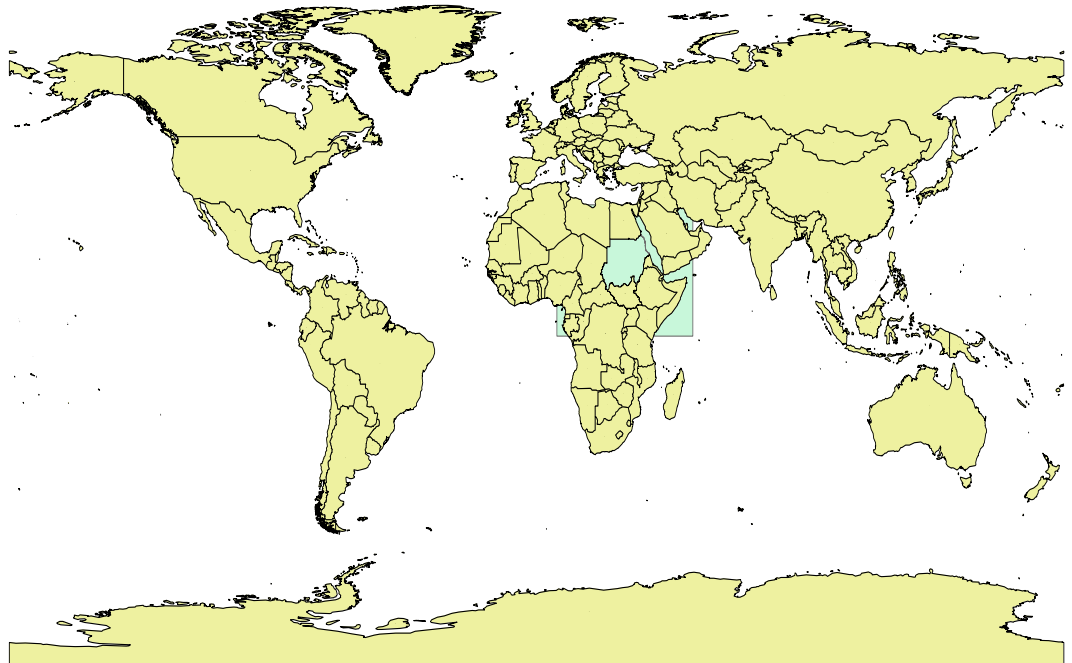




Sudan
Survey
Authority
(SSA)

UNGGIM-14 Sudan Country Report -2024 On the Implementation Status of the UNGGIM-National Geospatial Information Management

**Fourteenth Session of the UN Committee of Experts on Global Geospatial
Information Management (UN-GGIM), New York, 7 - 9 August 2024**



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1. Introduction

Sudan Survey Authority (SSA) is the focal geospatial coordinating agency in Sudan, for implementing UNGGIM geospatial Information management activities at the national level. As stated in our previous Sudan country reports [4] [10], SSA succeeded in encouraging its geospatial information partners from the Sudan federal and state governments and fully cooperated with its regional partners IGAD [10] and UGGM-Africa [14] and UGGM-Arabia to seek ways to implement the UNGGIM related strategy and initiatives and to be part of the effective implementers of the UNGGIM frames, UNGGRF and IGIF. Sudan understood the importance of the UNGGIM initiative to serve the global unification of reference frames, geospatial information integration, and the provision of geospatial information for the targeted United Nations Sustainable Development Goals [6]. Here the Sudan stakeholders started to empower the geospatial information for sustainable national developments in their respective areas of specialization. In this regard the SSA, started with the creation of geospatial technical working groups in the various sectors, followed by planning for projects to implement the UGGIM global frames related to the national Global Geodetic Reference Frame (NGGRF) [8], and National Integrated Geospatial Information Frame (NIGIF) [9]. The Sudan Survey Authority has developed and approved the Sudan National Basemap System (SNBS) for federal and state government entities. The SNBS is currently in the Implementation Stage. The authority has planned and designed the establishment of the Sudan National Basemap Center within its premises, connecting units such as Photogrammetry and satellite imagery, geodetic, GIS, and mapping departments. These are considered the main geospatial data providers, responsible for geospatial data updating and quality control in line with national SDI and SDG initiatives. In the future, the Sudan National Bureau of Statistics (SNBS) information, will be integrated with various entities, existing GIS, and geospatial systems in Sudan to create a national integrated geospatial framework. This framework will align UNGIM resolutions, guidelines, and strategies [5]. The Sudan Survey Authority will be responsible for implementing the SNBS, with the cooperation of all its strategic stakeholders and partners in Sudan and the region.

The Sudan acknowledges the achievements and efforts made by the Committee of Experts in the area, of global geospatial information management [13]. The committee has contributed significantly to strengthening geospatial information management capacities and utilization in developing countries, particularly, the achievement of, its sustainable development goals. The Sudan Survey Authority (SSA) has been functioning as a government surveying entity in Sudan for over 100 years. Currently, it provides

geospatial information, mapping, and surveying services for the entire country and, since 2020, it has been directed by the Sudan Transitional government to provide Geospatial Services to all government entities in Sudan. As Sudan's official Geospatial implementer, SSA has successfully built strong relationships with multiple government sector agencies in Sudan. Its goal is to maintain long-lasting connections with public, and private sector entities, and academia at national, regional, and global levels [10].

One of the promising steps forward for the implementation of the UGGIM global frames is that our nationally renowned expert staff are well aware of their role in implementing the SNBS to establish the Sudan geodetic network, develop the Sudan geoid model, and establish the States CORS networks which will form the critical national infrastructure of the Sudan for geospatial information provision.

2. Sudan Survey Authority

The Sudan Survey Authority (SSA) is the official surveying and mapping authority for Sudan, it is responsible for maintaining the nation's fundamental geospatial reference base. Since 1898, the Sudan government, the general public, and businesses have relied on the SSA for accurate and up-to-date geospatial information. In recent years the SSA has formed strategic partnerships with federal ministries to utilize Geospatial Information to provide effective government services and encourage sustainable investment in Sudan. The objective is to enhance geospatial information systems services by employing approved technologies and applications. The SSA collaborates with the Sudan geospatial community to ensure the country's geospatial standing is in line, with the United Nations Global Geospatial Information Management (UNGIM) Initiative. The SSA provides geomatics information to stakeholders, with the Sudan National digital basemap serving as the base for all geospatial information provided to the Ministries and their partners from the public government and private sectors.

To support geospatial data collection and management, the SSA emphasizes using unified and accurate geodetic references and integrated geospatial information frameworks [2]. This is crucial for data sharing, integration, and exchange. Collaboration with Sudan Federal Departments and state governments Spatial Data Infrastructure (SDI) [7, 11] is essential to facilitate the availability and access of geospatial data [11, 12] at all levels of government, the private sector, and academic organizations.

Here it could be confirmed that the SSA leverages modern geospatial technologies, including GNSS, Geographic Information Systems (GIS), aerial bone photogrammetry, UAV, and remote sensing satellite imagery, to collect, process, analyze, and visualize geospatial data. These technologies enable informed decision-making based on accurate, real-time information, minimizing risks and maximizing benefits in government processes. In summary, the role of the Sudan Survey Authority includes organizing survey work activities, unifying datums and reference systems, establishing geodetic control networks, supervising geomatics activities, addressing technical issues related to boundaries, developing standards, and collaborating with regional and global surveying and geospatial organizations.

3. Sudan Council of Ministers Directives

The Sudan Council of Ministers, approval the SNBS and given unlimited support by the Ministry of Finance and their endorsement for the necessity of good preparation and excellent design, execution, and SNBS implementations at Federal and State levels in Sudan> The Sudan Council of Ministers acknowledge the importance of SNBS implementation, with the provision of geospatial services, as well as the consideration of the big challenges that may face the implementation processes. Based on this, SSA team depends on the following main directives for 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. Meeting national and international requirements such as UNGGIM regulations.
7. The previous and required technical efforts.
8. Inception, Conceptual, logical, and physical data models, Figure 3.
9. Extracted User cases with the scenarios and policies required to be built in the conceptual model and for completing the attributes in the physical model.
10. The group of data and concepts extracted from the conceptual model in the previous SNBS stages and in this project at the analysis stage.
11. The data structure design during the preparation of the logical model.
12. SSA decision makers and the end users' requirements.
13. The requirements and basic specifications for the SSA GIS and digital maps.
14. Technical risks and project time duration
15. Consideration of previous national, regional, and international experiences.



Figure 1: shows the basic directives of Sudan Basemap

3.1 UN-GGIM- Sudan Main National Stakeholders and Partners

The SSA stakeholders include all federal and local government entities, private and public sector organizations, and the Sudan geospatial community. SSA has met and coordinated with the following entities to implement the Sudan National Basemap. For this purpose, has signed a memorandum of understanding with all state ministries of infrastructure and some federal ministries.

Table 1: shows SSA's Main Stakeholders

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

3.2 Strategic Projects for the Implementation of UNGGIM-GGRF:

P1-Sudan Geodetic Network: The primary objective of this project is to establish the Sudan Geodetic Network [8] to obtain the geodetic coordinates and ellipsoidal heights as well as the UTM projected coordinates of first-order ground control points, using geodetic GPS receivers for the observation of about 800 points. If required the mean sea level heights for all points can be automatically derived from ellipsoidal heights using and enhancing the available global models or local geometrical geoid.

The significant features of this project are:

- Determination of the Cartesian, X, Y, Z, and geographic coordinate's latitude, longitude, and ellipsoidal heights.

- Transforming and ensuring that all provided data will be given in ITRF2008.0, with consistent Geographic and UTM coordinates transformation from ITRF2008.0 to other ITRF epochs.
- The mean sea level heights will be given for all geodetic control points based on geometrical and global geoid models.

The Sudan Reference System can be considered as the official unified geodetic and geospatial reference system [8], which shall be a common reference for all geospatial data, Geomatics, and GIS applications and provides key elements for integration and sharing of spatial data and thematic information. The unification and implementation of the Sudan reference system will lead to:

- * Better accuracy in connection with national and regional datums;
- * Removal of systematic regional biases in gravity anomaly data;
- * Enhancing the homogeneity of surveying and map data,
- * Converting national and regional coordinates and data sets to global reference systems.

Project.1: Establishment of Sudan Geodetic Control Network

- 1 List and review the existing entities' geodetic networks and their ground control point locations
- 2 Geodetic Network Design and Selection of the location of geodetic Control Points
- 3 Monumentation of Geodetic Control Stations
Field Survey Observation, data processing, and quality assurance
- 4 Adjustment of Sudan Geodetic Control Network

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

- 1 Densification of the Sudan Vertical Datum, connecting the existing benchmarks with the newly established points.
- 2 Design and Selection of the vertical geodetic Control Points for densification.
- 3 Monumentation of Vertical Benchmarks Control Stations
- 4 Field Survey Observation, data processing, and quality assurance
- 5 Adjustment of Sudan Geodetic Control Network

P3-Determination Approach of the Sudan National Gravimetric Geoid Model

The Geoid Model is mainly used to determine the orthometric height in surveying, mapping, geospatial data infrastructure, and in the industry for public and private sectors to generate and transmit the vertical corrections for the RTK measurements for planning, land reclamation, development, and construction, oil prospection, etc. Such wide use of the data puts special requirements on the data quality and reliability of the geoid model results. To ensure the quality and high reliability of the geoid model, extensive measurements, testing and validation of the geoid model should be implemented.

The development of the Sudan National Gravimetric Geoid Model (SNGGM) [15]; requires absolute and relative gravity measurements, GNSS grid observations for existing and

newly established benchmarks, and Geodetic Control Points (GCPs). As well as the acquisition and analysis of existing local and global gravity data that is needed for geoid model computations and fitting processes incorporating gravity, leveling, GNSS, and DTM data. The final validation of the computed Geoid Model will be done using the ground truth data, and independent ground control points will be used for the quality check of the derived Geoid model [15].

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

The execution cost of these three projects is agreed to be financed, half of the cost by the Ministry of Finance, hoping the rest of the funds from UNGGIM and international support.

4. Sudan National Basemap System

One of the primary objectives of SNBS is to implement an enhanced information management system that will dramatically improve the level of support for the activities in the SSA and the Sudan geospatial community, by providing solutions that enable the effective and efficient collection, editing, storing, and delivery of geospatial data and information [9].

After a thorough investigation, SSA has planned and outlined the requirements of the spatial database components, Figure 2, the IT system and its components and any upgrades and additions to the current IT infrastructure as required for delivery of the geospatial information, management system to an acceptable level of confidentiality, availability, and performance. The SSA project team shall undertake and revise the previous needs assessment to capture requirements for SSA Departments and Units' business processes. It is recognized that this plan will be influenced by the base map and spatial data provision, in addition to the following:

- (1) Hardware, servers, end-user computers, and physical security.
- (2) Networks and Telecommunications: Local Area Networks and Internet addressing
- (3) Observations on the Current Infrastructure and data volumes.
- (4) Database: database architecture, merging, and database solutions.
- (5) Application Development: this relates to enabling the business processes to be modeled through the development of open-source [3] custom software applications.
- (6) Software Licensing: SSA will indicate the Operating System licensing implications of the planned system. In particular, an explanation shall be given of the requirements for Access Licenses resulting from system Implementation, stating versions and

preferred licensing model, with the description of the licensing structure to be purchased as part of the final system.

(7) For sustainable implementation SSA shall apply a quality control systems and approach to include testing, formal system and user acceptance testing.

(8) Then SSA Basemap centre team shall train identified trainers and ensure lead users are trained to support the system at a departmental level with sufficient supervision at all stages of the implementation.

(9) Post implementation support shall be planned and offered in a structured and logical manner. Propagation of the use of the new system will be a dedicated task and shall address this with a plan for how to involve the staff.

5. 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 working packages (WP) or activities have been sub-divided into sub-tasks as follows

Table 2: shows the Main SNBS project activities

No.	SNBS Working Packages (WPs)
	WP 1: Conduct Inception Meetings
1.1	Arrange a series of meetings with SSA stakeholders' teams to introduce SNBS, clarify any points about the project scope, review the project management approach, and agree on project communications and reporting conventions to be followed. During the inception sessions, mutual expectations regarding the project scope, schedule, and the specific roles and responsibilities of both SSA and stakeholder teams are addressed.
1.2	The topics addressed above and mutually agreed conclusions are to be documented in an "Inception Report" which has been reviewed and approved, see Figure 3.
	WP 2: Convene SNBS Working Group
2.1	SSA with the support of the strategic stakeholders convened the Sudan government to support the project with the information and input from several key stakeholders
2.2	Several existing geospatial systems in use by different organizations covering different geographic areas in Sudan are to be, addressed during the SNBS stakeholder assessment.
2.3	Initiating formal engagement with the UN GGIM program to benefit from its international experience and commence a formal engagement process.
2.4	SSA collaborates with stakeholders to identify the full range of potential contributors.
2.5	Preparation of a charter to be distributed to prospective members.
	WP 3: Conduct Existing Situation Assessment

3.1	The SSA Consultants have been responsible for conducting a thorough assessment of the existing situation related to geospatial matters in Sudan, i.e. working closely with SSA stakeholders and Sudan geospatial community members.
3.2	Information collected from each stakeholder was systematically consolidated into a draft writeup for each involved. Each write-up must undergo review and approval by relevant entities before consolidating the information into the draft SNBS Program Situation Assessment Report.
3.3	SSA will submit the draft “SNBS Program Situation Assessment Report” to the Stakeholders for review and comment. Feedback from stakeholders will be incorporated into the final draft of the report by the SSA project. The SSA will consider alignment with the UN GGIM program and international best practices.
WP 4: Conduct Requirements Analysis and Outline Options	
4.1	Upon further analysis of the information collected from previous activities, a comparison of the existing situation with the UN GGIM program and international best practices, to outline all the essential requirements needed to establish a modern, accurate, sustainable, and accessible SNBS.
4.2	A key component of the requirements analysis It's important to comprehend the specifications for geospatial infrastructure. This includes instruments, technology, data, data repositories, analysis, human resources, products, and services needed to address the socio-economic, and environmental impact questions in Sudan. The requirements analysis has addressed all the components outlined in WP 5 for preparing the Sudan National Basemap System Program Design. It also outlines all the components and issues being addressed in the Program Design.
4.3	The SSA consultants prepared and submitted the first draft of the SNBS Requirements Analysis report, then presented it to the stakeholders in various workshops over the past few years. The next step will be to prepare a final draft of the requirements analysis report.
WP 5: Preparation of SNBS Program Design	
5.1	SSA Consultants used the results of the previous work package activities for the preparation of a comprehensive design for the SNBS Program, to include the interrelated components given by SSA.
5.2	SSA Consultants described in detail their approach for defining each of the components and any other elements needed to accurately and completely describe all of the targets that will need to be in place for a modern, effectively functioning, and sustainable SNBS.
5.3	This activity shall define the form and function of the future SNBS Center of Excellence (SCoE) that is to be established, to support the initial development

	and ongoing maintenance of the SNBS. This will include both the Center itself as well as the formulation and the charter for a permanent SNBS Special Interest Group comprising representatives from all SSA key stakeholders to support the communications and coordination among the members.
5.4	The SSA project team shall support geospatial education, training, and capacity building within all the relevant stakeholder organizations. Facilitate communications and outreach among the SNBS stakeholders. Assist Sudan in identifying and/or refining its geospatial needs, and pathways to meet these needs in line with the National Spatial Data Infrastructure (NSDI), and continuously monitor for technological advances and innovations that can be applied to the SNBS.
5.5	The SSA team shall indicate its approach to the functional charter and organizational design for the SCoE, define its organization chart, and describe staff roles and responsibilities. The SSA team shall also describe its approach to the development of a functional charter for the Geospatial Special Interest Group and what content is to be included.
5.6	Policies, Standards, and Conventions The project Consultant will be responsible for identifying and defining the policy statements and standards that will be required to support the SNBS as a national program, as well as support its contribution to the regional and international levels. These statements and standards will be authored in a manner that can be added to the overall Sudan/NSDI policy and standards frameworks that are to be defined in the context of the future NSDI program design project, with special consideration to SSA's existing policies and standards.
5.7	Geospatial Infrastructure. The SSA project team will define detailed specifications for all elements of the integrated Sudan geospatial infrastructure. Knowing that the Existing Situation Assessment conducted in Activity 3 and the Requirements Analysis conducted in Activity 4 will guide the geospatial infrastructure needs to support the integrated Sudan SNBS.
5.8	Document the steps to developing and implementing a new National Sudan Reference System based on the most current realization of ITRF and in line with the African vision. The ITRF2008 reference system will be the future foundation of the Sudan NSDI and will need the systems, tools, and transformation methodologies to translate all of Sudan's spatial datasets to the new reference system. These processes also need to be specified in detail by the SSA project team.
5.9	Specifications of a National Geospatial Database based on internationally recognized data exchange formats, with provisions for storing and managing all geospatial records (historical and current) and data e.g. maps, geodetic mark information, geodetic observations, adjustments, coordinates, heights, geoids,

	datums and transformations, various entities layers and records, etc. Also, online tools to provide access to geospatial information required by industry.
5.10	SSA confirms his consideration of Education, Training, and Capacity Building, as required, to the SNBS program design and to include a training and capacity building component to ensure that the relevant federal and State-level stakeholders have the competency to effectively participate in the development, implementation, management, and maintenance of the SNBS. The Project team is also required to develop a high-level research and development program to support the science that underpins the SNBS and consider how Sudan can contribute to the GGIM in a meaningful way. This may include infrastructure for research as well as support for research institutions.
5.11	Communications and Outreach. The SSA project team shall design a communications and outreach program to ensure that the SNBS can be effectively communicated to the Sudan leadership, decision-makers, financiers, and all stakeholder entities. To this end, a Geospatial Strategy for the Sudan can be proposed based on the learnings from the Activities in this document.
5.12	SSA understands that the Business Model needs to consider avenues for funding the implementation of the SNBS Program as well as the ongoing operational costs without placing a huge direct financial burden on users that would in effect defeat the purpose of developing the SNBS. SSA will develop a Business Model that details the current and future operating environment, business model, and data policy that will support the implementation of the SNBS Program.
	WP 6: Prepare Implementation Plan and Operational Model
6.1	The SSA project team will define a detailed implementation plan, addressing the steps that need to be taken to implement all the components of the SNBS Program Design.
6.2	The implementation plan will be outlined below.

6. SNBS Implementation Terms

Sudan Survey Authority (SSA) is established with the mandate of being a prime Sudan government Consultant for geomatics and geospatial activities related. Based on this, SSA should submit technical proposals related to SNBS implementation, including, the preparation and establishment of an SNBS Center in SSA according to the directives, objectives, and technical procedures adopted.

The implementation of SNBS is important to guide the Sudan government's 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 for sustainable development goals.

The Sudan Survey Authority (SSA) is constituted of the following Departments, which are responsible for all geomatics works and implementation of SNBS at 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

6.1 SNBS Implementation Terms and Stages

First Stage

- a. Review SNBS's previous work such as data models and system frames, Figure 3.
- b. Establishment of the SNBS center, Figure 4.
- 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 Department's conditions for geospatial data security and dissemination.

Basic Components of Sudan National Base Map

Serial No.	Use Case	Partial No.	Theme	Coverage	Serial No.	Use Case	Partial No.	Theme	Coverage	Serial No.	Use Case	Partial No.	Theme	Coverage	Serial No.	Use Case	Partial No.	Theme	Coverage		
1	Administrative Boundary	1	International	Globe	36	Transportation	8	Water Stations		72	Transportation	36		Wad Madani	109	Energy	1	Railways			
2		2	Regional	Sudan Region	37		1	Highways	Country Territory	73		37		110	2		Bridges		2	Bridges	Country Territory
3		3	State		38		2	Tracks		74		38		111	3		Airports		3	Airports	
4		4	Districts		39		3	Town Roads	Khartoum	75		39		112	4		Runways (Airports)		4	Runways (Airports)	Country Territory
5		5	Administrative Units	Country Territory	40		4		Omdurman	76		40		113	1		Villages		1	Villages	Country Territory
6		6	Urban Areas		41		5		Bhri	77		41		114	1		Vegetation		1	Vegetation	
7	Elevation (Topographic & Relief)	1	Contour 10m	Country Territory	42	6	Jabel Awlia		78	42		115	2	Forests (Woodland)		2	Forests (Woodland)	Country Territory			
8		2		Khartoum	43	7	Tuti Island		79	43		116	1	Agricultural Projects		1	Agricultural Projects				
9		3		Dongola	44	8	Port Sudan		80	44		117	4	Agricultural Land		4	Agricultural Land				
10		4		Damir	45	9	Town Roads	Arkawit	81	45		118	5	Sandy Land		5	Sandy Land				
11		5		Port Sudan	46	10		Dongola	82	46		119	1	Geological Structures		1	Geological Structures				
12		6		Kassala	47	11		Ed Daba	83	47		120	2	Geological Era		2	Geological Era	Country Territory			
13		7		Qadiriif	48	12		El Gaba	84	48		121	3	Geological Era		3	Geological Era				
14		8		Wad Madani	49	13		El Goldi	85	49		122	4	Earthquakes		4	Earthquakes				
15		9		Sinnar	50	14		Korti	86	50		123	5	Volcanics		5	Volcanics				
16		10		Rabak	51	15		Wadi Halfa	87	51		124	1	Oil Concession Blocks		1	Oil Concession Blocks	Country Territory			
17	11		Damazeen	52	16		Marawet	88	52		125	2	Pipeline		2	Pipeline					
18	12		El Obeid	53	17		Korima	89	53		126	3	Refiners & Mines		3	Refiners & Mines	Country Territory				
19	13		El Foulia	54	18		Karma	90	54		127	1	Tourism Sites		1	Tourism Sites	Country Territory				
20	14		El Fashir	55	19		Abu Hamad	91	55		128	1	Sewers		1	Sewers	Khartoum City				
21	15		Nyala	56	20		Atbara	92	56		129	2	Water Net		2	Water Net					
22	16		Zalingi	57	21		Damir	93	57		130	3	Electrical Net		3	Electrical Net					
23	17		Eljannayna	58	22		Berber	94	58		131	4	Elect. H. T. Towers		4	Elect. H. T. Towers	Country Territory				
24	18		El Dein	59	23		Shendi	95	59		132	5	Telecom Net		5	Telecom Net					
25	19		Drainage	60	24		Abu Zabad	96	60		133	6	Telecom Towers		6	Telecom Towers					
26	20		Hills	61	25		Kassala	97	61		Sum		133								
27	21		Spo. Heights	62	26		Aroma	98	62												
28	22		Hydrosphere	63	27		Kashm. ElGerba	99	63												
29	23		Rivers	64	28		New Halfa	100	64												
30	24		Islands	65	29		Qadiriif	101	65												
31	25		Water Basin	66	30		El Dindir	102	66												
32	26		Ground Water	67	31		El Kurmak	103	67												
33	27		Water Resources	68	32		El Fao	104	68												
34	28		Lakes	69	33		El Shouli	105	69												
35	29			70	34		El Souki	106	70												
				71	35		Singa	107	71												
								108	72												

(133 Thematic Layer)

Figure 2: Shows the basic components of the Sudan National Basemap

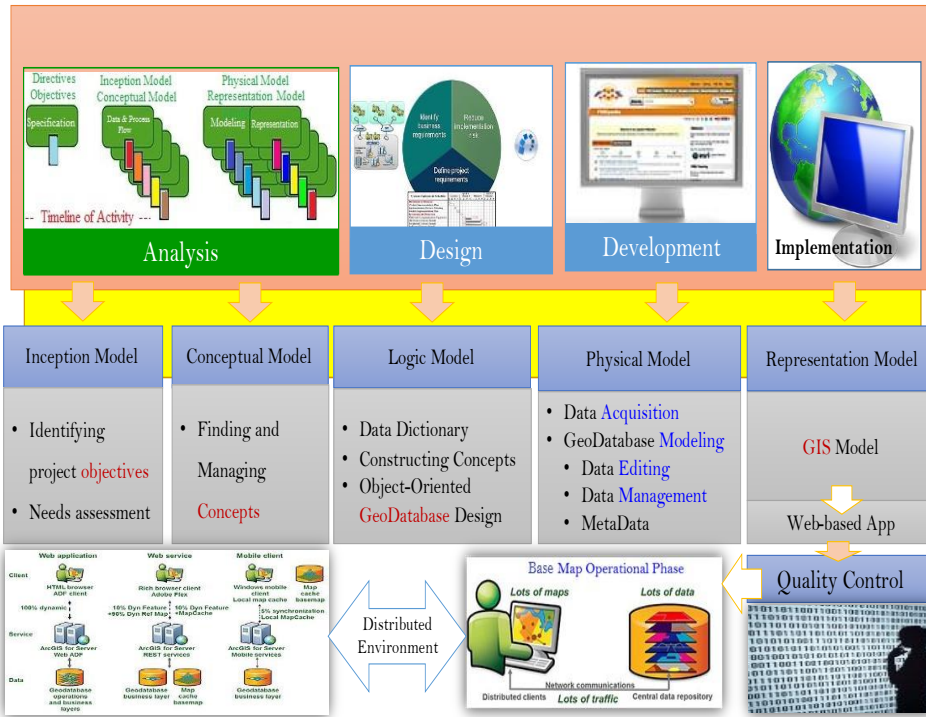


Figure 3: Shows the SNBS data models design and Development

Second Stage:

- a. Preparation of SSA Department Data models
- b. Preparation of SSA Department Databases and layers, Figure 2.
- 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 checking for maintaining the technical assurance and quality control for the established SNBS in:

- a. Fullness of Geospatial data specifications.
- b. Data model conformance

Fourth Stage:

- a. Establishment of the system operating environment and installation of the primary server, Figure 4, and the network infrastructure and the connectivity with SSA Departments.
- b. Preparation of user case specifications following the policies adopted.
- c. structure and SSA business processes, roles, and responsibilities.

Sudan National Integrated Basemap System

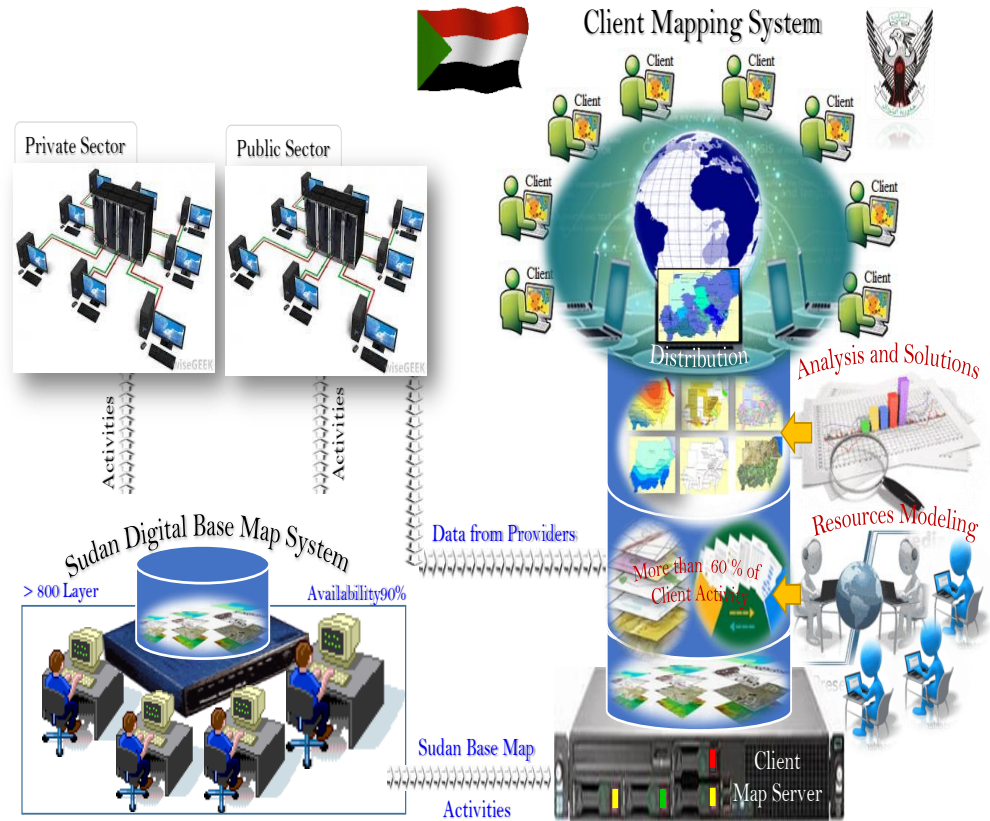


Figure 4: Shows the Sudan National Integrated Basemap System

6.2 Technical Processes for SNBS Implementation

These technical approaches were in accordance, with the required workload to execute the implementation processes and to attain the stated objectives. These approaches 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 Team
6. Technical support and Quality control and on-the-job and educational training.
7. Communication Plan
8. Hardware, software and System Specification
9. Project execution cost, half of it agreed to be financed by the Ministry of Finance, and the rest of the funds require intervention of UNGGIM and international support.

7. Sudan Collaboration With RCMRD- Africa

The Sudan Survey Authority (SSA) has long planned to collaborate with and participate in all RCMRD activities. This decision is based on the need to utilize RCMRD's capabilities and technical assets to develop Sudan's natural resources. Specifically, the focus will be on the following:

(a) Policies and legislations: Recently the Sudan government has issued the new Sudan Survey Act to organize all surveying activities in the country, in which the SSA will mainly:

- 1- be responsible for regulating all surveying and mapping activities in Sudan.
- 2- develop standards specifications and survey guidelines.
- 3- develop a professional survey certificate for the Sudanese Surveyors as well as the surveyors in the region.
- 4- The general Survey Directorates at the state level shall be responsible for all municipal and state survey activities with full coordination with SSA.
- 5- be Sudan Government Consultant to supervise all surveying and mapping activities performed by private sectors.

(b) Infrastructure Development: The main infrastructure development maintained can be summarized as follows:

- 1- Sudan adopted the ITRF 2008 as its unified reference system to be fully implemented in 2020. So, it is known as the Sudan Reference System 2020 [8].
- 2- Based On the adopted SRS2020, SSA designed its new geodetic network which is planned to be executed in the year 2024 but the Sudan political crisis stopped an implementation of such a plan.
- 3- Sudan has completed and approved its Sudan Digital Basemap [9, 10], which shall be the base of Sudan's Geospatial and surveying activities in the country. The implementation of Sudan Basemap is planned to be commenced in 2023 to cover all government entities. However, the Sudan political crisis stopped the implementation of such a plan.

(c) Challenges and Future Activities: Future activities need some support from the UN-GGIM shall be based on:

- 1- Training and knowledge transfer for the Sudan geospatial professional, surveyors and survey companies in the Country.
- 2- Development of the Sudan National Geospatial Strategy in the coming two years.
- 3- Implementation of the UN-GGIM national Geodetic Reference Frame (GRF) by the establishment of the Sudan geodetic network [8], the Determination of the Sudan gravimetric geoid [15], and the unification of Sudan reference frame for the government entities, private sectors, and the geospatial community in Sudan.

4- Implementation of the UN-GGIM national Integrated Geospatial Information Frame (IGIF) by connecting all geospatial entities by the Sudan base map [9], to provide all geospatial services and to update the relevant data of the basemap from the entity's transactional work, and the unifying the Sudan reference frame for all stakeholders by georeferencing their legacy spatial data.

5. To raise the capability of the Government awareness about the importance and role of surveying and geospatial information in implementing Sudan's Sustainable development Goals

8. UN-GGIM: Africa

Sudan Survey Authority has participated in the eight meetings of the UN-GGIM-Africa and presented the Sudan base map contents and the ways forward for its implementation []. SSA already, adopted some of the UN-GGIM-Africa [14] resolutions and recommendations that were agreed upon at its Eighth Meeting in October 2022, including the UN-GGIM: Africa Governance for the functioning of the national geospatial technical working Groups in various geospatial applications and to enhance the involvement of the private sector for geospatial technological advancements, communication, collaboration, and cooperation.

The following adopted UN-GGIM: Africa Working Groups are adopted upon which the following national working groups are to be established [1]:

- a. National Geodetic Reference Frame: To undertake the national geodetic reference framework, to unify the geodetic reference frame (GRF) for the public and private sector geospatial users to offer unified, efficient systems for analyzing and transmitting geospatial information in addition to being an accurate and effective method for positioning data;
- b. Fundamental Datasets and Standards: based on the UN-GGIM-led Working Group on Global Fundamental Geospatial Data Themes, Sudan started to form national working groups based on the data types, uses, and functions
- c. Institutional and Legal frameworks: SSA started with the issuance of the Sudan Survey Act and its executive regulations to govern the geospatial information integration processes and the creation of specialized entities information system [6] and the developments of their geospatial information management legal and legislative frameworks.
- d. Capacity and capability development: to strengthen the capacity building in implementing the current innovative technologies in the areas of GNSS positioning and networking, geospatial, and digital technologies, artificial intelligence and open-source programming.
- e. integration of Geospatial and Statistical Information: Sudan started with the national statistics authority to see how to apply the Global Geospatial Statistic Framework in all domains of applicability, particularly the Sudan national basemap.

9. Intergovernmental Authority on Development (IGAD)

Sudan has participated in the program for the validation workshop of the IGAD land Management Tools in Djibouti between 29th January – 2nd February 2023, and agreed with the following IGAD teams initiatives and geospatial recommendations [4]: -

- (1) Empowering Geospatial Information as a key success factor for Sustainable Development of IGAD Countries. This necessitates that, the following basic geospatial infrastructure are to be maintained:
 - (i) Unification of IGAD Geodetic Reference Frame (IGRF) and establishment of unified regional Geodetic Network.
 - (ii) Development of IGAD Integrated Geospatial Information Frame.
 - (a) Formation of IGAD geospatial working groups, especially the Geodetic Reference Frame and the Integrated Geospatial Information working groups.
- (2) Development of Integrated Land Governance system for IGAD member countries
 - (i) IGAD Land Information System
 - (ii) IGAD Land Administration Management, and
 - (iii) Establishment of IGAD Land Governance Working group

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