

**Review**

## **Fostering environmental and resources management in Sudan through geo-information systems: A prospective approach for sustainability**

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### **Abstract**

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Environmental and land resource degradation is a serious problem that poses significant challenges in Sudan and worldwide generally. Despite the fact that the physical environment components are the underlying economic resources and production assets in developing countries like Sudan, and they directly affect the nation's socioeconomic aspects of income, health, water availability, food security, and many others. The interventions and protective measures were insufficient to meet the magnitude and extent of the ongoing degradation and resource wastage. Based on the analysis of the indicators and trends of the environmental and natural resources management 'status quo', this paper is an attempt to overview and investigate the state of environmental and natural resources management and governance in Sudan. Further discussion delves into the utilization of geo-information systems in Sudan's environmental and resource management by analyzing and reviewing "some previous case studies" where GIS approaches and techniques were deployed. The paper further strives to explore and highlight the opportunities and potential contributions of GIS in the context of Sudan's environmental and resource management. Lessons learned from the previous experiences were considered, and the recommendations for the future use of a tailored geo-information system in Sudan context were highlighted and suggested to support better practices and sustainability insights for environmental governance and resources management.

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### **Introduction**

Owing to its geographic location, Sudan lies in expanses of area that form a mosaic of different climatic and ecological regions. Thus, the country celebrates a diverse range of natural resources, including varied vegetation, fertile soils, abundant fresh water, and rich mineral deposits. Despite this, the country instead of being powerful and prosperous, a catastrophic situation prevailed, i.e., there are degraded environments, spoiled resources, a less

developed economy, and a weakened society (Siddig et al., 2019; Ali, 2022; Abdalla et al., 2023;).

The greater part of Sudan is characterized by fragile ecosystems, and more than two-thirds of the country's total area are drylands (UNEP, 2012). This is due to slower and limited natural restoration capacity, rapid land degradation, and environmental deterioration. However, there are other factors leading to exacerbation and worsening situations of the country's environment and natural resources, for instance, the ever-increasing pressure caused by

population growth, urbanization, and economic activities alongside weakened governance and institutions (Siddig, 2014).

Therefore, it was clearly stated in Sudan's first environmental outlook report (UNEP, 2020) and other official and UN reports, for instance (UNEP, 2007; FAO, 2010; FAO, 2015) that the environmental governance in Sudan is undermined and weakened due to lack of collaboration, integration, and networking among the official institutions acting and concerned with fields of environmental and natural resources management (Siddig, 2014; Siddig et al., 2019). This — in addition to the widespread institutionalized poverty, fragile ecosystems, and marginal environments — had, consequently, led to the prevalence of degraded environment and constantly deteriorating ecosystems' productivity.

A nation's economic and human development viability is exclusively dependent on how efficient and to what extent the nation exploits its resources, especially in the case of developing countries, such as Sudan, where the economies are well-known for their direct association with natural resources and primary economic activities. Therefore, natural resources are the backbone assets for the activities and production that fuel these economies. Environmental conservation and natural resource maintenance should be alphabetized in developmental procedures as a determinant factor when formulating development policies and decisions (Eltayeb, 1995; Dinh and Dinh, 2016; Sarkar et al., 2023; Orlandi, 2023).

Despite this significance and the adverse social, economic, and political consequences of environmental degradation, the planners and policymakers of Sudan's successive governments did not prioritize the maintenance of the environment and natural resources. Thus, there were reported cases of overexploitation and prioritizing production maximization without assuring environmental and land resources conservation (Eltayeb, 2011; Deafalla et al., 2019; Deafalla et al., 2021; Musa and Sahoo, 2023). Moreover, the government's rush to invest in land, such as the distribution of agricultural schemes, without having a land use map that governs and ensures strategic planning and efficient land use allocation is well documented. (Deafalla et al., 2021)

For this, balanced development strategies need to be adopted to enable sustaining the community and economy and getting the maximum out of the environment and resources along with conservation and degradation combating. The pressing necessity to manage all of these complexities and interrelated issues has led to a growing need for effective environmental and natural resources management in Sudan, which is solely possible through a computerized Geo-information system since the Geo-information systems (GIS) have emerged as a powerful tool for addressing this need. GIS provides the ability to integrate, analyze, and visualize large

amounts of spatial data (Bourrough, 1989; Richardson et al., 2013; Deafalla et al., 2019; Abdelrahman, 2021)

In the same context, the new advancements in information and communication technologies (ICT), such as internet telecommunication, data science analytics, and the advent of geospatial technologies of geographic information systems (GIS) and remote sensing (RS) have revolutionized the practices in the environmental and natural resources management (Kumar et al., 2015; Zhang et al., 2022) via provisioning mechanisms and tools for data storage, sharing, analyses, and modeling. For the sake of informed planning and decision-making. These technologies, likewise, serve as platforms for inter-institutional integration and collaboration.

The prime objective of this study is to provide a comprehensive overview of Sudan's environmental state and its related management and governance issues, then explore the effective environmental and resources management and the prospects of geospatial technologies utilization. The paper ultimately seeks to highlight the potentialities and optimum approaches for enhancing environmental and natural resources management in Sudan. The paper, furthermore, attempts to investigate the impacts brought to the field of environment and natural resources subsequent to the introduction and engagement of geospatial information technologies of GIS, GPS, RS, geo-portals, and spatial data infrastructures (SDI) and decision support systems, for purposes of better and sustainable environmental and resources management.

## Sustainability Challenges in Sudan and Geospatial Technologies Rationale

Natural resources and environmental management are critical for sustaining life on planet Earth. In Sudan, the state of the environment and natural resources is confronted with a number of critical, challenging, and threatening factors to these resources and environment, to mention some; population growth, climate change (Ahmed, 2020; Abdelrahman, 2021), the rapid transformation in land use and its patterns, competition over control and access to lands, urbanization, and others. Together, these factors exhausted the environment and resulted in food insecurity, institutionalized poverty, and increasing tensions and conflicts (Egemi, 2017; Musa and Sahoo, 2023).

Another factors, rather than the aforementioned ones, leading to an increasing state of environmental deterioration in Sudan, as a developing state, is the lack of political will for balanced and sustainable development. This is reflected in neglecting environmental maintenance and poverty alleviation as well as the lower investment in economic development, and other civil sectors facilities. Most of the budget is allotted to military expenditure leaving very little amount and minimal priority to human and economic development (Eltayeb, 2017; Sarkar et al.,

2023). Therefore, authorities acting in the field of environment and natural resources need—in their endeavor of overcoming fund and budgetary barriers—to find cost-effective and efficient tools and mechanisms to assist them in achieving their stated institutional goals of achieving sustainable environmental and natural resources management.

The use of geospatial technologies is an efficient solution. The technologies of geographical information systems (GIS) and remote sensing (RS) have become increasingly prevalent in environmental and resource management fields, as they provide means to visualize, analyze, and manage geographical data. Furthermore, vast amounts of data and information can be generated by these technologies to aid and enhance planning and decision-making, with minimal time and cost (Kumar et al., 2015; Shekhar and Aryal, 2019; Zhang et al., 2022).

Currently, utilizing GIS and RS technologies in natural resources and environmental management could have a significant impact on various sectors such as agriculture, forestry, water resources management, and others through providing solid, accurate, and up-to-date databases, monitoring mechanisms, and analytical environment, to utilize these data, to ultimately assist environmental and resources managers and practitioners in making informed decisions, developing enhanced and appropriate strategies and planning for future scenarios, and hence, more efficient and effective management of the environment and resources. (Samadzadegan et al., 2013; Kumar et al., 2015; Pei et al., 2021).

## Overview of Sudan's Environment and Natural Resources

Sudan occupies a very extensive size that lies in the tropics and varies from hyper-arid desert to sub-humid savannah, however, approximately 60%-70% of the country's total size falls into desert and semi-desert lands. Thus, the environment and natural resources in Sudan, despite being diverse and relatively abundant; especially, when comparing the lands with population density and distribution across the country. Due to this vulnerability and marginal environments, some scholars have argued against the collective belief of the richness of natural resources in Sudan (Abdalla and Nour, 2001; UNEP, 2012; Egemi and Ganawa, 2014; Mahgoub, 2014; Siddig, 2014; FAO, 2019) (Figure 1). These fragile arid and semi-arid ecosystems of Sudan are constantly deteriorating and exacerbating due to natural forces such as climate change, floods, ongoing desertification, and frequent drought strikes (Eltoum et al., 2015; USAID, 2016; Sax et al., 2023) which have severely affected the environment and resource bases such as forests, soil, and rangelands. However, these resources and environment are, similarly, confronted by very pressing anthropogenic factors such as the excessive pressure on the environment and natural resources stimulated by rapid urbanization and growth of both human and animal populations, in addition to the challenges of addressing the national priorities of economic development, food security (Ahmed, 2020; Mondal and Palit, 2022) water supply, public health, and others (Eltayeb, 2011; Mahgoub, 2014)

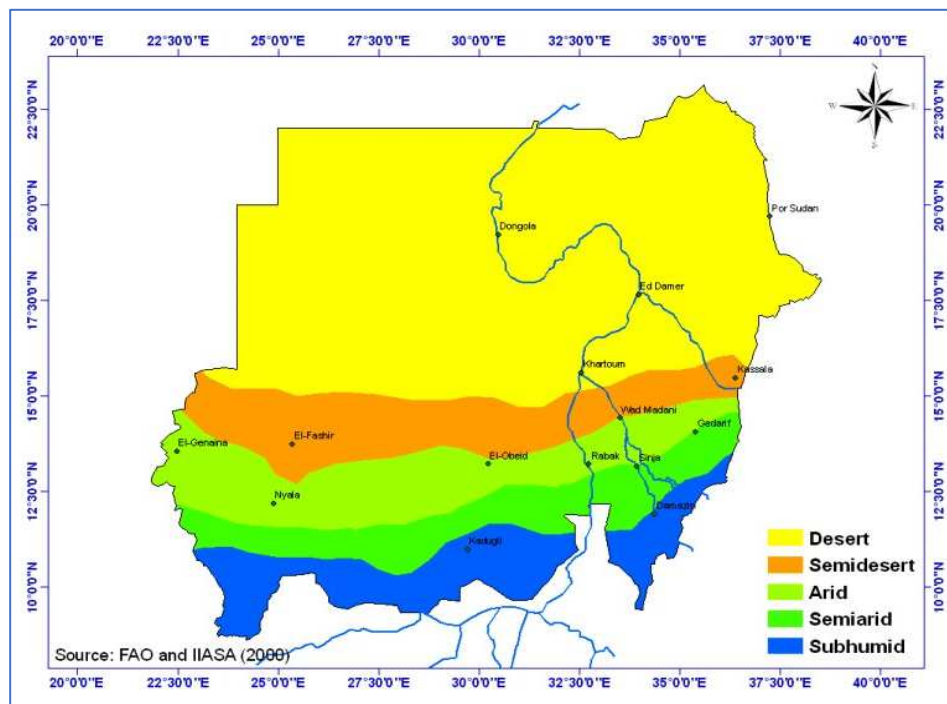


Figure 1. The spatial distribution of various Sudan ecological regions.  
Source: adopted from (Abdalla et al., 2013).

For this reason, Sudan, as Heul stated, is one of the countries vulnerable the most to environmental change or degradation, especially changes induced by extreme weather and uncertainties of climate change. (Heul, 2009). Therefore, Sudan should be alert to climatic variability and change, which is a significant influencer of its environment and vital natural resources for the major and productive economic sectors of agriculture and pastoralism (Hudo, 2016; Leal Filho et al., 2020; Mohamed, 2022). Numerous of other factors and witnesses prove and assure the state of extensive environmental degradation and natural resources deterioration in Sudan, to mention some of those remarkable adverse environmental changes, the country's grasslands are progressively declining. Estimates suggest that Sudan has lost 20% to 50% of its rangelands over the last few decades (Egemi, 2017; Alhelo et al., 2023; Alredaisy, 2023).

This indicates the fact that Sudan presently suffers from a severe problem of land degradation and irrational utilization and management of land. The most visible and remarkable resulting manifestations of irrational land utilization issues include reduced land capability and productivity, soil erosion, degradation of forests and rangelands, and general loss of biodiversity, all well documented (Zakieldeen et al., 2016; Egemi, 2017; Alhelo et al., 2023; Alredaisy, 2023) and others.

In the same context, the study of Ayoub (1998) examined land degradation in Sudan; and revealed that environmental degradation is remarkably embodied in the clearance of woodlands in wide land expanses where 76% of the country's population located, the lands have been degraded due to, overgrazing and soil deterioration, soils lost its chemical contents "due to nutrients loss", wind soil erosion in the arid parts and water soil erosion in the semi-arid zones. Likewise, the prevalence of extensive and different indicators of desertification in the country's central plains was also observed and documented (Akhtar, 1994; Sulieman, 2018; Mohamed, 2020; Gadallah et al., 2021; Yasin et al., 2022).

Generally, the rapidly growing population i.e., 2.6% annually (CBS, 2008), accelerated urbanization, land use pattern transformations, mismanagement, and irrational development plans, escorted by the natural factors of environmental fragility and climate change, are responsible for the greatest part of environmental deprivation.

### Some Aspects of Sudan's Environment and Resources Governance

The above brief overview showed an alarming degradation in different natural resources and environmental components of Sudan, as a result of natural and anthropogenic causes (Sulieman, 2018; Eltoun and Bashir, 2022). However, the weakened and poor environmental governance embodied in mismanagement and irrational and chaotic

exploitation is responsible for disastrous environmental and resources deterioration as well.

What truthfully reflects and summarizes the state of environmental governance in Sudan has been observed in ongoing resources investments and exploitation, such as distribution and expansion of agricultural schemas, which continues despite the absence of a land use map that guides regulations and embodies clear-cut boundaries to separate various land use categories (Ali, 2022; Antoniazzi, 2022). This means that the state, which is in charge of planning for land use and resources exploitation, does not have well-stated and predefined strategic plans for resources exploitation and development agendas, therefore, catastrophic development status and messy resources utilization prevailed.

In the same respect, Sudan's environment and resources cannot be protected without having a clear policy that grants investments and resources conservation; especially there are multi-leveled and multi-governmental institutions that work in the fields of environment and natural resources management. For this, there are some interferences and ambiguity at times in ordinances interpretation and institutional authority over land and resources among the varied national, regional and local levels of governments (UNEP, 2012; World Bank, 2021)

Likewise, the weakening of the environmental governance in Sudan was caused by weakened and constantly changing institutional order of offices acting in the theatre of environmental and resources management. These offices, due to their instability, resulted in a confused legal framework, disordered organizational situations, therefore, institutions were unable to integrate and coordinate with each other and they failed to meet their responsibilities and achieve their outlined goals of environmental conservation and natural resources maintenance (UNEP, 2017; 2022).

The funding and financing of the environment and resources sector is, similarly, a barrier and limiting factor for environmental and resources issues. The study of (Eltayeb, 2017) reported the absence of political will to sustain the environment and natural resources. This is reflected in the minimal prioritization of investing in sustainable productive economic sectors as well as the least attention paid by the government to human development and services' facilities. The major budgetary expenditures of Sudan are allocated to the military and security sectors, leaving minimal expenditures to the rest of the other sectors.

It is well known that in developing nations, such as Sudan, livelihoods and productive sectors are predominantly primary economic activities that exclusively rely on the physical environment and natural resources; this indicates the existence of strong interchangeable and mutual influences among environmental status and socioeconomic aspects (Wang et al., 2020; Jayachandran, 2022; Madni et al., 2022). It is, therefore, imperative that these current

deterioration trends should be reversed through appropriate land use management interventions (ELD, 2015) Through the respective regional and federal offices. That should have a unified platform and framework to coordinate and use the same national plan to prevent contradictive and plurality of institutions and mandate duplication and interventions. Hence, establishing clear and worthwhile national and local strategic action plans for efficient and sustainable environmental and natural resources management.

### Potentialities and Critical Roles of GIS in Environment and Natural Resources Management

Geoinformation systems have been defined as a set of effective tools that collect, store, analyze, retrieve upon need, and view data about the real world for the purposes of assisting the abstraction of its complexities (Burrough, 1986; de Lange, 2023; Kumar et al., 2023). Recent geoinformation system technologies have become vital instruments for data analysis and explanation of real-world information (Valenzuela, 1990; Gaur and Garg, 2023). Therefore, it is critical to utilize GIS to understand complex reality and natural systems. This acts as a basis for development and problem-solving, as it is a mechanism and approach to integrate holistic concepts and ideas from different perspectives and disciplines for sustainable resources management.

GIS technology, in particular, provides a flexible environment for storing, analyzing, and displaying digital data necessary for change detection and database development. Satellite imageries are used to monitor discrete land cover types by spectral classification or to estimate biophysical characteristics of land surfaces via linear relationships with spectral reflectance's or indices (Kumar et al., 2015; Asokan and Anitha, 2019; Kumar, 2021).

Due to their renewability, natural resources could be regenerated through sustainable management. Hence, using remote sensing data and GIS techniques, resource managers can generate information, updates, and assessments regarding land resources present in the area of interest. Such information is crucial for the development of resource management strategies and decision-making to ensure that effective policies are put in place to control and govern the manners of resource utilization (Kumar, 2018; Pei et al., 2021).

To entice these scientific and data/information-based sustainability plans and decisions, remote sensing is an abundant and powerful tool for inventories, status observation, and quick updates of natural resources database, for this purpose, the exhaustive data provided by remote sensing serves as an input data for several environmental modeling processes (Melesse et al., 2007; Melesse and Wang, 2007; Lechner et al., 2020). Remote sensing, thus, is an immense and potential tool to study changes in land cover, forest density, and biodiversity, even in

inaccessible or remote places. Moreover, the integrated use of remotely sensed data, GPS, and GIS will assist consultants, natural resource managers, and researchers in agencies and conservation institutions to develop management plans for various natural resources (Philipson and Lindell, 2003; ESRI, 2024).

Accordingly, GIS technology is critically needed since it offers an integrated spatial analysis environment for databases of resource inventories and baseline analysis for the sake of change tracking. Additionally, the combination of GIS and RS will enable authorities to constantly update, assess, and monitor resource conditions and trends. In light of this, right and sustainable economic and social development along with degradation combating will be enabled through the fulfilling requirements of data provision, visualization, and modeling, which are the prerequisites for sound planning and sustainable management (Reddy, 2018; Ang et al., 2023).

Furthermore, GIS databases are based on spatial data infrastructure and SDI methods to serve agriculture, forest, and rangelands sectors. A number of projects related to environmental protection and natural resources conservation for the purpose of sustainability have been carried out; there were no unified data formats and platforms, which led to loss or unavailability, redundancy, and inconsistency of data. SDI, thus, is inevitably needed to facilitate the sharing and provisioning of solid and updated baselines and databases with minimal effort, time, and cost. Collection of the achieved projects at federal and local scales will form worthwhile databases that are useful for planners and researchers. (Vaitis et al., 2022; Kotsev et al., 2020).

Practitioners in the fields of environmental management, thus, communally use GIS to organize existing information and communicate that information throughout their organizations. *“GIS can be used as a strategic tool to automate processes, transform environmental management operations by garnering new knowledge, and support decisions that make a profound difference on our environment. GIS is considered enterprise if, by design, it is part of the overall information technology architecture of the organization. Both GIS functionality and data-accessing ability can be embedded directly into other agency applications. GIS workflow applications simplify and automate procedures within environmental management operations, resulting in improved efficiency and significant time savings”* (ESRI, 2015).

Recently, pressing needs have emerged for critically studying and analyzing environmental degradation by means of causes and implications to propose a comprehensive environmental and natural resources management strategy that grants environmentally oriented and economic-feasible development practices. GIS is a suitable technology since it can efficiently handle these complicated and thorny issues through provisioning massive inventory

databases, models, monitoring mechanisms, and other decision-making facilitation techniques. This will assist and enable attaining resource sustainability, hence empowering economic and social prosperity.

### Potential Contribution of GIS in the Sudan Context

In light of the fact that the right policies and strategies should be based on informed decisions driven from accurate and truthful information and solid databases. It is strongly recommended that an information system should be built to enable proper environmental management along with the reasonable exploitation of natural resources to ultimately combat environmental degradation in the central plains of Sudan (Alhadary, 2007).

Similarly, endeavors to combat factors threatening Sudan's natural resources, such as desertification and deforestation, and achieve sustainability (Ganawa, 2017) have emphasized the importance and critical role of building a national natural resources database to meet the requirements of strategic planning for sustainable land and resources management, which necessarily requires solid baseline data of natural resources, such as vegetation cover, soils, and climate. Therefore, the compilation of a GIS-based data format and information system was suggested for better management, retrieval, and updating of the information.

Currently, GIS technology is complementarily reliant on powerful tools and abundant modern technology data sources, including the global positioning system (GPS) and remote sensing (RS). This conjunction and integrated technology proved to have been widely applicable and recognized as a powerful and effective tool in detecting land use and land cover change and other environmental applications. It further provides timely and cost-effective (Goyal et al., 2020) multi-spectral and multi-temporal data with analytical capability to turn them into valuable information for understanding and monitoring land resources, their utilization patterns, and developmental processes.

Therefore, with special reference to Sudan, the acute deficit and big gap in environmental and resources databases and information availability, insufficient baseline data, inconstantly and unsystematically conducted inventories, and lack of detailed and deep analytical studies, all due to lack of funding and financing of the environment and resources sectors. Integration of GIS and RS will assist in overcoming these issues and bridging data availability and accessibility gaps, as it enables analyzing and getting the maximum out of available remotely sensed data, to support science-based decisions that are based on solid and inclusive data (Kumar et al., 2015) along with the ability to quickly and efficiently update databases of environment and resources through constant monitoring and

observations, particularly for long-term monitoring. (Mashala et al., 2023). All in a limitless scale of spatial coverage.

In the same context, the study of (Elfaig and Ganawa, 2011) strongly suggested the usage of geospatial technologies as a tool to enable the identification of hazards, monitoring them and quantification of hazards and their magnitude and various effects. Owing to the capabilities of these technologies to provide predictive models of future scenarios as well as offering geo-database and environmental visualization models that enable scientific planning and testing coping strategies for environmental changes. Additionally, remote sensing techniques can be utilized in the evaluation and consistent assessment of current situations of environment and natural resources via the designing and operating of observation and surveillance systems.

Here are the prominent opportunities offered to the sector of environment and resources management due to the advent of the advanced geospatial technologies of GIS and remote sensing especially. Without the geoinformation systems, these viabilities and privileges will not be possible to embody in Sudan, to mention some:

1. Overcoming the problems of fund deficits to the sectors and institutions concerned with the environment and natural resources through the provision of cost-effective and timely data with advanced storage and analysis mechanisms.
2. Unified data formats and integrated databases for all sectors and fields of environmental and natural resources.
3. Bridge the gap in knowledge and available datasets.
4. Easy, affordable, quick, and (efficient and reliable) data collection and baseline surveys, which cover an in-depth study of the geography, environment, and resources of the country.
5. Quick and constant updates of existing studies to analyze the environment and natural resources changes continuously.
6. Archiving, storing, and analyzing massive amounts of data for different purposes.
7. Enable and facilitate means for proper exchange and dissemination of geoinformation and data.
8. Better and informed planning based on solid and accurate data and knowledge bases.
9. Constant, accurate, and (nearly) real-time monitoring to enable an early warning system.
10. Mechanisms for coordination and institutional integration for governance's sake.

Taking advantage of the geoinformation systems and exploiting the above-listed capabilities will radically leverage and boost the practices in the various sectors of the environment and natural resources and will solve a greater part of their conic problems and hindrances to achieve their ultimate goals of achieving sustainability.

## Case Studies and Success Stories

In order to illustrate the effectiveness of using GIS in the special case of Sudan and prove the increasing need and pressing necessity for GIS-based environmental and natural resources management in Sudan. This section will provide an overview and analyze certain examples where GIS approaches have been deployed in support of environmental and natural resources management in Sudan. This will further provide a more in-depth understanding of how GIS would critically leverage efforts for improved environmental and resource management in Sudan.

The usage of geo-information systems and technologies in Sudan is not widely used and is a relatively newly adopted technology in institutions. These case studies exemplify and represent a various spectrum of usages of geo-information systems in the endeavor of enhancing practices and decision-making for sustainable environment and resources. As explained per below examples:

### 1. Sudan geoportals

The Sudan Geoportals project was initiated and implemented by Sudan Higher Council of Environment and Natural Resources, with technical support from the Communication Ministry. The project's prime objective was to find a unified mechanism for efficient storage, proper and easy dissemination and increased usability of the geographic information and data that resulted from the previously conducted projects. GIS-based geoportals and spatial data infrastructure (SDI) are reliable, cost-effective, and efficient data storing and sharing tools that further contribute to reducing data loss, redundancy, and format inconsistency. This project would assist in saving time, effort, and financial expenditure for the latter projects.

### 2. Sudan digital base map

The Sudan digital base map is an inter-ministerial and governmental project launched and operated by the Sudan Survey Authority with a prime objective of establishing, documenting, and provisioning basic geographic information from the Sudan digital format and joint geodatabase platform. To ultimately support and assist other ministries and governmental agencies with their institutional missions and endeavors, for instance, to help with population censuses, agricultural inventories, and planning for strategic investments.

### 3. Sudan land cover update projects

With the assistance of the UN FAO Sudan office, the National Forests Corporation has been constantly updating and reporting the changes in the land use land cover of the country. In the last two projects, GIS and remote sensing were extensively employed. The remotely sensed data served as the major data source and the backbone of the project content. Likewise, over the last project, machine learning and Google

Earth Engine were utilized to analyze and classify the surface categories to determine the changes that occurred over the structures of LULC across Sudan. Machine learning and remotely sensed data combination proved to be a time saving, cost-effective, and inclusive tool and mechanism when compared to traditional image classification or fieldwork.

### 4. Vulnerability mapping for Sudan NAP

On a regular basis, Sudan has been studying, evaluating, and analyzing the environment and its resources in light of climate change and its adverse influences, with the aim of preparing national plans to adapt to climate change. In the current year of 2023, through the national adaptation plan, the NAP study, environmental vulnerability, and susceptibility to the adverse consequences of climate change were studied and evaluated.

Due to the fact that severity and level of vulnerability to climate change vary according to the magnitude of climatic impacts on the environment and natural resources, since the communities' livelihoods and economics depend on them. RS and GIS have been employed to collect and analyze data to detect fragility and its magnitudes as well as mapping the fragile areas, taking advantage of the GIS capability to associate environmental and socioeconomic variables through stacking spatial and attributive data together to find relations and spatial patterns of phenomena. In this case, severity and vulnerability to climate change.

In this study, the deployment of geospatial information technologies contributed significantly to a deeper, more comprehensive, and more accurate understanding of the vulnerability and magnitudes of adverse climate change impacts. The deployed GIS method is based on the multi-criteria evaluation that relies on more diverse data types to generate results and conclusions. This is, due to the ability of geographic information systems to collect and integrate diverse and multiple data in one environment and for a pre-defined objective.

### 5. Sudan soil information system

The Sudan Soil Information System (SuSIS), is a project funded by the FAO Sudan office and has been implemented and operated since 2016 by the Sudan Agricultural Research Corporation (ARC). To establish a dynamic information system. The project aims to create a central repository for collecting and collating scattered and multi-formatted databases of Sudan soils into one unified and online information system to enable proper storage, dissemination, and usability of those data. All of these are intended to benefit accurate and sustainable exploitation of soil and land resources in Sudan.

The SUSIS system managed to assemble all soil data in Sudan from soil profile observations, hardcopy maps and documents, and laboratory analyses, using the digital soil mapping (DSM) technique. The project

thus celebrates an enormous database of present and historical collections of Sudan soil and land information (SUSIS, 2016).

From the above brief overviews, it is obvious that commencing the usage and engagement of geospatial technologies in the various applications of environmental and resources management fields is a transformative process. Likewise, despite being introduced very recently and having been used infrequently in Sudan, establishing geoinformation systems has boosted the availability and usability of data in different sectors of environmental and resources management, because more geo-information systems are required, and adoption of the advanced geospatial technologies is indeed encouraged for sustainable environmental and resources management in Sudan.

## Conclusion

This paper analytically examined the status of environmental and natural resources management in Sudan and then placed a spotlight on the potential of Geographic Information Systems (GIS). The Occurrence of environmental degradation in Sudan has become a non-negotiable fact, and the deterioration in natural resources is witnessed in population dynamics and livelihood instability. For this, a need emerged for critically studying and analyzing environmental degradation's causes and implications to propose a comprehensive environmental and natural resources management strategy that grants environmentally oriented and economically feasible development practices. GIS proved to be a powerful and viable tool for that. It can efficiently handle these complicated and thorny issues by provisioning inventory databases, models, monitoring mechanisms, and other decision-support tools. This facilitates and enables attaining sustainability in Sudan's resources, hence empowering economic and social prosperity and stability.

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