International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
Vol. 9 Issue 8 August - 2025, Pages: 1-8

Enterprise Geodatabase Management System Renewable Energy Resources

Taha Alfadul Taha Ali,

Associate Professor of Information Technology (Geoinformatics),
College of Computer Science & Information Technology, Alzaiem Alazhari University, Khartoum
Tahapilot13@gmail.com, Https://Orcid.Org/0000-0003-1906-0110

Abstract: *This research illustrates the Enterprise Geodatabase Management System for Renewable Energy Resources in Butana Region (in Sudan country), the aim of this research to support the decision support makers. the objectives are To Design GIS Data model for renewable energy, To Develop Geodatabase for renewable energy, To Version Geodatabase for Renewable Energy, To Replicate Geodatabase for Renewable Energy, To manage Users Access Geodatabase for Renewable Energy, To Secure Geodatabase for Renewable Energy. And To Archive for Geodatabase Renewable Energy. The methodology depends on five phases. There are many results: design a GIS data model for renewable energy in Butana Regions (Energy, Environment, and Economic Model). Design Geodatabase for renewable energy (Solar, wind, and biomass energy) in Butana Region (in Sudan). Implementation the Versioning, Replication, manage Users Access, Secure, and Archiving for Renewable Energy Resources in Butana Region (in Sudan country), in additionally apply Solar Energy in Khartoum State and Gazera State, Wind Energy in North State and Nile River State and Biomass in Kasala State and Gadarf State. In addation to design 4 Dataset (GeoLocation, Energy, Environment, and Economic). The future research: using AI, Big data, IoT, Cyber Security, Data Cloud, and Remote Sensing for Enterprise Geodatabase Management System for Renewable Energy Resources.*

Keywords: GIS, Distribution Geodatabase, RDMS, Geoinformatics.

1. Introduction

The significance of developing sustainable energy sources like Solar Energy, wind Energy, and biomass Energy is crucial for the future of renewable energy in Butana Region, Sudan. With the growing demand for electricity and the necessity to shift towards Clean or Green energy sources, there is an urgent need to concentrate on Geospatial solutions for managing renewable energy resources. The potential of solar, wind and biomass energy in the Butana Regions, Sudan, as well as in specific areas such as North State, Nile River State, Kasala State, Gadarf State, Gazera State, and Khartoum State, emphasizes the requirement for efficient geospatial analysis and data modeling[1]. Sudan's abundant potential to harness renewable energy resources such as solar, wind, and biomass energy is evident. Nevertheless, there are challenges related to energy poverty in Butana Region that need to be addressed. Electrifying underserved areas, particularly in rural settings, demands a significant amount of required energy resources. The Sustainable Energy for All initiative aims to achieve universal access to modern energy services by 2030[2],[3]. The central assumption is that Butana's diverse sources of renewable energy are not being fully utilized. By focusing on sustainable enterprise geodatabase management systems utilizing GIS modeling, Geospatial analysis, and multi-criteria decision-making methods, it becomes possible to develop a sturdy framework for managing renewable energy resources. This involves determining data requirements, creating geodatabase schema, populating it with renewable energy data, Storage, and applications[4]. In order to maximize its potential for renewable energy production, Butana Region could adopt existing successful energy policies from other African and Asia countries. This would require careful planning and diligent alignment within an enterprise GIS architecture. Thorough review of the model among teams is necessary in order to optimize publication and maintenance[5]. The future research agenda for geospatial renewable energy analysis includes decentralized data storage, sensor data via internet of things (IoT), big data utilization, blockchain technology application, integration of 3D building models into GIS systems, implementation of cybersecurity measures, as well as advanced geovisualization techniques[6][7]. Ultimately, with careful planning and strategic implementation of an Enterprise Geodatabase Management System focusing on sustainable renewable energy resources in Butana, Sudan will play a critical role in achieving universal access to modern energy services while supporting global sustainable development goals [8],[9]. An Enterprise Geodatabase Management System (EGDBMS) is a system that allows for the convenient management, querying, and modification of data, improving working efficiency and data safety performance [10]. It involves the use of a database server module for integrated data management [11]. Additionally, the system can store information in a cloud server, allowing for easy querying, retrieval, and downloading of electronic archives, facilitating resource integration and improving working efficiency [12]. The system also enables information networking through a cloud database, eliminating geographical limitations and allowing for anytime, anywhere access to needed information [13]. Furthermore, the system can carry out online management of enterprises through user classification, making information networked and more convenient to work with [14]. The system adopts a B/S operating mode,

eliminating the need for program installation on user terminals and allowing for information management unaffected by geographical limitations [15],[16],[17].

The Versioning allows multiple users to modify the same data in an ArcSDE Geodatabase for renewable energy in Butana Region (in Sudan) without imposing locks or duplicating data. This feature ensures that users consistently access an ArcSDE geodatabase for renewable energy in Butana Region (in Sudan) through a version, facilitating seamless collaboration and editing capabilities while upholding data integrity. Furthermore, versioning is crucial for maintaining transaction processing, particularly in the context of geospatial technology, where transactions are typically prolonged and extensive. By supporting multiple transactions on the data, versioning guarantees that all edits and changes are meticulously tracked and managed, providing a comprehensive record of the geodatabase's for renewable energy in Butana Region (in Sudan) evolution. Additionally, versioning is closely linked to archiving as it permits the creation of historical versions of transactional data. This historical data is vital for monitoring changes over time and examining the progression of renewable energy resources for renewable energy in Butana Region (in Sudan). Archiving complements versioning by storing previous transactional versions, contributing to a comprehensive database of historical information. In addition to these advantages, versioning also strengthens user access and security measures within the geodatabase. It enables effective control over user roles and permissions, ensuring that authorized users can access specific versions based on their needs. This level of user access control is critical for upholding data integrity and security within the geodatabase. In conclusion, comprehending versioning concepts and benefits is essential for maximizing the potential of an enterprise geodatabase management system for renewable energy resources in Butana Region (in Sudan). It establishes a sturdy foundation for collaborative editing, comprehensive historical tracking, efficient user access controls, and robust security measures within the Geodatabase for renewable energy in Butana Region (in Sudan) [18][19][20].

When delving into the replication options and considerations for Renewable Energy Resources in Butana Region (in Sudan), it is vital to grasp the different types of replicas and their practical applications. Geodatabase replication Renewable Energy Resources in Butana Region (in Sudan) enables the distribution of data across multiple geodatabases for Renewable Energy Resources in Butana Region (in Sudan), which is crucial for scenarios such as mobile users and field crews, copies of data at various organizational levels, and production and publication geodatabases Renewable Energy Resources in Butana Region (in Sudan). It supports both LAN and WAN environments, facilitating synchronization between local and remote geodatabases for Renewable Energy Resources in Butana Region (in Sudan) [21].An essential concept in geodatabase replication for Renewable Energy Resources in Butana Region (in Sudan) is the capability to replicate specific versions, datasets, or subsets of features within selected datasets. This flexibility allows for efficient data distribution based on the specific needs of different user groups or geographic facilities[22].Considering versioning concepts and benefits is also important when implementing geodatabase replication. Version management plays a significant role in ensuring data integrity and tracking changes across distributed geodatabases. By comprehending versioning concepts, organizations can effectively implement version management in the replicated geodatabases for Renewable Energy Resources in Butana Region (in Sudan) [23],[24]. Another critical consideration is the implementation of security measures to protect the replicated geodatabases for Renewable Energy Resources in Butana Region (in Sudan). Identifying security risks and vulnerabilities is crucial for applying appropriate security measures to safeguard the distributed renewable energy data. This involves defining user roles and permissions, implementing user access controls, and considering encryption methods to protect sensitive information [25]. Furthermore, organizations should define archiving policies and requirements for the replicated geodatabases for Renewable Energy Resources in Butana Region (in Sudan). Implementing data archiving strategies ensures that historical data is preserved and can be accessed when needed. This is particularly important for tracking changes over time in renewable energy resources and maintaining a comprehensive dataset for future analysis [26]. Overall, exploring replication options and considerations for a geodatabase for Renewable Energy Resources in Butana Region (in Sudan) involves understanding use cases, versioning concepts, security measures, and archiving policies. By addressing these factors, organizations can effectively distribute renewable energy data across multiple geodatabases for Renewable Energy Resources in Butana Region (in Sudan) while ensuring data integrity, security, and accessibility [27][28].

Establishing user roles and permissions within an enterprise geodatabase for Renewable Energy Resources in Butana Region (in Sudan) is a critical aspect of efficient and secure data management. As previously mentioned, the process of defining user roles and permissions includes granting Data Definition Language (DDL) privileges to create, alter, or drop objects in the database. This responsibility lies with the database administrator, who can utilize database tools to assign these privileges [29]. Individual data owners also have a role in managing user access by controlling Data Manipulation Language (DML) privileges on their datasets. They have the authority to grant privileges to other users or groups, allowing them to select, insert, update, or delete records in their tables and feature classes. This procedure can be managed through wizards in ArcGIS Pro or by using geoprocessing tools [30]. It is worth noting that the required privileges are determined by a person's role within the organization. Therefore, specific help pages for each supported database management system offer detailed information on this matter. Furthermore, defining user roles and permissions encompasses implementing user access controls within the Geodatabase for Renewable Energy Resources in Butana Region (in Sudan) as a way to enforce security measures and ensure that data is only accessed by authorized personnel [31]. In summary, defining user roles and permissions entails a collaborative effort between the database administrator and individual data

owners to effectively manage access while upholding security and integrity within the enterprise geodatabase for renewable energy [32][33][34]. Safeguarding an enterprise geodatabase for Renewable Energy Resources in Butana Region (in Sudan) requires a thorough identification of security risks and vulnerabilities. With the growing emphasis on sustainable energy systems, it is imperative to guarantee the security of the geodatabase against potential threats that could jeopardize the confidentiality and integrity of renewable energy data(Solar, wind, biomass energy) [35]. Among the primary security risks for geodatabases in the context of renewable energy in Butana Region(in Sudan) is the potential for unauthorized access to sensitive information. This encompassess exclusive data related to renewable energy sources, infrastructure, and development plans. Unauthorized access could result in data breaches and compromise the competitiveness of renewable energy projects[36]. Another critical security vulnerability that demands attention is the risk of cyber-attacks. Geodatabases housing valuable renewable energy data are alluring targets for malicious actors seeking to disrupt or pilfer information. Therefore, robust cybersecurity measures such as hacking, malware, or denial-of-service attacks must be implemented to protect against potential threats[37]. Moreover, ensuring data integrity and reliability is vital for geodatabases managing renewable energy resources in Butana Region (in Sudan). Any compromise in data integrity could have significant implications for decision-making processes concerning renewable energy projects and investments. As a result, measures such as encryption, data validation, and regular backups need to be implemented to safeguard against potential integrity issues[38]. Additionally, compliance with relevant regulations and standards is indispensable for securing a geodatabase for Renewable Energy Resources in Butana Region (in Sudan). This involves adhering to industry-specific guidelines as well as broader data protection laws to ensure that the handling of sensitive renewable energy data meets legal requirements. In conclusion, identifying security risks and vulnerabilities in a for Renewable Energy Resources in Butana Region (in Sudan) entails addressing potential threats related to unauthorized access, cyber-attacks, data integrity, and regulatory compliance. By implementing robust security measures, it is possible to mitigate these risks and ensure the secure management of valuable Renewable Energy Resources in Butana Region (in Sudan) [39][40][41][42],[43].

Establishing effective archiving policies and requirements is essential for the efficient management of a geodatabase for Renewable Energy Resources in Butana Region (in Sudan). Geodatabase archiving for Renewable Energy Resources in Butana Region (in Sudan) offers the functionality to document and access changes made to data in a geodatabase, enabling organizations to preserve and manage data modifications. By enabling geodatabase archiving, organizations can address common inquiries about their renewable energy data, such as the value of a specific attribute at a particular time or how a specific feature has evolved over time,[44],[45] [46][47].

2. Methodology

There are five phases to Develop enterprise Geodatabase renewable energy resources: GIS Data Model, Design Geodatabase, Version Geodatabase, Distribution Geodatabase, and Archive Geodatabase.

2.1. Design Renewable Energy GIS Data Model [48]: here we should design GIS -Data Model throw three Steps: Conceptual Model (identify business requirement, identify thematic layers, identify required applications, and document), Logical Model (Define tabular database structure, Define relationships, Determine spatial properties, and document), and Physical Model (Create and implement model design, generate physical schema in the RDBMS/ FGDB, Test and validate, and document). To design an effective GIS data model for renewable energy Butana Region (in Sudan), it is essential to analyze solar radiation maps, wind speed data, and geographical information to identify suitable locations for solar farms and wind energy systems based on the available resources and potential sites for renewable energy projects. The GIS data model should also integrate data from sources such as the Global Solar Atlas, Global Wind Atlas, Multi-Criteria Analysis for Planning Renewable Energy (MapRE), and other relevant datasets to provide a comprehensive view of the Butana Region (in Sudan) renewable energy potential.

2.2. Develop Renewable Energy Geodatabase: here we should develop Geodatabase throw five Steps (ADDIE): Analysis, Design, Develop, Implementation, Evaluation. In summary, determining the data requirements for the Enterprise Geodatabase Management System entails a comprehensive analysis of both current renewable energy resources in the Butana Region (in Sudan) as well as future prospects. It involves evaluating geographical aspects, distribution patterns, environmental assessments, investment projects, and application of new renewable sources of energy.

2.3. Renewable Energy Versioning Geodatabase: here we should implement of version management in the geodatabase for Renewable Energy Resources in Butana Region (in Sudan) involves establishing versioning specifications and workflows, defining how versions will be handled, and leveraging geodatabase replication for Renewable Energy Resources in Butana Region (in Sudan) whenever possible. These steps are essential for ensuring efficient collaboration among multiple users while maintaining data integrity and accessibility[49]

2.4. Renewable Energy Distributing Geodatabase : proficiently setting up and managing geodatabase replication for renewable energy involves understanding use cases, establishing data requirements, versioning concepts, user access controls, security measures, among other factors. By adhering to best practices in configuring replication for renewable energy resources in

Sudan, organizations can ensure that their geodatabases are effectively synchronized across different locations while upholding data integrity and security[50]. the management of user access controls within the renewable energy Geodatabase entails the assignment of permissions at various levels, including DDL and DML privileges based on specific roles and responsibilities within the organization [51]. identifying security risks and vulnerabilities in a Geodatabase for renewable energy resources in Butana Region (in Sudan) entails addressing potential threats related to unauthorized access, cyber-attacks, data integrity, and regulatory compliance. By implementing robust security measures, it is possible to mitigate these risks and ensure the secure management of valuable renewable energy resources.

2.5. Renewable Energy Archiving Geodatabase : establishing archiving policies and requirements for managing a geodatabase for Renewable Energy Resources in Butana Region (in Sudan) involves thoughtful consideration of data management practices and security measures. By implementing effective archiving policies, organizations can ensure that their renewable energy data is preserved, accessible when necessary, and safeguarded from potential risks or threats[52].

3. Results

This research to discuss and implementation the enterprise Geodatabase for renewable energy (solar, wind, and biomass energy) in Butana Region (in Sudan).

Designing a GIS Data Model for Renewable Energy in Butana Region (in Sudan) requires a thorough understanding of the specific requirements and needs of the renewable energy sector in the region. Butana Region (in Sudan) is abundant in solar irradiation, wind energy, hydropower, geothermal, and biomass resources, with an annual radiation range that surpasses the global average and ample unused land available for renewable energy development. Furthermore, Solar, wind, and biomass energy has been identified in various areas of Butana Region (in Sudan), indicating further opportunities for tapping into diverse renewable energy sources. Additionally, populating the geodatabase with renewable energy data is crucial for creating an accurate representation of the available resources[53]. Gathering information on solar radiation, wind speeds, and biomass resources will create a detailed database that can guide planning and decision-making in the renewable energy sector. By developing a robust GIS data model tailored to Sudan's renewable energy landscape, it becomes possible to harness the full potential of diverse sources such as solar, wind, and biomass resources[54]. This sets the stage for informed decision-making and strategic planning to maximize sustainable energy production in Butana Region (in Sudan). Also we need many steps to integrity and validation strategies of data renewable energy resources : Don't allow start editing(read only users, without land base layers), No inserts without pre-requisite checks(Out side of editing areas, street light without Poles, Equipment without structures, required attribute values (WO Number, Number of Phrases, etc) in attribute columns), Reconcile/Save edits only after rules validation (Domain checks, Connectivity rules), allow to post data with warnings (Run batch processes to perform additional checks)). Moreover, when implementing the physical Geodatabase for renewable energy, it is essential to prototype, test, review, and refine the design. Attention should be dedicated to factors such as projection on-the-fly costs, density of features, spatial placement vs. logical placement, and data update cycles. These aspects can significantly impact functionality and usability [55][56][57]. In order to establish the data needs for the Enterprise Geodatabase Management System for Renewable Energy Resources in Butana Region (in Sudan), it is crucial to take into consideration a variety of factors. Butana Region (in Sudan), with its favorable climate and extensive land areas, holds significant potential for utilizing renewable energy sources such as solar, wind, and biomass energies. This necessitates designing the Geodatabase to accommodate data related to these diverse energy sources[58]. When developing a geodatabase schema for renewable energy(Solar, Wind, Biomass energy), it is crucial to carefully consider the conceptual, logical and physical relationships of the data within the Geodatabase. Furthermore, comprehending the current energy situation and distribution of energy production and consumption according to various sources in Butana Region (in Sudan) is imperative. Here we are focusing on three resources (Solar, Wind, Biomass energy), and we select apply Solar Energy in Khartoum State and Gazera State, Wind Energy in North State and Nile River State and Biomass in Kasala State and Gadarf State. In addation to design 4 Dataset (GeoLocation, Energy, Environment, and Economic.)

It is also vital to take into account the necessity for SQL support, collaborative editing, and long transactions. Ensuring functionality and seamless data access for multiple users and states concurrently is equally important. The schema design should also encompass quality control and assurance measures to uphold data accuracy [59].Incorporating renewable energy data into the Geodatabase for renewable energy is a critical step in harnessing Sudan's renewable energy resources. With the availability of geodata services from ArcGIS Server, remote access to the Geodatabase for renewable energy becomes feasible, enabling querying, data extraction, and replication operations. This creates opportunities to populate the geodatabase with renewable energy data from various sources, including assessments of solar and wind potential, studies on economic viability, and geographic information system (GIS) based multi-criteria decision-making methods [60].The schema must uphold data integrity and quality, reflecting the structure and organization of the data elements such as dataset, feature classes, tables, domains, and relationships.

We selected five functions to enterprise Geodatabase for renewable energy in Butana Region (in Sudan): Renewable Energy Versioning Geodatabase, Renewable Energy Replications Geodatabase, Renewable Energy User Access Geodatabase, And Renewable Energy Archiving Geodatabase

we need to versioning type as traditional versioning and branch versioning. The implementation of version management in the geodatabase is a critical factor in ensuring the efficient and effective utilization of renewable energy resources in Butana Region (in Sudan). Versioning allows multiple users to edit the same data in an ArcSDE geodatabase without imposing locks or duplicating data. It is crucial to establish versioning specifications and workflows, including elements such as versioning structure, reconcile, post, and compress regimes, and edit volumes to handle multiple transactions on the data. This ensures a streamlined platform for collaborative data editing. When implementing version management, it is important to carefully consider how versions will be handled. This involves determining aspects such as lifespan, conflict management, naming conventions, structure, security, and workflow management systems for handling versions. Through careful planning and definition of these aspects, organizations can optimize the geodatabase for Renewable Energy Resources in Butana Region (in Sudan) for multiuser editing while maintaining data integrity and security. Furthermore, leveraging geodatabase replication for Renewable Energy Resources in Butana Region (in Sudan) when possible is essential as it provides support for the full geodatabase data model for Renewable Energy Resources in Butana Region (in Sudan), including topologies, networks, terrains, relationships, etc., while avoiding limits or complexities associated with other methods. Replication plays a crucial role in improving access to data and enhancing performance by placing the data close to users within an enterprise environment [61].

Geodatabase replication serves as a crucial tool for dispersing data across multiple geodatabases for Renewable Energy Resources in Butana Region (in Sudan), particularly in the realm of managing enterprise-level renewable energy resources. There are various scenarios in which geodatabase replication proves beneficial, such as supporting mobile users and field crews, creating duplicates of data at diverse organizational levels and geographic facilities, and replicating production and publication geodatabases. Replication can be executed over LAN or WAN connections, allowing for the synchronization of local and remote geodatabases for Renewable Energy Resources in Butana Region (in Sudan). When setting up and overseeing geodatabase replication for Renewable Energy Resources in Butana Region (in Sudan), it is imperative to ascertain the data requirements and devise a schema that aligns with the specific needs of the renewable energy sector. This encompasses deliberating on the types of replicas required, such as one-way or two-way replication, while also pinpointing the source and target geodatabases. An essential consideration when configuring replication for renewable energy is version management. Grasping versioning concepts and benefits is paramount when integrating version management in the geodatabase to ensure that updates and changes are accurately tracked and synchronized across replicas. Another crucial aspect of configuring geodatabase replication for Renewable Energy Resources in Butana Region (in Sudan) is regulating user access. Defining user roles and permissions aids in controlling who can make alterations to the replicated data, guaranteeing that only authorized personnel can access and amend information in the Geodatabase for Renewable Energy Resources in Butana Region (in Sudan). Finally, security measures must be applied to safeguard the replicated geodatabase for Renewable Energy Resources in Butana Region (in Sudan) from potential risks and vulnerabilities. This entails identifying security risks specific for Renewable Energy Resources in Butana Region (in Sudan) data and instituting appropriate measures to uphold the integrity and confidentiality of the information [62].

To effectively manage user access controls within the renewable energy Geodatabase in Butana Region(in Sudan), it is crucial to assign permissions to user accounts, groups, or roles in order to enable them to carry out necessary tasks. The responsibility of granting Data Definition Language (DDL) privileges to create, alter, or drop database objects falls on the shoulders of the database administrator and can be executed using specialized database tools. Moreover, individual data owners play a key role in regulating Data Manipulation Language (DML) privileges on their datasets and have the authority to bestow these privileges upon other users or groups, permitting them to perform actions such as selecting, inserting, updating, and deleting records within tables and feature classes. In addition, those managing datasets in an enterprise Geodatabase for Renewable Energy Resources in Butana Region (in Sudan) are tasked with not only adding datasets but also providing other users with access to the data. Their responsibilities also include maintaining networks, defining topological relationships and rules, creating domains, defining subtypes, enabling editor tracking, defining attribute rules, enabling archiving or versioning, as well as altering the table schema. Furthermore, geodatabase administrators must take ownership of all the database objects that constitute an enterprise Geodatabase for Renewable Energy Resources in Butana Region (in Sudan) and undertake specific maintenance tasks related to geodatabase management. It is important to note that they do not require as many privileges within the database management system as traditional database administrators [63].

The types of users like Editors, Managers, Administrators, Views, and Stakeholders. The type of access granted can be any like, read-only, read, and write. There are two methods are using to access control: Privileges (Geodatabase/System/Object Privileges), and Roles (Reduced privilege administration, Dynamic privilege management, Application-specific security). There are Three Stages to Enterprise Geodatabase Manage Users Access Renewable Energy Resources: Accounts, Rules & Privileges, and Connect. Safeguarding an enterprise Geodatabase for for Renewable Energy Resources in Butana Region (in Sudan) requires a thorough identification of security risks and vulnerabilities. With the growing emphasis on sustainable energy systems, it is imperative to guarantee the security of the Geodatabase for Renewable Energy Resources in Butana Region (in Sudan) against potential threats that could jeopardize the confidentiality and integrity of renewable energy data. Among the primary security risks

for geodatabases in the context of renewable energy in Butana Regio (in Sudan) is the potential for unauthorized access to sensitive information. This encompassess exclusive data related to renewable energy sources, infrastructure, and development plans. Unauthorized access could result in data breaches and compromise the competitiveness of renewable energy projects. Another critical security vulnerability that demands attention is the risk of cyber-attacks. Geodatabases housing valuable renewable energy data (Solar, wind, and biomass energy) are alluring targets for malicious actors seeking to disrupt or pilfer information. Therefore, robust cybersecurity measures such as hacking, malware, or denial-of-service attacks must be implemented to protect against potential threats. Moreover, ensuring data integrity and reliability is vital for geodatabases managing renewable energy resources in Butana Region(in Sudan). Any compromise in data integrity could have significant implications for decision-making processes concerning renewable energy projects and investments. As a result, measures such as encryption, data validation, and regular backups need to be implemented to safeguard against potential integrity issues. Additionally, compliance with relevant regulations and standards is indispensable for securing a geodatabase for renewable energy resources in Butana Region (in Sudan). This involves adhering to industry-specific guidelines as well as broader data protection laws to ensure that the handling of sensitive renewable energy data meets legal requirements[64][65].

Geodatabase archiving for Renewable Energy Resources in Butana Region (in Sudan) captures changes from the moment it is activated until it is deactivated, allowing users to connect to historical versions of the data. Historical versions present a read-only representation of the geodatabase at a specific moment in time, allowing users to easily examine data changes[66],[67]. To define archiving policies and requirements effectively, organizations must take into account factors such as data needs, schema creation, populating the geodatabase with renewable energy data (Solar. Wind, and Biomass), and version management. Establishing user roles, permissions, and access controls is also crucial to ensure that only authorized users can access and modify renewable energy data in the Geodatabase Renewable Energy Resources in Butana Region (in Sudan). Additionally, organizations should identify security risks and vulnerabilities related to their renewable energy geodatabases and implement security measures to safeguard the data from unauthorized access or breaches. This involves implementing encryption mechanisms, access controls, and other security measures as necessary. Furthermore, defining archiving policies includes determining what data needs to be archived, how frequently it should be archived, and under what conditions. Implementing strategies for archiving historical versions of renewable energy data enables organizations to maintain comprehensive records of changes over time

4. Conclusion

There are many results: design a GIS data model for renewable energy in Butana Regions (Energy, Environment, and Economic Model). Design Geodatabase for renewable energy (Solar, wind, and biomass energy) in Butana Region (in Sudan). Implementation the Versioning, Replication, manage Users Access, Secure, and Archiving for Renewable Energy Resources in Butana Region (in Sudan country), in additionally apply Solar Energy in Khartoum State and Gazera State, Wind Energy in North State and Nile River State and Biomass in Kasala State and Gadarf State. In addation to design 4 Dataset (GeoLocation, Energy, Environment, and Economic). The future research: using AI, Big data, IoT, Cyber Security, Data Cloud, and Remote Sensing for Enterprise Geodatabase Management System for Renewable Energy Resources.

References

[1] Esri. "Planning: Enterprise Geodatabase Solutions". Aug 2013. [Online]. Available: https://proceedings.esri.com/library/userconf/proc13/tech-workshops/tw_432.pdf
[2] Enterprise Geospatial Database Develop Coronavirus Disease (Covid-19), TAT Ali, Rihan Journal for Scientific Publishing, 2022.
[3] Museum Tourism in Khartoum, Analysis and Decision Sudan: A Geoinformatics Support System, TAT Ali, S Subair, H AlEisa, Proceedings of the International Conference on Image Processing, Computer , 2017
[4] Geospatial Economic Crisis Response Gas Station, TAT Ali, Asian Research Journal of Current Science 4 (1), 197-204, 2022
[5] r. ck. "Thesis Report On". Mar 2019. [Online]. Available: https://kth.diva-portal.org/smash/get/diva2:1293378/FULLTEXT01.pdf
[6] S. "Geospatial Technology Renewable Energy Trends & Opportunities & Futures Research". Apr 2023. [Online]. Available: https://globalpresshub.com/index.php/ABAARJ/article/download/1526/1297
[7] T. A. T. Ali and Taha Alfadul.Taha Ali. "Geospatial Technology Renewable Energy Trends & Opportunities & Futures Research, Asian Basic and Applied Research Journal 5(4): 12-15, 2022;Article no.ABAARJ.923". Mar 2022. [Online]. Available: https://www.researchgate.net/publication/359939070_Geospatial_Technology_Renewable_Energy_Trends_Opportunities_Futures_Research_Asian_Basic_and_Applied_Research_Journal_54_12-15_2022Article_noABAARJ923
[8] Geospatial Technology Renewable Energy Trends & Opportunities & Futures Research, TAT Ali, Asian Basic and Applied Research Journal 5 (4), 12-15, 2022
[9] GIS-based Model: 5A's Business Tourisms Attractions Tourism, Accommodations, Access Transportation, Amenity Service, Awareness, TAT Ali, Asian Research Journal of Current Science, Indian 4 (1), 188-196, 2022

[10] Li, D. "Enterprise information management system." Accessed: 01 Jun 2016.
[11] Zhu, B. "Enterprise management system."Available: 21 Dec 2018.
[12] Feng, T. "Enterprise information management system." [Online]. Available: [Accessed: Month Day, Year].
[13] Shi, X., Jing, X. "Enterprise data management system." 05 Apr 2017.
[14] "Geographic data management."Accessed: 01 Jan 2023.
[15] GeoSpatial Technology Documental Historical Tourism Site: Turkey in Khartoum, TAT Ali, JCCO Joint International Conference on ICT in Education and Training,2018
[16] Geospatial-Enable Hotels Call Center in sudan, TAT Ali, Sudanese Journal of Computing and Geoinformatics, 2018t
[17] Business Hotels Tourism Sites in Khartoum, TAT Ali, GIS Web-based,Sudan (1-5), 2018
[18] lot. "PPT - Geodatabase Versioning, Replication, and Archiving PowerPoint Presentation - ID:280850". Mar 2012. [Online]. Available: https://www.slideserve.com/lot/geodatabase-versioning-replication-and-archiving
[19] "GeoDB, ESRI Geodatabase ArcSDE". Aug 2011. [Online]. Available: https://www.loc.gov/preservation/digital/formats/fdd/fdd000329.shtml
[20] Geoinformatics distribution Reality Analysis For Sustainable Business Tourism Development, TAT Ali, Gadarif University Journal Of Humanity Science(ISSN:1858-8840) 3 (1), 2017
[21] Space Technology and Development (Social, Economic and Environment), TAT Ali, Digital Transformation Towards Efficiency and Excellence 1 (1), 1-13, 2023
[22] GIS UML-based Business Object Modelling: Renewable Energy, TAT Ali, International Journal of Engineering and Information Systems (IJEAIS), 2022
[23]Sudanese Enterprise Museum System - SEMS, TAT Ali, Algulzum Scientific Journal(ISSN:1858-9766) 1 (11), 55-74
[24] GIS-based Analysis : Water & wastewater Distribution Network, TAT Ali, M Daleel, Algulzum Scientific & Security& Strategy Journal, 8 (1), 133-148, 2021
[25] Geoinformatics Tourism Optimal Site Selection Analysis, Khartoum, Sudan, TAT Ali, Academic Journal of Research and Scientific Publishing| AJRSP, 2020
[26] GIS-based DSS Data Model Business Tourism in Sudan, TAT Ali, Sudanese Journal of Computing and Geoinformatics , 2017.
[27] "Managing Distributed Data with Geodatabase Replication. Patrisha Wells - PDF Free Download". (accessed Jan 09, 2024). [Online]. Available: https://docplayer.net/92343573-Managing-distributed-data-with-geodatabase-replication-patrisha-wells.html
[28] "GeoDB, ESRI Geodatabase ArcSDE". Aug 2011. [Online]. Available: https://www.loc.gov/preservation/digital/formats/fdd/fdd000329.shtml
[29]Data Model Business Tourism in Sudan, TAT Ali, DSS GIS-based
Sudanese Journal of Computing and Geoinformatics, Geoinformatics Center, 2017
[30] GIS Data Model Solar Energy Development, TAT Ali, R Saeed, G Hayder, 1st Science Engineering Technology and Sustainability International , 2021
[31] Geospatial Big Data Analytics Applications Trends, Challenges & Opportunities.TAT Ali, Asian Basic and Applied Research Journal, India 5 (3), 1-5, 2022
[32] "Geodatabase management-ArcGIS Pro | Documentation". May 2022. [Online]. Available: https://pro.arcgis.com/en/pro-app/3.0/help/data/geodatabases/introduction/geodatabase-administration.htm
[33] "Enterprise geodatabases and ArcGIS Enterprise-ArcGIS Server | Documentation for ArcGIS Enterprise". Jun 2023. [Online]. Available: https://enterprise.arcgis.com/en/server/11.1/manage-data/windows/enterprise-geodatabases-and-arcgis-enterprise.htm
[34] Geoinformatics Technology Distributed Geospatial Database Development for Economic Crisis Management and Natural Disasters, TAT Ali, Academic Journal of Research and Scientific Publishing| AJRSP(2706-6495) 35, 2022
[35] Geoinformatics Applications : Tourisms Applications System, TAT Ali, M Daleel, Algulzum Scientific Journal, 17 (1), 2022
[36] Geospatial Technology Archaeologies: Gari Region, TAT Ali, Academic Journal of Research and Scientific Publishing| AJRSP, 34 , 2022
[37] Spatial Statistics Nearest Neighbor Distribution Analysis For Tourism& Archaeology In Khartoum, Sudan, TAT Ali, Journal of The Faculty of Science and Technology (JFST),2019
[38] GIS & RS-Based Archaeologies Site Documents: Gari Region, Khartoum, Sudan, TAT Ali, JCCO Joint International Conference on ICT in Education and Training. 2018
[39] T. A. L. F. A. D. U. L. T. Ali. "Geospatial Technology Renewable Energy Trends & Opportunities & Futures Research". Jan 2022. [Online]. Available: https://www.academia.edu/3125556/Geospatial_Technology_Renewable_Energy_Trends_and_Opportunities_and_Futures_Research
[40] S. Shah, K. I. Al-Sulaiti, J. Abbas and Q. Zhang. "Waste management, quality of life and natural resources utilization matter for renewable electricity generation: The main and moderate role of environmental policy". Jun 2023. [Online]. Available: https://www.researchgate.net/publication/371370351_Waste_management_quality_of_life_and_natural_resources_utilization_matter_for_renewable_electricity_generation_The_main_and_moderate_role_of_environmental_policy
[41] "How To: Migrate an On-Premises Enterprise Geodatabase in SQL Server to Azure SQL Database". Oct 2022. [Online]. Available: https://support.esri.com/en-us/knowledge-base/how-to-migrate-an-onpremises-enterprise-geodatabase-in-000023991
[42]GIS-based E-Promotion: Prehistoric Sudan: The Mesolithic and Neolithic Periods, TAT Ali, GIS&Geospace Applications Journal.
[43] GIS-based Reality Analysis: Business Hotels Tourism In Khartoum State, TAT Ali, Red Sea University Journal of Basic and Applied Science, 2017
[44] GMGD: Geospatial Measuring Geographic Distributions Cellular Phone Towers, TAT Ali, International Journal of Engineering and Information Systems (IJEAIS), 6 ,4 , 2022
[45] GIS-based web Application Marketing: Turkey Historical Site in Khartoum, TAT Ali, Rihan Journal for Scientific Publishing, 2022
[46] "Geodatabase archiving-ArcMap | Documentation". Sep 2021. [Online]. Available: https://desktop.arcgis.com/en/arcmap/latest/manage-data/geodatabases/geodatabase-archiving.htm
[47]] "Enterprise geodatabases and ArcGIS Enterprise-ArcGIS Server | Documentation for ArcGIS Enterprise". Jun 2023. [Online]. Available: https://enterprise.arcgis.com/en/server/11.1/manage-data/windows/enterprise-geodatabases-and-arcgis-enterprise.htm

[48] GIS Data Model Solar Energy Development, TAT Ali, R Saeed, G Hayder, 1st Science Engineering Technology and Sustainability International , 2021
[49] . "Planning: Enterprise Geodatabase Solutions". Aug 2013. [Online]. Available: https://proceedings.esri.com/library/userconf/proc13/tech-workshops/tw_432.pdf
[50] "Managing Distributed Data with Geodatabase Replication. Patrisha Wells - PDF Free Download". (accessed Jan 09, 2024). [Online]. Available: https://docplayer.net/92343573-Managing-distributed-data-with-geodatabase-replication-patrisha-wells.html
[51] "Enterprise geodatabases-ArcGIS Server | Documentation for ArcGIS Enterprise". Jan 2022. [Online]. Available: https://enterprise.arcgis.com/en/server/10.9/manage-data/windows/enterprise-geodatabases-and-arcgis-enterprise.htm
[52] lot. "PPT - Geodatabase Versioning, Replication, and Archiving PowerPoint Presentation - ID:280850". Mar 2012. [Online]. Available: https://www.slideserve.com/lot/geodatabase-versioning-replication-and-archiving
[53] A.M. Omer. "Overview of renewable energy sources in the Republic of the Sudan". Jun 2002. [Online]. Available: https://www.researchgate.net/publication/222322217_Overview_of_renewable_energy_sources_in_the_Republic_of_the_Sudan
[54] T. A. T. Ali and Taha Alfadul.Taha Ali. "Geospatial Technology Renewable Energy Trends & Opportunities & Futures Research, Asian Basic and Applied Research Journal 5(4): 12-15, 2022;Article no.ABAARJ.923". Mar 2022. [Online]. Available: https://www.researchgate.net/publication/359939070_Geospatial_Technology_Renewable_Energy_Trends_Opportunities_Futures_Research_Asian_Basic_and_Applied_Research_Journal_54_12-15_2022Article_noABAARJ923
[55] Esri. "Planning: Enterprise Geodatabase Solutions". Aug 2013. [Online]. Available: https://proceedings.esri.com/library/userconf/proc13/tech-workshops/tw_432.pdf
[56] "How To: Migrate an On-Premises Enterprise Geodatabase in SQL Server to Azure SQL Database". Oct 2022. [Online]. Available: https://support.esri.com/en-us/knowledge-base/how-to-migrate-an-onpremises-enterprise-geodatabase-in-000023991
[57] "What are the steps to create a geodatabase?". (accessed Jan 09, 2024). [Online]. Available: https://www.linkedin.com/advice/1/what-steps-create-geodatabase-skills-geographic-information-syst
[58] "Prospects of Renewable Energy in Sudan". Dec 2022. [Online]. Available: https://irispublishers.com/gjes/pdf/GJES.MS.ID.000742.pdf
[59] S. Shah, K. I. Al-Sulaiti, J. Abbas and Q. Zhang. "Waste management, quality of life and natural resources utilization matter for renewable electricity generation: The main and moderate role of environmental policy". Jun 2023. [Online]. Available: https://www.researchgate.net/publication/371370351_Waste_management_quality_of_life_and_natural_resources_utilization_matter_for_renewable_electricity_generation_The_main_and_moderate_role_of_environmental_policy
[60] "Geodatabase replication and ArcGIS Server-ArcMap | Documentation". Sep 2021. [Online]. Available: https://desktop.arcgis.com/en/arcmap/latest/manage-data/geodatabases/geodatabase-replication-and-arcgis-server.htm
[61] lot. "PPT - Geodatabase Versioning, Replication, and Archiving PowerPoint Presentation - ID:280850". Mar 2012. [Online]. Available: https://www.slideserve.com/lot/geodatabase-versioning-replication-and-archiving
[62] Melia. "Microsoft Word - 9-3-1 Mobile Checklist B - Configure Replication.doc". Apr 2010. [Online]. Available: https://arcfmdirectorscut.typepad.com/files/9-3-1-mobile-checklist-b---configure-replication.pdf
[63] "Geodatabase management-ArcGIS Pro | Documentation". May 2022. [Online]. Available: https://pro.arcgis.com/en/pro-app/3.0/help/data/geodatabases/introduction/geodatabase-administration.htm
[64]] Esri. "Planning: Enterprise Geodatabase Solutions". Aug 2013. [Online]. Available: https://proceedings.esri.com/library/userconf/proc13/tech-workshops/tw_432.pdf
[65] "Geodatabase management-ArcGIS Pro | Documentation". May 2022. [Online]. Available: https://pro.arcgis.com/en/pro-app/3.0/help/data/geodatabases/introduction/geodatabase-administration.htm
[66] Enterprise GeoSpatial Database Development : Strategic Affairs in Sudan, TAT Ali, Journal of science & Space Technology,5, 56-64, 2019
[67] Agile Enterprise Geographic Information System (AEGIS) from design and development perspective, TAT Ali, RA Saeed, OO Khalifa, ES Ali, N Odeh, G Hayder, AA Hashim, 8th International Conference on Mechatronics Engineering (ICOM 2022), 26-31, 2022