

GIS for Land Use and Land Administration

India with only 2.4% of the total land area of the world is supporting 18% of the global population. Naturally, the pressure on the land is much beyond its actual carrying capacity. An unavoidable outcome of this scenario is the land's constant degradation and the fast conversion of productive lands into wastelands. Mapping of degraded lands in the country by ISRO's Space Applications Centre has indicated that an area of 97.85 million hectares, which accounts for about 29.77% of the country's total geographic area, is under degradation as of 2018-19.

Land provides the foundation for shelter, supports agriculture and natural resources, contributes to cultural identity, fosters economic development, and plays a crucial role in environmental health. As the global population continues to grow, sustainable land management becomes increasingly important to ensure the well-being of present and future generations.

Inequality arising due to ambiguity in land ownership is also a great cause of concern. Land ownership is often linked to various aspects of social, economic, and political inequality. Ambiguity or lack of clear land ownership leads to unequal distribution of land resources. In many cases, a small percentage of the population holds a large proportion of the land, while a significant number of people have limited or no access to land.

Disparities in land ownership also contribute to rural poverty. Small and marginalized farmers may struggle to access land, leading to economic hardships and perpetuating a cycle of poverty. Land-related disputes and lack of clarity in ownership also often lead to conflicts.

Intelligent Land Information Systems can help solve these problems. Land parcel data (also known as cadastral data) provide geographically referenced information about the rights, interests, and ownership of land. The data can be used by governments to make informed decisions about land titles, land development, property tax management, law enforcement, and more. Accurate measurement of land parcels also helps the government to assess property taxes more accurately and earn more revenue.

Intelligent Land Information Systems

The three necessary systems that comprise an Intelligent Land Information System are the “**System of Record**” (parcel data), the “**System of Insight**” (valuation), and the “**System of Engagement**” (stakeholder and public engagement). GIS efficiently delivers all three on a single platform.

Additionally, as land administration increasingly moves towards adopting the “Sensor to Software” approach, GIS can offer a cost-effective, efficient, and safe way to monitor land, analyze data, and make informed decisions about land management. With the help of drones, urban

planners are able to collect large amounts of up-to-date data in a short period of time. They are able to reach areas, otherwise difficult for people to reach and do manual surveys. The images collected by drones allow planners to examine the existing social and environmental conditions of the sites and take into account the impact of different scenarios. Aerial images taken by drones accelerate and simplify topographic surveys, necessary for land management and planning. For the purpose of land management, it is necessary to process the data collected by drones effectively. GIS enables the production of high-accuracy cadastral maps, high-resolution orthomosaics, and detailed 3D models from drone data quickly and easily, even in complex environments. Using GIS, surveyors can extract features from the images, such as signs, curbs, road markers, fire hydrants, and drains, leading to highly efficient land use planning and management. Esri's ArcGIS is an effective platform that enables users to exploit, manage, and share the data captured by any UAV.

GIS as a System of Record: Parcel Data Management

Parcel data is a complex web of ownership, boundaries, and historical data. Managing these efficiently and accurately can be daunting, but thanks to tools like Esri's ArcGIS Pro and ArcGIS Enterprise, authorities can achieve streamlined land administration. As a System of Record, GIS provides crucial information about land ownership, land use, and various property-related transactions. This information is maintained by government authorities at the local, regional, or national level and serves as a crucial component of a well-functioning land administration system.



Figure 1: GIS Workflow in Parcel Data Management

Indo ArcGIS is a unique product, developed by Esri India to solve some of the most pressing social and business challenges the country is facing today. Indo ArcGIS includes solutions and data products for achieving

excellence in land records management, property tax management, urban and regional planning, etc. These solutions are supported by 800+ layers of Indian datasets available through the Indian edition of ArcGIS Living Atlas.

A comprehensive GIS Solution for parcel management helps in achieving efficient workflows, improved field operations, higher accuracy, aggregated parcel data, better visualization, and more informed decisions.



Figure 2: Comprehensive GIS Solution for Parcel Data Management

Accurate land records verification and management systems help in establishing and verifying property rights, supporting land transactions, and ensuring transparency and legal compliance in land-related matters. Improved analytical systems bring more power to the citizens, allowing them to use their land as a financial asset as well.

Accurate land parcel data management also helps in the process of mutation or transfer of land. In case of rural land many times, historical data about the ownership of the land is not available, and this creates a risk of litigation. GIS-based Land Information Systems, by enabling mapping and registration of lands, play an important role in land dispute resolutions. The risk of litigation also comes down due to the availability of historical data about land ownership.

GIS also helps in the accurate valuation of a piece of land based on its location. For instance, if a land is nearer to a river, a highway, or a road, the value of the land is typically higher than the land that is located inside. Once this kind of valuation is recorded, the accurate stamp duty charging at the time of registration can also be easily achieved. Accurate valuation of land also helps in matters of transferring land as part of inheritance.

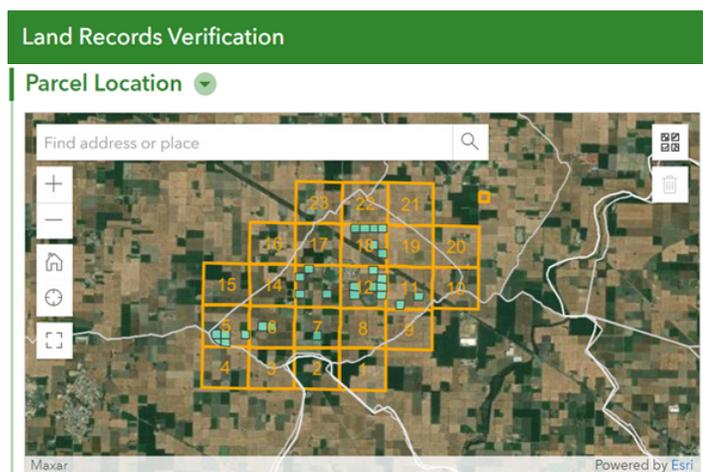


Figure 3: Land Records Verification Powered by Indo ArcGIS

GIS as a System of Insight: Valuation Modelling

Assessors are often looking for information to analyze how well their assessments are performing at various levels of the spatial hierarchy—in certain market or submarket areas or neighborhoods. Assessment inequity, or dissimilarities among assessments of similar properties, can be caused by many factors, such as field appraisers miscoding a property's features. This can bring errors in defining assessment models and drawing market areas.

When authorities map and analyze property values with GIS, they achieve significant improvement in property value assessments. Location analytics enables them to enrich their data and visualize the results to uncover trends and patterns. With the help of GIS, they can quickly detect errors and outliers, refine valuation models, and deliver more accurate data to the stakeholders and taxpayers. GIS also allows quick mapping of price per square foot, comparable properties, and sales ratios to improve efficiency and property analysis.

Using GIS as a System of Insight, assessors can visualize sales ratio studies at different levels of aggregation—by the market, submarket, or neighborhood level, for instance. This information helps them to see where they are performing well and where assessments may need to be shored up or reevaluated.

GIS dashboards also allow assessors to select property data and drag it onto a card to visualize it as a map, chart, or table. The cards can be linked, making digging deeper into the data quick and easy. To concentrate on one data selection, such as market area or quality of construction, a user can pick that row in a table to automatically change the maps, charts, and graphs. Esri's ArcGIS offers a variety of tools that can provide invaluable insights to officials for better management. Indo ArcGIS' solutions for Land Records Management can enable the Revenue Department to collect data from the field, assess it, and make more informed decisions.

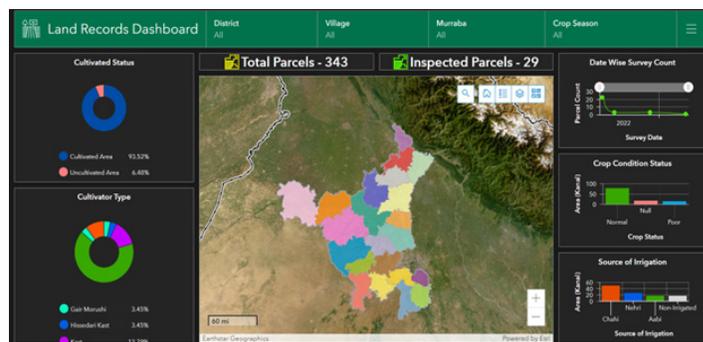


Figure 4: Land Records Dashboard

Local government organizations are always in need of quick, cost-effective ways that can help them get more insight out of their data. GIS-powered dashboards serve as a great tool for presenting operational, analytical, and other types of data. These dashboards allow local government officials to easily visualize and analyze the data they have collected, helping them to make informed decisions.

For example, the following Green Cover Dashboard powered by ArcGIS enables the Brihanmumbai Municipal Corporation (BMC) to assess the green cover for the years 2002, 2012, and 2022 providing a representation of the changing landscape over the past two decades. Users can easily compare and analyze the declination of green cover, highlighting significant alterations in land use and environmental trends. This tool offers valuable insights into the shifting dynamics of vegetation and urban development over time.

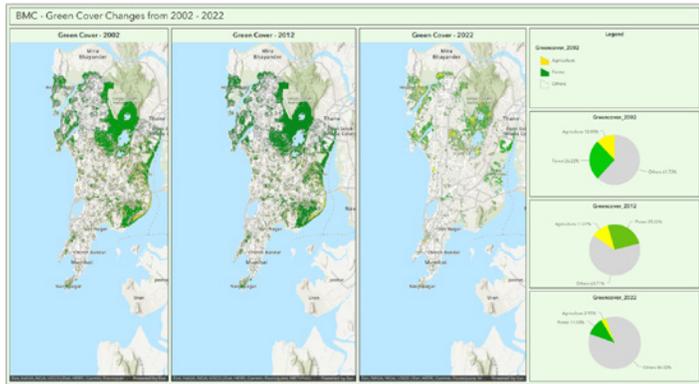


Figure 5: BMC Green Cover Dashboard

Also, ArcGIS powered MahaBHUMI Geo-Portal used by the Maharashtra Remote Sensing Centre (MRSAC) allows GIS to serve as an effective System of Insight by providing the users the ability to query and access geospatial data in various domains including transport, urban planning, topography, land use & land cover. It serves as a valuable resource for government agencies to access and analyze geospatial data for informed decision-making and planning.



Figure 6: MahaBHUMI Land use/Landcover Theme Sample Dashboard – for Gondia District

GIS as a System of Engagement: Collaborative Decision-Making

GIS enables authorities to improve transparency and stakeholder engagement. It is vital for land authorities to maintain public trust and confidence. In the past, sharing data and property information internally and with the public involved property cards, folios, and paper maps. Today, citizens, taxpayers, and the public expect property information to be easy to find, quick to understand, and available on any device. GIS as a System of Engagement allows the agencies to share property information with web maps, apps, open data, hubs,

and services. Additionally, sharing authoritative data internally with services allows systems to connect to each other eliminating duplicate data and duplicated work.



Figure 7: Indo ArcGIS Solutions enable the Public to Gather Details about their Properties

GIS-powered dashboards keep organizations and the public in the know with a vast amount of valuable information daily. GIS delivers transformational technology to assessors. GIS-based land information management systems can be used to inform taxpayers of critical timelines in the assessment process, allow the public to access property data at any time and on any device with modern, easy-to-use maps and apps, and enable easy sharing of data among the stakeholders.

For example, a Geospatial Hub powered by ArcGIS enables BMC to provide access to a wide range of geospatial data and tools to the public. By making various geospatial datasets and applications publicly available, the application allows BMC to gain higher engagement with the citizens. It is user-friendly and can be used in a collaborative manner across different domains.

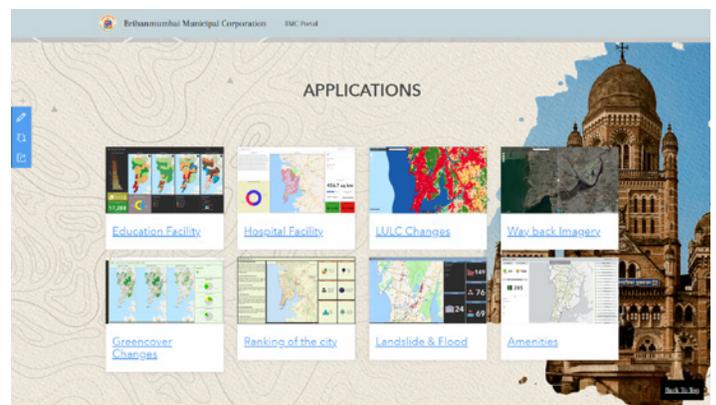


Figure 8: BMC Geospatial Hub Fostering Higher Citizen Engagement

In Summary

GIS qualifies as an effective tool for accurate large-scale spatial data management, data integration, mapping, analysis, modeling, and decision-making. It streamlines workflows, thereby helping authorities avoid duplication of effort and problems with data accuracy. By linking maps and legal descriptions to land ownership records, GIS provides an efficient method for record-keeping as well as identifying errors in land records. A GIS-based workflow that uses topology tools helps eliminate errors resulting from overlapping boundaries, incomplete parcel descriptions, and other discrepancies in land records. Additionally, advances in Web GIS make parcel information and maps readily available to the public, businesses, and other agencies, and that saves time and money.

GIS technology easily accommodates multiple users, parcel history maintenance, and data security. Its capabilities for data sharing and documentation enable organizations to build and share information more widely, and a GIS facilitates the creation of data of known quality, making it the preferred means to distribute public geospatial data.

With its focus on data, GIS technology can manage large amounts of information covering a wide geographic extent in a single, seamless spatial database. GIS has the capability to store real-world features accurately and effectively. GIS features are stored as elements in spatial databases, and data structures manage the connectivity of linear features into linear or polygon networks. Boundaries can be made of simple or complex linear features. GIS technology uses the concept of layering for segregating different kinds of information into more easily managed units.

The interoperability tools of GIS overcome the usual problems associated with file conversion. Users can perform data migration or support map distribution according to their specific needs. They can use the appropriate tool for the job while ensuring the flow of information across the enterprise. Local governments generally are concerned with the issues related to a single, common geography, which points to the need for a centrally managed and shared GIS. An enterprise GIS enables users from different departments in an organization to use common data for their specific tasks. Adopting an enterprise geodatabase is more widespread because it helps organizations be more accountable and efficient. GIS enables stakeholders to respond to requests for information faster, serve clients better, and respond to governmental issues, all while reducing costs.

ArcGIS is a valuable tool in the field of land administration, offering a comprehensive set of capabilities for managing and analyzing spatial data related to land resources. It enhances the efficiency, transparency, and effectiveness of land administration processes. ArcGIS Parcel Fabric allows organizations to effectively manage 2D, 3D, and 4D parcel data, including strata and subsurface information, ownership records, and agricultural and natural resource rights.

A GIS-powered Land Information Management System helps authorities overcome the challenges usually associated with land administration such as incomplete cadastre, moving from paper to digital, ensuring data is up to date and accurate, quality improvement, and delivering new products and land information services. A GIS-powered Land Information Management System aids in effective land administration by supporting the land administration trends of automated workflows,

digital submission, connected workers, systems consolidation, 3D cadastre, cadastre as basis for national SDI, standards compliance, open data & transparency, “fit for purpose” cadastre, etc.



Figure 9: ArcGIS enabling Land Administration

Integration of GIS in land administration practices enables government agencies, landowners, and stakeholders to make informed decisions, reduce errors, and achieve excellence in land governance and administration.

