ArcGIS and Land Administration
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GIS and Land Administration

Introduction

Land is an essential resource that supports nearly every aspect of a nation's social fabric and economic well-being. It is also in finite supply and must be governed appropriately to support sustainable economic growth, social equity, and access to services and to prevent conflict. Good land governance controls and manages the effective use of physical space and does so through a combination of policies, processes, and institutions. This includes the processes of determining, recording, and disseminating information about the tenure, value, and use of land.

As countries increase their engagement in the global economy, expectations and requirements—both internal and external—evolve to accommodate new demands for an improved infrastructure to record landownership and effect land use policies.

The rapid economic, technological, and social transformations over the last decade have increased the demand for modern land administration systems that support the collection, management, and dissemination of complete, reliable, authoritative land administration data—thus creating the system of record. The lack of available, standardized, high-quality, and usable land data represents a significant obstacle for a successful economy.

A standards-based land administration solution, grounded in a legal and institutional framework, is critical to documenting and managing municipal, provincial, state, national, and private-sector land-based resources. It is also essential to support the standard functions of a modern government, such as providing e-government services, property valuation and taxation, access to utilities, and urban and regional planning activities.

Geographic information system (GIS) technology has been an essential component of successful land administration and cadastral agencies for many years, solving common problems. ArcGIS software, the world-leading GIS, provides a comprehensive technology platform to enable land administration organizations to modernize and to meet new challenges by providing efficient, well-managed workflows; rigorous systems that manage data integrity and security; and capabilities that deliver contemporary information products and services to stakeholders, taxpayers, and citizens. ArcGIS leverages geodatabase technology, open standards, cloud computing, and extensive worldwide data and high-resolution imagery as well as 3D and mobile device capabilities. ArcGIS provides the essential infrastructure backbone for successful land administration systems, whether for a national, state/provincial, or local/municipal organization.
Global Challenges in Land Administration

Incomplete Cadastre
Around the globe, many countries have not completed the demarcation and registration of all properties within their borders. There are a variety of reasons why—ranging from poorly written laws and policies that serve as a disincentive for registration—to inefficient and outdated workflows built on legacy custom-developed applications. Whether using a formal or informal system, not having a complete cadastre poses challenges to guaranteeing tenure security for citizens and providing the necessary information to support a healthy land market, equitable taxation, and access to services.

Data Management and Sharing
Managing vast amounts of vector, survey, attribute, and imagery data requires different offices within the same organization and across government to share and collaborate. Decentralized or regional land offices are frequently called on to publish parcel data to the central organization to better support national-level planning, resource allocation, and disaster response. Connecting to other databases and synchronizing information within a single enterprise system have been long-standing but seldom realized goals. The inability to easily aggregate, synchronize, and share cadastral data frequently results in duplicate and out-of-sync data, which can increase costs, conflicts, and the incidence of fraud, undermining the integrity of the organization.

Legacy Systems
Many legacy land administration systems still in use today were created by their organization’s in-house developers using highly customized workflows not designed to leverage industry best practices or evolve with changing technology standards. Changes in staff over time often leaves these organizations without the few individuals who can properly maintain and update their custom solutions. Not wanting to squander their original investment, it is common to allow these “good enough” solutions to outlive their effective use, keeping the land records organization at a disadvantage relative to others using modern commercial off-the-shelf technology (COTS). To keep up with today’s rapidly changing environment for security, data sharing, and transparency, smart organizations typically employ a “COTS First” strategy.

New Products and Services
Citizens expect easy access to current and relevant land data and information products on a variety of devices—Androids, iPhones, tablets, etc. The ongoing development of mobile technology continues to evolve public expectations. Clear, accessible, and easy-to-use information from government websites—combined with e-government initiatives and increased citizen expectations for engagement, transparency, and service-level agreements—presents land administration professionals with new challenges. But this also provides new opportunities to deliver better and more services for citizens and officials. Land administration agencies need a platform for deploying maps, applications, data, and information products to citizens, businesses, and other government departments for use on the web, smartphones, and tablets.
Land administration agencies worldwide are embracing ArcGIS capabilities to take full advantage of new COTS technology. Contemporary challenges are just too significant and rapidly changing to address using custom, homegrown solutions. There is a growing understanding of not just the cost to develop custom systems but also the ongoing cost to maintain them, add capabilities, and train new staff. Configuring COTS technology for specific information products that are unique to a system and for developing products can enhance existing revenue streams and easily create new ones.

Security is one area where this is most notable. With the growing number of global threats and the new devices and applications being developed daily, it is very difficult for land administration agencies to keep current and secure.

Many two-dimensional cadastres are moving to being fully three-dimensional, recognizing rights and restrictions in 3D space. This provides a full understanding of value and supports better planning and design.
A multipurpose cadastre has been a goal of national governments for many years. It has been a longstanding challenge to aggregate and manage a disparate set of data and technologies and deliver access to data and applications across government. An increased awareness in the value of land data is creating more collaboration within single agencies and with other government departments to implement a successful National Spatial Data Infrastructure (NSDI). For instance, Ireland is deploying its multipurpose cadastre in GeoHive.

*GeoHive, implemented by Ordnance Survey Ireland, uses ArcGIS to allow citizens to search, visualize, display, and share data and apps.*

Open, transparent systems are the force multiplier when realizing value from your data. This is becoming the norm in developed countries, and local jurisdictions
around the globe, enabling more accountability and improving the trust and confidence of the public. This transparency is also fueling the open data movement enabling new engagement with landowners and taxpayers. Deploying open data technology is also now a COTS-configured implementation. The Property Lots in DC webpage is a great example of providing authoritative data with useful application programming interfaces (APIs).

Property or parcel data is a critical layer to any city or statewide data holdings. In our city’s complex urban environment, this includes numerous geographies that identify federal government lands, reservations, District lands, personal property and so much more. The District’s Vector Property Mapping (VPM) project works daily to capture property lot transactions so that city planners, business development leaders and residents stay current. Read below to help you identify how DC lot data is organized and key points on their relationships.

**History and Benefits**

Vector property mapping data is recorded and maintained with the oversight of the Office of Chief Technology Officer (OCIO), Office of the Surveyor, and the Real Property Tax Administration (RPTA). The data you see here represents active lots as of September 1, 2006. Prior to this date, lot history was not tracked or captured.

Property transactions have since been applied to keep the data current. If you’re interested in lot history, these can still be found utilizing other publicly available resources such as the Office of the Surveyor’s SurDoco management system (square cards, plats, and miscellaneous documents), ballot books, and property scan images.

**Property Lots in DC**, an ArcGIS Open Data portal configuration, provides useful data and tools with clear explanations for using the data and its capabilities to improve transparency, citizen engagement, and initiative-driven activities. —Go.esri.com/propertylotsDC

Engineered to be open and interoperable to work with other business systems, ArcGIS provides the technology platform for land administration activities, including property boundary and attribute capture in the field, cadastral data editing and management with standardized workflows, feature extraction from imagery, legacy cadastral document digitization, and the dissemination and sharing of critical land information. ArcGIS provides a scalable platform that can be deployed as fit for purpose, allowing simple field-capture, management, and parcel data publication in the cloud or in an enterprise system that meets the needs of a modern land administration office. ArcGIS capabilities include being responsive to jurisdictions that may require a higher degree of spatial data accuracy, automated workflows, multiuser editing, and visualization and management of parcel data in a 3D environment. This flexibility allows Esri users around the globe to leverage current trends and take on more functionality as their capacity and functional needs and volume of transactions grow over time.

Globally, hundreds of cadastre organizations use Esri’s software platform for the collection, management, and dissemination of critically important land tenure and valuation data. This ranges from countries in sub-Saharan Africa—still in the early stages of creating their national parcel fabric—to the US Bureau of Land Management, one of the world’s largest land management agencies.
Why have these agencies selected ArcGIS? Because ArcGIS has capabilities that are built into the system, includes apps that leverage the platform, is based on open standards, and provides required security and identity. With ArcGIS, you can begin at any level—from fit for purpose to enterprise land administration—and extend existing investments. By using ArcGIS as the location platform for all land-related activities, an organization becomes part of a global community that continues to grow and improve.

**Essential Systems**

There are three essential systems in land administration: the system of record, the system of insight, and the system of engagement. Each of these systems plays a key part and is critical to the success of the entire system of systems. ArcGIS is a system of systems and manages all these subsystems in a common platform.

**System of Record**

A system of record is defined as a data storage and management system for authoritative data. In land administration, this is the cadastre—the single, authoritative, secure, defensible legal record of landownership. In most systems, this is a nonnegotiable single source of landownership data and property characteristics. This system must be secure, stable, and incorruptible to provide unquestionable authoritative data for widespread use and to maintain the public’s trust and confidence in the cadastre information.

Maintaining the system of record requires standards—standard data structures and security protocols in a data-integrity-enforced environment. It requires data history preservation, editor tracking/auditing documentation, and secure maintenance of the original survey record. ArcGIS provides all this with standards-based workflows to ensure consistency and completeness while delivering throughput efficiencies.

**Exceptional Parcel Management**

Core to the ArcGIS for Land Administration solution is the ability to efficiently create and manage parcels from a wide variety of data types and workflows. Quality and accuracy demands have evolved over time; consequently, Esri has invested heavily in developing technology and workflows specific to parcel management—the system of record.

*Purpose-Built COTS Cadastral Parcel Fabric Workflows*

Whether splitting or merging lots, or creating a detailed 500-lot subdivision, or entering a new parcel from survey data or a technical description, ArcGIS provides specific, efficient tools designed to speed data entry and place annotation. Many agencies report a 50 percent increase in throughput using parcel fabric workflows.
Data Aggregation

Many cadastral agencies have isolated district offices, and many are municipal or provincial/state based and need to aggregate parcel data into a seamless, countrywide parcel fabric. These capabilities are COTS based and easily deployed to any number of parcel management jurisdictions.

Enterprise Workflow Management

The core functions of collecting survey data, managing control, editing parcels, integrating with the registry, and sharing data are all similar among land administration agencies, but legal frameworks, customs, data, capacity, and land histories are all different. These differences in workflows are managed through advanced web-based tools, allowing any land administration organization to utilize COTS products while respecting its uniqueness.

System of Insight

Land administration organizations collect vast amounts of data. This can be from recorded documents, parcels, surveys, imagery, basemaps, property characteristics, addresses, and more. Extracting information from these disparate datasets can be challenging. A system of insight can extract information from this data and, when spatially enabled with ArcGIS, trends and patterns can be uncovered, delivering greater understanding into what is happening. ArcGIS provides the analytical and visualization tools to quickly uncover information and deliver a modern view with maps, charts, and graphs to help you understand what is hidden within your property data. The ArcGIS system of insight enables you to see the status of work in your organization and act intelligently.

Valuation

For many reasons, property values are higher in certain areas than in others—location matters. Understand, analyze, and visualize what impacts property value and by how much. Traffic counts, development restrictions, population characteristics, access to services—many factors contribute. ArcGIS enables you to make sense of
this data and use advanced analysis and visualization to understand property value. This is perhaps the most underutilized capability of GIS. Using spatial analysis capabilities like geographically weighted regression and surface response modeling, you can refine valuation models and present data in new ways, delivering more accurate valuations.

Configurable dashboards enable you to quickly visualize data and analysis to make decisions at a glance.

System of Engagement

Engaging citizens and landowners a few decades ago meant having a set of maps and property folios on paper, available to view. This has evolved over time and will continue to do so—no longer can we maintain a static set of maps and engagement tools. Today a system of engagement for a land administration agency means providing simple apps, data services, and information products to other departments and the public in ways that the data and information are usable. Engaging citizens now means providing apps that answer specific questions, facilitate the exchange of information, and provide data services that connect to other systems—all while remaining modern and agile and ready for change.

ArcGIS provides the platform and many ready-to-use apps for viewing land data along with open data capabilities that allow the public to download your authoritative data or access it via APIs. The ArcGIS platform delivers app builders to help you configure your own apps so you don’t have to support large software development capabilities.
Have the status of work at your fingertips—whether you’re in the office or the field—with the Workforce for ArcGIS dashboard.

Modernizing the Field

Mobility
In the field, work is more efficient if surveyors have access to the enterprise cadastral mapping and control database. In the office, work is more efficient with timely updates from the field. ArcGIS delivers organizational efficiency by enabling all staff to access enterprise data anywhere, anytime, on any device, even in a disconnected environment. This organization-wide access to the single authoritative source eliminates redundant and otherwise unnecessary work.

In addition to having access to enterprise data, field surveyors collect data with platform apps for Android devices and iPhones and connect to high-precision GPS, eliminating the need for additional data collection hardware. By employing standard field data collection apps such as Collector for ArcGIS and Survey123 for ArcGIS, surveyors can take advantage of new mobile GIS advances without developing costly custom applications. When point survey data collection isn't enough, use the platform app Drone2Map for ArcGIS to seamlessly collect and rectify drone imagery and input it into your enterprise cadastral system.
Use any GPS with the Collector app and improve data collection workflows with high-accuracy GPS.

Modernizing with 3D
Land rights and restrictions reside in a three-dimensional world. Traditionally, these have been represented in only two dimensions because of technology restrictions. This is no longer the case; 3D is now a core capability in ArcGIS. There are many drivers for 3D cadastre including the necessity for cities to grow vertically and add square footage, preserve valuable views, and have a full understanding of what rights and restrictions exist to obtain financing from financial institutions. This includes subterranean rights as well as restrictions for managing mineral rights, utility easements, and transportation expansion.

Understanding viewsheds, sun exposure, and existing rights and restrictions is critical for proper valuation of urban properties. Many agencies don't yet have full 3D data of the properties that need to be assessed, but they still have a need to better understand the urban landscape for development and valuation. For leveraging information in disparate systems—such as the number of floors and building use—ArcGIS has the ability to extrude and build urban models to help land agencies maximize their ability to plan and to fairly and equitably valuate real estate.
ArcGIS is the technology backbone of a modern enterprise land administration system. Embracing global trends and adhering to accepted security protocols, ArcGIS delivers an open platform for new capabilities and enterprise apps to ensure that your system evolves with the changing demands of your organization and your stakeholders. ArcGIS will continue to grow and evolve. Whether for 3D cadastre, drone deployment, or distributed GIS systems, you can trust that industry leader Esri will always be ready to meet your needs.

Gone are the days of custom-built cadastral systems—there is neither time nor budget. Esri has spent considerable effort and many years researching and has created a solution that can be configured to meet unique in-country legal requirements and workflows. The goal is not to build a custom system but to configure the COTS ArcGIS platform to fit your needs. Eliminate costly custom software development and support—configure the system that is sustainable and will continue to deliver new capabilities with each release.

Whether the requirement is to map and visualize rights and restrictions, develop a survey accurate coordinate based, cadastre, improve valuation and taxation, securely share data internally and with the public, or begin with a fit-for-purpose system, ArcGIS provides the platform to ensure faster data updating with better data integrity, and shorten the implementation of your system from years to months.

Esri has a global network of offices, distributors, and partners to help you configure and implement the ArcGIS platform. Are you ready to get started?
Additional Resources

The ArcGIS platform conforms to ISO 27001, SSAE16 SOC1 Type 2, FedRAMP, FISMA, Privacy Shield Framework, and TRUSTe privacy certification.

Additional Security Information—Go.esri.com/TrustArcGIS

Map Book Production—Go.esri.com/mapbook

Parcel Fabric—Go.esri.com/parcelfabric

Addressing—Go.esri.com/addressing

ArcGIS Land Records Solutions—Go.esri.com/landsolutions

White paper: ArcGIS for Assessment, Tax, and Land Records—Go.esri.com/LRWP
Esri, the global market leader in geographic information system (GIS) software, offers the most powerful mapping and spatial analytics technology available.

Since 1969, Esri has helped customers unlock the full potential of data to improve operational and business results. Today, Esri software is deployed in more than 350,000 organizations including the world’s largest cities, most national governments, 75 percent of Fortune 500 companies, and more than 7,000 colleges and universities. Esri engineers the most advanced solutions for digital transformation, the Internet of Things (IoT), and location analytics to inform the most authoritative maps in the world.

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Contact Esri

380 New York Street
Redlands, California 92373-8100 USA

1 800 447 9778
T 909 793 2853
F 909 793 5953
info@esri.com
esri.com

Offices worldwide
esri.com/locations