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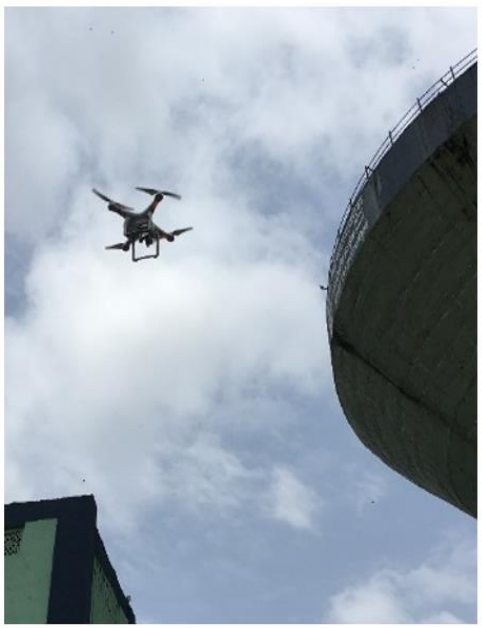
Policy Brief #4


PROPERTY MAPPING IN MAHARASHTRA: SELECTING A SUITABLE SURVEY TECHNOLOGY

Introduction

The Digital India Land Records Modernisation Programme (DILRMP), a central government scheme launched in August 2008, aims to improve the quality and accessibility of land records. These records, which provide details of a land parcel such as dimensions, ownership and value, exist in spatial and non-spatial forms. Maintained by state governments, they contain precise representations of land parcels and serve as an ongoing Record of Rights.

The state of Maharashtra has both spatial and non-spatial land records for agricultural areas. However, in the case of built-up or *abadi* areas—termed as '*gaothan*'—there are mostly textual and very few spatial records. This is because the task of capturing the ownership of *gaothan* areas has not received much importance, causing a hindrance for the Government of Maharashtra (GoM) while undertaking administrative tasks such as infrastructure development work and charging property tax. Another impediment is caused by discrepancies between spatial and textual records, thereby leading to ambiguities in government records.

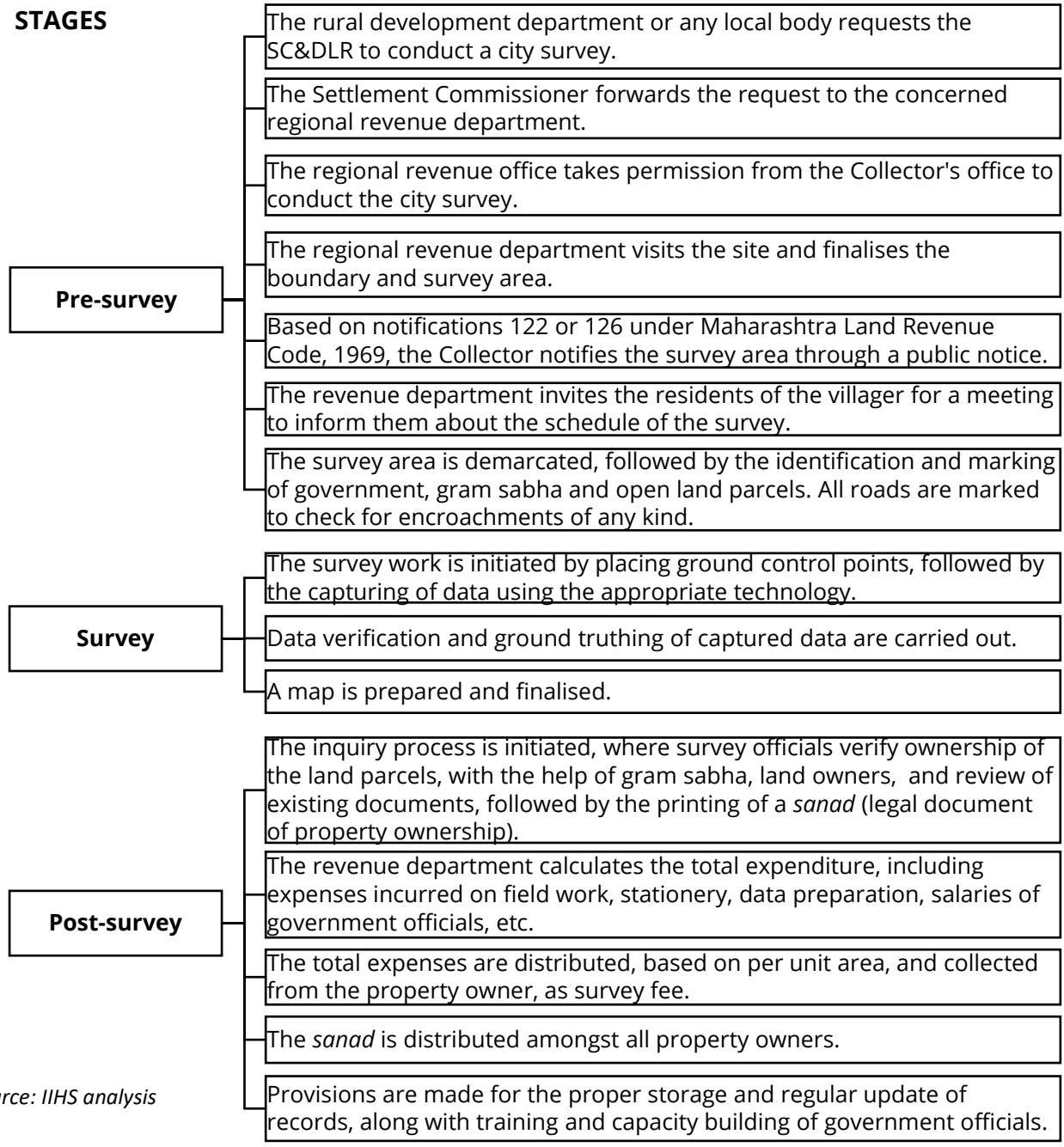
Of the 43,665 villages in Maharashtra, only 3,800 have been surveyed since the colonial period.[i] These surveys were conducted using the pure ground method, which is extremely time-consuming. Given the sheer size of the remaining survey area—approximately 40,000 villages—timely completion of the survey has been a concern for GoM. In an attempt to address these challenges, GoM has initiated a state-wide survey to map ownership titles in *gaothan* areas. A pilot survey of Sonori village, Pune, was conducted in April 2018. Based on a detailed study of the survey methodology adopted by the GoM *gaothan*, this policy brief proposes a suitability matrix that could assist state governments to select an appropriate survey technology.

Current process and available technologies

The current process to conduct a city survey is covered under the Maharashtra Land Revenue (Village, Town and City Survey) Rules, 1969.

The major stakeholders are the District Collector, Settlement Commissioner and Director of Land Records (SC&DLR), Revenue Department, Rural Development Department, local bodies and property owners. Figure 1 illustrates the decision-making process for conducting a city survey.

Figure 1: Workflow for Conducting a City Survey



Source: IIHS analysis

At present, the range of available survey techniques is as follows:

a) Pure ground method, using Electronic Total Station (ETS) and Global Positioning System (GPS)
b) Hybrid methodology using High-Resolution Satellite Imagery (HRSI) and ground truthing by ETS and GPS
c) Aerial Photography using Unmanned Aerial Vehicle (UAV)/drone and ground truthing by ETS and GPS
d) LiDAR and GPS

Suitability matrix to identify an appropriate survey technology

Pure ground method, HRSI and aerial photography were suggested by DILRMP in 2009, and have been used by various states in the respective resurvey initiatives. The use of drones and LiDAR is relatively new. In India, the GoM is amongst its initial users.

Given that technology is a pivotal component of any survey exercise, a team of researchers from the Indian Institute for Human Settlements (IIHS) designed a suitability matrix that can be used as a tool for selecting the most appropriate surveying technology, keeping in mind the requirements of any such project.

The first step towards developing the matrix was to identify and list the most important parameters for choosing a suitable survey technology. These are: high built-up density, accuracy of data, timelines, affordability and spatial resolution.

Each technology is assigned a value between 0 and 3 based on its performance on each parameter. The cumulative scores for each survey technology then determine which one is most suitable. Figure 2 illustrates the use of the matrix in identifying the most suitable survey technology in the case of Maharashtra's *gaothan* areas.

Figure 2: Suitability matrix for selecting a survey technology for city survey

		Survey Technologies					
		Conventional Methods	Electronic Total Station	HRSI	LiDAR (Aerial/ Terrestrial)	Aerial Photography	
						Aircraft	Drone
Parameters	High built-up density	1	3	2	2	2	2
	Accuracy	1	2	2	3	2	2
	Timelines	0	1	2	3	3	3
	Cost	1	1	2	0	0	2
	Spatial resolution	1	2	2	3	3	3
TOTAL		04	09	10	11	10	12

Index:

Highly Suitable	Suitable	Less Suitable	Not Suitable
3	2	1	0

Source: IIHS analysis

Parameters

High built-up density: In built-up areas, high-rise buildings prevent aerial/satellite images from capturing building corners and boundaries. A lot of shadow areas appear in the remote sensing data, depending upon the height of the buildings. In such conditions, pure ground-based methods using ETS+GPS are preferable for a property survey. In contrast to lower density built-up areas, aerial photography or high-resolution satellite images are likely to give better results.

Accuracy: In the property survey, the scale of the map and the precision of the instruments significantly influence its accuracy. The accuracy of the survey is highest in the case of LiDAR, followed by drone, ETS, HRSI and aerial photography.

Time: Ground truthing methods such as ETS, which require 100 per cent measurement to be made on the ground, are time-consuming. Ortho-products from aerial photos and satellite images supplemented by ground validation greatly reduce the time taken to conduct a property survey.

Cost: Costs are a driving force in adopting a particular technology for any kind of survey. Drone and HRSI are the most cost-effective, as compared to LiDAR and aircraft photography, ETS and ground truthing methods.

Spatial resolution: Spatial resolution is one of the most vital parameters to judge the quality of captured data. It determines the level of detail in a piece of captured data that is visible to the human eye. The ability to 'resolve' or separate small details is termed as spatial resolution.

Results

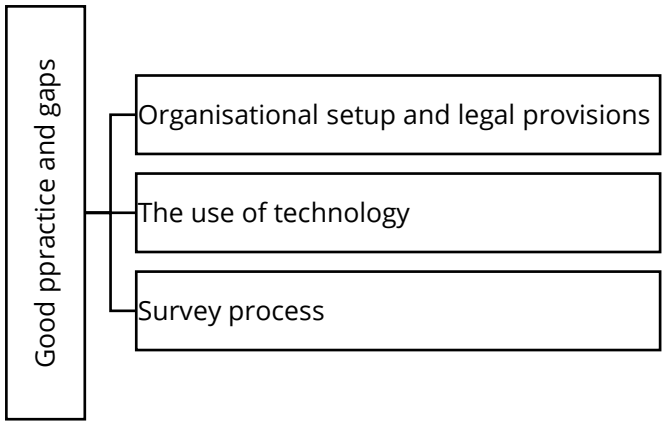
In view of the above, it is evident that drone technology scores the highest in the suitability index, followed by LiDAR and then ETS and HRSI. It has been found to be 'highly suitable' in terms of timelines and spatial resolution, and 'suitable' in terms of accuracy, high density built-up area and cost. Hence, drones seem to be the most appropriate technology for conducting the city survey.

The suitability index and its results would vary for conducting surveys at regional or state level, depending on the built-up density, costs and required spatial resolution.

City Survey by the Government of Maharashtra: 'Good Practices' and 'Gaps'

Table 1 highlights the 'good practices' and 'gaps' in the survey conducted by the GoM. It presents an analysis of the city survey of *gaothan* areas in Maharashtra, looking at issues analysis could be classified into three sections (refer to Figure 3) including governance, the technological aspects as well as survey process.

Figure 3: 'Good practices' and 'gaps'



Source: IIHS analysis

Table 1: 'Good practices' and 'gaps'

S. No.	'Good Practices'	'Gaps'
1. Organisational setup and legal provision		
	• GoM's initiative to conduct the city survey will help in the consolidation of unclaimed government properties and collection of property tax by local bodies. • Maharashtra Land Revenue Code, 1966 and the Maharashtra Land Revenue (Village, Town and City Survey) Rules, 1969 provide the legal basis for conducting city surveys in *gaothan* areas. • The timely survey of *gaothan* areas, before further development takes place, would help in the better management of land ownership records. • The Survey of India (SoI) has been providing technical services to GoM. • There is a separate provision in the Maharashtra Land Revenue Rules, 1969 for the collection of survey fees.	• Greater co-ordination is required between local bodies and the revenue (settlement) department during delineation of survey area, survey operation and ground truthing. • While conducting the survey and digitising records, ownership disputes and court cases may arise, which can interrupt the progress of the survey. • Due to the limited manpower to conduct ground truthing and ETS exercises, the survey process is extremely time consuming, often leading to delays.
2. The use of technology		
	• Using drone technology to conduct the city survey led to high accuracy and resolution data. It was a time- and cost-effective technology. • The time taken between the survey operation and distribution of *sanad* is effectively minimised.	• In high-density areas, drones can only provide roof dimensions and not plinth area measurements, which could lead to inaccuracies in the database. • Analysing drone data and operating mapping software require trained manpower in revenue offices, without whom it may be difficult to carry out the periodic update of property records or a re-survey. • Drone or aerial surveys cannot be conducted when visibility is poor—for example, during rain, cloudy skies or fog. Therefore, weather conditions will always be a constraint.
3. Survey Process		
	• GPS has been used to capture the Ground Control Point (GCP) to geo-reference the drone images. This helped enhance data accuracy.	• In order to ensure higher accuracy, geo-referencing the captured image require a higher number of GCPs as compared to LiDAR or aerial photography (using aircrafts). This needs frequent site visits to conduct ground truthing and quality checks, which can be time-consuming.

Conclusion

In view of the above, it is evident that a city survey helps determine property boundaries, which, in turn, enables better planning, digitisation of records, as well as solving property dispute cases. The exercise is important for the effective preparation and execution of plans and for establishing good governance practices. It also helps identify and protect government properties against illegal construction and encroachment. As a result, the government can administer its fiscal responsibilities more effectively, including recovery of property tax, revenue, challans and interest, among others.

Technology plays a crucial role in executing the entire survey process. As the suitability matrix demonstrates, the appropriate technology is key to fulfilling project requirements within the established time frame and with the desired accuracy. In the case of Maharashtra, a combination of drone and ETS technology has helped deliver high-resolution and accurate data in a timely manner. Hence, this exercise could serve as a successful case study for other state governments to conduct property surveys.

[i] Source: SC&DLR office, 2018.