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Institut d'Enseignement Superieur de Ruhengeri (INES)
Bahir Dar University (BDU)
Technical University of Kenya (TUK)
ESRI Rwanda (ESRI).

1 Executive Summary

Deliverable D6.5 documents the outcome of task T6.5. The aim of task T6.5 is the preparation of documentation for Publish and Share.

The Publish and Share platform is primarily intended as a development platform to be used in land administration related projects. Typical users of its4land Publish and Share are independent software vendors (ISV) or integrators to create services / applications for end-users.

Publish and Share offers a set of high-level geocloud based services for developers of land administration systems to use or integrate spatial references for land tenure registration. Using these geocloud services allows a vendor to concentrate on functionalities required by their customer instead of re-implementing common solutions for common problems. All these services are based on the concepts introduced by LADM.

Four different usage models have been developed to improve Land Administration workflows and tasks by Publish and Share:

Application: A self-contained application for an end-user.

Integration: Publish and Share functionality is integrated into a Land Administration workflow.

Tools: A self-contained functionality used for integration or applications.

Platform extension: New core functionalities of the platform.

The documentation set developed in T6.5 provides a software developer or a system architect the necessary knowledge to design and implement individual land administration workflows on Publish and Share.

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Abbreviations

FOSS	Free Open Source Software
GDAL	Geospatial Data Abstraction Library
GRASS	Geographic Resources Analysis Support System
GUI	Graphical User Interface
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ISV	Independent Software Vendor
JSON	JavaScript Object Notation
LADM	Land Administration Domain Model
LAS	Land Administration System
OAS	OpenAPI Specification
OGC	Open Geospatial Consortium
ORM	Object-relational mapping
REST	Representational State Transfer
SME	Small-Medium-Enterprises
TRL	Technical Readiness Level
UAV	Unmanned Aerial Vehicle
UML	Unified Modeling Language
URI	Uniform Resource Identifier
WFS	Web Feature Service
WMS	Web Map Service

2 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 cheaply map millions of unrecognized land rights in the region. ICT innovation is intended to play a key role. Many existing ICT-based approaches to land tenure recording in the region have failed: 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 sketch maps, 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 capitalization. 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 contextualization, design, and eventual land sector transformation. In line with Living Labs thinking, localized 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 are 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.

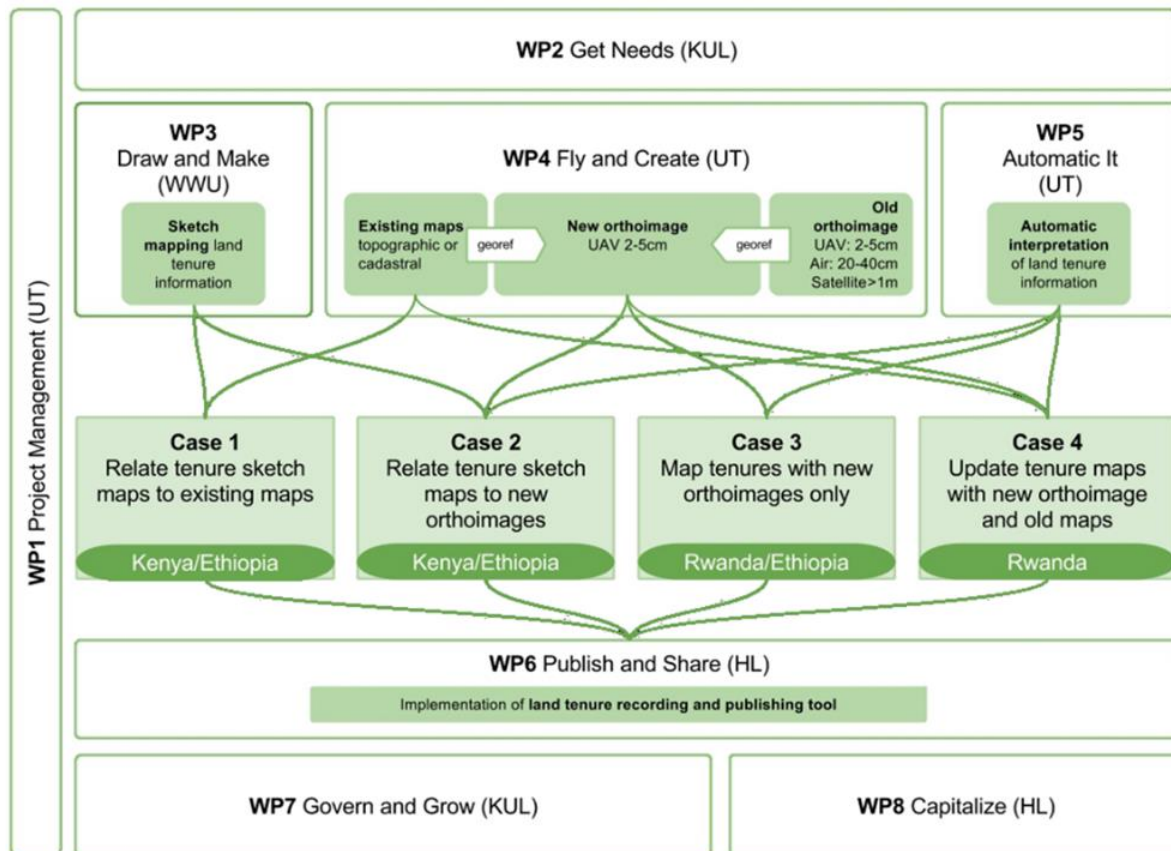
2.1 The Publish and Share platform in its4land

Publish and Share combines the tools and methods developed in *Draw and Make*, *Fly and Create* and *Automate It* in a technical platform (see **Figure 1**).

The Publish and Share platform can be considered on the one hand as a runtime environment for the tools developed in its4land and on the other hand as a provider of data and information for existing land administration systems (LAS) or other tools. The platform will be accessible via service interfaces based on standards from Open Geospatial Consortium (OGC) and World-Wide-Web Consortium (W3C). The modelling of the interfaces follows the concepts introduced by Land Administration Domain Model (LADM). External systems like LAS or planning systems can use the service interfaces to integrate data into their own processes, based on specific national rules. The usage scenarios and workflows to combine

the its4land tools with land administration systems will be defined and implemented to a prototype level.

Figure 1: Overview of the its4land work packages



The implementation of the Publish and Share platform follows a toolbox approach and will provide a framework consisting of common APIs and services used by all its4land tools. From this toolbox, a user can select those its4land tools fitting his tasks best.

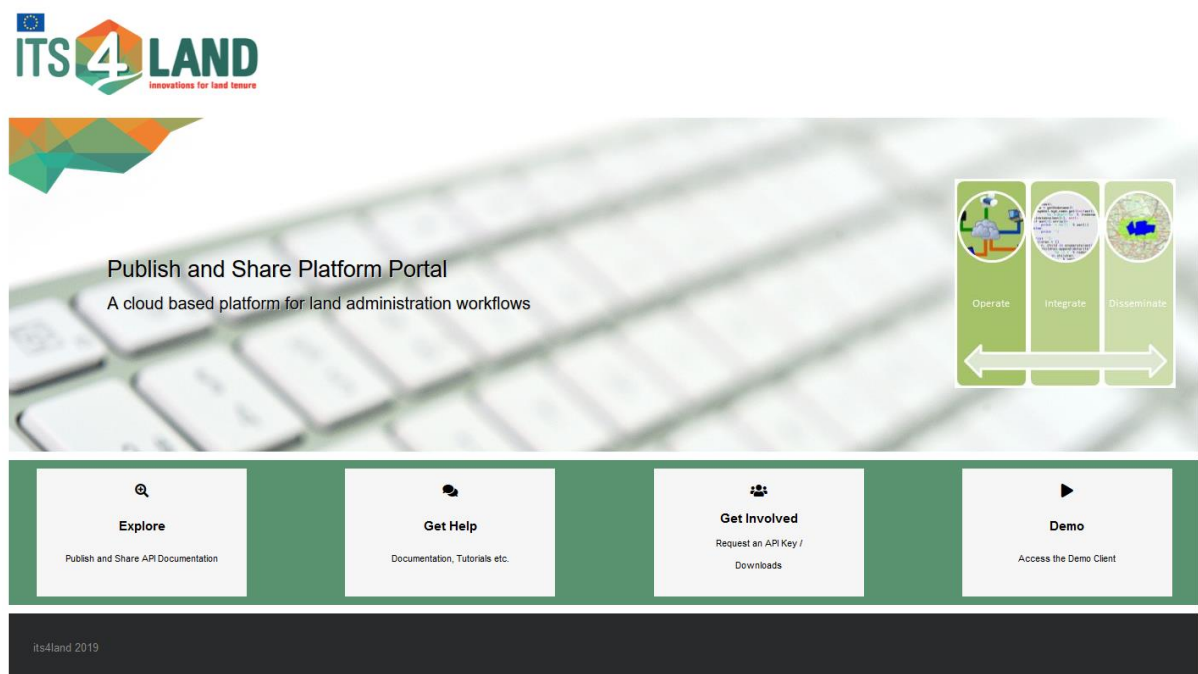
As per the paradigm of geocloud, the tools will be implemented as services accessible via an Application Programming Interface (API) based on web standards. Tools which are capable of calling a REST API can make use of any kind of Publish and Share service, like public APIs or storage services. For 3rd party tools developed outside the scope of its4land, it is the responsibility of the 3rd party tool vendor or creator to adapt their tools to Publish and Share.

Its4land's claim is the development of state of the art methods for recording land rights with special consideration for the needs of local stakeholders in developing countries. To achieve a close integration with local stakeholders, adopting needs and land tenure concepts is required.

3 Overview of the Publish and Share Platform Website

The Publish and Share platform website is the central starting point for Software developers who want to develop on top of the Publish and Share platform.

Figure 2: The Publish and Share web site



The website provides resources for developers such as documentation, source code, libraries and contact information for support.

The website and all the resources of Publish and Share are available as a sub domain of the domain its4land.com:

<http://platform.its4land.com/>.

The website provides four main areas:

- Explore
- Get Help
- Get Involved
- Demo

3.1 Explore

Explore directs the user to the interactive online documentation of the Public API. The API documentation contains detailed information on any REST-Endpoint of the Public API.

Figure 3: The Public API reference

its4land Public API 0.8.2

[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

[Authorize](#)

Site	Everything about Site. A site corresponds to an installation of the Publish and Share platform.	Find out more: https://platform.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://platform.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://platform.its4land.com/
TrainingSets	Everything about TrainingSets. A TrainingSet is part of Model and the base for a classifier	Find out more: https://platform.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://platform.its4land.com/
AdminSources	Everything about AdminSources. A AdminSource documents the evidence for a interest in land. This could be a right like ownership or a restriction like right of way. The AdminSource document itself is not the registration, it provides an evidence for a later registration in a LAS. The AdminSource Document is related to a SpatialUnit. See LADM for more details.	Find out more: https://platform.its4land.com/
SpatialUnits	Everything about SpatialUnits. Details defined by the Concept. See LADM for more details.	Find out more: https://platform.its4land.com/
BoundaryFaceString	Everything about BoundaryFaceString. See LADM for more details.	Find out more: https://platform.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://platform.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://platform.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://platform.its4land.com/
MetricMapFeatures	Everything about MetricMapFeatures. Handel of Point-, Line- and Polygon-TopographicFeature.	Find out more: https://platform.its4land.com/
Images	Everything about Images. Orthoimages that should be published on Publish and Share	Find out more: https://platform.its4land.com/
Tags	Everything about Tags. Nearly every resource accessible via this API can be tagged. Endpoint for handle Tags.	Find out more: https://platform.its4land.com/
WP5ValidationSets	Everything about WP5ValidationSets. WP5 requires a different kind of classification. This Endpoint is only used by WP5	Find out more: https://platform.its4land.com/
Tools	Everything about tools	Find out more: https://platform.its4land.com/
Processes	Everything about processes	Find out more: https://platform.its4land.com/
Misc	General endpoints	Find out more: https://platform.its4land.com/

Models

VALID {~}

3.2 Get Help

Under the topic Get Help, the user can find manual and tutorials on how to use the Publish and Share platform in projects. The documentation under this topic is primarily intended for software developers who want to implement Land Administration related workflows and functionalities. For a detailed description of the manual see Chapter 4. In this section, the manual for the its4land tools *Draw and Create*, *Fly and Create* and *Automate it* that are accessible in the demo-client can also be hosted.

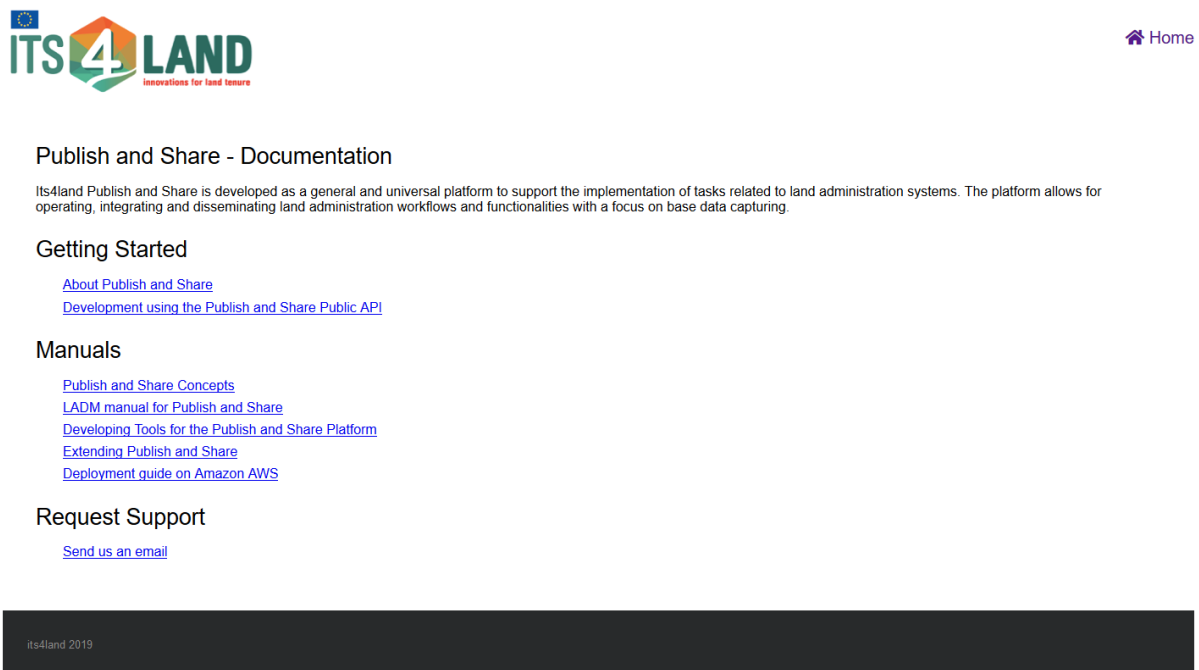
In this section following manuals are currently available:

- Publish and Share Concepts
- LADM manual for Publish and Share
- Developing tools for the Publish and Share platform
- Extending Publish and Share
- Deployment guide on Amazon AWS

The manual are described in greater detail in chapter 4.

This area also contains the possibility to contact developers for support via Email.

Figure 4: The "Get Help" section of the Publish and Share web site



3.3 Get Involved

Under this topic we have placed some resources for developers using the Public and Share platform.

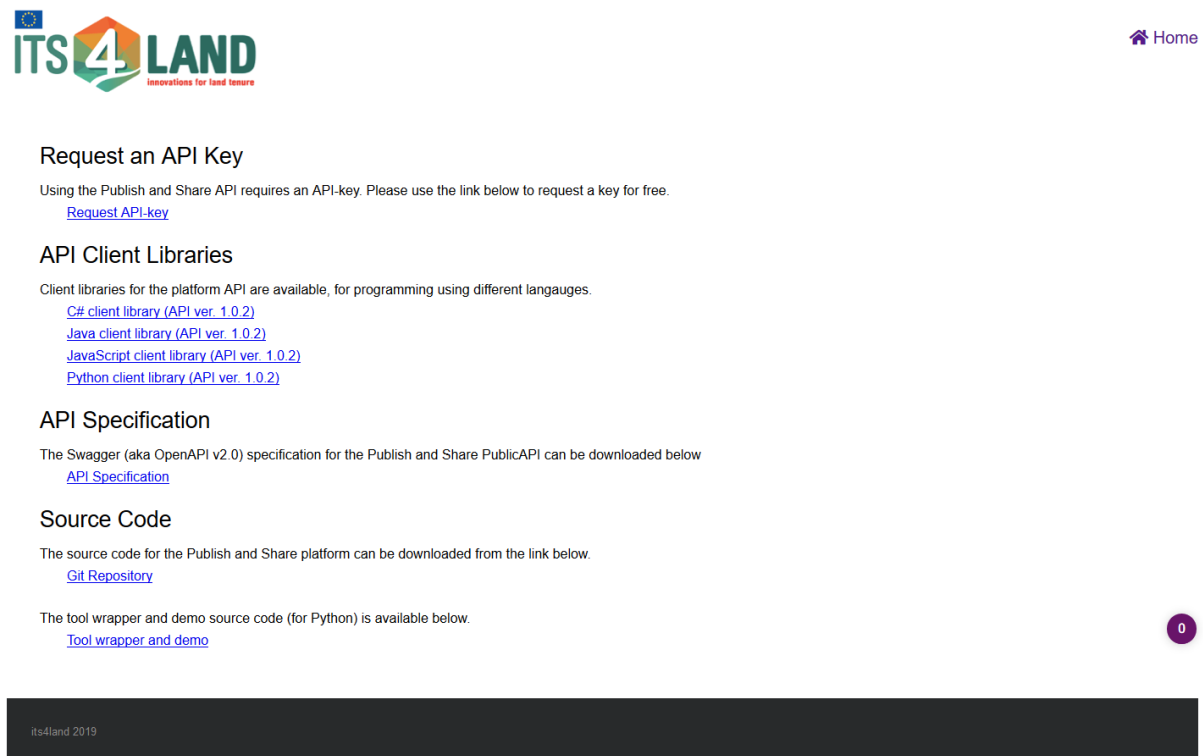
First, the developer can request an API key. This key is required for external developers to use the Public API. We have decided to use an API Key due to following reasons:

- to protect the system from unauthorized use
- to track usage and keep control of the resource spending in the platform

Under “Get Involved” the developer can also find ready to use client libraries for different programming languages that simplify the use of the Public API. The client library versions will be in sync with the interactive online documentation. The API specification using the OpenAPI v2.0 standard is provided here as well.

The last resource is a link to the git-hub repository containing the source code of the platform. Source code for the tool wrapper and a demonstration tool, written using the Python programming language, are available here as well.

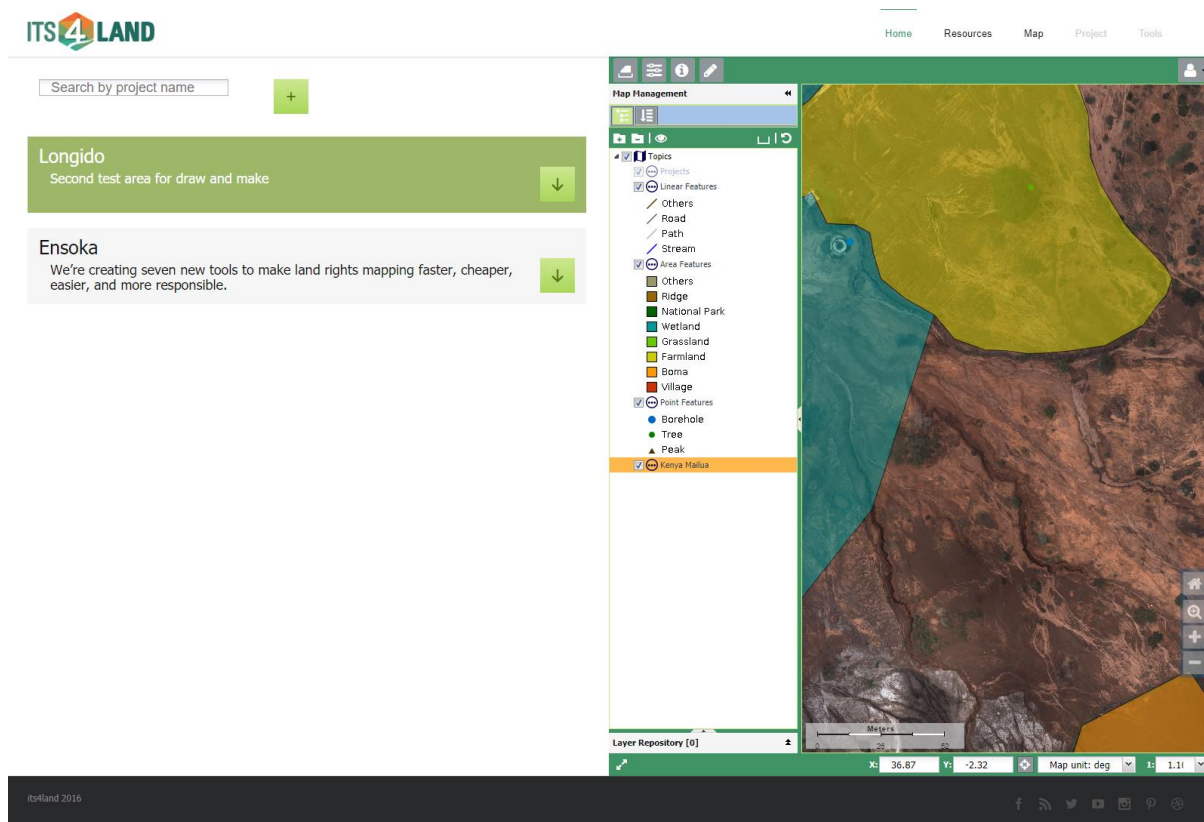
Figure 5: The "Get Involved" section of the Publish and Share web site



3.4 Demo

Under demo the general purpose web-client is accessible. The web client is a showcase of the functionalities of the Publish and Share platform. The main intention of the client is to demonstrate the integration of the its4land tools *Draw and Make*, *Automate it* and *Fly and create*.

Figure 6: The Publish and Share demo client



4 List of Manuals

This chapter provides a brief overview of the Publish and Share documentation for developers. The most recent versions of the manuals can be obtained from the Publish and Share web site <http://platform.its4land.com> in the sections “Explore” for the API reference and “Get Help” for the other manuals.

All manuals are also available on [share4land](#) in the folder “Documents / 09 Work Packages / WP6 Publish and Share / Manuals”.

The following table provides a matrix of the manuals and typical stakeholder in a software development projects. Cells in green indicate that it is highly recommended for the stakeholder to read the manual. Yellow cells indicate manuals which help the stakeholder to gain a deeper understanding of Publish and Share, but which are not necessary for the core task of the stakeholder.

Table 1: Suggested readings for stakeholder in a software development project

	Concept manual	LADM manual	Development using the Publish and Share Public API	Developing Tools for the Publish & Share Platform	Extending Publish and Share	External Deployment on Amazon AWS	API Reference
Consultant/ Business Analyst							
System architect							
Software developer Application							
Software Developer Integration							
Software Developer Tools							
Software Developer Extending the platform							
Operator							

4.1 Publish and Share Concepts manual

The Publish and Share concepts manual provides a high level overview of the platform. This manual describes the technical architecture as it is necessary for a developer to understand the Publish and Share platform.

The manual describes furthermore, the four usage models of Publish and Share. This includes a discussion of their characteristics and enable a user of Publish and Share to choose the right model for their development task.

The concept manual is intended as an introductory manual for developers. Another major group of readers are software architects and business analysts and consultants. These groups require an understanding of the underlying concepts, capabilities and limitations of Publish and Share to implement land administration workflows.

The concept manual requires some technical background and software development skills. A basic understanding of land administration processes is helpful. Furthermore, an understanding of state of the art software architecture concepts, like single-page application [1], platform as a service (PAAS) [2] or Web API [3] is beneficial. The knowledge of a specific programming language is not required.

Diagrams are drawn according to the UML syntax. The reader should be able to read and understand Class Diagrams, Object Diagrams, Sequence Diagrams and Activity Diagrams.

4.2 Publish and Share LADM manual

The LADM manual contains a brief introduction to the LADM standard and how it is used in Publish and Share. This contains a mapping of LADM concepts (like LA_SpatialUnit) to the corresponding structures in Publish and Share.

The manual is mainly intended for business analysts and consultants who learn more about how land administration system and workflows based on LADM can make use of Publish and Share.

4.3 Development using the Publish and Share Public API

This manual covers the usage of the Public API. The Public API is essential for developing software following the four usage model of Publish and Share described in D6.4 [4]. The manual is written as a tutorial with practical examples. The API itself is documented in the interactive online API reference.

This manual requires deeper knowledge of software development techniques and an understanding of Publish and Share concepts.

The examples in this manual are presented with the tool CURL [5] or in the development languages Python [6] and JavaScript [7].

CURL was chosen, because it provides an easy way of interacting and testing with web-based APIs like the Public API. CURL is often used in software development projects to do automated tests of APIs. The online API-reference is able to produce CURL calls for each endpoint.

The programming examples are presented in Python and Javascript. Both languages are widely used.

4.4 Developing Tools for the Publish & Share Platform

This manual focus on the usage model “Tools” as development model for Publish and Share. The manual describes how to create, test and deploy an its4land tool for the Publish and Share runtime environment.

The manual contains a small example to illustrate the development process. The example is developed as Python application, since Python is the preferred language in the its4land technical work packages. Python furthermore provides several advantages, which makes Python the language of choice to illustrate Publish and Share Tool development:

- Easy to learn, with a very clear and readable syntax
- Very well documented and supported.
- No cost for tools, etc. required
- “Battery included” approach: A Python installation contains all libraries for typical development tasks. Furthermore, there is a flourishing ecosystem of third party and user contributed libraries to ease software development.

This manual also describes the so called Publish and Share tool wrapper. The tool wrapper is a small library that is provided by its4land to simplify the interaction with the it4land runtime environment.

The runtime environment is built on top of Docker [8]. Some Docker and Linux skills are required to understand and use this manual.

4.5 Extending Publish and Share

This manual describes how to implement new functionalities in Publish and Share according to the usage model “Platform Extension”. An extension of the platform is done by implementing new endpoints in the Public API. Therefore, this usage model requires advanced technical skills. The manual covers:

- Specification and implementation of the REST interface

- Implementation and integration of the business logic into the Publish and Share platform
- Build and deploy the Publish and Share software after implementation of the extension

Implementation following this usage model requires several technical skills, like advanced JavaScript and Linux knowledge. Furthermore, it requires understanding of REST-based Web-APIs. Beside this, some specific knowledge is required. The Public-API is specified with Open API Specification (OAS, aka. Swagger [9]). To build own extensions to the platform as new REST-API endpoints an understanding of the OAS Syntax and OAS tools, like the code generator, is necessary.

4.6 External Deployment on Amazon AWS

This manual describes how to deploy a Publish and Share installation on an own Amazon Web Service account, to operate the platform independently from its4land.

This manual provides also a deeper look on internal technical structure of Publish and Share, especially how the technical communication between the technical building block of Publish and Share are realised

Due to the technical characteristic of this manual, a high level of technical prior knowledge in following areas is required:

- General understanding of the cloud-based computing approach
- Good understanding of the AWS services like:
 - Simple Storage Service (S3)
 - Elastic Compute Cloud (EC2)
 - Relational Database Storage (RDS)
- Security concepts like Public-Private-Key infrastructures
- Linux administration knowledge
- IP based network administration

Introduction to the above technological areas are not subject of the documentation created as part of the its4land project.

4.7 Public API Reference

The Public API Reference is not a classic manual. It is implemented as an interactive, online web application. The reference describes for each single endpoint the behaviour, parameters and return values. A developer can use the reference to create sample API calls for experimenting and better understanding.

Figure 7: Parameter section of endpoint GET /adminsources in the Public API online reference

GET /adminsources Returns a list of AdminSource document indices	
Returns a list of AdminSource document indices	
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
uid array[string] (query)	Comma separated list of AdminSources UID
name array[string] (query)	Comma separated list of AdminSources names
type array[string] (query)	Comma separated list of AdminSources types
projects array[string] (query)	Comma separated list of project UID
spatialunits array[string] (query)	Comma separated list of SpatialUnit UID
tags array[string] (query)	Comma separated list of tags
page integer (query)	Requests for collections can return between 0 and N results, controlled using the per_page and page query parameters. All endpoints are limited to 10 results by default.
sort string (query)	The sorting is initiated by the sort query parameter and a list of comma separated list of fields to sort by.
fields array[string] (query)	Comma separated list of tags
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)

Figure 8: Response section of endpoint GET /adminsources in the Public API online reference

Responses	
Response content type application/json	
Code	Description
200	OK
	<div>Example Value</div> <div>Model</div> <pre>[{ "Concept": "Concept", "UID": "UID", "Type": "Type", "Description": "Description", "LongDescription": "LongDescription", "ExtDescriptionURL": "ExtDescriptionURL", "Projects": [{ "UID": "UID" }, { "UID": "UID" }], "SpatialUnits": [{ "UID": "UID" }, { "UID": "UID" }], "ContentItem": "ContentItem", "Tags": ["Tags", "Tags"] }]</pre>
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
403	Forbidden - Authenticated user does not have access
404	Not Found - Resource not found
409	Conflict
415	Unsupported Media Type
422	Unprocessable Entry
423	Locked
500	Internal Server Error
501	Not Implemented

The online reference is directly created from the OAS API specification which is used to generate the interface of the API. This ensures that the implemented API and the documented API are in sync.

5 Conclusion

In Task T6.5 we have created a set of manuals, tools and other documentation to allow external developers to make use of the Publish and Share platform. The four usage models which have been developed in T6.4 are covered by this documentation set.

The documentation set is under constant development and will be updated based on suggestions and experiences from the field test. The most recent versions of the manuals can be obtained for the its4land Publish and Share web-site.

The current focus of Publish and Share is to host the platform under the responsibility of its4land WP6. As part of the later commercialisation of its4land after the end of the current project, this may require additional services (training, consulting) as part of the its4land toolbox. This additional services could be provided by a follow-up of its4land in combination with local companies.

We acknowledge that the level of technological skills which are required to master Publish and Share and incorporate it into projects can be seen as an obstacle which impedes the use of Publish and Share. On the other hand we see this as an opportunity. Publish and Share uses state of the art concepts and techniques, like cloud and platform based computing or API centered architectures. These are techniques and concepts which are widely used in today's IT projects in every usage domain and not only limited to the land administration sector. By incorporating and training the local its4land project partners in these technologies and concepts, Publish and Share can be seen as a starting step for evolving cloud based computing and open source in East-Africa not only for the domain of land administration.

The remaining time of the project will be used for enabling our East-African project partner in using the Publish and Share Platform and supporting WP8 in launching the its4land toolbox.

The expected feedback from partners and the launch events will be used to fine tune the platform and documentation.

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