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Towards Enterprise Geospatial Web for Sudan Water Harvesting

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***Abstract*—*This article aims to highlight the concepts developed for the implementation of a full-featured enterprise geospatial web system in Sudan, for mapping and analysis using a computer-based system, that includes a robust GIS server, enterprise database, and dedicated web-based geospatial infrastructure to organize, share, and integrate geospatial application and services on local network infrastructure. The Dams Implementation Unit as part of the Irrigation and Water Resources Foundation in Sudan, has performed many projects in the area of water harvesting and agricultural irrigated projects. These types of water harvesting projects need a large amount of geospatial data, which requires effective database management. The database management system has been conceptually modeled to effectively manage all kinds of geospatial data and information to establish the enterprise Dams Implementation Unit database system and create its web applications. This paper reviews a simple and easy-to-use methodology for creating an Enterprise geospatial web system for the Dam Implementation Unit in Sudan and web applications created and tested.*

***Keywords*— *DIU, SNB, WEB, Integration, Basemap, Geospatial Information, Water harvesting.*

I. INTRODUCTION

The Dam Implementation Unit (DIU) in Sudan designed a geographic information system (GIS) to capture, store, manipulate, analyze, display, manage, and present unlimited water sources and geospatial [2, 4, 11]. The paper outlines the requirements of the database management system, used to store, organize, and update water sources' geospatial data accurately and effectively. The database management system offers, enormous possibilities that DIU departments its stakeholders, and private sector organizations can benefit from its services. The enterprise database management system provided a highly efficient means of handling multiple types of data, storing, organizing, analyzing, retrieving, sharing, integrating, and managing large amounts of spatial and non-spatial data.

The Ministry of Irrigation and the Dam Implementation Unit use a lot of geospatial information to perform their investigations, design, development, and project executions, therefore, they need to manage this geospatial data effectively and can be easily updated, in a secure environment. This will help, to avoid the current situation issues related to data access and duplication. In addition, currently, the data cannot easily be shared or integrated due to the use of different horizontal and vertical control data and coordinate systems. By using, an enterprise database management system, different departments would be linked by integrating their databases using a unified geospatial frame, standards, and specifications.

In this study, an enterprise database was established for the Dams Implementation Unit (as the study case) by creating ArcGIS Web, and web applications, including, storing, organizing, analyzing, retrieving, sharing, publishing, and managing geospatial data. The paper presents how to create a GIS-Web system, using water harvesting data.

II. SUDAN NATIONAL BASEMAP

The Sudan National Basemap (SNB), was created to provide geospatial data to both, the public and private sectors across Sudan. This includes essential information such as the location of features like boundaries, water bodies, settlements, and basic infrastructure. Additionally, the National Basemap serves, as the foundational reference framework for integrating all other map features of a particular area, including ground survey control points and topographic features. In essence, the Sudan basemap is a federal strategy aimed at optimizing the value of geospatial information for public and private organizations. The spatial data used for the basemap has been collected from various government entities in Sudan, and both existing and missing data have been reviewed and validated. The mapping system specifications have been thoroughly analyzed and documented, encompassing data collection and processing modules for digitizing, analog data, digital data, high spectral and spatial images, and aerial photography. The main components of the Sudan National Basemap [4, 11] are summarized in Figure 3.

Figure 4 illustrates the Sudan National Base Map showing the water bodies layer emphasizing the river Nile, wadis, streams and lakes, and the Red Sea and the islands areas [11].

The core business of the Sudan Survey Authority is focused on the SNB implementation [6] together with the geospatial data collection, creation, maintenance, management, and supply of geographic information that is designed to meet the needs of all aspects of national infrastructure requirements. SSA creates and maintains the definitive Basemap geographic database for Sudan from which its geospatial products, services, and solutions are to be derived.

SNBS should be viewed as a mapping function of SSA that can uniquely portray the geospatial data and information stored by SSA and its strategic stakeholders in Sudan. The ability to view data in a spatial dimension has always made geospatial systems a valuable tool [5, 9].

Basic Components of Sudan National Base Map

Serial No.	Use Case	Partial No.	Theme	Coverage
1	Administration Boundary	1	International	Globe
2		2	Regional	Sudan Region
3		3	State	Country Territory
4		4	Districts	
5		5	Administrative Units	
6		6	Urban Areas	
7	Elevation (Topographic & Relief)	1	Contour 10m	Country Territory
8		2	Contour 5m	Khartoum
9		3		Dongola
10		4		Damr
11		5		Portsudan
12		6		Kassala
13		7		Qadarif
14		8		Wad Madani
15		9		Sinnar
16		10		Rabak
17		11		Damazeen
18		12		El Obeid
19		13		El Foulla
20		14		El Fashir
21		15		Nyala
22		16		Zalingi
23		17		Eljeneena
24		18		El Dein
25		19	Drainage	Country Territory
27		20	Hills	
28		21	Spo_Heights	
29	Water Bodies	1	Hydrosphere	Globe
30		2	Rivers	Country Territory
31		3	Islands	
32		4	Water Basin	
33		5	Ground Water	
34		6	Water Resources	
35		7	Lakes	
36		8	Water Stations	
37	Transportation	1	Highways	Country Territory
38		2	Tracks	
39		3	Town Roads	Khartoum
40		4		Omdurman
41		5		Bhri
42		6		Jabel Awlia
43		7		Tuti Island
44		8		Portsudan
45		9		Arbaweit
46		10	Town Roads	Dongola
47		11		Ed Dalia
48		12		El Gaba
49		13		El Golid
50		14		Karti
51		15		Wadi Halfa
52		16		Marawi
53		17		Kiriyma
54		18		Karima
55		19		Abu Hamad
56		20		Atbara
57		21		Damir
58		22		Berber
59		23		Shendi
60		24		Abu Zabad
61		25		Kassala
62		26		Aroma
63		27		Kashm ElGerba
64		28		New Halfa
65		29		Qadarif
66		30		El Divelr
67		31		El Karmak
68		32		El Fao
69		33		El Shoul
70		34		El Souki
71		35		Singa
72	Transportation	36		Wad Madani
73		37		Kamleen
74		38		Hesehesa
75		39		Rofaa
76		40		Arkil
77		41		El Managil
78		42		El Madina Arab
79		43		El Masood
80		44		Ad Damazeen
81		45		Rabak
82		46		Kosti
83		47		Ed Dewim
84		48		Sinnar
85		49		El Obeid
86		50		El Foula
87		51		Lagawa
88		52		Kadugli
89		53		El Rahad
90		54		El Fashir
91		55		Umm Kadada
92		56		El Tiyna
93		57		Kutuk
94		58		Nyala
95		59		Kass
96		60		El Geneina
97		61		Zalingi
98		62		Kabkabyia
99		63		Meleit
100		64		El Geneina
101		65		El Dein
102		66		Ganila
103		67		Asalaia
104		68		Habiyla
105		69		Umm Rowaba
106		70		Bara
107		71		El Semeih
108		72		El Nihoud
109		1	Railways	Country Territory
110		2	Bridges	
111		3	Airports	
112		4	Runways (Airports)	
113		1	Villages	Country Territory
114	Land Cover	1	Vegetation	Country Territory
115		2	Forests (Woodland)	
116		3	Agricultural Projects	
117		4	Agricultural Land	
118		5	Sandy Land	
119	Geology	1	Geological Structures	Country Territory
120		2	Geological Eon	
121		3	Geological Era	
122		4	Earthquakes	
123		5	Volcanics	
124	Energy	1	Oil Concession Blocks	Country Territory
125		2	Pipeline	
126		3	Refinerıs & Mines	
127		1	Tourism Sites	Country Territory
128	Service Networks	1	Sewers	Khartoum City
129		2	Water Net	
130		3	Electrical Net	Country Territory
131		4	Elect. H. T. Towers	
132		5	Telecom Net	
133		6	Telecom Towers	
Sum	133			

(133 Thematic Layer)

Sudan Survey Authority

Figure 3: shows the main components of the Sudan National Base map

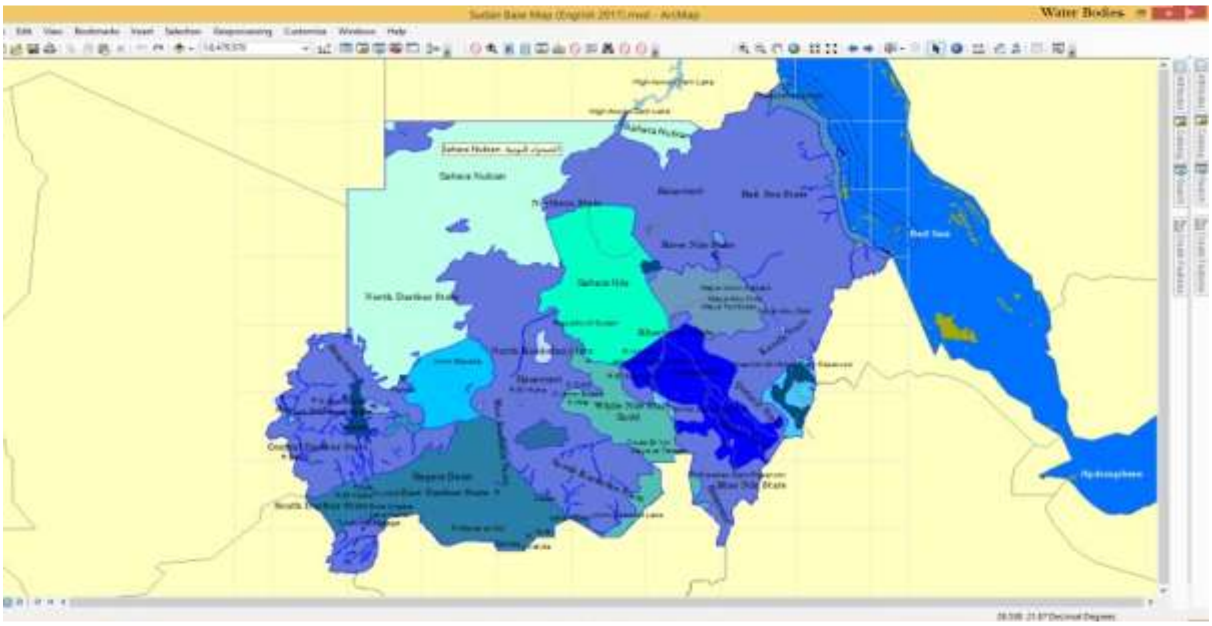


Figure.4: shows the water bodies layer of the National Basemap

Figure 5 Sudan National Basemap data sharing and data integration process

To integrate SNBS, SSA maintains the idealistic viewpoint that the National Basemap System can be considered a scientific tool and a technology that can influence the basic services to all stakeholders in the well-known procedures and methodologies of work [12, 15]. The conditions of SSA regarding the implementation and development of Sudan geospatial information shall be assessed by examining the major factors that have been identified including factors that affect the implementation of geospatial technology in Sudan organizations [6]. These are: (1) Organizational characteristics, (2) Current Activities and potential GIS applications, (3) Data availability and quality, (4) Human resources, (5) Financial resources, and (6) GIS Support.

III. Water Resources Geospatial Information

The 18 states of Sudan are divided into localities, with each locality further subdivided into Administrative Units (AUs). These AUs are then subdivided into village councils and neighborhood councils. At each administrative level, there are assemblies of elected members. There are significant variations in the population sizes of the states and localities. The impacts of drought and climate change, are experienced in most of Sudan's states, excluding those in the Nile River Basin. This led to the fact that the competition for water resources has increased significantly and necessitated the importance of water resources assessment and development. Great pressure is exerted on the federal and state governments to seek immediate actions, for water sector reforms and institutional capacity development programs, to contribute towards building resilient and sustainable water for the satisfaction of all citizens, farmers, and animal producers or beneficiaries in Sudan to contribute to peacebuilding, improving livelihoods and building resilience against climate variability and change. In this regard, the paper focuses on developing geospatial information for water harvesting and monitoring water resources in Sudan.

The main DIU hydrologic activities taken into consideration for hydrologic investigations and water harvesting can be summarized as, hydrological investigations required information, spatial data for the assessment of surface water resources and identification of priority areas, estimation of the annual yields of the river Nile, and the main Wadis and water courses, and identification of areas for construction of earth dams and/or water harvesting facilities for water supply, agriculture and animal production. In this study, satellite images and Radar, topographic data have been used to obtain the relevant water source information, hydrological characteristics, land use, and land cover

The geospatial information included here is mainly for the surface water development as manifested in River Nile and other rivers, Wadi, Turda's, and Hafeers. Dams, khors crossing, Lakes for water harvesting for humans, and animals, irrigation along fisheries. The geospatial information used in this study also highlighted the population movements and updating of socioeconomic information which is vital for water harvesting projects, as population movement is one of the processes that significantly change the size and composition of a population in a given area of a country. Generally, the geospatial information is also required for Environmental Social Impact Assessment (ESIA) alongside, the Environmental Management Plan (EMP) present measures and actions to reduce negative socio-economic and environmental impacts and to maximize the benefits of water harvesting projects.

The main objectives of the study, are the provision of geospatial information for water harvesting services to carry out detailed engineering design of water distribution networks and water transmission lines for water supply systems, agriculture, and animal production within the territories of Sudan [13, 16]. The Sudan National Basemap also includes information, about the soil, geology, and hydrology.

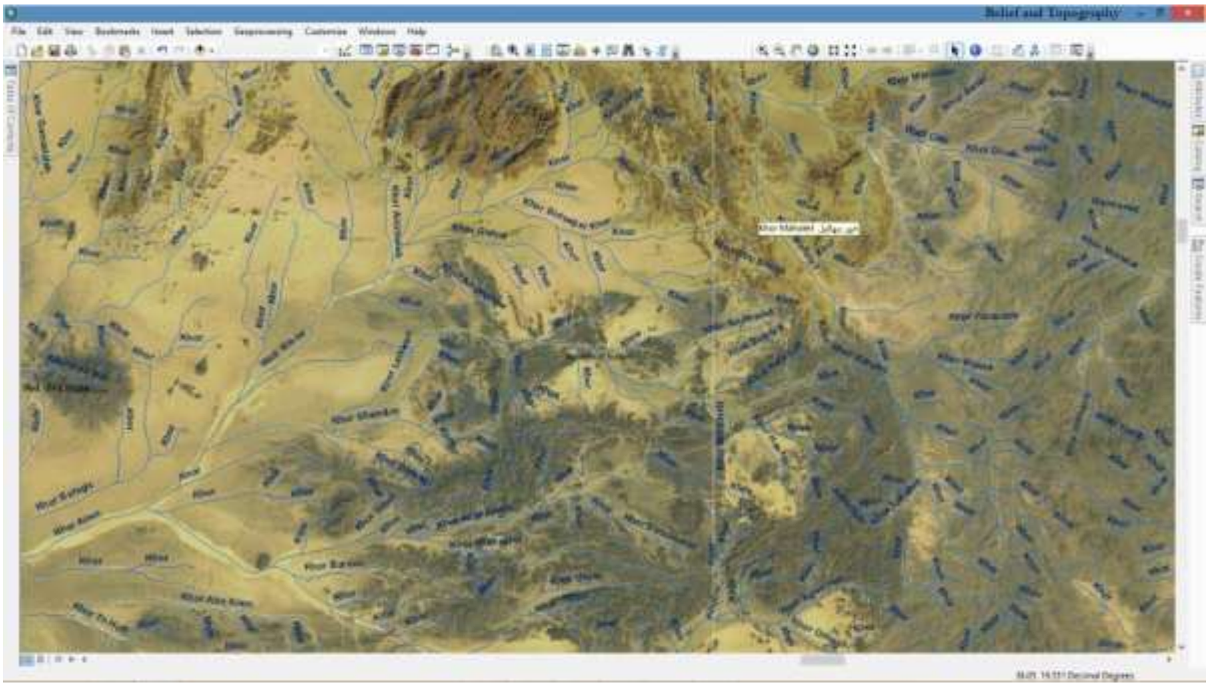


Figure 6 Shows samples of watercourses that could be used for rural water harvesting projects

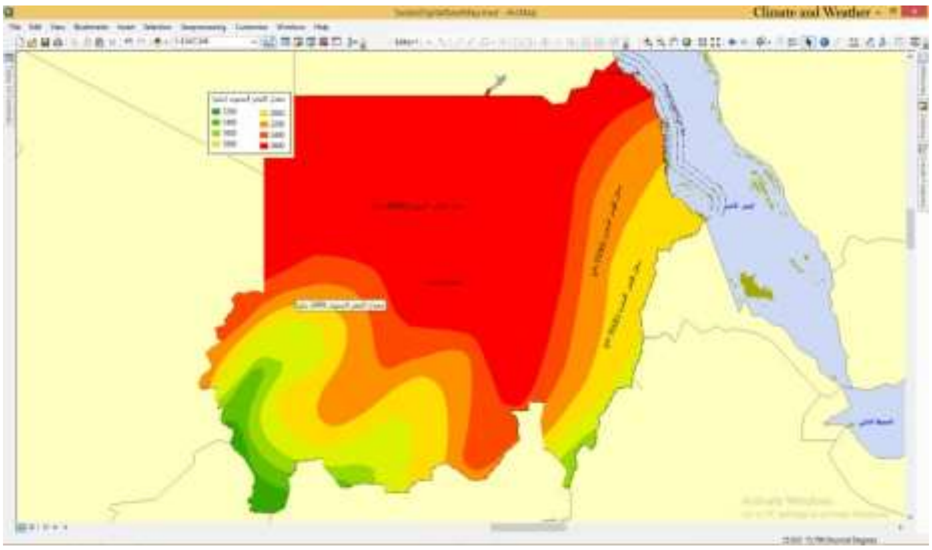


Figure 7 shows the variation in Climate and Weather in the country

Water resources in Sudan out of river Nile planes include rainfall, surface runoff, and groundwater. Groundwater and surface water are very much constrained by climate change, wide seasonal and annual variations, poor accessibility, limited capacities of water storage facilities, and inadequate infrastructure and databases to plan for water development and management. These result in localized water abundance but supplies remain scarce in both time and place and they are vulnerable to climatic fluctuation and changes. Despite these constraints, if water resources are properly utilized, developed, and managed, they can sustain livelihoods, improve the environment and natural resources, secure subsistence food production, and ultimately reduce conflicts in the state.

The main causes of conflicts over land and natural resources in Sudan can be summarized as follows: mechanized agriculture expansion at the expense of natural ranges and animal migratory routes, shortage of water supply at such routes, and on top of that water centers are unevenly distributed, cultivation of itineraries that lead to water centers, local conflicts over land tenure [7].

Increases in natural population, and animal stocks in Sudan, coupled with the degradation of land necessities the development of harvesting water projects in Sudan, and the implementation of geospatial information.

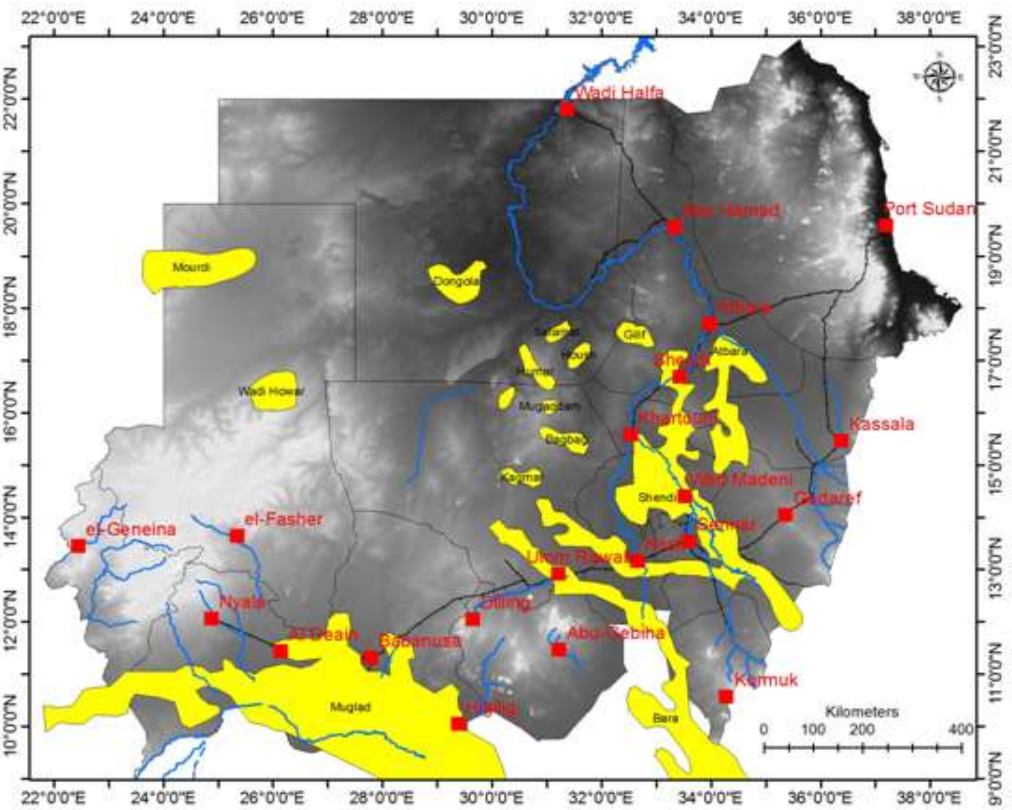


Fig.8: Rift related basins in Sudan

Therefore, the total abstraction represents only about 10% of the annual recharge indicating that there is still high potential for aquifer development.

IV. Development of Geospatial Web case use models

The geospatial environment was initialized to create an enterprise database, where, ArcGIS Desktop, ArcGIS Server, and database management system (SQL Server) were installed, adding users' permissions, versions, distributed database, publishing service, and developing web applications. Enterprise databases allow simultaneous access to a large number of DIU users and can be used in the future by both the Dam Implementation Unit (DIU) and SSA organizations, where it has many advantages, such as managing their huge collection of data effectively, being robust enough to successfully handle the queries of multiple users simultaneously, the number of users editing data at a time is large, data size depends on server size and type of database systems used [4, 6].

Web GIS can be defined, as any geographic information system that uses web technology to communicate between the server and the user. Web GIS is a type of, distributed information system that includes at least a server and the user's browser. Figure 5 shows the geospatial data sharing and integration processes that can be desktop-based, server applications, or mobile applications.

4.1 Cooperative WebGIS interactive information systems for water resources

The dissemination and management of water-related data using web-based information systems is a promising technological approach for sharing knowledge with water source developers, users, and the general public. The synchronous information systems facilitate spatial data and descriptive information sharing over the cloud and are accessible through common web browsers [14, 16]. The data harmonization is based on standards satisfying common data formats and transmission protocols [8, 9]. In this paper, two cooperative web-based information systems are described, the first one serves spatially distributed and descriptive information from national databases related to transboundary aquifers of the African continent. The second is a holistic information system for providing near real-time alerts of flood events for the Greek part of the Styron transboundary river basin [5, 9]. In both cases, all the included data, as well as metadata and auxiliary information, are available to the stakeholders involved and they satisfy interoperability requirements [11].

Geospatial (GIS Web) exhibits characteristics common to both stand-alone and web-based systems making it necessary to apply a hybrid methodology during their development [5, 13]. This paper, also, proposes a methodology, for developing Web GIS that is herein referred to as the Y-Model Web GIS Development Methodology (YWDM) which has been adapted from existing software development methodologies and applied to the context of Web GIS development. The paper details the methodology phases and its viability by testing it in the implementation of the Web GIS.

4.2 Developing Map Use Model for Web Mapping and GIS

In this paper, a model for web mapping use was considered based on the Sudan base map used. The model contains, the technology, usability, and information to be considered in the development and future of online geospatial mapping and services. Such a model assists in the design and development of, web mapping and GIS for informing the project directions being taken in a fast-evolving discipline.

The geospatial data was collected from the Dam Implementation Unit (DIU), followed by intensive management, development, and Protection of the geospatial Information System. As mentioned, the data used in this study include the water harvesting data, including the wells, Hafeer, dams, drainage lines, drainage points, adjoint catchments, catchment areas, and other Sudan national base map data such as railway, river, soil texture, basin, and administrative units. The geospatial data also includes the coordinates indicating the locations of the data, the names of the localities, the names of wells, Hafeers, dams, the names of the basins, and some other data (Figure 8). Part of the data has a coordinate system which is a Geographic Coordinate System based on the WGS84 epoch (GCS_WGS_1984) and the other part has a coordinate system which is based on the Transverse Mercator Projection (WGS_1984_UTM). The stags of Web GIS system creation are illustrated in Figure 8 and Figure 9.

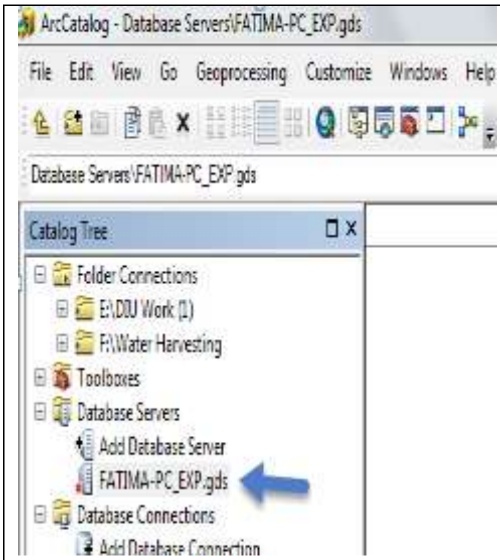


Figure.8: Database Server Creation

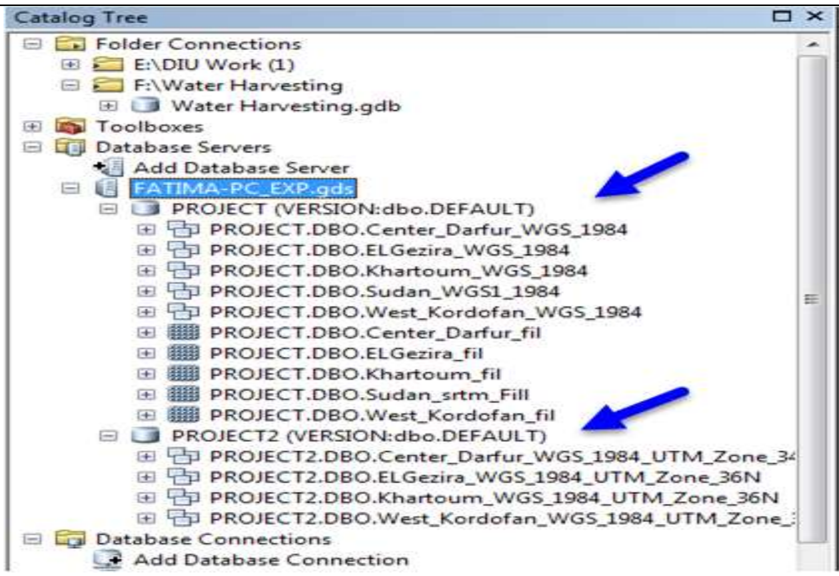


Figure 9: Data imports into the enterprise database.

Create the enterprise database: An appropriate environment has been configured to create the enterprise database in which the required programs were installed. The Arc Catalogue was used to create a new database server (Figure.8), here the x on the server means that it is offline and is linked by clicking on it twice. After the connection to the server, comes the stage of establishing the Enterprise database. Here, the Arc Toolbox was used to create the database. Two databases were created, one named PROJECT, and PROJECT2, and the data was imported into the enterprise database (Figure 9).

4.3 Specifying Users and their Defined privileges.

Each DIU user will be identified and set the required permissions. There are several DIU users; each one of them can be identified with different privileges, and the types of users were identified as:

1. Administrator user or system administrator: The administrator has the privileges to control the database as a whole, such as erasing, modifying, or adding new data.

2. Editor users: have the privileges of editing, erasing, and adding new data.

3. Reader users: Can only read and view the data.

All users will use their usernames and passwords, to use the web and to perform their work. The user names also can be used by system administrators to track the users, to see what modifications they made and when. In the DIU system, two enterprise databases used are in one server (i.e., PROJECT, PROJECT2, each database has its own data. To control and manage these databases, communications are established with the database connections for enterprise databases PROJECT and PROJECT2. These connections allow the administrator to create accounts for employees and determine and verify their privileges.

4.4 Creation of Versions for Users.

The database is connected to the Internet and often there are some users connected to the database at a time when a database update is required. In this case, if any user has made any update, it will show this update to the rest of the users. In this case, the user updates the database in an environment that can be separated from the original database and then transfers the updates when it is finished to the original database. This process is done by creating versions. Versions are a reflection of the database; it gives the current form of the database. So one should keep in mind the following information that, If another user updates the original database, the update will not be visible in the other user's version, and vice versa. Versions are created through connections, so each user has their version.

There are three permissions for a version: (a) Private: only the creator and the administrator can see it, (b) Public: visible to everyone, and (c) Protected: visible to everyone and can only be modified by the creator and the administrator. In certain situations, the administrator will create the main version, and each employee will be required to make a sub-version of it. An example demonstrating how versions function is shown in Figure 10, where the user (Editor) has added the "Khartoum" dataset from the Project Editor Database to the ArcMap.

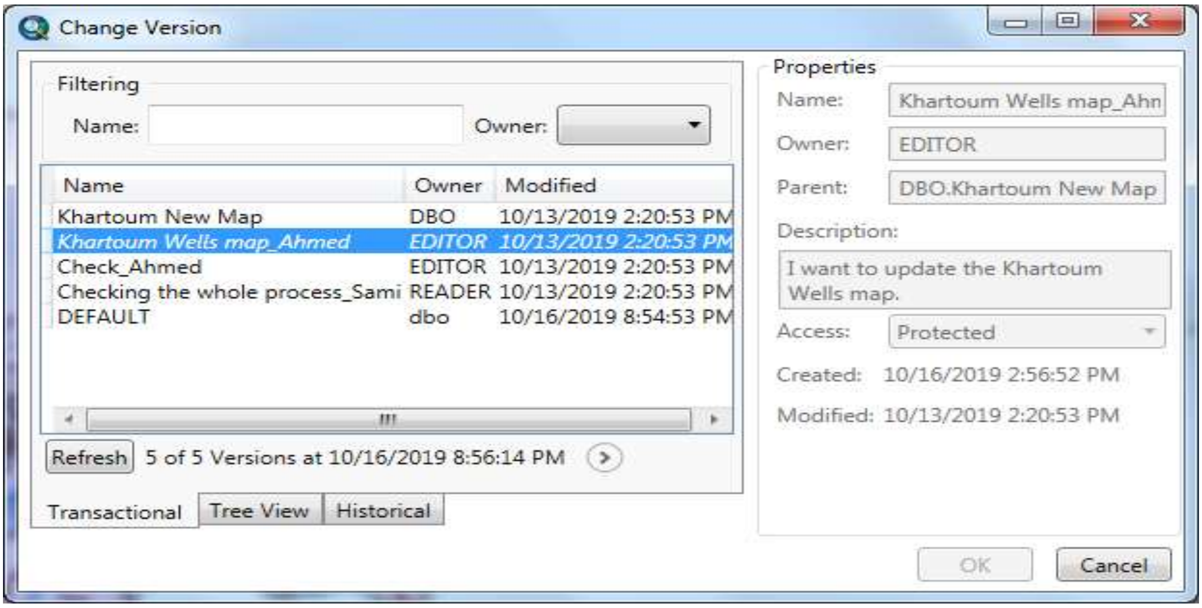


Figure 10: Shows Web Change Version

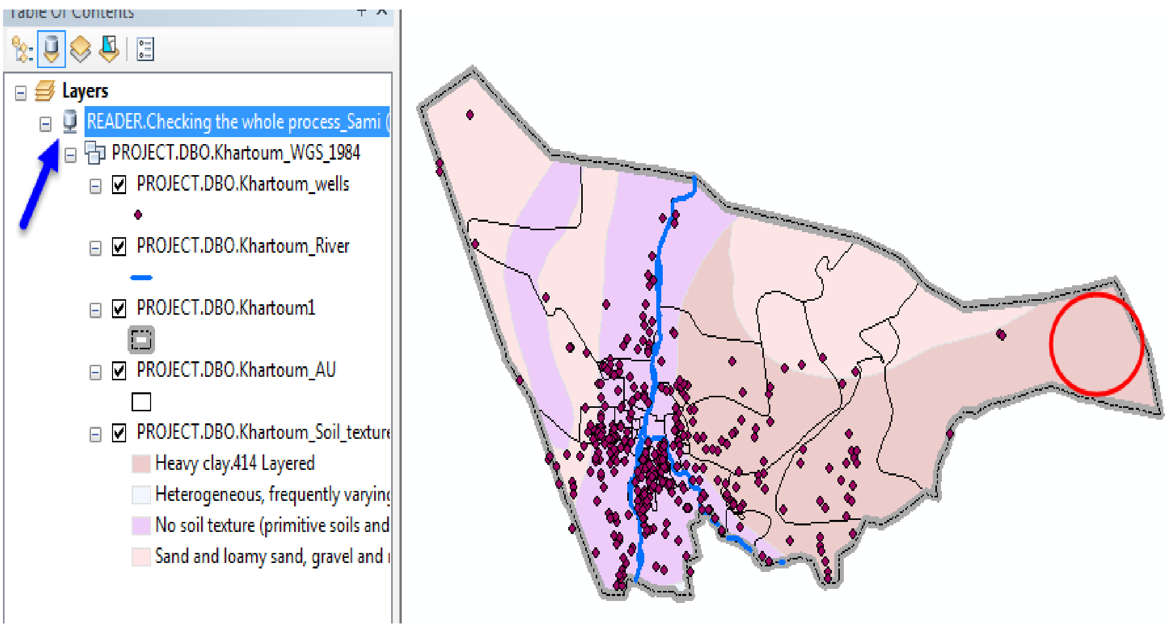


Figure 11: shows the reader checking Khartoum data processes

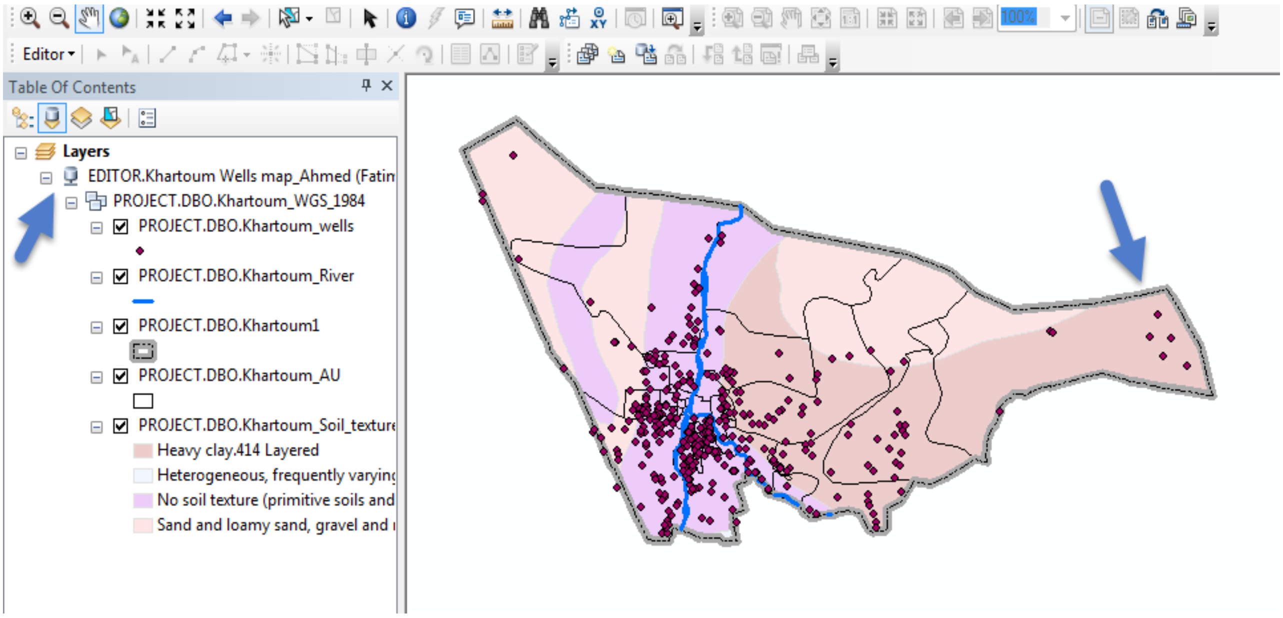


Figure.12 illustrates, the user, adding five new wells to Khartoum's existing wells map.

This data modification will appear only in this version and does not appear in the rest of the versions until compatibility is done between versions, and then sends the modification to the parent version. If the user wants to send the modifications made in his version (Figure 11), to the administrator version of Figure 12, it will be updated by adding new features such as the five wells.

4.5 Creation of Distributed Geodatabases:

The principle for updating two or more databases, each of the two databases should be linked and considered as a pair, all updating in the first database will be transferred to the second database. Distributed geodatabases can be used to give a replica of the parent Database (Figure 13), or for data shared between two departments or institutions. In such cases, updates can be directly done between the two institutions' databases. There are three relationships for the link between pairs:

(i) *Check out the relation:* It links between the SDE database and any other type of database and allows the database, to be updated only once.
(ii) *One-way relation:* It links between the SDE database and any other type of database that allows the database to be updated more than once.
(iii) *Two-way relation*: It connects only between SDE databases and updates can be sent from the first database to the second and vice versa.

To establish the relationships mentioned above, the data in each pair of databases needs to be identical and to create distributed geodatabases, two conditions must be met: the data must be registered as a version and global IDs must be added to ensure each feature has a unique key that does not repeat.

4.4 Creation of site for ArcGIS Server manager

First, the site has been created, and its settings have been adjusted, from this site, one can manage the server and control the privileges and services, and the services page, where each service will be displayed and published.

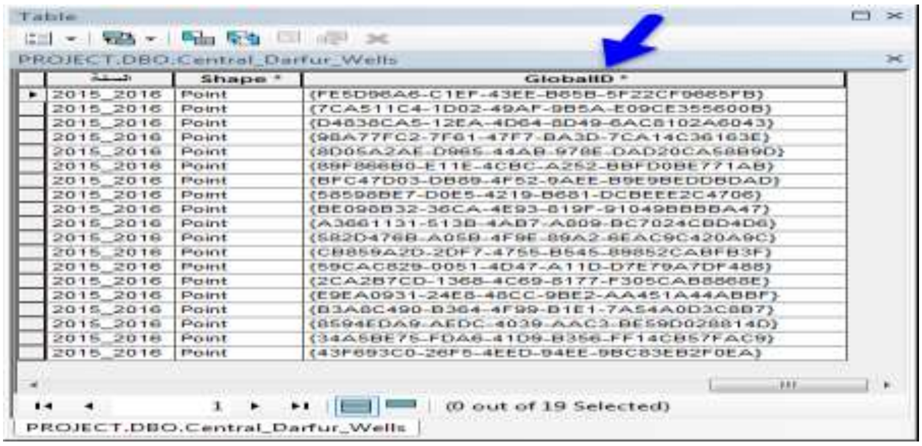


Table
PROJECT.DBO.Central_Darfur_Wells

	Shape *	GlobalID *
2015_2016	Point	{FE5D96A6-C1EF-43EE-B65B-5F22CF0665FB}
2015_2016	Point	{7CA511C4-1D02-49AF-9B5A-E09CE355600B}
2015_2016	Point	{D4638CA5-12EA-4D64-8D49-6AC8102A6043}
2015_2016	Point	{98A77FC2-7F61-47F7-BA3D-7CA14C36163E}
2015_2016	Point	{8D05A2AE-D965-44AB-978E-DAD20CA58B9D}
2015_2016	Point	{89F866B0-E11E-4CBC-A252-BBFD0BE771AB}
2015_2016	Point	{BFC47D03-DB69-4F52-9AEE-B9E9BEDDBDAD}
2015_2016	Point	{58598BE7-D0E5-4219-B681-DCBEEE2C4706}
2015_2016	Point	{BE098B32-36CA-4E93-819F-91049BBBBA47}
2015_2016	Point	{A3661131-513B-4AB7-A809-BC7024CBD4D6}
2015_2016	Point	{582D476B-A05B-4F9E-89A2-6EAC9C420A9C}
2015_2016	Point	{CB859A2D-2DF7-4755-B545-89852CABFB3F}
2015_2016	Point	{59CAC829-0051-4D47-A11D-D7E79A7DF488}
2015_2016	Point	{2CA2B7CD-1368-4C69-8177-F305CAB8868E}
2015_2016	Point	{E9EA0931-24E6-48CC-9BE2-AA451A44ABBF}
2015_2016	Point	{B3A8C490-B364-4F99-B1E1-7A54A0D3C8B7}
2015_2016	Point	{8594EDA9-AEDC-4039-AAC3-BE59D028814D}
2015_2016	Point	{34A5BE75-FDA6-41D9-B356-FF14CB57FAC9}
2015_2016	Point	{43F693C0-26F5-4EED-94EE-9BC83EB2F0EA}

1 (0 out of 19 Selected)
PROJECT.DBO.Central_Darfur_Wells

Figure. 13: Creation of Replica for the database

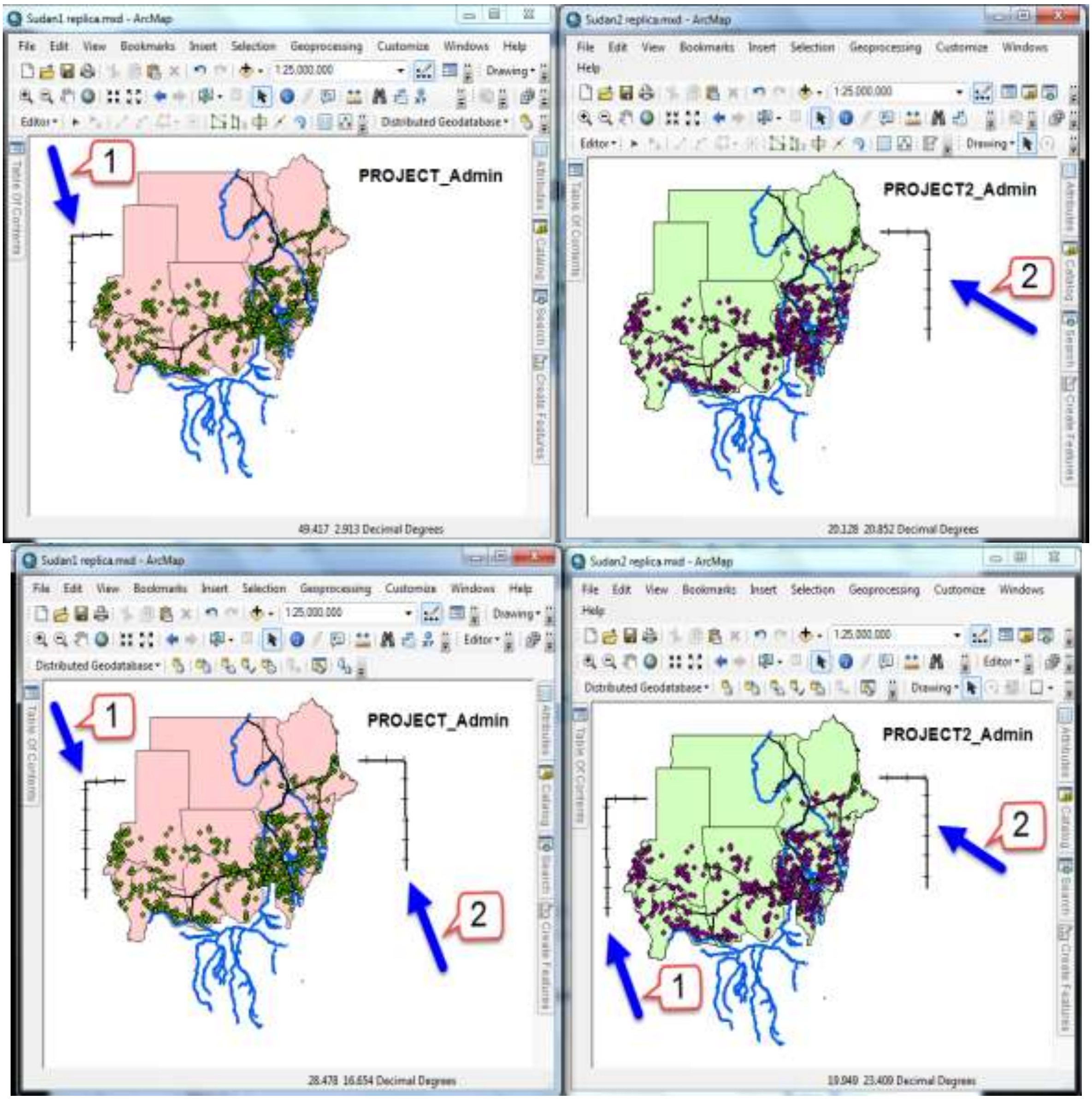


Figure 14: Databases Updating Each Other

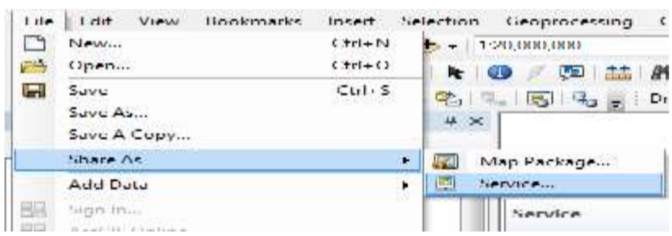
Figure 15 Entering ArcGIS server username

A feature was added to the first database and second database, and both databases have been updated by each other (Figure 14).

The user publisher has all permissions on the services, but the rest of the user's permission will be controlled by the administrator (Figure 15). Each user who does not have permission to publish cannot access the site, but they can use the services via ArcGIS Desktop. Finally, the GIS server is added to the manager, user publisher, and user viewer.

4.6 Publish Maps Services

To publish any data in the form of a maps service, the map must be saved in a .mxd file (Figure 16), such as the Gazera map and Sudan map were saved in the mxd file and then published. While the maps service appeared in the ArcGIS Server in Arc map.



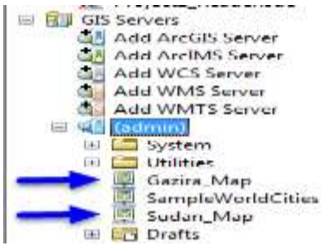


Figure 16: Saving the available maps such as Gazera and Sudan Basemap

After the service has been published, it will appear in the Server Manager site i.e. the Sudan map and Gazera map services will appear in the Server Manager site.

4.7 Account Creation in ArcGIS Online

An account in ArcGIS Online will be created, Figure 17.

The Sudan map (Figure 18) and Gazira map (Figure 16) services were opened in ArcGIS online map, and saved in ArcGIS online account.

Figure 17: Shows Account creation in ArcGIS

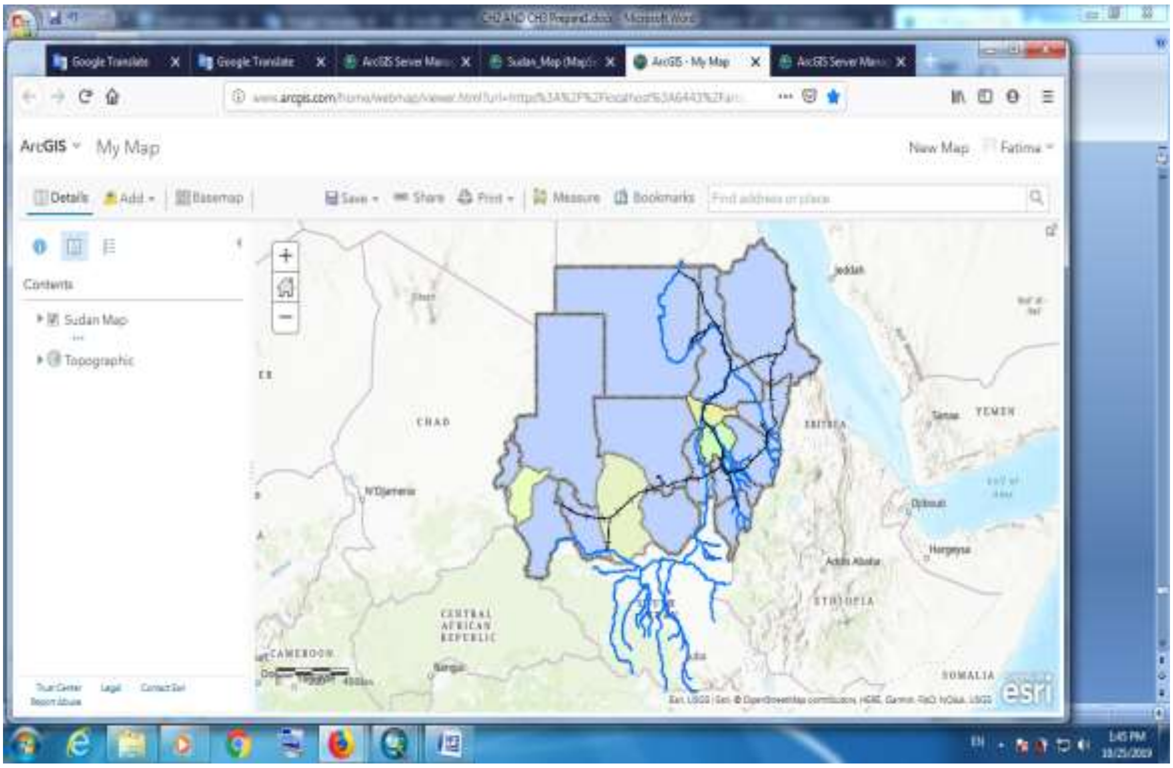


Figure 18: ArcGIS Server - Sudan map service

4.8 Creation of the Web Application.

The web application will be created and the basic viewer application will be selected, to launch for example the Sudan Map applications.

V. Water Harvesting Web Implementation:

The Dams implementation Unit has an enterprise water harvesting database for DIU data Figure 21. The two enterprise databases are ready for use, containing the data of the dam implementation unit, the first database contains data with the coordinate system GCS_WGS_1984, and the second database contains data with the coordinate system WGS_1984_UTM_Zone_36N. The enterprise database allows managing data effectively, in terms of data storage, retrieval, analysis, and data sharing. The editing system includes users who use the system, versions where any user has their version, distributed geodatabase where each two databases is linked and considered as a pair.

The DIU Enterprise geodatabase system (Figure 22) now supports simultaneous access for a large number of users, simultaneous modification, simultaneous updating, and backups can be created, users are monitored so there is no random modification of data, and the administrator has all the powers to manage the database more effectively. The Web GIS Server will be working allowing the service maps to be published and managed (Figure 23).

The web GIS provides Maps, which gives a new paradigm for how people everywhere access and use geographic information (Figure 24). They can use GIS Maps on their desktops, web, tablets, and smartphones for a variety of activities to apply advanced geographic information and the Web application will be ready for use.

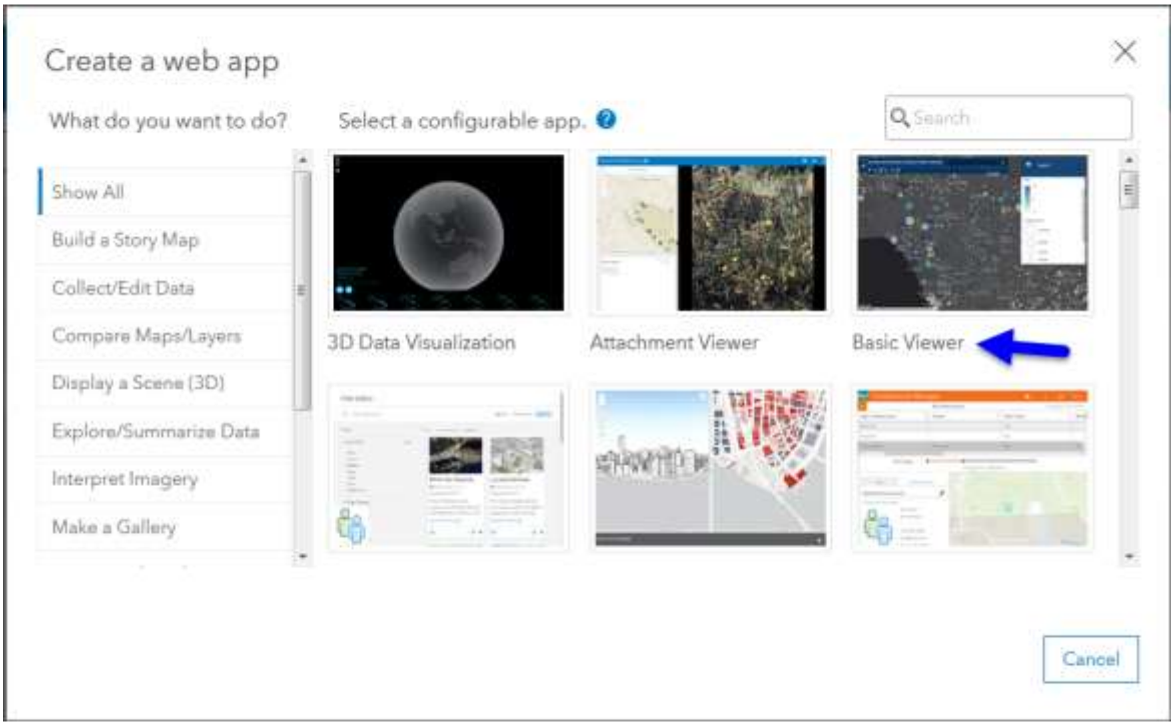


Figure 19: basic Web Viewer application

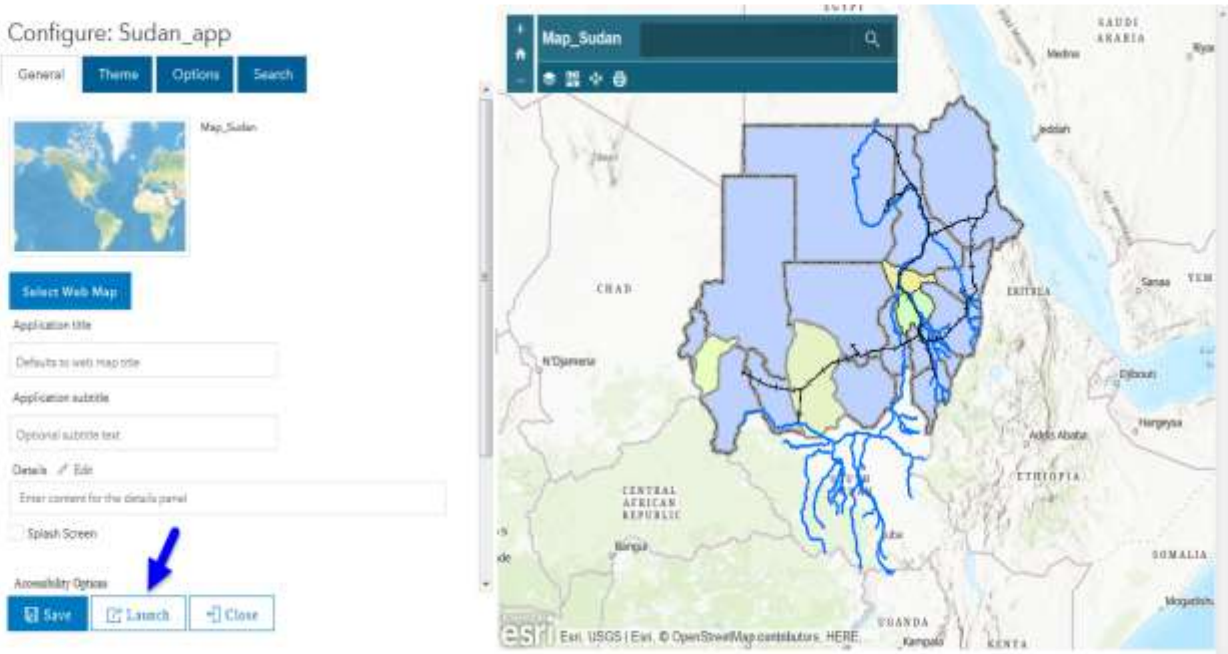


Figure 20: Launch configuration of Sudan map applications

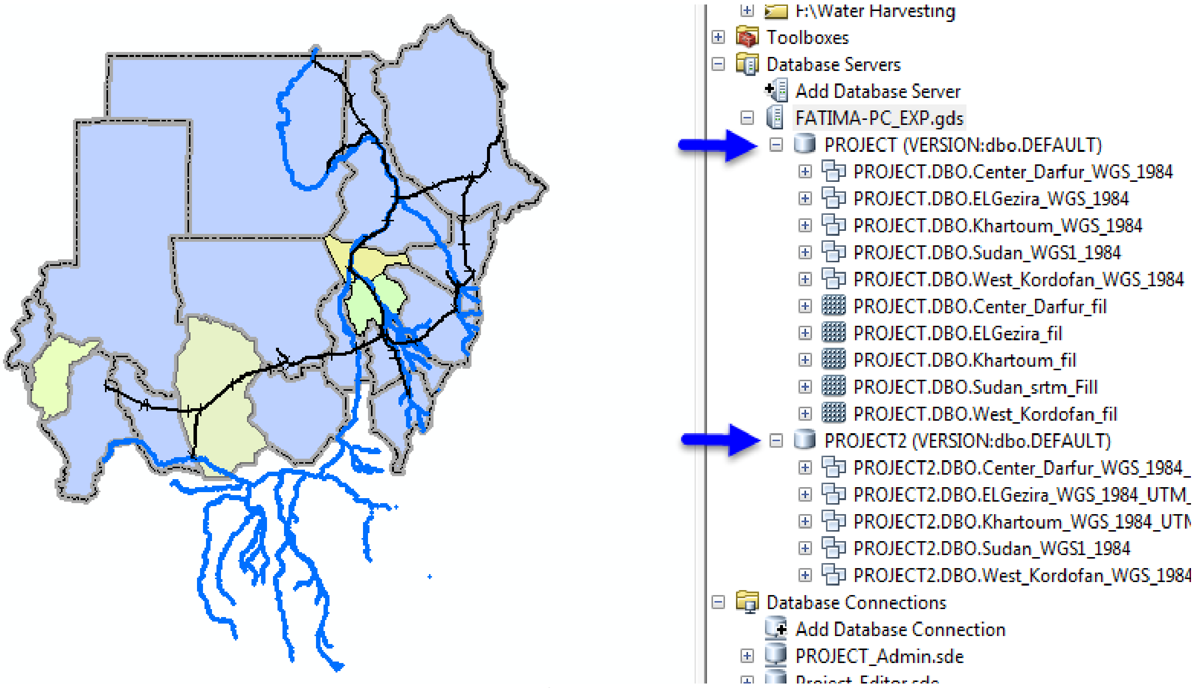


Figure 21: Components of Water Harvesting Database Server

Table 22: shows part of DIU Enterprise geodatabase

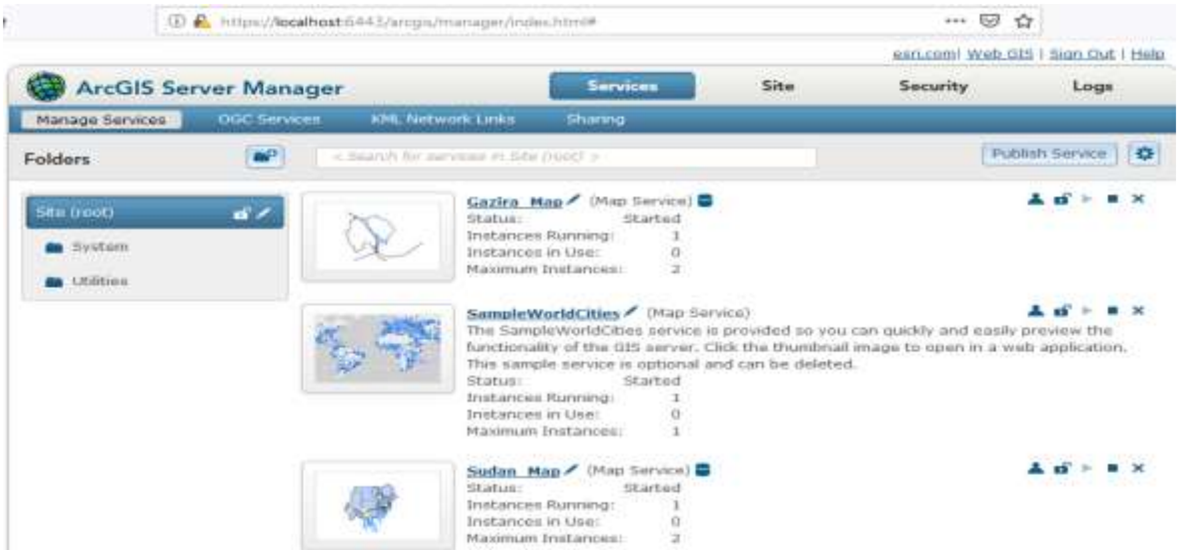


Figure 23: ArcGIS server Manager Services

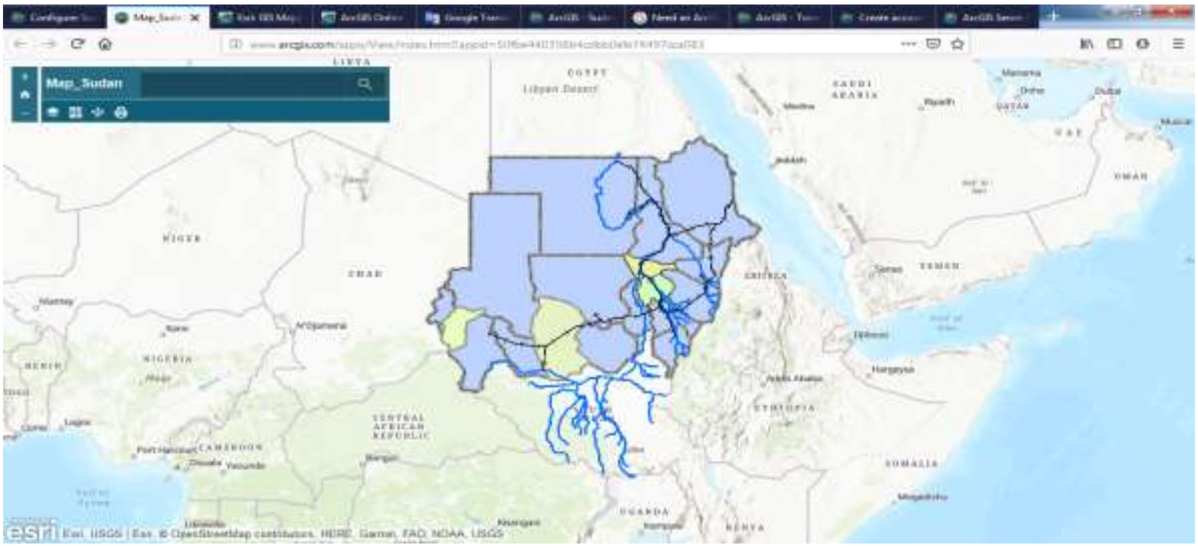


Figure. 24: Shows sample of the Web application

The web application opens maps, making it easier and faster than opening them from known GIS programs. It is accessible via computers or smart mobile phones.

VI. CONCLUSION

The Dams Implementation Unit as part of the Irrigation and Water Resources Foundation in Sudan, has performed many projects in the area of water harvesting and agricultural irrigated projects. These projects need a large amount of geospatial data, which requires effective database management. Therefore, a database management system has been conceptually modeled to effectively manage all kinds of geospatial data and information implementing web applications. Currently, the irrigation data of Sudan data cannot easily be shared or integrated due to the use of different horizontal and vertical control references and coordinate systems. By using an enterprise database management system, different departments would be linked by integrating their databases using a unified geospatial frame standard, and specifications.

This article aims to showcase the DIU full-featured enterprise geospatial web system, which is usually used for mapping and analysis through a computer-based system. This system includes a robust GIS server, enterprise database, and dedicated web-based geospatial infrastructure. Its purpose is to organize, share, and integrate geospatial applications and water services on a local network infrastructure. The article also discusses how to create a GIS-Web system for managing water harvesting data in Sudan. Additionally, it reviews a simple and easy-to-use methodology for creating enterprise geospatial web systems and web applications that have been created and tested to address issues related to data access and duplications in the current situation.

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