Critical Assessment on the implementation of LADM as per ISO 19152:2012 in Indian scenario – Existing System, Challenges and Possible Implementation Strategies

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Key words: SDG, e-governance, Land Administration, Standards, Indian Scenario, LADM, ISO 19152:2012.

SUMMARY

The existence of a robust spatial database for land administration is indispensable for the growth and development of any nation. It not only provides insights into the existing land use pattern but also helps the authorities to strategize for any prospective venture, whether an infrastructure project or a social scheme to serve its beneficiaries. As such, ISO 19152:2012 defines the conceptual schema of the Land Administration Database Model (LADM) which contributes to the Sustainable Development Goals (SDG) 1, 2, 9, 11, 14, and 15.

This paper presents a literature review on the current status of land management in the Indian scenario followed by analyzing and correlating the LADM with the available systems of geoinformation, pinpointing the gaps, if any, existing between the two and suggesting a way ahead to provide an efficient base for effective e-governance and for better decision making to achieve the SDGs. The paper will also discuss at length the various schemes and programs that the Indian government has undertaken in line with PM's vision such as SVAMITVA and DILRMP.

India is the second most populous and the seventh largest (by landmass) country in the world. It is also, perhaps, one of the most diverse countries in the world with 22 official languages in 28 states and 8 Union Territories with an essentially quasi-federal system of governance. As per the Constitution of India, various subjects related to land administration are divided into Union, State, and Concurrent lists. This makes the compilation of the land administration data a complex area that requires in-depth knowledge of the legal framework of each state. The paper also intends to list the various potential challenges that can be encountered during the implementation of the said model.

Based on the aforementioned, it is intended to present a possible mechanism for implementing LADM by recommending some modifications in terms of integrating multiple digital cadastres into a unified database.

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1. INTRODUCTION

In today's world, geospatial data has a huge significance on the growth and development of any nation. It is crucial for any government, to have exhaustive and credible locational information, in order to make an informed decision that potentially is going to have a substantial economic, environmental, or social impact. The first-hand comprehensive knowledge about the topography, land use pattern, population distribution, etc., enables the authorities to make strategies concerning resource management, infrastructure development, rolling out of social schemes, and emergency response in case of any natural hazard or climate change. Thus, geospatial information is indispensable for realising the 2030 Agenda of Sustainable Development Goals (SDG) by any nation.

As the world is inching towards e-governance, the complete digitization of geospatial information is the need of the hour. United Nations – Global Geospatial Information Management (UN-GGIM) in its Integrated Geospatial Information Framework (IGIF) has signified the criticality of geospatial information by describing it as a nation's 'digital currency' for evidence-based decision-making. It holds, especially in the case of sectors like land administration, which traditionally has been dependent on physical cadastral maps, primarily being managed by the local authorities. The non-uniformity in the format of these documents, the difficulties in monitoring the data management at a centralized level, and the arduous procedure to access these physical records by the common citizens, have so long posed a challenge for the authorities to provide effective citizen-centric services. However, all of the above issues can be potentially eradicated by the digital consolidation of the land records into a unified schema.

UN-GGIM through its Addis Ababa Declaration Geospatial Information Management Towards Good Land Governance for the 2030 Agenda, has further solidified the idea that updated and easily accessible geospatial information over space and time is essential for good land administration and management which in turn acts as a pillar of good and effective governance. It also supports the development of fit-for-purpose land administration, particularly in developing countries. The concept of a 'Fit-for-purpose land administration system', as described in Enemark et al., 2014, is fundamentally a human rights approach that is participatory and inclusive. Fit-for-purpose means that the land administration systems – and especially the underlying spatial framework of large-scale mapping – should be designed to manage current land issues within a specific country or region rather than simply following more advanced technical standards.

Further, the Framework for Effective Land Administration (FELA) by UN-GGIM defines how an effective land administration relates to the SDGs through its 5 P's (People, Planet,

Prosperity, Peace, and Partnership). People-to-land relationships, directly and indirectly, influence all SDGs. Some of the examples of the SDGs along with the Target and Indicator related to the Land administration system are enumerated below:

Goal	Target	Target Description	Indicator	Target Description
1. No Poverty	1.4	By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	1.4.2	Proportion of total adult population with secure tenure rights to land, (a) with legally recognized documentation, and (b) who perceive their rights to land as secure, by sex and by type of tenure
5. Gender Equality	5.a	Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws	5.a.1	(a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure
			5.a.2	Proportion of countries where the legal framework (including customary law) guarantees women's equal rights to land ownership and/or control
9. Industry, innovation and Infrastructure	9.1	Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	9.1.1	Proportion of the rural population who live within 2 km of an all-season road
11. Sustainable Cities and Communities	11.1	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	11.1.1	Proportion of urban population living in slums, informal settlements or inadequate housing
	11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	11.3.1	Ratio of land consumption rate to population growth rate

Fig 1.1: Examples of Goals, Targets, and Indicators related to land administration systems

India is the second most populous and the seventh largest (by landmass) country in the world with a population density of approximately 470 people per sq. km. Almost 65% of the total Indian population lives in rural areas with agriculture as their primary source of livelihood. Needless to describe the utter significance of a robust digital cadastre as the foundation of efficient e-governance in a developing country like India. Infrastructure projects for better connectivity (transportation and internet), social schemes for improving standards of living (hunger, sanitization, gender gap), preparedness for any natural disaster, and preserving the natural biodiversity, are directly or indirectly dependent on the land management records.
The objective of this paper is to give a critical review of the implementation of LADM in India – the system already in place, the challenges likely to be faced by the authorities, and the possible workaround amidst the ongoing projects.

2. LAND ADMINISTRATION DOMAIN MODEL (LADM)

The Land Administration Domain Model (LADM) defined by ISO 19125:2012 is a reference model covering basic information-related components of land administration (over water and land, and elements above and below the surface of the earth). The standard is a descriptive standard rather than prescriptive and it provides a conceptual model relating parties (people and organizations), ownership details (Rights, responsibilities, and Restrictions), and spatial units (parcels, legal space of the buildings, and utility network) regarding the spatial sources and representations. The standard for the land administration domain serves the following goals (Lemmen et al., 2015):

- Establishment of a shared ontology.
- Support for the development of the application software for land administration.
- Facilitation of cadastral data exchange with and from a distributed land administration.
- Support for data quality management in land administration.

As such LADM consists of three packages, viz., Party Package, Administrative Package, and Spatial Unit Package; and one subpackage, viz., the Surveying and Representation Subpackage. The LADM can be described by the following Universal Modelling Language (UML) diagram for each package and subpackage as provided in the standard:

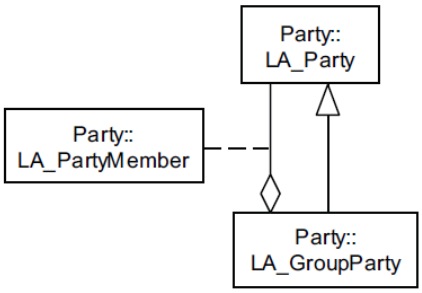


Fig 2.1: Classes of Party Package

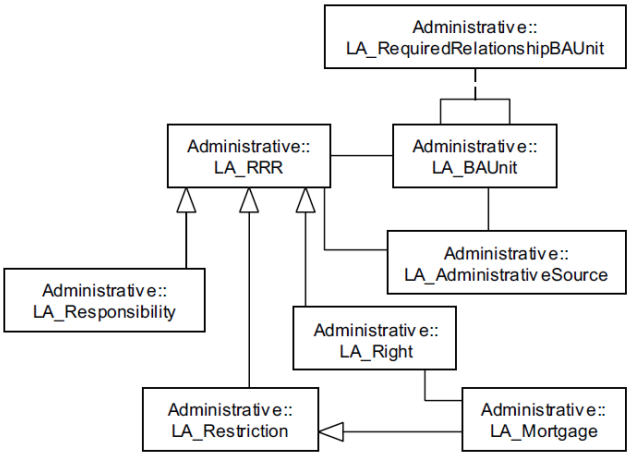


Fig 2.2: Classes of Administrative Package

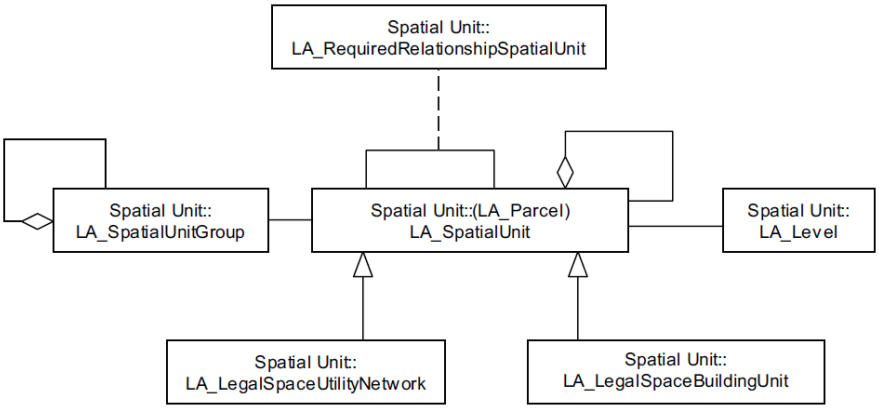


Fig 2.3: Classes of Spatial Unit Package

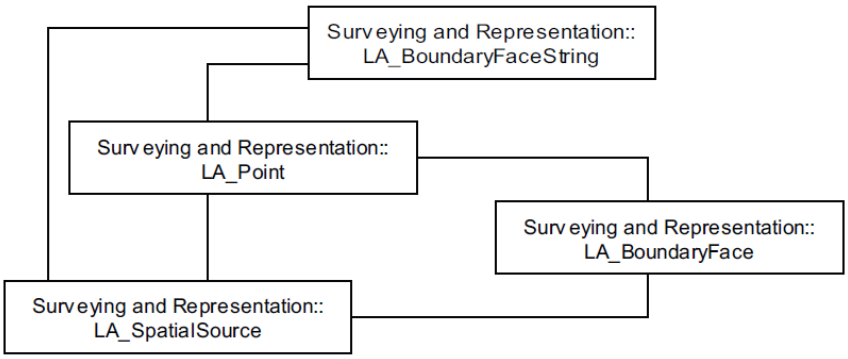


Fig 2.4: Classes of Surveying and Representation Subpackage

Further, the standard also consists of the associations among different basic classes belonging to different packages along with other details such as value types and multiplicity, etc. As mentioned earlier, the LADM specifies a conceptual schema. To use it, an application schema, such as a country profile, is required to be developed. Annexure A of ISO 19152:2012 specifies an abstract test suite to determine whether a specific application schema is conformant with the LADM in terms of package and level. Thus, the countries yet to adopt the LADM model can check the conformity of their existing profile using the test suite and can also introduce necessary changes in the system to make it more compliant.

3. EXISTING SYSTEMS IN INDIA

The land records system in India originated during the reign of the Mughals. Over the period of the Mughal rule, the system of land revenue collection and assessment was transformed into a systematic practice by appointing a clerk in every village (known as Patwari). This system of maintenance of land records is still prevalent in the country which was later improved by the British and subsequently by the Government of India. The original land survey was carried out in most of India during the 19th and 20th centuries, except in many North-eastern states and parts

of the states of Maharashtra, Odisha, Tripura, and Chhattisgarh, using surveying techniques such as cross-staff and steel chain. (Source: Best Practices in Digital India Land Records Modernization Programme (DILRMP), 2020).

However, the need for the digital transformation of paper-based records was felt during the 1980s, during and after which the following centrally sponsored schemes for the digitization of land records were undertaken:

* This project specifically covers the settlement (inhabited) areas of villages in India.

However, currently, only the last two schemes mentioned above are functional.

3.1 Digital India Land Record Modernization Programme

It is a program of the Department of Land Records, Government of India, which serves the purpose to digitize and modernize land records and develop a centralized land record management system and move towards government-guaranteed titles. Essentially DILRMP is a revamped version of NLRMP with 100% funding from the Central Government. The programme consists of eight key components as shown below.

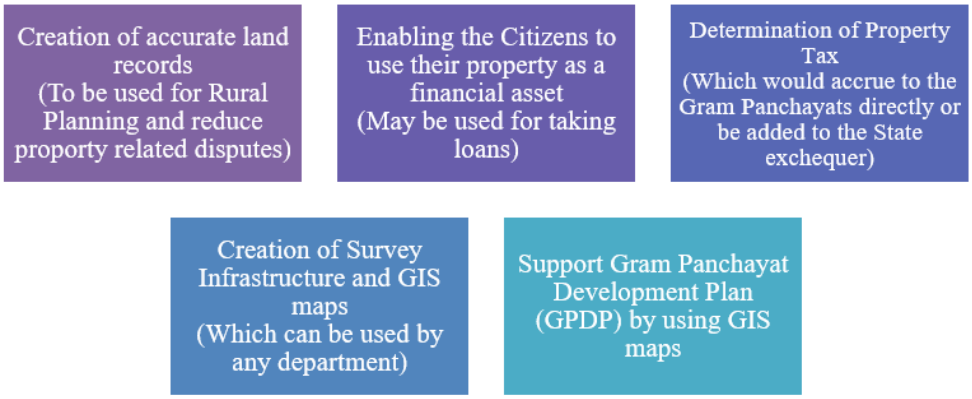
- **Computerization of Land Records**	- **Computerization of Registration**
- **Survey/ Resurvey and Innovative Initiatives**	- **Modern Record Rooms**
- **Training and Capacity Building, IEC and Evaluation Studies**	- **Project Management Unit**
- **Consent based linkage of Aadhaar with records of rights**	- **Computerization of Revenue**

One of the important and crucial aspects of DILRMP is the introduction of the Unique Land Parcel Identification Number (ULPIN) into the land administration system. It is a 14-digit alphanumeric code for each land parcel based on the coordinates of the vertices of the parcel. ULPIN complies with the Electronic Commerce Code Management Association (ECCMA) and

Open Geospatial Consortium (OGC) standards. It applies to both horizontal and vertical properties.

3.2 Survey of Village Abadi and Mapping with Improvised Technology in Village Areas (SVAMITVA)

It is a scheme of the Ministry of Panchayati Raj, Government of India. Aiming particularly at the inhabited village areas, the objectives of this scheme are as follows:



Under this scheme, ortho-rectified images captured using survey-grade drones are used to digitize the parcel boundaries. Based on the digitized features and the records collected on the ground, property cards are generated and distributed among the owners. The citizens are then allowed to rectify any discrepancy in the said cards within a specified period, thereby making the process inclusive and participatory. Post the resolution of all such objections, the property cards are finalised and recorded in the database.
Establishment of Continuously Operating Reference Stations (CORS) is also within the scope of this scheme. Till now (i.e., as on February 2023), a total of 959 CORS stations (561 under this scheme and 398 under various other schemes) are monumented all across India.

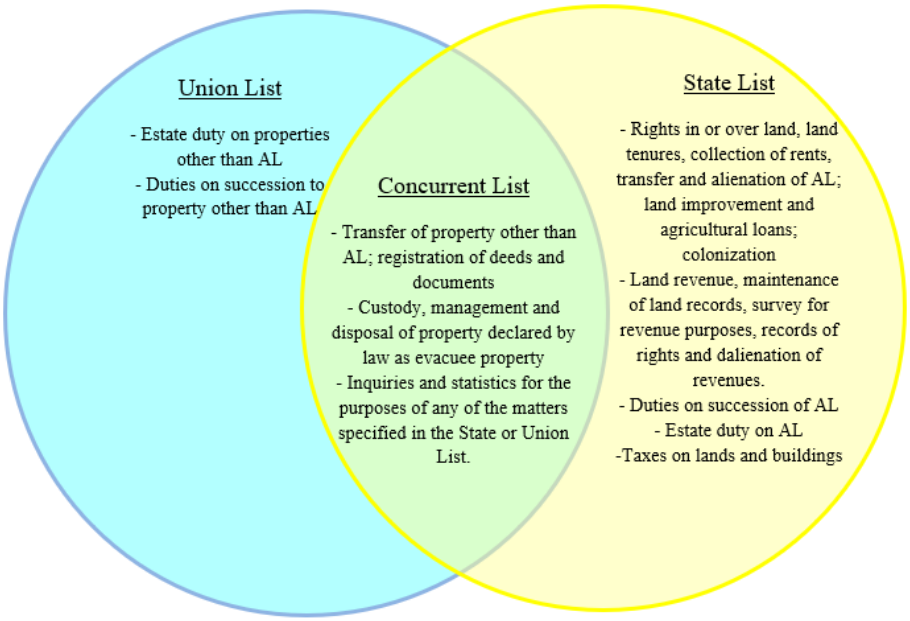
4. POTENTIAL CHALLENGES

Generation of land information data after survey/resurvey or digitization of existing land records are only one end of the land administration spectrum. In order to deliver efficient citizen-centric services, a unified database of the standard schema (conforming to LADM) and a standard framework for its subsequent updation, maintenance, and dissemination (of information related to the people-land relationship) is necessary. However, the following possible challenges are identified in this regard in the Indian scenario:

4.1 System of Governance

The Supreme court of India, in one of its verdicts, stated "…our Constitution adopted a federal structure with a strong bias towards the Centre. Under such a structure, while the Centre remains

strong to prevent the development of fissiparous tendencies, the States are made practically autonomous in ordinary times within the spheres allotted to them." Article 246 of the Constitution of India confers powers to the Parliament and the state legislatures to make laws concerning matters enumerated in List I (Union List) and List II (State List) of the seventh schedule respectively. Whereas both the Parliament and the State Legislatures are entitled to form laws on the matters enlisted in List III (Concurrent List) of the said schedule.



AL – Agricultural Land

Fig 4.1: Distribution of powers between Union and State to make laws on subjects related to land administration and collection of revenue and taxes as per Constitution

As evident from the figure above, the authority to make laws with respect to the land records and maintenance thereafter is majorly conferred to the respective States.

Moreover, Article 244(2) and the Sixth Schedule of the Constitution of India, confers the administration of the tribal areas (also known as Autonomous Districts or Autonomous Region) of the states of Assam, Meghalaya, Tripura, and Mizoram, to the District or Regional Council, the members of which are either directly elected or nominated by the Governor. These councils have been entrusted with the power to make laws on several subjects, among which the most relevant to the paper are as follows:

- The allotment, occupation or use, or the setting apart, of land, other than any land which is a reserved forest for agriculture or grazing or for residential or other non-agricultural purposes or for any other purpose likely to promote the interests of the inhabitants of any village or town.
- Any other matter relating to village or town administration, including village or town police and public health and sanitation.
- The inheritance of property.

4.2 Legal Framework

As evident from the previous section, the state legislatures are responsible to formulate and promulgate laws about land revenue, land record maintenance, land tenure, etc. Many states in India have separate acts/codes for land revenue, land reforms, land acquisition and requisition, land transfer, etc. For example, the state of Rajasthan has different acts for land revenue and land reforms viz., The Rajasthan Land Revenue Act, 1956, and The Rajasthan Land Reforms and Acquisition of Land Owner's Estate Act, 1963. Whereas some states have clubbed a few of these areas together and included them in a single act. For example, the state of Manipur and the Union Territory of Andaman and Nicobar Islands have Manipur Land Revenue and Land Reforms Act, 1960, and Andaman and Nicobar Islands Land Revenue and Land Reforms Regulation, 1966 respectively. To unify the land record databases belonging to different states based on respective land laws, one needs to have a good grasp of each of the state legal frameworks.

4.3 Diversity in Topography

India, apart from its cultural and linguistic diversity, is also blessed with geographical diversity. One can witness here from cold mountainous ranges, rich and fertile river valleys, desert, and thick forest cover, to humid coastal areas and plateau. Thus, the physical features found on the ground vary from one region to another and so varies the land use pattern and nature of the human settlement. One of the three basic components of the concept of fit-for-purpose (Enemark et al., 2015) is the use of affordable modern technologies for building spatial frameworks based on the scale and accuracy of mapping which in turn depends on the building density, topography, and other aspects. Hence, from an economic standpoint, one cannot depend on a common surveying methodology for pan-India coverage.

4.4 Multilinguism

Although the official language of the Union of India is Hindi in Devanagari script (as per Article 343), the Constitution of India through its Article 345 has provided the liberty to the States to adopt (by law) any one or more of the languages in use in the State or Hindi as the language or languages to be used for all or any of the official purposes of that State. As such the Eighth Schedule of the Indian Constitution (in line with Articles 344(1) and 351) consists of 22 languages. Traditionally, the land records for each respective state were maintained in the regional language (authorized under Article 345 for use in official purposes). Even in the present day, some of the states have chosen to digitize the records in their original languages.

4.5 Ontology

Consequent to the reasons explained in sections 4.1,4.2 and 4.4, different terminologies are used in different regions of India for the common land administration domain semantics. For example, the inhabited or homestead area of a village, which is the major focal point of the SVAMITVA scheme, is known as Abadi (in most of the North and Central Indian states) Lal

Dora area (in Haryana), Gaothan (in Maharashtra), Gramathana (in Karnataka), Natham Purambok (in Tamil Nadu) among others. Such diversity in the vocabulary of core technical terms of the land administration systems poses a roadblock when it comes to the creation of a unified database for land administration.

4.6 Schema

Consequent to the reasons explained in sections 4.1,4.2,4.3 and 4.5, different schemas of databases are adopted by different state authorities for storing their land record data. There is variability in the set of objects/features/entities and the type of associations/relationships among each other, across all the schemas. Even for the semantically common objects/features/entities, one can find differences in the ontology, list of attributes, their value type, and established constraints.

4.7 Temporal Aspect

Data about land administration is dynamic in nature. Williamson et al., 2010, described four dimensions of dynamism in Land Administration System (LAS). The first dimension involves changes to reflect the continual evolution of people-to-land relationships which can be triggered by economic, social, and environmental drivers. The second is caused by evolving ICT and globalisation, and their effects on the design and operation of LAS. The third dimension is caused by the dynamic nature of the information within LAS, such as changes in ownership, valuation, land use, and the land parcel through subdivision. The fourth dimension involves changes in the use of land information.
Hence it is necessary to maintain the historical data in the database. However, the databases of the ongoing projects don't explicitly describe the preservation of historical data.

5. POSSIBLE IMPLEMENTATION STRATEGIES

5.1 Interoperability Framework

The Global Statistical Geospatial Framework, a joint initiative by the Department of Economic and Social Affairs UN Secretariat, United Nations Statistical Division (UNSD), UN-GGIM, and United Nations Statistical Commission (UNSC), in one of its five principles endorsed the European Interoperability Framework, which consists of the following components:

5.1.1 Legal Interoperability

It enables organisations operating under different legal frameworks, policies, and strategies to work together. The first step towards addressing legal interoperability is to identify the interoperability barriers: sectoral or geographical. To ensure an up-and-running database based on LADM, provisions must be inserted or amended in the existing laws of the land to make it more compliant with the common goals.

Some states have recently made such amendments in their respective land revenue laws to fulfill the objectives of the ongoing schemes in India (Report of Expert Committee on SVAMITVA Scheme). The same may be expected with respect to LADM.

5.1.2 Organisational Interoperability

It refers to how different public administrations (i.e., government agencies and organisations) align their business processes, responsibilities, and expectations to achieve commonly agreed goals.

5.1.3 Schematic Interoperability

It ensures that the precise format and meaning of exchanged data and information among various organisations are preserved and understood. This includes syntactic aspects, such as the terminology used to describe concepts, as well describing the exact format of the information.

5.1.4 Data Interoperability

It covers the linking systems and services of applications and infrastructures. Aspects include interface and services specifications, and data and metadata standards and formats.

5.2 Transliteration Model

As discussed in sections 4.4 and 4.5, the use of different regional languages for documenting land records by different state governments poses an obstacle to the seamless unification of the databases into one. Hence a transliteration model is required to be adopted to convert texts from one language to another based on phonetic similarity. This would be useful to store data about the attributes such as the names of the owners (party or party group), localities, street names, etc. This could serve as a pre-processing stage for any record/data before its inclusion in the common database.
It is noteworthy that the Survey of India (The national mapping agency of India), already has such a transliteration system in place which is being used for transliterating geographical names. The adoption of the same in the land administration system can help break linguistic barriers.

5.3 Standardisation

One of the nine strategic pathways prescribed by the Integrated Geospatial Information Framework, UN-GGIM is Standards- which establishes and ensures the adoption of, best practice standards and compliance mechanisms that enable legal, data, semantic, and technical interoperability, which are fundamental to delivering integrated geospatial information and knowledge creation. Standards about the surveying techniques and accuracy requirement in accordance with the fit-for-purpose concept, application schema conforming to LADM, data

storage, and data dissemination are required to be created and implemented to ensure a functional land administration system.

5.4 Versioning of Data

The dynamism of any real-life system can be modeled in the digital environment either by using event-based modeling or state-based modeling. In event-based modeling, the events/occurrences/transactions are modeled as separate entities with their own identity and attributes. In state-based modeling, the states (i.e. the results) are modeled explicitly. The LADM has taken care of the dynamism through VersionedObject (State-based modeling) or class LA_Source (Event-based modeling).

It is pertinent to mention that India has recently published the National Geospatial Policy (NGP). It is a citizen-centric policy implemented in December 2022 that seeks to strengthen the Geospatial sector to support national development, economic prosperity, and a thriving information economy. The policy has laid down various clauses with respect to the strategy and approach, institutional framework, strengthening of geospatial infrastructures, geospatial education, skill development, geospatial enterprise, etc. However, the aspects of the policy which are most relevant to this section of the paper are as follows:

- Assignment of responsibility to each nodal department/ministry with respect to the fourteen global fundamental geospatial data themes recognized by UN-GGIM.
- Provision of access to the national geospatial data by all stakeholders in the country through a National Geospatial Data Registry (NGDR).
- Operationalization of a Unified Geospatial Interface for the provision of consumer-oriented products, applications, services, and solutions. This electronic data querying and processing service will utilise data contained in the NGDR and the data supply chains from the Central and State level Partnering Agencies.

6. CONCLUSION

India has already identified the need to digitize land records for effective land administration. As such, the Government has launched several schemes and programmes to cater to the requisition. Although the creation of such a mammoth database itself is an Everest, however, to account for the variability and dynamism in the unified land administration database (conforming to LADM) and to make it usable in the long run thereby contributing to the realisation of the SDGs, proper mechanism of maintenance and updation with a robust and stringent interoperability framework is absolutely essential for delivering efficient citizen-centric services.

With the advent of NGP, the seed is already sown. However, in order to reap the benefits, proper nurturing (in terms of implementation of the policy and effective execution thereafter) is essential.

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BIOGRAPHICAL NOTES

Ms. Debanjana Gupta completed her Bachelor of Technology (B. Tech) degree in Civil Engineering from the National Institute of Technology, Silchar, and is the recipient of the Institute's Silver medal for securing the highest cumulative grade point average (CGPA) in Civil Engineering. She later completed her Master of Technology (M. Tech) degree in Geotechnical and Geoenvironmental Engineering from the prestigious Indian Institute of Technology, Delhi, and secured the highest Degree Grade Point Average in her specialization. After getting selected in the competitive Indian Engineering Services Examination, she joined Survey of India, Department of Science and Technology, Government of India in 2018. Currently, she is serving as a Superintending Surveyor at Karnataka Geospatial Data Centre (KGDC), Survey of India, Department of Science and Technology, Government of India. She is looking after the data acquisition (by UAV) under the SVAMITVA scheme and the Large Scale Mapping project in the state of Karnataka.

Lt Col Siddarth Shekhawat is among the merit holder in Mining Engineering from Nagpur University. He is an alumnus of the Indian Military Academy, Dehradun. He was commissioned into the Corps of Engineers, Indian Army in 2006. The officer has an outstanding performance in Engineer's Young Officers' course and has a Diploma in Geo-Informatics from CDAC (Mohali). He completed Long Survey Course at the prestigious Indian Institute of Surveying and Mapping (Now renamed as National Institute of Geospatial ST) at Hyderabad, where he participated in the project on "Semi-Automatic Compilation Of SOI Data Using GIS Software". He has personally supervised all kinds of surveying activities including the Generation of High-Resolution Topographic Databases, High Precision Levelling, Toponomy, etc. He is currently working as the Director of Karnataka Geospatial Data Centre (KGDC), Survey of India, Department of Science and Technology, Government of India. He is the Project Director and Nodal Officer of the SVAMITVA scheme and the Large Scale Mapping project (from Survey of India) in the state of Karnataka.

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