Effective Mapping Protocol for Forest Rights Mapping in India:

Insights from a Collaborative Field Pilot in Chhattisgarh and Odisha

NRMC

FES
FOUNDATION FOR ECOLOGICAL SECURITY

CADASTA
Your Rights, Your Future







Introduction

Secure land tenure is critical to good governance and achieving developmental goals such as poverty alleviation, improving food security, and ensuring climate change adaptation. Land tenure security is often equated with clear, transparent and up-to-date land records; records that document parcel information and details of the land holder as well as the rights, restrictions, and responsibilities relating to land under the prevailing legal regime. However, less than 50 percent of countries have comprehensively mapped and registered private land in capital cities, and less than 30 percent of countries maintain digital land data for effective urban decision-making (Deininger, 2018). According to estimates in India from the NRMC Centre for Land Governance, approximately 1.5 billion parcels across the country are in need of record updates. The India Summary report on the Land Governance. Assessment Framework (2015), by the World Bank underlines the importance of investing in mapping pilots to address the tenurial heterogeneity, with clear criteria to assess the successes, failures, time frames, cost-effectiveness, and strategies for scaling up successful approaches

The Forest Rights Act (FRA) enacted in 2006 has seen a slow pace in recognition of claims by rural indigenous communities; a major reason for this is the lack of surveyors on the ground who are able to assist the Village Assembly (Gram Sabha), compounded by the limited transparency and uniformity in the processes of recognition and integration of rights in the registry. Claimed as the biggest land reform in the world upon its launch, the Forest Rights Act can potentially impact approximately 150 million people living in 170,000 villages, recognizing individual and community rights to over forty (40) million hectares of forest land, almost half of India's forest.

However, more than a decade after encasement, only about 13 million acres (less than 15 percent of the potential acres) have been realized to date. Such limited and ad hoc efforts may in fact exacerbate the very injustice that the FRA was designed to address, as seen by the recent Supreme Court case threatening potential eviction of 1.91 million forest-dwelling households. It is critical that the recognition of forest rights be an inclusive and just process to avoid perpetuation or repetition of similar injustices, unjust denials and future conflicts. Analysts cite the recent Indian election results in some central Indian states (viz. Chhattisgarh, MP, Jharkhand etc.), with dominant tribal population and forest rights in which the opposition party was elected after 1 incumbent candidates failed at FRA implementation. This potentially highlights the need to expedite forest rights recognition in order to stem citizen discontent, unrest and ensure inclusive growth and development.

Since the enactment of the FRA, various approaches have been used to document evidence of occupation and historical use of land, from traditional survey approaches, to the use of handheld global positioning system (GPS) receivers, or the use of aerial photography, drone imagery or satellite imagery from the likes of Google Earth. Rapidly-changing technology is finally enabling the possibility to scale up the recognition of forest rights in a cost-effective and participatory manner. This rapidly-changing technology landscape presents its own challenges however given the various contexts in which different tools and approaches might be used; therefore, an analysis of the most common tools being used in a variety of geographical contexts is needed to identify what tools might be most effective and in what context.

Global Scenario

Effective land administration is a cornerstone of good governance; it is critical for the delivery of services, collection of revenue and effective planning by governments at all levels. Population growth and an increasing competition for land has outpaced the growth in land professionals or the ability for governments to provide services to citizens in many countries. While programs to improve land information management have been a development priority for decades, few countries can boast of having a registry and cadastre with national coverage, leaving the majority of citizens globally without secure rights to the land they occupy.



Despite the considerable investment by the donor communities and national government alike, the degree of informality in land rights has not significantly changed in recent decades. There has been a growing recognition of this fact, as witnessed by the recent joint World Bank and International Federation of Surveyors (FIG) publication, Fit for Purpose Land Administration in 2014, which highlighted the issues of building sustainable land administration systems as opposed to "blindly complying with top-end technological solution and rigid regulations for accuracy." This is particularly relevant in rural and forested areas, where highly precise measurements may have limited utility when measuring boundaries which are vaguely defined and cover vast areas. However, there is an urgency to recognize rights faster, as is the case with FRA in India.

Rapid advancement of technologies and their increasing accessibility, of late, has become a focal point of enabling change. Traditional surveying methodologies are now considered too expensive, too elitist and exclusive—and therefore, too unrealistic (Enemark, Bell, Lemmen, & McLaren, 2014).

A "third-generation" of land tools are now emerging to make the technical aspects of titling and [1] registration cheaper, easier, and more responsible (Bennett et al., 2017).

Endorsement by the international donor and surveying community alike, coupled with advancements in technology, has led to a growing recognition of the utility of adopting low-cost approaches to secure land rights and develop an effective land administration system. Governments, NGOs and businesses welcome them with legal reforms, institutional innovations and investments. Innovative land administrative platforms now integrate personal information, spatial location and parcel characteristics. Such platforms offer positive development-externalities beyond land records, viz. around land use planning, multi-purpose cadastre etc. From Ghana to India, global and local agencies are piloting and upscaling such mapping through the innovative use of technology, low-cost options and partnership-ecosystems, and social-entrepreneurships [2].

[1] These include point cadastres, digital pens, unmanned aerial systems, and machine learning for boundary recognition (Koeva et al., 2017; Stöcker et al., 2019; Zevenbergen, De Vries, & Bennett, 2015) and EO.

[2] Perhaps best illustrated in Rwanda, using a model centered on digitization of imagery and community validation, approximately 10.3 million parcels were documented at an average cost of less than $10 dollars per parcel in just three years under the Land Tenure Regularisation Programme. In Tanzania, USAID developed an approach using smartphones and mobile applications managed by trained community members led to the documentation for over 50,000 households in 2015—an approach that has now been replicated in Uganda, Liberia, and Colombia to name a few and is now recognized as a viable approach. More recently, drone imagery has proved an effective and cost effective way to document land rights and has been enshrined into law in the Philippines and Colombia. The use of new technologies when coordinated with community training and the utilization of "para-surveyors" from within the community resulted in a much more cost effective and timely collection of data.

While the advances of geospatial technology, tools and platforms simultaneously expand opportunities, the complexities of India's plural land tenure systems and evolving legal, social, cultural and ecological concerns demand local adaptations and strategic localization. Growing recognitions of ethics, data privacy, free and prior informed consent as well as human rights issues associated with land tenure digitization and mapping, more so in the forest rights context, implicate their strategic embedding to address inevitable sustainability, participation and inclusion. Adequate due diligence in surveying and mapping of forest rights is critical; particularly understanding and analyzing the role of technology—both as tools and in processes, merit close attention.



Methodology

In late 2019, NRMC, FES and Cadasta collaborated to test a range of technology currently being utilized by a community-led mapping process. Through a partnership approach with local organizations and community institutions in four villages in Odisha and Chhattisgarh states. This pilot ensured that all stakeholders are brought together including the community, government, user organizations, and technology providers to have a common understanding on the objectives and outcomes of the mapping exercise. It was key to the pilot that any tools and processes tested needed to be simple, adaptable, and scalable in line with fit-for-purpose approaches applied globally. Different technological options were tested with the objective to lower the cost, ensure participation, legal compliance, community participation and the appropriateness of the technology given variations in topography, internet access, and technical literacy of the communities. The process started with community sensitization, engaging with the Forest Right Committee (FRC) following the provisions of the FRA and ensuring observance of prescribed roles and responsibilities in the claim-making process. The sensitization was followed by the participatory mapping and defining of the village boundary by identifying physical features (bisections/trisections stones) using Differential Global Navigation Satellite Systems (DGNSS) tools and the geo-referencing of the cadastral maps where available.

For the purpose of the pilot, four categories of land parcels were selected as samples; open fields, open woodland, low density forest, and moderate density forest. The characteristics of each category of land were explained to the community members and they were facilitated in selecting two parcels of each category for mapping. To ensure appropriate boundary marking, the community members put wooden/bamboo poles on the boundaries of the parcel (in each corner/ bend points). The mapping of the sample land parcels were made using multiple devices which included a single frequency GNSS mobile phone, a dual frequency GNSS mobile phone, tablets (small and large Samsung model), external GNSS antenna (Bad Elf & Gagan Dongle) and a sophisticated external antenna (Geolysis GNSS). For comparison purposes, an electronic total station (ETS) was used to map the same sample parcels.

Test conducted under the pilot included:

* **Precision test** (static test) to examine the ability of each device to obtain a fixed location;
* **Accuracy test** (rectangle test) to examine the ability of the device to record the parcel shape; and
* **Real world test** to test device accuracy and software application to assess ability to system interface and usability while mapping actual plots.

The Result

Each of the tests conducted showed predictable trends in precision and accuracy. Where the canopy was not present or thin, measurements were more accurate and consistent in temporal precision tests, with accuracy and consistency declining based on canopy density. As canopy becomes denser, the reliability drops and several devices (including the dual frequency device which is meant to have a wider choice of satellites) were unable to measure all locations in a plot.

Within this general trend, some devices performed better than others. The Geolysis DGNSS, when measured against the ETS performed the best[3]. Both the Gagan Dongle and the Bad Elf were an improvement compared to the stand alone accuracy of the mobile devices, but in some instances they were not reliable under the canopy. The Gagan Dongle in particular had some erratic errors of up to 4m from the control measurement but gave a fair result in most cases.

The dual frequency phone did have some instances where it was very accurate, but, particularly under the canopy, it gave either large errors or was not able to record locations at all. Of the single frequency devices, the Samsung tablet gave the best results in most cases.

Using the mapping facility by digitizing satellite imagery on the Cadasta platform (and the large tablet) in the field proved difficult. The conditions (bright sunlight and no visible demarcation) made it difficult to see the imagery clearly; even where boundaries were obvious (on rice field bunds. In some cases, the field to be digitized was misidentified on the imagery by the landholders. Where tree cover existed, mapping using satellite imagery with accuracy proved impossible.

When entering the attributes, the results were generally device-neutral. Using a tablet gave some advantage as the

[3] However, this was not extensively tested as the ETS only gave reliable results for one village and was unable to be deployed in Chhattisgarh, where the Geolysis was taken as the control device in place of the ETS.

forms were clearer, but the effect was marginal. With both recording locations and entering information, the touch sensitive screens could occasionally cause errors; the user may accidently hold the device in a way which recorded erroneous points at the screen edge, or move the form on without data being entered.



Some of the errors recorded could be attributed to the experience of the team and familiarity with the device (particularly as the full methodology had several elements and quality control was needed to ensure standard measurements). A rain delay and poor light in Bhaluntangar may account for some of the more erratic results recorded that day.

The consequence of failing to identify points compromises any area calculation, as does recording significantly erroneous points. Despite these difficulties, comparing errors calculated by the control device (ETS or Geolysis) with the other devices shows again that the Bad Elf performs well, and the Gagan Dongle has fair results. It shows that an external device significantly improves the accuracy for a relatively low cost.

Usability

The overall user experience was moderately easy in using the mobile application and survey devices. While the users found it very easy to use the single frequency and dual frequency devices (those built into the phones/tablets) and digital imagery for mapping, the additional external antennas (the Bad ELF and Gagan Dongol) added a degree of complexity given the need to connect devices and "switch" the antennae being used from that installed onto the phone/tablet). The Trimble and Geolysis GNSS required additional steps and were more complex.

The major challenge for users was to establish the connectivity between the external antenna and mobile device for mapping. During initial setup equipment the Bad ELF and Tremble took a little more time to set up as compared to other devices. However, being internet dependent, the Trimble antenna was not used much as there was limited connectivity in the villages where the mapping pilot was conducted. However, a user variability analysis is conducted to assess the user experience in different contexts.

Discussion

The study has extensively explored the devices, processes, ergonomics, usability, and issues of forest rights mapping with a series of tests. The main intention is to identify which is the best suited tool or combination of tools for forest rights mapping, but many important ancillary issues have been raised which cannot be ignored. Better technology by itself is not the cure-all for mapping; application design, form design, training, community sensitization and quality control have to be considered to make a coherent and rigorous solution. Irrespective of individual devices, the static, rectangle and field tests have shown that canopy cover is a major factor in reducing the precision and accuracy determining location, in the most extreme cases barring the collection of data. Not surprisingly, the more expensive and sophisticated tools resulted in higher precision, and did not degrade as significantly as the environment becomes more difficult to work in. From the limited set of results possible from the field studies, it is difficult to tease out the issues related to the variability in some devices in gathering reliably accurate data. Despite the controls taken to standardize the testing methodology, human errors cannot be ruled out in the recording of points and the team cannot fully identify what the constellation of satellites in the sky were at any point in time.

The combination of good procedures, training—including both those procedures and how to deal with troubleshooting issues and quality assurance—would probably reduce some of the variability found in the accuracy tests and bring the measurements within the threshold for accuracy in open field and forest environments. Given the usability, there is no reason to exclude local community members from the mapping process; these exercises demonstrate that given clear training and guidance, almost any smartphone, tablet and combination smartphone/tablet with simple external antenna (Gagan Dongle or Bad Elf) are all easy to use tools, and the Survey123 app can sit on any mobile device once given license access. The inevitable fact that use of technology also raises the expectation of local community, while also triggering participation, however, has to be kept in mind and community must be explained in advance adequately about the caveats and limitations. It is also critical to ensure Free and Prior Informed Consent around use of technology and collection of personal information, particularly as the very nature of the work for the FRA it involves indigenous communities. The provisions of FRA, as well as the upcoming legal framework around data privacy and ethics, make it more binding.

Conclusion

The study has shown, though, that several of the technical tools could, in theory, be used in parallel or in combination in an actual roll out program. In low to medium density forest canopy with coverage of, up to about 35 percent, these tools continue to function without serious loss of accuracy. Under thicker canopies accuracy will be compromised, but this may be within acceptable limits when dealing with delimitation of forest boundaries.

What is imperative is to reduce other errors by clearly agreeing and marking boundaries before survey, training personnel to be as accurate as possible and having a reliable quality assurance protocol in place to check results as they are created. The study also highlights the need for a more nuanced look at other such technology options including feature extractions and use of EO to supplement and complement physical mapping interfaces with use of handheld devices by the local community surveyors. What is more importantly also coming out, is the need of localizing and contextualizing technology solutions and information collection, particularly to embed in local socio-cultural, legal contexts, and growingly critical, ethics concerns.

Recommendation

It is important to bridge the gap between the need for documentation of land rights with its affordability to communities. These tests help to both demonstrate which technology works and what important procedures and training are needed to give the necessary rigour to the documentation. The choice of technology and method are often based on the level of accuracy, time, and cost in a given context. However, more important is employing locally adaptive training, procedures, and documentation needs while ensuring consent and participation of an informed community and ensuring proper quality control and ethics protocol with in-field checking during the mapping process.