation and build shared prosperity through the social and economic transformation of the continent. In order to achieve this noble objective, they have also pledged to be part of the global drive, through the United Nations and other multilateral organizations, to find multilateral approaches to the most pressing concerns of humanity, including human security and peace, the eradication of poverty, hunger and disease, gender equality and climate change, and adopted the Common African Position on the post-2015 Development Agenda.

Subsequently, in the 2030 Agenda for Sustainable Development (United Nations, 2015), the Member States of the United Nations also recognized that eradicating poverty in all its forms and dimensions, including extreme poverty, was the greatest global challenge and an indispensable requirement for sustainable development. Governments further committed themselves to achieving sustainable development in its three dimensions – economic, social and environmental – in a balanced and integrated manner.

The goals of the African Union and United Nations agendas are set out below.

B. Sustainable development agendas

1. *Agenda 2063: The Africa We Want*

In May 2013, African Heads of State and Government signed the Fiftieth Anniversary Solemn Declaration as an affirmation of their commitment to support the continent's new path to attaining inclusive and sustainable economic growth and development. The declaration marked the re-dedication of Africa towards the attainment of the pan-African vision of "*An integrated, prosperous and peaceful Africa, driven by its own citizens, representing a dynamic force in the international arena" (AU, 2015).*

Agenda 2063 is the concrete manifestation of how the continent intends to achieve this vision within a 50-year period between 2013 and 2063. The Agenda has set seven aspirations and 20 goals (see table 1).

Table 1: African Union Agenda 2063 - aspirations and goals

Aspirations	Goals
A prosperous Africa, based on inclusive growth and sustainable development	A high standard of living, quality of life and well-being for all citizens
	Well-educated citizens and a skills revolution underpinned by science, technology and innovation
	Healthy and well-nourished citizens
	Transformed economies
	Modern agriculture for increased productivity and production
	Blue/ocean economy for accelerated economic growth
	Environmentally sustainable and climate-resilient economies and communities
An integrated continent politically united and based on the ideals of pan-Africanism and the vision of African Renaissance	A united Africa (federal or confederate)
	Continental financial and monetary institutions are established and functional
	World-class infrastructure criss-crosses Africa
An Africa of good governance, democracy, respect for human rights, justice and the rule of law	Democratic values and practices, universal principles of human rights, justice and the rule of law entrenched
	Capable institutions and transformative leadership in place
	Peace security and stability is preserved
A peaceful and secure Africa	A stable and peaceful Africa
	A fully functional and operational APSA
Africa with a strong cultural identity common heritage, values and ethics	African Cultural Renaissance is preeminent
An Africa whose development is people-driven, relying on the potential offered by African people, especially its women and youth, and caring for children	Full gender equality in all spheres of life
	Engaged and empowered youth and children

2. *United Nations 2030 Agenda for Sustainable Development*

In September 2015, the General Assembly of the United Nations adopted the Sustainable Development Goals in Transforming our world: the 2030 Agenda for Sustainable

Development**.** There are 17 Goals (see figure 1), with 169 associated targets, which are integrated and indivisible.

The Agenda aims to end poverty in all its forms and dimensions, including eradicating extreme poverty, by 2030. The Goals and targets should be met by all nations and people and for all segments of society, by reaching first those who are furthest behind, and ensuring that no one is left behind.

To date, global agreement has been reached on 232 global indicators to monitor and follow up the progress made towards achieving the Goals. The indicators have been developed by the Inter-Agency and Expert Group on Sustainable Development Goal Indicators and endorsed by the General Assembly.

3. Correspondence between Agenda 2063 and the 2030 Agenda

As both Agenda 2063 and the 2030 Agenda are commitments by world leaders to sustainable and inclusive development, the goals of both are correlated as indicated in table 2, so success in the implementation of one leads to success in the implementation of the other.

The Sustainable Development Goals indicate the interlinked, multifaceted and ambitious aspirations for the continued development of nations and societies. Effective reporting of progress toward achieving them requires the

Figure 1
Sustainable Development Goals

use of multiple types of data, taking into account new sources of data, including geospatial data, in addition to traditional statistical and administrative data.

C. Why geospatial information?

Geospatial data or geospatial information is spatially-related or location-based information

Table 2
Correlation between the Sustainable Development Goals and the Agenda 2063 goals

Sustainable Development Goals	Equivalent Agenda 2063 goals
Goal 1: End poverty in all its forms everywhere	Goal 1: A high standard of living, quality of life and well-being for all citizens.
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Goal 1: A high standard of living, quality of life and well-being for all citizens. Goal 5: Modern agriculture for increased productivity and production.
Goal 3: Ensure healthy lives and promote well-being for all at all ages	Goal 3: Healthy and well-nourished citizens.
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Goal 2: Well educated citizens and a skills revolution underpinned by science, technology and innovation. Goal 18: Engaged and empowered youth and children.
Goal 5: Achieve gender equality and empower all women and girls	Goal 17: Full gender equality in all spheres of life. Goal 18: Engaged and empowered youth and children.
Goal 6: Ensure availability and sustainable management of water and sanitation for all	Goal 7: Environmentally sustainable and climate-resilient economies and communities.
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all	Goal 7: Environmentally sustainable and climate-resilient economies and communities.
Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Goal 1: A high standard of living, quality of life and well-being for all citizens.
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Goal 10: World-class infrastructure criss-crosses Africa.
Goal 10: Reduce inequality within and among countries	Goal 20: Africa takes full responsibility for financing her development.
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable	Goal 1: A high standard of living,quality of life and well-being for all citizens.
Goal 12: Ensure sustainable consumption and production patterns	Goal 7: Environmentally sustainable and climate-resilient economies and communities.
Goal 13: Take urgent action to combat climate change and its impacts	Goal 7: Environmentally sustainable and climate-resilient economies and communities.
Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Goal 6: Blue/ocean economy for accelerated economic growth.
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Goal 7: Environmentally sustainable and climate-resilient economies and communities.
Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Goal 11: Democratic values, practices, universal principles of human rights, justice and the rule of law entrenched.

and is used to answer the question "Where?".

Geospatial information can also be used to answer the following questions:

- Condition: ***What is its status, quantity, value…?***
- Trends: ***What has changed since ….?***
- Patterns: ***What spatial pattern exists?***
- Analysis/modelling/scenarios: ***What if?***

Geospatial information is therefore critical information that plays an important role in supporting effective decision-making to address sustainable development issues. Having access to up-to-date, definitive and reliable geospatial data allows decision makers to see where resources, infrastructure and people are located, and the condition they are in. This is essential information for evidence-based decision-making.

In essence, geospatial information is an essential national information resource with proven multisectoral values. These values encompass all three pillars of sustainable development – the economic, the social and the environmental.

Examples of the multisectoral uses of geospatial information are shown in table 3.

The multisectoral uses of geospatial information outlined above demonstrate the important role it can play in the planning, tracking and monitoring of progress towards achieving the Sustainable Development Goals.

When the General Assembly adopted the Sustainable Development Goals, it emphasized that the follow-up and review processes would at all levels be guided by a series of principles, one of which was that "they will be rigorous and based on evidence, informed by country-led evaluations and data which is high-quality, accessible, timely, reliable and disaggregated by … geographic locations and other characteristics relevant in national contexts".

D. Role of geospatial information in achieving Agenda 2063 and the 2030 Agenda

In its 2019 task report, the working group on geospatial information under the Inter-Agency and Expert Group on Sustainable Development Goal Indicators, estimates that approximately 20 per cent of the Sustainable Development Goal indicators and, by analogy, the Agenda 2063 goals, can be interpreted and measured either through direct use of geospatial data themselves or through their integration with other statistical data. Obtaining reliable geospatial data has therefore become a crucial task for African Union and United Nations member States in planning and monitoring implementation of the Sustainable Development Goals and the Agenda 2063 goals, and preparing their national reports.

Figure 2 shows some of the Sustainable Development Goal targets and indicators that can be measured using geospatial information.

It was in recognition of this important role of geospatial information in implementing the Sustainable Development Goals that the General Assembly undertook to support developing countries, in particular African countries, least developed countries, small island developing States and landlocked developing countries, in strengthening the capacity of national statistical offices and data systems to ensure access to high-quality, timely, reliable and disaggregated data.

Table 3
Multisectoral uses of geospatial information

Sector	Typical use of geospatial information
Political and administrative	International, regional, national and local boundary delineation; election services.
National planning	Economic planning, statistics, population and housing census, demographic studies.
Agriculture	Precision farming, cultivation inventory, vegetation cover, soil study, rivers, dams and irrigation, land use monitoring, crop yield monitoring.
Land surveying and mapping	Land use planning; land use and cover monitoring and change studies; urban planning and urban development; land use mapping; land administration; urban and rural cadastre.
Environment	Risk zone mapping; environmental inventory and monitoring; flood, erosion, and desertification monitoring; land degradation monitoring; natural habitat conservation; environmental change detection; environmental impact assessment.
Transport and communications	Road and railway design, airport runway design, air navigation charts, surface modelling for communications, search and rescue operations.
Energy	Oil, gas and hydropower exploration; electric power generation, transmission, distribution and monitoring.
Education	Facilities planning, instructional and learning aids (e.g. school atlases), location of institutions.
Health	Locations of epidemic hot spots; prevention and forecasting; health facilities planning and distribution.
Finance	Revenue generation, customs and immigration, taxation
Local government	Taxation, land use, land records, urban development, utility services.
National security	Defence, crime monitoring and prevention, search and rescue operations, logistics planning.
Culture and recreation	Facilities planning, development and management; georeferencing historical sites, cultural preservation and sports development.
Tourism	Road network maps and street guides, tourist attractions and hotel locations (tourist maps).

In order to achieve this objective, target 17.18 (revitalize the Global Partnership for Sustainable Development) promises to enhance capacity-building support to developing countries, including least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts.

The working group on geospatial information under the Inter-Agency and Expert Group on Sustainable Development Goal Indicators has recommended that, in order to develop and promote the use of geospatial information in informing Sustainable Development Goal indicators, a number of activities need to be conducted by Member States with the support of the United Nations and other international development partners. These activities include:

1. Assess the status of core data sets useful for the Sustainable Development Goals and derive and communicate requirements with data providers.

2. Promote a collaborative geospatial information service in support of the Sustainable Development Goals.

Figure 2
Earth observation and geospatial information linkages to Sustainable Development Goals, targets and indicators

Source: Group on Earth Observations (GEO).

3. Demonstrations and practices for data uptake by countries and stakeholders.

4. Design an on-line dynamic atlas to communicate SDG indicators.

5. Strengthen national spatial data infrastructure.

6. Establish standards and frameworks that enable harmonization of content comparability among the different data sets.

From the above, it may be concluded that the effective and efficient implementation of national spatial data infrastructure will be an important instrument for ensuring the attainment of the Sustainable Development Goals and the associated targets, particularly in developing countries, including in Africa, by ensuring the production, analysis, administration and sharing of accurate, timely and authoritative geospatial information.

IV. Brief 0verview of national spatial data infrastructure

A. Understanding national spatial data infrastructure

The term "spatial data infrastructure" is often used to denote the basic set of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. It provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the private sector, the non-profit sector, academia and civil society.

In national spatial data infrastructure terminology, the word "infrastructure" is used to promote the concept of a reliable, supporting environment, analogous to a road or telecommunications network, that facilitates access to geographic information using a minimum set of standard practices, protocols and specifications.

The United States Federal Geographic Data Committee (FGDC) defines national spatial data infrastructure as an umbrella of policies, standards and procedures under which organizations and technologies interact to foster more efficient use, management, and production of geospatial data in a country. It further explains that such infrastructure consists of organizations and individuals that generate or use geospatial data and the technologies that facilitate the use and transfer of geospatial data.

National spatial data infrastructure is in effect more than a single data set or database as it also hosts geographic data and attributes, sufficient documentation (metadata), a means of discovering, visualizing and evaluating the data (catalogues and web mapping), and some method to provide access to the geographic data. National spatial data infrastructure can therefore be said to encompass policies, geospatial data, standards, people and related organizational aspects, and delivery mechanisms to end-users.

In short, the national spatial data infrastructure of a country can generally be defined as a framework of policies, standards, technology, human resources (people), institutional arrangements and related activities necessary to acquire, process, distribute, share, use, maintain and preserve geospatial information. It promotes geospatial data-sharing throughout all levels of government, academia, the private sector and civil society and among individual citizens, thus enabling effective use of geospatial data for sustainable national development and other everyday requirements.

In Africa, ECA recognized the important role such infrastructure played in the continent's development endeavour and therefore pioneered the establishment of national spatial data infrastructure, supported by a number of professional associations and the private sector. In the past 15 years, several awareness-raising and capacity-building seminars and workshops have been organized regionally and nationally to create awareness about the nature of such infrastructure, how it is built, how it works and why it is important.

Despite the efforts of ECA and other global and regional bodies, national spatial data infrastructure implementation in Africa still lags behind the other regions of the world, however, so African countries are not in a position to make adequate use of it.

B. Components of national spatial data infrastructure

National spatial data infrastructure consists of many components. In addition to digital geospatial resources, it also requires hardware, software, people, organizations, standards, policies and much else to function properly. In 2002, an EIS-Africa position paper identified five factors that determine a country's ability to use geospatial information effectively:

- Existence of core data sets
- The accessibility of documentation about existing geospatial information
- The adherence of geospatial information to accepted standards
- Policies and practices promoting the exchange and reuse of geospatial information
- Sufficient human and technical resources to collect, manipulate, and distribute geospatial information.

SDI Africa: An Implementation Guide, published in 2003,) identified the same five factors as key components.

Compiling the various interpretations and views of such infrastructure by the different interest groups, researchers have identified five core components common to all national spatial data infrastructure implementation (Coleman and McLaughlin, 1998; Rajabifard and Williams, 2002).

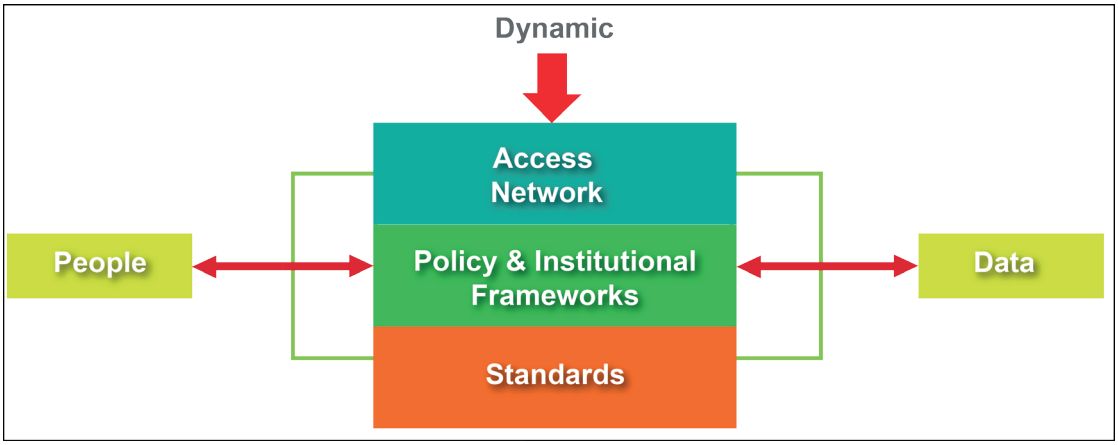
1. Policies and institutional frameworks (governance, data-sharing, funding)
2. Data (framework/fundamental data, metadata)
3. Standards (framework/fundamental data, metadata, services)
4. Access network (technology: hardware, software, ICT networks)
5. People (knowledge and skills of available human resources, capacity development, geospatial awareness).

All the components are strongly related to each other, resulting in an interrelated infrastructure as shown in figure 3.

1. Policy and institutional frameworks

In this context, policy and institutional frameworks includes legal frameworks that underpin each of the other four (people, data, standards, access network) components indicated above and the way in which they should interact and operate.

Figure 3
Components of national spatial data infrastructure



Adapted from Rajabifard.

Policies should be developed at national level to encourage consistency and commonality. The policy framework should address both strategic and operational level issues that help facilitate the implementation, maintenance and use of national spatial data infrastructure.

Strategic policies address high-level issues and set directions for organizations (for example enforcing compliance with certain standards and procedures). Operational policies address topics related to the maintenance of spatial data and help facilitate access to and use of spatial information (e.g., guidelines and manuals dealing with data collection, management, dissemination and use).

a) Data

Accurate and authoritative framework data (alternatively called fundamental data) are essential components of national spatial data infrastructure, either underpinning or enabling spatial applications by helping to integrate other types of spatial data (sometimes called thematic data).

Data also includes the metadata that accompany the geospatial data sets produced.

b) Standards

To ensure interoperability, national spatial data infrastructure needs to rely on a set of common spatial data standards and protocols, the use of which should be mandated and compliance with them monitored and enforced.

Countries implementing national spatial data infrastructure typically adopt international standards developed collaboratively by the International Organization for Standardization (ISO) and the Open Geospatial Consortium (OGC).

c) Access network

The question may be asked: What data-sharing and dissemination platform(s) are available in the country?

Access services define how users obtain information and services. The Internet is the highway through which data and services are accessed, and applications use data from web services so that users can produce and analyse spatial information to make informed decisions.

Access to technologies and infrastructure that facilitate geospatial data-sharing and dissemination is therefore critical for national spatial data infrastructure implementation. Without this information and communications technology (ICT) backbone infrastructure, it is inconceivable.

However, ICT infrastructure is still very poorly developed in many parts of the developing world, including in African countries. Thus, modern day concepts such as “digital revolution”, “information society” and “Fourth Industrial Revolution” are a remote luxury or meaningless to many Africans as 45 per cent still have no access to electricity, and 65 per cent no access to Internet facilities.

National governments and development partners therefore need to give priority to narrowing every aspect of the digital divide between the developed and developing countries as part of facilitating the access network for realistic national geospatial data implementation.

d) **People**

To fully leverage the enabling capabilities of geospatial information for sustainable development, the United Nations Global Geospatial Information Management for Africa (UN-GGIM: Africa) has recognized capacity-building as a key aspect that requires

immediate attention by African countries. It is in this connection that building human resource capacity has been considered a priority because the lack of skilled human resources, the human capital component of national spatial data infrastructure, has always been identified as the Achilles heel of African countries. Thus, undertaking human resource capacity-building activities in parallel with the processes of national spatial data infrastructure implementation is critical in Africa, where implementing such initiatives often depends on a very limited number of people with the necessary geographic information knowledge and skills.

Another key aspect that requires attention in African countries with regard to the people component of national spatial data infrastructure, is building geospatial information literacy (awareness). An intensive awareness-raising campaign on the role of geospatial information science and technology in sustainable development in all African countries is therefore essential.

C. Rationale for national spatial data infrastructure

1. Benefits of national spatial data infrastructure

In order to fully realize their national development objectives, African countries need to establish a national repository of their spatial data holdings and provide the mechanisms to enable access, sharing and dissemination. The development of national spatial data infrastructure is the enabling architecture that will ensure this need is fulfilled.

As explained in chapter II, national spatial data infrastructure is a framework of policies, institutional arrangements, technologies, data and people that enables sharing and effective use of geospatial information organized at the national level. Among its many benefits, its major contribution is that it enables governments and other sectors of society to access geospatial information that can inform decision-making by providing data and evidence, as geospatial information is the link that allows many different sets of data and statistics to be combined and is a very powerful visualization and analytical tool.

The main benefits of creating effective national spatial data infrastructure include:

1. **Decision-making support** – Better planning, management and monitoring of activities by governments (at all levels), the private sector, non-governmental organizations, academia and citizens by supporting decision-making with a core set of interoperable geospatial data that is up-to-date and fit for purpose.

2. **Trend analysis** – Being able to combine data sets makes it possible to observe patterns, allow analysis and simulate "what if?" scenarios; for example, to simulate the effects of climate change, to plan and design transport infrastructure, utilities, buildings, etc., so that adequate preventive and contingency measures can be put in place.

3. **Transparent and participatory governance** – Good governance requires promoting the development and understanding of knowledge about the physical and economic geography of the nation. National spatial data infrastructure ensures the availability of spatial information to the majority of citizens. This initiates developmental planning at the local level, leading to participatory planning. The new developmental initiatives and concerns will demand more spatial information, thus opening up governance to ever-more transparency.

4. **Creating e-government services for citizens** that are cost-effective and efficient, with widespread access and transparency. National spatial data infrastructure will be a major component of e-government because almost 80 per cent of all information is spatial.

5. **Cost reduction** – Geospatial data, if properly managed and maintained, constitute critical resources in their own right that can be used and reused as base information for national planning, research, education, etc. For these reasons, it is important as a matter of policy that maximum benefits are derived from data once acquired, thus eliminating duplication of effort in data acquisition.

6. **Sustainable development** – Providing data sets for all sectors to support their economic, social and environmental development activities, and for the development of new services. National spatial data infrastructure allows widespread use of geospatial information that plays an increasing role in sustainable development, innovation and technological advance.

In short, the main purpose of creating national spatial data infrastructure can be simply explained as facilitating the availability of accurate, timely and fit-for-purpose geospatial information through mechanisms that allow geospatial data sets to be accessed, combined together and shared, so that countries can reap the benefits of quality geospatial information.

2. Objectives of national spatial data infrastructure

The main reasons for the establishment of national spatial data infrastructure can thus be summarized as follows:

1. Eliminate redundancy in geospatial data creation and maintenance (produce once, use many times);

2. Reduce the costs of geospatial data creation and maintenance;

3. Facilitate access to geospatial data;

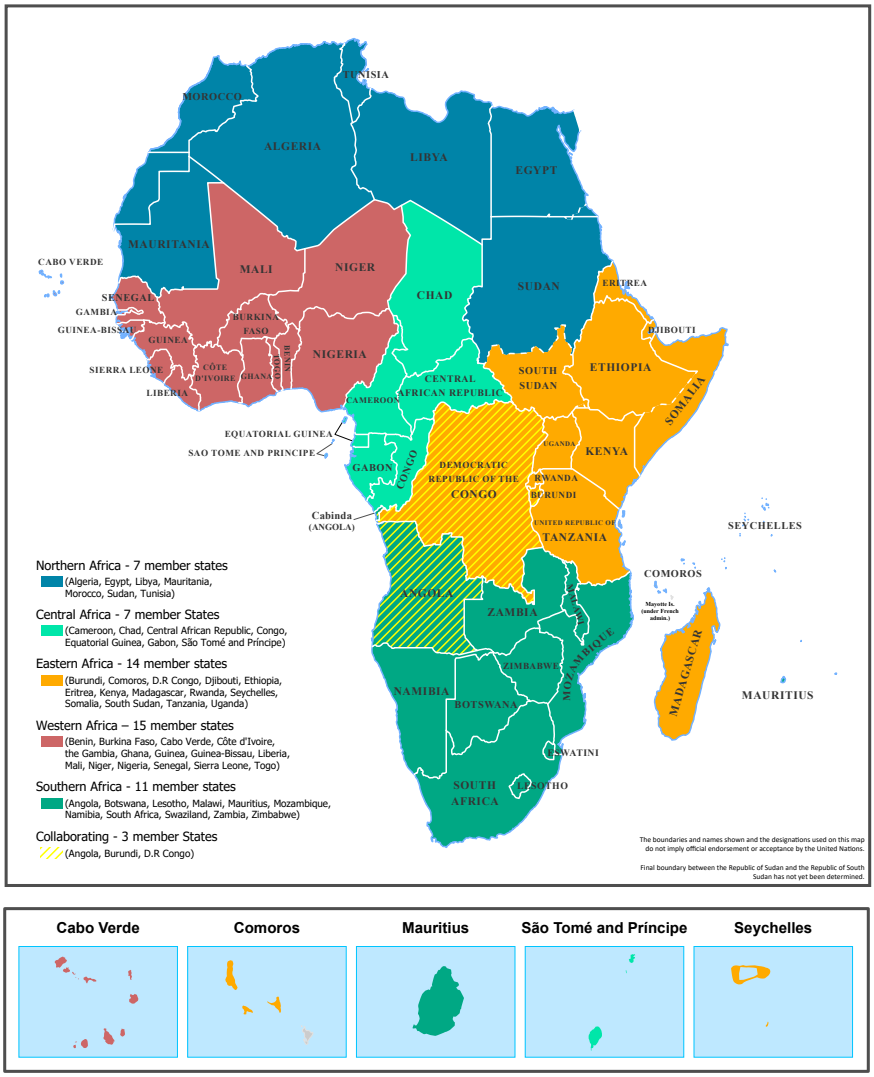
4. Improve the quality of geospatial data used by the broader user community.

V. Review of the current status of national spatial data infrastructure implementation in African countries: the as-is scenario

A. Background

In terms of size and population, Africa is the second-largest continent, after Asia. ECA has 54 member States clustered into five subregional offices (North Africa, West Africa, Central Africa, Eastern Africa and Southern Africa) as shown in figure 4 and table 5.

Figure 4
ECA subregions[1]



1 Note: The boundaries and names shown and the designations used on this and other maps in the present report do not imply official endorsement or acceptance by the United Nations.

Table 4
Countries by ECA subregion

North Africa (7 member States)	West Africa (15 member States)	Central Africa (7 member States)	Eastern Africa (14 member States)	Southern Africa (11 member States)
1. Algeria	1. Benin	1. Cameroon	1. Burundi**	1. Angola**
2. Egypt	2. Burkina Faso	2. Central African Republic	2. Comoros	2. Botswana
3. Libya	3. Cabo Verde	3. Chad	3. Democratic Republic of the Congo**	3. Eswatini
4. Mauritania*	4. Côte d'Ivoire	4. Congo	4. Djibouti	4. Lesotho
5. Morocco	5. Gambia	5. Equatorial Guinea	5. Eritrea	5. Malawi
6. Sudan	6. Ghana	6. Gabon	6. Ethiopia	6. Mauritius
7. Tunisia	7. Guinea	7. Sao Tome and Principe	7. Kenya	7. Mozambique
	8. Guinea-Bissau		8. Madagascar	8. Namibia
	9. Liberia		9. Rwanda	9. South Africa
	10. Mali		10. Seychelles	10. Zambia
	11. Niger		11. Somalia	11. Zimbabwe
	12. Nigeria		12. South Sudan	
	13. Senegal		13. Uganda	
	14. Sierra Leone		14. United Republic of Tanzania	
	15. Togo			

* Countries in red are countries included in the United Nations list of least developed countries.

** Angola, Burundi and the Democratic Republic of the Congo also collaborate with the Central Africa subregion.

Africa is also the most poorly mapped continent. Only about 3 per cent of the continent is mapped at a scale of 1:25,000 (world average 33.5 per cent) and only about 41 per cent at a scale of 1:50,000 (world average 65.6 per cent). This shows that African countries lack awareness of the true value of geospatial information. As a result, it is not considered a priority area for national investment and development, although there is increasing awareness globally that geospatial data should be considered part of the national infrastructure of a country in the same way as other national critical infrastructure, such as transport and telecommunications.

B. Assessment framework

Researchers and practitioners involved in the implementation of national spatial data infrastructure have developed and used various assessment frameworks to evaluate the status of implementation in the different regions and countries of the world. Among the more frequently cited, the assessment frameworks described in the following papers have been thoroughly reviewed:

1. Evaluation and performance indicators to assess spatial data infrastructure initiatives (Steudler and others, 2008).

2. Key variables to assess national spatial data infrastructures in developing countries (Eelderink, 2006).

3. Assessing a spatial data infrastructure readiness index (Delgado Fernandez and others, 2005).

4. INSPIRE state of play methodology (Vandenbroucke, 2009).

5. Drawing on best practice to assess the geomaturity of a country's national

spatial data infrastructure (Lamprou and others, 2018).

Following a critical review of the assessment frameworks discussed in these papers, 14 key indicators and variables have been selected as the most relevant for the assessment of the national spatial data infrastructure status in African countries. They are set out in table 6, based on the components shown in figure 5.

C. Assessment data

Just as a sound comparative assessment in any area of study necessitates the availability of reliable, timely and comparable data, the review of the status of national spatial data infrastructure implementation in African countries requires adequate, timely and comparable data that can be used to evaluate the status in each of the 54 African countries.

Figure 5
Components of national spatial data infrastructure

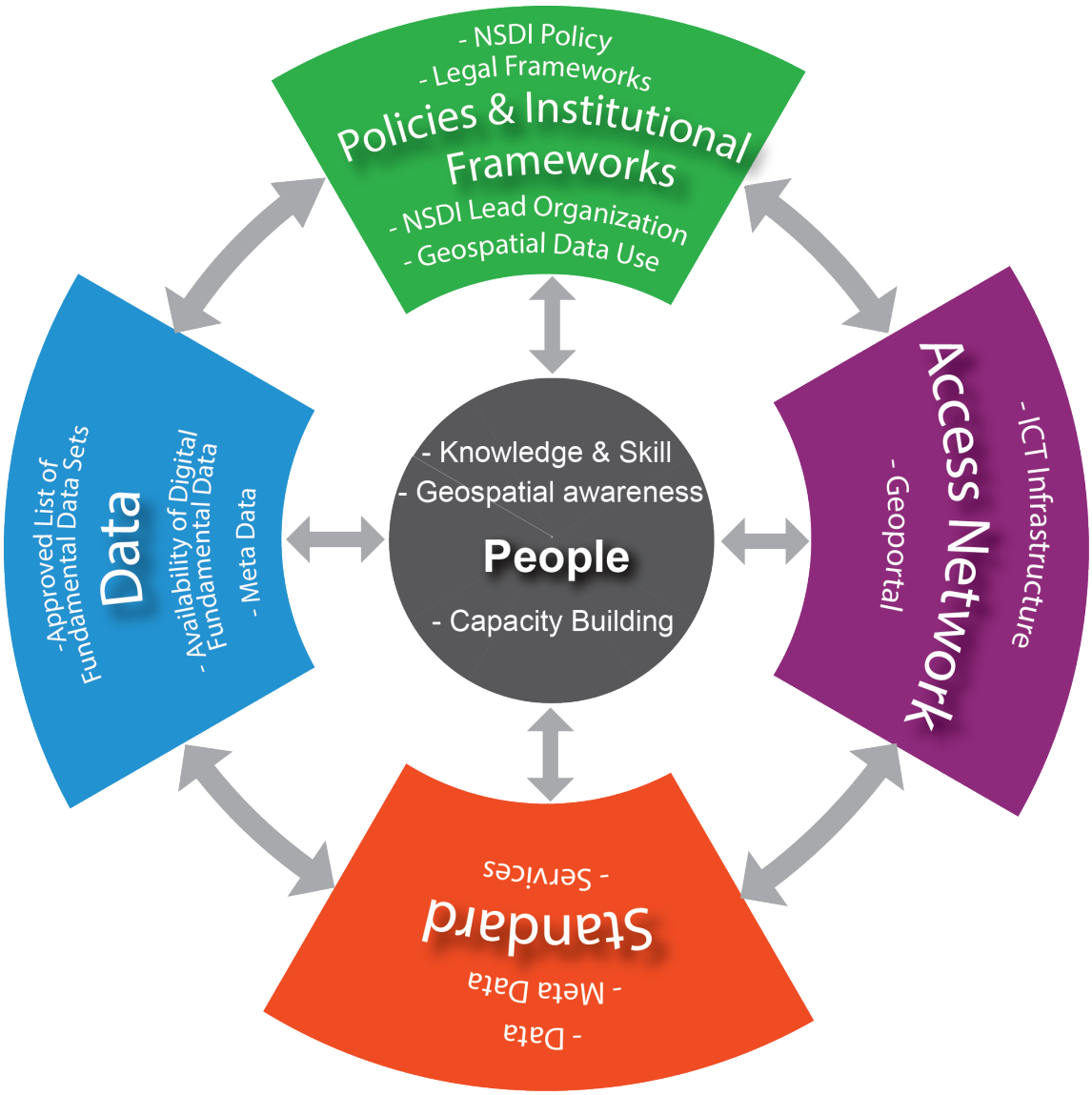


Table 5
Key national spatial data infrastructure indicators selected for African countries

Component	Key indicators
Policy and institutional frameworks	1.1. Availability of a functioning policy framework (Act of Parliament, government regulation, directive, etc.) to support the implementation and maintenance of national spatial data infrastructure.
	1.2. Availability of a legally established public body acting as national spatial data infrastructure lead organization (coordinator).
	1.3. Availability of legal frameworks regarding geospatial data use (data-sharing, copyright, data ownership, data custodianship, etc.)
	1.4. Allocation of budget to fund national spatial data infrastructure activities.
Data	Adoption of agreed-upon list of national fundamental geospatial data sets.
	2.2. Availability of digital fundamental data sets.
	2.3. Creation of metadata for geospatial data produced.
Standards	3.1. Availability of standards for geospatial data creation.
	3.2. Availability of standards for metadata creation.
Access network	4.1. Access to electricity, ICT infrastructure and the Internet.
	4.2. Availability of geoportal for data dissemination.
People	5.1. Level of geospatial awareness.
	5.2. Availability of geospatial knowledge and skill.
	5.3. Capacity-building and training

Considerable effort was made to use a combination of primary and secondary data sources for the assessment of the current status of national spatial data infrastructure in African countries but insufficient up-to-date primary data were obtained. The assessment was therefore mainly based on secondary data collected from various sources, including books, journals, research papers and other resources obtained from Internet searches. These secondary data were as far as possible corroborated by primary data obtained from the country reports of some African States during the First Regional Forum on National Spatial Data Infrastructure held in Rwanda in July 2015, and a questionnaire survey on geospatial readiness for monitoring the Sustainable Development Goals among African countries conducted by ECA in 2018.

The data obtained from the country reports and questionnaires were used to evaluate the status of national spatial data infrastructure implementation in selected African countries based on the assessment methodology described below.

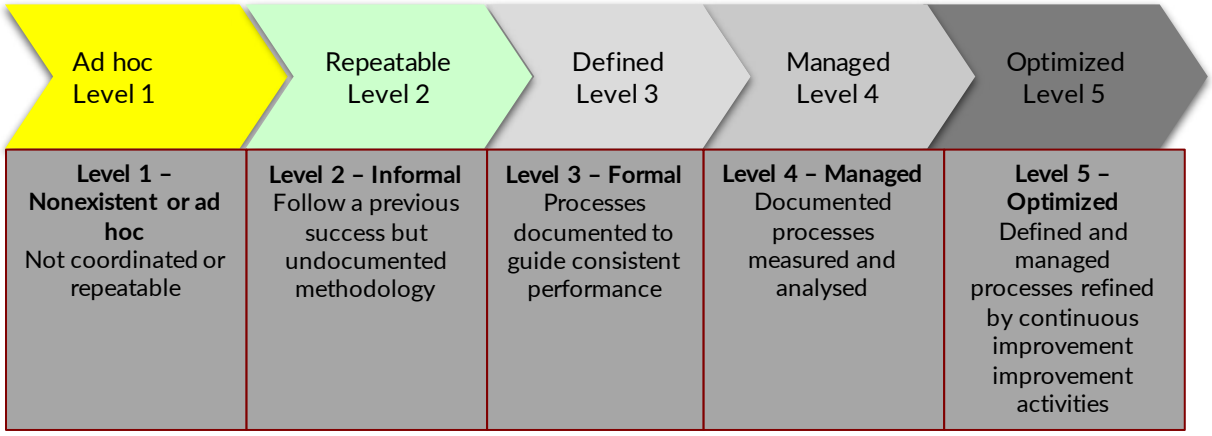
D. Assessment methodology

The assessment methodology adopted for this study is based on the Capability Maturity Level Analysis Model adapted by Vanessa Laurence and others as depicted in figure 6.

Using this model, 18 countries constituting 33 per cent of ECA member States were selected, some from each ECA subregion, and assessed on the basis of the evaluation of the status of each of the 14 indicators. The countries were selected to take into account geographic representation and data availability.

The 18 countries selected account for about 65 per cent of the total population of Africa and 73 per cent of the total gross domestic

Figure 6
Assessment methodology (adapted from Vanessa Laurence)



product (GDP) of the continent as indicated in table 6.

Despite the qualitative nature of the indicators, an effort was made to evaluate the status of each indicator in the selected countries objectively based on the available data. Based

Table 6
Countries selected for national spatial data infrastructure assessment

Subregion	Selected countries	Population (millions)*	GDP (billion USD PPP)*	Population %	GDP %
1. North Africa	Algeria	41.7	630	3.5	9.1
	Egypt	99.4	1200	8.3	17.4
	Morocco	34.3	298.8	2.9	4.3
2. West Africa	Burkina Faso	19.7	35.9	1.6	0.5
	Ghana	28.1	134.0	2.3	1.9
	Nigeria	203.5	1100	17.0	15.9
	Senegal	15.0	54.8	1.3	0.8
3. Central Africa	Cameroon	25.6	89.5	2.1	1.3
	Gabon	2.1	36.7	0.2	0.5
4. Eastern Africa	1. Ethiopia	108.4	200.6	9.0	2.9
	2. Kenya	48.4	163.7	4.0	2.4
	3. Rwanda	12.2	24.7	1.0	0.4
	4. United Republic of Tanzania	55.5	162.5	4.6	2.4
5. Southern Africa	Botswana	2.2	39.0	0.2	0.6
	Eswatini	1.1	11.6	0.1	0.2
	Madagascar	25.7	39.9	2.1	0.6
	Namibia	2.5	26.6	0.2	0.4
	South Africa	55.4	767.2	4.6	11.1
Total selected countries		780.8	5015.5	65	72.7
Africa Total		1,200	6,900	100	100

*Population and GDP data were obtained from The World Factbook - www.cia.gov/library/publications/the-world-factbook/.

on that evaluation, the maturity level of each of the key indicators for all the selected countries was graded on a scale of 0–5, with 0 (lowest score) indicating a non-existent process and 5 (highest score) indicating an optimized (defined and managed) process under continuous monitoring and evaluation that facilitates continued improvement.

The result obtained by using this Capability Maturity Level Analysis Model to review the status of national spatial data infrastructure implementation in African countries was compared with the Country Geospatial Information Readiness Index ranking based on the assessment by Geospatial Media and Communications for validation.

The assessment results in table 7 show that only two countries (South Africa and Senegal) are ranked above average, while all the other assessed countries are ranked below average. The highest ranking country is South Africa, with an average score of 3 (Level 3) out of a possible 5, making it the only country in Africa that, on the basis of the model, can be classified as having implemented formal documented national spatial data infrastructure. All the other assessed African countries are at the basic stage of implementation.

The assessment of the selected African countries shows that there is an ongoing effort to implement national spatial data infrastructure in African countries, even though implementation is at a basic level. The effort so far has been mainly bottom-up, however, and therefore lacks the top-level policy and institutional frameworks that support the implementation process; it has remained at an informal and basic level only.

In addition to top-level political support, African countries also lack skilled human capital, and timely and accurate authoritative basic data that enable national spatial data infrastructure implementation. This is further exacerbated by the lack of adequate access networks (infrastructure) as only 43 per cent of the people of the continent have access to electricity, and only about 36 per cent are connected to the Internet, as table 8 shows.

E. Geospatial Readiness Index ranking of African countries based on Geospatial Media and Communications assessment

The Country Geospatial Readiness Index was first introduced in 2017 by Geospatial Media and Communications. In the first two editions (2017, 2018), 50 countries were assessed; the list was increased to 75 countries in the third edition (2019). The countries were chosen by mainly taking the following two considerations into account:

- Geographic representation
- Economic representation

Countries were shortlisted on the basis of global geospatial expertise and assessment of the geospatial industry as a whole by Geospatial Media and Communications.

Seven African countries were included in the first two editions (2017, 2018) and 14 in the third edition (2019).

The Country Geospatial Readiness Index seeks to equip decision-makers and the broader community of stakeholders with a comparative reference framework to enable them to engage effectively with various parameters for holistic development of the geospatial sector.

The Index assessment framework has continued to be developed over the three years

Table 7
National spatial data infrastructure assessment results

ECA Subregion	Country	Key indicator assessment scores														
		1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	4.1	4.2	5.1	5.2	5.3	Average
North Africa	1. Algeria	2	3	2	2	2	3	3	2	2	3	3	2	2	2	2.4
	2. Egypt	2	3	2	2	2	3	3	2	2	3	3	2	2	2	2.4
	3. Morocco	2	3	2	2	2	3	2	2	2	3	2	2	2	2	2.2
West Africa	1. Burkina Faso	3	3	2	3	3	3	2	3	3	1	1	2	2	2	2.4
	2. Ghana	2	2	2	1	1	1	1	1	1	2	1	2	2	3	1.6
	3. Nigeria	1	3	1	1	3	1	2	2	2	3	1	2	1	1	1.7
	4. Senegal	3	3	2	1	3	3	3	3	3	3	3	3	2	2	2.6
Central Africa	1. Cameroon	1	2	3	3	3	2	2	2	2	1	1	2	2	3	2.1
	2. Gabon	2	2	1	1	1	1	1	1	1	3	1	1	1	1	1.3
Eastern Africa	1. Ethiopia	3	3	1	1	2	2	2	2	2	1	3	1	3	3	2.1
	2. Kenya	2	2	2	2	2	2	2	2	2	3	2	2	3	3	2.2
	3. Rwanda	2	2	2	2	2	2	2	2	2	1	1	2	1	1	1.7
	4. United Republic of Tanzania	2	2	1	2	2	2	2	2	2	2	1	1	2	3	1.9
Southern Africa	1. Botswana	3	3	2	2	3	3	2	2	2	2	2	2	2	2	2.3
	2. Eswatini	1	3	2	1	3	3	1	2	2	2	1	2	2	2	1.9
	3. Madagascar	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2. Namibia	3	3	2	2	3	3	2	2	2	2	2	2	2	2	2.3
	3. South Africa	3	3	2	2	3	4	4	4	4	3	3	3	3	3	3.1

*The 14 key indicators (1.1–5.3) in the table represent the following:

1. Component 1: Policy and institutional frameworks

Availability of functioning policy framework

Availability of national lead organization (coordinator)

Availability of legal frameworks

Funding

2. Data

2.1. Defined national fundamental geospatial data sets

2.2. Availability of digital fundamental data sets

2.3. Metadata creation for geospatial data produced

3. Standards

3.1. Establishment of geospatial data standards

3.2. Establishment of metadata standards

4. Access network

4.1. ICT infrastructure

4.2. Availability of national spatial data infrastructure geoportal

5. People

5.1. Geospatial information and national spatial data infrastructure awareness

5.2. Knowledge and skills

5.3. Capacity-building

Table 8
Status of access networks in selected African countries

Subregion	Selected countries	Access to electricity (%)1	Internet penetration (%)2
1. North Africa	Algeria	99.4	49.2
	Egypt	100	48.7
	Morocco	100	61.2
2. West Africa	Burkina Faso	19.2	18.2
	Ghana	79.3	33.6
	Nigeria	59.3	55.5
	Senegal	64.5	58.2
3. Central Africa	Cameroon	60.1	24.2
	Gabon	91.4	46.7
4. Eastern Africa	Ethiopia	42.9	14.9
	Kenya	56.0	83.0
	Rwanda	29.4	29.1
	United Republic of Tanzania	32.8	37.8
3. Southern Africa	Botswana	60.7	38.9
	Eswatini	65.8	31.5
	Madagascar	22.9	7.0
	Namibia	51.8	30.2
	South Africa	84.2	53.7
Total Africa		42.8	35.9
World total		87.4	56.1

[1] Access to electricity data is based on World Bank Data for 2016 (www.data.worldbank.org)

[2] Internet penetration is based on Internet World Stats for March 2019 (www.internetworldstats.com)

since its introduction, but has focused on five pillars in all three editions:

- Geospatial data infrastructure
- Policy frameworks
- Institutional capacity
- User adoption
- Geospatial industry fabric.

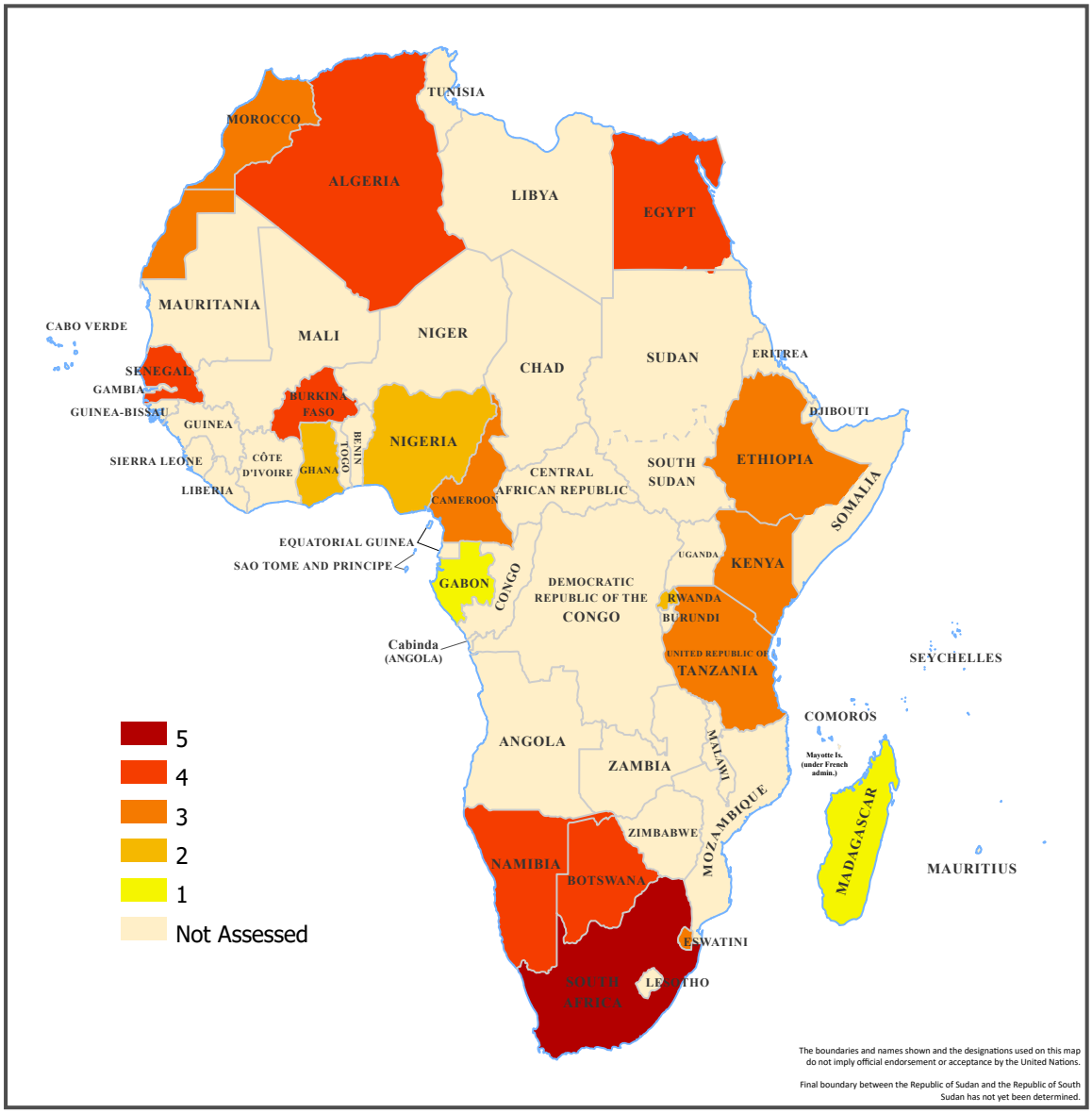
On the basis of the Country Geospatial Readiness Index, the assessed African countries have been ranked as indicated in table 9 and figure 8.

F. Comparison of national spatial data infrastructure ranking and Geospatial Readiness Index ranking

Of the 18 African countries selected for national spatial data infrastructure status review, 11 were included in the 2019 Geospatial Media and Communications Country Geospatial Readiness Index assessment and ranking. Comparison of the assessments and rankings indicate similar results, both assessments indicating low scores for all the assessed African countries.

According to both assessments, South Africa has the highest score and is therefore ranked first. The next seven countries with more or

Figure 7
National spatial data infrastructure ranking of assessed African countries



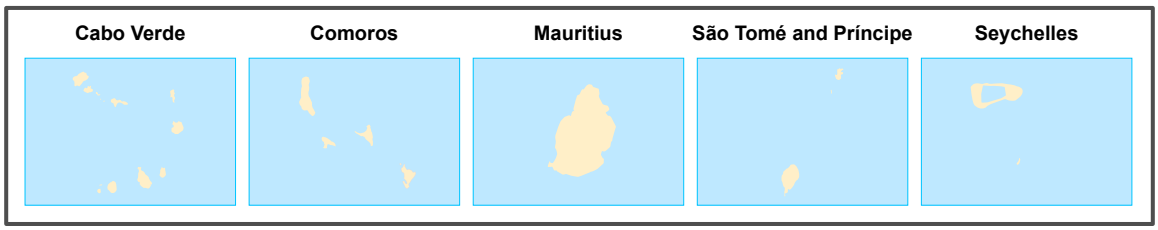


Table 9
Geospatial Readiness Index ranking of African countries

Country	Total score1			Global ranking2			Rank in Africa3		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
South Africa	-	15.32	24.42	29	30	31	1	1	1
Egypt	-	12.45	14.43	37	36	51	2	2	3
Kenya	-	11.95	15.40	40	37	48	3	3	2
Ethiopia	-	8.65	11.89	42	43	57	4	5	6
Nigeria	-	10.16	14.21	43	39	52	5	4	4
Ghana	-	8.05	9.82	44	45	65	6	6	10
Zimbabwe	-	7.69	9.62	48	46	68	7	7	11
Botswana	-	-	11.94	-	-	56	-	-	5
Rwanda	-	-	10.68	-	-	59	-	-	7
Morocco	-	-	10.53	-	-	60	-	-	8
United Republic of Tanzania	-	-	10.01	-	-	64	-	-	9
Namibia	-	-	9.30	-	-	70	-	-	12
Uganda	-	-	7.97	-	-	72	-	-	13
Sudan	-	-	5.77	-	-	75	-	-	14

[1] Total score is out of 100. The low score of African countries should be seen in comparison with 67.77, the highest score for the top ranked country, the United States of America, and 40.63, the score of the country ranked second, the United Kingdom of Great Britain and Northern Ireland.

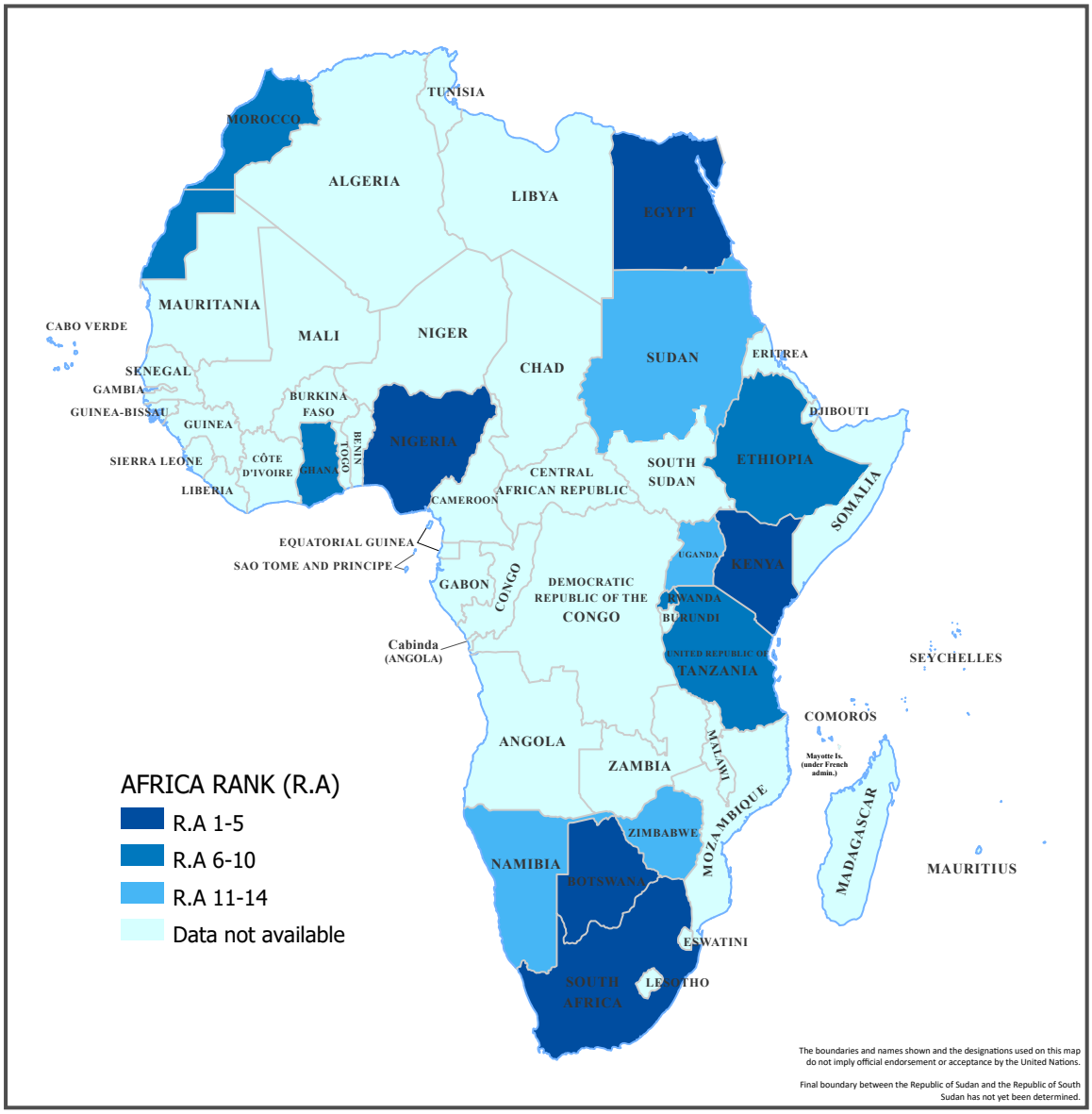
[2] Global ranking is out of the 50 selected countries for 2017 and 2018, and out of the 75 selected countries for 2019 for Country Geospatial Readiness Index assessment.

[3] Rank in Africa indicates the ranking of African countries included in the list of countries selected for Country Geospatial Readiness Index assessment.

less comparable scores according to both assessments and among the top ten performers are Botswana, Egypt, Ethiopia, Ghana, Kenya, Morocco and Nigeria. Algeria and Senegal were not included in the Geospatial Readiness Index ranking but are the other two countries in the top ten list of African countries with relatively better national spatial data infrastructure implementation status.

Thus it can be concluded that the assessments corroborate each other, showing that all the assessed African countries scored way below average in terms of both national spatial data infrastructure implementation status and the Geospatial Information Readiness Index compared to the rest of the world.

Figure 8
Geospatial Readiness Index ranking of African countries based on 2019 ranking



Source: Geospatial Media and Communications.

VI. National spatial data infrastructure implementation in other regions: best practices from developed and developing countries

A. Relevance of best practices

The development and widespread use of digital technology – mainly developments in the Internet and the World Wide Web – over the past 25 years, have facilitated the recognition and widespread use of geospatial data as a critical national development infrastructure that underpins all three pillars of sustainable development, economic development, social development and environmental development. Geospatial data services encompass all aspects of government organizations, non-governmental organizations, the private sector, and civil society. Such recognition and use of geospatial information allows policy-makers and decision makers to bring a wide variety of location-based information together to better understand problems and make informed decisions.

The pioneer in this was the United States of America, taking the lead in establishing national spatial data infrastructure in a 1994 Executive Order as "the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve the utilization of geospatial data". The Executive Order also created the Federal Geographic Data Committee to coordinate the development of national spatial data infrastructure across government (United States of America, Federal Geographic Data Committee, 2016).

Other developed countries followed suit and have embraced national spatial data infrastructure to reap its growing benefits. Despite the efforts of ECA and other development partners and professional groups, however, African countries have remained behind in national spatial data infrastructure implementation, thus widening the geospatial-digital divide between the developing and developed world.

It is therefore recommended that African countries start the national spatial data infrastructure implementation effort afresh by learning from the countries that are in the forefront in this regard. It is with this in mind that best practices from other regions are reviewed.

The countries selected for review are Canada in the Americas, India in the Asia Pacific Region and the INSPIRE initiative in Europe. The countries have been selected taking into account geographic coverage and the relevance of their practices to the context of African countries.

The materials for this review were compiled from the websites of the respective lead organizations (www.GeoConnections.NRCan.gc.ca for Canada, www.nsdiindia.gov.in/nsdi/nsdiportal for India and www.inspire.ec.europa.eu/ for Europe).

A. Canadian geospatial data infrastructure

1. Background

The geospatial data infrastructure of Canada is the relevant base collection of standards, policies, applications, and governance that facilitate the access, use, integration, and preservation of spatial data. GeoConnections is a national programme with the mandate and responsibility to lead Canadian geospatial data infrastructure. Canadian geospatial data infrastructure provides an online network of resources that improve the sharing, use and integration of information tied to geographic location in Canada.

GeoConnections is a national initiative led by Natural Resources Canada that supports the integration and use of Canadian geospatial data infrastructure. The initiative was developed in phases, with the first – establishment – phase covering a period of five years of the GeoConnections programme (1999–2005) that resulted in the development of an infrastructure that includes data and services, and the establishment of key relationships and partnerships. The second phase (2005–2010) focused on growing and evolving the infrastructure, while the third phase (2010–2015) focused on integrating and sustaining it.

2. Components and guiding principles

Vision

The vision of Canadian geospatial data infrastructure is:

> *Canadians have open, secure and continually available access to comprehensive location-based information about Canada through the community-sustained CGDI in support of prosperity and well-being for all.*

The key components of Canadian geospatial data infrastructure are categorized as policies, framework data, standards, technologies, and collaboration and partnerships. These components are similar to the national spatial data infrastructure components described in section IV.B. of these guidelines, except that "access network" is replaced by "technologies", and "people" is replaced by "collaborations and partnerships". In both cases, the people (collaborations and partnerships) component is considered to be a crosscutting component through which the national spatial data infrastructure objective is realized.

The key components of Canadian geospatial data infrastructure (realized through collaboration) are defined as:

a) Policies

Policies are essential to eliminating barriers and enabling users to exchange location-based information effectively and efficiently. Policies address topics related to the lifecycle of location-based data (i.e. collection, management, dissemination, use) and make issues, such as data access, quality, ownership, and integrity, easier to manage.

b) Framework data

The core data set of the Canadian geospatial data infrastructure framework data is the common, up-to date, and maintained base of quality location-based data for the whole of Canada. These data provide context and references to physical features and other types of information linked to geography. These data sets are the base mapping layers required to develop applications and are freely available for reuse. Framework data are the foundation upon which location-based information becomes spatially relevant to users.

c) Standards

Technical and data standards allow diverse data sources, services, applications and systems to operate with each other. The Canadian geospatial data infrastructure is built upon international standards that allow it to work with other infrastructures in Canada and around the world. This harmonization of standards is fundamental to ensuring efficient exchange of location-based information.

d) Technologies

Canadian geospatial data infrastructure uses a suite of innovative tools to provide a functional and accessible environment, which enables the development of systems and applications that integrate location-based information. Its open and flexible architecture continually adapts to the rapidly evolving Internet. These technologies help users to discover, access, integrate, share and disseminate location-based information.

e) Collaboration and partnerships

Collaboration and partnerships between federal, provincial, territorial and regional governments, the private sector, non-governmental organizations and academia ensure interoperability. This interoperability is achieved by the convergence of framework data, policies, standards and technologies necessary to harmonize location-based information.

f) Benefits to Canadians

Canadian geospatial data infrastructure allows users to discover, evaluate and use a wide range of location-based information from various sources that would otherwise have been difficult to find. It helps decision makers from all levels of government, the private sector, non-governmental organizations and academia to use location-based information to make effective decisions on social, economic and environmental priorities.

C. National spatial data infrastructure in India

1. Background

To meet the needs of users, planners, policymakers, industry and academia and to reap the benefits of geospatial information combined with fast computers and information and communications technologies that can facilitate the ways and means of supplying spatial data to users on their desktops, a single source of geospatial information infrastructure was a long felt need in India. With this objective in view, the Department of Science and Technology formed a task force, with the Surveyor General of India as Chair, on 30 October 2000.

The task force was assigned the task of developing a vision for the national spatial data infrastructure of India, and formulating a strategy and action plan. A vision, strategy and action plan document was then prepared and discussed at an international workshop organized jointly by the Department of Space and the Department of Science and Technology in February 2001. Government departments, academia, industry and international experts participated in the workshop, which unanimously endorsed the strategy and action plan document and urged the Government to expedite the establishment of the national spatial data infrastructure as conceptualized by the task force.

Further to this, the national spatial data infrastructure task force has developed standards for metadata, the exchange format, content standard, etc. A prototype was developed and demonstrated covering a fully-fledged metadata server and demonstration-level data and applications servers.

2. *Establishment of national spatial data infrastructure in India*

Following the recommendations of the task force, and as a precursor to national spatial data infrastructure, the Cabinet approved the National Map Policy in May 2005, and constituted the National Spatial Data Commission (NSDC), the apex authority for formulation and implementation of appropriate policies, strategies and programmes for the establishment, operation, and management of national spatial data infrastructure and other activities related to spatial data in the country (Singh, 2009). A national spatial data infrastructure executive committee was formed to undertake all implementing and executive functions on behalf of the Commission, including functions delegated to it by the Commission.

In the preamble to the resolution establishing the Commission, the Cabinet underlined the following key issues:

- Spatial data infrastructure is a collection of technologies, policies and institutional arrangements to facilitate availability of and access to spatial data acquired and held by different agencies and organizations to a vast, diverse and ever-growing community of users and to promote the use of spatial data infrastructure at community, local, state, regional and national levels for sustained economic growth.

- The Government of India would establish a national infrastructure known as the National Spatial Data Infrastructure for the purposes of acquiring, processing, storing, distributing, and improving use of spatial data which would be a gateway of spatial data generated by various government agencies

- The data-producing governmental agencies would initially be the contributing agencies of the National Spatial Data Infrastructure and that the Government, through the National Spatial Data Commission, would facilitate participation by other data-producing agencies for that purpose.

The geoportal for the National Spatial Data infrastructure (India GeoPortal) was launched on 22 December 2008 by the Minister for Science and Technology and Earth Sciences, with the mandate of making spatial data available to all stakeholders. The GeoPortal includes web services compliant with Open Geospatial Consortium (OGC).

3. Constitution and functions of the National Spatial Data Commission

a. Constitution of the National Spatial Data Commission

It has the following permanent members (ex officio):

1. Minister of State for Science and Technology, Chair
2. Secretary, Department of Science and Technology
3. Secretary, Department of Space
4. Secretary, Ministry of Home Affairs
5. Secretary, Ministry of Defence
6. Secretary, Ministry of Water Resources
7. Secretary, Department of Land Resources
8. Secretary, Planning Commission
9. Secretary, Ministry of Environment and Forests
10. Secretary, Ministry of Urban Development

11. Secretary, Department of Ocean Development

12. Secretary, Ministry of Mines

13. Secretary, Ministry of Information Technology

14. Registrar-General, Census of India

15. Surveyor General, Survey of India

16. Director, National Remote Sensing Agency, Secretary

The Commission may appoint the following additional members:

1. Maximum of five secretary-rank officials of the Government of India or state government departments whose activities are related to national spatial data infrastructure.

2. Maximum of five experts with experience and qualifications in fields related to national spatial data infrastructure: geographical information systems, remote sensing, digital mapping, photogrammetry, spatial and non-spatial databases, information technology, networking, software, business management, law and other related fields.

3. Maximum of five representatives of industry, academia and non-governmental organizations.

b. Functions and powers of the Commission

1. The Commission is the apex national authority for the formulation and implementation of appropriate policies, strategies and programmes for the establishment, operation, management and use of national spatial data infrastructure and any other activities related to spatial data in the country. As part of this, the Commission:

2. Determines the requirement for spatial data in the country and requires the creation or collection of spatial data accordingly.

3. Formulates and positions policies on all aspects of the national spatial data infrastructure, including its establishment, access, pricing, etc.

4. Decides and arbitrates on issues relating to spatial data generation and availability in the country.

5. Promotes and enables investment in the spatial business sector to create an environment that encourages competitive excellence.

6. Promotes the development of human resources in the spatial data sector by encouraging existing training institutes, universities and institutions offering specialized courses to undertake human resources development activities for national spatial data infrastructure.

7. Promotes advanced research related to national spatial data infrastructure activities and enables an ambience of research and development for national spatial data infrastructure in the country.

8. Requires members, persons, entities or organizations to provide access to any data at such costs as may be reasonable.

9. Aids and advises central Government on any matter related to or connected with the national spatial data infrastructure.

10. Enters into appropriate arrangements with any third party to undertake any specific activity connected with or

related to any of the activities of the national spatial data infrastructure, including marketing, data generation, data assimilation, access, consulting, commercial exploitation of any data, etc.

11. Does everything necessary to achieve the objectives of the national spatial data infrastructure.

D. Infrastructure for spatial information in the European Union (INSPIRE)

1. Background

A significant part of all information used by public authorities and exchanged with the public refers to specific locations. Its quality depends on the availability of spatial data collected and linked (georeferenced) to location and then processed to derive the information. Most environmental data, such as emission measurements, biodiversity observations and environmental quality data, are spatial.

Policy-relevant assessments and analyses are often based on a combination of different types of environmental and geographical data, e.g. on land use, administrative boundaries, elevation, hydrology, transport networks, production facilities, protected sites, etc. Geophysical data on meteorology, geology, soils and so forth are also relevant to environment policy, as are socioeconomic data, such as population density or data on human health and safety.

The programmes and measures laid down in thematic environmental legislation and policies having an impact on the environment (such as agriculture, transport, energy, spatial development, etc.) generally entail the mitigation of risks arising from societal pressures on the environment or those related to natural or man-made hazards potentially leading to disasters (with climate change a driving factor).

For example, data on air quality and meteorological conditions, combined with data on transport, the location of industrial, urban and agricultural sources of emissions, population and epidemiology, are needed to assess the health impacts of air pollution. Such data allow sources of pollution to be identified and emission reduction targets to be calibrated in policies on air quality.

Extensive fact-finding and public consultations undertaken in the course of the preparation of the INSPIRE directive (2001–2004), identified several important obstacles preventing the widespread use of the spatial data needed for environment policies and policies with an impact on the environment. The most common obstacles identified were:

1. Spatial data are often missing or incomplete.

2. The description (documentation) of available spatial data is often incomplete.

3. Spatial data sets can often not be combined with other spatial data sets.

4. The systems for finding, accessing and using spatial data often function only in isolation and are not compatible with each other.

5. Cultural, institutional, financial and legal barriers prevent or delay the sharing and re-use of existing spatial data.

INSPIRE is based on the following common principles:

- Data should be collected only once and kept where they can be maintained most effectively.

- It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.

- It should be possible for information collected at one level or scale to be shared with all levels and scales, detailed for thorough investigations, general for strategic purposes.

- Geographic information needed for good governance at all levels should be readily and transparently available.

- It should be easy to find what geographic information is available, how it can be used to meet a particular need, and under what conditions it can be acquired and used.

2. INSPIRE legislation

The INSPIRE Directive was published in the *Official Journal* on 25 April 2007 and entered into force on 15 May 2007:

Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

3. INSPIRE implementing rules

To ensure that the spatial data infrastructure of member States was compatible and usable in a Community and transboundary context, the INSPIRE Directive required common Implementing Rules to be adopted in a number of specific areas such as:

- Data specifications

- Metadata

- Network services

- Data and service sharing, etc.

These Implementing Rules were adopted as Commission Decisions or Regulations and are binding in their entirety.

E. Lessons learned

The experience of Canada, India and the European Union shows that policy and legal frameworks, including governance and institutional arrangements, are the driving force of national spatial data infrastructure.

In the case of Canada, under the patronage of Natural Resources Canada, GeoConnections, is the mandated lead organization for the implementation of the Canadian geospatial data infrastructure.

In the case of India, under the patronage of the Department of Science and Technology, the National Spatial Data Commission is the mandated lead organization of Indian national spatial data infrastructure.

In the case of the European Union, INSPIRE is the legally mandated lead organization that leads the spatial data infrastructure in the European Union.

In all three, the implementation process followed both a top-down and a bottom-up approach and all the lead organizations were legally constituted.

VII. Step-by-step national spatial data infrastructure implementation guide for African countries

A. Approach

There is growing global recognition that accurate, timely and properly maintained geospatial information and resilient institutional mechanisms like national spatial data infrastructure for the collection, analysis, administration and dissemination of geospatial data are essential ingredients for effective policymaking, good governance and, ultimately, sustainable development. This recognition has been further enhanced following the adoption of the United Nations 2030 Agenda for Sustainable Development, which states that the follow-up and review processes of the Goals will be guided at all levels by a series of principles, one of which is that "they will be rigorous and based on evidence, informed by country-led evaluations and data which is high-quality, accessible, timely, reliable and disaggregated, including by … geographic location and other characteristics relevant in national contexts".

As a result, most countries in the world are in the process of developing national spatial data infrastructure, now widely seen as a basic component of national infrastructure, just as important as road, rail or power networks.

National spatial data infrastructure has an important role to play in Africa, as African countries need to make sense of and exploit the vast volumes of big data being produced globally, so as to be able to narrow the geospatial digital divide that has become a clear and present challenge for sustainable development in Africa. African countries must also take advantage of the 2030 Agenda pledge to leave no one behind and its promise of a better world by reaching the furthest behind first.

These facts call for African countries urgently to initiate or strengthen their respective efforts to implement national spatial data infrastructure, encompassing nationally coherent policies, standards and institutional arrangements for obtaining, processing, maintaining and using geospatial information from a variety of sources, and delivering it to the widest possible group of potential users. This effort by African countries needs to be complemented by the support of development partners such as United Nations agencies, the World Bank and other multilateral and bilateral agencies.

Successful implementation of national spatial data infrastructure requires the proper functioning of all five components of national spatial data infrastructure:

1. Policies and institutional frameworks (governance, data-sharing, funding)
2. Data (framework/fundamental data, metadata)
3. Standards (framework/fundamental data, metadata, services)
4. Access network (technology – hardware, software, ICT networks)
5. People (knowledge and skills of available human resources, capacity development, geospatial awareness).

It also requires the adoption of a culture of sharing of spatial data, and an absence of duplication of spatial data creation.

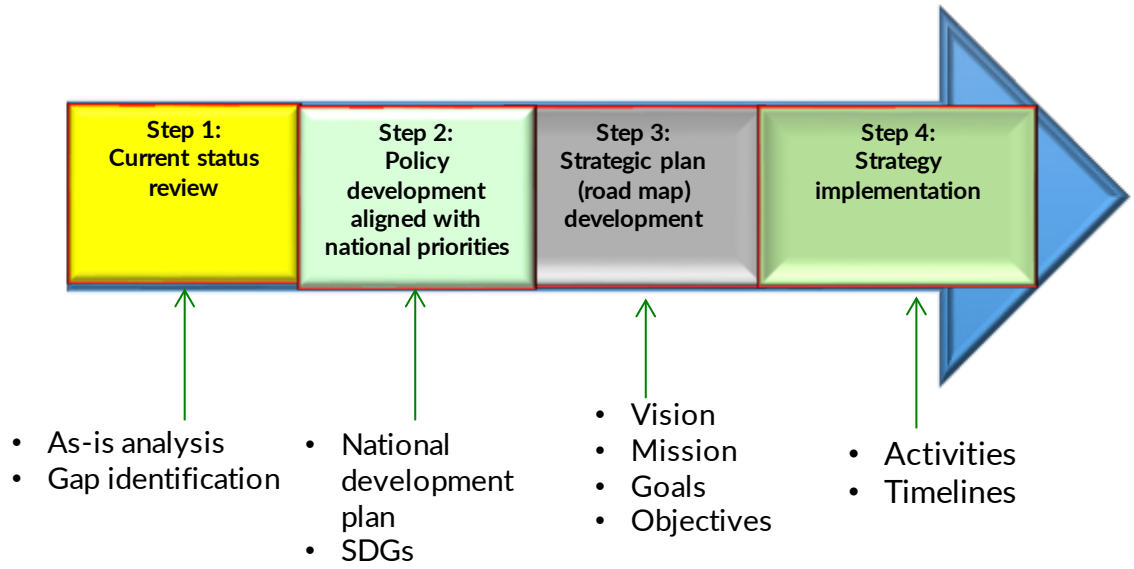
Despite the sustained effort by ECA over the last 15 years, it is evident from the findings of the assessment based on key indicators in chapter V of these guidelines, that all the components of national spatial data infrastructure are at a very basic or moderate level of development in Africa. The main challenge for successful implementation of national spatial data infrastructure to date is believed to be the lack of political commitment to it by the top political leadership of African countries.

These national spatial data infrastructure implementation guidelines have been prepared with a view to overcoming this challenge, and it is in this context that the main focus of these guidelines is based on adopting a top-down approach, in addition to the previously attempted bottom-up approach, to national spatial data infrastructure implementation in African countries.

In order to facilitate the commitment of the top political leadership to successful national spatial data infrastructure implementation in African countries, it is recommended that the steps depicted in figure 9 be followed. Details of the steps will be given in the following sections.

The steps are based on the recommended mandatory model of national spatial data infrastructure implementation in African countries. Although it is recommended that the steps be followed in a more or less sequential manner, this does not mean that one step must be fully completed before starting on the next. All the steps can be carried out in parallel, as long as there is sufficient data exchange between the parties engaged in the effort.

Figure 9
Steps of national spatial data infrastructure implementation



B. Current status review (Step 1)

1. Relevance of current status review

The first step in national spatial data infrastructure implementation is to assess its current status in the country. Here, it is essential to gather together what the country already has in place. Such data are often scattered and no previous attempt may have been made to bring together any aspect of the material produced to date.

Once this has been done, it is useful to categorize everything into one of five components, as these are the key elements in the national spatial data infrastructure components model:

- **Policy and institutional frameworks**. There may already be committees or groups in place that meet regularly, and policies, partnerships and legislative frameworks.

- **Data.** There may already be many tens or hundreds of data sets in many different formats, some proprietary and some that conform to accepted standards, some well-organized and their metadata categorized, while much may not be categorized at all.

- **Standards**. There may be a mixture of historical, local, national and global standards in use.

- **Access Networks.** There are likely to be multiple different systems in use that are not necessarily interoperable.

- **People**. There may be multiple different skills in the country. Some people will have valuable cutting-edge skills and others valuable, but out-dated skills that can maintain historical systems. This component should include capacity-building, both the institutions that can provide it and the materials that support it.

2. Who should perform the assessment?

Based on the status review of national spatial data infrastructure implementation in African countries as outlined in chapter V, it would seem that almost all African countries have made some attempt to implement national spatial data infrastructure. It is essential to review in detail the status of implementation in each African country before embarking upon the implementation anew.

Who should perform the assessment and how long it will take will vary. However, in the context of African countries, it is highly recommended that the Government, with the mandatory participation of civil society, academia and the private sector, should spearhead the assessment process. In order to carry out an effective review, it is recommended that the Government, preferably the Head of Government, (President or Prime Minister, as the case may be), or the minister in charge of geospatial information, appoint a high-level task team to conduct the review of the status of national spatial data infrastructure implementation.

The composition of the task team should be carefully considered so that, in addition to the relevant high-level government officials, academia, civil society and the private sector are also included. It is recommended that UN-GGIM: Africa, in collaboration with other multilateral development partners such as the World Bank and bilateral development partners, support the task team by providing external consultants to produce an adequate survey within the framework of the country's national spatial data infrastructure, by investigating the geospatial information status of the country through the lens of the five components of national spatial data infrastructure:

policy and institutional arrangements, data availability, standards, access networks and people.

3. Assessment model

The first step towards a comprehensive as-is assessment is to scan the environment of the geospatial information sector internally for strengths and weaknesses (from the organizations' point of view), and externally to identify opportunities and threats. Such analysis, referred to as SWOT (strengths, weaknesses, opportunities and threats) analysis, is the most widely used framework for the current status or as-is review of organizations. This framework helps to assess the external or macro environment to identify opportunities and threats, and assess the internal environment to identify strengths and weaknesses. It is therefore recommended to use the SWOT framework to conduct the current status review of national spatial data infrastructure implementation in the country.

The first step in this regard is to scan the external environment to assess the opportunities and threats for national spatial data infrastructure implementation. Key dimensions of the external environment include the analysis of the political, economic, social, technological, legal and environmental aspects, known as the PESTEL analysis, with a focus on national priorities and programmes, legal frameworks and data policies, stakeholder analysis, ICT infrastructure in the country and, above all, an understanding of how national spatial data infrastructure advocates in other countries have succeeded in garnering political support. Table 10 illustrates how the PESTEL framework can be used to assess the external environment in the context of national spatial data infrastructure implementation.

Table 10:
Macro environmental influences in national spatial data infrastructure implementation

1. What external and environmental factors are affecting national spatial data infrastructure implementation?
2. Which of these factors are most important at the present time? What are the gaps?

Political factors

- Is there adequate geospatial information awareness among high-level policy decision makers?
- Is there political support for the national spatial data infrastructure initiative?
- Is there a formally proclaimed (Act of Parliament) national spatial data infrastructure policy?

Sociocultural factors

- To what extent is the awareness and culture of using geospatial information developed in the country?
- Is the society open to data-sharing?
- Environmental factors
- Is there adequate awareness of the role of geospatial information in environmental protection activities?

Economic factors

- Does the Government allocate funding for national spatial data infrastructure implementation?
- Are there other sources of funding (donors, private sector, etc.) for national spatial data infrastructure and geospatial information activities?
- Is the market for geospatial information products and services developed?

Technological

- How much is the ICT infrastructure developed in the country?
- What is the level of Internet usage and penetration in the country?

Legal

- Is there a law on access to information or geospatial information?
- Are intellectual property rights promulgated?

This should be followed by internal assessment to assess the strengths and weaknesses within the country to lead the national spatial data infrastructure effort. The McKinsey 7 - S model is recommended. It involves seven interdependent factors as shown in figure 10 that are categorized as "hard" or "soft" elements.

The hard factors are strategy, structures and systems; while the soft elements are staff, skills, style and shared values. Figure 10 illustrates the interdependence of the factors.

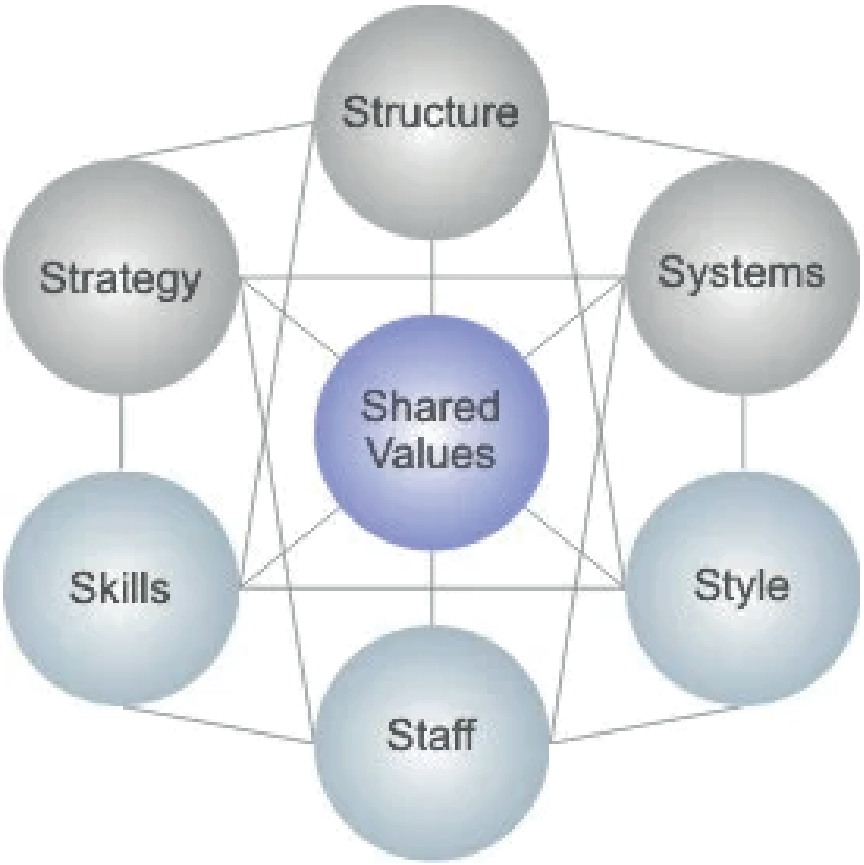
Placing shared values in the middle is mainly relevant for national spatial data infrastructure implementing organizations. The main shared value – data-sharing or open data – is central to the development of all the other factors, as this core value is the *raison d'être*, the reason why national spatial data infrastructure is created and what it stands for.

Table 11 shows how the 7-S model can be used to assess the internal environment with respect to the assessment of national spatial data infrastructure implementation.

4. Deliverables

The main deliverable of this step will be a report on the as-is situation in the country under review covering the following components of

Figure 10
Internal assessment 7-S framework



Source: www.mckinsey.com.

Table 11
Internal environmental influences in national spatial data infrastructure implementation

3. What internal factors are affecting national spatial data infrastructure implementation?
4. Which of these factors are most important at the present time? What are the gaps?

Strategy

- Is there an implementation strategy?
- Is there a plan for meeting national spatial data infrastructure objectives?
- How are developments in geospatial information user needs addressed?

Structure

- Does a national spatial data infrastructure organization structure exist in the country?
- What is the hierarchy?
- Does the structure involve all major stakeholders?

Systems

- Are appropriate systems available to maintain and develop the national spatial data infrastructure initiative?
- Is there an adequate monitoring and control mechanism?

Shared values

- Are the core values of the national spatial data infrastructure organization well-articulated?
- Are open data (data-sharing), teamwork, and transparency included in the core values of the national spatial data infrastructure organization?

Style

- Is the national spatial data infrastructure leadership style participatory?
- Is the national spatial data infrastructure leadership effective?

Staff

- Is the national spatial data infrastructure organization adequately manned?
- Are there gaps in required competencies?

Skill

- What are the strongest skills available in the national spatial data infrastructure organization?
- Are there skills gaps?
- How are skills monitored and assessed?

national spatial data infrastructure implementation, based on the SWOT analysis:

- Assessment and gap analysis with respect to policy and institutional frameworks, including, governance, legal frameworks, and funding mechanisms.

- Status of fundamental geospatial data sets and related metadata availability and gap analysis.

- Availability and gap analysis of geospatial data standards that facilitate data interoperability, data-sharing, and data consistency.

- Assessment of ICT infrastructure in the country with respect to access network availability, including Internet penetration and electric power connectivity and gap analysis.

- Assessment and gap analysis of the available people, knowledge and skills in the country under review, including capacity-building: both the institutions that can provide capacity-building, and the level of national spatial data infrastructure awareness in the country, particularly at the policymaking level.

C. Policy development: aligning with national, regional, and global priorities (Step 2)

1. National priorities and programmes

Policy is the key component of national spatial data infrastructure, so policy development should be a priority activity in its implementation. This is especially relevant to African countries, as the recommended model for national spatial data infrastructure implementation in Africa is the mandatory model, with a combination of top-down and bottom-up approaches.

In the context of national spatial data infrastructure, data policy provides legal frameworks setting out basic principles specific to geospatial data to be observed by individuals and institutions when generating, collecting, transforming, disseminating, preserving, and making use of such data.

In their policy development endeavour, the lead organizations for national spatial data infrastructure implementation in African countries need to take government priorities into account to gain political support for the initiative. Examples of government priorities that can benefit from national spatial data infrastructure include e-government (open government), economic development, environmental and sustainable resource development, infrastructure development, public safety and defence, emergency management, public health, etc.

Such priorities can be ascertained from a number of sources, such as:

- Annual budget documents
- Ministerial and departmental strategic and annual plans
- Speeches by senior government officials
- Government press releases and media coverage
- Other print and online publications, websites, etc.

Once priorities are established, the key stakeholders must be identified and convinced of the role that national spatial data infrastructure can play in helping them to address those priorities. It is critical to ensure that the stronger users of spatial information (typically national planning, natural resource and land management, engineering and public infrastructure works and defence organizations) are engaged and supportive in the initial stages of national spatial data infrastructure planning, and then to expand the engagement process to include less experienced spatial data user groups.

National spatial data infrastructure implementation in African countries should also take into consideration the fact that effective implementation of Agenda 2063 and the 2030 Agenda for Sustainable Development requires them to scale up investment in science, technology and innovation, which are significant enablers of spatial data infrastructure implementation.

2. Policy formulation process

Like any other viable policy formulation process, national spatial data infrastructure policy must be developed on a consultative basis. Accordingly, the initial phase of policy development normally involves stakeholder consultations followed by a formal decision-making (endorsement) process by the relevant government authority (Cabinet decision or Act of Parliament).

The following factors affecting the priority accorded to policy issues should be given due

consideration in the policy formulation process.

- **Scope** – The number of parties and stakeholders that need to be involved in developing and implementing the policy (for example, one ministry or department versus multiple levels of government).

- **Impact** – The consequences of a policy in terms of how it affects existing systems, business processes and human and financial resources.

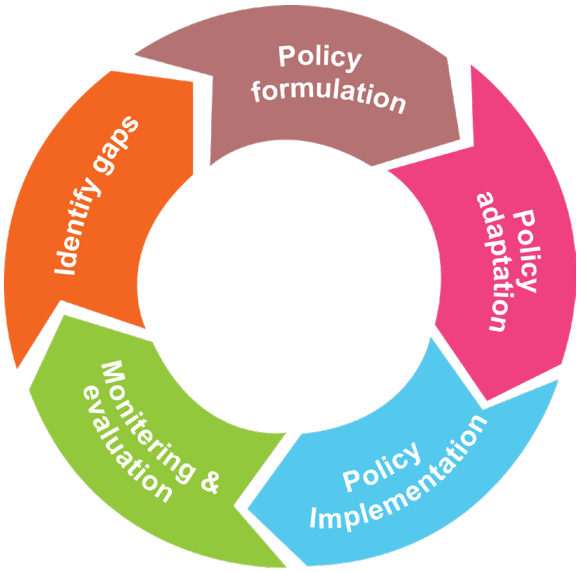
- **Importance** – The scope of demand for the policy and the extent to which the issues are critical.

- **Complexity** – How challenging it will be to develop and implement the policy (for example, technical, legal and administrative complexity).

These factors should be addressed in such a compelling way that priority is given to the policy issue by convincing high-level policy decision makers to devote the necessary time and resources to national spatial data infrastructure policy.

No policy should be considered static, so national spatial data infrastructure policy needs to be continuously improved on a cyclic basis (based on the strategic planning cycle of the country or when the situation or policy in the country changes (for example, as a result of a change of government) as shown in figure 11.

Figure 11
Continuous improvement cycle in policy development



3. Policy issues

The existing policy and legal frameworks, if any, should be reviewed to assess whether or not they adequately address the emerging legal issues on the national spatial data infrastructure initiative. It is imperative that new policy and legal frameworks be put in place to address such policy and legal issues. Furthermore, effort should be made to make harmonious linkages with other related government policy documents, such as ICT policy, national land administration policy and e-government strategy.

Some of the common policy and legal issues that need to be addressed in the spatial data infrastructure policy are briefly discussed below.

a. Data policy

Since fundamental/framework data are one of the key components of national spatial data infrastructure, its production, ongoing maintenance, and dissemination should be regulated. It is in this regard that policy is required to ensure that the data are compiled and revised

by all in accordance with common specifications and rules.

b. Data-sharing and integration

The main objective of national spatial data infrastructure initiatives is to facilitate data-sharing and integration in keeping with the broader open data movement. The common goals of data-sharing are as follows:

- Encourage data to be collected with the intention of its being used many times
- Remove restrictions on use and dissemination
- Disseminating works at minimal or no cost
- Improving public use and access in the public interest.

Spatial data-sharing is the transfer of location-based information between two or more organizations. It can take many forms, from sharing metadata to individual data layers or complete databases. Data integration can be described as the process of matching different data sets geometrically and topologically and establishing the correspondence of attributes to create a new product that is richer in content than in the original sources (Mohammadi, Rajabifard, and Williamson, 2009).

c. Data custodianship

The custodianship of geospatial information is a crucial component of national spatial data infrastructure. Since most fundamental data sets are provided by public organizations, it is often necessary to identify an authoritative source of data sets produced using public funds as this provides accountability for fundamental data sets.

The custodian is the legal body responsible for the production, storage, management and distribution of the data set on behalf of the producer.

The producer of public-funded data is the custodian, not the owner, and manages the data as a trustee for the community and the authoritative source of the fundamental data set in its care.

The custodian of a data set is responsible for:

- Quality control and assurance
- Validation and maintenance
- Storage and security
- Accessibility of the data through supply of the metadata to the clearing house.

d. Data ownership

The owner of a geospatial data set is the person or organization that funds data production, storage, management and distribution.

The owner of a data set is responsible for:

- Quality control and assurance
- Data content and formats
- Validation and maintenance
- Storage and security
- Maintenance and updating of metadata
- Accessibility of the data through supply of the metadata to the clearing house

e. Confidentiality, privacy and liability

- Data providers disclose or make available their data sets on request, unless law prevents it.

- Only geospatial data related to national security is confidential. Confidential data may be shared at the discretion of the custodian, however.

- A geospatial data custodian or owner is not accountable for the integrity of data that has been modified by a user.

- A geospatial data custodian or owner is deemed to possess indemnity against any liability arising from unlawful use of the data set.

- Users report to the provider and the clearing house any error that in their opinion affects the quality of a geospatial datum, and shall do so in the shortest time possible after discovering the error. Users reporting any error must provide sufficient information to enable the provider to identify the record(s) that contain error(s) that make the data unsuitable and, where possible, provide evidence of the error.

f. Intellectual property rights

- A geospatial data custodian or owner owns the copyright of the data.

- For value-added data, the producer owns the copyright of the new data and acknowledges the source of the original data.

- For integrated data sets, the producer of the data owns the copyright, provided that permission has been obtained from the copyright holder(s) of the individual base data.

- Before using any geospatial data set to which they have gained access, geospatial data custodians or owners must enter into a licensing agreement concerning the use of the data set. The licensing agreement should provide for the following:

- The duration of the agreement

- The legal protection of the copyright of the custodian and any other interested party.

- A maximum number of permitted users within the organization, where an organization is the beneficiary of the agreement.

- Any other provisions that the parties may deem necessary.

- A user will not supply data to a third party, unless this is covered by a licensing agreement between the user and the provider.

D. Strategic plan development (Step 3)

As illustrated in figure 12, the strategic planning process begins with the articulation of a vision statement for the national spatial data infrastructure initiative. As indicated by the Canadian partnership programme GeoConnections, a good vision statement is a long-term view that describes the desired future for the spatial data infrastructure and is intended to inspire, motivate and align the activities of those interested in seeing that future become a reality. The mission statement describes what the national spatial data infrastructure initiative seeks to achieve in the long term and provides guidance to all stakeholders working to achieve the vision.

Figure 12
Strategic planning process

Source: CP – IDEA.

The strategic plan or road map then goes on to define the path to the achievement of the vision, as follows:

- **Goals** – High-level, qualitative statements that describe what needs to be accomplished to achieve the vision in broad terms.

- **Objectives** – Measurable steps that, taken together, lead to the achievement of goals. Objectives must be specific, measurable, achievable, realistic and time-bound (SMART).

- **Initiatives** – Investments of time and money in projects that must be undertaken by specific stakeholders in order to achieve the objectives and ultimately realize the vision of the national spatial data infrastructure.

1. Vision, mission and objectives

a. Vision

The recommended vision for all African countries to be attained by 2030 is:

To ensure that spatial data permeates every aspect of society and are available to people who need them, when they need them, and in a form that they can use to make decisions with minimal pre-processing. Moreover, the collected data sets should be put to the maximum possible number of uses by publicizing their existence and making them easily available to the widest possible audience.

Or alternatively:

To enable African countries to have a world-class infrastructure for the production, access and use of geospatial information in decision-making at national and local levels for good governance and sustainable development.

b. Mission

To promote coordination in the production, sharing and use of geospatial information for good governance and sustainable development.

c. Objectives

1. To develop national policy, an institutional framework and administrative arrangements that provide mechanisms for the development, administration and sharing of geospatial data sets.

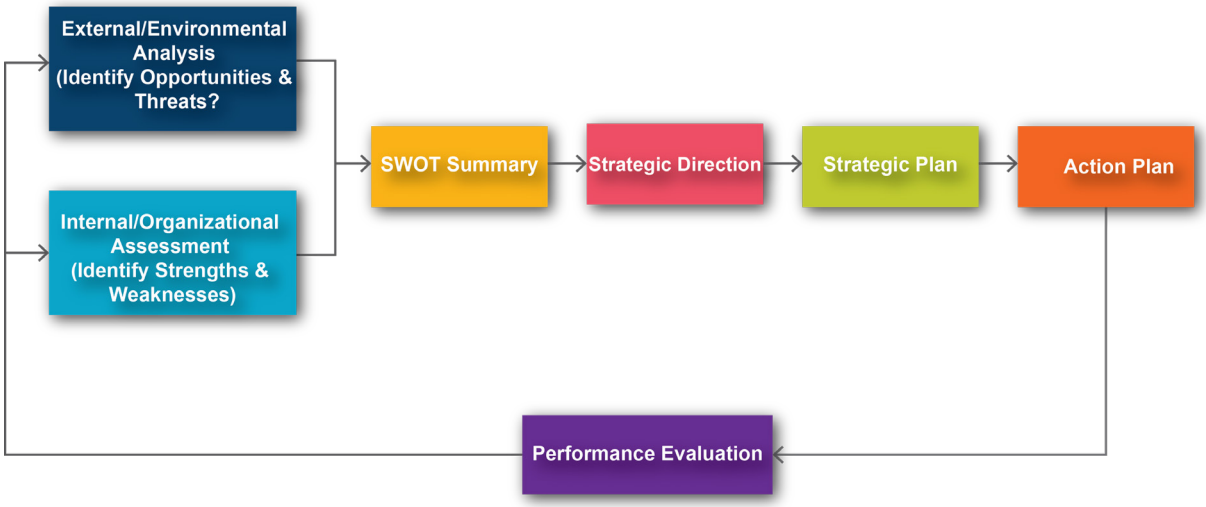
2. To eliminate wastage of resources and duplication of effort in the production of geospatial information (produce once, use many times).

3. To develop acceptable standards for data production and distribution.

4. To develop a solution for easy discovery and access of geospatial data.

5. To promote and coordinate national participation in international initiatives on

Figure 13
Strategic planning cycle



the development of regional and global spatial data infrastructures.

Once the vision, mission and objectives are identified, it is essential to review the SWOT analysis, as indicated in figure 13, in order to be able to determine a strategic direction that bolsters opportunities and strengths and helps to overcome threats and weaknesses.

2. Governance and institutional arrangements

a. Recommended organizational structure

The structure comprises the minister in charge of national spatial data infrastructure implementation, the national executive council, the national spatial data infrastructure secretariat and the working groups, as shown in figure 14.

a. Functional descriptions of the main components of the organization structure

The main components of the organization structure and their functions are briefly described below.

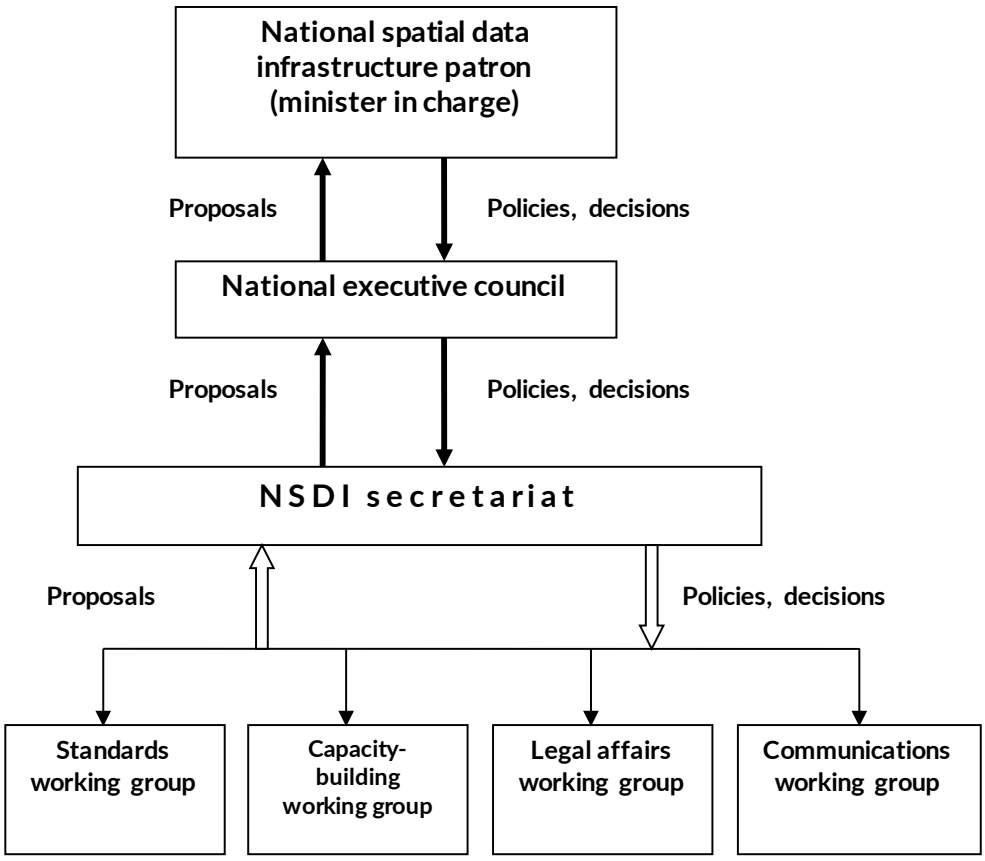
Patron (minister in charge of national spatial data infrastructure)

Depending on the structure of government, this should be the ministry in charge of the main development sector of which geospatial information is a subsector. To provide stronger support at policy level, it would be preferable for the minister in charge to be the office of the prime minister or president, as the case may be.

Function:

As patron of national spatial data infrastructure, the minister in charge ensures that the concept is understood and supported in the governmental and parliamentary spheres (political advocacy), that the administrative requirements for its development and operation are met (administration advocacy) and that the Government provides the required financial resources and helps to mobilize the external requirements (financial advocacy and provision).

Figure 14
Generic national spatial data infrastructure organization structure



National executive council

Membership:

Ministers and permanent secretaries of main stakeholder ministries and agencies

Chair:

Minister or permanent secretary of the ministry in charge of national spatial data infrastructure

Function:

This organ is composed of the key stakeholder organizations and works towards the achievement of the objectives of national spatial data infrastructure, by analysing the outcome of the activities undertaken by the lower level organs and making recommendations to the minister in charge, and by facilitating the implementation of the decisions once taken by the latter.

National spatial data infrastructure secretariat or lead organization

Membership:

The relevant government agency is nominated as the secretariat. The national spatial data infrastructure secretariat or lead organization will usually be an institution with a mandate related to geospatial data production and management in the country, the national

mapping and geospatial information organizations, for example.

Function:

National spatial data infrastructure needs an institution in charge of coordinating actions regarding the development and operation of the entire structure. It will play the role of secretariat with regard to the other organs, administratively facilitate the functioning of the spatial data infrastructure, provide office space and related facilities for its operation, manage its resources, undertake the networking, management functions and linkage with other national spatial data infrastructure initiatives, and coordinate the national executive council and working groups.

Working groups

Working groups are technical task forces, and are usually formed to focus on specific problem areas of national spatial data infrastructure development and operation. They help deepen the analysis of the issues involved and identify the best solutions by, for example, drafting standards and policies, suggesting capacity-building programmes, etc.

Membership:

Experts from partner and key stakeholder organizations.

Function:

Making recommendations in accordance with their terms of reference to the secretariat. The recommended working groups and main content of their respective terms of reference are as follows:

Standards working group

- Data framework (types, scale, etc.)
- Coding system
- Reference system
- Exchange format
- Metadata standards.

Legal affairs working group

- Copyright
- Liability
- Privacy
- Data policy (access, restriction, pricing, enforcement of copyright for original data and secondary data, etc.)

Capacity-building working group

- Training
- Research
- Sensitization (advocacy and awareness-raising)

Communication working group

- Clearing house
- Metadata
- Website or portal for national spatial data infrastructure
- Partnership and cooperation

E. Strategic issues (Step 4)

Under strategic issues, the status of the components of national spatial data infrastructure that relate to geospatial data – fundamental data, metadata, standards, and access

networks (technology) – are reviewed and evaluated.

1. Fundamental data sets

Determination of fundamental data sets for Africa (ECA, 2007) defines fundamental data sets as the minimum primary sets of data that cannot be derived from other data sets, and that are required to spatially represent phenomena, objects, or themes important for the realization of economic, social and environmental benefits consistently across Africa at the local, national, subregional and regional levels.

Being the key component of national spatial data infrastructure, fundamental data sets – also referred to as framework data sets – are the core data required for its implementation. African countries should therefore give due consideration to the collection, updating and management of fundamental geospatial data sets as a key driver for national spatial data infrastructure implementation.

In order to be able to collect, update and manage fundamental data, it is essential to determine and agree upon the minimum list of fundamental data sets. In this regard, further to the work of ECA to determine fundamental data sets for Africa, the United Nations Global Geospatial Information Management has established a Working Group on Global Fundamental Geospatial Data Themes to determine the global minimum list of fundamental data themes.

The working group recommended 14 fundamental data themes (indicated in table 12) that were adopted by UN-GGIM. Accordingly, it is recommended that African countries adopt these 14 fundamental data themes, customizing each to their particular country circumstances.

Following the determination of the fundamental data themes, each African country needs to examine what fundamental data sets are available in the country and how the missing data can be provided.

2. Metadata

Metadata are data about data. They include such details as the geographical extent of data, quality of data, currency of data and the supplier of the data. These details are described in a metadata structure and they enhance the use of geospatial information in making appropriate decisions.

Metadata assist the user to determine how best to use the data. They also benefit data-producing agencies because, as personnel change in an organization, undocumented data may lose their value due to poor understanding of their content and uses by new staff. Moreover, lack of knowledge about other organization's data sets can lead to duplication of effort.

The value of a data set is therefore dependent on its documentation.

Geospatial data producers need to provide metadata for each data set they produce and any subsequent updates. The metadata provided should conform to national and international standards.

The metadata content should include at least the following information:

- Data quality (positional accuracy, attribute accuracy, temporal accuracy, lineage, completeness and logical consistency)
- Content (the features included)
- Structure (the representation of objects, topology, etc.)
- Spatial reference (coordinate system, datum, projection)

Table 12
Minimum list of global fundamental data themes

Datatheme	Theme description
Global Geodetic Reference Frame	The Global Geodetic Reference Frame is a framework that allows users to determine precisely and express locations on Earth, and to quantify changes on Earth in space and time. It is not a data theme in the same sense as the other themes, but is a prerequisite for the accurate collection, integration and use of all other geospatial data.
Geographical names	Geographical names are location identifiers for features of the real world, i.e. cultural and physical features on Earth, such as regions, settlements, or any cultural, geographical or topographical feature of public or historical interest, and provide a link to cultural, social and historical heritage. They are often used as a proxy for other data themes such as settlements and natural features.
Addresses	An address is a structured label – usually containing a property number, a road name and a locality name – used to identify a plot of land, a building or part of a building or some other construction together with geographical co-ordinates. They may be postal or non-postal. They are often used as a proxy for other data themes such as land parcels.
Functional areas	Functional areas are the spatial extent of administrative, legislative, regulatory, electoral, statistical, governance and service delivery areas.
Buildings and settlements	A building refers to any structure permanently constructed or erected on its site and usable for the protection of humans, animals, things or the production of economic goods. Settlements can be considered to be collections of buildings and associated features where a community carries out socioeconomic activities.
Land parcels and properties	Parcels of land with common ownership, occupation and/or use. This can include individual fields and cadastral parcels.
Transport networks	Transport networks are the set of road, rail, air, cable, and water transport networks with their related infrastructure and nodal connections.
Elevation and depth	Earth's surface, on land and under a body of water, relative to a vertical datum.
Population distribution	Geographical distribution of people, including population characteristics.
Land cover and use	Physical and biological cover of Earth's surface including artificial surfaces, agricultural areas, forests, (semi-) natural areas, wetlands, water bodies. Also the use, which is its current and future, planned functional dimension or socioeconomic purpose.
Geology and soils	Geology characterized according to composition and structure. Includes bedrock, aquifers, geomorphology, mineral resources and soils.
Physical infrastructure and service delivery points	Includes industrial and utility facilities and administrative and social governmental services such as public administrations, civil protection sites, schools and hospitals.
Water	Extent and conditions of all water features including rivers and lakes and marine features.
Imagery	Georeferenced image data of the Earth's surface, from satellite or airborne sensors. Although not a theme in its own right, it is included because, when interpreted, it is a widely used data source for many data sets.

Source: UNGGIM.

- Identification information (name of data, geographic coverage)
- Entity and attribute information (formats, type, measurement units)
- Distribution information (distributor, format, access protocol, procedure), etc.

3. Standards

Standards provide consistent specifications for creating, reproducing, updating and maintaining geospatial information, such as how data should be structured to represent geographic features and how the information is exchanged between systems. Many technical barriers to sharing geospatial information are now successfully managed with technology and standards. When data content is standardized, information can be accessed, exchanged and used by people and computers more effectively.

As has been repeatedly stated in this document, the key purpose of national spatial data infrastructure is to provide the mechanisms that facilitate geospatial data-sharing. This requires interoperability between systems and system components, and the specification and adoption of a compatible suite of standards is a critical means of enabling that. Standards are necessary for facilitating robust, open transfer of geospatial data packages between platforms, especially in a varied network of computers that are managing a diverse range of spatial data stores and data types.

Standards related to national spatial data infrastructure development and operation can be grouped into three categories:

- **Data content standards** – for understanding the contents of different data themes by providing a data model of spatial features, attributes, relationships, and a data dictionary.
- **Data management standards** – for handling spatial data involving actions, such as discovery of data through metadata, spatial referencing of data, collection of data from the field, submission of data by contractors to stakeholders and tiling of image-based maps.
- **Data portrayal standards** – for visual portrayal of spatial data using cartographic feature symbology.

4. Access network (technology)

Access services provide a means to access a data set. Information and communications technology infrastructure provides the technological backbone to facilitate access to the Internet and the World Wide Web (WWW), which together constitute cyberspace, a computer-generated public domain with no territorial boundaries or physical attributes and in perpetual use. The Internet is the worldwide physical network of computer networks. Although Internet architecture is global in theory, the reality on the ground is different. Lack of a telephone line, a computer and a modem (ICT infrastructure) excludes the majority of Africans from accessing the Internet.

Exclusion for technical and economic reasons makes the Internet a de facto club for the rich, despite the theoretical hype. At a global scale, the bulk of Internet connectivity in Mb/sec is between the developed countries. Africa has very thin lines reaching the developed countries.

This can be seen from the very low ranking of African countries in the ranking based on the Networked Readiness Index. The *Global Information Technology Report: Readiness for the networked world 2001-2002* included five African countries among the top 75 countries, with South Africa ranked highest (40), followed by Mauritius (51), Egypt (60), Zimbabwe (70) and Nigeria (75). But in

2016, the World Economic Forum included only one African country, South Africa, among the top 75 countries, its ranking having fallen to 65.

Despite the poor state of ICT infrastructure, African countries still need to make use of the ICT infrastructure they have to make geospatial data available through a national spatial data infrastructure Web portal, a geoportal to facilitate data-sharing.

F. People (capacity development)

1. Relevance

The status of geospatial data technologies in African countries is still at the basic stage. This implies that there is an urgent need for training and capacity development, if the continent is to fully embrace these technologies for its much-needed sustainable development. The objective is to raise awareness and develop and strengthen the knowledge and skills that organizations and communities require to produce, maintain, use and share geospatial information for decision-making.

The focus for training and capacity-building for national spatial data infrastructure rests on five key pillars:

a. Human resource development in geospatial information

b. Geospatial information curriculum development

c. Research in geospatial information technologies and applications

d. Public and user awareness-raising campaigns

e. Liaison with strategic partners.

2. Policy recommendations

a. Geospatial information projects need to include a training component for various grades of staff (operators, supervisors, managers, etc.) in relevant aspects of geospatial information.

b. The coordinating agency and other stakeholders should carry out public awareness programmes on issues related to national spatial data infrastructure from time to time.

c. All educational institutions offering geospatial information-related programmes should review their geospatial information curricula on a regular basis.

d. An impact assessment of geospatial information projects on the society needs to be carried out by national spatial data infrastructure stakeholders.

e. Government, through the national spatial data infrastructure coordinating agency, needs to encourage research on new innovations in geospatial information and its applications.

f. Continuing professional development for geospatial information practitioners should be mandatory.

g. Geospatial information stakeholders must be encouraged to forge strategic links with reputable local and international partners.

h. Accreditation of geospatial information training programmes based on international standards and practices should be encouraged.

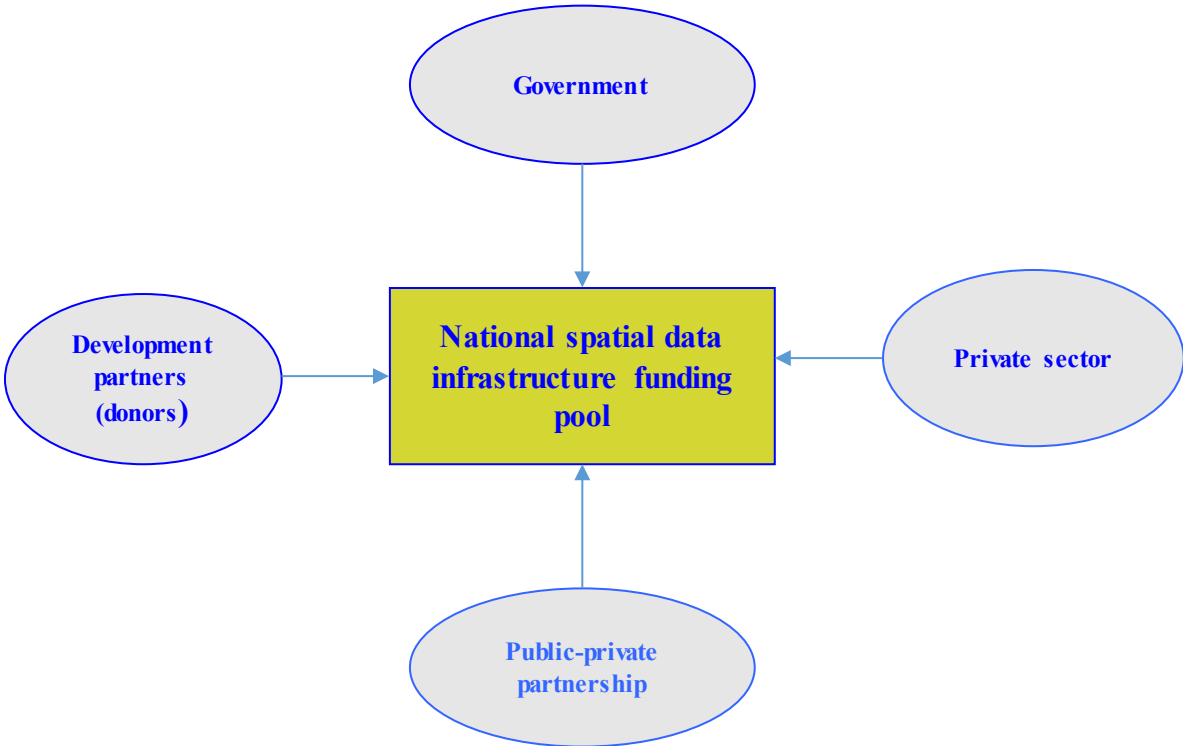
G. Funding

Funding mechanisms are essential tools for national spatial data infrastructure implementation since, without proper financing, it is impossible to efficiently implement and maintain such infrastructure. To facilitate this essential financial resource, the national spatial data infrastructure secretariat should work out the mechanism and make recommendations to the national executive council for government approval.

The major options for funding, as indicated in figure 15, include government, donor funding, public-private partnership, the private sector, etc. However, it is envisioned that governments will take the lead and provide the enabling mechanism to generate finances for national spatial data infrastructure, including an annual budget to support operations for infrastructure sustainability.

With national commitment to spatial data infrastructure, each stakeholder could build up a fund base for its respective operations. It is also envisaged that, at an appropriate time after operationalization, the national spatial data infrastructure could explore ways of commercializing its operations.

Figure 15
Potential national spatial data infrastructure funding mechanisms



VIII Recommended implementation plan

A. Detailed tasks and milestones

- Establishment of a national spatial data infrastructure task team.
- Preparation of the national spatial data infrastructure policy and action plan, in consultation with stakeholders.
- Government approval of the policy (Cabinet decision, Act of Parliament).
- Determination of fundamental data themes.
- Definition of national spatial data infrastructure standards: content, design, network, exchange, etc.
- Design and organization of national spatial data infrastructure metadata.
- Development of national spatial data infrastructure search and access protocols.
- Establishment of national spatial data infrastructure network (bandwidth and architecture).
- Establishment of national spatial data infrastructure portal.
- Official launch of national spatial data infrastructure.

B. Action plan

The template for the recommended action plan is shown in table 13.

Table 13
National spatial data infrastructure implementation action plan

	Objective	Activities	Time frame	Actors	Inputs	Outputs	Indicators
1	Draft NSDI policy	Establish task team to draft policy		NSDI patron (Head of State or Government or responsible minister	Stakeholders	Task force established	Letter from the NSDI patron
		Review existing draft policies and relevant implementation mechanisms (proclamation, regulation, manuals, etc.)		Task force	Office space, funding, related policy and documents	Revised preliminary draft policy and implementation mechanisms	Revised policy submitted to stakeholders
		Convene workshop to review draft policy		Task force, stakeholders	Funding	Comments on draft policy	Workshop proceedings
		Prepare draft final policy and relevant implementation mechanisms (proclamation, regulation, manuals, etc.)		Task force	Office space, funding, related policy documents	Draft final NSDI policy and implementation mechanisms	Draft policy submitted to Cabinet
		Adopt draft NSDI policy		Cabinet office, task force	NSDI draft final policy	NSDI policy and implementation mechanisms adopted	Cabinet decision
2	Establish NSDI institutional framework	1. Create the NSDI organization structure (patron, national executive council, secretariat, working groups)		NSDI patron, stakeholders	Cabinet decision establishing the NSDI	NSDI organization structure established	Letters of NSDI structure establishment from the NSDI patron
		2. Appoint membership of the NSDI structure		NSDI patron, national executive council	NSDI regulation NSDI organization structure	Letters of appointment	Letters of appointment signed by NSDI patron
		3. Establish the secretariat		NSDI patron, national executive council	NSDI regulation, funding, office space,	NSDI secretariat	Functional NSDI secretariat established
		5. Assign functions to NSDI members		National executive council, secretariat	NSDI regulation, NSDI organization structure	Job descriptions to NSDI members	Documented job descriptions

	Objective	Activities	Time frame	Actors	Inputs	Outputs	Indicators
3	Develop standards for geo-spatial data production and dis-semination	1. Identifica-tion of funda-mental data sets		Stakeholders, secretariat, standards working groups.	Existing or proposed national, regional and global data themes	List of funda-mental data sets	Officially adopted fundamental data sets
		2. Funda-mental data standards		Stakeholders, secretariat, standards working groups.	Existing or proposed national and standards	National geospatial data standards	
		3. Metadata Standards		Stakeholders, secretariat, standards working groups.	Existing or proposed national and international standards	National meta-data standards	
		4. Data transfer and exchange stan-dards		Stakeholders, secretariat, standards working groups.	Existing or proposed national and international standards		
4	Develop solution for easy discovery and access of geospa-tial data	1. Establish a clearing house		National exec-utive council, communica-tions working group, secretariat.	NSDI regula-tion, regional and international best prac-tices		
		2. Establish NSDI portal		National exec-utive council, communica-tions working group, secretariat.	Data policy, ICT infra-structure, funding,		
		3. Establish NSDI nodes		National exec-utive council, secretariat, stakeholders, communica-tions working group.			
		4. Official launch of NSDI		NSDI patron, National exec-utive council, secretariat, stakeholders, communica-tions working group.			High-level national workshop to launch NSDI officially.

IX. Integrating national spatial data infrastructure and the Integrated Geospatial Information Framework (IGIF)

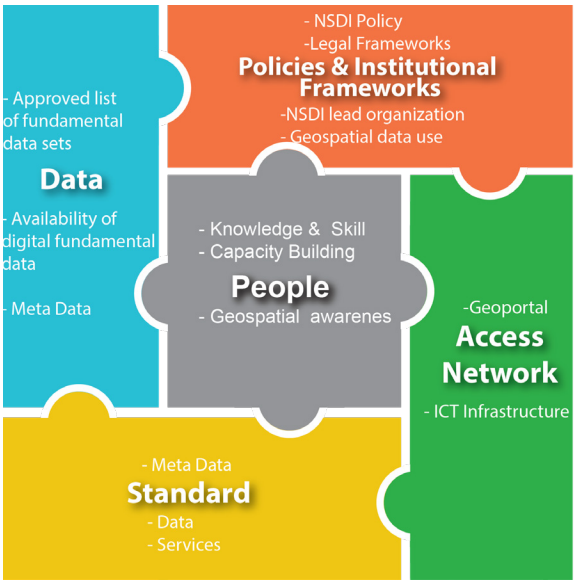
A. Comparative overview of national spatial data infrastructure and IGIF

As discussed elsewhere in this document, the national spatial data infrastructure of a country can generally be defined as a framework of policies, standards, technology and access network and policy and institutional arrangements that facilitate data providers to publish and users to access and integrate distributed heterogeneous geospatial information. It promotes geospatial data-sharing throughout all levels of government, academia, the private sector, civil society and individual citizens, thus enabling effective use of geospatial data for sustainable national development and other everyday requirements.

National spatial data infrastructure mainly consists of the following five interconnected core components – with people at the centre – common to the implementation of all such infrastructure (see figure 16):

1. Policies and institutional frameworks (legal frameworks, governance, funding)
2. Data (framework/fundamental data, metadata)
3. Standards (framework/fundamental data, metadata, services)
4. Access network (technology: hardware, software, ICT networks)
5. People (knowledge and skills of available human resources, capacity development, geospatial awareness).

Figure 16
Components of national spatial data infrastructure



The Integrated Geospatial Information Framework, on the other hand, is a mechanism that provides a basis and guide for developing, integrating and strengthening geospatial information management at national or subnational level.

The IGIF identifies seven underpinning principles, eight goals and nine strategic pathways. The strategic pathways fall within three main areas of influence, as indicated in table 14 and figure 17.

Table 14
Components of the Integrated Geospatial Information Framework

VISION

The efficient use of geospatial information by all countries to effectively measure, monitor and achieve sustainable social, economic and environmental development, leaving no one behind

MISSION

To promote and support innovation and provide the leadership, coordination and standards necessary to deliver integrated geospatial information that can be leveraged to find sustainable solutions for social, economic and environmental development.

STRATEGIC DRIVERS

National development agenda ● National strategic priorities ● National transformation programme ● Community expectations ● Multilateral trade agreements ● Transforming our world: the 2030 Agenda for Sustainable Development ● New Urban Agenda ● Sendai Framework for Disaster Risk Reduction 2015 – 2030 ● Addis Ababa Action Agenda ● Small Island Developing States Accelerated Modalities of Action (SAMOA) Pathway ● United Nations Framework Convention on Climate Change (Paris Agreement) ● United Nations Ocean Conference: Call for Action

UNDERPINNING PRINCIPLES

Transparent and accountable	Information accessible and easily used	Strategic enablement	Collaboration and cooperation	Integrative solution	Sustainable and valued	Leadership and commitment

GOALS

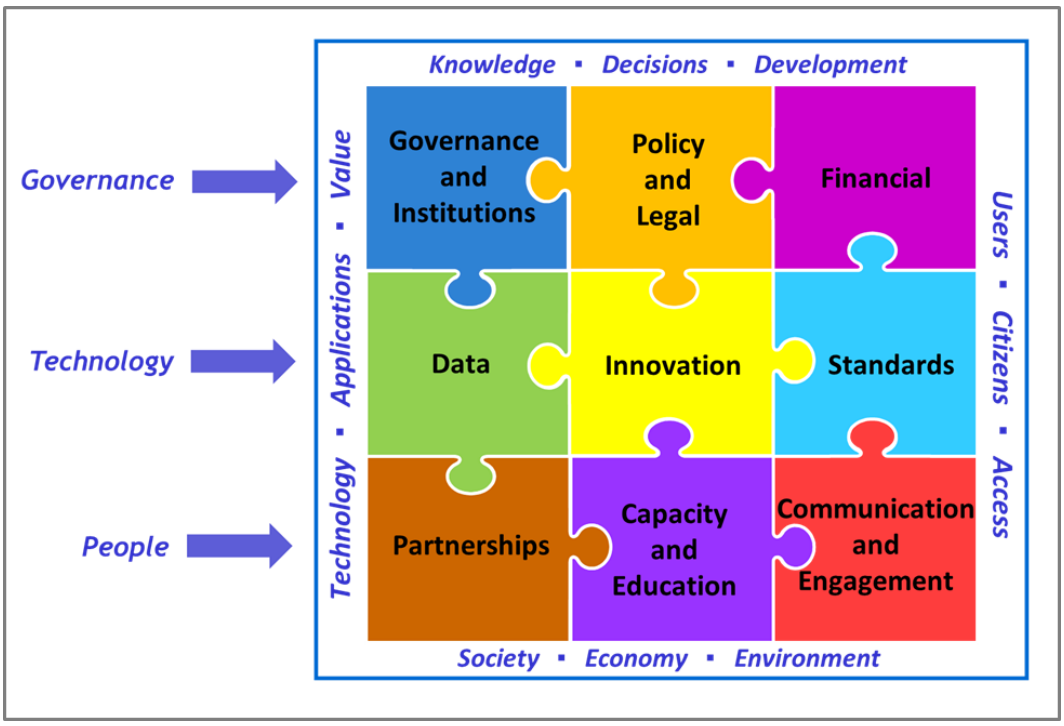
Effective geospatial information management	Increased capacity, capability, and knowledge transfer	Integrated geospatial information systems and services	Enhanced stakeholder engagement and communication
International cooperation and partnerships leveraged	Sustained education and training programmes	Economic return on investment	Enriched societal value and benefits

STRATEGIC PATHWAYS

Governance and institutions	Legal and policy	Financial	Data	Innovation	Standards	Partnerships	Capacity and education	Communication and engagement
• Value proposition	• Data protection and licensing	• Benefits realization	• Data curation and delivery	• Bridging the digital divide	• Technical interoperability	• International collaboration	• Professional development and workplace training	• Monitoring and evaluation
• Institutional arrangements	• Implementation and accountability	• Investment	• Data supply chain interlinkages	• Promoting innovation and creativity	• Semantic interoperability	• Community participation	• Entrepreneurship	• Planning and execution
• Leadership	• Norms, policies and guides	• Partnerships and opportunities	• Custodianship, acquisition and management	• Process improvement	• Data interoperability	• Industry partnerships and joint ventures	• Formal education	• Integrated engagement strategies
• Governance model	• Legislation	• Business model	• Fundamental geospatial data themes	• Technology and technological advances	• Legal interoperability	• Cross-sectoral and interdisciplinary cooperation	• Awareness-raising	• Stakeholder identification

Source: UN-GGIM.

Figure 17
The nine pathways and three areas of influence of IGIF



Source: UN-GGIM.

A comparison of the components and sub-components of NSDI, and the Areas

The correspondence between the components of national spatial data infrastructure and IGIF pathways is summarized in table 15.

B. Integrating IGIF and national spatial data infrastructure

As can be seen in table 15, all five components of national spatial data infrastructure are directly correlated with the nine IGIF pathways, and vice versa.

Hence it can be safely concluded that the full and successful implementation of spatial data infrastructure in a particular country will simultaneously result in the implementation of IGIF in that country. Conversely, it can also be safely concluded that the full and successful implementation of IGIF in a particular country can result in the implementation of spatial data infrastructure in that country.

Taking note of the high degree of commonality between spatial data infrastructure and IGIF, it is recommended that African countries focus on spatial data infrastructure implementation with a view to developing IGIF as the enabling platform.

This approach will help African countries to avoid a confusion in semantics that may be encountered when approaching policy decision makers in connection with the implementation of both frameworks (IGIF and national spatial data infrastructure) simultaneously and in isolation.

Table 15
Correspondence between NSDI components and IGIF pathways

S/N	NSDI component	Equivalent IGIF pathways
1	Policy and institutional arrangements	Policy and legal
		Governance and institutions
		Financial
2	Data	Data
3	Standards	Standards
4	Access network and technology	Innovation
5	People	Partnerships
		Capacity and education
		Communication and engagement

X. Conclusion

These National Spatial Data Infrastructure Implementation Guidelines for African countries have been prepared as a reference guide for developing and strengthening policy, legal, institutional, technical and capacity-related issues in national spatial data infrastructure implementation specifically in African countries. They take stock of the efforts made to implement such infrastructure in African countries over the last 15 years and take into account the lessons learned from those efforts.

Many African countries have so far followed the bottom-up approach, with little result. These Guidelines recommend combining the bottom-up with the top-down approach by involving top level policy decision makers from the start of the national spatial data infrastructure implementation process. This requires the agencies leading the implementation process to entice policy decision makers by showcasing the benefits of geospatial information for national sustainable development endeavours. Such showcasing should focus on the usefulness of such information for planning, monitoring and reporting on national development plans, the Sustainable Development Goals, and the Agenda 2063 goals.

The Guidelines further recommend the adoption of more of an output and product-based approach, rather than a process-based approach. The process-based approach was the main area of focus in earlier efforts by African countries to implement spatial data infrastructure, in which attempts were made to copy or adopt something similar to the INSPIRE initiative. The output and product-based approach focuses on ensuring the timely and cost-effective delivery of all five components of spatial data infrastructure with their affiliated variables as an outcome of implementation in a country.

The purpose of the Guidelines is to assist country-level implementation, taking into account the specific situation in individual African countries. Although much effort has been made to make the Guidelines prescriptive rather than descriptive, they nonetheless need to be customized to the specific conditions in each country.

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