Global Scientific JOURNALS
GSJ: Volume 11, Issue 12, December 2023, Online: ISSN 2320-9186
www.globalscientificjournal.com

Empowering Geospatial Information for Sudan Sustainable Land Governance

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Abstract:

This paper presents the recommended specifications for the collection and maintenance of property mapping information for Sudan Federal States. It contains the information required to ensure that the geospatial property information collected is standardized, corresponds to best practices adapted to Sudan and address the challenges of land information in Sudan, to provide geospatial land information, to be in line with the best international. Cadastral data in Sudan has a hug spectrum of stockholder/users. The main objective of this paper is to analysis and design a cadastral system for Sudan, focusing in the ways to enhance this traditional system with special consideration to the international best practices. The paper highlighted, the current design and validation of Sudan Cadastral domain model, the development of integrated Land Governance system, the establishment of geospatial data sharing of Land Information and Land Admiration in support of Land Governance.

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Key words: SDI, FIG, GIS, GNSS

1 Introduction.

This paper presents the recommended specifications for the collection and maintenance of property mapping information for Sudan Federal States. It contains the information required to ensure that the geospatial property information collected is standardized, corresponds to best practices adapted to Sudan context and will contribute to the international sustainable goals. The paper as well needs to address the challenges of land information in Sudan, to provide geospatial land information, to highlight the best international practices on accessibility to land information [1], documentation and standardization of land information, to facilitate easy accessibility, and on formulating national governance policies for accessing and sharing land information.

Cadastral data in Sudan has a hug spectrum of stockholder/users such as States governments and localities administrative departments, land and legal departments, planning, survey and building permits departments. Currently limited digital data for land property and history are available, in such situation data, maps and information cannot easily be linked. The traditional cadastral system is used, which does not reflect the land information management changes. This led to the fact that, relevant cadastral decisions cannot timely and easily be made. Therefore, the main objective of this study is to analysis and design a cadastral system for

Sudan. The paper will focus in the ways to enhance this traditional system with special consideration to the international best practices in cadastral management [3], and land administration systems. In this study, two phases are considered, the main Phase covers the analysis of the cadastral requirements based on the Sudan Regulations, observations of existing and operational system dealing with identification of actors, basic process of registration, spatial objects representation. While phase two builds a Conceptual Model for the system by identification of the classes, relation and attributes compare with the international standard (land administration domain model) using unified modeling language (UML).

2. Sudan Land Governance Institutional framework:

Responsibility for land management in Sudan is distributed across a range of institutions at all levels of government. Key among the institutions in federal level are the National Land Commission, States governments, Ministry of Urban Development, Ministry of Justice, Ministry of federal government and Ministry of agriculture and Ministry of investment. At State level Ministries of Planning/Infrastructure and Judiciary are the main decision makers in managing, registering and transaction of land in Sudan fig.1, each of them deal with their own particular types of land issues [7], [8].

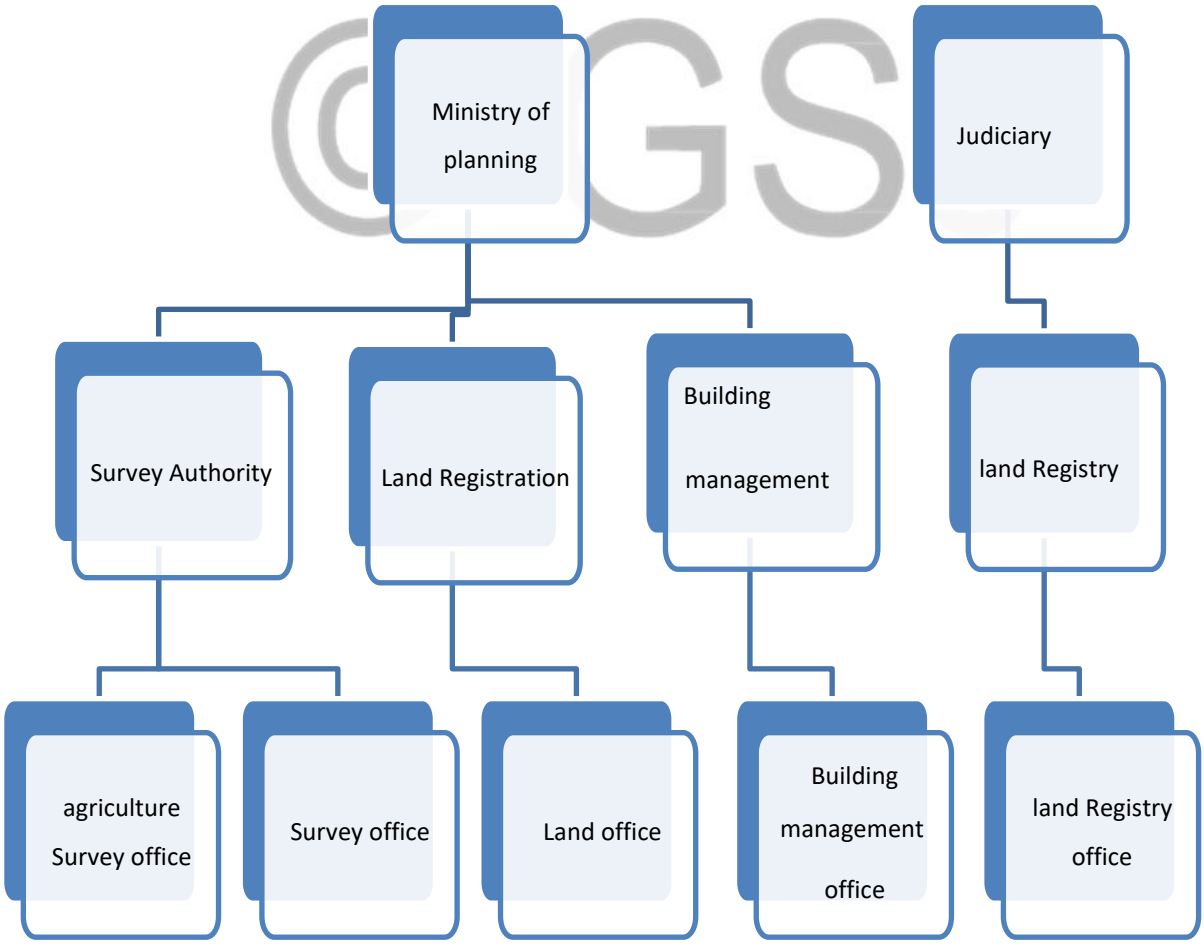

Figure.1 Sudan cadastral Institutions framework

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In describing the mechanisms for the formation of new land (Fig.2), the government process starts with Ministry of planning or other state government level identifies an existing informal settlement where they would like to pursue land change, demarcation. land title and registration activities.

In this paper, the Sudan cadastral system processes are identified, analyzed and then conceptually modelled. The workflow for the cadastral system in Sudan is illustrated, based on the current operational system for Land managements and Land administration systems. The workflow steps of registration of parcel are given together with the main activities of land formation process.

The study described the current design and validation of Sudan Cadastral domain model, the development of integrated Land Governance system, the establishment of geospatial data sharing of Land Information and Land Admiration in support of Land Governance. In addition to survey and mapping roles and the necessities of enabling geo-spatial information infrastructures.

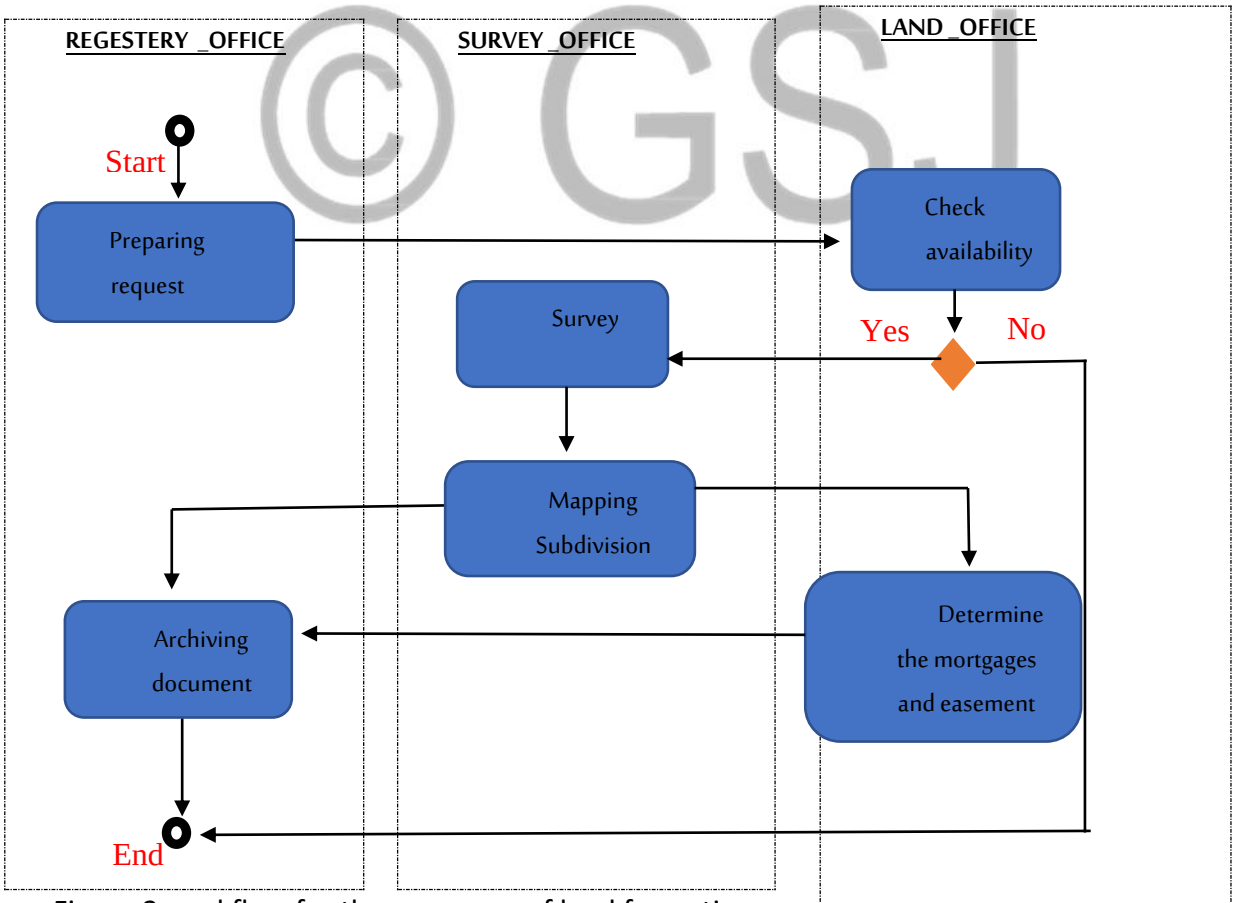

Figure.2 workflow for the processes of land formation

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The Land Registry Office in Judiciary Act prepare informal settlement (form A) for land change; the Survey Department in the Ministry of planning is to issue parcel numbers; this followed by the survey to determine the parcel areas and establish control points. The Land Department determine the mortgages and easement rights of the parcels and prepare informal settlement (contract). These documents provide evidence of ownership, and non-documentary forms of evidence are rarely used to obtain recognition of claims to property. In the last process, Land Registry Office in the ministry of Justice will prepare informal settlement (land certificate) for real property and to archive the documents. The main process of land formation and parcel identification for registration is summarized in fig. 3.

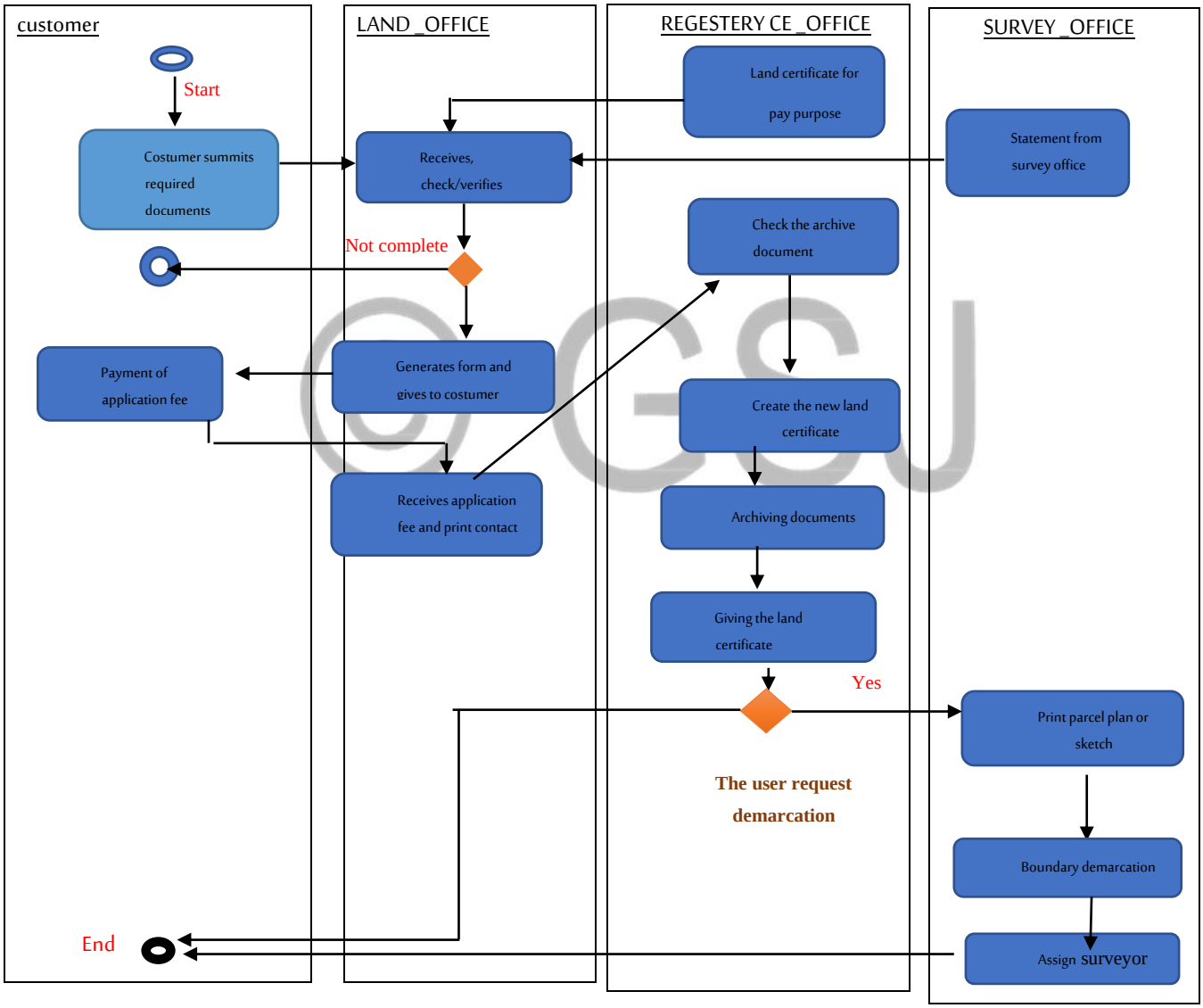

Figure.3 process Workflow of registration

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The workflow of registration of parcel is summarized in fig (3) and the main activities of land formation process include:

Step 1: Preparation of a legal form (A) for request document, land change, demarcation. Here the land title and registration activities are performed by Land Registry, then transferred to Land and survey offices.

Step 2: Based on the Letter of Survey Assignment, the surveyor brings all the documents and survey equipment's that used to collect the new survey data. There are two methods adopted for surveying of lands, the first method (most used) by simple measurements of the boundary lengths and diameters. In the second method the surveys are mainly, based on the use of the coordinates of the ground control points for the surveys and their quality control.

Step 3: Preparation of parcels site plans and numbers, the parcels maps and numbers are then stored separately in paper maps and in digital format.

Step 4: Land Registration Department determines the mortgages and easement rights of the parcels and prepare informal settlement (contract).

Step 5: For archiving the documents, the Registry officer archives the parcel map and the form for registration process.

3. Current Design and Validation of Sudan Cadastral domain model

Core classes of Sudan cadastral system in which the domain model contains four major packages [15]: (i)Parcel: provide spatial location and information of the land related to the certificate (survey office) (ii) Certificate: as evidence document for the owner of land (registry office) (iii) Contract: shows the rights, mortgage and responsibilities (land registration office) and (iv) Owner: Information of the owner (registry office).

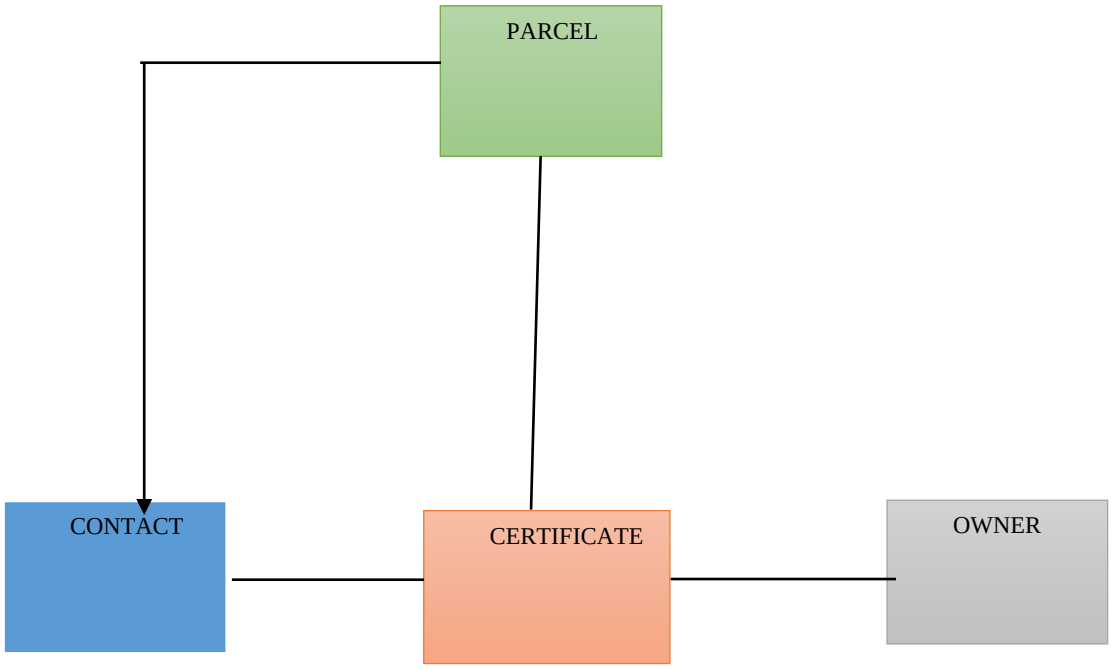

Figure 4.: Sudan cadastral domain model

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Relationship of classes, such as Parcel, contract and certificate are related to each other with (1:1) relationship, every one owner related to one or more certificates. This will be followed by the use of the validation model, in which validation occurs in every stage of the model cycle as a continuous process of conceptually construction validation using Sparax software building in tools, the second method is by converting the model to XML and finally, to import it to ARCGIS environment.

The accuracy of plot coordinates depends on the type of land and survey methods used. The objective is to acquire the best accuracy possible based on the technology employed to establish the plot coordinates. Officially, information and guidelines are available with class identifies the survey methods used and their accuracy with a recommendation that, in Urban areas, the accuracy should be better than 5 cm [14]. In Rural areas accuracy depends on the area to be surveyed and the methods used. These may include GNSS as well as aerial or satellite imagery, in which, the accuracy should be in the order of 1 meter [14].

There are many efforts to provide good quality of land administration system, and for successful implementation of land administration all over the world. Sudan has to adopt and use some international guidelines, specifications and models, such as the Land Administration [2], [5] Guidelines (United Nations Economic Commission for Europe, 1996).

The recommended specifications for the land administration system to be applied are to ensure that land information supports the Sudan sustainable development goals and the United Nation Global Geospatial Information Management (GGIM) resolutions [13]. These should be related to Sudan future Spatial Data Infrastructure (SDI); seamless Digital Cadastre [4]; integration of Legal and Physical data; locating Plots; plot numbering; lineage; attributes Content; property Areas. Taking into considerations all requirements related to geospatial 3-D Property; and property Mapping Operations.

As outlined above, the current operational system involved the cooperation of three Departments, namely Survey, land and registration departments. The land registration offices, flow one transition process, reviewing and registration of legal document. The legal framework for land in Sudan started in 1925 by Land Settlement Registration Act. This law setup a mechanism for individuals to register their land on a regional basis by providing documentation or witness that would verify the ownership of the land under consideration. All unregistered lands in Sudan are considered to be the government or State properties since 1970. The development of Land Tenure Rules in Sudan based on many acts, including: Land Settlement and Registration ordinance,1925, Land Acquisition Act,1930 (this law gives rights to take the individual property for public good with the equal compensation to the individual), The unregistered land Act,1970 (this law gives concept that all unregistered land in Sudan become the property of the government) and Urban planning and land disposal Act,1994 (this Act gives the regions a power in land disposal).

There are currently two datasets for storing property data, one covering the legal aspects such as owner, title, etc.) and the other one covering, the physical aspects such as plots and plot number. This means that in Sudan, currently, there are two organizations maintained the land

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data, one with legal expertise and the other with planning, mapping/surveying expertise. As the geospatial systems of today allow both geometrical and descriptive information to be stored and managed concurrently. It is thus recommended that in Sudan, both physical and legal information are to be managed as an integrated property class in a form of property map/layer integrated dataset.

4. Development of Integrated Land Governance system in Sudan

For the development of integrated land governance system, Sudan efforts are to be aligned with international and regional initiatives, such as the United Nation Global Geospatial Information Management (UNGGIM) and relevant regional committees such as UNGGIM-Africa [13] [14], and the Inter-Government Authority for Development (IGAD) [21]. The proposed integrated land governance system shall contribute in solving land administration/governance challenges that faced the Sudan, including tenure insecurity; escalating land conflicts; access to land and natural resources; outdated legal frameworks for land administration; limited capacities and motivations of reform implementing agencies. Here geospatial information plays a crucial role in land administration by supporting decision makers with the required information while planning for optimal allocation and use of land and natural resources for sustainable development. Land governance system in Sudan has common elements which include varying degrees of state sovereignty over land, but suffers from lack of accurate and reliable digital land information and records that can be utilized to support the key functions of land governance.

4.1 Establishment of an Infrastructure for Sharing Land Information:

As well known, that, Land information is part of the larger geospatial information context that should be disseminated to users in government, non-government organizations and the private sector. Sudan Geospatial infrastructure for land information sharing, exchange and integration is becoming vital as the best way to address land information accessibility and utilization challenges.

4.2 Land Information and Land Admiration in support of Land Governance

In order to explain the importance of accessibility to land records, it is essential to understand the relationship between land information, land administration, and sustainable development. This understanding is the key in justifying the rationale behind improving accessibility to land information and its positive impact, that are likely to have on the land administration system and overall sustainable development at the country and regional levels.

Land administration systems are key in national cities, agriculture and resources development. It is generally accepted [2], that “land administration” should describe those public sector activities required to support the alienation, development, use, valuation and transfer of land—including cadastre [4], land registers, land consolidation, valuation, and land information systems [6]. Land

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administration was earlier on defined to include the process of recording and disseminating information about ownership, value and use of land and associated resources [18]. More comprehensively, the World Bank [19] [20], defines land administration as a system, implemented by the State, to record and manage rights in land. According to this definition, a land administration system may include the following major elements: the management of public land [7]; the recording and registration of private rights in land; the recording, registration and publicizing of grants or transfers of rights in land through, for example, sale, gift, encumbrance, subdivision, and consolidation; the management of fiscal aspects of land, including land tax, historical sales data, and land valuation; and the control of land use, including zoning and the development application/approval process. In general, good land administration system [2], is based on applying principles of good land governance. In general, Land governance refers to the rules, processes, procedures and structures for making decisions based on use and ownership of land as well as managing competing interests in land utilization.

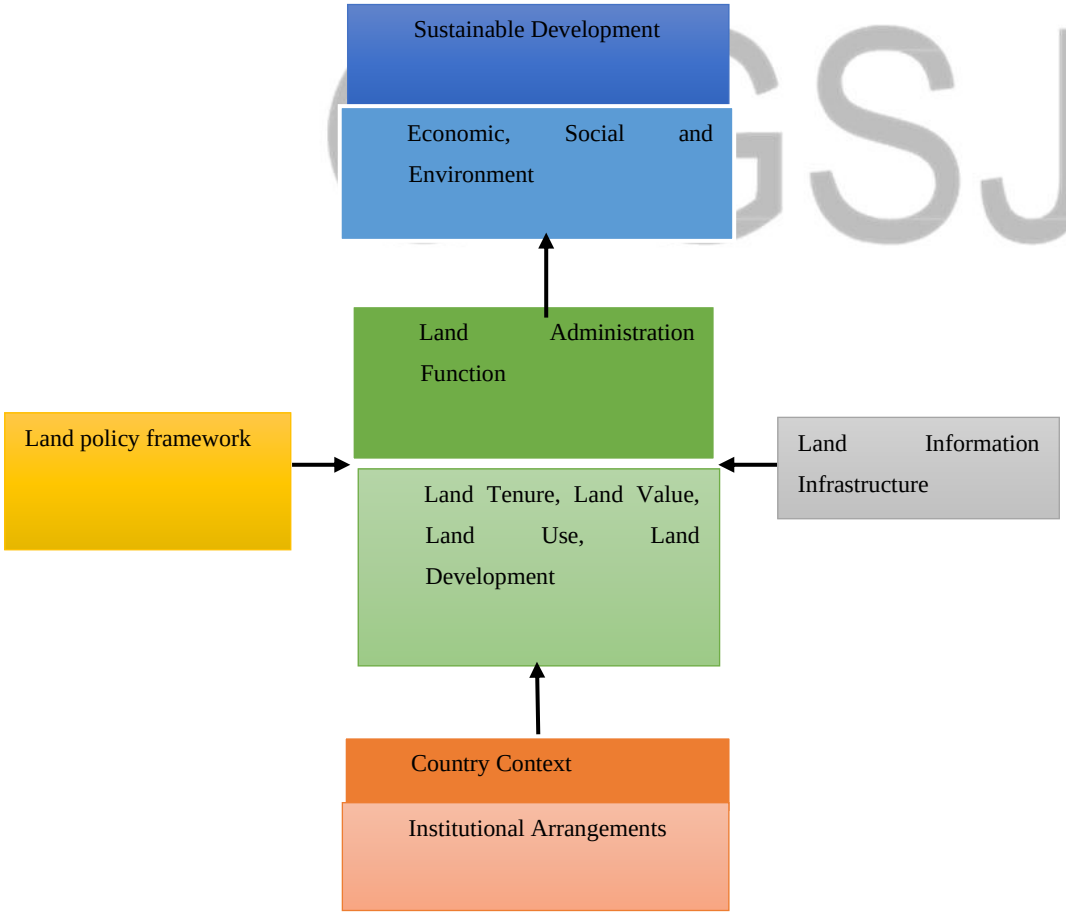

Figure 5: Interaction between Land Administration, Land Information, Land Policy and sustainable development [5]

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Modern land administration systems [6], should deliver detailed land information at the land parcel level. At that level, to service the needs of all categories of land information users including individuals, community, local governments, state governments and central / federal government departments and agencies. The benefits of accessibility to land information, include enhancing security of tenure; increasing transparency in land administration; facilitating secure and efficient land transactions; supporting the management of assets; and the provision of basic information in the processes of land dispute resolution [7], physical planning, valuation and taxation, land development and environmental /natural resource management.

4.3 Survey and Mapping Roles

In Sudan, land allocation is either preceded or follows a cadastral survey to define the boundaries of the property that is subject of offer. A cadastral survey is undertaken by land surveyors employed by government to undertake such surveys. A cadastral survey leads to specification of location of the property, dimensions of boundary lines and the area of the property [4] and [5]. The core records arising from a cadastral survey include coordinates of parcel corners, parcel identifiers, geodetic control information, parcel dimensions, area of parcel, type of boundary monuments, shape of parcel and information on adjoining parcels. Cadastral information may be supplemented by other information such as, natural physical features, accessibility, utilities and relief. Examples of land records relating to survey and mapping are presented in Table 1.

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Survey and mapping records assist in re-establishing property boundaries in case some of the boundary monuments have been destroyed. The precision for doing this depends on whether the law in a country permits fixed or general boundaries. Fixed boundaries require use of sophisticated survey equipment to define a boundary line within an allowable error of a few centimeters or millimeters. For such boundaries, use of concrete mark stones as boundary markers is very common. A typical mark stone has a Pin in the Centre where surveying equipment is centered to measure the boundary line. The records for fixed boundaries include coordinates of the boundary points, the point identifier, and details of the measurements and computations carried out to assign coordinates to the point.

Table 1: Examples of land records relating to survey and mapping departments in Khartoum State, which, are normally under the custody of institutions responsible for surveying and mapping. Depending on the land administration system used, these surveying records may be located within a central/federal Sudan Survey Authority or local government such as state survey Departments.

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Data Types	Description
Geodetic Reference Framework	A set of geodetic points that act as reference points for controlling all other surveys in the country [17]. Records associated with this include coordinates and detailed description for each point. The points are needed by land surveyors to tie cadastral and other types of survey.
Survey Files	Records to show details of how each survey was conducted including, the geodetic points that were used, the observations that were made, how computations were carried out and how the final parcel was created.
Index Map	Cadastral map showing parcel boundaries, dimensions and parcel identifiers.
Topographic base maps	Maps showing physical and manmade features, relief, administrative boundaries and any other relevant information [15]. Topographical maps are created at various scales to serve different purposes.
Thematic maps	These are specialized maps for a particular theme such as forests, land use, population etc.
Ortho-rectified imagery	These include high resolution satellite/aerial imagery that is used to check the accuracy of the cadastral boundaries and also provide additional information about the location of the parcel.

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Table 2: Examples of Land Records relating to Survey and Mapping in Khartoum State

4.4 Geo-spatial Information Infrastructures

Land administration systems are supported by application of geographical information systems (GIS) tools to improve accessibility and utilization of land information for planning and decision making. As well understood, Geographical information systems are computer-based tools for documenting, storing, manipulating, displaying spatial information and disseminating it in a variety of formats. A GIS links graphical information such as a parcel (represented as a polygon) with attribute information such as size, land use, land rights to enable query and analysis of the combined information [1]. GIS facilitates integration and visualization of land records together with other information in a unified manner. Within a GIS, land information pertaining to a parcel is overlaid with other information to provide insights on the ownership, third party rights, use, environmental management, planning constraints, population, soil fertility and any other relevant aspects.

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The term “Spatial Data Infrastructure" (SDI) [11], [12] is used to refer to a framework of technologies, standards, policies [9], and institutional arrangements that together facilitate the creation, exchange, and use of spatial data and related information resources across an information-sharing community (see **Error! Reference source not found.**6). In this regard, the S udan Spatial Data Infrastructures assist to remove barriers for accessing spatial data and hence promote the efficient application of geospatial technologies for planning and managing of the country resources.

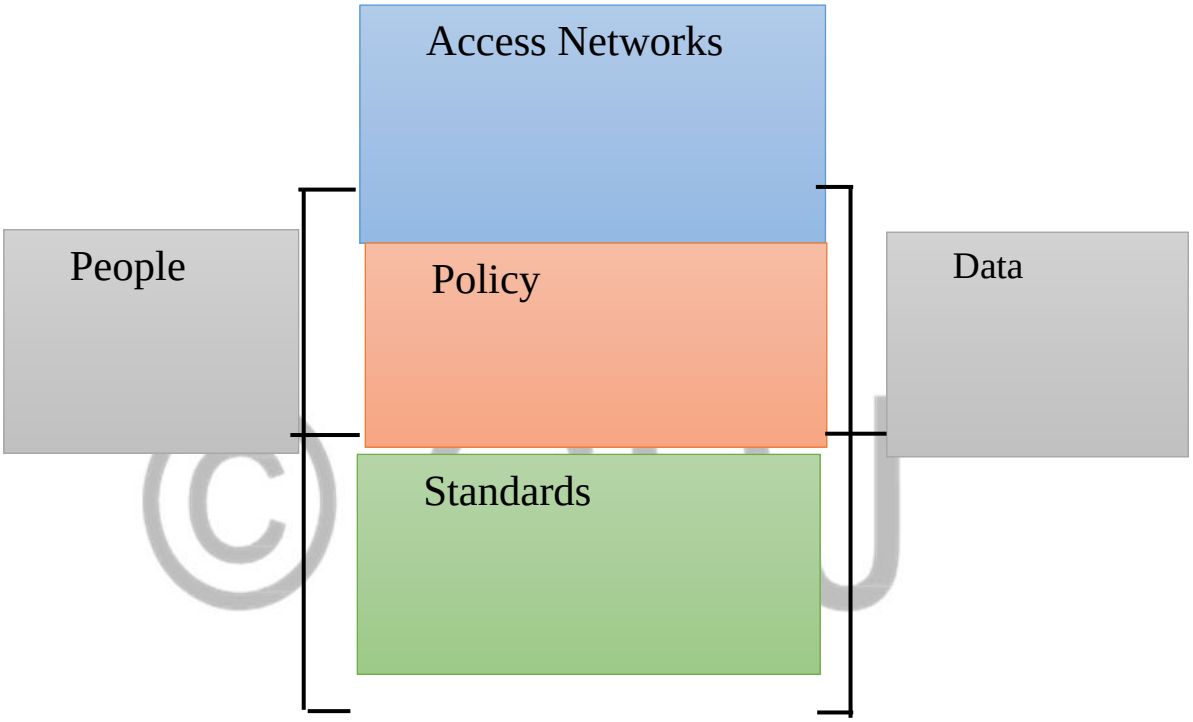

Figure 6: Components of a Spatial Data Infrastructure

Documentation of datasets or creation of metadata involves compiling descriptions of the data so that potential users get to understand details about the data before making a decision to acquire the datasets. Documentation of data improves accessibility to land information given that potential users are informed about the general description and technical details of the data that is in custody of government and non-government or private sector institutions.

There are four key international organizations are to be considered, whose objective is to develop standards for geospatial information: such as FIG, the International Organization for Standardization (ISO) [2]; the Open Geospatial Consortium (OGC) [10]; and the International Hydrographic Organization (IHO).

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Sudan National standards are to be developed through the consensus of experts from the country (from various departments and specializations) and are to be published by a nationally recognized body such as Sudan Survey Authority (SSA) [15]. At the national level, public and private sectors carry out technical regulation, standards accreditation, and conformity assessment (inspection and certification) activities.

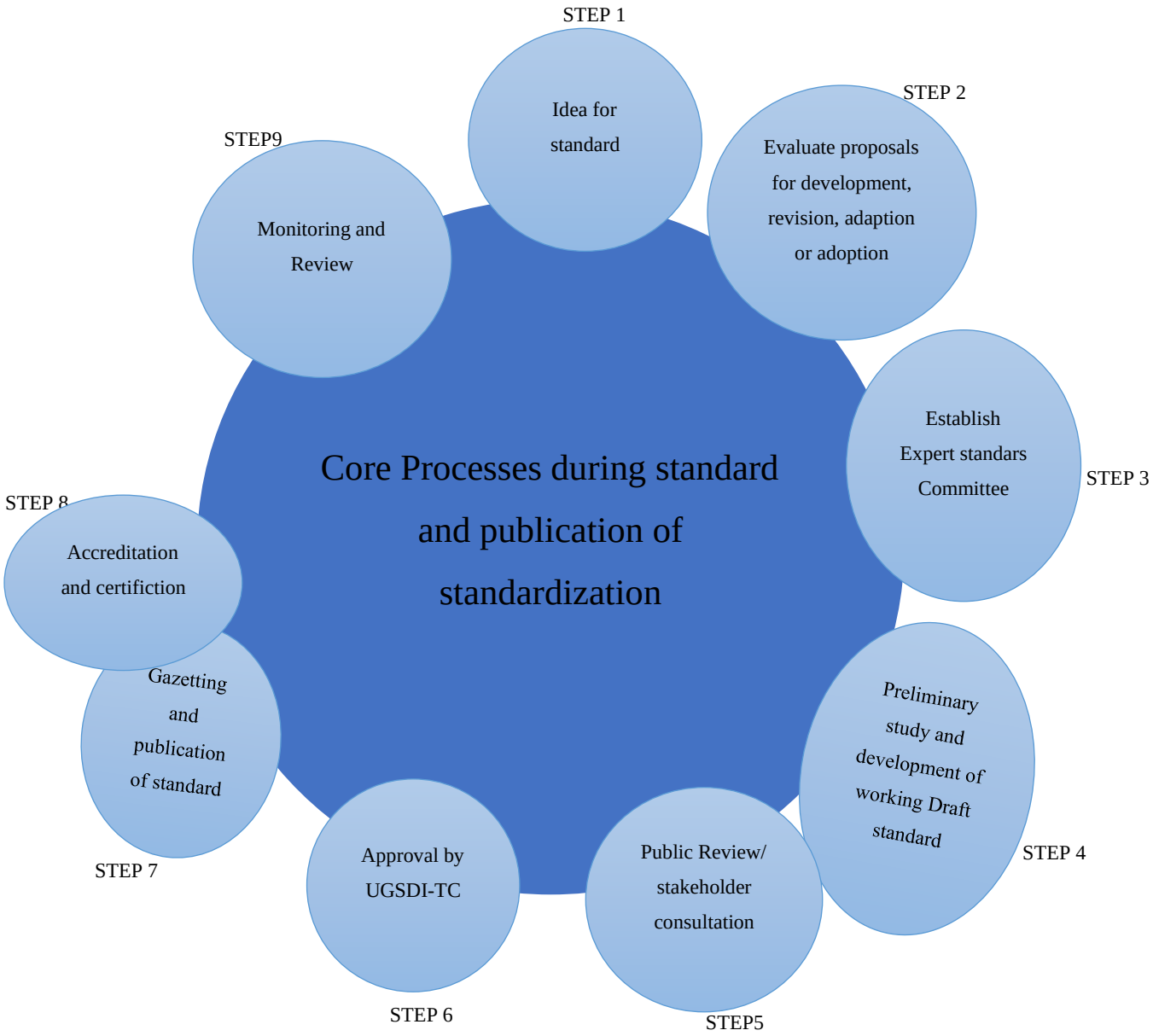

Figure 7: Core processes during standardization

The authors would like to emphasize, the necessity of the endorsement of the IGAD professionals and technical teams initiatives and recommendations, agreed upon during the validation of IGAD Land Management Tools Djibouti [21], namely, the following initiatives and recommendations:-

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(1) Empowering Geospatial Information as a key success factor for Sustainable Development of IGAD Countries, particularly: -
   (i) Unification of IGAD Geodetic Reference Frame (IGRF) and establishment of unified regional Geodetic Network.
   (ii) Development of IGAD Integrated Geospatial Information Frame.
(2) Establishment of the following IGAD geospatial working groups: -
   (a) Geodetic Reference Frame working group
   (b) Integrated Geospatial Information working group
   (c) Land Governance Work group
   (d) Land Governance Work group
(3) Land Governance Work group to investigate and coordinate the initiative related to the Development of Integrated Land Governance system for IGAD member countries.

7. Conclusion

In this paper, the Sudan cadastral system processes are identified, analyzed and then conceptually modelled. The workflow for the cadastral system in Sudan is illustrated, based on the current operational system for Land managements and Land administration systems. The workflow steps of registration of parcel are given together with the main activities of land formation process. The study described the current design and validation of Sudan Cadastral domain model, the development of integrated Land Governance system, the establishment of geospatial data sharing of Land Information and Land Admiration in support of Land Governance in Sudan, in addition to survey and mapping roles, that, necessities enabling geo-spatial information infrastructures.

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