BUILDING THIRD GENERATION LAND TOOLS:
ITS4LAND, SMART SKETCHMAPS, UAVS, AUTOMATIC FEATURE EXTRACTION, AND THE GEOCLOUD

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Abstract

A third generation of land tools is emerging: 'its4land' is part of the movement. The initiative aims to create seven new tools that further support faster, cheaper, easier, and more responsible land rights mapping. The tools are inspired by the continuum of land rights, fit-for-purpose land administration, and cadastral intelligence. The project is built around an ICT innovation process that incorporates a broad range of stakeholder groups with emergent geospatial technologies, including smart sketchmaps, UAVs, automated feature extraction, and geocloud services. By coupling the technologies, end-user needs and market forces, are better responded to. Backed by the European Commission, the work consists of a 4 year work plan, €3.9M in funding, and 8 consortium partners. The project is working with stakeholders from six case study locations in Ethiopia, Kenya, and Rwanda: tool development, prototyping, and demonstration is intended for local, national, regional, and international interest groups. The case locations include a mix of livelihoods and landscapes: urban, peri-urban, rural smallholder, and (former) pastoralist contexts are all included. This paper reports holistically on the first year of its4land activities: lessons from major achievements and barriers are outlined. Risks and future opportunities are also explored.

Key Words:

Innovation; Horizon2020; European Union; Land Tool; Eastern Africa

1. INTRODUCTION

Recent evidence shows many existing ICT-based approaches to land tenure recording do not deliver on expectations: recordation remains incomplete, disputes remain unresolved or exacerbated, both small and large-scale investment remains impeded or undermined, and the community's poorest are seen to regularly lose out. This applies to projects in many regions, including countries in sub Saharan Africa (Zevenbergen et al, 2013).

In response, and over the previous decade, momentum has built around alternative land tools. These seek to support the immense challenge of more rapidly and cheaply mapping millions of unrecognized land rights, the so-called 70%. The tools, many developed through the Global Land Tool Network (GLTN), have provided impetus for challenging conventional land administration design and project implementation. Several (e.g. STDM) demonstrate, in practical terms, what fit- for-purpose land administration can look like (UN-Habitat, 2012)

Building on these highly influential approaches – and aligning with the broader societal-pull and technologies-push forces – the next generation of land tools are quickly emerging. These are more firmly built upon responsibility, scalability – and the ability to transcend conventional institutions, technologies, and methods (de Vries et al, 2015).

The project - 'its4land' - forms part of this movement (EC, 2017). The work aims to create seven new tools that further support faster, cheaper, easier, and more responsible land rights mapping. The tools are inspired by the continuum of land rights, fit-for-purpose land administration, and cadastral intelligence. Specifically, the work combines an ICT innovation process – incorporating a broad range of stakeholder groups – with emergent geospatial technologies, including smart sketchmaps, UAVs, automated feature extraction, and geocloud services. The project seeks to enable tool combinations that are both end-user and market responsive. Importantly, the tools seek to support both formal land registration processes (top-down) and more informal community based land resource documentation (bottom-up). Creating a bridge between the two approaches is also an aim: cross over is important during transitions informal to formal land tenure systems.

This paper reports holistically on the first year of its4land activities: major achievements, findings, and obstacles are explored. Overviews of all work packages are provided, including 'Get Needs', 'Draw and

Make', 'Fly and Create', 'Automate It', 'Publish and Share', 'Govern and Grow' and 'Capitalize'. The case study locations across the three Eastern African countries, including both urban and rural contexts, are introduced and justified. Preliminary results in terms of spatial and social findings are presented. Technology selections and justifications are also covered – as is the overarching approach for coupling and decoupling the different tools. The challenge of maintaining the complex stakeholder network, ensuring adherence to complex webs of ethical and permit processes, and working in a transcontinental research environment are outlined. Conversely, the large-scale of the project offers the opportunity for technology partnerships, media linkages, and connection to other land sector initiatives.

2. BACKGROUND

its4land consists of a 4 year work plan, funding to the tune of €3.9M, and an 8 partner consortium. The project is a 'Research and Innovation Action' and is formally governed through the European Commission's Horizon 2020 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.

The project commenced in February 2016 and is being collaboratively implemented by partners from Belgium (KU Leuven), Ethiopia (Bahir Dar University), Germany (University of Muenster; Hansa Luftbild), Kenya (Technical University of Kenya) the Netherlands (University of Twente), and Rwanda (INES Ruhengeri; ESRI Rwanda). The consortium is working with stakeholders from six case study locations across Ethiopia, Kenya, and Rwanda. The work primarily consists of designing, prototyping, and demonstrating the tools to local, national, regional, and international stakeholders. The case locations include a mix of livelihoods and landscapes: urban, peri-urban, rural smallholder, and (former) pastoralist contexts are all included. Building from previous projects and long standing stakeholder relationships, the focus for the project is different in each case location. The work in Kenya (Kisumu and Kajiado) works on adapting tools to enable mapping of pastoralist land rights and layered disputes. In Rwanda (Musanze), the focus is on developing approaches that can support updating, at scale, land rights documents and maps. Meanwhile, in Ethiopia (Bahir Dar and Amhara Region), the interest is in developing approaches that improve plot recordation of both rural and urban smallholder and dwellers.

The project is also seeking to impact and provide benefits on several other fronts. It is reinforcing strategic collaboration between the EU and Eastern Africa: established local, national, and international partnerships are driving the project. In addition, and in alignment with next generation tools, the results are intended to illustrate how research projects can move beyond (R&D) into the commercial realm: scalability and transferability are therefore key focus points in each of the technical work packages. In this way, the project is also demonstrating how multi-sectorial, multi-national, and multidisciplinary design work can take place: the consortium includes SMEs and researchers from 3 EU countries and 3 East African countries. The transdisciplinary work also develops supportive models for governance, capacity development, and business capitalization. Gender sensitive analysis and design is also being incorporated.

In terms of implementation, three major project phases are hosting 9 work packages (including a dedicated ethics work package): these enable contextualization, design, and eventual land sector transformation activities. Phases 1 and 2 are currently in progress: in line with Living Labs thinking, localized pilots and demonstrations are being embedded into the design process. Independent to European Commission oversight, the project includes a dedicated Advisory Board, a Valorisation Panel, and communications and dissemination channels. The setup seeks to cover the depth and breadth of the land tool sector.

3. RWANDAN CASE

In the 2000s, Rwanda undertook significant policy and legal reform with regards to land. The aim was to regularize all existing lands under private, leasehold, and state tenures: customary tenures and informal arrangements would no longer carry legal recognition. The policies were generally seen as positive by the international land sector with regards to gender recognition, minority group recognition, and overall equality (Biraro, 2015a).

Part of the land reforms involved a nationwide adjudication, surveying, and recording program. Supported by international donors, around 12M parcels were mapped over a period of 4 years at a cost of around $8 per parcel. The Rwandan Natural Resources Authority (RNRA) is responsible for the maintenance of the land records, both the spatial and textual components. The establishment phase was considered a great success. In order to achieve such speeds and coverage, use was made of hardcopy aerial imagery, or high resolution satellite imagery (depending on availability). In each district, large

numbers of local inhabitants were employed by the project as para-surveyors, adjudicators, and recorders. Training in some cases only took a few days. Accuracy was sacrificed in the name of speed and cost: most boundaries were digitized within 1-5m of the 'true' position.

The specific challenge is that with establishment phase completed, attention has now turned to maintenance; whilst procedures for transaction processes are established, it is understood that many transactions may not be recorded in the new system, particularly in rural areas due to different obstacles within these processes (Biraro, 2015b). There are several issues at play: 1) all final recording must be done at the district level and the database managed centrally in Kigali: this might mean 3 hours walk for a rural dweller (Biraro, et al 2015a); 2) district land offices lack highly trained staff and ICT capacity meaning waiting times can be lengthy – even more than a day; 3) unlike the establishment program, higher fees now apply for transactions (although, other sources suggest changes to title information can still be performed free of charge in order to encourage updates): it is felt some land owners might not be willing to pay the fees; 4) surveying and mapping capacity is limited across the country: there are only a few surveying companies and public capacity to carry out surveys is limited to a few staff at the district level.

The challenge of land information updating has direct impact on spatial planning and urbanization strategies in Rwanda. Ho et al (2017) discuss this in terms of national policies for the realisaiton of six secondary cities and the Spatial Development Framework to support decision-making. In Musanze, up-to-date land information is needed to balance the demand for urbanization and expanded tourism- whilst preserving precious arable land. A district land use plan is established, however, its realisation is impeded by a range of factors – not the least being economic and administrative capacity. Ho et al (2017) claim:

> *"the almost absent ability to collect relevant land and property information at a certain frequency and scale"* impedes the ability *"to implement and enforce the district plan to achieve policy objectives around sustainable urbanisation. Where data does exist, current mechanisms and processes do not actively facilitate data integration with the cadastral map to support decision-making. The District needs to be able to do so in a manner that fits its current resource capacity. Such data is important not only as an updating mechanism and input into the land information system, but also missing also are general topological information, such as buildings, plots and visible infrastructure, etc., that is fundamental to planning and development. Likely ramifications at a local level are increasingly out-of-date cadastral data and the lack of a sound*

evidence base to develop subsequent district plans; at a national level, it is likely to impede the realisation of Vision 2020's objectives regarding sustainable urbanisation"

The challenge is to determine if and how geospatial tools might be used to improve the speed, cost and quality of land information updates in both urban and rural Rwanda.

4. KENYAN CASE

In Kenya, its4land's work is inspired by the efforts of Lengoiboni et al (2011), amongst others, who seek to understand and find solutions for better recognizing pastoralist land rights. Lengoiboni (2011) notes that pastoralism is a dominant land use in Kenyan rangelands (semi-arid and arid environments) that constitute 84% of the country's total land surface. The areas support about one third of the Kenyan population (±10 million people), account for more than 80% of the country's ecotourism, and 75% of the wildlife population. For pastoralists, home territories are linked to wet seasons whilst dry seasons entail movements of long distances (up to hundreds of kms) in search of water and grazing resources. The challenge is that the land pastoralist's pass through is increasingly privatized in the form of individualized parcels and group ranches. In statutory terms, pastoralists become trespassers, whereas in terms of legitimacy, they're exercising the customary land rights that are far more long standing.

The significant 2016/17 drought aside, a key problem can be seen as resulting from the process of formalization/privatization of land rights that overlooked the existence of 'customary right of movement across the land'. Spatial information about pastoralist's cattle tracks and migration corridors often remain as mental maps and undocumented. Their unavailability leads to this spatial information not being included in land information systems or in land use planning. The situation is worsening as land is continuously being surveyed, demarcated and allocated for private purposes. Social and economic welfare among pastoralists has declined as it depends on the freedom to access water and grazing areas.

The challenges for pastoralists in Kenya are the consequence of a confluence of colonial legacies that has embedded inequitable access to land, the conflict between modernisation and cultural preservation of indigenous peoples, the demand for land to meet the physical demands of urbanisation, and poor land governance systems that have resulted in poor quality land information – that perpetuates a lack of transparency. All of these have resulted in chronic land related conflict in the country. Many of these

issues are most pronounced in border towns adjacent to the capital city, Nairobi, and this investigation in particular focuses on Kajiado County.

The challenge is therefore to develop tools to record and raise awareness about specific customary land rights and holders, and include this information in local land information systems, so that it may contribute to better planning, inclusion and alleviating the problem resulting from depriving the pastoralists access to the daily and seasonal resources.

5. ETHIOPIAN CASE

In Ethiopia, the its4land project is working on challenges related to two different settings: peri-urban and rural landscapes. Each setting has its own problems and challenges in terms of land management.

On peri-urban areas, Bahir Dar is one of the fastest growing cities in Ethiopia. The growth is taking place in all directions, especially following highways and major roads. Where urban meets rural – peri-urban – an administrative vacuum is experienced. Unlike other countries, Ethiopia separates rural and urban land administration amongst different institutions: the boundary between landscapes is not always crisp and agreed upon. In these zones, higher levels of informality and non-statutory land occupation are evident. In response, urban authorities along with donors and other stakeholders are working to establish cadastres and land administration systems for urban contexts: combinations of tools, including imagery-based approaches (orthophotos), are being adopted. Emerging tools including UAVs and geocloud storage are seen as potential improvements to existing designs.

Regarding rural contexts, Robit Bata rural district (kebele[1]) – in close proximity to Bahir Dar (20km) - is focused upon. The area has a high level of land degradation and land fragmentation and these are considered to impede food production in the region. Land consolidation is seen as an alternate option for reducing poverty and enhancing land productivity, however, responsible land consolidation demands sound land records and participatory approaches (Bennett and Alemie, 2016). This type of land consolidation (i.e. responsible) is hardly explored in Ethiopia – and therefore the rural area presents the opportunity for providing local stakeholders with the basic ingredients – up-to-date imagery and tools for recording land data – that could later underpin any consolidation efforts.

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[1] Kebele is the lowest administrative unit in Ethiopia

6. GETTING NEEDS

Using the three case context outlines as a base, the first phase of the 'its4land' project focuses on contextualization and is operationalized entirely under Work Package 2 (WORK PACKAGE2). Specifically, the aims is to understand and identify the needs of stakeholders in the land sector and how the its4land suite of technologies might meet these needs. Stakeholders are defined as those who affect, or are affected by the land tenure information value system. The project distinguishes between *primary* and *secondary* stakeholders: the former are defined to be those who have a direct role in acquiring, recording, managing and distributing land tenure information; the latter, those who only re-use and/or add value to land tenure information to provide products and services. Stakeholders' needs are defined to be those practical information requirements and transaction processes necessary to support their individual/organizational aims relative to their position in the land tenure information value system. For the project, six main stakeholder group classes (and subclasses) are defined: public sector entities (land administration specific); public sector entities (adjacent policy domains or public organizations); non-statutory entities; private sector entities; NGOs/not-for-profit/donors and development partners; research and development. Key stakeholders for each country for each stakeholder group class have been identified both nationally and also in the context of the identified case study sites.

In addition to a needs assessment, WORK PACKAGE2 further seeks to analyse readiness in each country for adopting and using the identified its4land technology(s), as well as identify potential market opportunities associated with either the new technology, and/or more current data. To meet these three main objectives, WORK PACKAGE2 pursues four research questions, shown (in red text) in Figure 1, across the identified case study locations.
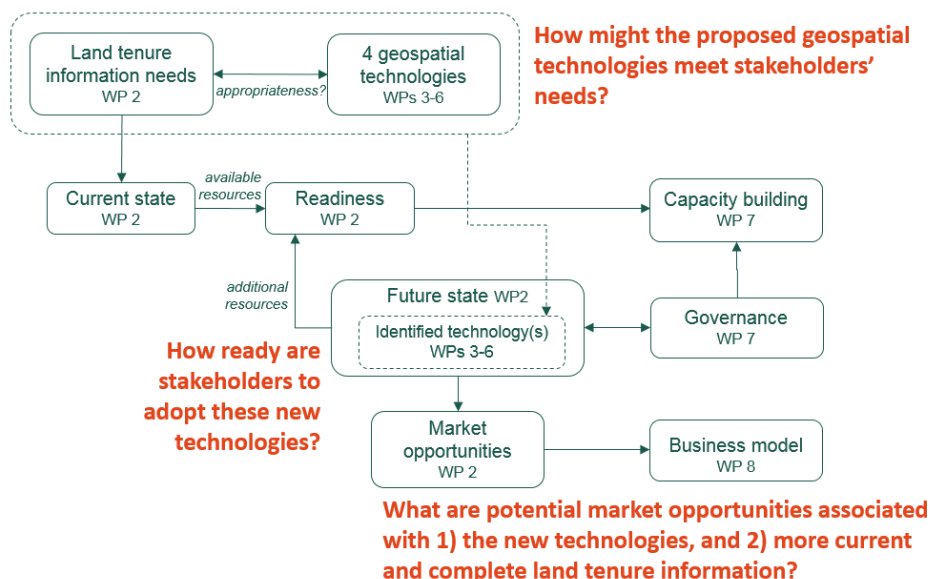
Figure 1. Aligning needs assessment and geospatial design work in its4land

In terms of progress to date, exploratory interviews in late 2016 provided greater familiarity and insight into local needs and challenges. Meanwhile, in 2017 a streamlined and participatory data capture activity is being pursued in all three case countries. Data is being collected using a series of stakeholder group-based workshops employing the Nominal Group Technique (NGT). This is form of group interview enables structured problem-solving or idea-generation: ideas are initially generated individually, but then as a group, gathered, combined and rank-ordered in terms of priority. As a data collection method, it builds on expert representation across stakeholder groups, and offers strong reliability and validity compared to other interviewing methods (Langford, 1994; Langford, Schoenfeld, & Izzo, 2002) as well as minimal bias from facilitators (Lloyd, 2011). At the time of writing, results were still to be finalised.

7. DRAWING AND MAKING

In parallel with the contextualization 'get needs' phase, its4land works on four technically oriented, but user driven, design activities. The first of these is based upon developments relating to sketch-map digitization and subsequent metric map generation. The approach is to be highly supportive of bottom-up land records documentation where land tenure relationships are recorded from the perspective of land users. Such approaches must be implemented using inclusive, community driven activities. Therefore, land tenure records in bottom-up approaches must necessarily be modelled using concepts of land and

land tenure that are local to specific communities. The spatial component of land tenure records in bottom-up approaches can be obtained as hand sketched maps created by the communities themselves. The state of the art in analysing such maps involves manual digitization on top of some base topographic maps that is usually a tedious, time consuming, and error prone process.

The its4land smart sketch maps tool builds from previous work (c.f. Schweing et al, 2014) and automates the digitization process for extracting both the spatial and non-spatial aspects of the information in a sketch map, and integrates that data with an underlying base map. The aim is to support non-governmental organizations such as Namati and Water Aid in the use of sketching as a method creating land resource maps. Figure 2 shows an early prototype of a user interface for exploring the result of an alignment between a sketch map and base map comprising a satellite image (adapted for research and demonstrative purposes from Google Earth) and vector data overlaid on the image.

In developing the Smart Sketch Maps tool the focus is on: i) developing a domain model of concepts used in the description of land resources and tenures within localized contexts (e.g. at community level or within cultural groups); ii) developing spatial models for representing sketch maps as records of land tenure information; iii) developing methods for recognition of land tenure sketch maps and for embedding the sketch maps within existing spatial data sets (sketch map alignment).

In order to process a sketch map, the Smart Sketch Maps system relies on knowing beforehand the types of symbols and strokes to expect in any sketch. Rather than working with unstructured, freehand sketches, we have opted for prescribing a visual sketch language. The challenge is in defining a visual language that is expressive enough to capture a variety of salient concepts, while not being "visually verbose" resulting in cluttered sketches that are difficult to interpret.

The visual language is based on a specialised domain model. The domain model documents the spatial concepts that users (e.g. pastoralists) consider important for their everyday activities, and in describing land and land relationships. Thus, the system can be adapted to local cultural contexts of different communities by adapting the underlying domain model.

During field visits, data will also be collected to support the design of an appropriate visual language. The main challenges in this aspect will be interpreting the data that will invariably be in local languages and may include concepts that are not directly available in the English language and our experiences.

Solutions found: Alignment 2 ▾   Number of matched objects: 23   hide

Figure 2: Prototype user interface for exploring possible alignments of a sketch map with a vector-raster overlay (http://chipofya.staff.ifgi.de/tech4land/alignment_demo.html). Exploring more intuitive visualizations to improve user experience is part of the work to realize an effective Smart Sketch Maps solution (satellite image courtesy of Google earth V7.1.7.2606).

8. FLYING AND CREATING

The second technical tool relates to the use of UAVs in land administration workflows. Amongst others, unmanned aerial vehicles – UAVs (ICAO 2011) are evolving as a tool for alternative land tenure data acquisition approaches. The advent of low cost, reliable, user-friendly and lightweight UAVs and recent developments in digital photogrammetry have created new opportunities for collecting timely, tailored, detailed and high-quality geospatial information. Even though UAVs seem to be a very promising technology, major bottlenecks are evident: cumbersome regulatory frameworks and undeveloped ground truthing strategies, amongst others, are issues currently impeding large-scale implementation. Thus, the question if the application of UAVs can address the requirement of appropriate land tools remains. Embedded in the technical work packages of its4land, Work Package 4 (fly and create) aims to design, test, and validate a UAV driven land administration workflow. In order to reach this goal, Work Package 4 follows a logical approach that will first study policy and legal developments regarding UAV

regulations. Based on these outcomes a phase of prototyping will deliver guidelines to design efficient operational UAV workflows that are adapted to stakeholder needs.

In order to establish a UAV based workflow, one need a UAV, a UAV pilot, and a permission to fly (see Figure 3). Work package 4 opted for a fixed wing UAV that is specialized for large area UAV mapping: the DT 18 PPK UAV by DelairTech. The flight time amounts up to 90 min and thus permits to capture more than 1 km^2 during one flight. Facilitated by means of a post-processing kinematic system, this UAV allows for direct georeferencing and thus tremendously minimizes time and costs for ground truthing activities. Test data from Toulouse reveals final geometric accuracies of 5-8cm. Each of the African countries will receive one UAV and respective UAV pilot training in order to develop local expertise and human resources. Besides the UAV and the UAV pilot, flight permissions are the third prerequisite for the successful commencement of UAV data capture activities. A global overview of UAV regulations as per October 2016 reveals that nearly one third of all countries have respective regulatory documents in place. In contrast to the pending status in Kenya and Ethiopia, Rwanda already enacted UAV regulations (Rwanda Civil Aviation Authority 2016).
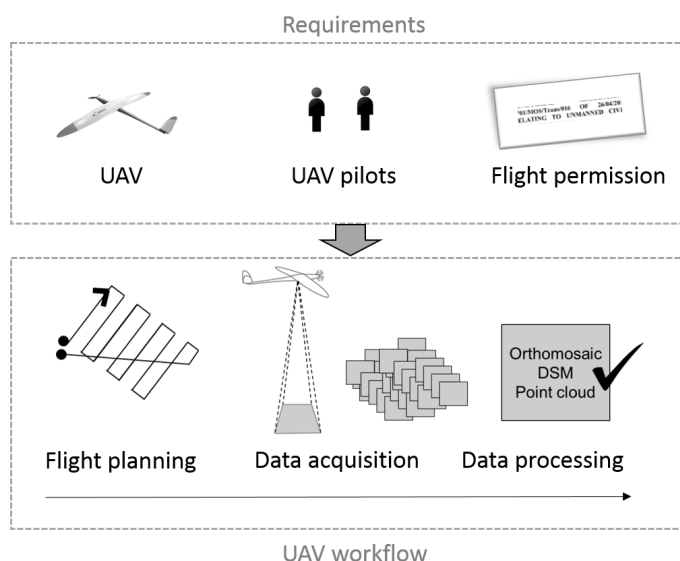

Figure 3. Key ingredients for a UAV-based land tenure recording tool

Current challenges are regulatory uncertainties in all three African countries. Although Rwanda has enacted UAV regulations, we encountered cumbersome administrative procedures and missing capacities to license pilots. We expect further challenges in complex acquisition processes – especially in East Africa. This concerns mainly the selection of appropriate sites for take-off and landing, environmental

challenges to the UAV equipment and the dependency on human resources (UAV pilots). However, the chosen UAV platform brings various features like adaptive flight planning and image previews in order to design suitable UAV workflows as an appropriate land tool.

9. AUTOMATING IT

Work package 5 (Automate It) seeks to design and implement a tool that enables the automated delineation of visible cadastral boundaries from UAV data. Ideally, the tool should use orthoimages and surface models derived from UAV imagery as an input, employ automatic feature extraction algorithms and deliver cadastral boundary features as an output. In this context, automatic feature extraction refers to algorithms that enable the identification and vectorization of real-world objects of interest, *i.e.*, cadastral boundaries. The tool will be designed to extract visible boundaries only, which are assumed to make up a large portion of all cadastral boundaries (Zevenbergen and Bennett, 2015). From a technical point of view, the tool aims to be highly automatic, generic and adaptive to different scenarios. Overall, work package 5 aims to facilitate and accelerate the cadastral mapping process, while integrating concepts in land administration such as fit-for-purpose (Enemark et al, 2014) and responsible land administration (Zevenbergen et al, 2015).

Regarding achievements to date, in past work, different aspects related to work package 5 have been reviewed in order to better contextualize the potential of possible approaches and challenges related to the topic (Crommelinck et al, 2016). This reviewing work includes cadastral boundary concepts and characteristics, cadastral mapping approaches on high-resolution optical sensor data as well as automatic extraction methods for features of boundary characteristics. The review introduces a workflow considered applicable for automated boundary delineation from UAV data (Figure 4). This was done by reviewing approaches for feature extraction from various application fields and synthesizing these into a hypothetical generalized workflow. The usability of the reviewed methods has then been tested on UAV test data from Germany. The choice of methods has been based on available implementations within open source software such as QGIS, GRASS, SAGA and Orfeo. However, the results showed limitations in terms of completeness, correctness and automatization. Therefore, more comprehensive state-of the art computer vision methods have been examined. One investigated method, namely *global Pb* contour detection (Arbelaez et al, 2011) provided valuable results. However, its transferability to remote sensing data and specifically UAV data required investigations as computer vision methods are mostly not

designed to work on large remote sensing scenes. Current work has shown advantages and limitations related to the transferability of *global Pb* contour detection to UAV data and its applicability for automated cadastral mapping [*add gPb paper, if published by then*]. Future work will focus on the incorporation of further methods such as image segmentation as well as machine learning to integrate object knowledge.
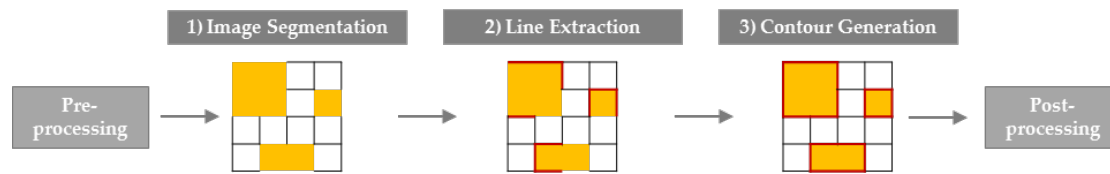

Figure 4: Sequence of commonly applied workflow steps to detect and extract linear features considered applicable for automated boundary delineation from UAV data.

In terms of upcoming challenges and opportunities, one key issue is the current unavailability of data from its4land use cases. Visible cadastral boundary characteristics as well as reference data can only be estimated. This makes statements about the usability of certain approaches challenging. European datasets, but later also data captured in Africa, will be considered in ongoing work that focuses on the integration of object knowledge. This aims to reliably delineate a closed and geometrically and topologically correct network of boundaries. Thereafter, human interaction will be added to the tool design. In the end, the entire tool will be evaluated in terms of its usability and limitations for cadastral mapping based on its4land use cases.

10. PUBLISHING AND SHARING

This work package is aiming to prove a concept for the integration of data, workflows, publication, and sharing of land tenure information resulting from the other technical work packages (UAV data, smark sketchmaps, and automated feature extraction). The result is intended to be an integrated land information tool for processing and sharing the data obtained from the methodologies developed in the other work packages. An adapted version of the land administration domain model (LADM) forms the basis for organizing and integrating data and processes.

Kicking off in early 2017, five main tasks will be carried out in order to achieve the aims of this work package 1) Integration of mobile capturing and in-field processing system of UAV aerial imagery with the methodologies of (semi) automated feature extraction. The planned software system will provide the framework for integrating the mobile capture and in-field processing with the automated feature extraction into standard open source GIS; 2) Integration of qualitative information from sketch maps with quantitative information in order to represent land with cadastral boundaries. In this task an extension for quantitative databases will be developed to include a qualitative layer on top of which can be stored the descriptive information from sketch maps and thus integrating the data into one database; 3) Setting the workflow for matching the output from the first two tasks to a LADM based LAS. Since the previous work packages will develop methods to capture information, which is necessary for tenure security, this task will consist of developing and implementing the workflow in order to bring both sources of information together as structured data. This data can later be transferred to a central cadastral database; 4) Development and implementation of a land administration system based on LADM which will be extended to handle qualitative descriptions of boundaries and rights, derived from sketch maps. The basis of the implementation will be the LADM based land administration system developed by Hansa Luftbild using open source software; and 5) Training of local staff of the African project partners to use the system in the field. The training will not only focus on the pure usage of the software and application of the methodologies, but will also help the trainees to pass on their knowledge to their respective communities. Figure 5 shows the relationship between the business processes of smart sketching (sketch maps), UAV-based land tenure data acquisition and processing, feature extraction for land tenure and the publish and share work package.
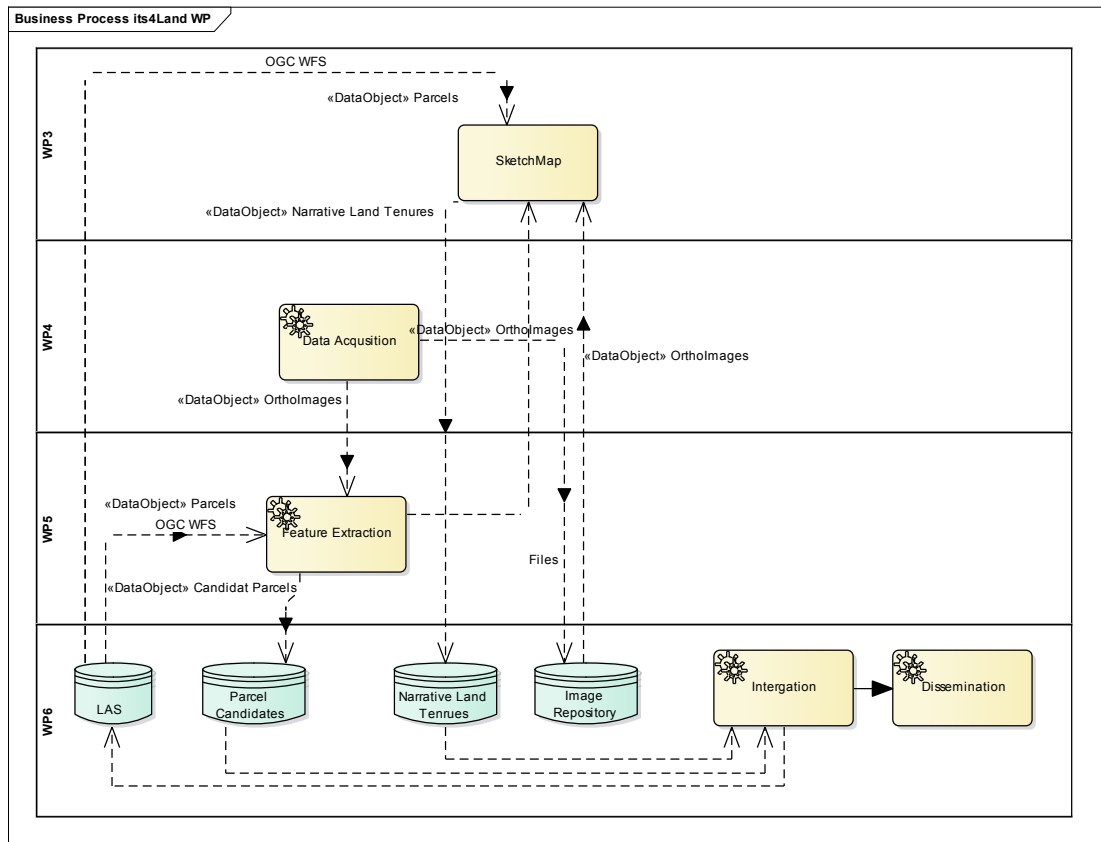
Figure 5: Business processes of the data capture work packages in relation to the publish and share work package (source: Hansa Luftbild AG, 2016)

Hansa Luftbild is taking a leading role for this work package with further input and contributions from consortium partners in the Netherlands, Germany, Ethiopia, Kenya and Rwanda. The two European partners will support the conversion process of results from their respective work packages into inputs to design the system architecture, while the African partners will provide end-user access, field locations for testing, and expertise on functionality and qualitative testing.

The work package considers the acceptance of open source software by developing countries to be crucial when establishing land administration systems in such countries. Know-how in open source software platforms can easily be gained but wide acceptance by the land administration community is required in order to make the land administration system viable for usage and maintenance. In addition, this work package will positively impact the availability of land administration system to developing countries not just at national level but also at local level.

11. GOVERNING AND GROWING

The its4land project differentiates itself by incorporating a parallel investigation into potential strategies for the governance of its tools. To understand how these technologies can be adopted and sustained, this work package necessarily incorporates inputs from work packages 2-6. That is, outcomes regarding the country contexts, the types of tenures that exist, the operation of current government systems (national, intermediary and local) and related institutions (rules and structures) that regulate land tenure and land administration systems, and proposed workflows around the new tools – are used as input for establishing sustainable governance models for the tools. The approach attends to the diversity in the stakeholder environment, which introduces a level of complexity in understanding how best to coordinate and manage the use of the proposed technologies to deliver maximum benefits.

Whilst the work package is yet to officially kick off, considering the governance of the innovative geospatial tools is seen as critical to enabling their longer-term success. This requires an examination of not only how these innovative tools can be useful for improving a specific land issue, but also focusing on all stakeholders and end-users interests, influences, relationships and interactions. This will also lead to recommendations in terms of capacity development across institutional and technical domains. The research will comprise theoretical, empirical and applied parts: based on insight from relevant theories in combination with empirical evidence derived from extensive interviews in Ethiopia, Kenya and Rwanda, governance and capacity development models will be developed, tested and valorized.

12. CAPITALIZING

Work package 8 involves the development of a sustainable business model for commercialization of the integrated suite of land tenure recording tools, within the end-user markets. Using the results from the previous work packages and in parallel with the work package covering the development of sustainable governance and capacity building models this work package will combine actor preferences (local communities, government, investors, and small and medium-sized enterprises [SME]), with product, place, in order to define a range of business model scenarios for the different sectors and case contexts. The results of the project will be commercialized and marketed as appropriate, as a product or service, and offered to the public.

Opportunistic use of the largest geospatial industry trade shows (e.g. ESRI user conference, GeoBusiness (UK), Intergeo (Ger)) will be used to demonstrate tools and piloted results and deliverables as they come online – to both larger and smaller technology vendors (e.g. Hexagon, Trimble, ESRI). Components deemed suitable for open-source dissemination and consumption (i.e. the majority) will be made available via the project website. Subsequently, they will be linked to open source communities already working on land tool developments. Beyond the project lifespan, the commercial consortium partners and open-source communities drive further exploitation and innovation.

The work package includes: 1) Developing and choosing a business model that best fits the product or services resulting from the innovations. The previous work packages will throughout their life span expose its4land to the world through conferences and publications. This will provide an initial concept for the business model which will be designed to include the necessary building blocks such as value propositions, distribution channels, customer relationships, value configurations, core capabilities, partner network, cost structure, and revenue model these will be defined and set taking the market situation as a basis. 2) Business plan construction which will cover the development of the product descriptions and the advantages of the product when compared to other technologies; the market opportunity; the financial projections; and the funding requirements. The business plan will underline to potential customers the gains which they will make through acquiring the product. It will also include the marketing approach and strategy used in order to bring the product to the customers. 3) Launching the product and services after defining a strategy which demonstrates the gains to be made by using the product and services.

The developed options in the work package will consider viable business partners; refine the product and service offerings developed in its4land; further define the market and marketing plan; make clear delineations of product, place, price, and promotion; and consider supporting management, organizational, and financing options.

13. DISCUSSIONS, CONCLUSIONS, AND LOOKING FORWARD

its4land is progressing as planned at the 1-year mark, with all set tasks, deliverables, and milestones being either already completed or commenced. The initial focus of the project necessarily focused on setting up project management aspects and ensuring ethical frameworks were in place and being followed. Content wise, the core focus between month 1 and 6 was on WP2 Get Needs: reconnaissance visits to selected case study countries were key activities in this regard. Developing appropriate data collection instruments

for WP2 that satisfy the technical WPs (3, 4, 5 and 6) has been key. The consortium is working towards the data collection, piloting and demonstration activities - at six case study locations across the three Eastern African countries – between month 9 and M12. Importantly, both urban and rural contexts are being pursued in each country. This has involved undertaking reconnaissance visits to the sites, conducting workshops within the consortium, and iterative data collection instrument development. Meanwhile, test locations in Germany (Gronau) and France (Toulouse) are also being used to trial data acquisition methods and undertake training, particularly with regards to the use of the UAVs. Preliminary results in terms of spatial data (e.g. test flights) are now being achieved. Initial technology selections, justifications, and acquisitions are also being completed for the technical work packages (e.g. UAV purchases). A decoupled approach to tool development is being used – but regular technical meetings (tech4land) are being used to ensure an underpinning reference architecture will be adhered to. Large distances between European and Eastern Africa partners, and less than desirable internet infrastructure (and access), create challenges for ongoing communication and project management activities – and developing and maintaining the complex stakeholder network. However, to date, these issues are not seen to have impeded the project progress in any significant way. Understanding and ensuring adherence to the complex ethics and research permit process across all relevant institutions, countries, and regions represents a significant challenge between M1 and M6. However, it is noted that the large-scale nature of the project offers the opportunity for excellent ICT sector and land industry engagement – including the development of technology partnerships, media linkages, and connection to other land and ICT sector initiatives (e.g. FIRE).

Major achievements thus far are considered to be: completion of the selection, reconnaissance, and sensitization of all 6 case locations; the undertaking of broad awareness raising activities (e.g. UN-GGIM, FIG, World Bank); the completion of technology selection for several work packages and have technical coupling between work packages far more defined; and the near completion of all ethics and permit process across the 6 countries involves. Significant challenges are identified as: ensuring cohesive and coherent management of the complex stakeholder network linked to the project; uncertainly and overlapping regulations relating to undertaking transcontinental research activities and UAV flights; overcoming limited communications and internet infrastructures in the Eastern African contexts; and the difficulties in ensuring alignment of between the administrative and financial standards of the European Commission and those in operation in the Eastern African countries.

Short term opportunities are identified as: seeking to establish stronger partnerships with technology SMEs the project is engaging with; linking more coherently with other Eastern African technology projects and initiatives (e.g. EALAN, Refresher Courses, FIRE, H2020 Innovation actions); utilizing our network to better interact with top-down and bottom-up users; and setting up media partnerships with reputable global geospatial industry publications. Immediate threats to project progress were also identified and risk management options were also outlined: this did not differ from those proposed during Grant Agreement. The key threats include: emergent and on-going instability in Ethiopia's Amhara region; uncertainty in the passing of upcoming UAV regulatory frameworks; potential challenges to academic freedoms in the Eastern African context; and the challenge to adequately compensate Eastern African partners.

ACKNOWLEDGEMENTS

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