Deliverable 2.5

Requirements Synthesis

30 September 2017

Version 1.1

Abstract:
This is an analysis and synthesis of the data collected under WP2 'Get Needs' for input into the development of the its4land tools.

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Executive Summary

its4land is a European Commission Horizon 2020 project funded under its Industrial Leadership program, under an ICT call (H2020-ICT-2015) with the topic of 'International partnership building in low and middle income countries'. its4land combines an innovation process with emerging geospatial technologies, including smart sketchmaps, UAVs, automated feature extraction, and geocloud services, to deliver land recording services that are end-user responsive, market driven, and fit-for-purpose. The transdisciplinary work also develops supportive models for governance, capacity development, and business capitalisation.

To deliver on its objectives, the foundational phase of its4land is operationalised through Work Package 2 (WP2), 'Get Needs', which aims to capture the range of end user needs, readiness and market opportunities. Over the last year, WP2 has engaged with 57 organisations and community groups across three case countries – Ethiopia, Kenya and Rwanda – seeking to identify relevant land issues, document land tenure information needs in response to the challenge of sustainable urbanisation, readiness requirements for using its4land technologies and potential market opportunities. By no means exhaustive, WP2 seeks to offer exploratory insight into stakeholder needs that can be leveraged for detailed investigation in subsequent work packages. This deliverable, Deliverable 2.5 (D2.5), is the fifth and final deliverable report under WP2. D2.5 provides an analysis and interpretation of the data collected under WP2, including synthesised requirements as development input into the other its4and work packages, and should be read as a companion piece to Deliverable 2.4.

Key findings

The its4land case study countries reflect the urbanisation trend being experienced across Africa, and notably in East Africa: one of rapid spatial change, growing urban populations, and the challenge to transition traditionally agrarian societies to new economies. Yet the pace of physical development and timeline of aspired progress is unsupported by much-needed structural transformation, leaving countries unable to capitalise on urbanisation for much-needed socio-economic gains.

Central to all countries is the past and current wielding of land as an instrument of political control. Land also sits at the intersection of social and human rights issues (dispossession, gender, ethnicity, youth, etc.), economic progress, and environmental and physical sustainable development. However, differences in history, culture, geographies and models of government have resulted in different land issues and land information needs.

Nonetheless, data collected from the three case countries show that cadastral data is still recognised as a land information need across stakeholder groups, especially in Ethiopia and Kenya. This need encapsulates common conventional requirements: accurate spatial data (e.g. area, location, boundaries) – and this applies broadly across all tenure types, tenure systems and inherent rights, restrictions and responsibilities (RRRs) (including those of the government's in Ethiopia), and a range of socio-economic attributes of the right holder. The history of land-based conflict in these

countries was also manifest in stakeholders' identification of the need to acquire other ownership evidence (e.g. history of acquisition, neighbours, etc.) to support unambiguous determination of land tenure RRRs. Poor expropriation and compensation practices also stimulated the desire among communities for other property data (e.g. type of crops, fixtures on land, irrigation systems, etc.). Rwanda offered a point of difference. Stakeholders needs reflected the desire to capitalise on the country's solid base of digital cadastral data, with attention turned towards the collection of non-cadastral data to support policy objectives around spatial planning and regional development. The need for better data management and analysis was also clearly identified here, focused on leveraging the cadastral fabric to underpin other development decision-making.

In Rwanda, a highly centralised government authority is focusing on balancing urban-regional growth. Therefore, of greatest importance to stakeholders was the need to realise development objectives – and these are predicated on improving the quality of non-cadastral data and integrating this with the cadastral fabric for more insightful decision-making. Following from this, it was no surprise that stakeholders also agreed on the need to improve data management, especially data accessibility. A successful national land tenure regularisation program has provided the government with a good source of data for decision-making; nonetheless, national government stakeholders in particular are still keen to improve the quality of cadastral data.

It came as little surprise then that UAV technology was considered to be of greatest potential for meeting land information needs. However, this perception is tempered by the recognition that the ability to adopt and implement this technology is contingent on meeting a long list of enabling conditions, including not just the establishment of a legal, regulatory and policy framework around commercial UAV application, but also its institutionalisation, culminating in capacitated frontline staff who have responsibility for operationalising these frameworks. This latter aspect appears to be the challenge, as evident in Rwanda and Kenya, where UAV legislation exists in passed or draft form.

The other its4land tools – smart sketchmaps, automated feature extraction and geocloud services – had less clear innovation pathways, attributed to the difficulties that stakeholders often had in understanding the concepts behind the technologies, and often based their perceptions on the more familiar aspects of the technologies. Smart sketchmapping was often judged on the basis of the familiarity of sketchmapping as a process, and less on the data outputs of the technology. This generated acceptance for the tool on one hand, but also induced uncertainty as to what its value proposition might be especially in countries like Rwanda and Ethiopia, where sketchmapping has already been used to deliver large-scale certification programs. For automated feature extraction, stakeholders in Rwanda and Kenya, with a more active private land surveying profession, were better at grasping the technology and perceiving its potential. In Ethiopia, where a private land surveying profession is almost non-existent, and first-level certification produced only a legal cadastre (without spatial data), it was more difficult for stakeholders to consider the application of the tool. For geocloud services, although there was broad consensus in support of its application across the three countries, technical challenges abound including the need for an entirely different set of ICT skills than the ones found amongst today's desktop GIS users. This skills gap is exacerbated in both Rwanda and Kenya where open source GIS is not prevalent and proprietary GIS software is still used (and a reliance on software providers for technical support and training).

Recommendations
To use these technologies, stakeholders agreed on common readiness requirements. Strategic requirements seek to align need with policies and political will and directed the presence of change leadership. Structural and/or governance requirements were necessary to develop appropriate frameworks for directing action at a national level by those stakeholders affected by the technologies, and possibly coordinate and manage new relationships between stakeholders for using the technologies and their data. Organisational requirements related to localised changes that sought to build organisational capacity – including technical elements – for using the technologies. Based on this, **a generalised basic change model** is put forward.

In terms of potential market opportunities, the limited insight provided indicated that the likely 'market' for the its4land technologies lay in producing land information as a public good. In the short term, the main market will be the public sector; however, sound land information can lead to the development of secondary markets such as location-based goods and services in the private sector. It should also be noted that the its4land technologies face competition for resources in each of the countries: donor-funded certification and a rural land information system in Ethiopia, other fit-for-purpose technology testing in Kenya, and a reliance on proprietary GIS systems in Rwanda. In all countries, innovation will also likely disrupt existing workflows and processes. It is incumbent upon the project **to clarify the innovation proposition**.

As indicated by stakeholders, the challenge of innovation now lies in further contextualisation and customisation through **pilot studies**, especially since the findings communicate that these innovations will challenge prevailing social systems at all levels of society.

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1 Report background

1.1 Introduction

its4land is a European Commission Horizon 2020 project funded under its Industrial Leadership program, specifically the 'Leadership in enabling and industrial technologies – Information and Communication Technologies ICT (H2020-EU.2.1.1.)', under the call H2020-ICT-2015 – and the specific topic – 'International partnership building in low and middle income countries' ICT-39-2015.

its4land aims to deliver an innovative suite of land tenure recording tools that respond to sub Saharan Africa's immense challenge to rapidly and inexpensively map millions of unrecognised and/or unrecorded land rights in the region and register them in formal land administration systems. ICT innovation is intended to play a key role. Many existing ICT-based approaches to land tenure recording in the region have not been successful: disputes abound, investment is impeded, and the community's poorest lose out. its4land seeks to reinforce strategic collaboration between the EU and East Africa via a scalable and transferrable ICT solution. Established local, national, and international partnerships seek to drive the project results beyond R&D into the commercial realm. its4land combines an innovation process with emerging geospatial technologies, including smart sketchmaps, UAVs, automated feature extraction, and geocloud services, to deliver land recording services that are end-user responsive, market driven, and fit-for-purpose. The transdisciplinary work also develops supportive models for governance, capacity development, and business capitalisation. Gender sensitive analysis and design is also incorporated. Set in the East African development hotbeds of Rwanda, Kenya, and Ethiopia, its4land falls within TRL 5-7: 3 major phases host 8 work packages that enable contextualisation, design, and eventual land sector transformation. In line with Living Labs thinking, localised pilots and demonstrations are embedded in the design process. The experienced consortium is multi-sectorial, multi-national, and multidisciplinary. It includes SMEs and researchers from 3 EU countries and 3 East African countries: the necessary complementary skills and expertise is delivered. Responses to the range of barriers are prepared: strong networks across East Africa are key in mitigation. The tailored project management plan ensures clear milestones and deliverables, and supports result dissemination and exploitation: specific work packages and roles focus on the latter.

This document is the final deliverable report for 'Work Package 2 (WP2) – 'Get Needs' of the its4land project. It seeks to analyse and synthesise the empirical findings regarding stakeholders' needs, readiness and market opportunities regarding the application of the four its4land technologies to support design activities in WPs 3-6 and modelling activities in WPs 7-8. These technologies are intended to facilitate land tenure recording purposes in the three East African countries of Ethiopia, Rwanda and Kenya. Ultimately, these geospatial innovations aim to augment the land tenure information value system in these countries.

1.2 Scope of work

WP2 is the foundational phase of the its4land project. It aims to capture stakeholders' needs, readiness and market opportunities in all three case countries, i.e. Ethiopia, Kenya and Rwanda. At the commencement of the work, it was not yet clear if all its4land technologies would be tested in each of the countries. WP2 had clear phases of progression, approximating to each of the deliverables:

- Phase 1: stakeholder identification (D2.2), Feb-May 2016
- Phase 2: research design and approach (D2.3), April-July 2016, Nov-Dec 2016
- Phase 3: empirical data collection (D2.4), Nov 2016 to June 2017
- Phase 4: analysis of results (D2.5), July-Sep 2017.

1.2.1 Review of work to date

Phase 1: Stakeholder identification

Land tenure and land administration in East Africa involves a diverse array of stakeholders. The political nature of land, and the socio-political and economic environment within each country also indicated the high likelihood that vested interests would be present. The project also sought to remain conscious and responsive to gender inclusion. Originally six classes of stakeholders were identified to help structure stakeholder auditing:

1. Public Sector Entities: Land administration specific (National, County)
2. Public Sector Entities: Adjacent policy domains or public organisations
3. Non-statutory entities
4. Private sector entities
5. NGOs, Not-for-profit/Donors and Development partners
6. Research & Development (R&D).

This produced a vast landscape of stakeholders; in reality, it was not possible nor practical to meet with every stakeholder class separately and the classes that were met with are detailed in Deliverable 2.4.

Phase 2: Research design and approach

The research approach for WP2 was redesigned after exploratory visits to Rwanda and Kenya in 2016. Assumptions around methodological approaches had to be revisited as initial testing of methods in the field demonstrated varying degrees of effectiveness amongst stakeholders (including lack of interest across stakeholder segments and puzzlement at the perceived 'problem' – especially in Rwanda). It was also acknowledged to be limited in its ability to attend to power imbalances in group settings.

its4land had initially identified specific land tenure information needs for each country: peri-urban land in Ethiopia, pastoral lands in Kenya and cadastral map updating in Rwanda. However, from exploratory site visits, preliminary conversations, as well as a review of country policy documents, it became clear that all these issues were inherently linked to – and continue to be compounded by – challenges of rapid urbanisation. Data collection activities were subsequently reframed from the perspective of land tenure information challenges in the context of supporting policy objectives around sustainable urbanisation, which resonated soundly with stakeholders. Contemporary challenges of urbanisation was a lived experience: it coloured organisational missions, it was evident in country policies, and it was a pressing local, national, regional and global challenge –

everyone had an opinion, everyone was invested, and everyone was interested in how the its4land technologies could enable them. What this also achieved was an ability to undertake cross-country analysis and generalise the findings for other countries.

The final methodological approach is an application of the Nominal Group Technique, a form of structured group interview that has been able to yield both qualitative and quantitative results – outputs that were endorsed by one of the project's European Commission reviewers from Kenya.

Phase 3: Empirical data collection

The empirical portion of the work was originally intended to commence in September 2016, but was delayed till November 2016, and concluded in June 2017. Fieldwork was undertaken in:

- Kajiado County, Kenya (Nov 2016, Feb 2017)
- Yibab and Robit Bata Kebeles, Ethiopia (June 2017)
- Musanze, Rwanda (Nov 2016, Jan 2017).

The empirical data from WP2 was collected primarily from group interviews where the Nominal Group Technique (NGT) was used to elicit priorities around land information needs, but also to some extent on aspects of readiness. NGT was developed for a group process model to support the identification and prioritisation of problems and/or solutions amongst groups of stakeholders by facilitating equal participation (Delbecq & Van de Ven, 1971; Gallagher, Hares, Spencer, Bradshaw, & Webb, 1993; Harvey & Holmes, 2012) Assessment of its4land technologies against needs often was a roundtable discussion with 'yes' or 'no' answers. Other data on stakeholder needs was collected through purposive samples of community groups and involved semi-structured interviews using an interview guide.

Data on readiness and market opportunities were only collected through workshops. This was undertaken using an appreciative inquiry approach (Cooperrider & Srivastva, 1987): stakeholders were provided with an overview of the technologies (developed with leaders of WPs 3, 4, 5 and 6) and their characteristics and demands (Appendix 1), and asked to provide ideas on how what ideal conditions would be required to enable them to successfully use these technologies within the organisations and social systems that they operate. Even then, many stakeholders were limited in their estimation of market opportunities.

These multiple methods yielded results that were both qualitative (e.g. description of needs, interviews, etc.) and quantitative (number of votes). Voting was only undertaken for land information needs and the votes simply tell us how stakeholders prioritise the identified issues/needs/requirements. Ten NGT workshops were held across the three countries with purposively sampled participants deemed to be experts in the topic; groups ranged between two to nine people. For local communities, and some stakeholders who could not attend the workshops, semi-structured interviews were conducted. In total, 104 organisations and groups across government, private sector, third sector, academia and local communities were contacted, of which 59 participated in data collection activities – an average response rate of 57%, as shown in Table 1.1 (see D2.4 for a full list of organisations).

Organisations/Groups	Ethiopia	Kenya	Rwanda	Totals
Contacted	37	29	38	104
Participated	17	20	22	59
Response rate	46%	69%	58%	57%

Table 1.1 Response rate for data collection workshops.

Fieldwork was organised and conducted in collaboration with the local African project partners. Interviews with local communities (and at times, local governments) were conducted in the local language either by the local partner, or a translator. For all data collection activities, consent was sought (including for images); where permitted, interviews were recorded and transcribed, otherwise handwritten notes were taken. On average, interviews lasted between 30 to 60 minutes. In the workshops, voting materials were collected. All research materials including field notes are securely archived in Belgium.

1.2.2 Key land tenure information challenges

Africa is urbanising rapidly: it is the second fastest urbanising continent with emerging megacities. This has led to economic growth, with East Africa leading the region (African Development Bank, 2017). Yet slow structural transformation has also resulted in poor socioeconomic capitalisation of this phenomenon leaving the region *under*-urbanised – on average, only 55% of the region's population will be urban (Beegle et al., 2015).

Both aspects of this development have significant impact on land, as witnessed in the its4land case countries: uncontrolled development; insufficient housing and infrastructure to cope with rural-urban workforce migration and rapidly expanding cities; inefficient and/or informal property markets; urban incursion into limited agricultural land; increasingly contested land resources due to extreme weather events, preservation of wildlife spaces and need for food security. The need for good quality land tenure information as fundamental input for land-related decision-making for sustainable development is evident. Often, this heightens longstanding inequity associated with elitism, ethnicity and gender. Key land tenure information issues for each country are overviewed below with details provided in the chapters for each country in this report.

Ethiopia. In Ethiopia, all land is state-owned with long-term use rights for citizens for which different rules apply to urban and rural areas. In general, use rights can be inherited but cannot be used to access credit (i.e. mortgaged, although foreign investors can mortgage leased land). Land reform in the country has been ongoing since the 1990s, enabled by foreign donors (especially from USA, United Kingdom, Finland, Sweden and the World Bank). Land tenure records have been produced incrementally through first and second level (which added a spatial component) certification programs, mainly targeting rural households, but have also touched on urban areas and communal land. Ethiopia is one of the success stories of affordable and rapid registration in a developing country context (Deininger, Ali, Holden, & Zevenbergen, 2008), yet there are still gaps in land tenure information and tenure security remains a significant challenge (Ege, 2017). The nature of the Ethiopian federation, where progress in land administration is very much state-driven, means that there are varying levels of progress across the country.

Kenya. To deal with the legacy of inequitable access (especially for women (FAO, 2017)) from past colonial and Kenyan government policies, the 2010 Kenyan constitution guaranteed all Kenyans equal access to land. The implementation of the Constitution is still a work in progress, with responsibility for land administration now devolved to the country's 47 county governments. A particularly complex issue that the country is contending with is registration of communal tenure, only recently acknowledged as a legal tenure type. It is estimated that two-thirds of land in Kenya is held under communal tenure (i.e. untitled) and supports about 10 million people and 70% of the livestock population (Njagi, 2016). Registration of communal land is a priority as it is often subject to urban sprawl and human-wildlife conflict. Kenya's cadastral data suffers from significant issues including inaccurate boundary information, incomplete coverage and a high incidence of fraud. Currently, a National Land Information System has been proposed and is in the process of development, as is a country profile for the Land Administration Domain Model.

Rwanda. Major land reform in Rwanda was achieved through legal and policy reform commencing in the late 1990s and a large-scale Land Tenure Regularisation Program (LTRP) that removed customary forms of tenure and introduced individualised land rights. Running from 2008 to 2011, this was a donor-funded initiative (by the UK) using a systematic and participatory approach to register over 10 million parcels of land, providing the country with (almost) complete cadastral coverage. It also succeeded in vastly improving women's rights to land (Daley, Dore-Weeks, & Umuhoza, 2010): more than 90% of land titles now include the name of a woman (DAI, n.d.). Nonetheless, the success of the program has raised new challenges as greater awareness of the value of land in land-scarce Rwanda has fuelled an increase in land disputes, especially within families and over parcels less than one hectare in size (Gillingham & Buckle, 2014; Karuhanga, 2013). In addition, it remains uncertain to what extent the land administration system established by the LTRP is sustainable (Gillingham & Buckle, 2014).

1.3 Analytical approach

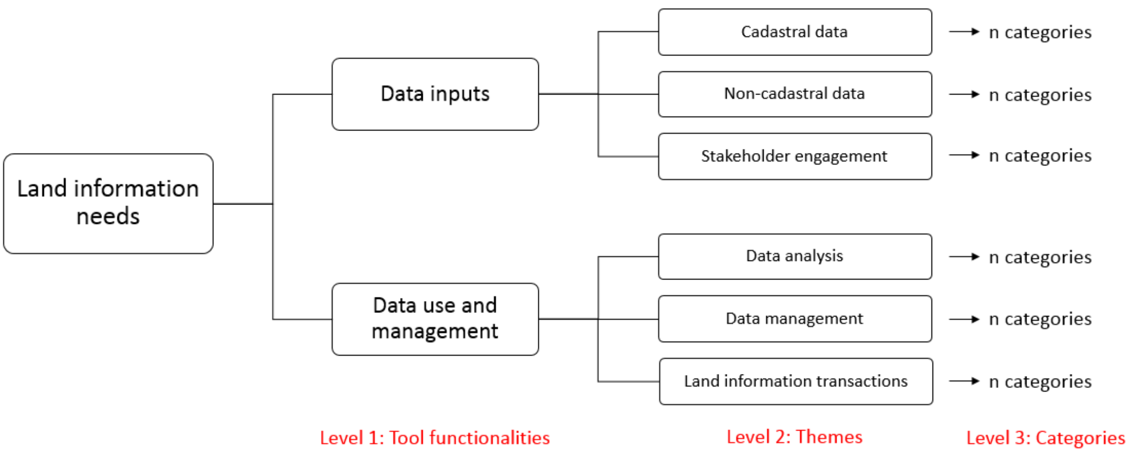
WP2 aimed to collect perspectives from a cross-section of stakeholders regarding land tenure information needs, the possibility of its4land technologies to meet these needs and what change requirements might be, and potential market opportunities. The scope of the inquiry was land tenure information. The aim of the analysis of D2.5 is to take into consideration where these perspectives converge and diverge to provide input into the other WPs in the its4land project to facilitate development of the tools.

Given the heterogeneous nature of the data, content analysis was used as the approach for looking at commonalities and differences in the data. Two cycles of coding were undertaken (Saldaña, 2016). First, initial coding was conducted inductively using a descriptive approach. Codes were then compared to deduce and develop a coding framework by clustering the initial codes. This was to enable comparisons to be made across data sets, across stakeholders and across countries. In the second cycle, focused coding was undertaken where the data was recoded deductively by applying the framework to classifying the data into the relevant themes. Of interest as well was how common a theme was, i.e. how often a relevant code under a theme occurred in the data (Thomas, 2006). Therefore, the metric used to quantify this for comparative purposes was frequency of code occurrences. This is an adaptation of a large sample analytical method for NGT-based studies (McMillan, King, & Tully, 2016).

To contextualise this approach, an example of the analysis for land information needs is provided below, which comprised three steps:

Step 1. A three-level coding framework was developed by an initial inductive coding of the data. This was to ensure that themes were comparable across the countries for analysis and synthesis. Level 1 represents high level constructs that relate to the functionalities of the its4land tools (primarily in acquiring data and providing data for input into formal systems, and data use and management). Level 2 represents the key themes that were derived. Level three reflects the dimensions under each theme. The framework is shown in Figure 1.1.

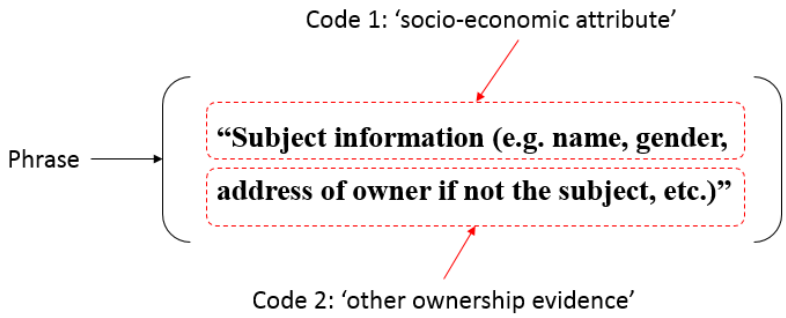
Figure 1.1 Three-level coding framework for land information needs.



Step 2. All raw textual data was subsequently re-coded in the RQDA [1] software environment using the coding framework. Refinements were made to codes along the way to support abstraction, comparison, dimensionalisation, refutation and integration (Spiggle, 1994). While data gathered through the workshops aimed to be as unambiguous as possible, this was not always the case and sometimes had to be further disambiguated during the coding process. For this reason as well, incorporating the number of votes in the analysis would have been problematic.

Figure 1.2 Coding example.

[1] RQDA is an open source R package for qualitative data analysis - see http://rqda.r-forge.r-project.org/.



For example, as shown in Figure 1.2, the phrase, "Subject information (e.g. name, gender, address of owner if not the subject, etc." was separated into two codes that reflect different types of information: 'socio-economic attribute' to capture data like name, gender, and other owner, and 'other ownership evidence' reflects other types of data to support clarity of ownership, in this instance the address of the owner if he/she does not live at the property. This is shown in Figure 1.2.

Step 3. Analysis of the frequency of the codes was performed within RQDA. In D2.4, the votes were used to indicate how each stakeholder group prioritised different land information needs. However, in D2.5, the aim is to understand how often these issues/needs were mentioned across the different stakeholder segments. To represent this, the number of occurrences of a code was used as an *indicative* metric for stakeholder consensus. Therefore, the strength of the consensus across the stakeholders (i.e. how often this code occurred across the corpus of data) for a particular dimension of a theme was calculated as:

$$\left(\frac{\text{Total no. of code occurrences for a specific dimension}}{\text{Total no. of codes occurrences recorded for the whole theme}} \right) \text{X } 100\%$$

Step 4. Cross-country analysis of the codes were undertaken by processing the outcomes from RQDA in Microsoft Excel.

The data on readiness requirements was inductively coded. From this process, four main themes emerged that accounted for most of the codes:

- strategic requirements
- structural and governance requirements
- organisational requirements
- technical requirements.

These themes will be used throughout this report, with variations discussed as required under the country sections.

Due to limited data, the data on market opportunities was simply critically compared.

Each country section concludes with an overall analysis in terms of the development and potential for each of the its4land technologies that is based on all the empirical data collected for that country and the preceding analysis and discussion.

To understand the outcomes of WP2 across the three countries, a critical analysis was undertaken. An interpretive approach was used to address aspects of meaning or significance by identifying observed patterns and anomalies across themes (Bevir and Kedar, 2008).

1.4 Limitations of the study

The scope of WP2 was ambitious given the complexity of land tenure issues in each of the case countries and the diversity of the stakeholders. Data collection was also complicated by on-the-ground challenges such as political unrest (Ethiopia) and drought (Kenya). In addition, although numerous efforts were made to encourage participation in workshops, actual turnout on the day often varied from the initial responses. The limitations of the sampling are in part overcome by the expertise represented in the groups, and the fact that similarities in terms of issues and needs emerged from the data across stakeholder segments.

1.5 Structure of the report

This report, D2.5, should be read as a companion piece to the report, Deliverable 2.4 (D2.4), since it analyses the data reported there. The report first analyses each of the three countries, and makes recommendations for the development requirements for the its4land technologies, before a cross-country analysis is undertaken and the findings of WP2 are discussed and the main outcomes summarised.

2 Ethiopia – country analysis

2.1 Summary of country setting and major land tenure issues

Ethiopia is a federation of nine ethnic-based states. It is ranked amongst the lowest 10% of countries in the UN's Human Development Index (UNDP, 2016). Land in Ethiopia is considered to be owned by the state with long term use rights provided to citizens. Urban and rural land are subject to different legislations, governance and processes, but in general, land can be rented and leased, but not mortgaged. Land is critical for mitigating the country's food insecurity, and is also the mainstay of its economy in terms of employment and exports. Around 80% of its citizens live in rural areas and engage in small scale farming (CIA, 2017). However, Ethiopia is urbanising and its urban population is expected to reach more than 42 million people (or 60% of the population) in the next 20 years (World Bank, 2015). To contend with this, the government published an urban master plan which sought to increase the spatial extent of Addis Ababa – effectively to twenty times its current size by extending the city's boundaries by more than one million hectares. This plan would have displaced (mainly Oromo) residents and farmers from traditional lands and urban development was perceived to be coming at a cost to the Oromo people once again and was opposed by the people.

These characteristics and recent events indicate the importance of sound land and land tenure information. Improving tenure security, especially for the majority of the population who are small-scale farmers in rural areas, has been the focus of multiple, multi-million dollar donor-funded titling projects. Ethiopia has had one of the largest, fastest and least expensive land registration and certification reforms in Africa under the first-level certification process covering around 20 million parcels (out of an estimated 50 million parcels in the country), mainly in rural areas (Deininger et al., 2008). Currently, an ambitious second-level certification process is ongoing. Funded by the UK government, this aims to provide titles to 70% of landholders upon completion of the project in 2020 (Abegaz, Allebachew, Edwards, & Leckie, 2016). To capitalise on the data that has, and will emerge from these initiatives, the Ethiopian government has invested in developing a national rural land administration system and purchasing an aircraft for aerial image acquisition and orthophoto production. The 2014 proclamation on urban land also now states what information should be collected for land administration purposes. Related to these outcomes, and predicated on secure tenure are other projects seeking to improve agriculture and land-based access to loans. The complexity and multi-dimensionality of land issues in Ethiopia is reflected in the issues and the needs captured in the research in WP2.

2.2 Land issues and land information needs

2.2.1 Land issues

Stakeholders at national level (government and non-government organisations), regional (government and non-government organisations) and local (communities) levels participated in the data collection process. The data was coded to reveal five key themes perceived as drivers of land issues. These themes and their respective categories, and their relevance to each stakeholder group, are shown as a thematic map in Table 2.1. The numbers indicate the frequency with which the code occurred in the data for each stakeholder group. To note, there were no issues coded as 'land issues' against the data for regional stakeholders (government and non-government).

Land issues: themes and categories	Nat_Gov	Nat_ Non Gov1	Nat_ Non Gov2	Comm_ Robit Bata	Comm_ Yibab	Strength of consensus*
Information issues	**6**	**2**	**9**	**2**	**2**	**30.9%**
Data quality	4	1	5	2	1	13
Unclear RRRs	2	1	1		1	5
Transactions/ processes			3			3
Governance issues	**3**	**4**	**9**	**3**	**1**	**29.4%**
Trust/transparency		1	4	3	1	9
Capacity	1	2	3			6
Laws	1	1	2			4
Organisational arrangements	1					1
Policy issues	**2**	**2**	**3**	**3**	**2**	**17.6%**
Expropriation/ compensation		1	1	2	2	6
Loan access			2	1		3
Planning system	1	1				2
Government guarantee	1					1
Social issues	**2**	**1**	**1**	**2**	**3**	**13.2%**
Tenure security	2		1	1	3	7
Informality		1		1		2
Nowhere to go					1	1
Physical development issues		**1**	**1**	**2**	**3**	**10.3%**
Land scarcity		1	1	1	1	4
Urban incursion				1	1	2
Informal settlements					1	1

**Strength of consensus for each dimension is calculated as the total number of code occurrences for the specific dimension as a percentage of the total number of codes recorded under the themes (n=68).*

Table 2.1 Distribution of key thematic land issues raised across Ethiopian stakeholder groups.

The table shows that both land-related information issues and governance issues received the most consensus amongst the stakeholders. The categories within each of the themes are discussed below (with reference to stakeholder groups made using the abbreviated codes in Table 2.1).

2.2.1.1 Information issues

The theme of land information issues had a fair degree of consensus across stakeholders. The theme was expressed as three different categories, discussed below.

a. **Data quality** relates to data already captured and inputted into formal systems. Data quality issues included limited or not updated data (especially spatial information), complete absence of data, or data that did not correspond to reality (e.g. overlap in boundaries). These resulted in issues of low confidence in the data and ongoing conflict. Therefore, there was a sense that communities had to be involved to improve the data quality.

b. **Unclear rights, restrictions and responsibilities (RRRs)** relates to legislated rights. Lack of clarity was seen as a consequence of the urban-rural dual system of tenure, ongoing legislative revisions (especially regarding urban land), as well as city/state-specific processes such as urban regularisation processes where the information used to determine spatial development tended to be unclear. Another aspect of this issue was the lack of documentation of the owner's duties and responsibilities (including those of the government's) in the book of holdings.
c. **Transactions/processes** describe the land transactions and processes as a category of information issues. There were three main issues: proliferation of traditional ways of recording land transactions in villages, lack of an efficient updating process and the fact that this can only be done at the Woreda level, and a protracted and complicated dispute process. All these affect the quality of the data produced or recorded in the system, or leads to conflict, or disincentivises engagement with formal systems.

Most of these issues were raised by national-level organisations (both government and non-government), although some of the opinions provided by one of the non-government organisations (Nat_NonGov2) reflected his experience as a senior manager with a regional government. Not surprisingly, these issues were also experienced by communities.

2.2.1.2 Governance issues

The theme of governance issues comprised four different categories.

a. **Trust/transparency** reflects the relationship between people and the public sector. This category of issues is indicative of citizens' trust in the government's capacity to administer and manage land, including the operations of existing land administration systems (Nat_NonGov1, Nat_NonGov2). Supportive of this are communities' experiences of expropriation and compensation processes, where government promises made to them were not being honoured. Known issues in the integrity of land records are also believed to be leading to the government displaying distrust in their own systems and therefore, strategies like reliance on public notices for verification of records are still common. And yet, participants' experiences of such strategies (e.g. during first-level certification) indicate that this too has its limitations – especially when owners are non-resident in the Kebele, or belong to vulnerable groups (e.g. female farmers); extended and complicated dispute resolutions processes also contribute to a lack of transparency. Finally, there was also a perception that the government's intentional lack of action over some issues enables poor development (Nat_NonGov1).
b. **Laws** as a category of this theme relates to the instability of the legal framework dictating the rules that govern the land. For example, in urban areas, there are currently between five to seven different pieces of land-related mandates which overlap to some extent (Nat_NonGov1). Land-related regulations are also updated continuously, which also affects organisational processes and service delivery (Nat_Non_Gov2).

c. **Capacity** relates to the ability, facility or power to effectively manage land at government, organisational, professional and individual levels. Deficiencies are evident in local governments (Nat_NonGov1), lack of skilled professionals in the land sector, and technical and financial resources (Nat_NonGov2). Capacity (or lack thereof) was linked to the small pipeline of graduates trained in land administration, and the dependency so far on donor-funded projects for capturing land information. There are also differing levels of capacity across different regional governments, which challenges federal coordination of land information (Nat_NonGov1).
d. **Organisational arrangements**, which are perceived to be changing constantly, are considered to be impacting the effectiveness of land administration and a significant factor in reducing the clarity in understanding the land rights (NatGov).

The issues were mainly voiced by national non-government organisations. What is striking is the lack of experience by communities in the other issues apart from trust/transparency, suggesting limited interaction with formal land administration systems outside of the Kebele, but also perhaps indicating that their needs are sufficiently met by the Kebele land officer.

2.2.1.3 Policy issues

Policy issues raised here are closely linked to the other themes. Of greatest concern are those policies that are currently affecting the livelihoods of people – the policies for **expropriation and compensation**, which communities (and backed up by non-government organisations) feel are inadequate and not transparently calculated. There is clear frustration with this aspect. Another category under this theme is the issue of non-existent policies – which people wish to have to improve their livelihoods – such as land-based **loan access**. Finally, other (less significant) categories of policy issues were related to tenure security including over rigid **planning systems** (especially urban planning, which was perceived to be unable to cope with the demands of development), and the government's new policy providing **government guarantee** over new titles. Unlike the other dimensions, this aspect of land issues was experienced fairly uniformly across stakeholders.

2.2.1.4 Social issues

Social issues were described by three categories. **Tenure security** was the aspect that most stakeholders voiced concern about and this relates to the governance issues raised above, particularly pertaining to laws, organisational arrangements and capacity. This impacts the government's ability to clearly implement the law or provide services that supports the rights of owners. However there was also an indication that tenure security would always be challenged and that people would always be disadvantaged since the land was the state's, and ultimately, they were within their right to do whatever they wanted. This is also likely a consequence of the lack of trust and transparency between the government and the people. Unsurprising, this possibly contributes to the **informality** in terms of land transactions, particularly over land acquisitions since formal systems do not seem to be effective and to adequately attend to the needs and the demands of the people. Finally, the frustration and worry that communities have over tenure security and the perceived position of disadvantage that the people are in in terms of land-related transactions are clearly communicated in the concern that their children in particular will have **nowhere to go** in terms of housing.

2.2.1.5 Physical development issues

Last but not least, and perhaps reflecting the fact that these issues are outside their control, is the aspect of physical development. Primarily, this concerns chronic **land scarcity**, increasing **urban incursion** in the peri-urban areas, and the rise in **informal settlements** due to a lack of formal housing supply. All this bears out in the country analysis provided in D2.4.

2.2.2 Land information needs

Reflecting the nature of the information identified in land issues, five thematic areas of land information needs emerged, but only three of these themes had consensus across the stakeholders. These themes were:

a. cadastral data needs
b. non-cadastral data needs
c. data management needs

These themes and their sub-categories are shown as a thematic map in Table 2.2.

The other two nominal themes (rating around 0.5% strength of consensus), land transactions and data analysis, are not shown in the table as they are not considered sufficiently significant but will be briefly touched on in the discussion below. The different stakeholder groups are shown as column headers.

Land information needs: themes and categories	Nat_Gov	Nat_NonGov1	Nat_NonGov2	RegGov	Reg_NonGov	Comm_ Robit Bata	Comm_ Yibab	Strength of consensus*
Cadastral data	**7**	**4**	**9**	**3**	**4**	**1**	**1**	**63%**
Spatial attributes	1		3	1	1			6
Socio-economic attributes	1	1	1	1	2			5
Tenure type/RRRs	1	1	1	1	1			5
Other ownership evidence	1	1	2		1			5
Property attributes	2	1	1				1	5
Accurate data			1			1		2
Geodetic control points	1							1
Non-cadastral data	**2**			**2**	**3**		**2**	**19.5%**
Land use zone				2			2	4
Land use	1				1			2
Administrative boundaries	1				1			2
Data management			**2**	**3**				**10.9%**
Data maintenance			1	1				2
Data security			1	1				2

Land information needs: themes and categories	**Nat_Gov**	**Nat_NonGov1**	**Nat_NonGov2**	**RegGov**	**Reg_NonGov**	**Comm_ Robit Bata**	**Comm_ Yibab**	**Strength of consensus***
LIS				1				1

**Strength of consensus for each dimension is calculated as the total number of code occurrences for the specific dimension as a percentage of the total number of codes recorded under the themes (n=46, including the themes not shown here).*

Table 2.2 Distribution of key thematic land information needs raised across stakeholder groups.

2.2.2.1 Cadastral data

Table 2.2 shows that cadastral data has significant consensus (almost two-thirds consensus) across Ethiopia's stakeholder groups as a land information need. This theme is represented by seven categories of needs and these are discussed below.

a. **Spatial attributes** here reflect territorial spatial characteristics. Stakeholders agreed that there was an urgent need for improved boundary information (NatGov, Nat_NonGov2, RegGov, and Reg_NonGov), and this might not even need to be absolutely accurate, but had to have good relative accuracy. Other types of spatial attributes mentioned included area and location of parcel, particularly for urban areas.
b. **Socio-economic attributes** here represent a variety of personal information about the right holder of the land, or user of the land (if not the right holder). Examples of such information included name, gender and address of owner and/or user, but really the aim of this dimension is information to support clear interpretation of tenure rights (Reg_NonGov). In terms of economic attributes, the need for data to support determination of the economic value of the land was indicated, such as taxes and mortgages (Reg_NonGov).
c. **Tenure type/RRRs** represent the legally determined rights, restrictions and responsibilities (RRRs) related to any particular type of tenure (e.g. private, public, communal). Examples of RRRs included permits, leases, third-party interests, etc. The need here responds to the issues raised around unclear RRRs and tenure insecurity, and was a shared concern of all government and non-government organisations.
d. **Other ownership evidence** captures other types of data that are neither spatial nor socio-economic. Commonly provided examples in the data include land parcel history (including acquisition history of the right of use), type of acquisition (e.g. inheritance) and neighbours.
e. **Property attributes** captures land information needs about fixtures on land and other types of possessions on land that improves its value, e.g. land value, crops, wells, irrigation systems, etc. This likely responds to the need to reach more commensurate levels of compensation, as well as being ready to enable land-based access to loans.
f. **Accurate data** here relates directly to accuracy as a property of data. Stakeholders highlighted the need for spatial and non-spatial data to be accurate across the information lifecycle to reduce conflict.

g. **Geodetic control points** refers to the need for good quality basic surveying infrastructure to produce good quality georeferenced land information (Nat_Gov).

2.2.2.2 Non-cadastral data

Non-cadastral data as a theme of land information needs experienced a much lower strength of consensus across the stakeholder groups – almost 20%. Table 2.2 shows that those stakeholders mainly concerned with this dimension of land information needs were the national government, regional government and non-government organisations and the peri-urban community. This theme had three dimensions:

a. **Land use zone** refers to the need for clearly demarcated land use zones (prospective use of land) and their implementation for more effective use of land resources. However, the community was sceptical of the benefits this would bring to local residents, especially in terms of employment.
b. **Land use** refers to data about how land is currently used.
c. **Administrative boundaries** refers to boundaries of administrative region (e.g. city boundaries).

2.2.2.3 Data management

This theme had the lowest strength of consensus across stakeholders and was mainly voiced by national non-government organisations (who had/have roles in land administration projects in Ethiopia) and regional governments who had the responsibility for managing the data. **Data maintenance** was seen as a need to keep the cadastral system up to date and to reconcile existing data with new data. **Data security** was also a need due to the dominance of analogue data and lack of a backup system. Currently, land certificates were also vulnerable to forgery. Lastly, a digital **Land Information Systems (LIS)** with web access was seen as a necessary instrument to facilitate data maintenance and security.

2.2.2.4 Nominal aspects

These nominal themes indicate the need for improving the quality of **land transactions** to facilitate the collection of good quality cadastral data and improving **data analysis**, specifically data integration, to enable the cadastre to be used to underpin sound decision-making.

2.3 Meeting stakeholders' needs: which its4land technology(s)?

The findings around land issues and needs certainly indicate the potential for its4land technologies. Aggregating stakeholders' opinions from the workshops as to which technology(s) they felt would most suit their identified needs, Table 2.3 shows the distribution of 'yes' votes collected at the workshops in Ethiopia. a clear preference towards geocloud services, especially among non-government stakeholders. This is followed by smart sketchmaps and UAVs. The tool that had the lowest strength of consensus in terms of applicability was the automated feature extraction (AFE) tool.

Stakeholder	Smart Sketchmaps	UAVs	Automated Feature Extraction	Geocloud services
Nat_Gov	2	2	1	
Nat_NonGov1	4	2	2	5
RegGov	2	3		1
Reg_NonGov	3	2	2	8
Total no. of 'yes' votes	**11**	**9**	**5**	**14**

Table 2.3 Distribution of 'yes' votes for its4land technologies across stakeholder groups.

2.3.1 Innovative data management: geocloud services

Geocloud services was considered to offer significant opportunities for managing land information by serving as a national land information system (which Ethiopia is only just about to implement, and only for rural land administration). This opinion was mainly driven by preferences from stakeholders from non-governmental organisations, primarily in their perception that such a technology could facilitate data management of both cadastral and non-cadastral data holistically. It was also perceived to enable maintenance and security of data, but there were concerns around lack of experience and culture in managing shared data resources. In addition, for such a system to function effectively, stakeholders identified the need for predefined standards and guidelines around data ownership, access, sharing, publishing and reuse.

2.3.2 Innovative data collection: smart sketchmaps vs. UAVs

The broader consensus received around smart sketchmaps as a potential technology for Ethiopia is likely due to the fact that it was, interestingly, perceived to be able to meet more cadastral (nine instances) than non-cadastral information needs (three instances):

- Cadastral data: spatial attributes, socio-economic attributes (e.g. name and gender), tenure types/RRRs, and other ownership evidence (e.g. history of acquisition, address of owner if not the subject).
- Non-cadastral data: land use zones, land use.

In contrast, the perception around UAVs meeting needs was more balanced between cadastral data needs (six instances) and non-cadastral data needs (four instances). Similar to sketchmpas, UAVs were thought to be able to support the collection of:

- Cadastral data: spatial attributes, socio-economic attributes (e.g. name and gender), tenure types/RRRs, but also visible property attributes.
- Non-cadastral data: land use zones, land use.

The difference in terms of the adoptability of the two technologies as perceived by the stakeholders are shown in Table 2.4, mainly around cost, post-processing, verification and training.

	Smart Sketchmaps	UAV
Perceived advantages	Inclusive (participatory approach) Low-cost Simple to use Data already verified	Nimble, quick to deploy Able to map at high resolution Can collect a variety of visible on-ground data

	Scalable Can be deployed at any time, even by Kebele officers	
Perceived challenges	Some degree of training in methodology Training in post-processing	Needs a legislative and/or privacy framework for use of the technology Certification program for pilots. Significant equipment and maintenance costs Needs to be proven that it is a cheaper/better option than aerial imagery. Can only be deployed after harvesting in November

Table 2.4 Smart sketchmaps vs. UAVs: perceived advantages and challenges.

Although UAVs had consensus as a potential tool in Ethiopia for land tenure information recording, there were also specific start-up conditions identified that needed to first be overcome, mainly around costs and regulation. UAVs are perceived to have the significant barrier of first requiring an enabling legislative and/or privacy framework for use of the technology, but also around certification of pilots; there would also be significant ongoing costs associated with this. In addition, data collected by the UAV still had to be verified. The advantage of sketchmaps was seen in its inclusivity (participatory approach) which would enhance transparency and trust in the data, its simplicity (both in training and use), and that verification of on-ground data is built into the methodology. However, base data for providing sketchmaps with georeferencing may not be available (e.g. topographic data is non-existent in Ethiopia).

2.3.3 Automated feature extraction

Automated feature extraction (AFE) was seen to be useful in producing cadastral data, especially in terms of visible boundaries, but also potentially to support the collection of property data (e.g. by detecting building outlines).

2.4 What would it take to use these tools?

Stakeholders identified a range of readiness requirements likely needed to support the adoption and implementation of these tools: strategic, structural/governance, organisational, professional development and technical requirements. These are outlined and discussed below.

2.4.1 Strategic requirements

At a strategic level, there must foremost be a clear need that the technology(s) addresses, i.e. “policy alignment” (Nat_NonGov1). To ease adoption, the recommendation was also to adopt those technologies that were able to exploit existing legal and operational frameworks, and to start with less politicised land interests to reduce barriers to innovation. The need for a change champion was also identified – one who could clearly communicate the benefits of the technologies.

2.4.2 Structural and/or governance requirements

Looking further ahead, it was also clear that some of the technologies would need work in establishing structural and/or governance requirements to enable adoption and support sustainable use. In particular:

- a technology owner(s) and commensurate responsibilities must be clearly defined
- new standards and guidelines must be developed to govern consistency and use of the data outputs from the technologies
- workflows that align with federated structures and dual systems of tenure will also need to be developed.

UAVs and geocloud services had additional governance requirements:

- UAVs will likely need a legislative and ethical use framework
- Geocloud services will require a framework to enable stakeholder coordination both within and external to government.
- Data access, ownership, publishing, sharing and licensing rights will also need to be defined. This is particularly important as the country does not have much experience with such scalable systems.

2.4.3 Organisational requirements

At this level, requirements become more localised and context-specific. Mostly, this requires planning – assessment of needs, risk, benefits, challenges and additional resources (both people and technology). This may lead to other change management requirements in terms of training and awareness raising, with tailoring of training content to meet different needs within the organisational hierarchy. Internal processes and procedures also need to be developed, which requires consideration as to how the new technologies might intersect with existing systems.

2.4.4 Professional development requirements

In response to the small base of trained land professionals in Ethiopia, stakeholders recommended the development of appropriate university curriculum to augment the skillset of graduates as a requirement to sustain the use of the technologies. For example, training in image processing was used as an example (UAVs and automated feature extraction).

2.4.5 Technical requirements

For the technologies to be adopted, there will likely need to be a degree of local customisation. In addition, existing ICT infrastructure may also need to be upgraded, or pilots undertaken to understand how the new technologies might integrate with existing tools and processes. Although this was raised in relation to the use of UAVs, it is likely to be applicable to the other technologies as well. To use geocloud services, existing rural and urban land information systems will need to be updated, transformed and migrated. Finally, the growing use of QGIS in Ethiopia is likely to ease the use of the AFE tool.

2.5 Sustaining the technologies: market opportunities

The assessment provided by national non-government organisations in D2.4 regarding market opportunities for the its4land technologies provides a good summary: that although land information itself was valuable, the 'market' for it is currently as a public good, and not (yet) a commercial product. In the short term, the market will be the public sector, with anticipation that the its4land technologies will support the improvement of public services delivery. However, it should be noted that lessons from around the world indicates that sound land information leads to the development of secondary markets such as location-based goods and services in the private sector. In Ethiopia, stakeholders also identified the creation of other goods and services such as the development of a land-based loan market and a crop insurance market – both of which are potentially substantial additions to the economy.

2.6 Discussion and recommendations for Ethiopia

Ethiopia has clear land issues that it is progressing, with corollary information needs. Ensuring that land tenure information, especially with spatial attributes, for its approximately 50 million parcels (i.e. complete coverage) is collected is a priority for the country, as this will provide a foundation dataset for other decision-making in terms of sustainable urbanisation. In turn, collected data needs to be trustworthy, maintained and be kept secure so as to be reliably used. To meet the aim of registering all parcels by 2020-21, it has been estimated that Ethiopia will require approximately 40,000 technicians and professionals over the next five years, 7,500 of which are surveyors and almost 14,000 land and GIS technicians (Medendorp et al., 2015). It is not possible to meet this need with Ethiopia's current educational and vocational training pipelines, and land administration projects in Ethiopia tend to use para-surveyors. This suggests various innovation pathways and opportunities for its4land technologies; the key challenge lies in identifying the appropriate entry point and relevant value proposition.

Land-related data collection and data management are currently dominated by two large projects: the UK-funded second-level certification project, and the soon-to-be-concluded rural national land information system project (funded by the Finnish government, concluded with the Ethiopian Ministry of Agriculture and Natural Resources government, and contracted to Hansa Luftbild, leaders of WPs 6 and 8 in its4land). its4land technologies cannot compete; instead, they need to be complementary. The rationale for this stems from the concerns raised around resources (which are limited), the political economy of land data in the country (many vested interests), but also clear benefits to be gained from leveraging the momentum generated by current land administration projects.

Based on the empirical data collected, recommendations for the other work packages in the project are provided below.

2.6.1 WP3: Smart sketchmaps

Smart sketchmaps seems the most likely to succeed in Ethiopia due to perceived cost, ease of use and potential contribution to information transparency. Participatory mapping is not new in Ethiopia so the methodology would not be difficult to communicate. Barriers to implementation may be understanding its position along the land tenure information value chain. However, it should be noted that smart sketchmapping requires topographic data as base data for georeferencing and this is not available (except mainly in urban areas) in Ethiopia. It also remains questionable if the functionality of smart sketchmaps was truly understood by stakeholders, who may be using their own experiences of other similar methods to frame their consideration of the tool.

Currently, potential options may be:

- To support second-level certification as an initial field verification method, and to leverage the communal approach to collect and verify other ownership evidence and property attributes.
- To support incremental improvement of data collected during first-level certification by providing additional qualitative information and spatial objects pertaining to communal lands, properties and infrastructure.
- To support dispute resolution through a participatory approach.

Mainly, this leverages the sketch-mapping process. To benefit from the ‘smart’ component, the data collected and processed needs to be linked to a strategic objective, and translated into a final product of tangible value to the community. It is important to demonstrate a clear function for smart sketchmaps because community groups questioned the purpose of the tool.

To progress with innovation, WP3 should aim to undertake a pilot study with a regional government and/or DFID to assess fitness of the tool both as a method for data capture, and as a resource pipeline for other types of land-related data.

2.6.2 WP4: UAVs

The findings indicate mixed feelings about the UAV as a tool. On one hand, there is recognition of its benefits; yet the list of challenges raised by stakeholders is a lengthy one. In terms of the cost/benefit of UAV as an imagery acquisition channel, in general, UAVs offer a cheaper option for procuring imagery if the area is no great than 20 km^2. The reality is that there is currently no enabling environment for UAVs: no legislation, no regulations, no equipment, no pilots, limited data processing skills, limited receiving data environments. Against this, the main potential currently for UAVs lies in undertaking limited pilot studies to demonstrate the value of UAVs as a survey tool in Ethiopia. Potentially, this could be for:

- Up-to-date imagery of peri-urban areas for development decision-making. Currently, cities are free to use any data source.
- Up-to-date imagery of first-level certified areas for the basis of extracting spatial attributes.

Given the dominance of small-scale farming and growing urban development, Ethiopia should have a need for high-resolution imagery to support accurate boundary recordation. The Information Network Security Agency (INSA) is now aware of the its4land project in Ethiopia, which represents a high-level contact point to facilitate the resolution of regulatory issues for UAV research. The key question that needs to be resolved for UAV innovation to occur in Ethiopia appears to be: is it worth it? This needs to be addressed from the perspective of the public sector given there is almost no private land surveying sector in Ethiopia.

2.6.3 WP5: AFE

Given the process of land information production in Ethiopia, i.e. based on aerial imagery, the fact that QGIS is used in several donor-funded land administration projects, and the low cost (if any) of the tool, there is potentially a significant innovation opportunity for the AFE tool, although this is not borne out in stakeholders' perceptions. Barriers to innovation lie in limited GIS facilities and low GIS skill levels; also, the AFE could be construed as taking away jobs (there are often multiple people engaged in digitising at Woreda offices). Nonetheless, it would be a worthwhile exercise trialling the plugin at Woreda level or with DFID to test usability of the plugin and interaction with existing processes.

2.6.4 WP6: Geocloud services

There is a need for a national land information system in Ethiopia. This is reflected in stakeholders' perception of the potential of this tool. That the leader of WP6 is the same organisation developing the rural land administration system, and with similar previous experience developing a land information system for the City of Addis Ababa presents an opportunity to ensure geocloud services are interoperable with two of the main land information systems in the country. However, this may ironically also be an inhibitor of innovation: is WP6 inherently the same system and if so, is there a need then for geocloud services as a separate product in Ethiopia? If not, will it likely be conflated given the fact that the technology is being produced by the same organisation?

These questions aside, similar to WP3, the challenge for WP6 is to define its innovation proposition for the Ethiopian government. Similar to WP5, a potential test site (with approval from regional governments) may be at Woreda level where raw data becomes digital data, and where land transactions are processed. It may also be necessary to explore how Ethiopia's NSDI policy (implemented by INSA) would impact the operation of a geocloud platform.

2.6.5 WP7: Governance and capacity modelling

Governance, or lack thereof, over land, has been raised as an issue both in the literature and by research participants. This in turn, has impacted on land information production, use and management. Governance of the technologies should clearly identify and justify technology owners and resource streams, as well as a framework for coordinating stakeholders in data collection, use and management. Tensions with existing processes should also be identified, and where possible, the suggestion of new ones. Local, regional and federal levels should be targeted in WP7. Basic capacity requirements have also been identified; a more thorough examination should be undertaken in WP7, perhaps as a component of pilot studies with other WPs.

2.6.6 WP8: Business modelling

Three of the four its4land technologies have low to medium cost implications, and given the issues and land information needs, could be argued is likely to provide significant returns to government both in terms of improving internal processes and external-facing public service delivery. Technologies like smart sketchmaps, automated feature extraction and geocloud services represent products where the 'market' is likely to be government and is unlikely to be the private sector. Nonetheless, these three products have potential to contribute to the development of a single market around land information, with value of data likely to increase as data sharing improves discoverability, integration and re-use of land information as input into the development of secondary products. There are already potentially significant clients for such data including agricultural insurance and banks (if policies around land-based loan access are developed). However, this is unlikely to be realised in the short term as the existing data quality is not adequate.

2.6.7 Summary analysis of innovation outlook

Based on the empirical data, the research team has provided an overall summary assessment of the innovation outlook for each of the its4land technologies in Ethiopia. This is described in Table 2.5 and seeks to provide recommendations around the likely technology owner, indicative costs, potential ease of adoption, and strengths, weaknesses and opportunities of each of the technologies relative to the country setting and identified issues.

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
Likely technology owner			
Regional governments, conducted at Kebele level and maps processed at Woreda level.	County government and/or Ministry of Lands	Any level of government	Ministry of Agriculture and Natural Resources and regional governments
Likely costs			
• Low start-up and ongoing costs that may be accommodated in current budgets. • Some training costs especially at Kebele level (map production), Woreda level (data processing) and regional levels (data analysis and maintenance).	• Fairly significant start-up costs and ongoing costs. • Will likely require budgetary approval	• Low start-up and ongoing costs that may be accommodated in current budgets	• Medium to high start-up costs (depending on state of ICT infrastructure) • Likely to have ongoing costs that will need to be budgeted for annually • Will likely require budgetary approval
Ease of adoption			
• Take-up should be relatively quick once professionals are trained.	• Requires trained personnel immediately – technology transfer may take a while • Vertical organisational relationships may provide some barriers to adoption • Budgetary approval may delay adoption efforts	• Take-up should be relatively quick once professionals are trained	• Reorganisation of organisational processes may delay adoption efforts • Adoption may take some time due to training and institutionalisation of cloud-based work processes

<table>
<tr><th>Smart Sketchmaps</th><th>UAV</th><th>Automated Feature Extraction</th><th>Geocloud Services</th></tr>
<tr><td colspan="4">Strengths</td></tr>
<tr><td>Practical aspects:
• Flexible and adaptable to field conditions and community preferences for data production
• Rich data output suited for a range of cadastral and non-cadastral purposes
• Scalable
Strategic aspects:
• Participatory approach can mitigate community perceptions of trust/transparency in land information</td><td>Practical aspects:
• Nimble and quick to deploy
• Maps all terrestrial features
• Produces high quality digital, georeferenced aerial imagery</td><td>Practical aspects:
• Reduces human intervention and therefore errors.
• Code can be further developed for country specific conditions
• Scalable
Strategic aspects:
• Automated image interpretation may improve transparency in cadastral processes</td><td>Practical aspects:
• Provides more capability and security than what most government offices may currently have on the desktop
• Opportunity to integrate different government data sources using the cadastral fabric
Strategic aspects:
• Immediacy of the platform offers a potential solution to Ethiopia’s need for a NLIS.</td></tr>
<tr><td colspan="4">Weaknesses</td></tr>
<tr><td>• Data outputs may not be immediately usable/interoperable with existing records
• Community is not clear on the purpose of smart sketchmaps</td><td>• Perceived to be a slightly more expensive option than aerial photography with no clear advantage
• Data needs to be post-processed for cadastral purposes
• Needs trained personnel</td><td>• May reduce the number of digitisers employed at Woreda offices</td><td>• ICT infrastructure may not be adequate for cloud-based work.
• Organisations with existing land information systems may not want to switch</td></tr>
</table>

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
Opportunities			
• Can map any feature of local significance to provide an integrated document that is agreed on by the community. • Can be a source of information for future dispute resolution processes. • Existing body of para-surveyors that have worked in past/current donor land projects could be a ready source of human resource	• Potential to use UAV data to create 3D models. • Can be deployed for other purposes given the development objectives of the Ethiopian government • Potential opportunities for governments and academic institutions to provide relevant training and/or certification programs.	• Potential opportunities for governments and academic institutions to provide relevant training • Growing use of QGIS	• Offers Ethiopia a ready solution for a land information system • Developed by the same organisation who is developing the rural land administration system and City of Addis Ababa's land information system
Threats			
• Lifecycle of the sketchmap is not yet clearly understood. • Interaction of sketchmap data with local government processes and systems is not yet clearly understood.	• Lack of a clear regulatory framework and practical guidelines for flying. • No clear training/certification avenue for UAV pilots. • Potential ethical/privacy infringements in UAV activity if poorly governed.		• Requires a clear regulatory framework, processes and standards for data sharing horizontally and vertically • National rural land administration system about to be go live.

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
	• Not yet clear how UAVs will intersect with land data acquisition processes in a systematic way. • Not yet clear how many UAVs are required to be operationally viable. The cost of multiple UAVs may be a disincentive, especially if large areas need to be flown.		• Some regions may have their own systems (e.g. Addis Ababa).

Table 2.5 Overall analysis of Ethiopian conditions for its4land technologies by the research team.

3 Kenya – country analysis

3.1 Summary of country setting and major land tenure issues

Kenya is a federation of a national government and 47 county governments. Under the 2010 Constitution, responsibility of land was decentralised to offer greater transparency: county governments are now responsible for surveying and mapping, but also planning and management (of public lands). All land in Kenya falls under three types of tenure systems: public, private and community. While exact figures are difficult to come by, it is estimated that these categories account for 10%, 20% and 70% of Kenya's land (Siriba, Voß, & Mulaku, 2011). Community land was only recognised recently as a legal tenure type and a majority of this is yet to be mapped or registered.

Kenya was once considered to be have a good titling and cadastral system (Dale, 1976). However, mismanagement and politics of land distribution in both colonial and post-colonial governments have left Kenya contending with a multitude of land issues (Boone, 2012). There are also major land tenure issues associated with community land, especially in urban areas where this tenure dominates. Lack of legal certainty over land, poor quality land information, and informal land markets have led to widespread land-related fraud and conflict, and have restricted economic development. In terms of data, Kenya's cadastre, which has been in existence for more than 100 years, remains largely incomplete due to multiple land laws, a history of voluntary registration, and disconnected land administration functions (Siriba et al., 2011). Major land and land tenure reform was catalysed by the 2009 National Land Policy and the 2010 Constitution but its effectiveness continues to be challenged by good governance. Recently, the Ministry of Lands has succeeded in providing a digital lands registry service with provision of some online land transactions. By 2018, 58 land registries are expected to have been upgraded and included in the service.

3.2 Land issues and land information needs

3.2.1 Land issues

Stakeholders at national level (government and non-government organisations), county level (government organisations) and local levels (communities) participated in the data collection process. The data was coded to reveal four key thematic land issues. These themes and their respective categories, and their relevance to each stakeholder group, are shown as a thematic map in Table 3.1. The numbers indicate the frequency with which the code occurred in the data for each stakeholder group per thematic category. To note, there were no issues coded as 'land issues' against the data for academic/national government stakeholders. Although the strength of consensus has been calculated for each theme, the thematic map clearly shows that information issues had the greatest consensus, not only in terms of frequency of vote, but also in terms of the distribution of codes across all stakeholder groups.

The issues were mainly identified by local stakeholders, as can be seen by the number of issues raised by the county government and local Maasai. This generally reflects the insight that the county government has into land issues given its constitutional responsibility for land. The key themes that emerged from the analysis are: information issues, governance issues, resource/environmental issues and social issues. These are discussed below.

Land issues: themes and categories	Nat_NonGov	LocalGov1	LocalGov2	Maasai_M	Maasai_W	Strength of consensus*
Information issues		**1**	**4**	**5**	**2**	**36.4%**
Boundary conflict		1	2	4		7
Subdivision			2		2	4
Infrastructure				1		1
Governance issues	**1**	**1**	**5**	**1**		**24.2%**
Lack of gazetting			2	1		3
Lack of planning	1	1	1			3
Lack of regulation			2			2
Resource/environmental issues			**2**	**5**		**21.2%**
Environmental degradation			2			2
Resource destruction				4		4
Climate				1		1
Social issues			**1**	**2**	**3**	**18.2%**
Cultural vs legal practices					2	2
Outsiders			1	1		2
Expropriation/compensation				1		1
Women's land rights					1	1

**Strength of consensus for each dimension is calculated as the total number of code occurrences for the specific dimension as a percentage of the total number of codes recorded under the themes (n=38).*

Table 3.1 Distribution of key thematic land issues across the Kenyan stakeholder groups.

3.2.1.1 Information issues

This theme, regarding land and land-related information, has three sub-categories:

- **Boundary conflicts** in the region are longstanding, as discussed in Deliverable 2.4. While it appears that interpersonal dispute resolution processes are fairly well understood and now involve local county officials, the growing (anecdotal) incidence of conflict due to increased fencing of private land is compounded by the Maasai's observance of traditional grazing rights and their lack of understanding of the legal rights, restrictions and responsibilities associated with private tenure (Maasai_M). More generally, boundary conflicts are also occurring where human settlement is beginning to intrude into fragile natural areas, resulting in human wildlife conflict (LocalGov2).
- The category of **subdivision** is associated with the previous theme and is largely, according to comments made by stakeholders, the driver for boundary conflicts. However, it stands alone here as a category to represent the informal subdivision occurring in group ranches still held under the trusteeship model, where property becomes informally subdivided (i.e. untitled) – not legal but no less legitimate,

and which is a driver for intra-family conflict often involving mothers (who act as trustees once their husband passes away), sons and brothers.
- Lack of adequate documentation over public **infrastructure**, especially encumberances and restrictions, give rise to conflict because there is no clarity as to what the land can be used for. Another aspect of this dimension is the lack of proper expropriation and compensation systems over private or communal land for public infrastructure. One of the examples provided here are wayleaves for powerlines (Maasai_M).

3.2.1.2 Governance issues

Governance issues here are more to do with the act of governing, and relate to three different categories of concerns:
- **Lack of gazetting** relates to the limited or non-existent environmental protection and management (including gazetting of forests, water resources). This is not only impacting negatively on environmental sustainability, it is also leading to increased incidences of human-wildlife conflict (LocalGov2, Maasai_M).
- **Lack of planning** reflects the continued challenge of appropriate spatial planning, particularly in terms of defining areas for urban centres and expansion of urban settlements and land use zones for industrial activities (Local Gov1, LocalGov2, Nat_NonGov).
- **Lack of regulation** relates to the increase in small-scale local activities such as sand harvesting and charcoal production which are also not managed, leading to devastating impacts on land including increased deforestation and inhabitability of areas. Unregulated placements of boreholes (despite owners producing evidence of 'official approval' documents) are also threatening the viability of Kajiado's water table (LocalGov2).

3.2.1.3 Resource/environmental issues

This theme reflects physical issues about land and was mainly derived from data from the local government and community in Kajiado.
- **Environmental degradation** comprises one dimension of this theme, representing land issues caused, for example by soil eroseion and weed infestations.
- **Resource destruction**, here represents a range of activities that are impacting the Maasai's relationship with property or natural resources such as the destruction of property (land, water pipes, fences) by animals or humans (cutting down trees or poor animal husbandry).
- **Climate** reflects Kenya's ongoing issue with droughts.

3.2.1.4 Social issues

Social issues speak of those challenges experienced by the community that leads to a negative impact on their well-being. There are four categories of issues under this theme:
- **Cultural vs. legal practices** emerged mainly from data collected from the communities. It describes one of three things: tensions between cultural and legal approaches to dealing with land, or cultural interpretations of the law, or pursuing cultural approaches rather than legal ones. Examples of this are the non-inclusion

of Maasai daughters in land inheritance, practicing subdivision but without the legal finality and evidence of a formal subdivision application.

- **Outsiders** reflect the concern about the growing presence of "outsiders" (i.e. non-Maasai) within the urban areas of Kajiado. This issue stems from land being transferred out of Maasai ownership, often by men who sell the land without telling their wives (LocalGov2, Maasai_M). The selling activity has highlighted the lack of awareness among women of their legal rights to land, whilst buying activity is contributing to conflicts stemming from a lack of respect and/or understanding of the communal aspects of Maasai land and resource use and management. This has led to increasing incidences of land being fenced off.
- **Expropriation/compensation** here reflects the social challenges felt in the community when land is not properly acquired, both in terms of access and use of land, but also in financial terms. This dimension is linked to the lack of documentation around public infrastructure.
- **Women's land rights** as a category captures the limited awareness that women have about their legal rights over land concerning land transactions and emerged from data provided by the county government.

3.2.2 Land information needs

During data collection, stakeholders were directed to consider the types of land tenure and land-related information needs for responding to the issues raised. They identified six categories of land information needs:

a. cadastral data
b. non-cadastral data
c. data analysis
d. data management
e. land transaction
f. stakeholder engagement needs.

Land information needs: themes and categories	Acad/ NatGov1	NatGov2	Nat_NonGov	LocalGov1	LocalGov2	Maasai_M	Strength of consensus*
Cadastral data	**10**	**8**	**7**	**3**	**1**	**2**	**42%**
Accurate data	6	3	3	2			14
Tenure type/RRRs	2	3	2			2	9
Spatial attributes	2	1	1	1	1		6
Other ownership evidence		1	1				2
Non-cadastral data	**3**		**1**	**3**	**10**	**4**	**28.4%**
Land use zone			1		6		7
Natural resources	1			1	3	2	7
Infrastructure	1			2	1		4
Cultural sites						2	2
Land injustices	1						1
Data analysis		**2**	**2**	**4**			**10.8%**

Land information needs: themes and categories	**Acad/ NatGov1**	**NatGov2**	**Nat_NonGov**	**LocalGov1**	**LocalGov2**	**Maasai_M**	**Strength of consensus***
Data integration		2	1	1			4
Analytical functions				2			2
Digital data			1				1
Multipurpose use				1			1
Data management	**4**	**2**	**2**				**10.8%**
Data accessibility	1	1	1				3
Data ownership/availability		1					1
Data maintenance			1				1
Data security	1						1
Data integration	1						1
Digital data	1						1
Land transactions		**1**	**1**			**2**	**5.4%**
Dispute resolution			1			2	3
Affordability		1					1
Stakeholder engagement					**1**	**1**	**2.7%**
Legal aspects						1	1
Women's land rights					1		1

**Strength of consensus for each dimension is calculated as the total number of code occurrences for the specific dimension as a percentage of the total number of codes recorded under the themes (n=74).*

Table 3.2 Distribution of votes against land information needs.

3.2.2.1 Cadastral data

As Table 3.2 shows, cadastral data as a theme, was derived from data across all stakeholder groups indicating strong consensus (42%) of this as a land information need for Kenya. This theme has four categories of needs:

- **Accurate data** is about data that is spatially and temporally accurate, and can be perceived to be in response to identified information issues. Most of the data under this code was about accuracy of boundaries (which are spatial), but also accuracy about rights (extent, owner, etc.), especially over community and public lands.
- **Tenure type/RRRs** represent the legally determined rights, restrictions and responsibilities (RRRs) related to any particular type of tenure (e.g. private, public, communal). Here, stakeholders were most concerned about community land, and to a lesser extent, public lands.
- **Spatial attributes** here reflect territorial spatial characteristics. Of particular concern was data on boundaries (including subdivisions) and georeferencing.
- **Other ownership evidence** captures other types of data that are neither spatial nor socio-economic. Needs raised include historical data on land transactions as well as other types of ownership evidence as a means of improving transparency and reducing fraud, and stipulating boundary data accuracies.

3.2.2.2 Non-cadastral data

Non-cadastral data as a theme of land information needs experienced a lower strength of consensus across the stakeholder groups – almost 30%. Table 3.2 shows that those stakeholders mainly concerned with this thematic area of land information needs were the academics, national government, county government and local community. This theme had five categories of needs:

- **Land use zone** refers to the need for data to develop county-level land use zones (especially spatial plans) to mitigate development challenges and governance challenges and for more effective use of land resources.
- **Natural resources** refers to the need for data on fragile natural areas which are natural assets, water resources (especially fertile waterways), and human/wildlife zones.
- **Infrastructure** refers to the need for data about public facilities including roads, powerlines, and some private facilities like water dams and boreholes.
- **Cultural sites** refers to the need for data that on culturally significant sites that require protection (e.g. limited use/access).
- **Land injustices** represents the need for data about erroneous land transactions that have happened in the past that have resulted in loss of land for legitimate landowners.

3.2.2.3 Data analysis

This theme had a lower strength of consensus across stakeholders and was mainly voiced by national government and non-government organisations, and by county government. The need was mainly around **data integration** – the desire to link the digital cadastral map with other sources of data for improved decision-making. Stakeholders also voiced the need for **analytical functions**, especially around thresholds for land use and subdivisions. These needs are in turn, predicated on **digital data** being a prerequisite and finally, a desire to enable multipurpose use of land information.

3.2.2.4 Data management

Data management as a theme emerged mainly from the data collected from national level stakeholders and the theme's strength of consensus was only 10%. This theme covers six different categories:

- **Data accessibility** reflects stakeholders' desire to be able to access land information easily.
- **Data ownership/availability** reflects the link between knowing who owns what data (data provenance) and data management.
- **Data maintenance** echoes the need for accurate data by having systems, processes or transactions that support data updating.
- **Data security** reflects the desire for good data management to facilitate security of land records.
- **Data integration** reflects the stakeholders' recognition of the importance of the cadastral fabric as a base layer for providing greater locational and ownership rights context for analysing other datasets.
- **Digital data** reflects the stakeholders' recognition that having land data in digital format facilitates data management.

The last two themes documented below had low consensus among stakeholders and so are not significant but they have been included here for completeness.

3.2.2.5 Land transactions

Land transaction needs reflect two dimensions: dispute resolution and affordability of tenure. **Dispute resolution** reflects the need for alternative processes in both urban and rural areas. **Affordability of tenure** reflects the fact that tenure transactions are becoming more expensive and the desire is to have additional information to enable the client to estimate the costs (e.g. transparency, duration, cost of process, etc.).

3.2.2.6 Stakeholder engagement

Stakeholder engagement needs reflects the need for community buy-in to support improvement in the quality of land data. Primarily this was related to increasing community awareness of their legal entitlements regarding tenure. Two dimensions were identified: **legal aspects** of land tenure especially related to disputes, and **women's land rights**. The thematic map of the distribution of codes demonstrate that this theme emerged from needs identified by local level stakeholders (county government and community groups).

3.3 Meeting stakeholders' needs: which its4land technology(s)?

In the workshops, stakeholders were asked to provide an opinion on which its4land technologies were best suited to meet their identified land information needs. Table 3.3 provides an overview of the summary of 'yes' votes across four stakeholder groups when the technologies were assessed against the identified land information needs.

	Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
Acad/NatGov1	6	7	8	5
NatGov2	3	3	2	2
Nat_NonGov	1	1	1	1
LocalGov1	1	4	1	
Total no. of 'yes' votes	**11**	**15**	**12**	**8**

Table 3.3 Stakeholders' perspectives on applicability of its4land technologies.

3.3.1 Most likely to meet needs: UAVs

Table 3.3 indicates that stakeholders, particularly the academic/national government group, felt that UAVs were the most promising technology amongst the its4land technologies to meet land information needs. Primarily, this technology was perceived to be able to:

- meet **cadastral data** needs, especially acquisition of more accurate data particularly parcel boundaries (Acad/NatGov1, NatGov2) and improving georeferenced data (NatGov2, LocalGov1); mapping the spatial extent of community land to identify and register pastoralists land rights (Acad/NatGov1); mapping public land (NatGov2).

- meet **non-cadastral data** needs, especially to map natural resources for the purposes of improving documentation (LocalGov1); map current land use for land use zoning analysis (NatGov2, LocalGov1); map existing infrastructure e.g. man-made water resources and roads (Acad/NatGov1)
- support **data analysis** such as land fragmentation (LocalGov1).

While there was recognition that UAVs held potential, especially to support the production of georeferenced cadastral data, stakeholders also acknowledged that it was likely to be more applicable for planning and for small areas (LocalGov1). Some stakeholders also felt that UAVs could support **data analysis** functions like data integration (Acad/NatGov1). This is not immediately possible, but the discussion around this item indicates that stakeholders felt that UAVs provide a source of data that is more amenable to data integration.

3.3.2 Next best technology? AFE or Smart sketchmaps

For these technologies, most of the endorsement came again from the academic/national government stakeholder group. The applicability of the technology of the automated feature extraction (AFE) tool was mostly perceived to lie with meeting cadastral data needs, while smart sketchmaps were mainly perceived to have the potential to meet non-cadastral data needs. The differences in perceptions around these technologies are outlined in Table 3.4.

The automated feature extraction tool was often difficult for stakeholders to grasp. Similar to their perspective on UAVs, some stakeholders also felt that the AFE tool could support **data analysis** functions like data integration (Acad/NatGov1). Again, this is not immediately possible, but the discussion around this item indicates that stakeholders felt that AFE would facilitate the production of data that was suited to data integration.

	Smart Sketchmaps	**Automated Feature Extraction**
Cadastral data needs	• Location and extent of tenure type according to administrative boundaries (NatGov2, Acad/NatGov1) • Identification and documentation of public land (NatGov2) • Accurate and up-to-date spatial and non-spatial parcel information (Acad/NatGov1) • Community land and associated land and grazing rights (Acad/NatGov1)	• Georeferenced parcel information (NatGov2, LocalGov1) • Identification and documentation of public land (NatGov2) • Accurate and up-to-date spatial and non-spatial parcel information (Acad/NatGov1) • Community land and associated land and grazing rights (Acad/NatGov1) • Urban and rural boundaries (Acad/NatGov1)
Non-cadastral data needs	• Develop/update spatial development plans (Nat_NonGov) • Resource mapping and documentation (Acad/NatGov1) • Historical land injustices (Acad/Gov1) • Rural boundaries	• Accurate and up-to-date information about infrastructure • Resource mapping and documentation (Acad/NatGov1)

	Smart Sketchmaps	Automated Feature Extraction
Data analysis		• Providing georeferenced data for data analysis (LocalGov1)
Stakeholder engagement	• Community involvement in data collection (LocalGov1)	
Land transactions		• Alternative dispute resolution process (Nat_NonGov)

Table 3.4 Perceived potential of AFE and smart sketchmaps to meet land information needs.

3.3.3 Geocloud services

There was some agreement that geocloud services could support data analysis and management needs. Again, potential misunderstanding of the tool's functions also led to a belief that it could also support cadastral data acquisition (providing accurate attributes).

3.4 What would it take to use these tools?

The outcomes from the workshops provided fairly generic insights into potential operational conditions. It indicated that for the its4land technologies to be used in Kenya, there needed to be a change process that includes:

- **Structural requirements:** clear legislation/regulations, policies, standards and guidelines, but especially the need for authorising agencies to support the use of UAVs.
- **Organisational requirements:** specific organisational needs assessments to understand how best to apply the adopted technology for resource allocation; development of processes and procedures; development of monitoring and evaluation processes.
- **Infrastructure requirements:** acquire, develop and sustain human and physical infrastructure for the adopted technology(s).
- **Individual requirements:** develop and deliver targeted training about the various technologies for policy makers, decision-makers, practitioners (managers vs. technicians) and end-users to create awareness of the technologies and their respective benefits for particular user groups.

It was deemed essential that pilot studies be implemented to communicate the value of the technologies and to build trust. Another caveat is that existing land records in Kenya may need to be reorganised prior to the implementation of geocloud services (Acad/NatGov1).

3.5 Sustaining the technologies: market opportunities

The groups were fairly limited in their identification of potential market opportunities for the its4land technologies. Most of the opportunities were related to UAVs or geocloud services around improving existing government services due to more precise, accurate, up-to-date and accessible land, property, infrastructure and resource information, and therefore the ability to generate more revenue. Examples of such services included emergency services and response, better delivery and value-add of location-based services, and census mapping. However, new direct opportunities suggested included resale of digital data, and indirect opportunities included improving investor confidence in Kenya and encouraging more public-private partnerships, and enhancing tourism (due to better quality land data and inclusion of cultural sites).

3.6 Discussion and recommendations for Kenya

The data collected from Kenya demonstrates clear recognition of land related issues that correspond with a range of academic and grey literature (see D2.4 for the review). There is no doubt about the magnitude of land tenure information that needs to be acquired, processed and managed to implement the legalisation of community land as Kenya's third legal tenure type. While the existence of 43 different cultural groups indicate that community land is not a homogenous construct, the experience of working with the Maasai in rapidly urbanising Kajiado county suggests that understanding, identifying and meeting the needs of such communities are urgent because rapid physical and development changes are being visited upon them. These communities are not only living with the land tenure mistakes of the past, but also of the present. More importantly, urbanisation is drastically changing the cultural identify of towns like Kajiado and a phrase that succinctly communicates the implicit danger of such a phenomenon is that ***"the Maasai are becoming squatters on their own land"*** (personal communication with a member from the Council of Governors, Kenya).

From a research perspective, field experiences, and experiences of observing the UAV import process into the country, the enthusiasm for UAV technology documented in the data was mainly driven by the academic/national government stakeholder. The observation here was that there is great interest in taking up this technology because it is perceived to be "cutting edge" contemporary surveying equipment, but also that it offers a more flexible approach to data collection. This bodes well for technology acceptance in general (Parasuraman, 2000).

However, other factors have emerged that throw a shadow over UAVs as an innovative tool, mainly in terms of perceived usefulness and ease of use ((Davis, 1989). The fact that UAVs can only cover a small area indicates it will be a niche tool: for example, Kajiado, one of the largest counties in the country geographically, cannot use UAVs to resurvey large tracts of lands (as is urgently needed) as it would simply be cheaper to acquire aerial imagery. The fact that training is consistently raised as an issue for UAVs, and the protracted import process for the project's UAVs into Kenya, suggest challenges around ease of use (at the moment) are significant and there is some measure of distrust about the technology as well.

3.6.1 WP3: Sketchmaps

There is good potential applicability for using smart sketchmaps in Kenya to systematise community participation in the development and production of spatial plans and maps for both cadastral and non-cadastral purposes. Challenges lie in institutionalising this tool as part of the information production lifecycle – and corollary considerations for human and technological capacities.

3.6.2 WP4: UAVs

The UAV was the technology of greatest interest to the stakeholders. However, it is potentially a niche tool and one that may not yet be necessary in Kenya (despite enthusiasm for it) as an overhaul of cadastral data is more urgently required. This positions aerial imagery as a far cheaper option. Currently there are more barriers to adoption than enablers; successful adoption will rest entirely on explicitly identifying its direct role and function in supporting cadastral processes and cost-benefit implications.

3.6.3 WP5: AFE

There is high conceptual applicability for introducing the AFE into organisational processes in Kenya. The only practical challenge is whether there is a steady source of images that can be processed. It would be of high value, for example, if Kajiado was resurveyed completely, and whether the initial QGIS plugin is interoperable with existing systems. For ease of adoption, the plugin should aim to be compliant with ArcGIS.

3.6.4 WP6: Geocloud services

There is high conceptual applicability for introducing the geocloud into the county government systems as a first step and testing data sharing at a small scale. However, significant resources need to be put into digitising records. Offline capability must be robust due to frequent connectivity issues. The value proposition for longer-term use of the geocloud must tackle its relationship with the NLIS currently under development.

3.6.5 WP7: Governance and capacity modelling

Governance issues raised here are not necessarily related to the governance considerations around the introduction and use of the its4land tools. For the UAV, it is clear that governance challenges are intertwined with internal security considerations (flying permissions and restrictions): how should the industry be regulated and governed? How should relevant policies be designed and enforced? The inherent skills required (piloting, craft maintenance, image processing, etc.) suggests a clear pipeline of skilled human resources (and training infrastructure) is required for sustaining capacitated users. A broad decentralised base of county governments who have responsibility for land however indicates governance challenges around vertical coordination of data flows – this has direct implications for the use of geocloud services. In addition, long standing community distrust of government handling of land information, high levels of data fraud and corruption around data processes, and data itself, indicates the need for governance structures to prioritise the facilitation of transparency and integrity of land information acquisition, use and management.

3.6.6 WP8: Business modelling

Kenya is in the process of finalising its UAV legislation (draft legislation has been approved). This, in addition to other factors like a strong private surveying sector and the need to support documentation and registration of community land (around two-thirds of the land) indicates a potential market for commercial UAV applications. However, given current difficulties observed by the project in terms of getting the UAV through customs, and certifying pilots, the development of the market is likely to be relatively slow over the short to medium term (three to five years). Similar to Ethiopia, other its4land technologies like smart sketchmaps, automated feature extraction and geocloud services represent products where the 'market' is most likely to be government. A large presence of non-government organisations of varying sizes working on land-related issues in the country however, suggest that there may be a secondary market in terms of data access and reuse.

3.6.7 Summary analysis of innovation outlook

Based on the empirical data, the research team has provided an overall summary assessment of the innovation outlook for each of the its4land technologies in Kenya. This is described in Table 3.5 and seeks to provide recommendations around the likely technology owner, indicative costs, potential ease of adoption, and strengths, weaknesses and opportunities of each of the technologies relative to the country setting and identified issues.

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
Likely technology owner			
County government NGOs	County government and/or Ministry of Lands	Any level of government	Ministry of Lands and county governments
Likely costs			
• Low start-up and ongoing costs that may be accommodated in current budgets	• Fairly significant start-up costs and ongoing costs. • Will likely require budgetary approval	• Low start-up and ongoing costs that may be accommodated in current budgets	• Medium to high start-up costs (depending on state of ICT infrastructure) • Likely to have ongoing costs that will need to be budgeted for annually • Will likely require budgetary approval
Ease of adoption			
• Take-up should be relatively quick once professionals are trained (conceptual and field) • Easily scalable	• Requires trained personnel immediately – technology transfer may take a while • Vertical organisational relationships may provide some barriers to adoption • Budgetary approval may delay adoption efforts	• Take-up should be relatively quick once professionals are trained • Easily scalable	• Reorganisation of organisational processes may delay adoption efforts • Adoption may take some time due to training and institutionalisation of cloud-based work processes • Relatively easy to scale
Strengths			
Practical aspects:	Practical aspects: • Nimble and quick to deploy • Maps all terrestrial features	*Practical aspects:* • Reduces human intervention and therefore errors.	*Practical aspects:* • Provides more capability and security than what most

<table>
<tr><th>Smart Sketchmaps</th><th>UAV</th><th>Automated Feature Extraction</th><th>Geocloud Services</th></tr>
<tr><td>• Flexible and adaptable to field conditions and community preferences for data production
• Rich data output suited for a range of cadastral and non-cadastral purposes
Strategic aspects:
• Enables county governments to meet policy requirements for community participation.
• Improves transparency in a land system dogged with fraud and corruption</td><td>• Produces high quality digital, georeferenced aerial imagery
Strategic aspects:
• Recognisable and understood by the survey profession and likely to be supported by the Institute of Surveyors of Kenya
• A totemic technology signifying contemporary surveying methods, creating legitimacy for adoption</td><td>• Code can be further developed for country specific conditions
Strategic aspects:
• Automated image interpretation may improve transparency in cadastral processes</td><td>government offices may currently have on the desktop
• Opportunity to integrate different government data sources using the cadastral fabric
Strategic aspects:
• Immediacy of the platform offers a potential solution to Kenya’s need for a NLIS.</td></tr>
<tr><td colspan="4">Weaknesses</td></tr>
<tr><td>• Requires intensive stakeholder engagement and training
• Requires strong local leadership
• Local communities may never have the capacity (physical or technological) to access post-processed sketched data. This may result in disincentivised participation</td><td>• Large counties like Kajiado will only be able to use UAVs for very site-specific applications.
• Terrain in Kenya can be fairly homogenous (with boundaries that are not physically demarcated</td><td>• Requires a certain skill level in geodata processing.
• ArcGIS is the dominant GIS platform in use in Kenya.
• Can only be used to process images with visible boundaries.
• Requires a source of raster images</td><td>• Requires a critical mass of digital data. Existing (undigitised) land records cannot be introduced into a geocloud service.
• Kenya’s internet connectivity is not reliable
• May require further investigation into compliance with Kenya’s LADM profile</td></tr>
<tr><td colspan="4">Opportunities</td></tr>
<tr><td>• Can map any feature of local significance to provide an</td><td>• Potential to use UAV data to create 3D models.</td><td>• May reduce the workload at county survey offices</td><td>• Offers Kenya a ready land information system – whether as a proxy or a sustainable solution</td></tr>
</table>

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
integrated document that is agreed on by the community. • Co-production of land information to overcome fiscal limitations of county governments. • Can be a source of information for future dispute resolution processes. Inexpensive avenue to provide counties like Kajiado with rich data sets for future planning and development purposes.	• Can be deployed for other purposes e.g. checking environmental impact. • Potential opportunities for governments and academic institutions to provide relevant training and/or certification programs.	• Potential opportunities for governments and academic institutions to provide relevant training	• Support for data sharing and integration will help overcome some of the information challenges of decentralised land governance • Offers a system capable of supporting implementation of Kenya's LADM profile when ready.
Threats			
• Lifecycle of the sketchmap is not yet clearly understood. • Interaction of sketchmap data with local government processes and systems is not yet clearly understood. • Due to high land fraud, IP and provenance of sketchmaps as a community document needs to be established and recognised by all stakeholders.	• Lack of a clear regulatory framework and practical guidelines for flying. • No clear training/certification avenue for UAV pilots. • Potential ethical/privacy infringements in UAV activity if poorly governed. • Not yet clear how UAVs will intersect with land data acquisition processes in a systematic way. • Not yet clear how many UAVs are required to be operationally	• Limited uptake in the short-term if plugin only available for QGIS.	• Requires a clear regulatory framework to cover processes and standards for data sharing horizontally and vertically • Kenya has approved KSH 4 billion for the development of a NLIS (estimated to cost up to KSH 10 billion). The geocloud has to be positioned to be complementary (i.e. interoperable) as resources will surely be prioritised for the NLIS.

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
	viable. The cost of multiple UAVs may be a disincentive, especially if large areas need to be flown. • Other mobile, georeferenced fit-for-purpose technologies being trialled by the Institute of Surveyors Kenya in collaboration with overseas and local organisations.		

Table 3.5 SWOT analysis of Kenyan conditions for its4land technologies by the research team.

4 Rwanda – country analysis

4.1 Summary of country setting and major land tenure issues

Rwanda is the most densely populated country in Africa (more than 470 per km^2) with a population still largely rural and reliant on subsistence farming (NISR, 2014; The World Bank Group, 2016). The majority of Rwandans own land under leasehold (freehold is issued to those who have developed their land as planned) following a country-wide land tenure regularisation (LTR) program which resulted in the demarcation of 10.3 million parcels. Awarding land titles has been shown to have led to improved economic outcomes; however, it has also led to increased incidences of intra-family conflict (Karuhanga, 2013). Geo-information derived from the LTR program has also enabled the development of a national cadastral map and the creation of a land information system (LAIS). Although Rwanda has a highly centralised system of government, there has been increasing trends towards decentralisation, especially over land matters, to deliver social and economic reform policies (Gillingham & Buckle, 2014).

Like Ethiopia and Kenya, Rwanda is still dependent on agriculture as a form of employment and subsistence – despite its limited land resources. However, population pressures are resulting in increasing land fragmentation, which in turn negatively affects agricultural production and has increased interpersonal conflict over land holdings (Pritchard, 2013). These trends are being exacerbated by urbanisation and tackling this development challenge has been recognised by the government as crucial to economic growth. A key strategy has been to focus on the development of Rwanda's six secondary cities to balance urban-regional growth. To achieve this, land use planning and relevant spatial development is key, but major challenges persist including limited capacity at lower levels of government, ineffective implementation of the land use Master Plan, weak national coordination of the urban system, and lack of coherent planning for housing and infrastructure of grouped settlement sites (Republic of Rwanda, 2012; MINECOFIN, 2013):

4.2 Land issues and land information needs

Rwanda was the first country where the fieldwork was conducted. At the time, there was not much emphasis[2] on gathering data on land issues from stakeholders. However, some issues that local cell officials raised whilst discussing their role in implementing the District Land Use Plans were: instances of informal building, out-of-date information on land use on titles (due to owners not yet engaging in any land related transactions), and the fact that some community members still do not have land titles since the LTR program concluded (e.g. due to lack of formal identification, family dispute issues, etc.). In addition, post-workshop feedback indicated that land use planning, implementation and monitoring remain challenges for Rwanda.

[2] Subsequent fieldwork in Kenya and Ethiopia paid more attention to actually collecting data on these issues.

4.2.1 Land information needs

Data was from workshops with national government and non-government stakeholders, district government and cell officials (six cells). Data collection focused on land information needs required to facilitate sustainable development objectives. Four key themes emerged from the coding process

- non-cadastral data
- data management
- cadastral data
- data analysis.

These themes, their respective sub-categories, and their relevance to each stakeholder group, are shown as a thematic map in Table 4.1. There was also a minor theme on stakeholder engagement.

Land information needs: themes and categories	NatGov	Nat_ NonGov	Dist_Gov	Cell_Gov	Strength of consensus*
Non-cadastral data	**5**	**4**	**5**	**2**	**30.2%**
Infrastructure	2	1	2	1	7
Development plans		1	1	1	5
Land use	1	1	1		3
Land use zone		1			1
Geology			1		1
Topographic data	1				1
Climate	1				1
Data management	**5**	**3**	**1**	**5**	**22.2%**
Data accessibility	1	2	1	4	8
Data maintenance	1	1		1	3
Data ownership/availability	2				2
Open source	1				1
Mobile tools			1		1
Cadastral data	**4**	**3**	**4**	**3**	**22.2%**
Spatial attributes	1		2	2	5
Accurate data	2	1	1		4
Other ownership evidence		1	1		2
Property attributes	1			1	2
Socio-economic attributes		1			1
Data analysis	**2**			**6**	**15.9%**
GIS software				3	4
Data integration	2			1	3
Digital data				3	3
Stakeholder engagement		**1**	**1**		**3.2%**
Consultation		1	1		2

**Strength of consensus for each dimension is calculated as the total number of code occurrences for the specific dimension as a percentage of the total number of codes recorded under the themes (n=63).*

Table 4.1 Distribution of key thematic land issues across Rwandan stakeholder groups.

The numbers indicate the frequency with which the code occurred in the data for each thematic category per stakeholder group. More than in the other two countries, the needs identified by Rwandan stakeholders were more consistently experienced across stakeholder groups.

4.2.1.1 Non-cadastral data

Perhaps reflecting the fairly recent status of developing a national cadastral dataset, non-cadastral data emerged as the land information need with the greatest consensus – around 30% of all codes. The descriptive categories within the theme are fairly self-explanatory:

- **Infrastructure** data, including both planned and existing infrastructure (Cell_Gov, Nat_NonGov), underground infrastructure (Dist_Gov), wireless infrastructure (Dist_Gov), and utility supply data (NatGov).
- **Development plans** here refer to both master plans and district land use plans.
- Existing **land use**
- **Land use zone** here refers to more detailed land use planning (e.g. sub-use) in the master plan (Nat_NonGov)
- And a range of physical datasets like **geology** (Dist_Gov), **topography** and **climate** (NatGov).

4.2.1.2 Data management

This theme emerged mainly from data derived from national government and cell-level government stakeholders. At the national level, data management needs are reflected in most of the dimensions, but for the cell-level government, their needs reflect the lack of ICT facilities at that level, which they feel are impeding service delivery. The key categories of needs for this theme are:

- **Data accessibility** mainly concerns the limitations of analogue data being used at the cell-level, and a desire for digital data particularly around development plans and land title information. In particular, cell-level officials emphasised the need for spatial datasets.
- **Data maintenance** land use on land titles not updated and does not reflect actual state (Cell_Gov); Consistent collection of high resolution aerial imagery (6 months) (NatGov); Maintained web-based Master Plans (Nat_NonGov)
- **Data ownership/availability** To know what spatial data is available and held by whom (i.e. metadata) especially information about tenure rights, restrictions and responsibilities (RRR) (NatGov)
- **Mobile tools** more mobile tools to support local data management (Dist_Gov)

4.2.1.3 Cadastral data

The lesser desire for cadastral data among Rwandan stakeholders is perhaps indicative of the fact that the LTR cadastral data is meeting most of their needs. Feedback from participants indicate that the accuracy of cadastral boundaries is currently being incrementally improved during the maintenance phase at the land registry (presumed to be between 1 mm to 5cm accuracy). Nonetheless, some aspects of improvement were identified, including:

- **Spatial attributes**, especially area (for residential and agricultural purposes) (Cell_Gov; NatGov), physical characteristics of land, and boundaries (Dist_Gov).

- **Accurate data,** particularly for spatial attributes (Dist_Gov, NatGov, Nat_NonGov), but it also reflected the need for a sustained pipeline of high resolution aerial imagery (NatGov).
- **Other ownership evidence**, for example all transactions made on a parcel (LocalGov) and history of land information to support conflict resolution (Nat_NonGov)
- **Property attributes** reflected the need for information about existing developments at parcel level to support land and property valuation (NatGov).
- **Socio-economic attributes** reflected data such as the value of land (Nat_NonGov).

4.2.1.4 Data analysis

This theme mainly emerged from the data collected from cell-level officials, many of whom currently only deal with analogue data. It is not a major theme, but an important one because of its consistency across all local government stakeholders. The main categories of needs under this theme are:

- The desire for **GIS software** mainly at cell level to support service delivery and interpret spatial datasets (Cell_Gov)
- **Data integration** as an analytical function, particularly the integration of cadastral data with other datasets. Examples provided were the integration of the land use map with the land information database (Cell_Gov); to match land parcels to administrative boundaries (NatGov); and to integrate utility supply data (network location) (NatGov)
- The dimension of **digital data** highlights the desire for more usable data. A common need identified was spatial datasets (shapefiles) pertaining to the master plan so there is less dependence on sector level if information is needed about a certain parcel. In addition, plans in digital formats are perceived to be easier to perform analysis and query functions.

4.2.1.5 Stakeholder engagement

This theme reflects the need to embed an active **consultation** process in procuring or developing information about land including the need to provide stakeholders with information (DistGov) and have a consultative process around land use planning (Nat_NonGov).

4.3 Meeting stakeholders' needs: which its4land technology?

In the workshops, stakeholders were asked to provide an opinion on which its4land technologies were best suited to meet their identified land information needs. Only two stakeholder groups could do this and Table 4.2 provides an overview of the distribution of 'yes' votes. One of the stakeholder groups (Dist_Gov) refrained from voting as they did not feel sufficiently familiar with the technologies to form an opinion. However after input from the research team and a discussion, the group felt that both UAVs and geocloud services held potential for meeting the needs. As reported in D2.4, the discussion focused on lack of access to information and on not being able to know every transaction pertaining to a plot of land.

Even though the number of 'yes' votes is not representative of the views of all stakeholders, the highly centralised governance structure in Rwanda suggests that the perspectives of national government stakeholders may carry more weight as they are likely to be the technology owners. Table 4.2 shows clear preferences for UAVs and geocloud services – indicating a need for high resolution terrestrial aerial imagery data capture (for both cadastral and non-cadastral purposes) and corresponding potential of processed data outputs, and a desire for greater land information sharing across government (horizontally and vertically) and to support data analysis.

	Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
Nat_Gov	2	7	1	6
Nat_NonGov	4	5	2	2
Dist_Gov		✓		✓
Total no. of 'yes' votes	**6**	**12**	**3**	**8**

Table 4.2 Distribution of yes votes across Rwandan stakeholder groups who voted.

Government stakeholders supported the potential of UAVs for meeting Rwanda's land information needs. In contrast, non-government stakeholders felt that smart sketchmaps was an innovative technology of greater potential primarily because it offered a mechanism for collecting other types of land information that requires community input. In addition, the tool employed a participatory approach to data acquisition, which was considered important for supporting transparency and facilitating stakeholder consultation.

4.4 What would it take to use these tools?

Stakeholders identified a range of readiness requirements likely needed to support the adoption and implementation of these tools: strategic, governance, organisational, technical and financial requirements. These are outlined and discussed below.

4.4.1 Strategic requirements

At a strategic level, the need for political will was seen as a requirement, especially for UAVs, as there was a perception that there should be a drive to get non-government organisations involved in flying UAVs to facilitate the development of a healthy market in service provisions (Nat_NonGov). This aligns with the lessons learned from Rwanda's land regularisation program (Gillingham & Buckle, 2014). Rwanda's system of public accountability also indicates the need for pilot studies for benefits, opportunities, and challenges of the technologies to be identified.

4.4.2 Governance requirements

Common governance requirements identified were legal and policy frameworks (including compliance, monitoring and evaluation) that needed to be developed both for the use of UAVs, but also in terms of regulating data access, sharing, privacy and security conditions for geocloud services. Stakeholders also identified the need to examine how other supporting policies such as consent and open data would impact (Nat_NonGov, NatGov, DistGov)[3]. There was also a perception that a collaborative framework will need to be developed to facilitate a network of government and non-government users to develop a market for UAV applications (Nat_NonGov).

4.4.3 Organisational requirements

Stakeholders identified the need for appropriate organisational leadership and awareness raising with decision-makers (Dist_Gov, NatGov) as well as relevant organisational frameworks to support the implementation of geocloud services, especially if it requires existing systems to be converted to open source. In addition, there was emphasis on the need for capacitated entities to implement new workflows (covering the whole workflow from acquisition to data use), in particular for UAVs (Nat_NonGov).

4.4.4 Technical requirements

Common technical requirements identified across all stakeholder groups included upskilling in GIS software, but also data procurement, processing and analysis skills relevant to UAVs and geoclouds. For UAVs, stakeholders also felt that it was important not only to develop new capacity, but to sustain this capacity by incentivising skilled human resources to remain on the task/job (Nat_NonGov). Within organisations, stakeholders identified the need for equipment procurement, staff training and provision of appropriate ICT and organisational infrastructure to support adoption and use of technologies (Dist_Gov). Professional training was also identified for land surveyors (Dist_Gov).

4.4.5 Financial requirements

There was consensus for financial resources to support the implementation of the technologies.

4.5 Sustaining the technologies: market opportunities

In the context of those its4land technologies deemed to have greatest potential to meet Rwanda's needs, the stakeholders identified the following market opportunities:

- **UAVs:**
    - For the public sector, opportunities associated with improved decision-making (e.g. more effective decision-making and policy implementation, monitoring and reporting) were identified, as well as defence applications. Consequently, this would likely stimulate economic opportunities associated with increased efficiency, better service delivery and the creation of specialised employment.

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[3] The workshops took place in January 2017, while the Data Revolution Policy, which the Ministry of Youth and ICT had elaborated in 2016, was still under review in Cabinet. The Data Revolution Policy was approved by the Cabinet in April 2017 and Rwanda's National Institute of Statistics (NISR) was named as the implementing body. This important Cabinet decision however was not publicised widely and many stakeholders are still are not aware of it as we submit this report.

  - For the private sector, opportunities were mainly economic: value-added services could lead to larger markets, consultancies and specialised employment.
  - For academia, perceived opportunities lay with generating new knowledge and research programs, consultancies and delivery of training/teaching to build capacities in the use of the new technology(s).
- **Geocloud services:** For the public sector, similar decision-making opportunities to the UAVs were identified stemming from integrating existing systems, more accurate data and the potential to accommodate crowd-sourced data. This in turn led to suggestions of economic benefits related to reduced data duplication and data sharing.
- **Smart sketchmaps:** Opportunities associated with smart sketchmaps were again around policy implementation, but mainly to facilitate community engagement.

4.6 Discussion and recommendations

The research has revealed a real desire to build on the country-wide cadastral map produced by the land tenure regularisation program and to shift the focus from land use to land development (although spatial accuracy of boundaries remains an issue). The mindset is now one of a multi-purpose cadastre, integrating cadastral data with other land and land-related information as seen in the prioritisation of non-cadastral data. This integration is also perceived to be vital for more efficient service delivery at all levels of government. These perspectives carry through to the various types of market opportunities identified where the ability to more effectively implement policies and deliver services to citizens not only potentially leads to a range of economic benefits, but could arguably reinforce the legitimacy of the government and its development agenda to realise sustainable urbanisation.

To use the technologies, national government and non-government stakeholders perceived the biggest gap in readiness to be an enabling environment. However, sub-national governments were more focused on skill development. The workshops with national government stakeholders also indicated clear support for pilots of the its4land technologies to be undertaken with relevant organisations including the Rwanda Natural Resources Authority (now known as the Rwanda land Management and Use), the Ministry of Infrastructure, Rwanda Housing Authority, Rwanda Development Board and the National Agricultural Export Development Board. Based on the findings, recommendations for the other work packages are provided below.

4.6.1 WP3: Smart sketchmaps

Perspectives on the applicability of smart sketchmaps vary. Central government stakeholders perceived fewer applications for this technology than non-government and local government participants. Realistically, there is good potential for this tool in Rwanda to support non-cadastral data requirements: the sketching component is familiar to community, can be operationalised by cell-level officers, and can improve community input into development plans. Rwanda’s higher level of maturity in terms of information systems at the central government level also suggests that the smart sketchmap data could be readily integrated with the cadastral fabric.

4.6.2 WP4: UAVs

On paper, Rwanda should have the greatest potential for trialling the UAVs. It has approved legislation, and there was broad consensus around the potential of UAV technology in Rwanda: primarily, small plot sizes (which need higher accuracy data) and the hilly terrain are conditions that bode well for UAVs. However, in Musanze, volcanic terrain and unsealed roads will make it difficult for the project's UAVs to be landed safely. Timing of the flights will also be crucial (e.g. before crops get too tall) for detecting on-ground boundary markers (e.g. umuyenzi hedges, fences, paths, etc.). There are several central government agencies keen to support a pilot of UAV technology – this should be leveraged for WP4 activities.

4.6.3 WP5: AFE

This technology did not rate highly with Rwandan stakeholders, likely due to the fact that the country has a digital cadastral database. Nonetheless, it would be interesting for WP5 to work with the relevant central government agency to see if the tool could augment their cadastral data maintenance, or use UAV flight data from Rwanda to fine-tune boundary detection for small rural plots.

4.6.4 WP6: Geocloud services

Rwandan stakeholders were interested in geocloud services. Mainly this was due to their perspective that migrating to open source technologies will deliver cost savings. However, this is likely to be an over-simplistic assumption and realisation of these cost savings which are expected over the long term, and only if the system is established well. Practical challenges exist for adopting an open-source based geocloud service including existing use of proprietary software, which will require a wide-scale migration. There is hardly any local support for open source technologies, and GIS skills, particularly at local government levels, also tends to be low. Geocloud services may be easier to use in a streamlined mobile app version (which is also the format desired by these stakeholders). This is a development recommendation for WP6.

4.6.5 WP7: Governance and capacity modelling

Rwanda has a strong centralised government, although efforts are being made to devolve tasks to local government. It is likely that the owner and/or implementer of any of the its4land technologies is likely to be a central government agency. Governance modelling will have to take into consideration vertical and horizontal relationships, with initial modelling perhaps focusing on the five central agencies interested in the project, and the local sectors interviewed in Musanze. There are significant capacity issues at local levels both in terms of human skills and technical infrastructure. For example, many local cell offices do not have internet connectivity.

4.6.6 WP8: Business modelling

On paper, Rwanda appears a good candidate for establishing a market around commercial use of UAVs for land information recording, especially since mandatory legal frameworks and regulations are in place. However, the project's practical experience is that this has not provided an advantage to technology implementation, and this enabling environment is in fact being undermined by frontline staff yet to be adequately capacitated to implement the policies. In addition, as non-government stakeholders have indicated, the development of a commercial market around UAV technology and applications will be predicated on incentivising private sector participation and not permitting the market to become a government monopoly. Longer-term sustainability of the market will also depend on a capacitated bureaucracy, particularly at transactional levels. Rwanda's higher maturity in existing data and land information systems also indicates it will be in a better position to exploit the data outputs from the its4land technologies to improve data sharing and reuse. This is supported by a recently developed open data policy (see footnote 3). Richer and more up-to-date datasets are likely to support the country's objectives towards economic transformation and growth.

4.6.7 Summary analysis of innovation outlook

Based on the empirical data, the research team has provided an overall summary assessment of the innovation outlook for each of the its4land technologies in Rwanda. This is described in Table 4.3 and seeks to provide recommendations around the likely technology owner, indicative costs, potential ease of adoption, and strengths, weaknesses and opportunities of each of the technologies relative to the country setting and identified issues.

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
Likely technology owner			
Central government, but implemented by lower levels of government including cell officials.	Central government	Central government and district/sector level government offices.	Central government
Likely costs			
• Low start-up and ongoing costs that may be accommodated in current budgets	• Fairly significant start-up costs and ongoing costs. • Will likely require budgetary approval	• Low start-up and ongoing costs that may be accommodated in current budgets	• Medium to high start-up costs (depending on state of ICT infrastructure) • Likely to have ongoing costs that will need to be budgeted for annually • Will likely require budgetary approval
Ease of adoption			
• Take-up should be relatively quick once professionals are trained (conceptual and field) • Likely to be quickly implemented at cell levels, with data processing at sector levels	• Requires trained personnel immediately – technology transfer may take a while. • Requires personnel with a drone pilot license. • Highly centralised system of government can ease technology transfer • Budgetary approval may delay adoption efforts	• Take-up should be relatively quick once professionals are trained • Scaling at lower levels of government will require training	• Reorganisation of organisational processes and migration of data may delay adoption efforts • Lower levels of government will need appropriate ICT infrastructure and internet connectivity to access cloud services

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
Strengths			
Practical aspects: • Flexible and adaptable to field conditions and community preferences for data production • Rich data output well suited to Rwanda's needs for improving land use planning and for spatial development *Strategic aspects:* • Enables district governments to meet policy requirements for community participation.	Practical aspects: • Nimble and quick to deploy • Maps all visible terrestrial features • Produces high quality digital, georeferenced aerial imagery • Suited to map Rwanda's hilly terrain and able to produce 3D models if needed *Strategic aspects:* • Small plot sizes in Rwanda demands high accuracy boundary information that UAVs can deliver	*Practical aspects:* • Reduces human intervention and therefore errors. • Code can be further developed for country specific conditions *Strategic aspects:* • Automated image interpretation may improve transparency in cadastral processes	*Practical aspects:* • Provides more capability and security than what most government offices may currently have on the desktop • Opportunity to integrate different government data sources using the cadastral fabric *Strategic aspects:* • Can facilitate whole-of-government data sharing
Weaknesses			
• Requires intensive stakeholder engagement and training • Requires strong local leadership • Local communities may never have the capacity (physical or technological) to access post-processed 'smart' data. This may result in disincentivised participation	• Potentially long pre-innovation process due to regulatory requirements	• Requires a certain skill level in geodata processing. • ArcGIS is the dominant GIS platform. • Can only be used to process images with visible boundaries. • Requires a source of raster images	• Migration of whole organisational systems may pose a cultural and/or technical challenge. • Local organisations may not have required skills and capacity to maintain an open-source geocloud-system

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
Opportunities			
• Inexpensive avenue to provide local governments with rich data sets for planning and development purposes • Co-production of land information to overcome fiscal limitations of local governments. • Can be a source of information for dispute resolution • Communities are familiar with sketchmapping as a data acquisition process	• Potential to use UAV data to create 3D models. • Can be deployed for other purposes e.g. post-disaster. • Potential opportunities for governments and academic institutions to provide relevant training and/or certification programs.	• Potential opportunities for governments and academic institutions to provide relevant training	• Offers cell offices a way to access and engage with land-related datasets to improve their capacity and knowledge
Threats			
• Lifecycle of the sketchmap is not yet clearly understood. • Interaction of sketchmap data with local government processes and systems is not yet clearly understood.	• Lack of a clear regulatory framework and practical guidelines for flying. • No clear training/certification avenue for UAV pilots.	• Limited uptake in the short-term if plugin only available for QGIS.	• Requires the implementation and substantiation of the approved Data Revolution Policy and application to the technology • Path dependency[4] around existing systems may be too great to overcome.

[4] Within innovation studies, inertia to innovation has been expressed as path dependency. This concept is based on the assumption of positive returns, where initial processes become established as self-reinforcing due to perceived efficiencies (Arthur, 1989) Over time, this leads to organisations being locked into specific patterns of behaviour even though economic conditions inevitably change.

Smart Sketchmaps	UAV	Automated Feature Extraction	Geocloud Services
	• Potential ethical/privacy infringements if UAV activity if poorly governed. • Not yet clear how UAVs will intersect with land data acquisition processes in a systematic way. • Not yet clear how many UAVs are required to be operationally viable. The cost of multiple UAVs may be a disincentive, especially if large areas need to be flown.		

Table 4.3 Overall assessment of Rwandan conditions for its4land technologies by research team.

5 Cross-country analysis

5.1 Introduction

WP2 of the its4land project, 'Get Needs', sought to capture the needs, readiness and market opportunities of the three East African case countries, Ethiopia, Kenya and Rwanda, as the foundational stage of a fit-for-purpose innovation process to support responsible land administration. Fit-for-purpose geospatial innovation has become the latest catch-cry in the land administration sector: a concerted effort to think laterally to overcome the limitations of a small professional pipeline of trained surveyors, as well as the strictures of rigorous methods for producing land tenure information that are slow and expensive, since many countries simply cannot afford to wait. Responsible land administration makes a conscious and concerted effort to not only comply with legal, technical and administrative requirements, but also societal needs and demands (Zevenbergen, De Vries, & Bennett, 2015).

Initially, the project targeted specific tenure information needs of each country: peri-urban land in Ethiopia, pastoral lands in Kenya and cadastral map updating in Rwanda. However in exploratory site visits and preliminary conversations, as well as a review of country policy documents, it became clear that all these issues were inherently linked to, or were being compounded by, the challenges of rapid urbanisation. Localisation of field work in each of the case study countries – Robit Bata and Yibab Kebeles in Ethiopia, Kajiado County in Kenya, and Musanze city in Rwanda – provided context and insight into the political and social conditions that will influence technological innovation pathways. During the span of one year, 104 organisations across government, private sector, third sector and academia were contacted across the three countries, of which 57 participated in a series of national and regional workshops for data collection purposes. More importantly, the researchers were able to engage in conversations with communities at the various location sites. Data collection and stakeholder engagement was undertaken in close collaboration with the African partners and employed a mix of methods in the field.

In the preceding sections of this report, individual country analyses have been provided that drew together each country's stakeholders' perspectives on land tenure information needs and the potential for its4land technology(s) to meet these needs; readiness requirements to adopt these technologies (albeit in a hypothetical, aspirational sense); and potential market opportunities for sustaining the technologies. In this section, an interpretive approach is taken to distil the key learnings from the three countries to contribute regional insights on land tenure information needs in the context of sustainable urbanisation, but also a generalised hypothesis around fit-for-purpose geospatial innovation for responsible land administration.

5.2 Supporting sustainable urbanisation: land information needs

Ethiopia, Kenya and Rwanda are similar in their development status, their dependence on agriculture for economic health, and their shared experience of land as the central source of power struggles and ensuing conflict. But they also represent a set of interesting contrasts: land scarce Rwanda vs. the vastness of Ethiopia and Kenya; Rwanda and

Kenya's history of colonisation vs. Ethiopia's absence of a colonial past; a highly centralised government in Rwanda vs. Ethiopia and Kenya's federated structures; cultural homogeneity in Rwanda vs. cultural and ethnic diversity in Ethiopia and Kenya.

These differences have coloured their experience of land issues, land reform and urbanisation challenges, resulting in differing levels of maturity in land information needs. Both Rwanda and Ethiopia have recently undergone large-scale land registration programs, delivering titles to people and data to government. Yet Ethiopia's stakeholders indicate that they still have a pressing need for cadastral data, while Rwanda's challenge is in leveraging its cadastral data capital and focusing on combining cadastral data with other development related datasets. The data from Kenya reflects a country still grappling with fundamental cadastral data needs while also recognising the need to simultaneously improve other territorial datasets for development purposes. Table 5.1 provides a comparison of land information needs across the three countries (with the original strength of consensus scores provided in parentheses).

Pref.	Ethiopia	Kenya	Rwanda
Data input needs			
1	**Cadastral data (63%)** (Spatial attributes; socio-economic attributes; tenure type/RRRs; other ownership evidence; property attributes; accurate data; geodetic control points)	**Cadastral data (42%)** (Accurate data; tenure type/RRRs; spatial attributes; other ownership evidence)	**Non-cadastral data (30.2%)** (Infrastructure; development plans; land use; land use zone; geology; topographic data; climate)
2	**Non-cadastral data (19.5%)** (Land use zone; land use; administrative boundaries)	**Non-cadastral data (28.4%)** (Land use zone; natural resources; infrastructure; cultural sites; land injustices)	**Cadastral data (22.2%)** (Spatial attributes; accurate data; other ownership evidence; property attributes; socio-economic attributes)
3		**Stakeholder engagement (2.7%)** (Legal aspects; women's land rights)	**Stakeholder engagement (3.2%)** (Consultation)
Data use and management			
1	**Data management (10.9%)** (data maintenance; data security; LIS)	**Data analysis (10.8%)** (Data integration; analytical functions; digital data; multipurpose use)	**Data management (22.2%)** (Data accessibility; data maintenance; data ownership/availability; open source; mobile tools)
2		**Land transactions (5.4%)** (Dispute resolution; affordability)	**Data analysis (15.9%)** (GIS software; data integration; digital data)

Table 5.1 Overview of land information needs across Ethiopia, Kenya and Rwanda.

5.2.1.1 Data input

In terms of meeting needs on data inputs, stakeholders across all three countries clearly recognise that contending with the challenges of sustainable urbanisation requires multi-faceted information about land. Stakeholders are increasingly thinking of the data acquisition process as a holistic one, evidenced by the range of cadastral and non-cadastral data identified. Requirements are very similar: cadastral data requirements are in many ways defined by regulation, so consistency is expected. Common dimensions under the theme of cadastral data needs include spatial attributes, tenure types and associated rights, restrictions and responsibilities (RRRs), and other ownership evidence. There are also similarities around non-cadastral data, especially in prioritising existing land use, determining appropriate future land use zones and data about existing infrastructure.

However, there are also some differences. In Ethiopia, priority is given to an array of cadastral data, including property attributes, but there is recognition that surveying infrastructure (i.e. geodetic control points) to enable the production of georeferenced data is also needed. For Kenya, cadastral data needs are still focused on fundamental requirements, but its long history of distributional inequities over land resources, and the strong customary character of its lands, means that data that supports the documentation and recording of sites with cultural value and historical land injustices are also a priority. In Rwanda, the focus is on spatial development and following its successful land tenure regularisation program, non-cadastral data is now more urgently required. Rwandan stakeholders were also the only group to have some consensus on the need for stakeholder engagement to facilitate the quality of data input.

5.2.1.2 Data use and management

All three countries identified needs around data use and management. Ethiopia's concerns were on data management, while Kenya's concerns were focused on data analysis. Rwanda was the only country that identified needs pertaining to both data analysis and data management.

5.2.2 Potential scenarios for using its4land technologies

The suite of its4land technologies represent a range of technological functions that could address land tenure information needs in terms of data input, and data use and management:

- Data input: smart sketchmaps (sketching process and algoritm), UAVs, automated feature extraction, smart sketchmaps (algorithm)
- Data use and management: geocloud services.

Table 5.2 indicates the general preferences for the its4land tools across the three countries. A comparison and discussion of the potential applicability of the tools relative to their proposed functionality is offered below.

Preference	Ethiopia	Kenya	Rwanda
1	Geocloud services	UAVs	UAVs
2	Smart sketchmaps	Automated feature extraction	Geocloud services
3	UAVs	Geocloud services	Smart sketchmaps
4	Automated feature extraction	Smart sketchmaps	Automated feature extraction

Table 5.2 Preferences for its4land tools across Ethiopia, Kenya and Rwanda.

5.2.2.1 Data input

a) UAVS

Across the three countries, UAVs emerged as the tool that stakeholders perceived to hold the most potential for meeting land information needs. The characteristics of the its4land UAV (at the time of purchase, one of the highest quality civilian-grade UAVs being manufactured) is provided in Appendix 1. At the time of purchase, the cost of each UAV was 40,000 euros but prices of UAV technology have been generally getting lower.

There are clear advantages of UAV technology for meeting land tenure data acquisition needs: it produces high accuracy aerial imagery, it can be deployed at any time, it can capture data over difficult terrain, and this explains the attraction it holds for stakeholders in all countries. However, significant barriers to implementation have also been consistently identified, such as the development of legislative, regulatory and policy frameworks – which may easily take several years to develop, draft, finalise and implement. Even when a country has legislation, such as Rwanda, the project's experience in getting the UAV operational has been stymied by customs regulations and implementation aspects of the UAV legislation, e.g. the non-existence of an authorising body for certifying UAV pilots. The project commenced at the start of 2016 – to date, the UAV still has not taken flight in Rwanda. Similarly in Kenya, where draft legislation for commercial applications of UAVs was approved this year, the its4land project has also experienced significant difficulties (and costs) in getting the UAV released from customs. In Ethiopia, the its4land UAV is similarly still to be released from customs and much resources have been spent negotiating regulatory processes around importation. There is also the general trend towards restricting the use of UAVs in Africa (Kuo, 2017) – a trend which needs to be observed with caution.

Even if a country has enabling conditions, for UAV data to be used for cadastral purposes requires post-processing of the imagery, which in turn requires skills and appropriate ICT infrastructures that may not have yet been established. In addition, there are significant cost implications around equipment, training and maintenance. Against these settings, while UAVs might offer the greatest potential for meeting land information needs, it is uncertain that this will be a reality anytime in the near future due primarily to institutional (regulatory, normative and cultural) challenges.

b) Smart sketchmaps

Sketchmapping, as a process, was acknowledged by stakeholders as a useful method for data acquisition. This is most strongly represented in the views of Ethiopian and Rwandan stakeholders, likely due to the fact that both countries' land certification processes were predicated on variations of this methodology. In turn, this also indicates an existing body of para-surveyors that could potentially be leveraged to operationalise this tool. Importantly, communities' familiarity with the methodology will facilitate its acceptance and hence, participation. It was therefore interesting to note Kenya's low perception of sketchmapping in meeting their land information needs. Conceptually, smart sketchmaps as a land tenure recording tool offers a participatory and/or consensus-based approach for collecting community land tenure information – well-adapted for addressing issues such as boundary conflicts, and collecting data on social aspects of land such as land injustices.

Smart sketchmaps as a tool offers some clear advantages, primarily in requiring low resources (financial and technical) and without needing regulatory intervention. However, it was disadvantaged by the fact that it was a concept that was often difficult for stakeholders to grasp (participants were shown a short video demonstrating the tool), with semantic-based queries also not (yet) a familiar function. This led most to focus only on the sketchmapping component, with few considering the 'smart' component in terms of processed data outputs (digital objects, qualitative data, etc.), and even fewer thought further as to how these data outputs could be incorporated and/or added to existing data. Familiarity with sketchmapping as a process also poses a challenge: how is smart sketchmapping different from processes previously undertaken? One can see evidence of uncertainty amongst the Ethiopian communities who participated in the research: the sketchmapping process has already delivered first-level certification and to them, there was no clarity as to what another sketchmapping process might deliver as a tangible outcome. The challenge in implementing the technology is therefore likely to come from understanding how to use the data in a systematic way and to integrate with more traditional data sources, and to prove its value to communities.

Automated feature extraction (AFE), as a concept, faced similar challenges to smart sketchmaps in terms of stakeholder understanding of how it might be operationalised as a land information tool. However, instead of a video, images were used to communicate the concept of the AFE tool. Countries like Kenya and Rwanda, who have an active private land surveying profession, were better at understanding the concept, and this is reflected in automated feature extraction ranking higher on their list of preferences. In Ethiopia, where a private land surveying profession is almost non-existent, and first-level certification produced only a legal cadastre (without spatial data), it was more difficult for stakeholders to consider the application of the tool. From a research perspective, given that each Woreda has some staff dedicated to digitising land records, there is a potential that this tool could reduce workload and improve digitisation outcomes.

5.2.2.2 Data use and data management: geocloud services

There was broad consensus across the three countries that data analysis and data management functionalities could be improved through the adoption of geocloud services. Some of the common technical challenges expressed is the need for a cloud service to be accessible on mobile devices to support local levels of government, a need for a critical mass of digital data (which exists in varying degrees of quantity and quality across the countries). Another challenge that is inherent in a geocloud platform, but one that was not mentioned, is the need for an entirely different set of ICT skills than the ones found amongst today's desktop GIS users[5]. This skills gap is exacerbated in both Rwanda and Kenya by the fact that desktop GIS users are not using open source GIS but rather proprietary GIS software such as ArcGIS; in addition, they rely on the local Esri offices for technical support and training.

5.3 Enabling conditions: a generalised perspective

In terms of enabling conditions to support adoption and use of the its4land technologies, there was a high degree of similarity in readiness requirements identified. An overview of these requirements are presented in Table 5.3 and have been covered in detail in the earlier sections of the report.

The common aspects of readiness requirements appeared to touch on the following four aspects:

- **Strategic requirements** such as political will and leadership was a common requirement identified and supported by most stakeholders, but Ethiopian stakeholders in particular were explicit about being cognisant and sensitive to the political economy around land and land information.
- **Structural/governance requirements** were mainly around the adoption of UAVs and geocloud services, which were considered to need legal/regulatory frameworks, and associated standards, guidelines and procedures. However, this could also be extrapolated to other factors in each of the countries particularly around the development of national spatial data infrastructures and open data policies (especially with regards to public sector information).
- **Organisational requirements** tended to be more specific but focused on making more explicit the link between technologies and existing and required organisational structures. These included leadership, tailored training for awareness raising and internal processes, but Rwandan stakeholders also stressed the need for skills and capacity at organisational levels, perceiving these to be key to operationalising the technologies (or risk embedding a disconnect between high-level strategies and lower-level implementation).
- **Technical requirements**, arguably also an aspect of organisational requirements, were fairly consistent and reflected the need for appropriate procurement of equipment (hardware and software), upgrading of physical infrastructure and technical training (mostly GIS).

[5] Cloud services require skills security, sustained operations, customization, to a certain degree software development, and - if the cloud has to be in-country - in server management.

Ethiopia	Kenya	Rwanda
5.3.1.1 Strategic requirements		
• Clear need and policy alignment • Exploit existing legal and operational frameworks • Start with less politicised land interests to reduce barriers to innovation • Need for a change champion		• Political will, especially for UAVs, • Get non-government organisations involved in flying UAVs to facilitate the development of a healthy market
Structural/Governance requirements		
• A technology owner(s) and commensurate responsibilities must be clearly defined • New standards and guidelines to govern consistency and use of the data outputs from the technologies • New workflows that align with federated structures and dual systems of tenure • UAVs will need a legislative and ethical use framework • Geocloud services will require a framework to enable stakeholders' coordination both within and external to government. • Data access, ownership, publishing, sharing and licensing rights will need to be defined.	• Clear legislation/regulations, policies, standards and guidelines, but especially the need for authorising agencies to support the use of UAVs.	• Legal and policy framework (including compliance, monitoring and evaluation) for the use of UAVs • Legal and policy framework for regulating data access, sharing, privacy and security conditions for geocloud services • Supporting policies such as consent and open data – varying levels of policy maturity across the countries • Develop a collaborative framework to facilitate a network of government and non-government users to develop a market for UAV applications
Organisational requirements		
• Assessment of needs, risk, benefits, challenges and additional resources (both people and technology). • Training and awareness raising, with tailoring of training content to meet different needs within the organisational hierarchy	• Needs assessments to understand how best to apply the adopted technology for resource allocation • Develop processes and procedures • Develop monitoring and evaluation processes.	• Need for appropriate organisational leadership Awareness raising with decision-makers • Develop organisational frameworks to support the implementation of geocloud services, especially if existing systems are to be converted to open source

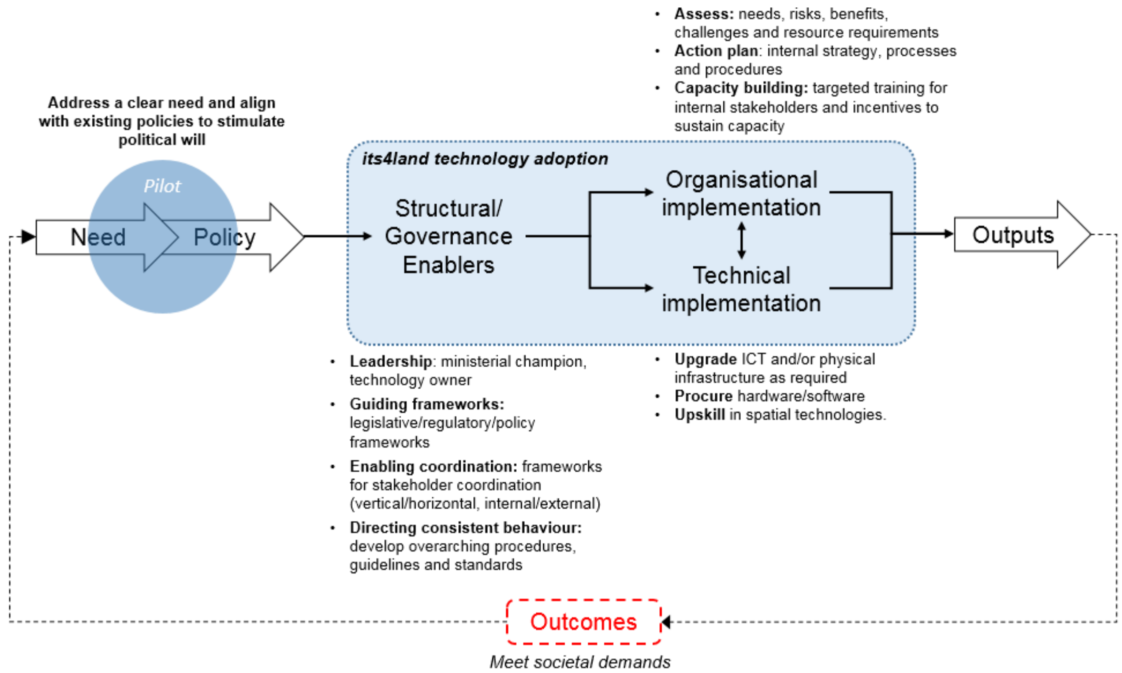
Ethiopia	Kenya	Rwanda
• Internal processes and procedures need to be developed	• Develop and deliver targeted training about the various technologies for policy makers, decision-makers, practitioners and end-users	• Need for capacitated entities to implement new workflows • Develop and sustain new capacity by incentivising skilled human resources to remain on the task/job
Technical requirements		
• Local customisation • Existing ICT infrastructure may need to be upgraded • Pilots undertaken to understand how the new technologies might integrate with existing tools and processes • Existing rural and urban land information systems will need to be updated, transformed and migrated to use geocloud services	• Acquire, develop and sustain physical infrastructure for the adopted technology(s).	• Upskilling in GIS software, but also data procurement, processing and analysis skills relevant to UAVs and geoclouds. • Need for equipment procurement, staff training and provision of appropriate ICT and organisational infrastructure to support adoption and use of technologies
Others		
• Develop appropriate university curriculum to augment the skillset of graduates to sustain the use of the technologies		• Financial resources to support the implementation of the technologies • Professional training for surveyors

Table 5.3 Comparison of readiness requirements identified by stakeholders across the three countries.

The consistency in the types of requirements identified, and the logic in how stakeholders framed these requirements, indicate the potential for generalising these outcomes into a change model, illustrated in Figure 5.1.

This model assumes a **pilot phase**, derived from stakeholders' consensus on the need for some practical proof-of-concept and defined value proposition to meet a country's land tenure need. From here, a **change strategy** can be developed that links the technology to a clear need and aligns with existing development policies, emphasised as important for stimulating the political will. Operationalisation of this change strategy to implement the its4land technology(s) includes **structural or governance enablement**, especially if the innovation requires new frameworks to direct and govern its use, as well as to embed new forms of collaboration or coordination amongst stakeholders (both within and external to government). At a more local level, **organisational implementation, including technical implementation,** attends to the practical aspects of innovation. These include internal resourcing for technologies and associated skills, new or integrated workflows and processes to accommodate new sources of data, and importantly, incentives to retain new capacities within the organisations, upgrading of existing facilities and infrastructure, technology procurement, and upskilling in geospatial data science. The technology should then produce outputs which will deliver outcomes that respond to users' needs.

Figure 5.1 Generalised change model of innovation readiness requirements.



5.4 Discussion

The its4land project is part of an emerging third generation of land tools aimed at delivering responsible land administration. This generation of tools continues to challenge conventional approaches to land tenure information recording, use and management by pursuing a fit-for-purpose approach to land administration that exploits opportunities offered by the increasing number of low-cost geospatial technologies.

However, it aims to do this in a way that is more conscious of the social and ethical implications of such innovation (de Vries, Bennett, & Zevenbergen, 2015). Inherent to this proposition is the need for awareness of societal demands and, for the its4land project, WP2 provides the main delivery mechanism for defining what this might be by capturing stakeholders' needs, readiness and market opportunities.

5.4.1 Societal demands for land administration and its4land technologies: key outcomes

In all three case study countries, land has been wielded as a political instrument of control and is at the heart of social and human rights discourse (e.g. gendered land rights, human development, housing, customary land rights, food security, etc.), positioned as the cornerstone of economic progress (dependence on agriculture), and fundamental to physical development and environmental sustainability (e.g. environmental degradation, spatial planning of peri-urban areas, etc.).

5.4.1.1 Ethiopia

In Ethiopia, land has been, and still is, a central to conflict, famine and poverty. Weak land governance persists, produced and reinforced by multiple legal reforms and the complexity this has introduced into institutional structures. Successive, large donor-funded projects have sought to improve land administration in the country, mostly through large scale land certification programs. However, promises in improved tenure security are being undermined by the de facto implications of an authoritarian model of state-ownership (rather than a socialist model of state administration) of land: conversations with local communities through the course of this research consistently conveyed the sentiment that tenure insecurity is the new 'normal' since the land is the government's and "they can do what they want". There is an array of other evidence that similarly indicates that the government is not delivering what people want or need: issues in housing supply, building development codes that inadvertently facilitate lateral expansion, expropriation and compensation, and to some extent, neither are the certification programs.

Communities in Ethiopia do not necessarily want further improvements in the actual data, but are more concerned with improving the integrity, transparency and equitability of land transaction processes. Nonetheless, government and non-government organisations overwhelmingly agree that improving cadastral data is a priority – not just conventional elements but also other types of evidence that enables unambiguous determination of land tenure rights. In light of these issues, it was surprising that stakeholders perceived geocloud services to offer the greatest potential in meeting their needs, followed by smart sketchmaps and UAV technology. Urban-rural differences in land governance, differing levels of maturity in land administration and land administration systems among regional governments all pose challenges for adoption and scaling. In addition, an explicit value-add proposition for the its4land technologies must be identified in order to compete with resources being directed towards other large land administration projects.

5.4.1.2 Kenya

In Kenya, registration of communally-held land is a priority as it is often subject to urban sprawl and human-wildlife conflict. WP2's foray into Kajiado, a county bordering

Nairobi and with a dominant Maasai culture, provided insight into why proper documentation of these lands are urgently required. Longstanding errors in cadastral data, maps at inappropriate scales, poorly designed trustee models of group ranches, and the demand for land near Nairobi, have all contributed to boundary conflicts, sale of land without family knowledge, and increasing numbers of private land owners. In turn, this has resulted in cultural disregard of communal land and animal husbandry practices, inappropriate development, and ensuing environmental impacts.

It was no surprise then that Kenyan stakeholders recognised the need for improved cadastral data, but also the importance of acquiring better quality non-cadastral data to achieve more sustainable development outcomes. Stakeholders therefore considered UAV technology to be of greatest potential, despite the vastness of the land. Kenya's emerging economy, digitisation of its land registries, and impending legislation on commercial use of UAVs all suggest the potential for a sustainable market for UAV technology in acquiring land tenure information. It also remains to be seen if the decentralised model of government would inhibit or enable technology scaling.

5.4.1.3 Rwanda

In Rwanda, scarce land resources and a dense population already exerts significant pressure on development. The desire to double Rwanda's urban population by 2020, and also to transform its economy, relies on devolving growth away from Kigali City to regional cities. This is turn requires planning of housing and infrastructure in secondary cities. In addition, land consolidation strategies are underway to improve agricultural productivity. In rural areas, there is a need to reconcile the various demands on limited land resources through land use allocation and management, and producing village/cell layout plans through a community-led process. Hence land use planning has become a significant mechanism for achieving these aims.

This is supported by the land information needs identified by stakeholders, who largely prioritised the need for non-cadastral data particularly around infrastructure (existing and planned), existing land use, land use zones, geology, topography and climate. Secondary to this was the need to improve data management capabilities as well as cadastral data elements. Therefore, UAV was the preferred technology especially among national level stakeholders, a technology also suited for data capture in Rwanda's hilly terrain. There was also significant support for geocloud services, but significant practical challenges exist for migrating current systems based on proprietary software, to an open source technology-based platform. These challenges relate to governance (in light of the country's open data policy), technical and capacity (especially in terms of appropriate skills to maintain open-source systems) aspects.

5.4.1.4 Regional synthesis

The data conveys some clear themes around land information needs in the context of sustainable urbanisation, with a focus on cadastral data for Ethiopia and Kenya, and more on non-cadastral data for Rwanda. Ethiopia and Rwanda have also both indicated needs in data analysis and management, and to a lesser extent, Kenya. The countries agree that the UAV technology has significant potential for meeting land tenure recording needs, but most stakeholders are concerned about the lack of an enabling environment that this technology specifically requires including governance structures, procedural frameworks and a capacitated workforce (both administrative and technical).

The other technologies also have potential, but with greater variation. Smart sketchmaps have potential to meet demands for community participation and increased transparency, but this alludes to the sketching component; consideration of the application of the data outputs was limited. Automated feature extraction was considered to be useful in both Kenya and Ethiopia (to a lesser extent), but rated lower with Rwandan stakeholders due to the quality (and completeness) of their current digital cadastral database. Geoclouds services appealed to stakeholders as a platform for facilitating data sharing and management but implementation of the technology will depend on the ability to reconcile this with existing or soon-to-be-live systems in all countries. In addition, only Ethiopia has some experience with open-source geospatial technologies; the other countries are reliant on proprietary GIS software.

WP2 also provided some insight for the other aspects of the project in terms of governance, capacity and business modelling. Ethiopia and Kenya are both federated systems and implementation of the technology will need to take into consideration vertical relationships between the different levels of government and where authority sits, especially in terms of land issues. For example, in Ethiopia, land administration tends to be regionally driven. The broad base of local government units across the three countries who have a role in delivering land services will also need to be considered in terms of data flows and capacity for using the technologies. In Kenya, the situation is further challenged by longstanding issues around poor governance of land information. In Rwanda, a strong central authority perhaps provides some clarity in terms of technology ownership, but limited implementation capacity at lower bureaucratic several levels of administration may be an impediment to quick wins from innovation. Across the three countries, market opportunities were often difficult for stakeholders to project, but there was broad agreement on the fundamental role of good quality land information in public service delivery and revenue generation, and as input into secondary services such as insurance, foreign investment and loans.

5.4.2 The challenge of innovation

The findings of WP2 also reinforces the nature of technological innovation as tending to be organisation-driven, pursuing objectives of effectiveness or efficiency. However, any innovation essentially represents a challenge for prevailing (i.e. stable) social systems – hence the oft-quoted characteristic of innovation as being ‘disruptive’. This is certainly reflected in the range of social aspects raised by stakeholders in terms of readiness requirements. Social systems prevail because they are accepted and regarded as authoritative: they are perceived to be effective at structuring and organising human and technological behaviour and interactions to ease transactions between individuals, groups and organisations (Friedland & Alford, 1991; Ostrom, 2005; Williamson, 1998). Such systems, particularly when speaking about organisations, are usually composed of regulatory, normative and cultural/cognitive elements (Scott, 2014).

The data collected in WP2 indicate that aspects of social systems of greatest interest in the initial innovation process – and hence the likely points on which failure and success are pivoted – are regulatory and normative elements (Scott, 2014):

- **regulatory elements** are associated with legislation, regulation and sanctions, and its purpose is to provide a conscious system for controlling behaviour through coercive pressure
- **normative elements** are less conscious elements where behaviour and action is influenced and perpetuated by prevailing social patterns such as values, norms and social or professional mores such that the basis for controlling behaviour is through the desire of people to conform either consciously or unconsciously (path dependency).

The influence of regulatory elements will have greatest influence on the introduction and use of UAVs, and to a lesser extent, geocloud services. This has been clearly communicated through the consistent identification of regulatory barriers to UAV use, and the identification of organising frameworks to coordinate inter- and intra-organisational data flows around data sharing in a cloud-based platform. The fact that all three countries have only recently developed coherent national land policies can be advantageous: technological innovation could be clearly linked to meeting new policy objectives (e.g. documenting and registering community land in Kenya, meeting urban land tenure data requirements in Ethiopia). However, the need to develop new legislation to govern and regulate UAV technologies may be a barrier, especially since this will likely be developed by other non-land ministries (e.g. aviation, defence, etc.).

Two of our three countries (Kenya and Rwanda) actually have UAV legislation either passed or approved as draft legislation, yet the project has not been able to initiate any flights. This indicates the strength of normative elements as barriers to innovation: awareness and understanding is lacking about how to implement the legislation and so government staff fall back on risk-averse positions that result in bureaucratic hurdles. Insecurity and discomfort are known inhibitors to technology acceptance (Parasuraman, 2000). It is also possible that Africa's emerging tendency towards a conservative approach to commercial applications of UAV could have a negative impact on the successful adoption of UAV technology.

Normative elements at a system level also features strongly in the adoption of geocloud services. Despite the fact that Kenya has an Open Data Policy in place for some years already, and Rwanda just had its Data Revolution Policy approved by cabinet, the many comments received identified the lack of data sharing frameworks and experiences suggest that even given these policies, data currently is not being shared. Apart from the apparently "remote" policy level, there seem to be little values, norms and expectations around data sharing which indicates that even surveyors and GIS professionals, let alone a wider public, may take considerable time to understand how to behave with such a system, potentially resulting in limited take-up of the technology. Similarly, technologies like smart sketchmaps while being somewhat familiar, have data outputs that stakeholders do not yet understand how to exploit. Importantly, this technology, more than the others, are predicated on establishing new collaborations with communities in a sustained way to co-produce land tenure information.

Yet both elements can also be leveraged as a strategy for change. Regulatory elements can obviously stimulate change through prescribing and enforcing new types of behaviour – if designed properly. The influence of regulatory elements as a change strategy could also be more effective in countries like Rwanda, where a strong centralised government authority can be directed to effect coercive pressure for implementing change. Normative elements can also play a role in creating change pathways. For example, studies have shown that optimism (a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives) and perceptions of innovativeness (tendency to be a technology pioneer and thought leader) about a technology are enabling conditions (Parasuraman & Colby, 2015: 60). This bodes well for UAVs, which are frequently positioned as being at the forefront of surveying technologies in professional media and we see recognition and awareness of this reflected in Kenyan stakeholders' (particularly those participants who are trained surveyors) enthusiasm for UAVs. For other technologies, for example like geocloud services, in the absence of a developed culture of use, change strategies will require identification of what types of behaviours are valuable and these will have to be developed, cultivated and institutionalised.

WP2 findings suggest that proving the its4land technologies offers functional and economic advantages over existing methods is required – but this is only addresses technical issues. Ultimately, as suggested by the Ethiopian stakeholders, the introduction and acceptance of these new technologies will likely be predicated on the innovator – whether the project or the country's technology owner – being able to position the value of the technology amongst existing values and systems of action that currently prescribes how land information is recorded, used and managed. This is not an easy task as it requires the innovation to be familiar to its intended users, but sufficiently different to set it apart as being novel.

5.5 Conclusion

Over the span of a year, engagement with the three case countries and almost 60 stakeholders and community groups across different stakeholder segments have provided a glimpse into the challenges of sustainable urbanisation confronting East Africa. The challenges experienced by these countries are not unique to their region, and indeed, to Africa. Although each country's experience varies, a consequence of their histories, geographies and culture, a shared experience is the need for good quality land tenure and land-related information to respond to urgent social and spatial development issues. The importance of spatial data is evident in ongoing second-level certification processes to add a spatial component to legal titles in Ethiopia, the prominence of boundary conflicts in Kenya, and the focus on land use planning and implementation in Rwanda.

The its4land technologies promise functionalities in data acquisition, processing, and management. The UAV technology is acknowledged as a potential tool for acquiring meeting cadastral and non-cadastral data needs but innovation potential looks set to be stymied by legal and bureaucratic challenges over the short to medium term. The utility of smart sketchmaps was recognised more for its participatory process of data production and its relatively low cost outlay. Unfortunately, there was limited recognition of how the 'smart' elements of smart sketchmaps could potentially contribute towards building richer data sets in all three countries to enable more sensitive decision-making around development. The potential of geocloud services for improving data use, management and security was acknowledged, but innovation remains contingent on an appropriate level of skills regarding open-source technologies, a culture of sharing data, and appropriate supporting policy frameworks. Automated feature extraction was considered to be useful in Kenya and Ethiopia for supporting the establishment of digital cadastral data, but less so in Rwanda.

At this initial phase of the innovation journey, there is consensus that there are land tenure information needs that these technologies can conceptually meet. The challenge of innovation now lies in further contextualisation and customisation through pilot studies. In addition, the its4land technologies face competition for resources in each of the countries: donor-funded certification and a rural land information system in Ethiopia, other fit-for-purpose technology testing in Kenya, and a reliance on proprietary GIS systems in Rwanda. In all countries, innovation will also likely disrupt existing workflows and processes; it is incumbent upon the project to clarify the innovation proposition.

From WP2 findings, it is also apparent that the project is not just delivering technological innovation, it is ultimately seeking to deliver social innovation[6]. The realisation of both types of innovation will be predicated on fostering a favourable legal, economic and social ecosystem to facilitate the use of these technologies and in particular, the outcomes of WPs 7 and 8 will be key. This may stem from public sector organisations, but trends in other fit-for-purpose technologies also indicate new forms of government-civil society collaboration will need to be fostered and embedded to exploit these technologies to improve information about land and facilitate the sharing of knowledge. This will enable the delivery of responsible land administration to realise sustainable urbanisation objectives.

[6] Social innovations are new ideas that seek to meet social needs and create new social relationships or collaborations (European Commission Enterprise and Industry, 2010: 9).

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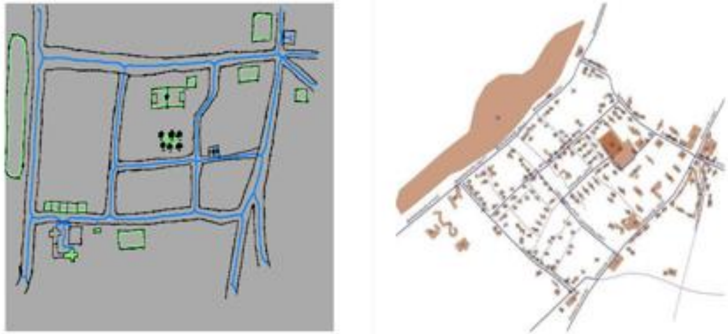
7 Appendix 1. its4land technology overview for stakeholders

	'Smart' Sketchmaps	Unmanned Aerial Vehicles (UAVs)	Automated Feature Extraction	Geocloud
What?	Sketching (by digital pen/pen and paper) to record land resources and land-user relationships using geographic features, which are then digitised and connected to base topographic maps.	Remote aerial imagery collection using small UAVs	Image interpretation tool that automatically extracts visual cadastral boundaries from a range of data sources (e.g. UAV data, sketchmaps, existing maps)	Access and dissemination of spatial data (sketchmaps, orthophotos, etc.) via cloud-based services.
Why?	• Community mapping approach for recording land resources and use as understood by the community. • Query system for users	• Small-scale data acquisition • High resolution data • Nimble	• Reusable and scalable • Increase speed • Lower costs • Improve repeatability and transparency of cadastral mapping	Secure data management, access and use
What will I get?	• Qualitative and spatial descriptions of land resource use • Digital sketch maps	High resolution ortho-images (2.5cm in X,Y; 5-10cm in Z)	Cadastral objects (visible boundaries)	Web-based platform
What IT resources are needed?	• Digital camera/scanner (12MB) • Digital pen and internet-connected device that works with pen • Licensed software for processing pen inputs • Device to submit/query sketch maps	• Licensed image processing software (e.g. Pix4D) • Laptop/PC	• Standard computing facilities • Open-source GIS software (e.g. QGIS)	• Standard computing facilities • Internet connection
What skills are needed?	• Basic GIS skills • Basic computer skills • Familiarity with the local context • Familiarity with query concepts • Familiarity with web maps	• Trained UAV pilots • UAV maintenance skills • Image processing skills	Knowledge and skills in the use of GIS software	Knowledge and skills in the use of GIS software
How much will it cost?	• Cost of digital pen • Cost of internet-connected device • Cost of digital camera • Cost of software	• Cost of UAV • Cost of software • Cost of flight training	Cost of ICT infrastructure	Cost of ICT infrastructure



Sketchmap that integrates with metric map.

Source: http://www.uni-muenster.de/Geoinformatics/en/sketchmapia/web-base-sketchmapia-framework.html

its4land UAV

Source: Twitter: @drone4land

Automatic extraction of cadastral boundaries from UAV image.

Source: Crommelinck, S., Bennett, R., Gerke, M,; Nex, F., Yang, M.Y., Vosselman, G. Review of Automatic Feature Extraction from High-Resolution Optical Sensor Data for UAV-Based Cadastral Mapping. Remote Sens. 2016, 8, 689.

Geocloud enabling web-based overlay of registry map onto aerial imagery.

Source: Expermap, Hansa Luftbild
(http://www.hansaluftbild.de/fileadmin/Dateien/PDF/Downloadcenter/Hansa_Luftbild_ExperMaps_EN.pdf)