Horizon 2020
European Union funding
for Research & Innovation

Catalyzing Innovation

ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 25-29, 2019

ITS4LAND
innovations for land tenure

MasterClass

"Its4land" - innovative geospatial tools for fit-for-purpose land rights mapping

Annual World Bank Conference on Land and Poverty

March 25-29, 2019

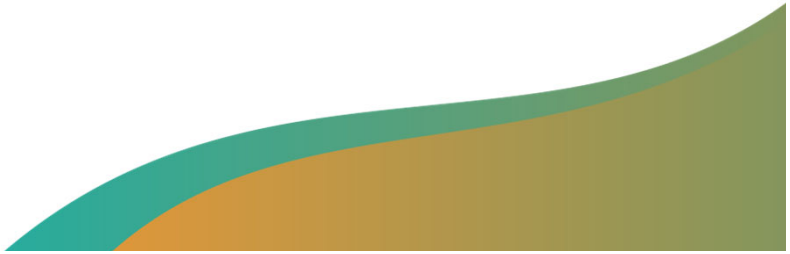
Washington D.C, United States

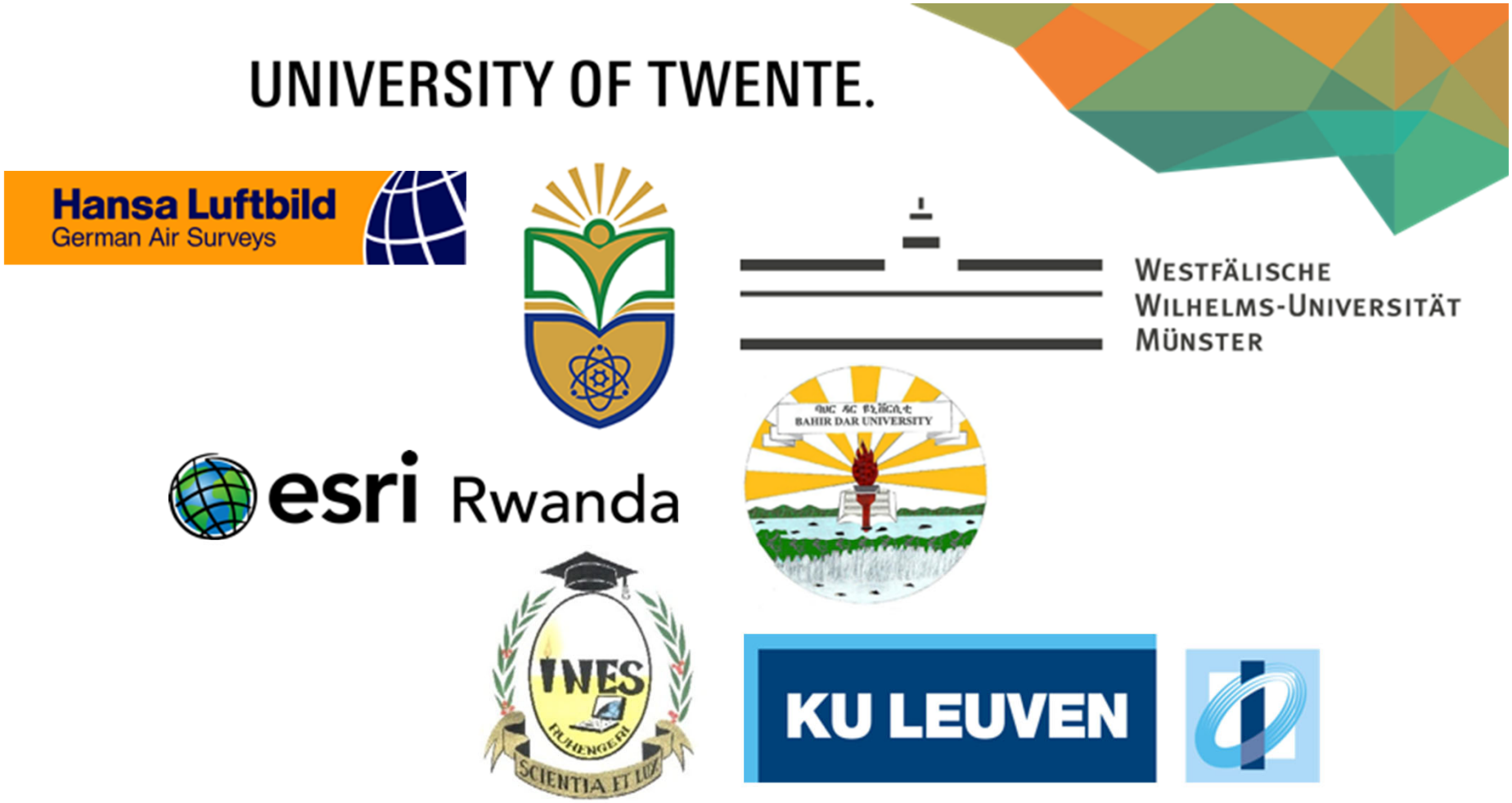
What are we going to do?

1. **Find out:** About ‘its4land’
2. **Learn from us:** its4land toolbox
3. **Learn from you:** Is the its4land toolbox something for you?

Snapshot

Program: H2020-ICT-2015
Type of Action: Research and Innovation (RIA)
Topic: International partnership building in low and middle income countries
Acronym: its4land
Number: 687828
Duration: 48 months
Start Date: 2016-02-01
Consortium: 8 partners
Budget: 3.9 EU




UNIVERSITY OF TWENTE.
Hansa Luftbild
German Air Surveys
WESTFÄLISCHE
WILHELMS-UNIVERSITÄT
MÜNSTER
BAHIR DAR UNIVERSITY
esri Rwanda
INES
RUHENGERI
SCIENTIA ET LUX
KU LEUVEN

Objective of its4land:

Developing an innovative suite of land tenure recording tools inspired by geo-information technologies that responds to end-user needs and market opportunities in sub Saharan Africa, reinforcing an existing strategic collaboration between EU and East Africa.

its4land - Innovation

The innovation process incorporates a broad range of stakeholders and emergent geospatial technologies including:

- Smart sketch maps
- Unmanned Aerial Vehicles (UAVs)
- Feature extraction
- Sharing and publishing through geocloud services

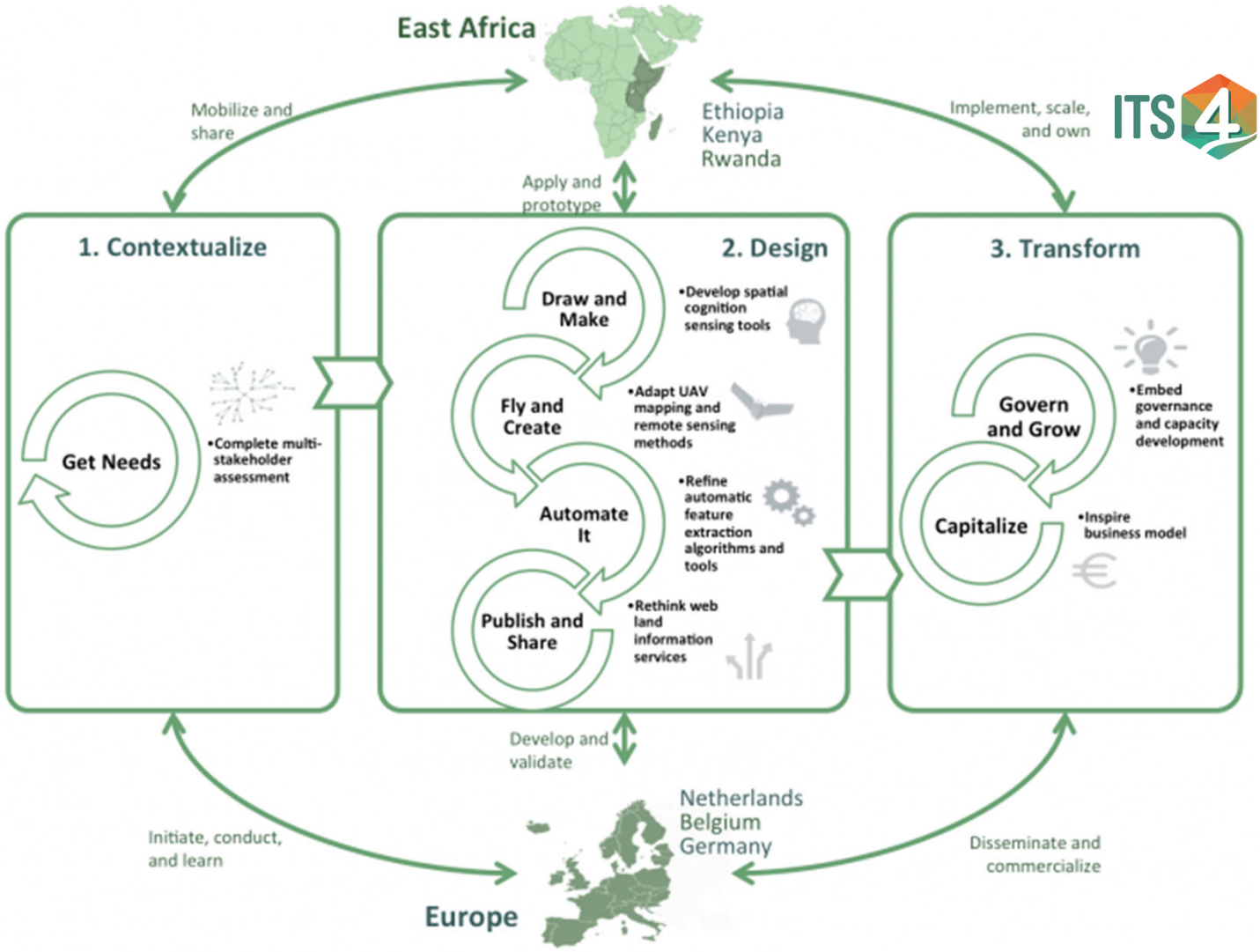
The aim is to combine these innovative approaches with the specific needs, market opportunities and readiness of end-users in the domain of land tenure information recording in East Africa.

Case locations

RWANDA - developing approaches that can support updating, at scale, land rights documents and maps

KENYA - adapting tools to enable mapping of pastoralist land rights and layered disputes

ETHIOPIA - developing approaches that improve plot recordation of urban smallholder and dwellers (peri-urban and rural landscapes)


East Africa
Ethiopia
Kenya
Rwanda
Mobilize and share
Implement, scale, and own
Apply and prototype
1. Contextualize
Get Needs
•Complete multi-stakeholder assessment
2. Design
Draw and Make
•Develop spatial cognition sensing tools
Fly and Create
•Adapt UAV mapping and remote sensing methods
Automate It
•Refine automatic feature extraction algorithms and tools
Publish and Share
•Rethink web land information services
3. Transform
Govern and Grow
•Embed governance and capacity development
Capitalize
•Inspire business model
Develop and validate
Netherlands
Belgium
Germany
Europe
Initiate, conduct, and learn
Disseminate and commercialize

Contextualization - Get Needs

KUL – Capture the specific needs, market opportunities, and readiness of end-users in the domain of land tenure information recording.

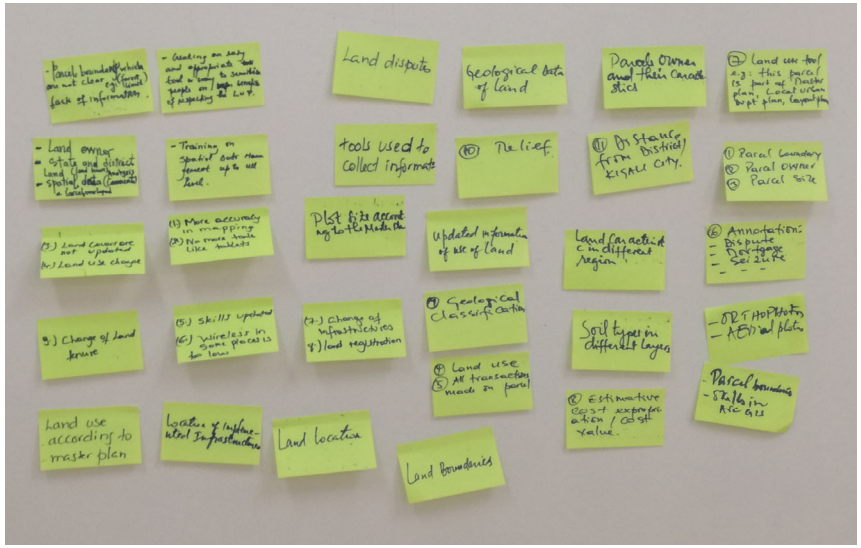
In 2017, they engaged with 57 organizations and community groups across the three case countries
(more than 100 individuals) – Ethiopia, Kenya and Rwanda

Get Needs Main Objectives

Capture the specific **needs, market opportunities, and readiness** of end-users in the domain of land tenure information recording in order to support design activities in WPs 3-6 and modelling activities in WPs 7-8.

Main activities

- Semi-structured group interviews
- Workshops
- Qualitative and quantitative analysis
- Dissemination and communication



Overview of Engagement

- 104 organisations and groups contacted
- 59 participated (57% response rate)

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

Overview of Engagement

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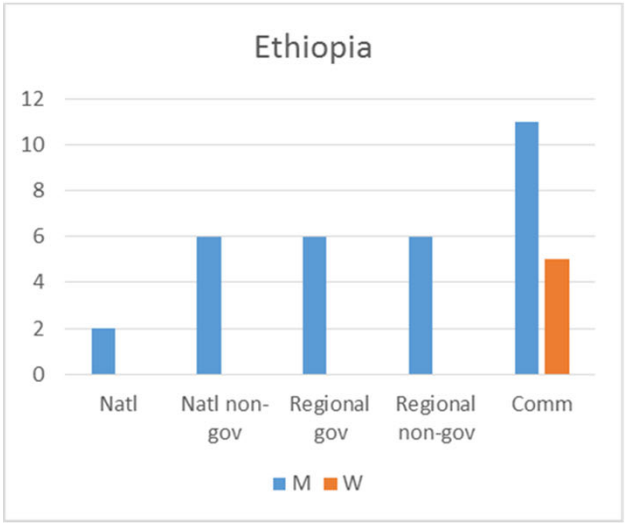
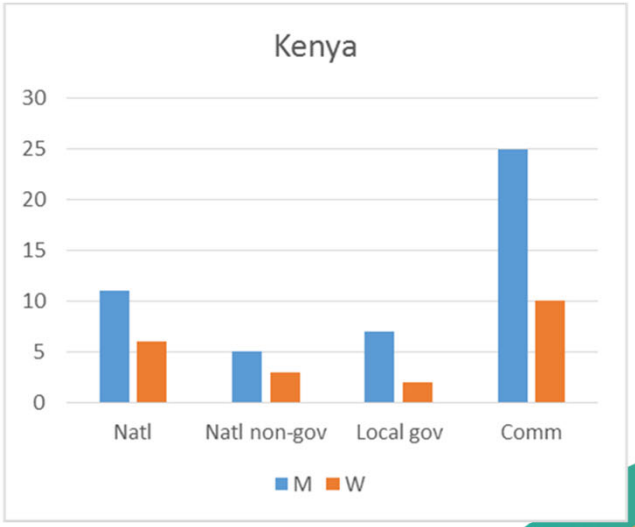
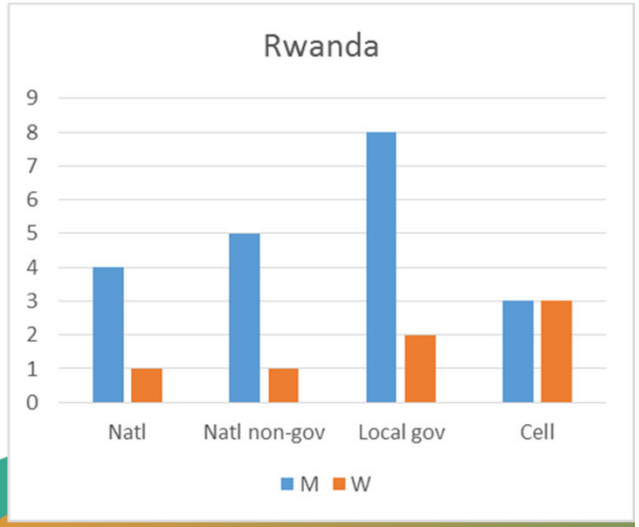
- 59 participated (57% response rate)







Land tenure/ Land information need	Frequency of vote	Strength of consensus	*Ranked Priority	**Relative importance
Georeferenced property information connected to registry index map	**0.75**	**30**	**#1**	**25**
County spatial plan	**0.88**	**24**	**#2**	**20**
Clearly marked ecologically fragile areas)	**0.63**	**15**	**#3**	**12.5**
Community involvement (sensitisation, etc.)	**0.5**	**13**	**#4**	**10.8**
Resurvey of adjudicated areas of public utilities	0.38	7	#5	5.8
Number of properties (and its attributes) in the county	0.25	7	#5	5.8
Overlaying minimum use threshold of land with other data	0.5	6	#6	5
Land fragmentation not properly controlled (subdivision too small)	0.38	5	#7	4.2
Proper documentation of utilities for protection (gazetting)	0.25	5	#7	4.2
Relationship of land laws especially around property transactions	0.25	4	#8	3.3
Improving data management for multi-purpose use	0.13	3	#9	2.5
Good practices related to surveying and mapping	0.13	1	#10	0.8

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)

Tool preferences

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

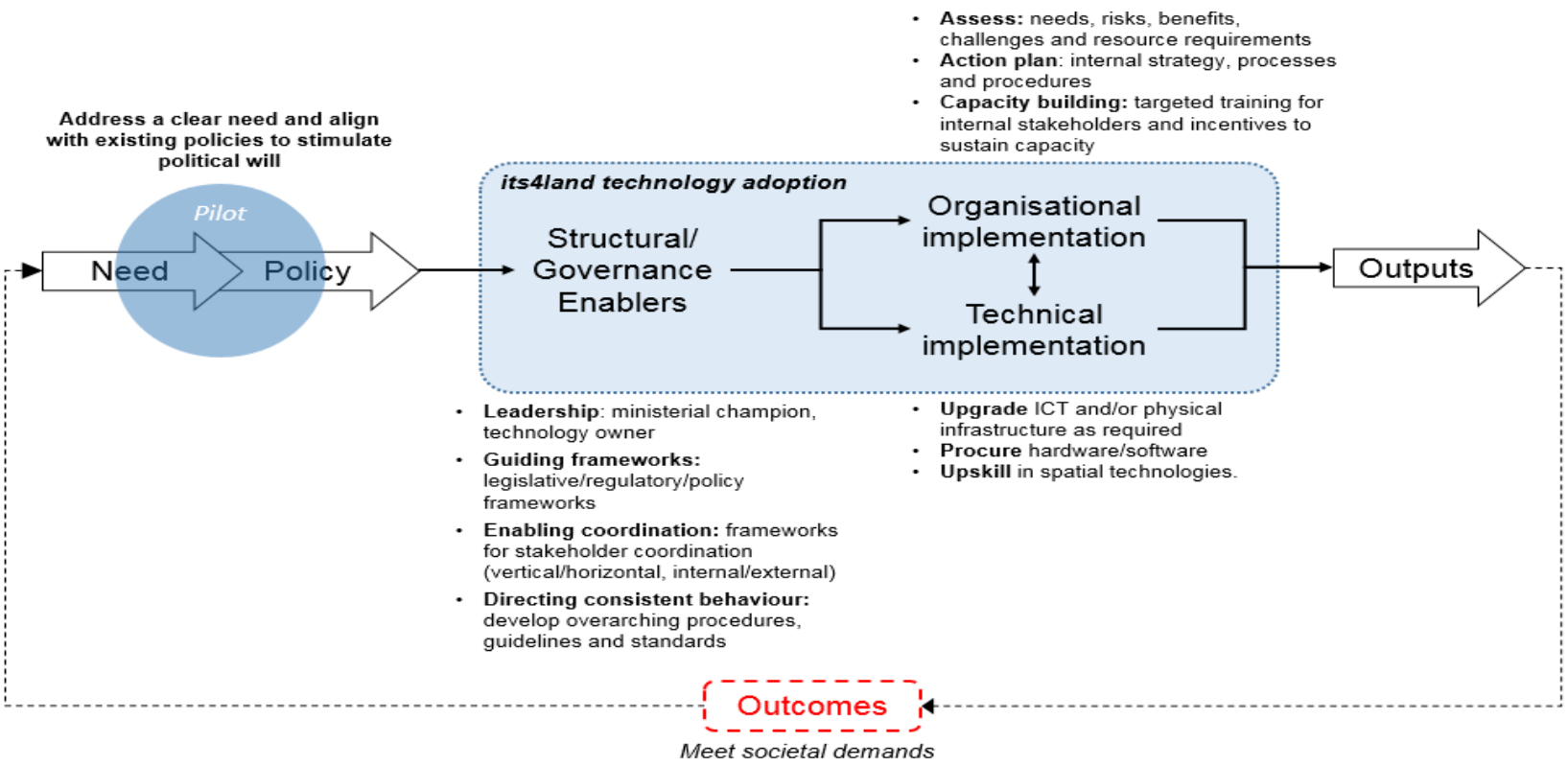
Identified pros and cons

Tool	Pros	Cons
UAVs	High accuracy aerial imagery Can be deployed at any time Can capture data over difficult terrain	Significant barriers to implementation Imagery requires post-processing - skills and ICT infrastructure Significant cost implications
Automated feature extraction	Reduce manual intervention in digitization	
Geocloud services	Improve data analysis and management functionalities	Technical challenges around implementation New skills required
Smart sketchmaps	Requiring low resources (financial and technical) and without needing regulatory intervention Sketching a familiar process	'Smart' component was difficult to understand, and how to incorporate with existing data.

Readiness requirements

- Strategic requirements
- Structural/governance requirements
- Organizational requirements
- Technical requirements

Readiness change model



What did we learn?

Ethiopia:

- Concerns around improving integrity, transparency and equitability of land transaction processes
- Cadastral data a priority + other types of evidence
- (1) geocloud services, (2) smart sketchmaps, (3) UAVs
- Challenges for adoption and scaling e.g. land governance, differing levels of maturity in land administration

What did we learn?

Kenya:

- Need for improved cadastral data, but also better quality non-cadastral data
- UAVs clearly preferred
- Challenges for adoption and scaling e.g. lack of regulatory framework

What did we learn?

Rwanda:

- Need non-cadastral data prioritised
- Need to improve data management capabilities
- Still a need to improve cadastral data elements
- (1) UAVs, (2) geocloud services
- Significant practical challenges e.g. governance, capacity, etc.

What did we learn?

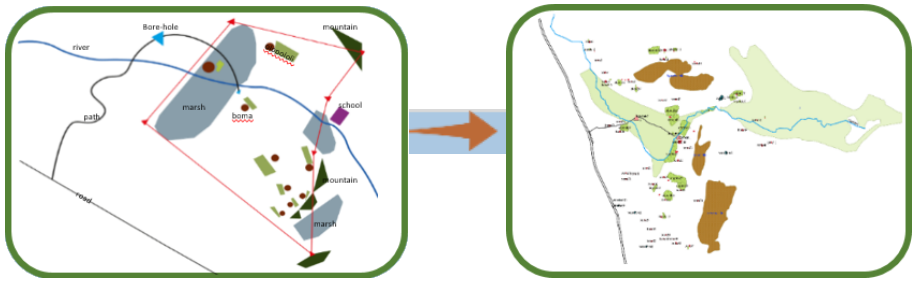
Regional outcomes

- Land info needs: cadastral data vs. non-cadastral data
- Data analysis and management needs: ET, RW
- All agree on potential of UAVs, but….
- other technologies also have potential, but with greater variation
- Governance conditions: federated systems vs. central govt
- Market opportunities difficult to identify but broad agreement on the fundamental role of good quality land information in public service delivery

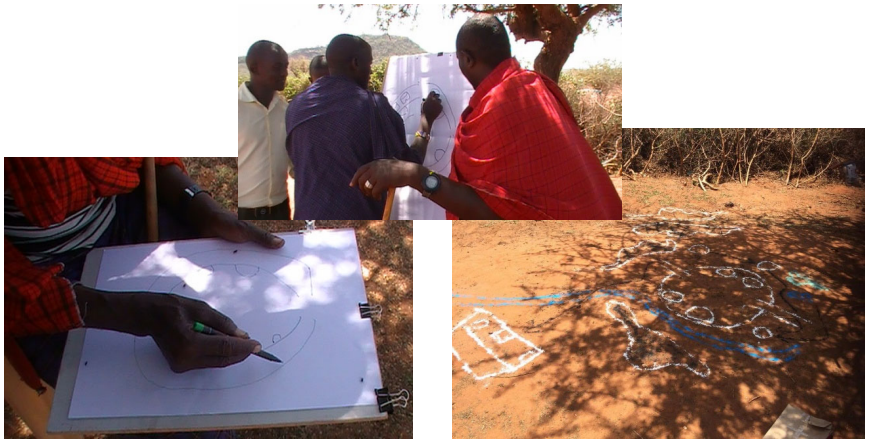
Land information needs	National govt	Sub-natl govt	Non-govt	No. of votes	% of total votes
Non-cadastral data linked to cadastre				92	31
Physical characteristics of land	*2*	*30*			
Current land use information	*13*	*5*	*10*		
Information to support development decisions		*4*	*20*		
Other information needs	*8*				
Spatially and temporally accurate data	*14*	*45*		69	23
Data discoverability and accessibility	*12*	*16*	*14*	42	14
Cadastral data				34	11
Land value			*17*		
Parcel boundaries		*4*	*5*		
Area	*6*				
Transactions		*2*			
Data tools		*17*		17	6
Communication with stakeholders		*6*	*9*	15	5
Data processes				10	3
Data harmonisation	*5*				
Data integration	*5*				
Decision-making ability		*9*		9	3
System needs	*5*			5	2
Monitoring ability	*5*			5	2

Draw and Make: Land Tenure Mapping with Smart Sketchmaps

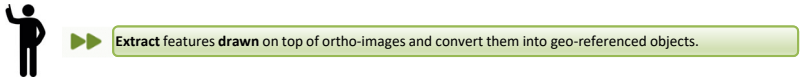
WWU Muenster - Implementation of a sketch based geospatial data recording to capture land tenure data from local perspective.

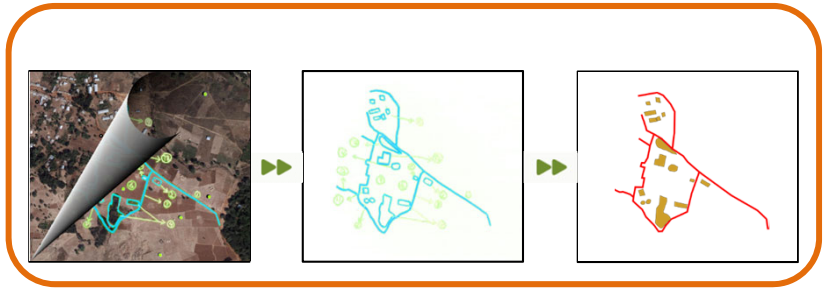


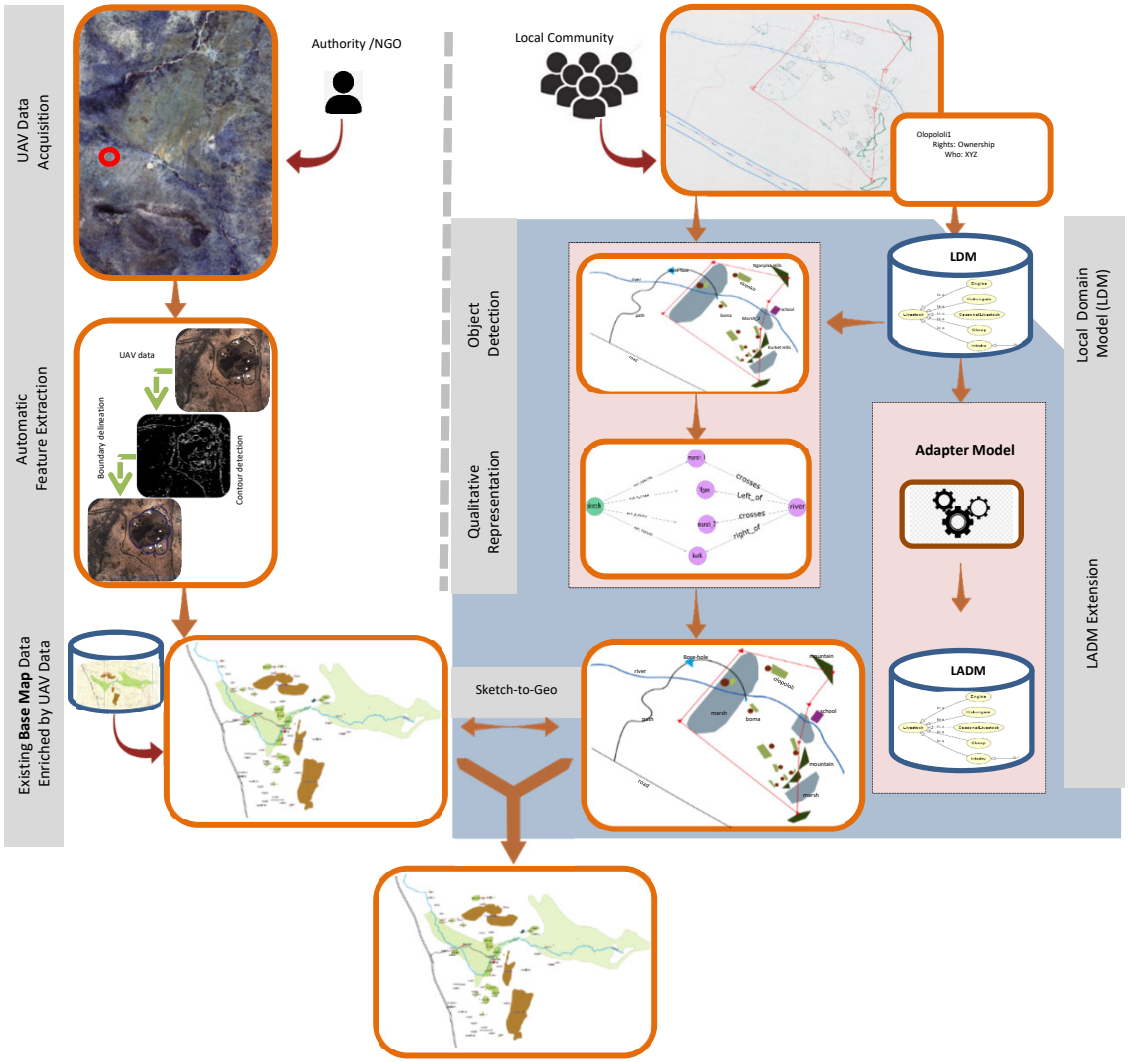
Field visits to Kajiado, Kenya and Bahir-Dar Ethiopia
(data collection, data verification/validation)



Draw and Make: Workflow



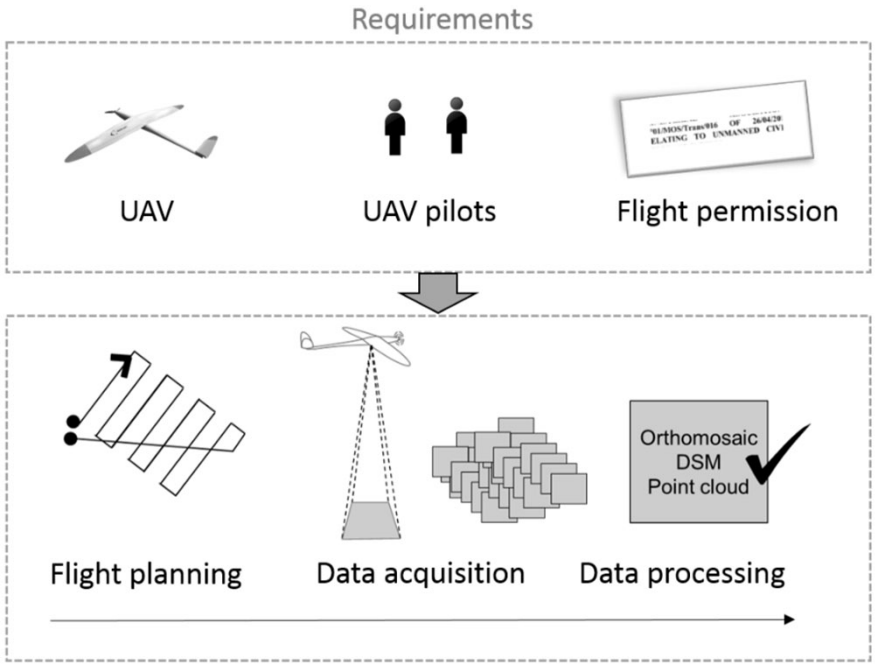




Draw and Make: Workflow

Fly and Create: UAV-based Land Tenure Data Acquisition

UT (ITC) – To design, test and validate UAV workflow



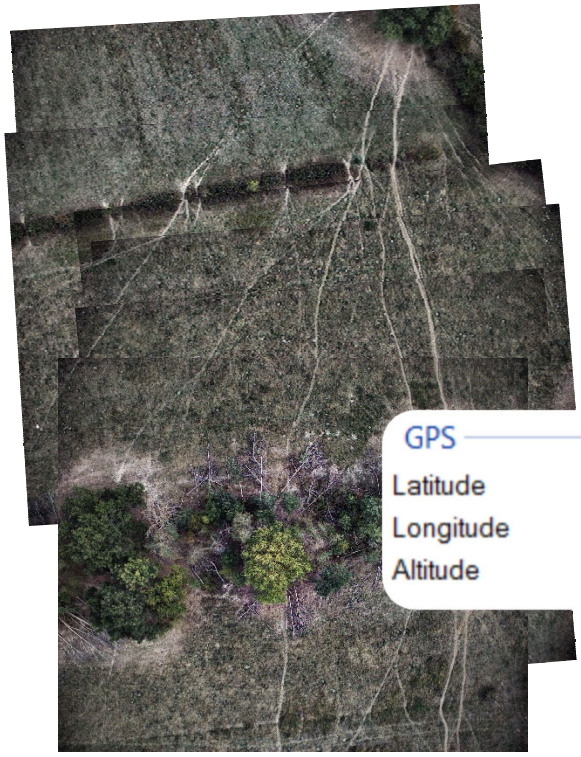
UAV workflow for land tenure data acquisition

- Selection of a suitable UAV
- Purchase, shipping and import UAVs
- Pilot training

delair-tech
AIRBORNE SENSORING

- Fixed wing UAV, 60 min of endurance
- Payload:
  - Industrial grade RGB camera
  - IMU/GNSS Applanix APX-15

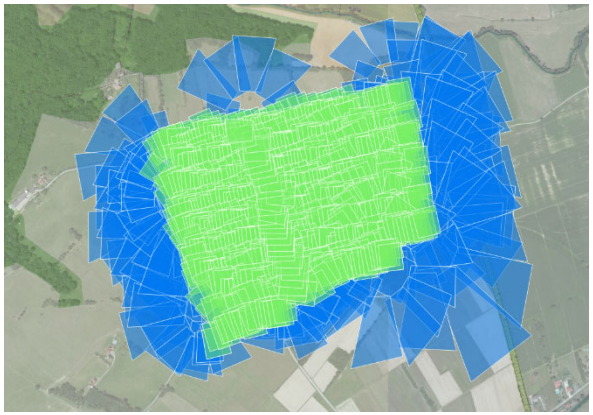
What can be provided by UAV imagery?



GPS	
Latitude	43; 13; 4.2147000000113977
Longitude	0; 59; 57.274920000000122
Altitude	416.136749

Metadata information: Geotag locations

Post-processing of images



What can be provided by UAV imagery?

- High resolution orthophotos
- Digital surface models
- 3D point clouds

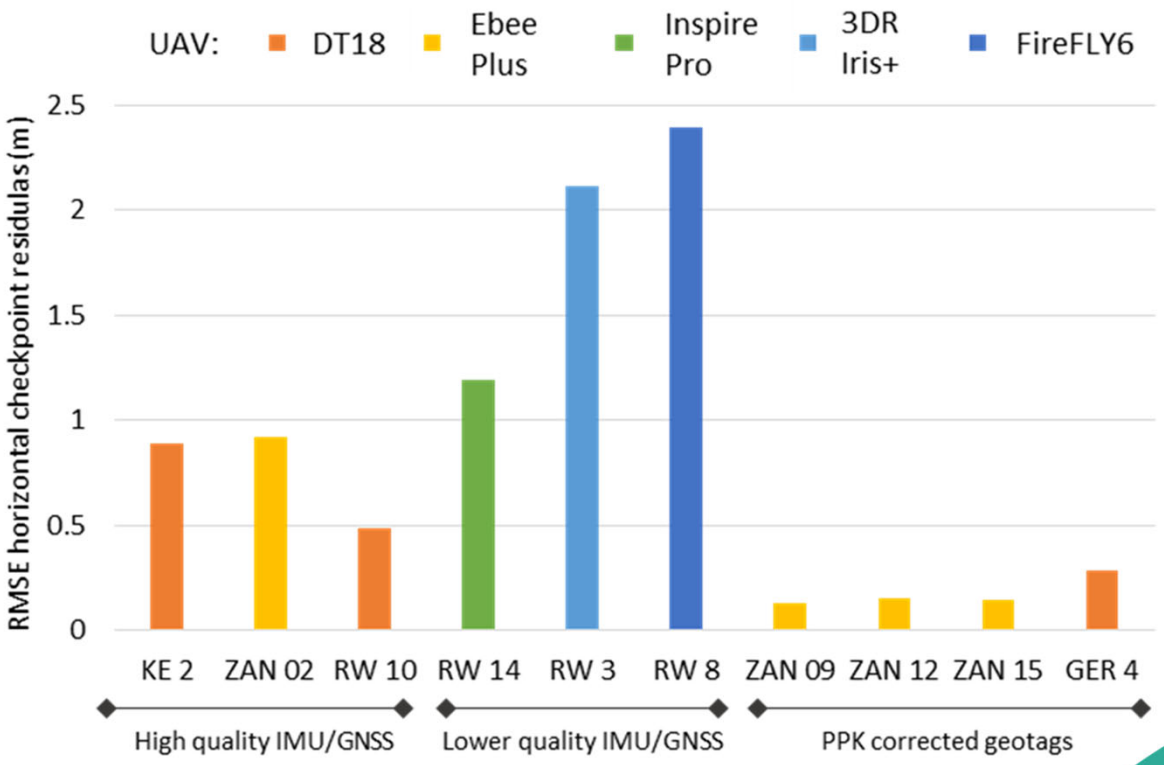
→ Derive information on land use, land tenure and land value
→ Automated image analysis to extract visible boundaries or land information

Rwanda

Kenya

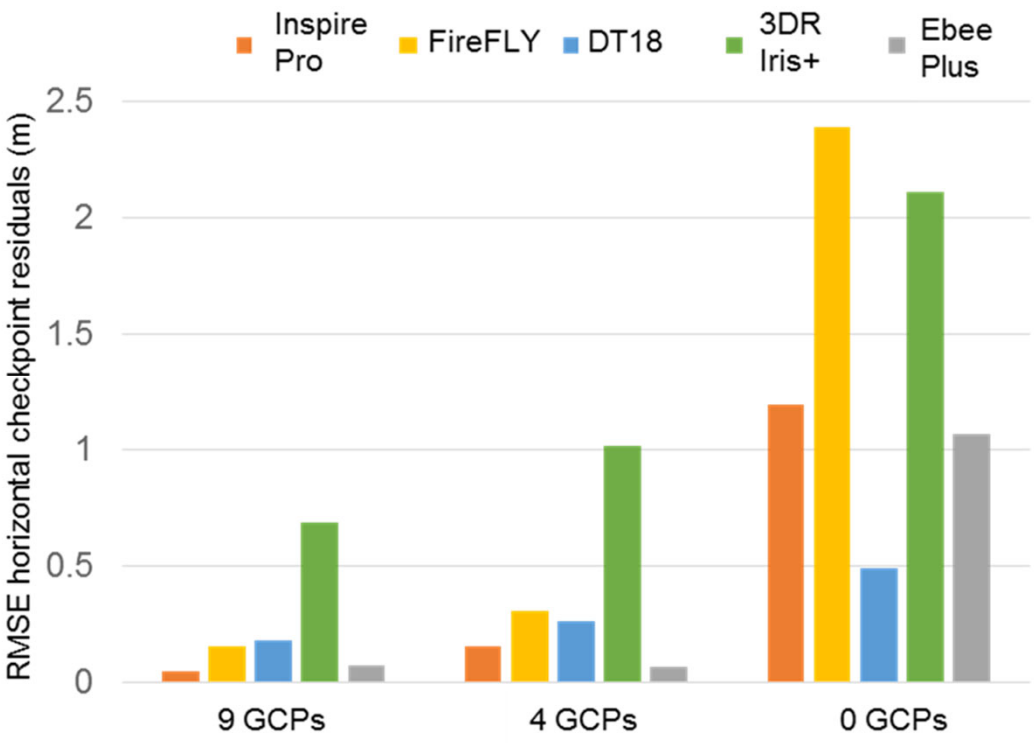
Tanzania

Data quality



- DT18 and Ebee plus operate with multi-frequency receiver
- InspirePro, 3DR Iris+ and FireFLY6 are equipped with a single frequency GNSS receiver

Data quality



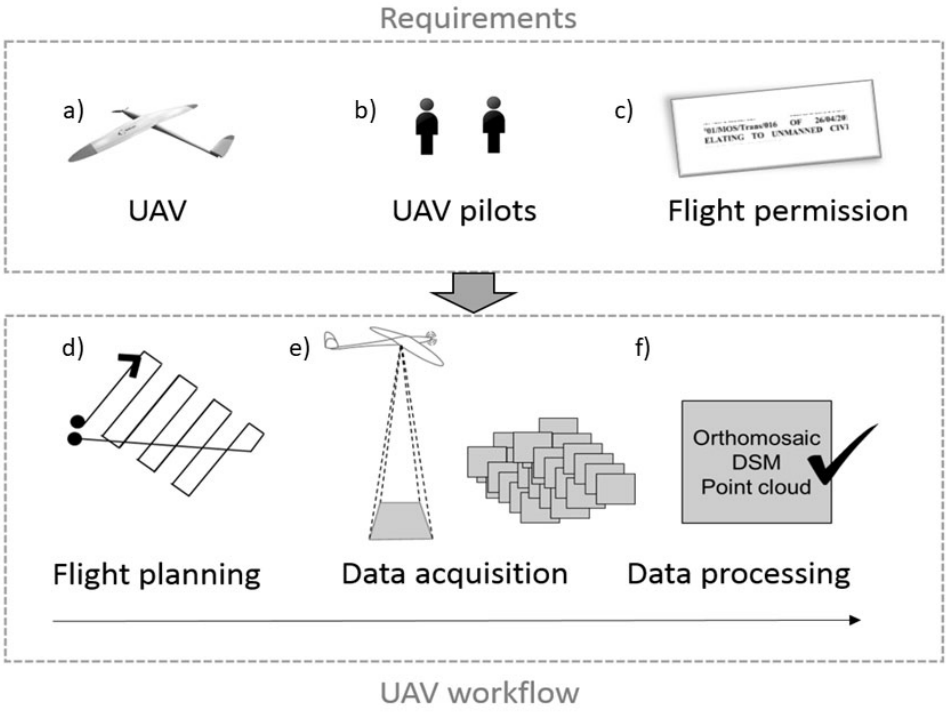
- Already 4 GCPs reduce systematic errors due to GNSS ambiguities
- High quality of DT18 GNSS with 0 GCPs
- If image quality is weak, even 9 GCPs cannot compensate poor block robustness

Fly and Create Exploitable Result – Consultancy Services

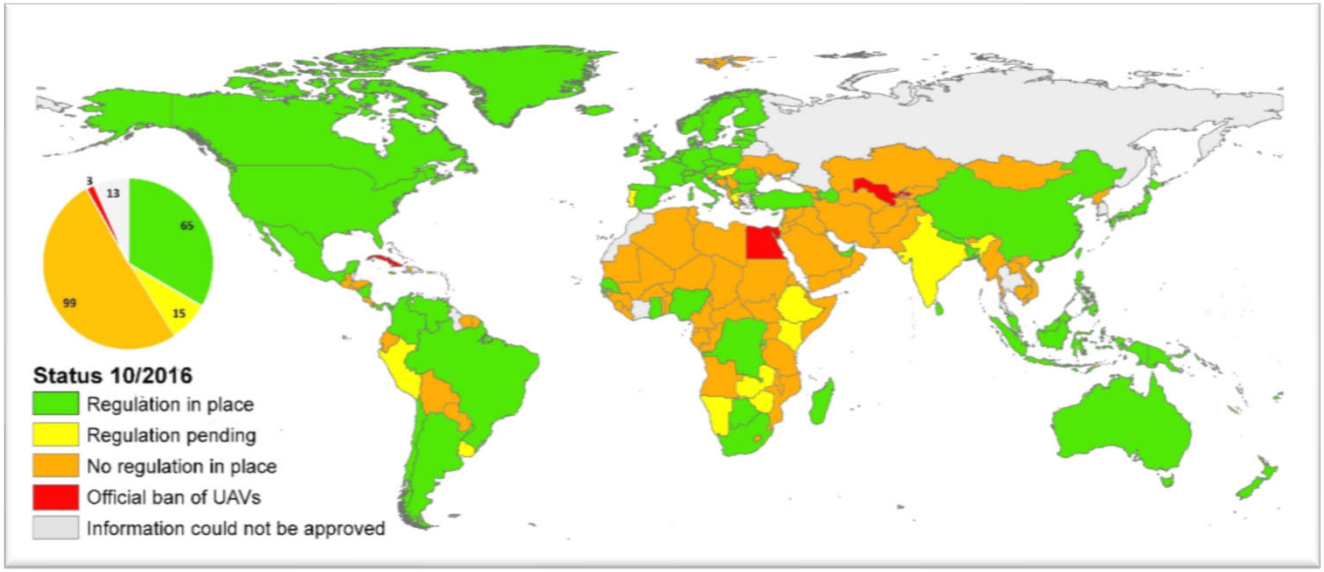
The consultancy service of WP4 includes guidelines and a customizable workflow for UAV-based data acquisition in the context of land administration.

Components of a UAV data collection

All requirements have to be fulfilled before starting the UAV data collection.



Flight Permission

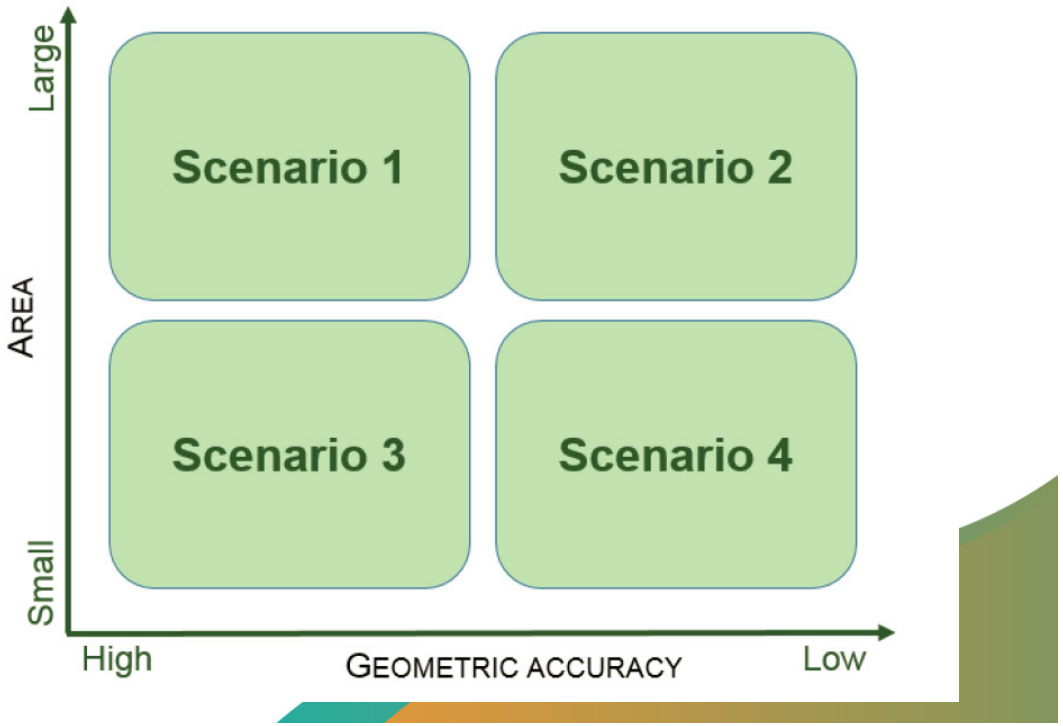


Significant impact on **how**, **where**, and **when** data can be captured

UAV workflow

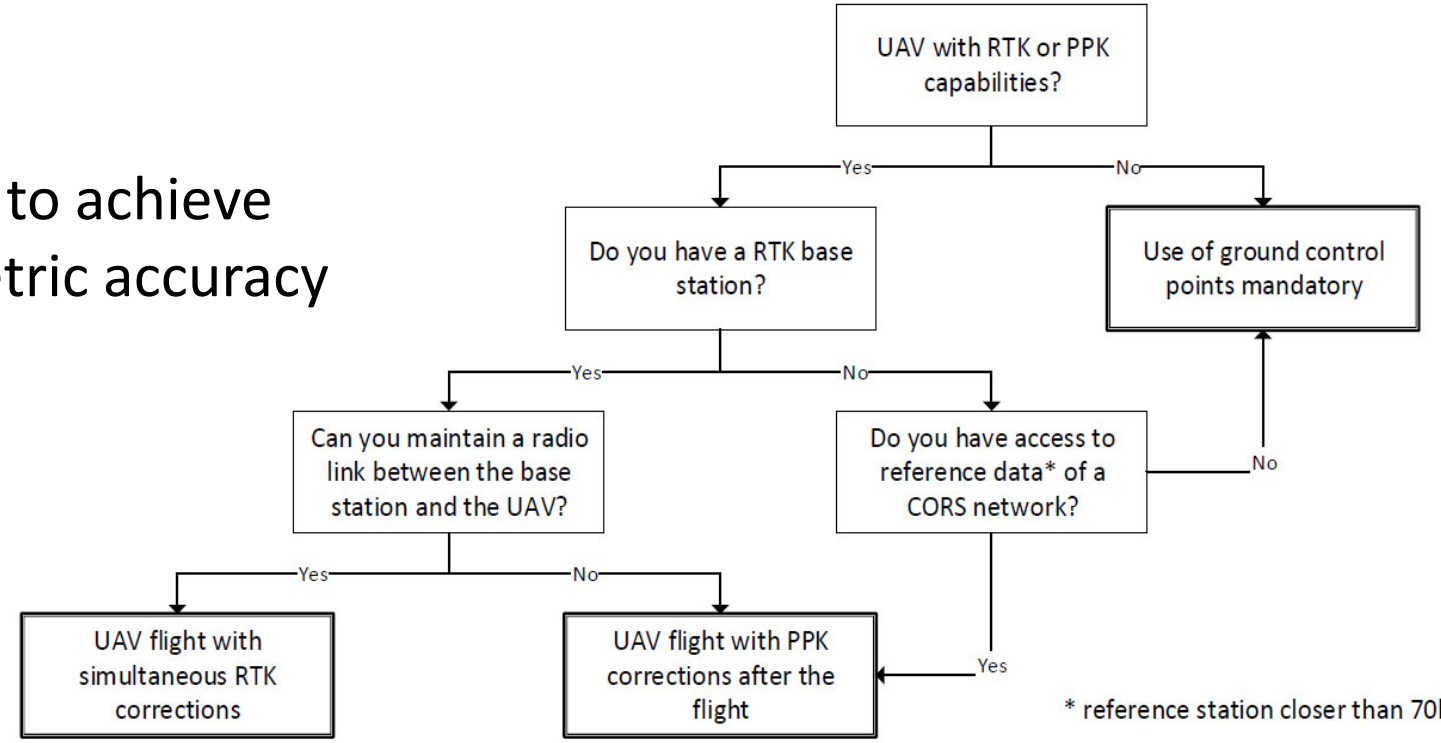
Scenario analysis:

- UAV equipment
- Flight planning
- Ground truthing
- Operational requirements



UAV workflow

Procedures to achieve high geometric accuracy

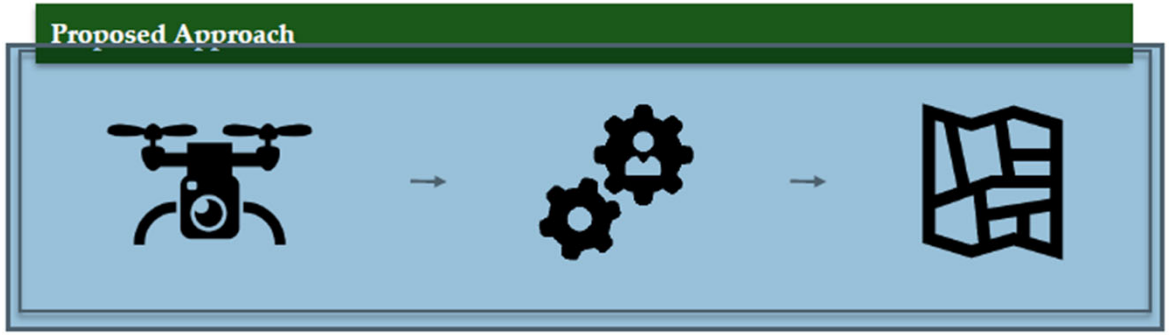


Boundary Creation: Feature Extraction

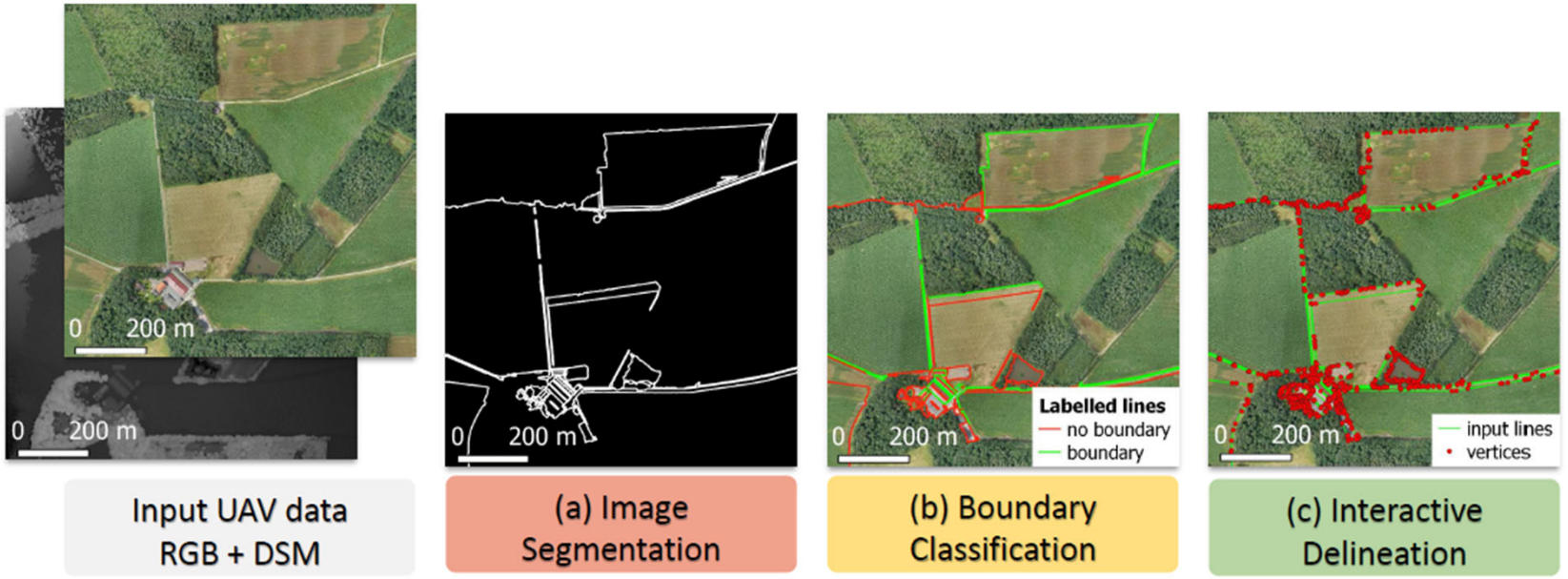
UT (ITC) – To design a tool for delineation of visible cadastral boundaries based on airborne /satellite images

Semi-automatic delineation of visible cadastral boundaries from aerial imagery

- Facilitate indirect cadastral surveying
  - by extracting visible boundary features
  - by making delineation more efficient



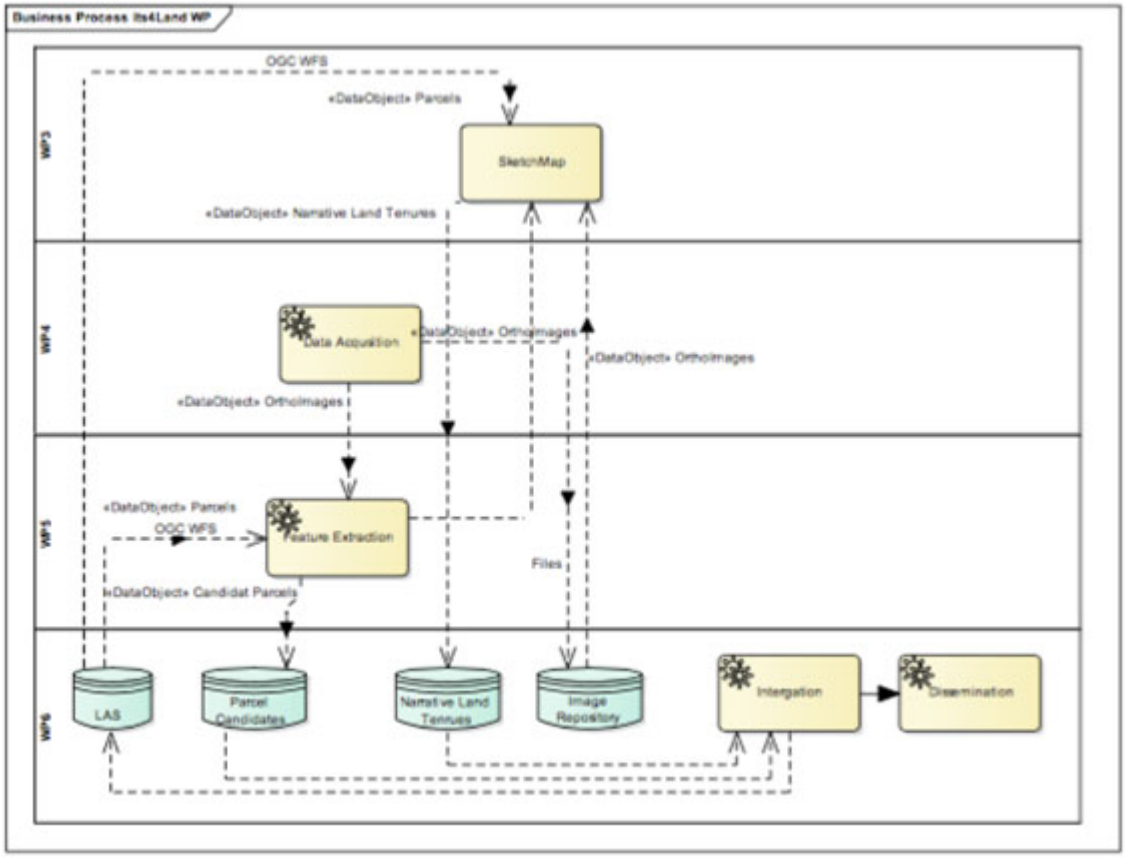
Feature Extraction Workflow



Applied workflow to detect and extract linear features considered for boundary delineation using airborne and satellite imagery

Publish and Share: GeoCloud

HL - Software tools integration in publish and share software platform



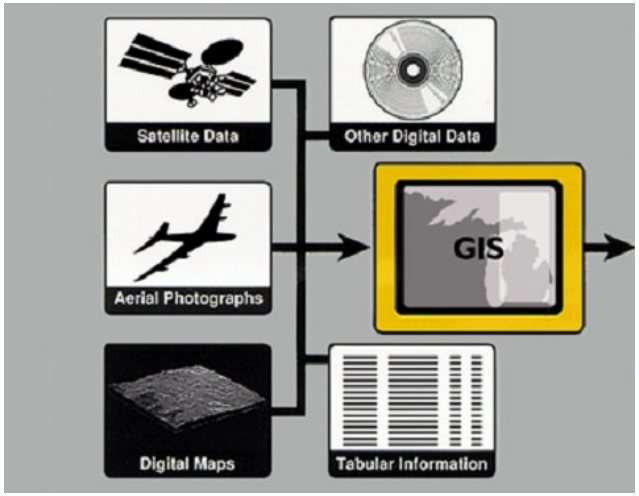
Exploitable Result of Publish and Share

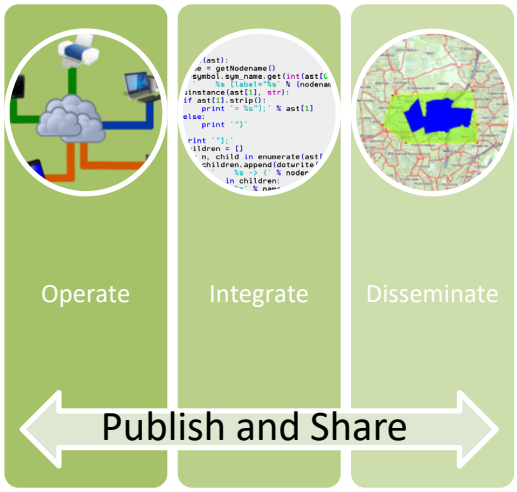
Publish and Share helps the integrator or ISV to efficiently build land administration workflows.

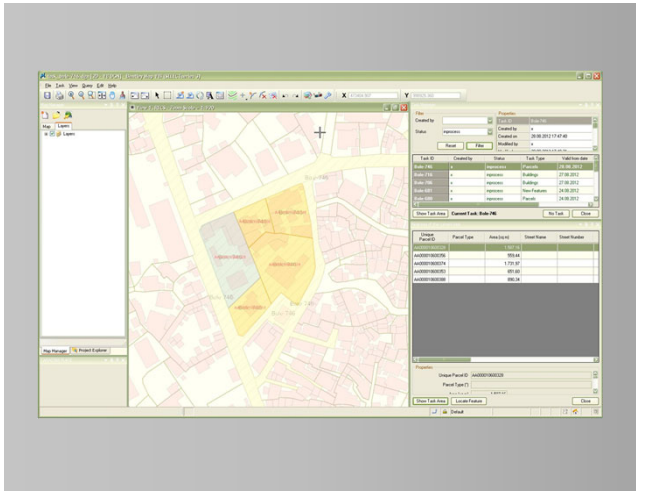
Publish and Share provides different usage models for developing land administration tasks

Publish and Share can be used in combination with the existing its4land tools or it can be extended by 3rd party tools

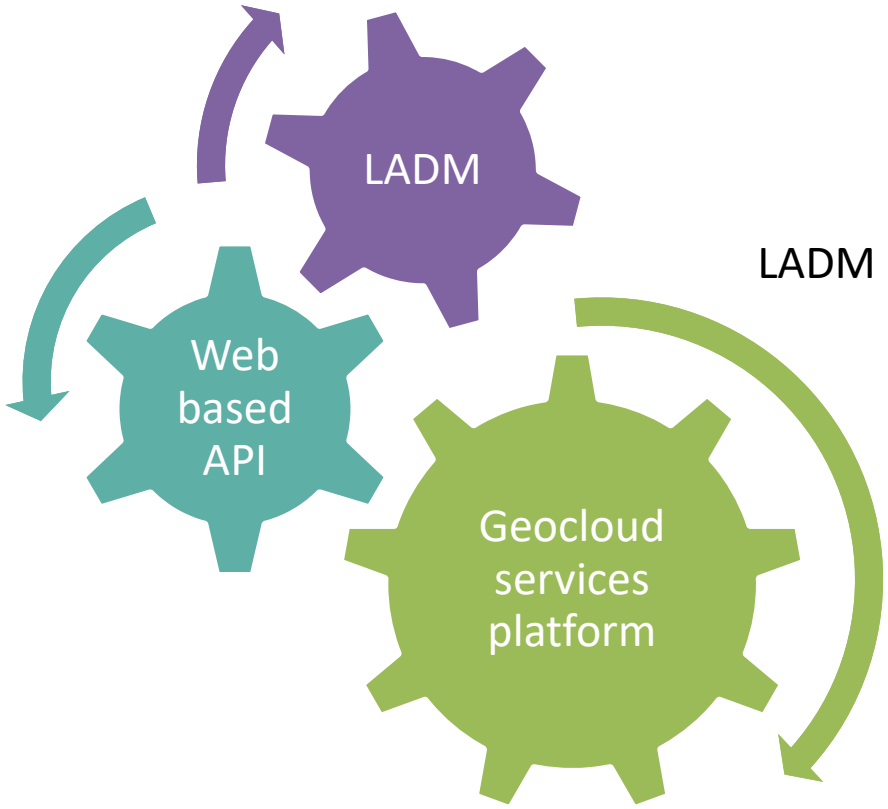
Publish and Share Platform







Core Concepts

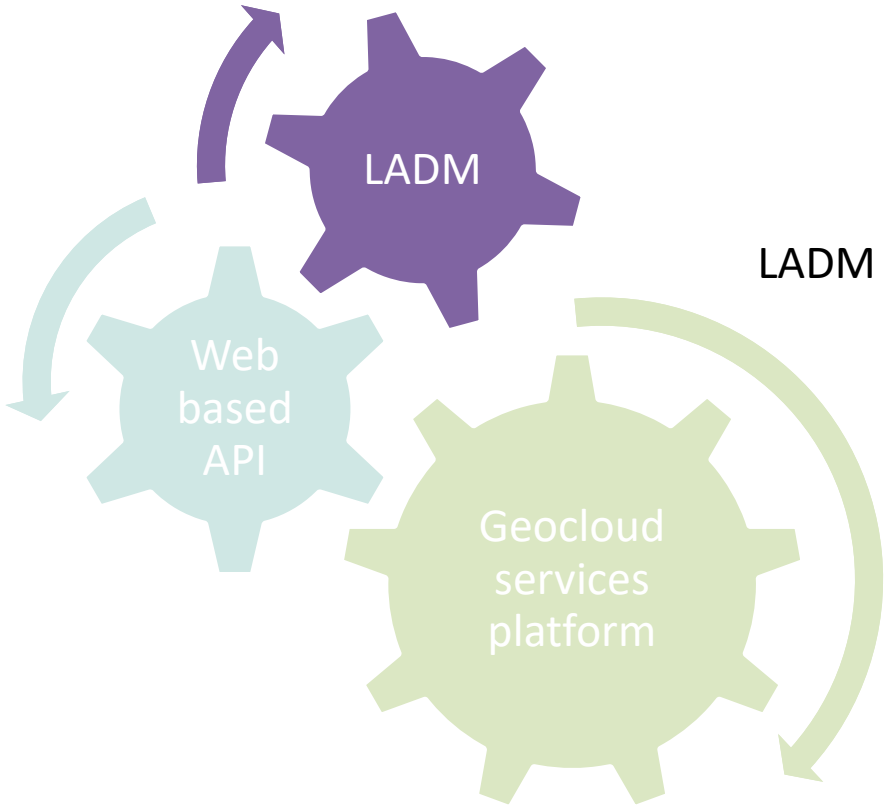


LADM provides the conceptual framework of terms

API based on state of the art standards

Cloud based computing for flexibility

Core Concepts



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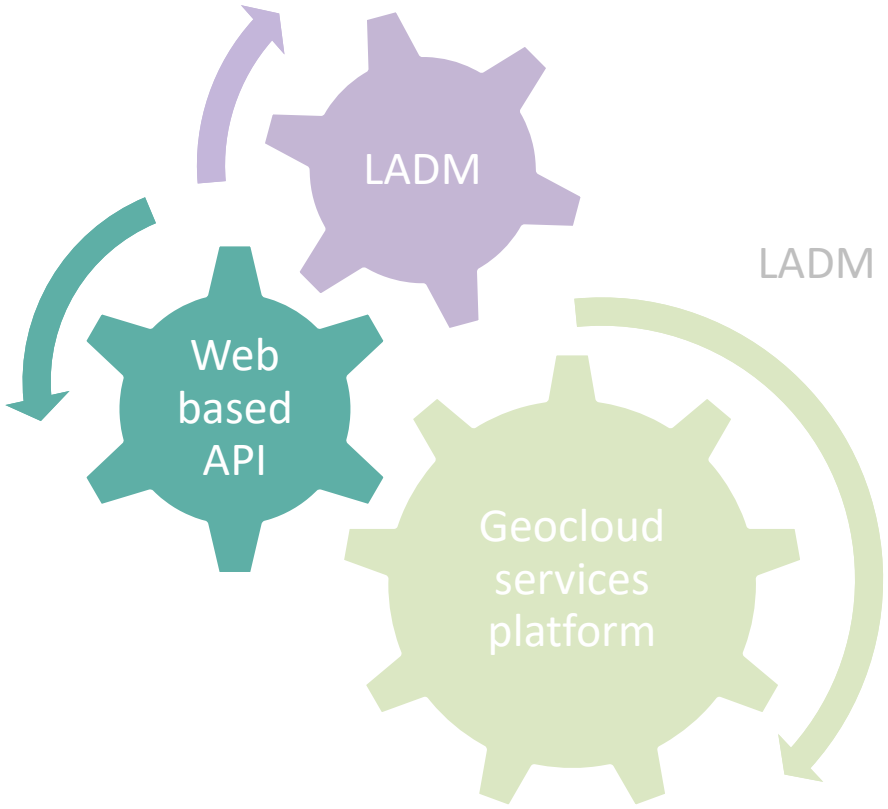

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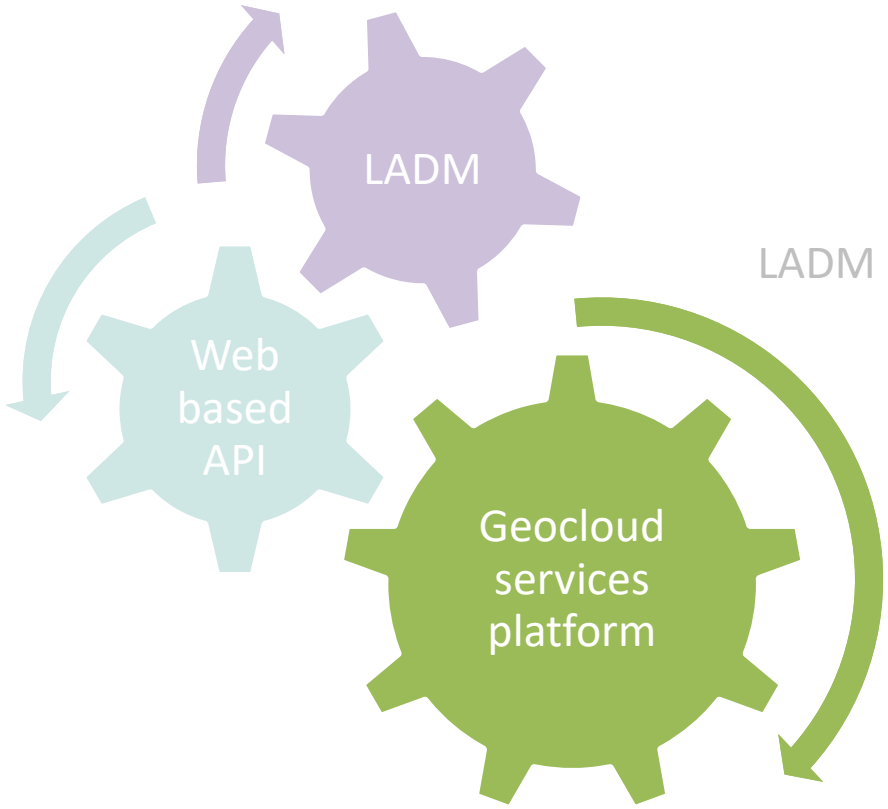

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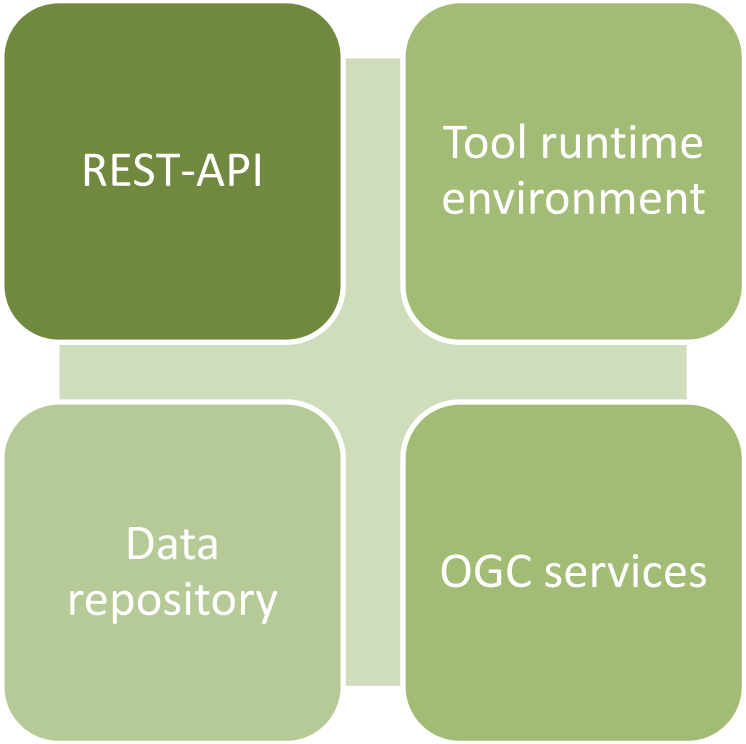
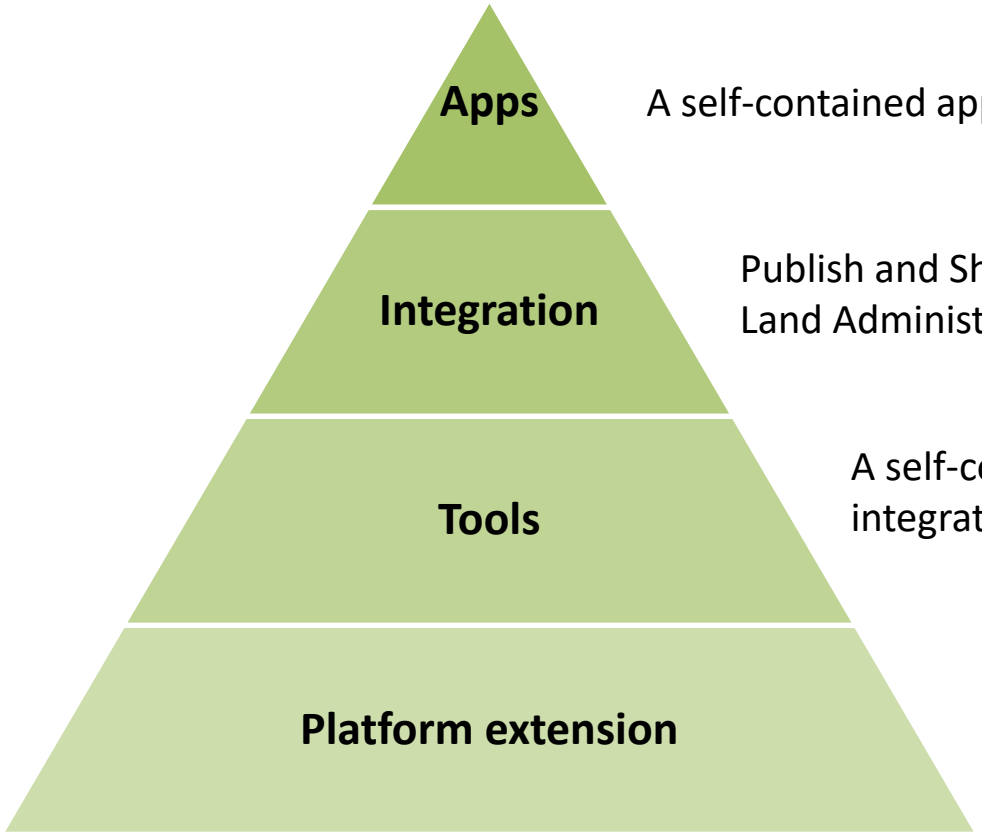
Building Blocks



1. A set of public REST-APIs that allows tools and applications to interact with the Publish and Share platform
2. A tool runtime environment for smart sketchmaps, image processing, boundary delineation and other tools
3. A data repository for alphanumeric, geo, binary and image data
4. OGC services for data dissemination

Usage models



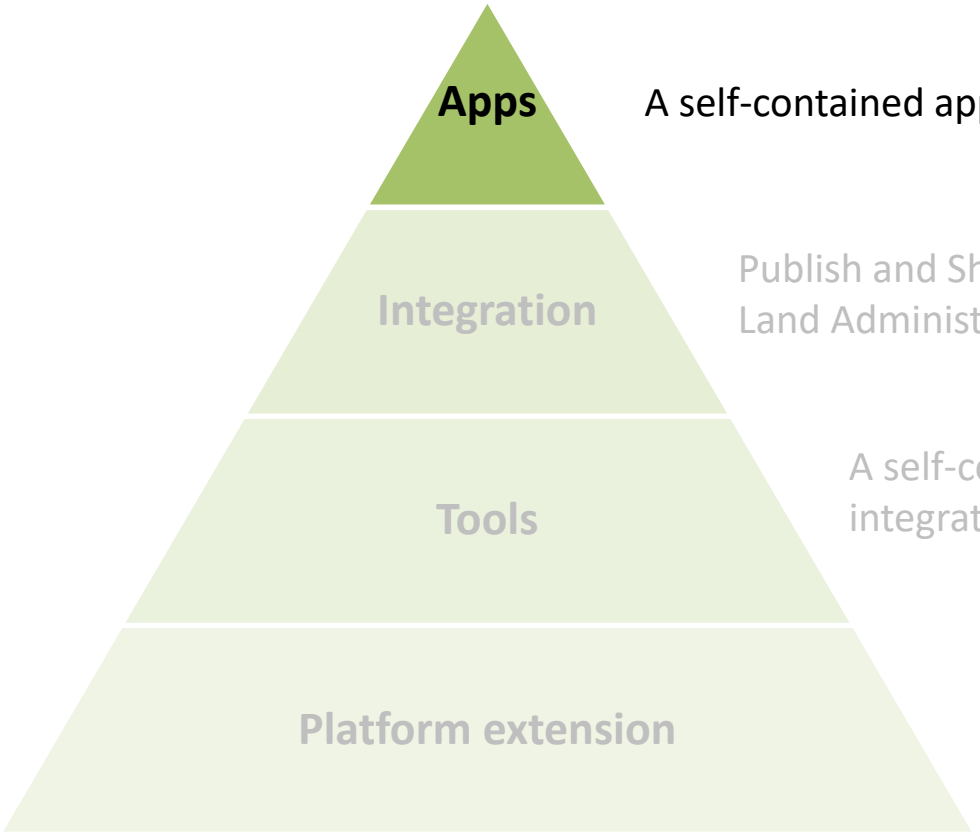
A self-contained application for an end-user.

Publish and Share functionality is integrated into a Land Administration workflow

A self-contained functionality used for integration or Apps

New core functionalities of the platform

Usage models



Apps A self-contained application for an end-user.

Publish and Share functionality is integrated into a Land Administration workflow

A self-contained functionality used for integration or Apps

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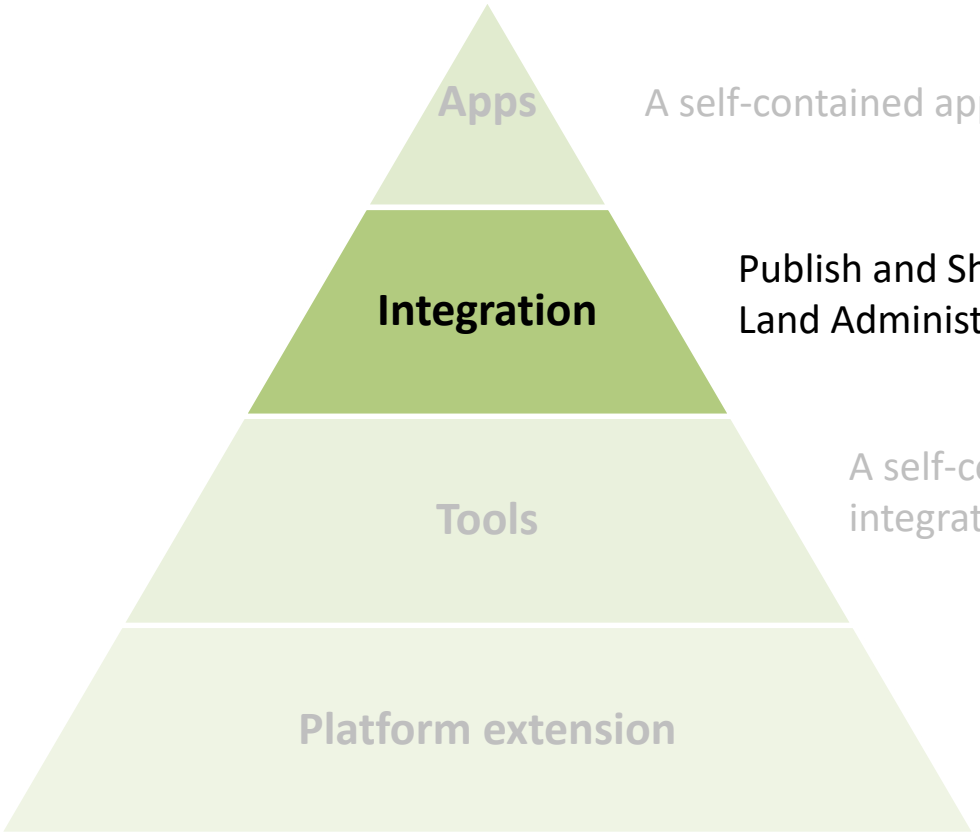

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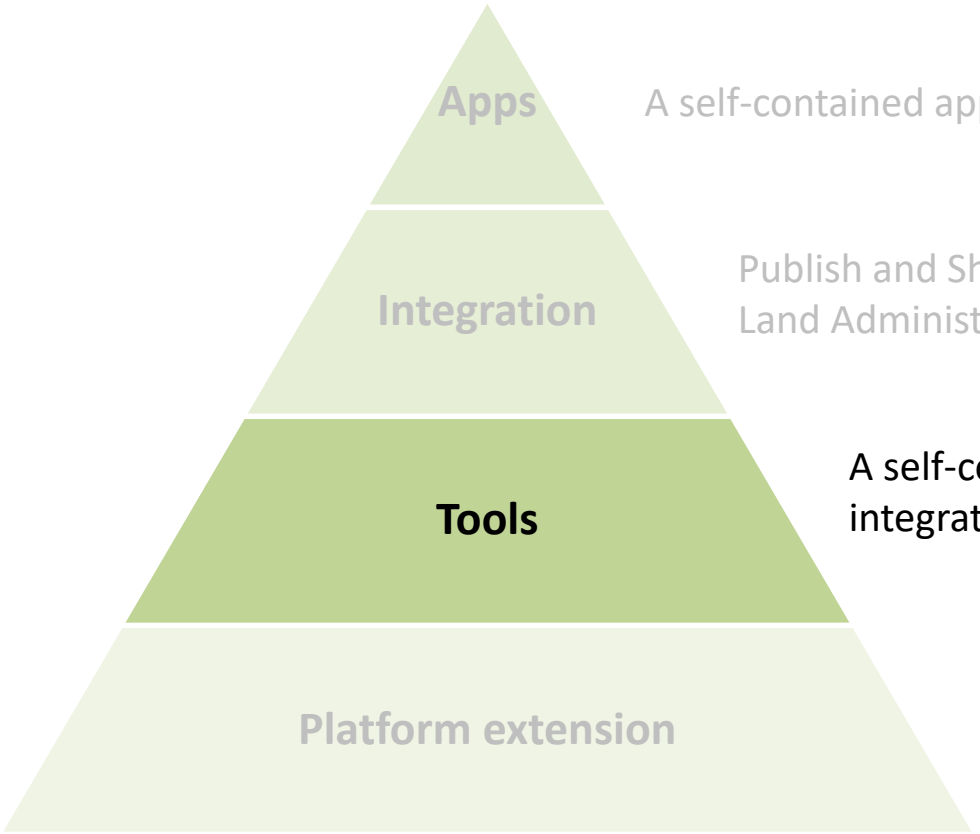

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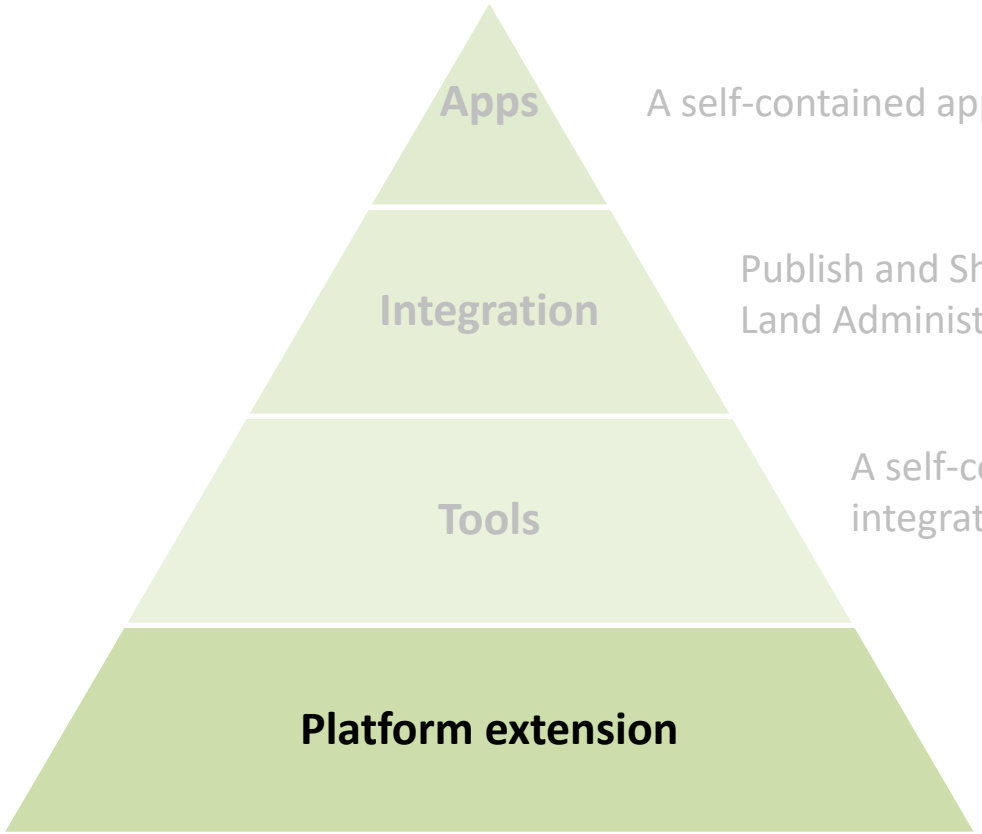

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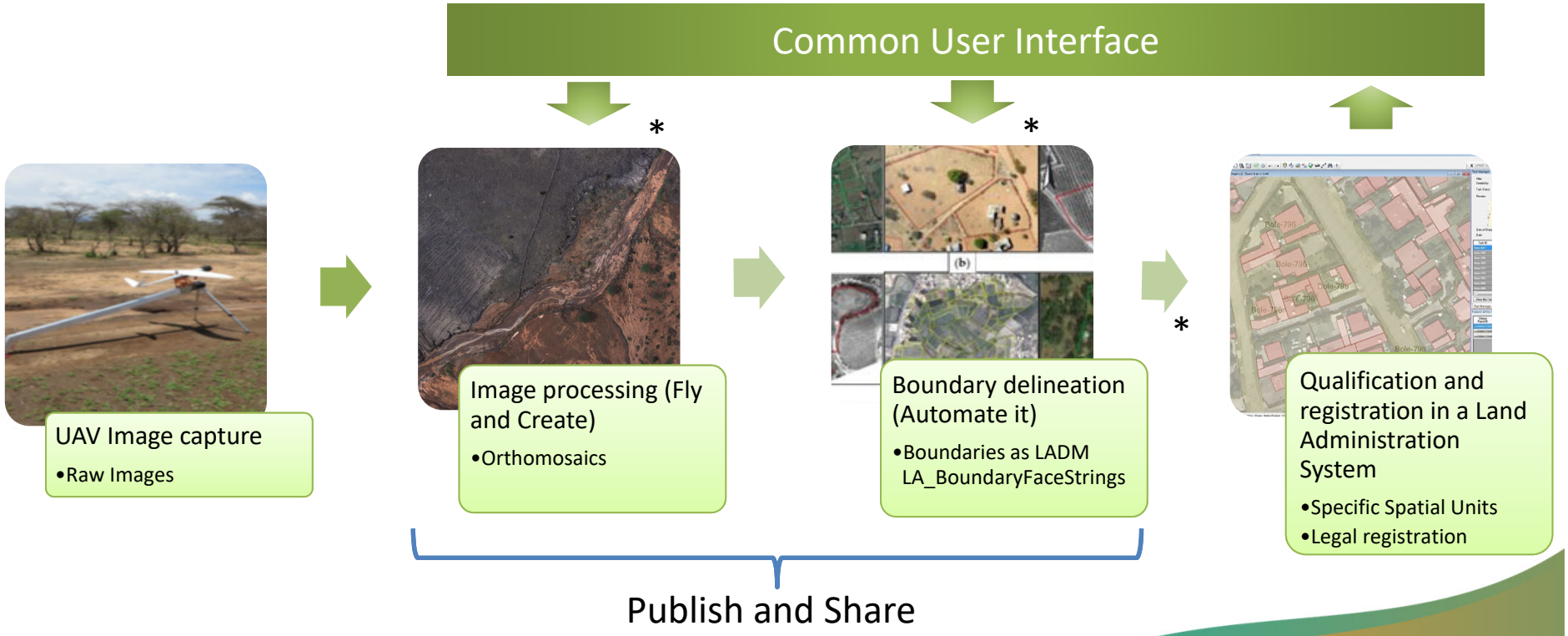
New core functionalities of the platform

Integration in LAS



* Publish and Share API and OGC Services

Publish and Share API

Implemented as a REST Web API

- Endpoints implement LADM concepts
  - Spatial Units, Spatial Source, Admin Source, etc.
- Fully documented by an interactive API reference
- Can be used with any programming language on all major operating systems

its4land Public API 0.0.2

[Base URL: platform.its4land.com/]

swagger.yaml

The its4land Public API provides access to the services of the its4land Publish and Share platform.

its4land - Website

Send email to its4land

MIT

Schemes

HTTPS

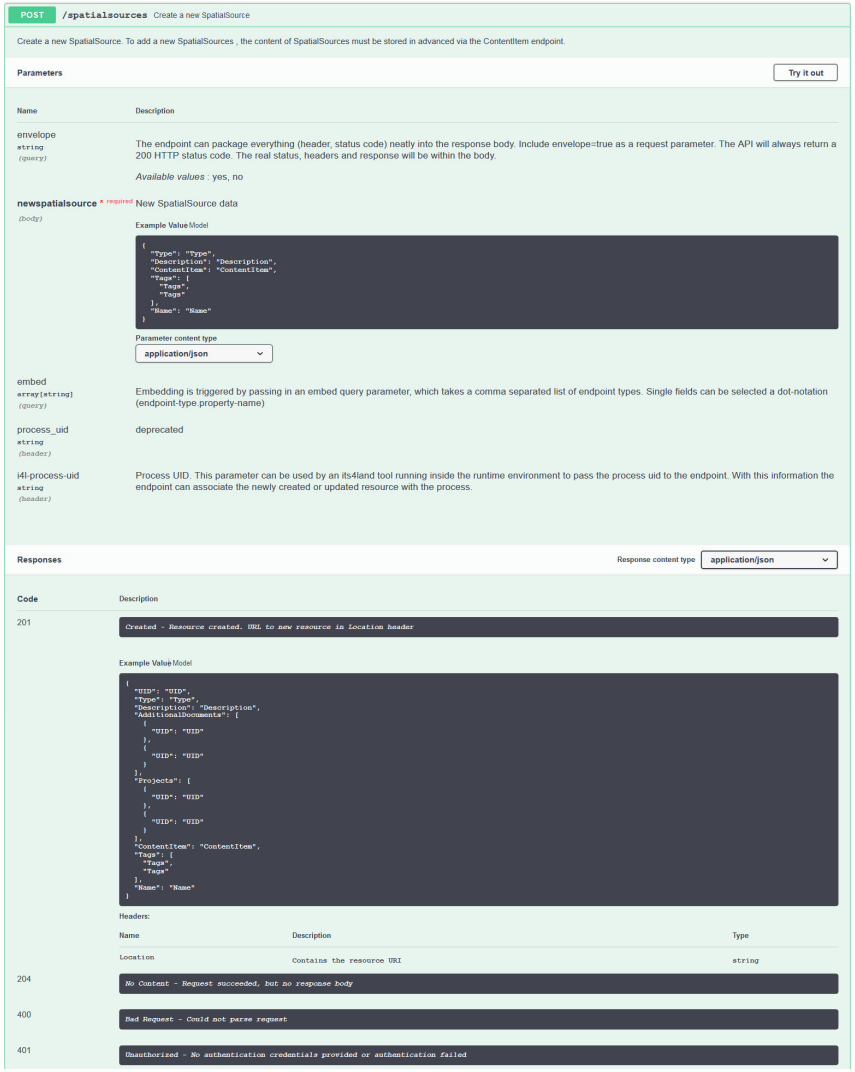
Site	Everything about Site. A site corresponds to an installation of the Publish and Share platform.	Find out more: https://plaform.its4land.com
Projects	Everything about projects. A project is the central structure in Publish and Share to organize task. A project has at least a Name and a AOI. Every data processed by tools in Publish and Share are accessible via the project	Find out more: https://plaform.its4land.com
Models	Everything about models. A model stores all data related to any kind of classification process based on any kind of TrainingSets. A Model is related to one or Project.	Find out more: https://plaform.its4land.com
TrainingSets	Everything about TrainingSets. A TrainingSet is part of Model and the base for a classifier	Find out more: https://plaform.its4land.com
SpatialSources	Everything about SpatialSources. A SpatialSource documents the evidence for as SpatialUnit. A SpatialSource can be a SketchMap, Orthoimages, etc. An SpatialSource may have several manifestations at the same time. See LADM for more details.	Find out more: https://plaform.its4land.com
Classifier	Everything about Classifier. A Classifier is part of a Model. The Classifier itself is defined by the Application.	Find out more: https://plaform.its4land.com
ModelClasses	Everything about ModelClasses. Assigned to Models. Describe the different class that can be detected by the Classifier of the Model.	Find out more: https://plaform.its4land.com
ContentItems	Everything about ContentItems. Any form of digital content, like files, images or other binary and non-binary structures.	Find out more: https://plaform.its4land.com
MetricMapFeatures	Everything about MetricMapFeatures. Handel of Point-, Line- and Polygon-TopographicFeature.	Find out more: https://plaform.its4land.com

SpatialSources

Everything about SpatialSources. A SpatialSource documents the evidence for as SpatialUnit. A SpatialSource can be a SketchMap, Orthoimages, etc. An SpatialSource may have several manifestations at the same time. See LADM for more details.

Find out more: https://plaform.its4land.com

GET	`/spatialsources`	Returns a list of SpatialSources
POST	`/spatialsources`	Create a new SpatialSource
GET	`/spatialsource/{spatialsource_uid}`	Returns a single SpatialSource
GET	`/spatialsource/{spatialsource_uid}/AdditionalDocument`	Returns the additional documents of a spatial source
POST	`/spatialsource/{spatialsource_uid}/AdditionalDocument`	Add a new additional document to a spatial source
GET	`/spatialsource/{spatialsource_uid}/AdditionalDocument/{adddoc_uid}`	Returns the additional documents of a spatial source
DELETE	`/spatialsource/{spatialsource_uid}/AdditionalDocument/{adddoc_uid}`	Removes an additional document for a spatial source.



POST `/spatialsources` Create a new SpatialSource

Create a new SpatialSource. To add a new SpatialSources , the content of SpatialSources must be stored in advanced via the ContentItem endpoint.

Parameters — Try it out

Name	Description
envelope string (query)	The endpoint can package everything (header, status code) neatly into the response body. Include envelope=true as a request parameter. The API will always return a 200 HTTP status code. The real status, headers and response will be within the body. *Available values :* yes, no
newspatialsource * required (body)	New SpatialSource data Example Value Model `{ "Type": "Type", "Description": "Description", "ContentItem": "ContentItem", "Tags": [ "Tags", "Tags" ], "Name": "Name" }` Parameter content type: application/json
embed array[string] (query)	Embedding is triggered by passing in an embed query parameter, which takes a comma separated list of endpoint types. Single fields can be selected a dot-notation (endpoint-type.property-name)
process_uid string (header)	deprecated
i4l-process-uid string (header)	Process UID. This parameter can be used by an its4land tool running inside the runtime environment to pass the process uid to the endpoint. With this information the endpoint can associate the newly created or updated resource with the process.

Responses — Response content type: application/json

Code	Description
201	*Created - Resource created. URL to new resource in Location header* Example Value Model `{ "UID": "UID", "Type": "Type", "Description": "Description", "AdditionalDocuments": [ { "UID": "UID" }, { "UID": "UID" } ], "Projects": [ { "UID": "UID" }, { "UID": "UID" } ], "ContentItem": "ContentItem", "Tags": [ "Tags", "Tags" ], "Name": "Name" }` Headers: Name: Location — Description: Contains the resource URI — Type: string
204	*No Content - Request succeeded, but no response body*
400	*Bad Request - Could not parse request*
401	*Unauthorized - No authentication credentials provided or authentication failed*

Govern and Grow:
Sustainable Governance and Capacity Building Models

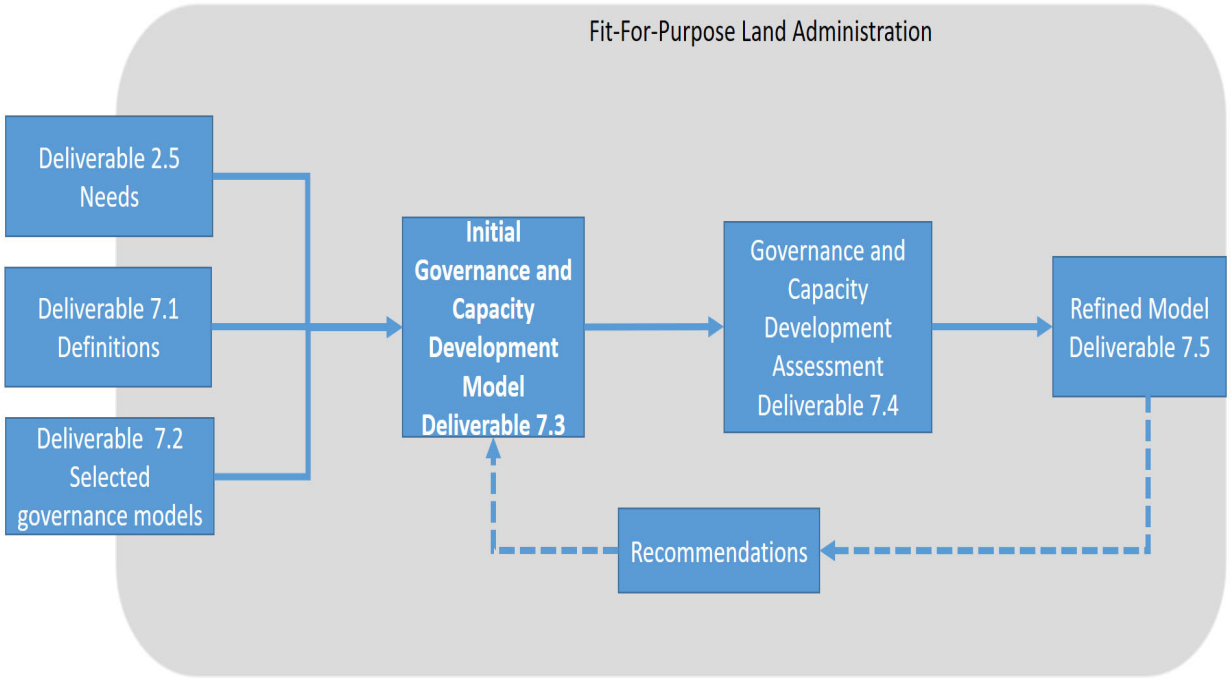
KUL - Developing of a governance and a capacity development model to support the implementation and evaluation of innovative tools

Review relevant ICT/land governance and capacity development models

The three “Good governance” models are:

- Multi-level Governance Assessment of OECD (OECD, 2011),
- Framework and Guidelines in Land Policy Africa (African Union, African Development Bank, & Economic Commission for Africa, 2010), and
- Land Governance Assessment Framework (World Bank, 2015).

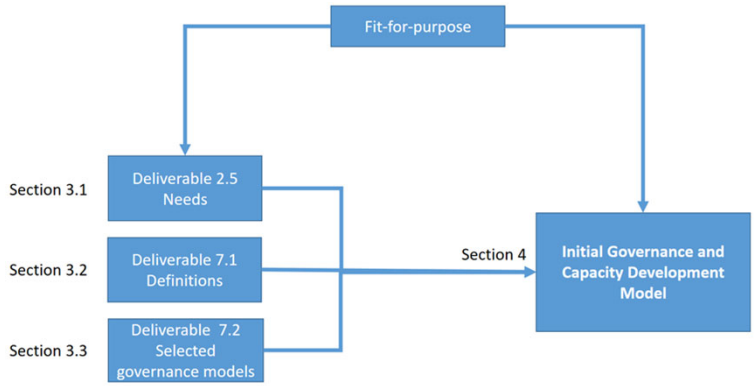
ITS4LAND governance and capacity development models



ITS4LAND governance and capacity development models

Three sources forming the foundation of the initial model, being:

- The needs from Deliverable 2.5, 2)
- The definitions of Deliverable 7.1
- The selected models presented in Deliverable 7.2.



T7.3 Initial versions of ITS4LAND governance and capacity development models

Initial Governance and Capacity Development Model (IGCDM) has three blocks:

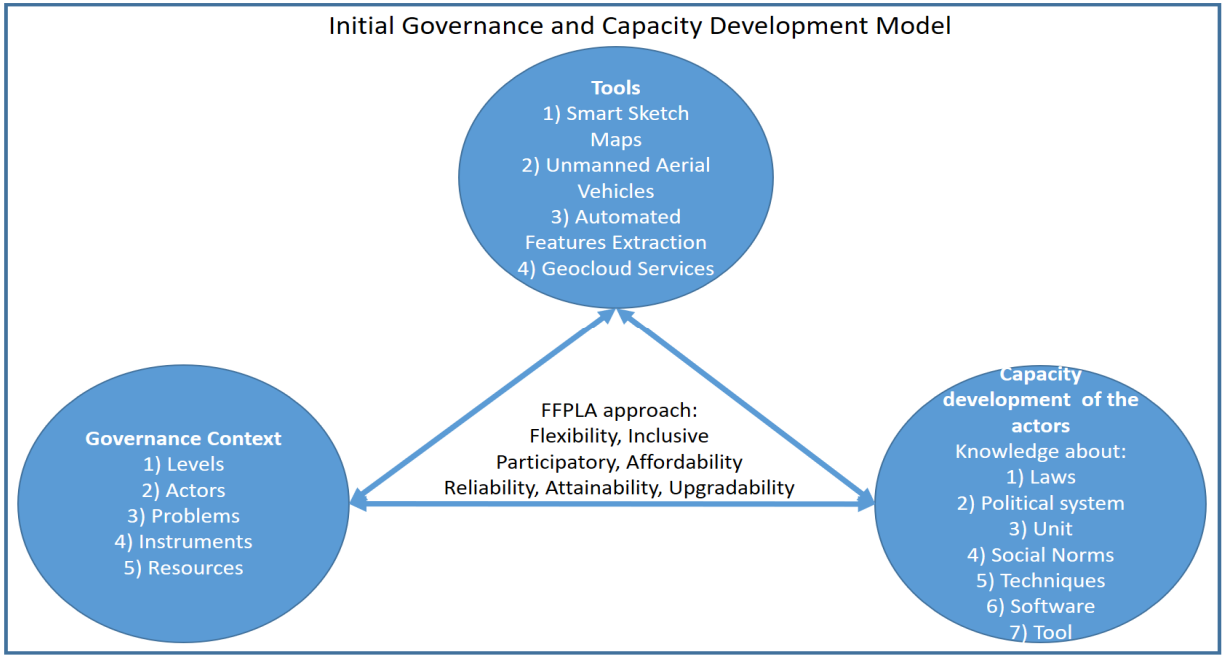
1) The its4land tools

2) The governance context

3) The capacity development.

Building blocks aligned with the seven Fit-for Purpose Land Administration (FFPLA) elements: 1) Flexibility, 2) Inclusive, 3) Participatory, 4) Affordability, 5) Reliability, 6) Attainability and 7) Upgradability (Enemark et al., 2014)..

ITS4LAND governance and capacity development models



Alignment between the tools and the FFPLA elements

FFP conditions	Smart Sketchmaps	Unmanned Aerial Vehicles	Automated Feature Extraction	Geocloud Services
Flexibility	The tool can provide information according to the users' needs	The tool can provide information according to the users' needs. It is flexible in spatial resolution and spectral information	The tool can be applied to delineate different types of boundaries, according to the user needs	The tool can be adapted for different usages and scenarios, according to the user needs
Inclusive	The tool has the capacity to capture the different land tenure practices	The tool has the capacity to cover the different types of land (spatial) information.	The tool supports image based identification and vectorization of visible cadastral boundaries	The tool provides information for registration in land administration systems
Participatory	The community is engaged in the adoption of the tool	The community is engaged in the adoption of the tool	The tool is intuitive and open to be used by different stakeholders	There is participation of the users
Affordability	The adoption of the tool is affordable in cost	The adoption of the tool is affordable	The adoption of the tool is affordable	The adoption of the tool is affordable
Reliability	The collected information could be updated and is recognized by the government	The collected information could be updated and officially recognized by the government	The created information can be updated and is recognized as reliable by the government	The collected information is recognized reliable by the government
Attainability	The SSM adoption can be made with the available resources in an efficient manner	The UAV adoption can be made with the available resources in an efficient manner. Cloud services can support its adoption	The AFE adoption can be made with the available resources in an efficient manner	The geocloud adoption can be made with the available resources in an efficient manner
Upgradability	The SSM could be upgraded by the users according to their needs. They can extend the domain of the models	The UAV's information could be upgraded according to the users' needs by flying again over the same area	The tool is developed in a modular fashion allowing partial adaptation and improvements	The geocloud service could be upgraded by the users according to their needs

ITS4LAND governance and capacity development models

Building blocks presented allowing an assessment of the its4land tools, the governance context and capacity development context

Setting the criteria to assess the its4land tools enhances the understanding of the governance and capacity development limitations of the tools' adoption

Understanding governance context facilitating the adoption process of the tools + recommendations at different governmental levels.

ITS4LAND governance and capacity development models

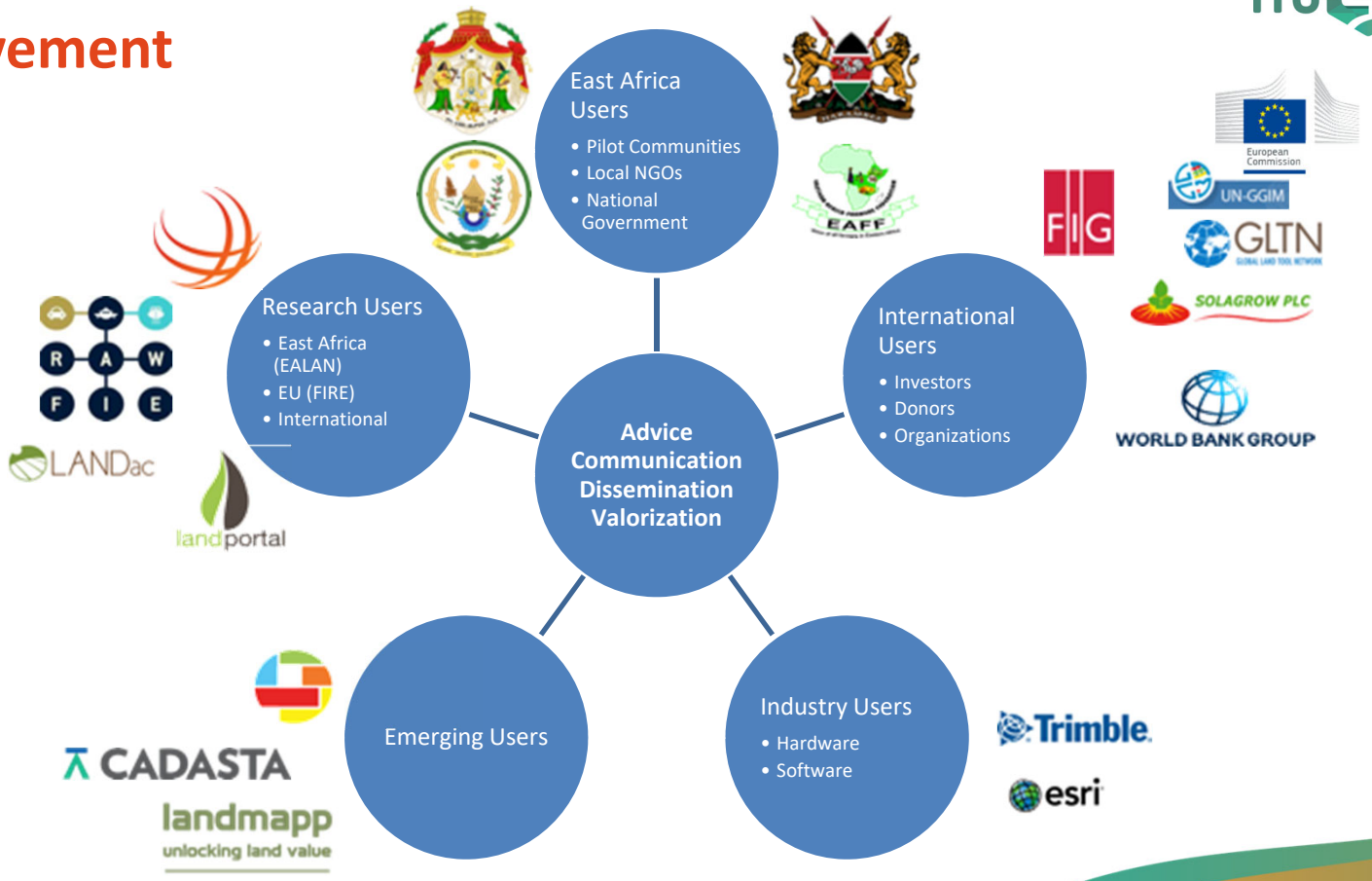
- A diagnose of the available capacity by distinguishing between the types of governance arrangements and the available capacity will facilitate the adoption of the tools.
- The application of the model -> See Deliverable 7.4 (under full construction)

Capitalize: Exploitation and Business Modelling

HL- Business Model and business plan development for key exploitable results (KERs) of each work package

KER Type	KER Name	KER Brief Description
Consultancy	Needs Assessment	Consultancy services for needs assessment
Software	Smart Sketchmap (Smart SkeMa) Data Collection Tool	Smart Sketchmap is a tool to record aspects of people to land relationships where the spatial component is captured using hand drawn sketch maps and described in a qualitative way (not surveyed) and then automatically transformed for further usage in a GIS
Consultancy	UAV-based Data Acquisition	Consultancy services for UAV-based data acquisition for land tenure recording
Software	Semi-automatic Visible Boundaries Delineator	A tool that facilitates image-based cadastral mapping by extracting visible boundaries automatically and by supporting the delineation procedure.
Software	Publish and Share	Platform with integrated tools to publish and share land information.
Consultancy	Governance and Capacity Building	Consultancy services to apply the governance and capacity development models for the use of the its4land geospatial tools

Involvement



Thank you for your attention.