

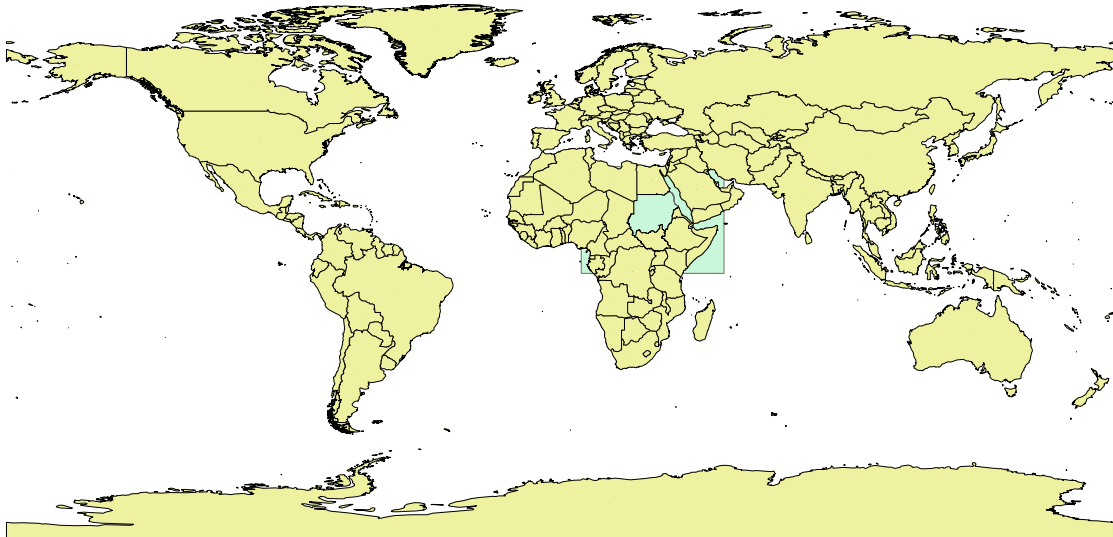


# Sudan Country Report -2022

Implementation Status of Sudan National Geospatial Information System

For

Committee of Experts on Global Geospatial Information Management



**UNGGIM 12 - 2022**



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### Implementation Status of Sudan National Geospatial Information System

#### 1. Introduction

Sudan Survey Authority (SSA) is pleased to inform the Committee of Experts on Global Geospatial Information Management (GGIM), about Sudan geospatial status, and that SSA has started to implement Sudan National Basemap System (SNBS) for Federal and State government entities. SSA is a renowned, and most reputed surveying, National Mapping and Geospatial authority in Sudan. The SSA has specialist experienced in the fields of geodetics, photogrammetric, remote sensing, GIS, mapping, ITC and local understanding of the Sudan geospatial requirements. SSA has been working in Sudan for more than 100 years, currently providing mapping and surveying services for the entire country. In recent years, SSA has been directed by the Sudan Transitional government in 2021, to provide Geospatial Services to all government entities in Sudan. SSA with its mandate as Sudan official geospatial development and management entity, has established strong and successful relationships with multiple of agencies and entities throughout Sudan and looking forward for the coordination with UNGGIM regional committees.

The SNBS has been logically, conceptually and physically modelled, designed and represented since 2020. Now SNBS is at the Implementation Stage in the National basemap Center at SSA premises. The SNBS shall be integrated with existing GIS and geospatial systems of Sudan various government entities, to form in the future the national integrated Geospatial frame to be in line and complying with UNGIM resolutions and requirements. Here we would like to confirm that, SSA will take the role of the prime SNBS implementer with the corporation of all its strategic Stakeholders at the federals and states government levels. Additionally, SSA is very proud of its relationship and support of the state's governments departments of Surveying and the four academic Surveying Engineering departments in Sudan.

The SSA will utilise its pre-existing resources to deliver collective benefits realisation based upon collaborative development in the country. Not only SSA will develop state-of-the art technical solutions, but will also implement them by building effective partnerships and encouraging positive collaborations that will ensure that geospatial standardisation, and all associated operational recommendations, are taken up willingly at all levels of government across the Sudan.

Concurrently, with the implementation of SNBS, SSA planned to establish in the near future, the Sudan geodetic network, to develop Sudan gravimetric geoid model and the scenarios of GNSS CORS network, which shall form the main part of the critical national GGRF infrastructure of the Sudan.

SSA is acknowledged as a national mapping agency and is recognised for its technical leadership and competence in all aspects of surveying and mapping. Many directors and senior staff in the field of geomatics maintain an international profile and influence geospatial policy and standards to be in line with UN-GGIM, and the Open Geospatial Consortium (OGC). This significant step by the government of adopting the SNBS to be at the forefront of geospatial development in the country,



has provided an opportunity for SSA to use their skill and Sudan expertise in the country and abroad to drive a collective and unified approach to promoting interoperability for the geospatial industry, and be capable to start coordinating with the UNGGIM and its regional committees. Other primary objective of this report is to confirm the creation of an enhanced data management system that improved the level of support for the activities in SSA and stakeholders entities by providing solutions that enable the effective and efficient collection, editing, storing and delivery of geospatial data in the country. The benefits of integration, increased efficiency and greater accuracy will translate into reduced costs and efforts for executing SSA and the Sudan geospatial community activities and hence better value for all geospatial users in Sudan.

After a thorough investigation, SSA has outlined the requirements of its IT system and components and any required upgrades and additions to the IT infrastructure for the delivery of the geospatial data, management system to an acceptable level of confidentiality, availability and performance. SSA undertook a needs assessment to capture requirements for its department's business processes. This study included, products and services required to be made available with work flow design, functionality definition and prototyping for each. It is recognised that this report will be influenced by the Sudan basemap and geospatial data creation, in addition to emphasize the consideration and limitation of the following:

- (1) International collaborations related to hardware, Servers and end-user licenses, and security.
- (2) Networks and Telecommunications: Local Area Network
- (3) Internet and web addressing
- (4) Observations on the Current Infrastructure and data volumes.
- (5) Database architecture, merging and database solutions.
- (6) Application Development, that relates to enabling the business processes to be modelled through the development of custom software applications for the benefit of all users.
- (7) Overall SSA shall concentrate on QGIS and in house developed open source modules, also SSA will indicate the operating System licensing implications of the proposed system.

For sustainable implementation, SSA shall apply a quality systems and approach with its stakeholders to include testing, formal system and user acceptance testing. Then SSA shall train identified trainers and ensure competent users are trained to support the system at a departmental level with sufficient supervision at all stages of the implementation to ensure full recognition of the new SNBS system. Post implementation support shall be planned and offered in a structured and logical manner.

To have a clear picture about SNBS implementation, its success and related problems in Sudan, a project for the implementation of SNBS in SSA is considered for demonstrating possible applications of SNBS. SSA technical staff highlighted most of the implications on SNBS implementation and focuses in the main factors that characterizing the SSA local conditions. The technical staff will also illustrate and prepare some guidelines for policies and strategies and give recommendations for SNBS implementation at Sudan Federal and State government levels.

## 1.1 Terminology

Technical term/ abbreviation	Description
CORS	Continually Operating Reference Stations
SNBS	Sudan National Basemap System
SSA	Sudan Survey Authority
FIG	International Federation of Surveyors
GCoE	SNBS Center of Excellence
GGRF	Global Geodetic Reference Frame
GIS	Geographic Information Systems
GMA	Geospatial Maturity Assessment
GNSS	Global Navigation Satellite Systems
IAG	International Associated of Geodesy
IGIF	Integrated Geospatial Information Framework
UN GGRF	United national global Geodetic Reference Frame
ITRF	International Terrestrial Reference Frame
NGRF	National Geodetic Reference Frame
<b>AFREF</b>	African Reference Frame
NSDI	National Spatial Data Infrastructure
OGC	Open Geospatial Consortium
UNGGIM	United Nations initiative on Global Geospatial Information Management
WP	Work Plan



## **1. SUDAN Survey Authority**

SUDAN Survey Authority (SSA) is the national surveying and mapping authority for Sudan, it is a national leading geospatial data and professional geomatics organisation. SSA is responsible for maintaining the master map – the nation’s fundamental geospatial reference base for the Sudan government. The general-public, and businesses are to be relied on Sudan Survey Authority as a legal and regulatory body for accurate and up-to-date geospatial information in the years to come.

Currently Sudan Survey Authority has started to set the standards for data capture, data management and planning for innovative services, shaping the geospatial industry and focusing to help Sudan government to become one of a leading digital nation in the region. The core business is focused on the SNBS implementation together with the collection, creation, maintenance, management and supply of geographic information designed to meet the needs of all aspects of national infrastructure requirements. SSA creates and maintains the definitive geographic database for Sudan from which its geospatial products, services and solutions are to be derived.

The Sudan Survey Act illustrated that, Sudan Survey Authority being responsible for the creation of geodetic network, aerial photography, processing and mapping, and planning for the design of national CORS network which can form a part of the critical national infrastructure of the Sudan, as well to be part of the existing unified African Reference frame (AFREF). SSA recognized and believes that location and geospatial data is integral to every nation’s economy and infrastructure, that, it enables efficiencies in the commercial sector and improves end-to end services in retail and finance, property, energy and utilities, aiming that all customers are to rely on high-quality geospatial data to support sustainable development. The UNGGIM and UNGGRF directives are considered at the level of development, taking consideration about location and place connects governments, businesses and individuals to their physical environment, effective government and data driven policy making, National and federal economic growth, safe, secure and sustainable local communities, efficiencies throughout government organizations, infrastructure development, the protection of assets and resources, citizen engagement, at last for improving quality of life.

## **3. Sudan National Basemap System**

### **3.1 General:**

One of the primary objective of this report is to highlight the project for creating an enhanced data management system that will improve the level of support for the activities of Sudan geospatial community, by providing solutions that enable the effective and efficient collection, editing, storing and delivery of geospatial data. The benefits of increased efficiency and greater accuracy will translate into reduced costs and efforts for executing SSA activities and hence better value for its users.



### 3.2 SNBS functionalities and Operations

SSA will be able to support all operational mandates by providing support to the fundamental operations and functions of its departments and its stakeholders. Expectations were determined during the identification of the system design requirements. Defining the realistic expectations of critical factors for ensuring that in future SSA will continue to achieve better operational capabilities and sustain the originally designed and updated programs. The implementation of operational programs can be greatly enhanced by utilizing technologies that are recognized as industry standards. These "mainstream" technologies can assist in reducing the costs of implementation, provide for alternative application development strategies, be hardware independent, and reduce training costs. Cost effective solutions for the implementation of SNBS programs, and their future integration with other existing Information System programs such as those implemented by Sudan government entities, is considered for becoming part of the mainstream market.

### 3.3 FINAL VIEWS

SNBS provides the logistical tools to become a mandatory SSA information service. The question in the future is how to best integrate the SSA stakeholders systems into their environments in a reasonable manner require full implementation of GGRF requirements. The effectiveness of the integration of the systems will be directly tied to the individuals that will be responsible for the implementation of the programs. Because of the many non-technical factors that also influence the program's success, the SSA Consultants will be tasked with a heavy effort in meeting all the expectations, building consensus within the organization, managing the workloads that result, and remaining open minded to other influences that may impact the implementation of SNBS.

## 4. Previous SNBS Major Activities for System Design and Future Operations

The previous main SNBS project activities and deliverables can be summarized as below, in which the six Activities have been sub-divided into sub-tasks or working packages as follows:

ACTIVITIES	Scope of Work
ACTIVITY 1	Conduct and arrangement of series of meetings with SSA stakeholders to introduce SNBS
ACTIVITY 2	Formation of SNBS Working Groups:- to support the project with the information and input from several key stakeholders
ACTIVITY 3	Conduct Existing Situation Assessment in close cooperation with SSA stakeholders and Sudan geospatial community members.
ACTIVITY 4	Conduct Requirements Analysis and outline options with full consideration of UNGGIM program and international best practices
ACTIVITY 5	SNBS Program Design, considering results of the previous activities for the comprehensive design for the SNBS Program, to include the interrelated components given by UNGGIM.
ACTIVITY 6	Implementation Plan and Operational Model



## 5.0 Factors Affecting SNBS Implementation

### 5.1 Overview

The conditions of SSA in relation to the implementation and development of GIS shall be assessed by examining the factors which shall be identified including major factors that affect the implementation of the geospatial technology in organisations. These are: (1) Organisational characteristics, (2) current activities and potential GIS applications, (3) data availability and quality, (4) human resources, (5) financial resources, (6) geospatial support.

### 5.2 Current Activities and Potential SNBS Applications

Investigation of the current activities resulted in understanding the SSA needs for geospatial information, how geographic data are acquired, what information they share, and what problems were and are encountered in these processes. A matrix, showing the functions of the departments and the data needs to fulfil these functions, will be developed by the project team to help identify the common data. By matching the departments' functions with capabilities that the GIS technology offers, potential GIS applications will emerge.

From the functions and activities of SSA and its Departments and their related agencies, along with their needs for geographic information, and the way these geographic data are used in the processes, the Project team will identify the potential geospatial applications in SSA. Owing to the expected diverse activities and will classify these potential geospatial applications into categories. As it is clear from this report, there is a very urgent need for various specialised geospatial applications to cover all the needs, which vary from one department to another depending on the nature of work in these departments. Despite these diverse applications, some geographic data are needed by most if not all which makes data sharing and updating very crucial in reducing implementation cost, as data acquisition often constitutes a considerable portion of the SNBS implementation project budget. Data sharing and transactional data updates, requires co-ordination and co-operation among the departments plus the prescription of some data format and accuracy standards.



### 5.3 Data Availability and Quality

As well known, the data availability, compatibility, and reliability is only meaningful in terms of pre-defined tasks, especially tasks that could be translated into SNBS applications. Various activities normally require different types of data, levels of detail, and different tolerances for data inaccuracy. Data availability and quality are considered to be critical in efforts for SNBS database development, which considered to be one of the most time-consuming processes in GIS implementation. The problems associated with data availability, again, call for geographic data type and quality needs assessment for all government departments as well as full co-ordination and co-operation among these departments.

### 6.0 Implications of the Findings on SNBS Implementation

The successful implementation of geographic information in SNBS system is a function of management and institutional capabilities rather than of technology, SSA higher authorities are needed to play active roles in:

- (1) Supporting and improving capabilities for evaluating their SNBS needs (e.g., through training, workshops, advisory and consultancy projects);
- (1) Encouraging and strengthening communication and co-ordination among, strategic stakeholders, data producers and data users.
- (2) Providing a framework for data standards and data sharing among various departments.
- (3) Geospatial expertise will help SSA in developing data standards, specifications and guidelines;
- (4) Supporting the provision of basic geospatial data (e.g., geo-referenced, satellite imagery).

Successful SNBS implementation, therefore, includes successfully dealing with characteristics of organisational culture, the dynamics of people interacting in teams, change processes, and the impacts of introducing new technology. The primary goals of SNBS implementation are to make information readily available to decision makers, geospatial producers and users and to provide tools to facilitate integrated management and analysis of the data.





## 7.0 Management of the SNBS project;

### 7.1 General

Geospatial advisors with good understanding of GIS projects shall be placed to assess SNBS implementation progress and make sure that it is following the path intended. This is very essential not only from the standpoint of monitoring progress, but also to ensure that there is continued commitment to the project as conceived. The project managers will therefore take the time to develop an adequate understanding of project objectives, plans, and budgets to assess the project progress effectively.

The SSA Project manager's responsibilities involve all aspects of the business including personnel, finances, and ensuring profitability or the mandated equivalent in the organisation. Successful geospatial implementation, also requires dedicated attention to some details, which calls for a special project management with systems analysis skills. However, SSA committed that, there will be a continuous need to have management-level staff to plan and schedule SNBS-related activities, and to manage technical and other details associated with SNBS implementation. This means that during implementation, there will be two key responsibility areas that must be satisfied: SNBS administrative management and SNBS technical management. SNBS administrative management involves budget planning, human resources management, and alignment of SNBS activities with other business activities of the organisation. SNBS Administrative manager should possess a conceptual understanding of geospatial principles and technology, and have knowledge of the organisation's functions to be supported by the GIS, goals and policies in addition to the administrative management experience.

SNBS technical management involves successful construction of applications and implementation of necessary components of the system. The Project technical staff will be geomatics experts and possess a broad range of skills including understanding of surveying and mapping, thematic data acquisition, administrative management, information system planning and design, design methodologies and tools, personnel management, and GIS modelling.

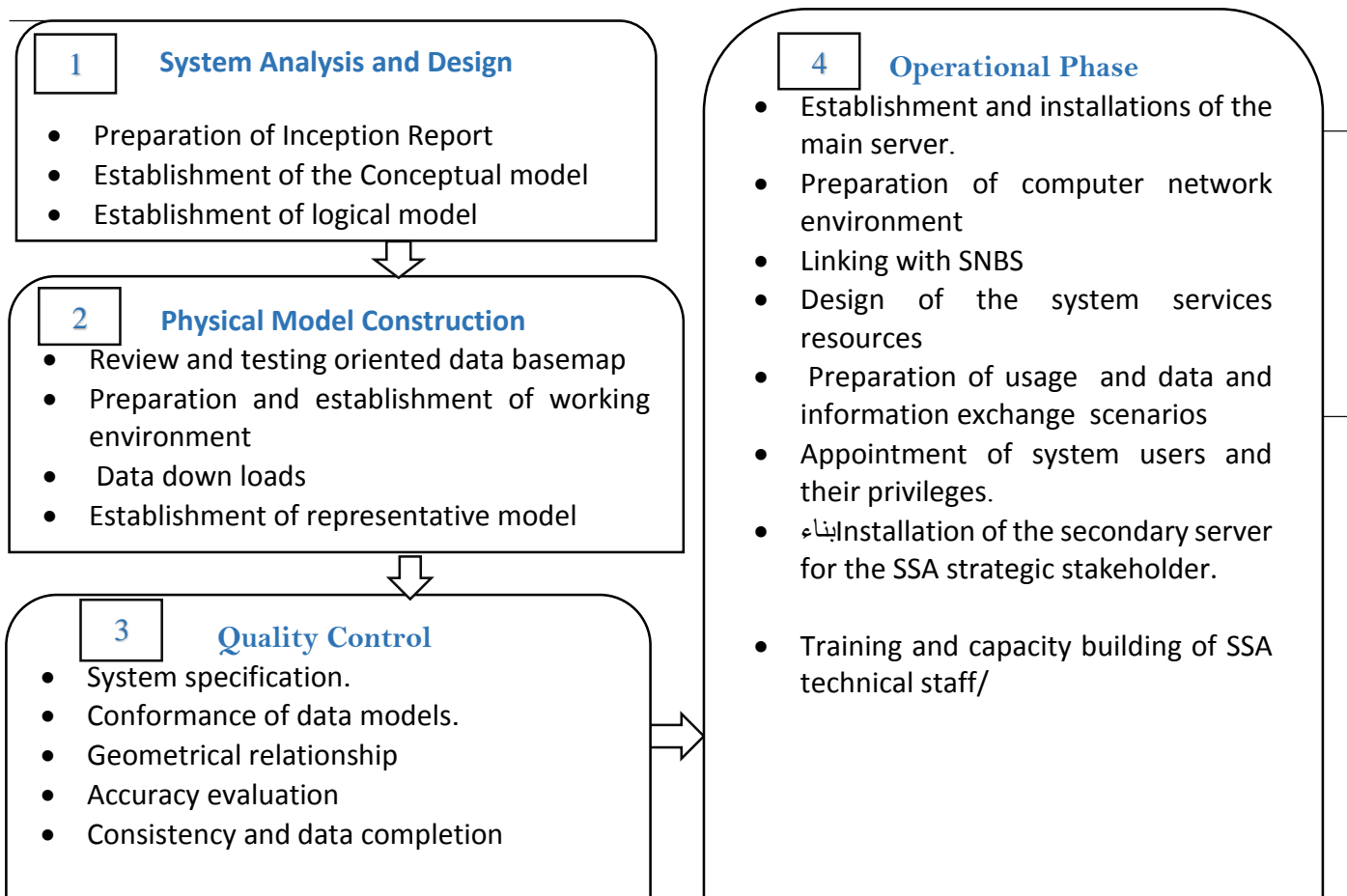


## 7.2 Establishment of SNBS Centre

A Center for SNBS to act as the focus for SNBS activities within SSA should be established. The mission of this Center should be the service and co-ordination of a systematic implementation of SNBS, which will simplify data transfer between all departments and related agencies, minimize data redundancy, and ensure availability of suitably trained personnel to operate and manage the various components of the SNBS system. This will be followed with the preparation of Specifications, Policies and Standards such as:

- (a) Data Standards
- (b) Network Standards
- (c) Application Standards
- (d) SNBS Implementation Policies**

The general structure of the SNBS plan is as below:





### 7.3 Recommendations

From the above and with the understanding of SNBS implementation requirements, SSA draws the following recommendations:

- (a) The SNBS functions and the geospatial data requirements should be identified for SSA and all its Departments. A need assessment should be carried out associating potential SNBS users and conducting inventory surveys for the functions and workflow.
- (a) Data model that defines the SNBS database and supports the detailed planning and design should be created. This will include the required data sets, inclusion of the data in the data model, creation of Metadata, collection and entry of data, updating, maintenance and retention.
- (b) Detailed database planning and design based on the data model should be developed. The potential data sources should be evaluated, and the cost of building SNBS database is to be estimated, and the data conversion plan is to be determined. Investigations to determine the size of hardware equipment's should be conducted and staff and user training programmes must be accomplished. Quality assurance and quality control procedures should be established.
- (c) System of SNBS integration is to be created and tested

## 8.0 SNBS Implementation Terms

### 8.1 General

Sudan Survey Authority (SSA) is established with the Sudan Survey Act mandates of being a prime Sudan government Consultant for geomatics and geospatial activities related. Based on this, SSA submitted this technical report for the preparation and execution of SNBS project in SSA according to the directives, objectives and technical procedures outlined in the previous sections.

The implementation of SNBS in this project is important to guide the Sudan government efforts for sustainable development in terms of the provision of electronic services related to geospatial infrastructure and its usages in the country, associated with the processes of data sharing, data exchange and geospatial data integration. SSA willingly, targeting to full all the requirements given here in this report with full confidence in the project team technical expertise, experts, specialists and professional staff and getting use of SSA surveying and mapping experiences extended for more than a century.



The Sudan Survey Authority (SSA) constituted from the following Departments, which are responsible for all geomatics activities and implementation and operation of SNBS in the Federal and State levels. The SSA targeted Departments in this project are:

1. Sudan National Basemap Center (SNBC)
2. Photogrammetry and remote sensing.
3. Geodesy and Land Surveying
4. Geographical Information System
5. Sudan Survey work Regulation

SNBS Implementation Terms and Scope of Work are:

#### **First Stage**

- a. Review SNBS previous work including designs, data models and system frame.
- b. Establishment of the SNBS center
- c. SNBS installation and operation in the Center and SSA Departments
- d. Training and capacity buildings for the system managers and operating staff
- e. Situation assessment study to the existing geospatial data in SSA and its Departments.
- f. SSA needs assessment with the consideration of international best practices.
- g. Documents preparation for all SSA geospatial standards, specifications, SNBS targeted data and the Departments conditions for geospatial data security and disseminations.

#### **Second Stage:**

- a. Preparation of SSA Department Data models
- b. Preparation of SSA Department Databases and layers.
- c. Establishment and operating SSA system in all its Departments.
- d. Business process reengineering for SSA departments.
- e. Advanced training and capacity building for SSA staff.

#### **Third Stage:**

This stage aims preparing guidelines and maintaining technical assurance and quality control for the established SNBS based on the application of:

- a. Geospatial data standards and specifications.
- b. Data model conformance
- c. System development guidelines.

#### **Fourth Stage:**

- a. Establishment of the system operating environment and installation of the primary server and the network infrastructure and the connectivity with SSA Departments.
- b. Preparation of user cases specifications in accordance with the policies adopted.
- c. Preparation of SSA structure and SSA business processes, roles and responsibilities.



## 8.2 Technical processes for SNBS Implementation

This technical report is prepared in accordance with the required work load for executing this project and to attain the given objectives. These can be summarized as follows:

1. Project work basic directives
2. Project work Plan
3. Project final products and deliverables
4. Timeline of project activities execution
5. Project technical and management staff
6. Technical support and Quality control, on job and educational training.
7. Communication Plan
8. Hardware, software and System Specification
9. Project execution cost

## 8.3 SNBS Implementation Directives

In accordance with the Sudan Council of Ministers approval for SNBS implementation and the unlimited support given by the Ministry of Finance and its endorsement for the necessity of good preparation and excellent design, execution and SNBS implementations at Federal and State levels in Sudan,

SSA acknowledge the importance of SNBS project, its scope of work and services as well as the big financial challenges facing the project in the preparation stage and during SNBS implementation and operation, and the long term sustainability of geospatial provision and updates in Sudan. Based on this, SSA and the project team shall depend on the following main directives throughout the project execution:

1. SSA Scope of work basic directives
2. SSA work's objectives and deterministic.
3. SSA survey act and the regulations governing SSA works
4. SSA works requirements and specifications
5. SSA departments' nature of work and the relevant originations participating in updating geospatial data and information for the SNBS.
6. Basic objectives of SNBS to meet national and international requirement.
7. The previous and required technical efforts.
8. Extracted user cases from which the scenarios and policies shall be built in the conceptual model and for completing the attributes in the physical model.
9. The group of data and concepts extracted from the conceptual model in the previous SNBS stages and in this project at the analysis stage.
10. The data structure design during the preparation of the logical model.
11. SSA decision maker's requirements and the end users as given in the early stages.
12. The requirements and basics specifications for SSA GIS and digital maps.
13. Technical risks and project time duration
14. Consideration of existing national, regional and international experiences.



#### 8.4 SSA Main Stakeholders and Partners

SSA stakeholders include Sudan geospatial community, all federal and local governments' entities, private and public sectors organizations. SSA has met and coordinated with the following entities for the implementation of the Sudan National Basemap. SSA has already signed memorandum of understanding with all States ministries of infrastructures and urban development and Federal ministries.

No.	Government Federal Entities		Government States Entities
1	Ministry of Defense	16	Khartoum State Ministries of Planning and Infrastructure
2	Ministry of Finance and Economic Planning	17	White Nile State Ministries and Localities
3	Ministry of Interior: * Buildings Security * Custom Department	18	Blue Nile Region and States
4	Ministry of Justice	19	Darfur Region and States
5	Ministry of Mining *Geological Research Authority	20	Al Jazeera State
6	Ministry of Council of Ministers	21	Northern State
7	Ministry of Irrigation	22	North Kordofan State
8	Ministry of Higher Education	23	West Kordofan State
9	Ministry of Transportation	24	South Kordofan State
10	Ministry of Health	25	Sinnar State
11	Ministry of Energy *Oil Information Center	26	Nile River State
12	Civil Aviation Authority	27	Al Gadarif State
13	National Information Center	28	Kassala State
14	National Statistics Authority	29	Red Sea State
15	General Intelligence Authority	30	Electric Distribution Company



## 9. SNBS Associated Strategic Projects:

### Projects for the Unification of Sudan Geospatial Reference System to comply with UNGGRF

#### **Project.1: Establishment of Sudan Geodetic Control Network**

- 1 List and review the existing entities geodetic networks and their ground control points locations
- 2 Sudan Geodetic Network Design and Selection of the location of geodetic Control Points
- 3 Monumentation of Geodetic Control Stations
- 4 Field Survey Observation, data processing and quality assurance
- 5 Adjustment of Sudan Geodetic Control Network
- 6 Establishment of one International/regional Station

#### **Project.2: Extension and Densification of Sudan Vertical Control Network**

- 1 Selection of Benchmarks locations, Design of levelling loops and Benchmarks monumentation.
- 2 Levelling and processing and adjustment of the levelling network

#### **Project.3: Determination of Sudan Gravimetric Geoid Model**

- 1 Sudan gravimetric Network Design
- 2 Gravity observations, processing and gravity reductions
- 3 Gravimetric Geoid Computation
- 4 Gravimetric Geoid fitting

#### **Project.4: establishment of Sudan Vertical Datum**

- 1 Selection of tide gauges locations in the Red sea
- 2 Tide measurements at the selected gauge points
- 3 Establishment of Sudan Vertical datum
- 4 Connecting Sudan Benchmarks with the Sudan Vertical datum point