Today's Technology Enables Multipurpose Cadastre

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SUMMARY

Beginning in 1980 with the groundbreaking "Need for a Multipurpose Cadastre" report published by the U.S. National Research Council, there has been a global vision for implementing a system that represents all rights, restrictions and responsibilities in a geographic context or map-centric system. Much work has been done in the direction of multipurpose cadastre (MPC), but operational MPC has yet to be realized.

Modernization, digitalization, and automation has occurred at different levels in many government agencies that have land information systems – registry, valuation, planning, natural resources, administrative records, and others. But little consideration has been given to how to integrate, share, and collaborate with other agencies also managing land, to have a single and comprehensive view of authoritative land information. This silo creation proliferates globally.

Geographic information systems (GIS) technology has evolved and is now capable of sharing and aggregating land information from disparate government departments to deliver single access to the nature and extent of property rights, restrictions, and responsibilities. Utilizing web services allows all government agencies to remain focused on their areas of responsibility while sharing up-to-date, authoritative data to a single point access for use by agencies and others with overlapping interests. Efficiency and accuracy are gained by limiting manual transmission of data, duplication of effort, and using current data straight from the source. Advantages that cannot be understated in a world fraught with accelerating challenges and needed discovery.

By leveraging standards such as the Land Administration Domain Model (LADM), Open Geospatial Consortium (OGC) standards, and globally available base maps, imagery, and data, realizing multipurpose cadastre can be a reality.

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1. INTRODUCTION

Beginning in 1980 with the groundbreaking "Need for a Multipurpose Cadastre" report published by the U.S. National Research Council, there has been a global vision for implementing a system that represents all rights, restrictions and responsibilities in a geographic context or map-centric system. Much work has been done in the direction of multipurpose cadastre (MPC), mostly on small localized scales, but a fully operational MPC has yet to be realized. While the content of land records has been considered more related to functions of local government (NRC, 1980), users now require precise spatial information in real time for the ability to develop and implement cross-jurisdictional and inter-agency solutions. Solutions which are designed to meet priorities, such as distaster response, climate mitigation, and sustainable development goals (Williamson, 2008).

2. VISION VERSUS REALITY

While the vision of a MPC is relatively straightforward in concept, the time that has elapsed since the 1980 report debuted without a functioning MPC in place, highlights some very real challenges in making the concept a reality (Figure 2.1). This lack of operational realization is due to a number of factors. In many countries, including the United States, land information is stored and maintained at local and state/provincial jurisdictions. Adding further complexity, are the land information silos that exist in these jurisdictions. For instance, information necessary for valuation and taxation purposes is often compiled and maintained by valuation officials. Data involving real property transactions might be maintained and managed by a different group, often in a registry or recording office. If a mapping component exisits, it may be with one group or the other but not necessarily linked together, and in some instances, mapping is maintained by an entirely different department.

Records have also traditionally been stored in a wide array of systems; some paper-based and others computerized. Many of the computerized systems are proprietary in nature or are limited in their ability to be interoperable with other systems due to inherence to open standards. Government tendency is for slow adoption of technology and for abrupt change in general because land administration systems underpin the economy of nations (GKI, 2022). The result is siloed data and static or transactional data sharing between all organizations, both private and public, with a vested interest in land information.

Capacity was cited as a concern for the viability of developing a MPC in the 1980 U.S. National Research Council report, which continues today. It, along with little to no resource committment at the federal level has contributed to slow progress towards a MPC.

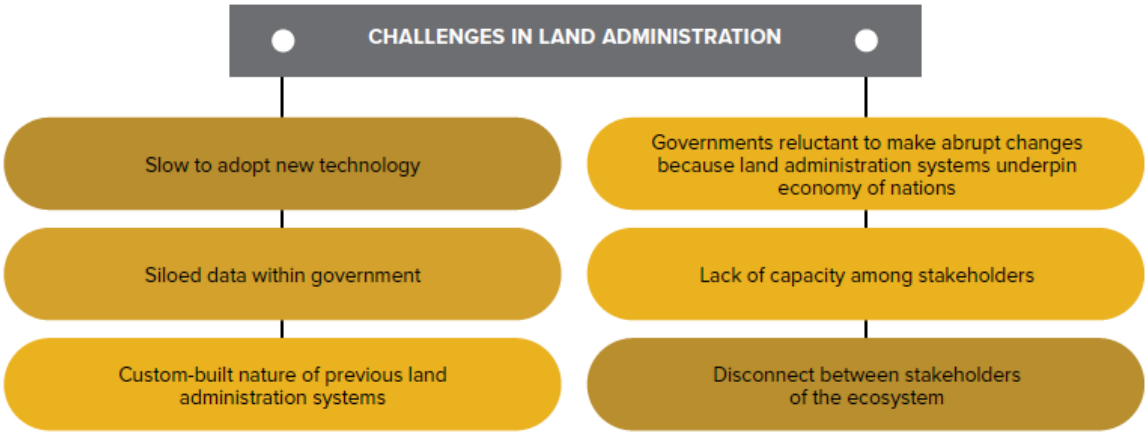

Figure 2.1. Challenges in land administration (GKI, 2022) contributing to slow realization of MPC.

3. TECHNOLOGY ADVANCEMENT

Modern Geographic information systems (GIS) technology has evolved and is now capable of sharing and aggregating land information from disparate government departments to deliver single access to the nature and extent of property rights, restrictions, and responsibilities. This ability to share and aggregate data more readily provides a solution that helps address some of the challenges in land administration (as shown above in Figure 2.1) that continue to hold progress back towards MPC.

Advances in artificial intelligence (AI) in recent years have been substantial and are continuing to mature and grow in sophistication. With the ability to match, or in some cases, even surpass human accuracy at tasks such as image reconginition, reading comprehension, and translating text (Land, 2022), the capacity challenge in reaching MPC may find some relief in the near future.

3.1 MODERN GIS

There are five key characteristics of modern GIS that promote sharing and aggregating of land information. As shown in Figure 3.1.A, they are:

- Scalability
- Security
- Standards and interoperability
- Services through the web
- Sustainability

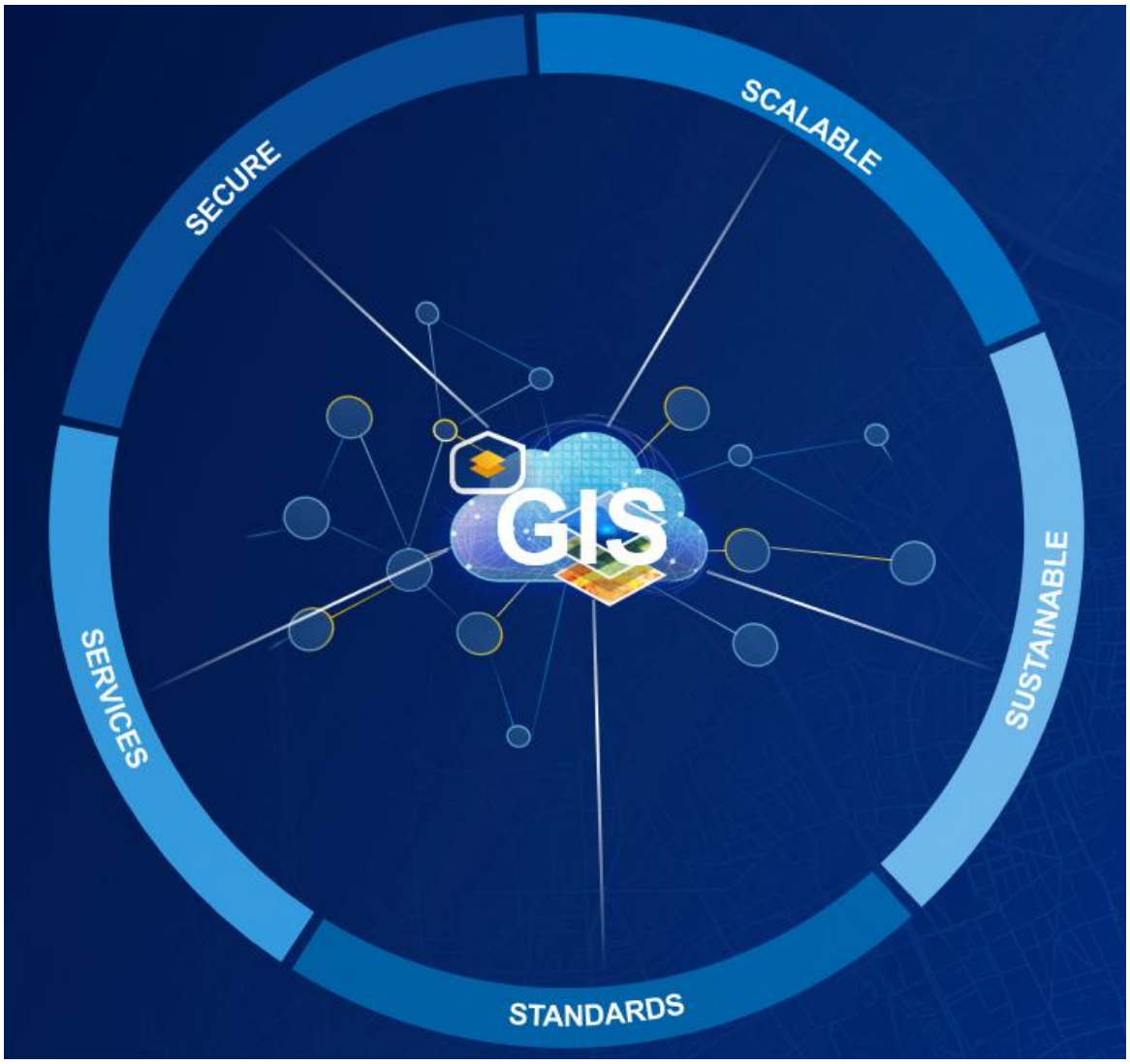

Figure 3.1.A. Five key characteristics of modern GIS, promoting sharing and aggregation of data.

3.1.1 Scalability

The scalabiltiy of modern GIS provides the opportunity for organizations of any size, and at any stage in their land administration odyssey, to fully realize the benefits of modern GIS. Whether working at an individual project level or as a mult-faceted organization comprised of many teams, there is a configuration that can accomodate (Figure 3.1.1.A).

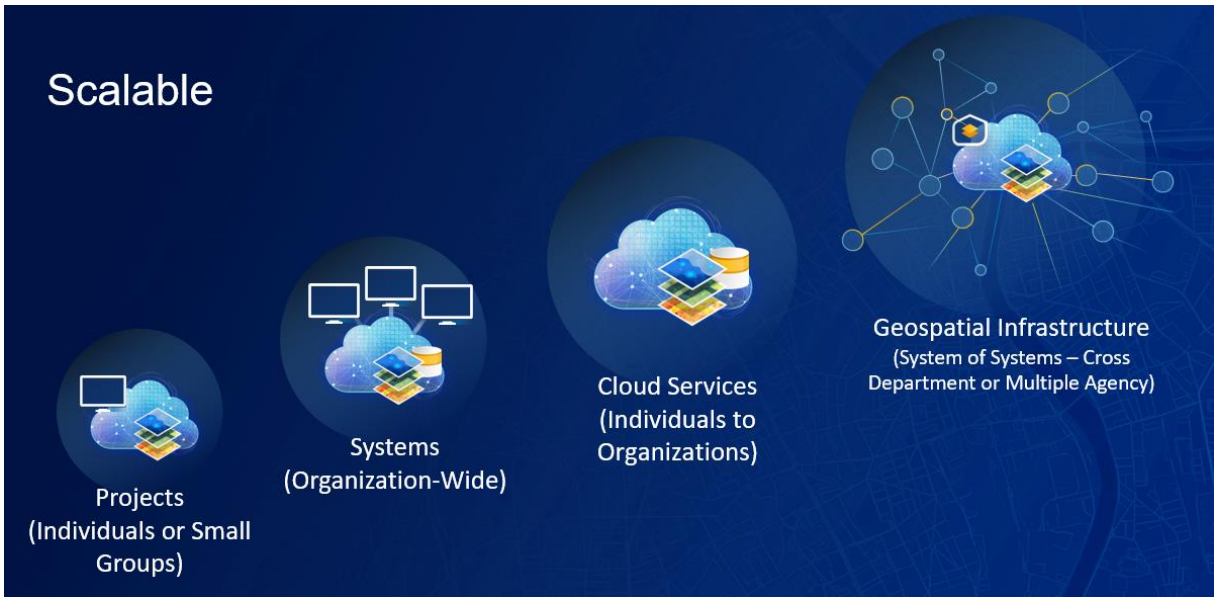

Figure 3.1.1.A. Modern GIS is scalable to meet organizational needs.

3.1.2 Security

Modern GIS, specifically commercial, off the shelf software (COTS) is designed and managed in alignment with regulations, standards, and best practices. Comprehensive security is provided througout the ecosystem including products and services, solutions, cloud infrastructure, and specific privacy and security initiatives (e.g. GDPR and FedRAMP).

3.1.3 Standards and interoperability

With a decades-long commitment to open standards and interoperability, modern GIS continues to contribute and support international standards development and has a history of open-sourcing its format specifications. With support for reading and writing standard and common data file types using industry and international standard data formats, and via the web through OGC services, GIS provides the interoperability needed to meet the evolving needs of the land administration community.

3.1.4 Services through the web

Utilizing web services allows all government agencies to remain focused on their areas of responsibility while sharing up-to-date, authoritative data to a single point access for use by agencies and others with overlapping interests. Efficiency and accuracy are gained by limiting manual transmission of data, duplication of effort, and using current data straight from the source. Advantages that cannot be understated in a world fraught with accelerating challenges and needed discovery.

3.1.5 Sustainability

The sum of the preceding four characteristics of a modern GIS is long-term sustainability. GIS system sustainability is critical in the pursuit to achieve MPC. As noted previously, one of the challenges in achieving MPC is the custom-built nature of legacy land administration systems. Custom-built systems are often vulnerable to security threats, require a high-level of specialized maintenance and are susceptible to high levels of technical debt.

3.2 ARTIFICIAL INTELLIGENCE

The intersection of AI and GIS, referred to as GeoAI, is creating enormous opportunity in the land administration space. Generally speaking, AI is the ability of computers to peform tasks that typically require some level of human intelligence (Land, 2022). Two areas showing promise are detection of cadastral boundaries from remotely sensed imgaery and the mapping of boundary descriptions from scanned documents using techniques like natural language processing (NLP) and machine learning (ML).

Each approach applies to different stages of land administration maturity. Boundary detection from imagery is being explored as an alternative to ”boots on the ground” surveying to expedite first registration of land, thus securing property rights and mobilizing land capital. Mapping of boundaries from existing documentation is intended to propel those organizations that have land registered in paper form, but not accessible in a mapped, digital format. First registration mapping or converting paper records to a digital format is the first step in the process towards realizing MPC.

4. CONCLUSION

Although widespread operationalized MPC has yet to be realized, all indications are that technological advances and increased concern for disaster mitigation, climate mitigation, and sustainable development is accelerating the process. For example, in the U.S., a number of statewide parcel aggregation projects have been successfully completed, and the Federal government recently passed the FLAIR Act which calls for the creation of a current, accurate inventory (cadastre) of Federal land. Both signify a commitment to larger land administration projects needed to eventually achieve MPC.

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BIOGRAPHICAL NOTES

Linda oversees Esri's worldwide strategic vision for land administration and surveying. With 20 years of experience working in the land and resource industry, she is a registered professional land surveyor and certified GIS professional. A leader in professional organizations, Linda was recently elected as the Vice President of the National Society of Professional Surveyors. She also holds a Bachelor of Science degree in Geological Engineering, and a Master's degree in GIS from Penn State University.

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