TESTING A FIT-FOR-PURPOSE LAND ADMINISTRATION APPROACH IN INDONESIA

Unmanned Aerial Systems for Cadastral Applications

In recent decades, imagery-based methods have gained legitimacy in the domain of cadastral data creation. Contemporary experiences from Rwanda, Ethiopia and Lesotho, along with older activities from Thailand, already demonstrate the potential of conventional aerial imagery and high-resolution satellite imagery. More recently, unmanned aerial systems (UASs) have received increasing interest in the field of land administration. Already documented trials and demonstrations are evident for Albania, Namibia and Rwanda. The exploratory work continues; results from trials undertaken in Indonesia are presented here with a view to identifying the opportunities and challenges for embedding the technologies in a fit-for-purpose way into the existing cadastral processes.

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Indonesia's existing cadastral data acquisition processes are coordinated by the National Land Agency ('Badan Pertanahan Nasional' or 'BPN'). Methods employed are primarily terrestrial, including use of measuring tape, total stations and global navigation satellite systems (GNSSs). Indonesia has a challenging topography – often hilly and with dense vegetation – and this creates problems for terrestrial surveying methods.

The Imagery Opportunity

Imagery-based methods provide the opportunity to expedite the initial cadastral establishment process, which at current speeds suggests that four further decades of work are needed. However, use of imagery-based methods is not widely practised in the country, primarily due to the lack of base imagery at the required scale. UASs could help to sporadically fill specific gaps in the base map in a cost-effective and timely manner. Utilising the imagery developed, participatory mapping activities could be used to undertake the boundary mapping exercises.

Exploring Regulations

Many countries are actively developing – and redeveloping – rules for civilian and commercial UAS operation. In Indonesia, new regulations were issued in mid-2015 and these have implications for the use of UASs for cadastral purposes. The regulation defines restricted areas for UAS operation (e.g. flight operation areas) and also stipulates that UAS operation below 150 metres does not require registration. These rules need to be taken into account to ensure appropriate site selection and suitable flight planning. However, as yet, there are no specific rules for the use of UASs in cadastral applications – although, any UAS-based approach would need to adhere to existing cadastral requirements.

Designing a Workflow

Beyond clear understandings of the existing policies and legal frameworks relating to UASs and cadastres, a flowchart for UAS-based cadastral data collection was developed. It included an adaptive procedure of orthophoto generation and subsequent participatory mapping. A field test in Lunyuk Ode, Sumbawa, Indonesia, was conducted using a low-cost rotor UAS with an onboard low-cost camera. In addition, a methodology was developed to utilise the orthophotos and to encourage community participation in the delineation of parcel boundaries. The procedure was based upon participatory mapping approaches. Participatory mapping is designed *for* and *by* communities; it seeks the acknowledgement of all parties involved through the boundary agreements made in the field.

Flying and Creating

The test flight was planned in accordance with all legal and technical cadastral requirements. This resulted in a designed flight above the altitude of 70m with a high overlap setting: 90% forward overlap and 60% side overlap. Average ground sampling distance (GSD) was 2.99cm. In total, 532 images covering 32ha including around 240 parcels were captured. Using GNSS real time kinematic (RTK), 26 distributed ground control points were surveyed in order to improve the accuracy. The flight delivered output of imagery with 3cm horizontal accuracy, conducted within 720 minutes for five parcels and with costs of around USD80 for each parcel. The cost figures were derived using the Costing and Financing of Land Administration Services (CoFLAS) guidelines by the Global Land Tool Network (GLTN). It is suggested that the approach greatly overestimates the cost and time needed per parcel; when applied at a scale beyond a single pilot area, several key costs (e.g. equipment) would not scale as they are fixed.

Fit-for-purpose Evaluation

The entire process was evaluated against fit-for-purpose criteria including ‘participatory’, ‘attainable’, ‘reliable’ and ‘affordable’. Overall, good levels of adherence were measured; the process was considered participative and is considered to be reproducible. Compared with conventional approaches, the UAS-based method was shown to be more cost and time effective in creating parcel records. The approach also produced highly accurate spatial outputs. Whilst not explicitly evaluated, other fit-for-purpose criteria – ‘flexible’, ‘inclusive’ and ‘upgradable’ – appear to be supported by the approach. The approach can adjust to spatial accuracy needs, different purposes, temporal requirements, different user-group demands and geographical characteristics and can be used to upgrade qualities in a sporadic fashion over time. Taking the above into account, with regards to the participatory mapping approach, there are no (global) standard guidelines or prescribed quality control measures for conducting boundary surveys using imagery with community involvement. Further studies regarding this issue are needed: ones that consider quality assurance and issues of certainty, amongst other criteria.

Looking Ahead

In recent decades, Indonesia has made steady gains with respect to the spatial coverage of its cadastral system. However, much work remains to be done – particularly in the more remote, hilly and highly vegetated areas of the complex and diverse archipelago. The approach developed here is not intended as a panacea; UASs are not suitable for all cadastral applications. Instead, the mix of UASs and participatory mapping techniques offers a niche fit-for-purpose solution for specific areas and communities where land rights remain unrecorded, yet are legitimate and deserving of being formally acknowledged.

Further Reading

- FIG (2014), Fit-For-Purpose Land Administration. *FIG Publication No. 60*, Copenhagen, Denmark
- GLTN (2015), Costing and Financing of Land Administration Services (CoFLAS) guidelines, UN-Habitat, Nairobi, Kenya.
- http://www.gim-international.com/content/article/uavs-revolutionise-land-administration

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