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A Reference Platform for Geo-interoperability

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The findings and conclusions presented in this report are the responsibility of the authors alone and do not necessarily represent the particular view of the organisations helping to develop the reference platform or of the European Commission.

Abstract

As part of the work of A Reusable INSPIRE Reference Platform (ARE3NA, ISA Action 1.17), this report presents the development of a new component of the INSPIRE Knowledge Base. The work involves the design and development of a collaborative platform to share details about tools and current practices for implementing and using the Spatial Data Infrastructure (SDI) associated with the INSPIRE Directive (2007/2/EC). The platform allows Geo-ICT solution providers to promote their tools and services in support of INSPIRE implementation, capacity building and use. It also allows implementers to document and explain to each other how they produce and share the metadata, data and services that INSPIRE requires. Lastly, the platform helps to showcase mobile apps and applications that are powered by SDIs, illustrating the benefits geospatial data-sharing offers in practice.

Glossary

ADMS	Asset Description Metadata Schema
ARE3NA	A Reusable INSPIRE Reference Platform (ISA Action 1.17)
ATS	Abstract Test Suite
CDDA	Common Database on Designated Areas
DEV	Development site of the platform
DGENV	Directorate General Environment
DIGIT	Directorate General Informatics
ECAS	European Commission Authentication Service
EEA	European Environment Agency
EFIR	European Federation of Interoperability Repositories
EICart	European Interoperability Cartography
EIF	European Interoperability Framework
EIRA	European Interoperability Reference Architecture
ELISE	European Location Interoperability Solutions for E-government
EULF	European Union Location Framework (ISA Action 2.13)
Geo-ICT	Geo-Information and Communication Technology
GI	Geographical Information
GINIE	Geographic Information Network in Europe
HALE	Humboldt ALignment Editor
ICT	Information and Communication Technology
INSPIRE	Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community
IR	Implementing Rules
ISA	Interoperability Solutions for European Public Administrations

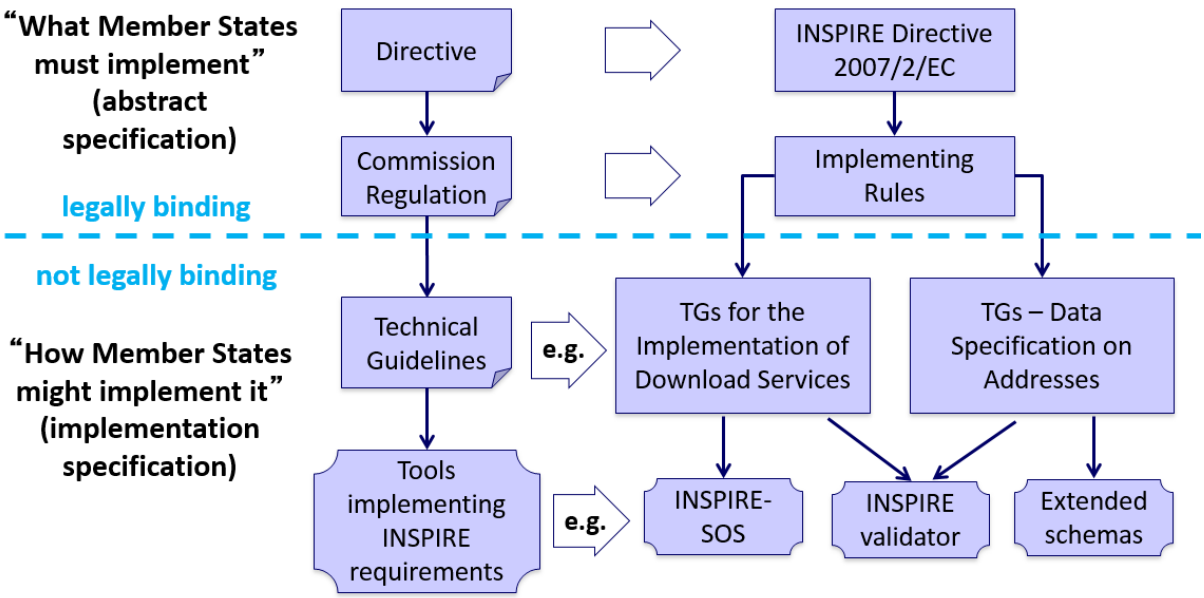
JRC	Joint Research Centre of the European Commission
LMOs	Legally Mandated Organisations of INSPIRE
MIF	Maintenance and Implementation Framework of INSPIRE
MIG	Maintenance and Implementation Group of INSPIRE
PDOK	*Publieke Dienstverlening Op de Kaart* (Dutch Cadastral Parcels dataset)
PROD	Production environment of the platform
PS	Protected Site
ROD	Reporting Obligation Database of the EEA
SDI	Spatial Data Infrastructure
SEO	Search Engine Optimisation
SME	Small to Medium Enterprise
STAGE	Test site of the platform
TG	Technical Guidelines

1 Introduction

Geographical Information (GI) plays an important role in many public sector and research activities, as well as the private sector in creating tools and products to handle the geospatial data to create it. Its ability to help combine and compare data about co-located phenomena from varying sources is one of its key strengths. Moreover, sharing geospatial data not only offers better information for decision-making (at the right time and place) but also the potential to act as a vehicle for organisational change and better public sector regulation. Better management and sharing of geospatial data can help to maximise the efficiencies of organisations, while offering new business potential and contributions to economic growth through the Digital Single Market, one of the European Commission's priorities.

The challenge for public administrations aiming to share such data is to do so in harmonised and interoperable ways, so that data-sharing can follow common data models and approaches, reusing tools and/or performing tasks in similar ways. A key activity in Europe in this context is the INSPIRE Directive (2007/2/EC)[1], including the current phase of organisations following INSPIRE's Implementing Rules (IRs; legally-binding Regulations) and Technical Guidelines (TGs; strongly recommended and documented technical approaches) to implement the Directive and create the pan-European Spatial Data Infrastructure (SDI) that INSPIRE envisages (See Fig. 1).

Figure 1: INSPIRE IRs, TGs and some examples of tools



Although the legal and technical documentation, to some extent, indicates what is required to be produced, there is not a 'recipe' for 'INSPIRE implementers'[2] to follow to achieve the

[1] See http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32007L0002

[2] In this context we consider implementers to be staff working for public administrations who have the legal obligation to implement the Directive as Legally Mandated Organisations (LMOs), including both managers and technical staff. In addition, given the potential of the Directive, implementers may also include organisations not considered as LMOs who want to contribute data to the infrastructure. Lastly, there may be some cases where organisations delegate technical

desired results. This is intentional, as the variety of organisations the Directive addresses are as diverse as those responsible for creating and managing the data in scope of the Directive, covering both environmental geospatial data and data that can help assess the condition of the environment, ranging from public health (helping to measure environment-related impacts) to road infrastructure (potentially offering estimates on vehicle emissions in certain areas), amongst a total of 34 data themes[3] outlined in the Annexes of the Directive.

As Technical Coordinator for the implementation of the INSPIRE Directive (working with DG Environment (DG ENV), DG Eurostat and the European Environment Agency (EEA)), the Joint Research Centre of the European Commission (JRC) has now a leading role in assessing and coordinating the technical activities associated with the implementation of INSPIRE in the Member States and, thus, the creation of the EU SDI. As an example of cross-border and cross-sector data-sharing and interoperability, some of the work to support this technical coordination has taken place under *A Reusable INSPIRE Reference Platform* (ARE3NA), Action 1.17 of the EU's Interoperability Solutions for European Public Administrations (ISA) Programme. Topics have included discovering and creating reusable tools and guidance to not only help implementation but also make INSPIRE more 'reusable' for other sectors for example by producing software that not only aids the implementation and functioning of the infrastructure but that could also be deployed by others as part of their data management approaches. A key example of this work has been the development of the **Re3gistry** software[4], which helps to manage the reference codes that INSPIRE implementers need to insert into their data to create semantically comparable cross-border datasets. Details of all ARE3NA solutions are available on the JoinUp platform[5].

Based on the experience of the Re3gistry's development and following requests from the Member States to help them to share current practices addressing implementation tasks, ARE3NA has been scoping and developing the creation of a collaborative platform for the development and potential 'reuse' of INSPIRE beyond the environmental domain. The platform helps to illustrate how organisations are implementing INSPIRE, which software solutions they have been adopting and are available currently from solution providers[6]. It should also act as a reference point for others interested in understanding INSPIRE's technical approach and to have material that could be reused in other sectors beyond the current documentation, including how the SDI can be used to support a range of applications for environmental policy and other sectors.

It should be noted that the creation of this platform is also taking place and contributing to an evolution of the entire INSPIRE website[7] moving from a simple repository to support the creation of the legal and technical framework of INSPIRE (IRs and TGs) to a 'knowledge base', as an integrated information system to support all aspects of INSPIRE implementation. In the terminology of the ISA Programme's European Interoperability

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implementation to support organisations and these could also be considered as implementers if the public administrations would be interested in them working with the platform.

[3] http://inspire.ec.europa.eu/theme

[4] https://joinup.ec.europa.eu/software/re3gistry/description

[5] https://joinup.ec.europa.eu/community/are3na/home

[6] We define this as a broad term for anyone who has developed or is offering software solutions or other tools that can help people implement and use INSPIRE. This can vary between large international software houses, to SMEs with open source solutions, to public administrations interested in sharing in-house developments and research/academic organisations/projects providing innovative/experimental but tested resources.

[7] http://inspire.ec.europa.eu/

Framework (EIF)[8], this work is creating resources which support simultaneously all the 'views' of legal, organisational, semantic and technical interoperability.

This brief report, therefore, presents the concepts and current status of the development by ARE3NA's of the collaborative '**reference platform**'. It addresses the approaches to engage and create a forum (in the broadest sense) for two key groups of actors: INSPIRE implementers and Geo-Information and Communication Technology (ICT) solution providers. Regarding implementers, the reference platform complements the INSPIRE Thematic clusters platform[9] by, for example, providing common ways for describing selected best practices. In the case of the group of Geo-information/ICT solution providers, including Small to Medium Enterprises (SMEs), the reference platform allows them to showcase their tools and services to support INSPIRE implementation and use; how implementers can document and follow others' examples through interactive implementation tutorials; and how current and potential users of the SDI can understand how to best use INSPIRE data and services (among other materials of the Directive), alongside a broader view of the development of SDI and INSPIRE-based apps and applications.

The report, therefore, aims to take stock of the work done in ARE3NA to develop the reference platform and the Interactive Data Specifications Toolkit as part of the new INSPIRE Knowledge Base. In particular, it outlines the concepts of the platform and the technical developments, focussing on the design of the content and what we have seen as more important in this first key phase of development. The discussion begins with a discussion of the concept itself of forming a 'collaborative platform' that helps stakeholders share good practices and details about supporting Geo-ICT tools, something we think can offer lessons for other sectors considering the ICT aspects of policy implementation (**Section 2**). **Section 3** then reports on the platform content and its underlying structure in terms of a series of inventories (and their metadata) that describe different technical aspects of INSPIRE, including what has INSPIRE been used for, what tools are available, which may be missing and what projects have been active in helping to implement INSPIRE. This section also includes information on the creation of an interactive tutorial in the platform where people can explain how they have in their organisation performed implementation tasks and what software they have used for other implementers (or anyone interested in INSPIRE) to follow. This is presented as a review to help use this report to have a checkpoint in the project as a whole and share key points with stakeholders. As much of the work has also involved software development, the report also provides a brief overview of the technical and operational development approach for the platform (**Section 4**) and the related development of the Interactive Data Specifications Toolkit, which not only is a specific tool supporting the initial implementation tasks presented in the platform but has also acted as an inspiration for how the platform could evolve and be better presented to end-user (**Section 5**). The last section provides some conclusions and observations from this report and indicated areas where there could be further development (**Section 6**), as the platform technology has the potential both to be reused in other sectors and to be repurposed for other e-policy related activities.

2 Collaborative Reference Platform concepts

From the outset, it is worth mentioning the term 'platform' has evolved in the course of Action 1.17 and may still need to be explored to best communicate the work done and the

[8] http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf

[9] https://themes.jrc.ec.europa.eu/

opportunities it offers. In its initial conception we foresaw the project as a platform, to help exchange evidence about software developments related to INSPIRE. This has been supported by all our project outputs being shared through the JoinUp platform (covering topics such as Linked Data, Access Control and Validation Tools for INSPIRE). The work with stakeholders, however, also pointed to the need to contextualise tools in particular contexts, to offer training and support to implementation and to show what INSPIRE means in terms of current practice that other sectors could benefit from, hence the current development. What has been driving this development, however, is to try and create a unique and distinct virtual space in a plethora of platforms. By being part of the INSPIRE website we can, at least to begin with, offer a more complete view of the infrastructure and offer a development experience and our own software that other platforms could use.

The main purpose of the platform is, therefore, to improve interoperability and reuse of solutions. These are the guiding notions of the ISA Programme and its recent successor, the ISA^2 Programme (2016-2020). Interoperability takes many forms but INSPIRE can be seen as a major effort on a European level to improve the comparability and sharing of existing geospatial data with a driver towards data interoperability. Moreover, the development of the federated infrastructure where the European of INSPIRE is built on top of existing national (and/or sub-national) SDIs can create both interoperability challenges/barriers but also opportunities for improved collaboration across borders and, in particular, the reuse of existing investments of in solution development or coordinated activity to the creation of common reusable solutions. Much of the work of ISA has been to help manage and create these solutions and ARE3NA is offering a dedicated approach to supporting the improvement of interoperability and reuse within the geospatial domain, as well as the way it interacts with other sectors in the exchange and use of data. The development of the reference platform, therefore, acts as a dedicated resource to contain and explore interoperability in the implementation of INSPIRE, while offering lessons for other sectors from this approach as well as explaining how INSPIRE can be 'reused' beyond its key application in the environmental policy domain.

In exploring the challenges and barriers to improve interoperability in INSPIRE one area requiring attention are the differences between what is required in the Directive's IRs and TGs and current practice. This also takes place in a rapidly evolving ICT environment with legacy data collection/provision methods and different cultures across Europe where there may be several valid approaches that can be taken to arrive at widespread, successful and efficient implementations. This work can, therefore, be seen as a support to coordination and collaboration amongst the infrastructures stakeholders, as well as an aid to capacity building in SDIs, where available skills may be limited or where the most appropriate approach for an organisation is hard to define. In exploring collaboration and capacity building in SDIs, the team working on the platform considered its development akin to a 'living lab' (Smith *et al*., 2015[10]). In particular, this development approach offers a means to foster and accelerate open innovation, while increasing opportunities to find ideas, identify new technologies and develop new products with co-creation and awareness raising in mind. Moreover, in terms of platform development, living labs can be defined as both a process and an environment, where the latter allows us to consider our work as both a milieu and, following the work of Ståhlbröst and Holst (2012)[11], an "arena". A key concept of the platform, therefore, is the idea of offering ownership of content to stakeholders and to aim to build capacity through common frames, in particular through the creation of the vocabularies developed to outline implementation tasks, the skills required and descriptions of all the outputs of INSPIRE to not only include the data, metadata and services that the infrastructure offers but also the reusable components such as the code lists and data models.

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[10] http://dx.doi.org/10.1109/eCHALLENGES.2015.7440968

[11] See http://www.ltu.se/cms_fs/1.101555!/file/LivingLabsMethodologyBook_web.pdf

One key area to note is that this reference platform differs from the JoinUp platform as it does not aim to store software solutions or other technologies but to act as a broker between different actors in the SDI and to provide light content that leads people to where they can explore more detailed content to other platforms, such as the INSPIRE Thematic Clusters or INSPIRE website. It also aims to share other reference material from INSPIRE that would otherwise be difficult to find. This reflects other work in ARE3NA on the Re3gistry and the software supporting the Interactive Data Specifications Toolkit[12] (also see below) by explicitly describing key technical components of the INSPIRE infrastructure. As such, it also acts as a means to define some of the semantics of INSPIRE and offers reusable material in a range of other applications beyond implementation.

3 Platform content, sources and outputs for others

The development of the platform was initiated with wide and ongoing consultation with stakeholders from INSPIRE and ISA. This included support from the *ISA Working Group for Spatial Information and Services* to initiate this work and a 'reality-check' with INSPIRE implementers through conferences and virtual meetings. Before creating the technical implementation of the platform, the content of the platform was defined, sources identified and a process to gather content explored. The creation of this content, as potential reference material, was also examined from the point of view of those less familiar with INSPIRE to help them to understand key concepts related to both implementing and using the SDI.

In its initial form, stakeholders were asked to comment on three key sections of the platform: the *e3xpo*, the *de3mo* and the *live3tutorial* that are outlined further below in terms of sources and their use by others.

3.1 The *e3xpo*

The ***e3xpo*** has been envisaged as a means to 'showcase' various elements of INSPIRE implementation and use. It currently covers the following elements:

- **Tools**: an inventory of software tools that can be used to implement or use/reuse data, metadata and/or services related to INSPIRE. It offers a unique space to solution providers to share details of their software and tools in relation to INSPIRE through the platform's Implementation Task vocabulary[13].
- **Apps and applications**: an inventory of end-user web-based applications and mobile 'apps' that showcase what SDIs, and in particular the ones powered by INSPIRE, can support. Creating such an inventory also helps to identify examples of end-users of SDIs.
- **Missing items**: an inventory of missing software and other tools, resources and guidance that stakeholders think would improve the functioning of the infrastructure or that could help it to become more useful for a larger group of stakeholders. This work reflects the ongoing approach of ARE3NA to help fill some of these technical gaps but with the ambition to create an open process to help point infrastructure users to appropriate discussions on other platforms e.g. INSPIRE Thematic Clusters, including developments related to INSPIRE's *Maintenance and Implementation Framework* (MIF)[14] and developments in ISA and the forthcoming ISA[2] Programme.

[12] http://inspire-regadmin.jrc.ec.europa.eu/dataspecification

[13] See https://inspire-reference.jrc.ec.europa.eu/tasks

[14] See http://inspire.ec.europa.eu/index.cfm/pageid/5160

- **Case studies**: longer descriptions of INSPIRE in practice, showing how particular aspects of INSPIRE can support public administration processes, with decision-makers as an audience for this material.

The remainder of this section outlines the current version of the metadata for each of the sections of *e3xpo*, alongside details of the sources of this information, current status and where this content may also be used.

3.1.1 Tools

The inventory of tools was one of the first outputs of ARE3NA, having followed a series of desk studies to identify, in particular, open source software that support the implementation of SDIs[15] and, specifically, INSPIRE. The work of organisations such as OSGEO offers opportunities to engage with this community to further refine and populate this initial list within the platform, alongside discussions with proprietary software providers. Moreover, as outlined below, INSPIRE implementers are being asked to identify the tools they are using in practice, helping to create further links with solution providers. More specifically, a series of events have been planned to consolidate this list of metadata items, including participation in conferences to co-develop and select the most pertinent content.

The current version of the platform aims to collect a limited core set of metadata elements to readily allow stakeholders to maintain the content avoiding the unnecessary duplication of the information collected from other platforms or websites (see **Table 1**). Those fields highlighted in grey are likely to be hidden from end-users in new versions of the platform.

Table 1: Tools Inventory Metadata

Element	Description	Example
Title	Name of the tool/software	Geoserver
Record author	Automatically generated text based on a registered user (logging in via DIGIT's *ECAS* authentication tools[16]), including: name of person inserting the details, date and time of entry	Submitted by Jeroen HOGEBOOM on Fri, 02/19/2016 - 15:26[17]
Short description	A short sentence (in English) describing the tool	GeoServer is an open source server for sharing geospatial data
Link	A hyperlink to where a user of the platform can find details of the software/tool	http://geoserver.org
Source Code	For open source software, in particular, a link to the software's source code is requested	http://docs.geoserver.org/latest/en/developer/source.html
License	For open source software, in particular, details of the software licence are sought (ideally as hyperlinks)	http://www.gnu.org/licenses/old-licenses/gpl-2.0.html

[15] https://joinup.ec.europa.eu/community/are3na/document/are3na-inventory-open-source-tools

[16] https://webgate.ec.europa.eu/cas/wayf?caller=%2Fcas%2Feim%2Fexternal%2Fregister.cgi

[17] In this case the example was entered by an implementer but we intend to hand-over the record to an appropriate solution provider

Platform	Details of the platform the software runs on are recorded, using a taxonomy based on research by Steiniger and Hunter (2012)[18]	Server
Type	Details of the type(s) of software are recorded, again using a taxonomy based on research by Steiniger and Hunter (2012)	Open source server
Programming Language	Details of the programming language(s) that the software is based on	Java

Following some discussion with stakeholders, it is likely that the next version of the inventory will not involve providing the following elements: *Source Code, License, Platform, Type and Programming Language*. This is partly because we believe the records are entering into too much technical detail for, in particular, INSPIRE implementers and that much of this content is well managed and readily found within other platforms (e.g. *JoinUp, SourceForge, GitHub*) or company websites and should not be further documented by ARE3NA in its role as a reference point. There are, however, some candidate elements that we would be interested in discussing with solution providers (see **Table 2**).

Table 2: Tools Inventory Metadata Candidate Extensions

Element	Description	Example
Missing Item link	A hyperlink to a discussion forum, wiki, requests page, feedback form or (potentially) e-mail list to request an update to existing tools in relation to INSPIRE (see further details below in relation to the Missing Items inventory)	To be decided
Tool video	Hyperlinks to online videos showing how the tool is either installed, configured, managed and/or used in practice, especially for cases involving INSPIRE	To be decided
Asset	A checklist of the relevant INSPIRE assets (see above) that a tool either (i) helps to produce/manage or (ii) use/share further	To be decided
Implementation Task	A more detailed checklist of the generic INSPIRE tasks (see above) that a tool supports. Ongoing work defining terms for 'using' INSPIRE may extend this element's taxonomy or create a new one to show which tools help people to use the assets/outputs of INSPIRE	To be decided

The content of this inventory may also be of use in other platforms. In particular, the process of identifying tools with solution providers and/or INSPIRE implementers could be valuable for other processes, especially those being developed by ISA. In particular, the ongoing work of the *European Interoperability Reference Architecture* (EIRA) and *European Interoperability Cartography* (EICart)[19], is interested in positioning the existing tools being used to support EC-related activities and policies to understand where there

[18] See http://www.sciencedirect.com/science/article/pii/S0198971512000890

[19] http://ec.europa.eu/isa/ready-to-use-solutions/eira_en.htm

are gaps and potential solutions for reuse. By identifying leading examples, reusable geospatial solutions could be approached for, for example, further documentation in JoinUp to provide more detailed metadata to support relevant assessments or exploration by potential users beyond INSPIRE or even the geospatial/Geo-ICT domain.

3.1.2 Apps and applications

ARE3NA, in collaboration with the British Geological Survey, started to scope the relevance of Apps and applications for the platform by surveying mobile app developments (topics and technologies) by members of EuroGeoSurveys, The European association of the National Geological Survey Organisations, including a related report[20]. The development of an inventory apps/applications (and the ***Case Studies***, discussed below) was inspired by some of the activities between 2001 and 2004 of the *Geographic Information Network in Europe* (GINIE) project[21], especially the development of a database and portfolio of 'Case Studies'. This work aimed to illustrate how Geographical Information and the associated technologies were increasingly being used to support a range of activities within the European economy. Examples came from diverse sources such as viticulture in the Czech Republic and a property observatory in Turin. The notion stemming from this work was to help exemplify SDIs in practice for end-user applications and provide a means to illustrate how INSPIRE is growing in some areas to provide a face to a somewhat hidden 'back-office' infrastructure.

The developments in this work have been moving in parallel in preparation of widely engaging app/application Providers (i.e. users of SDIs) who provide data and services to end-users, including public administrations, businesses and, where relevant, citizens. Specifically, a desk study has explored the type of details that could be collected from App/application Providers for around 200 examples, as a first load/baseline for the inventory, including:

- **Name**: the name of the app/application
- **Category**: whether the app/application is intended for end-users or technical experts.
- **Use case**: a sentence describing the main purpose of the app/application
- **Description**: a longer description of the app
- **Homepage**: a link to where details of the app/application can be found
- **Key features**: tools and functionalities that the app/application offers
- **Language**: the (mainly European) languages that the app is available in
- **Software used**: The software and programming languages the app/application has been developed in
- **INSPIRE Tasks** (and Label): Analysis of where the app/application could be positioned in terms of implementation tasks
- **Dead links**: Any notes of hyperlinks that seem to be broken

In addition, some work has been done to explore how App/applications could relate to particular target audiences, including INSPIRE implementers, including INSPIRE Thematic Cluster members[22] and those working in e-government/interoperability.

Currently, a review is taking place of the existing content. This includes trying to minimise the range of information gathered at this initial phase, including potentially not collecting information about the **Language** of a particular App/application. There is also ongoing

[20] https://joinup.ec.europa.eu/community/are3na/document/reusable-tools-smartphone-apps-innovative-activities-european-geological-s

[21] http://www.ec-gis.org/ginie/

[22] See the Thematic Cluster Platform: https://themes.jrc.ec.europa.eu/

analysis about the **Key Features**, as this could be standardised as a controlled vocabulary/taxonomy in the platform and help select the apps that do not relate to generic functions (e.g. those that perform some roles like a GIS) but, instead, offer some data/functionality in a specific sector to end-users. In addition, the draft inventory has limited details about the **Software used** and the mapping to the **INSPIRE Implementation Tasks** requires validation. Further discussion, therefore, is needed with App/application providers and some initial interviews are taking place with property-related INSPIRE data applications in the UK. In addition, as noted above, ongoing work to develop a vocabulary to explain how to 'use' INSPIRE (thus complementing the workflows related to implementing INSPIRE) will also help to further develop this topic, where necessary.

This material and study can already, however, provide content to the prototype platform, where the current metadata (and mapping) are outlined below (see **Table 3**).

Table 3: Apps/Application Inventory Metadata

Element	**Mapping to desk study elements**	**Description**	**Example**
Title	Name	A name of the app/application	Simacan Control Tower
Record author	N/A	Automatically generated text based on a registered user (logging in via DIGIT's ECAS authentication tools), including: name of person inserting the details, date and time of entry	Submitted by are3na_user on Tue, 05/26/2015 - 13:58[23]
Short description	Use Case and Description	A short sentence (in English) describing the tool	Simacan Control Tower gives shippers and transporters overview and control on their planning and operation
Link	Homepage	A hyperlink to where a user of the platform can find details about the app/application	https://www.simacan.com/en/products/control-tower
Languages	Language	A taxonomy in the platform to help label that language the app/application is available in	English

As with the Tools Inventory, there are also some candidate elements that we would like to discuss with solution providers in addition to the material in the baseline study (See **Table 4**)

[23] In this case, the example was entered by the ARE3NA team to illustrate the current information being sought

Table 4: Apps/Applications Inventory Candidate Metadata Extensions

Element	Description	Example
App video	Hyperlinks to online videos showing the app/application 'in action', or providing more details about its use etc.	To be decided
Policy link	Indicate if any apps/applications are linked to any specific policies. This is not within current scope but could be explored in the future.	To be decided

3.1.3 Missing items

The **Missing Items Inventory** was first generated as an in-house resource for the ARE3NA project based on a survey with INSPIRE stakeholders. The survey asked where technical developments could take place in key components of INSPIRE and where reusable tools should be created, alongside proposals for where technical developments could be made to help extend or 'reuse' INSPIRE in other sectors. This has led to us our work on the development of the *Re3gistry* software, exploring access control issues, seeing how INSPIRE data and metadata could be represented in Linked Data technologies and how Sensor Observation Services could be incorporated in the SDI, amongst others. The idea of this inventory involves creating a process where those interested in improving or extending the infrastructure could find topics that would need to be addressed and not only through ARE3NA, including opportunities for organisations to partner in, for example, the funding of software development when common/reusable tools are in scope.

Initial scoping of this work showed that although such an inventory is of general interest, the way in which it should be implemented is more problematic and, thus, no metadata has been created for the platform yet. The first issue faced was more organisational, and relates to the fact that there are several platforms where such conversations and lists of relevant topics could be positioned. Stakeholders also suggested that many of these conversations should also take place on the online resources of existing solution providers. Therefore, as discussed above in relation to the **Tool Inventory**, the future of this activity will partly involve asking Solution Providers to provide links to their discussion fora or feedback tools. A second phase could involve creating harvesting tools so that relevant requests or discussions could be collected in one place on the platform. A second and more technical issue will, therefore, be how to handle such content, if feasible.

Moving this topic forward must continue to involve user demand. To help this process a webinar was organised with some solution providers and implementers that agreed that this work has some value. A couple of follow-on interviews are planned to explore one case where similar software updates were requested by two different organisations, to understand if such potential duplication is needed or if more coordination across stakeholders through the above approach would be desirable. Depending on the conclusions of this work, the content of the inventory could be contained in the *INSPIRE Maintenance and Implementation Group* (MIG) Collaboration Platform[24], where many technical developments of INSPIRE are discussed and coordinated, with the technical experts in the Member States (MIG-T). Similarly, as ISA resources evolve and explore where there are missing interoperability solutions, there may be some benefit to follow a common approach, in particular in relation to developments in the EIRA, EICart and CarTool[25].

[24] https://ies-svn.jrc.ec.europa.eu/

[25] See https://joinup.ec.europa.eu/asset/eia/event/ms-eira/cartool-pilot-kick

3.1.4 Case Studies

The **Case Studies** were not designed to be an inventory but, instead, a more detailed description of where INSPIRE is already supporting activities in the Member States, including work beyond the environment domain that the Directive targets. As noted above, these longer descriptions take some inspiration from the case studies in GINIE but with the notion of developing comparable fiches for any topics stakeholders would like to share details about.

By following news stories and consulting facilitators of the *INSPIRE Thematic Clusters Platform* it was possible to identify cases where INSPIRE is already being used, at least in terms of components such as the INSPIRE data models. The three examples are close to being finalised.

This includes a review of the ***Basic Data Programme*** in Denmark[26], which help to share key information between public administrations, including location/address information based on INSPIRE data models and some of the core vocabularies developed by ISA. This provides an interesting example of where INSPIRE is more closely deployed to core e-government/interoperability activities in a Member State.

A second example involves the use of INSPIRE data models for the management of underground pipes and related infrastructure in Flanders. Following an accident several years ago, INSPIRE data models have been used as part of an information system that applicants who intend to excavate in Flanders need to use to check if there could be any other utilities present on their site. The development of this case is contrasted with similar work across the border in the Netherlands, with the potential to reference the related applications in this case in the Apps/Applications inventory, to offer a richer story of one particular case.

A third example is still being selected but could involve, for example, INSPIRE data and services being used outside of the environment and public domain as part of the data management activities of *Deutsch Bahn*, the German rail authority[27].

Unlike most of the platform content, these fiches are intended for a decision-maker audience, to help understand the tangible benefits of SDIs like INSPIRE and to help recognise some of the value in investing in them, including beyond the environmental domain. As such, plans are being put in place to store these examples as part of the new ***INSPIRE Knowledge Base*** and to discuss with stakeholders how similar examples could be later generated based on the content of the App/applications inventory.

3.2 The *de3mo*

The notion of the ***de3mo*** was to help highlight two areas where existing material related to INSPIRE could be found and reused within the platform, helping to 'demonstrate' INSPIRE in action alongside the implementation examples. Specifically, this section of the platform focuses on two areas: a series of videos and details about projects. In both cases these materials are now mainly going to belong to other sections of the INSPIRE Knowledge Base, where the developments under ARE3NA can help to form their layout and use.

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[26] See http://www.digst.dk/Home/Servicemenu/English/Digitisation/~/media/Files/English/BasicDataUKweb20121008.ashx

[27] See related news (in German) http://data.deutschebahn.com/datasets/streckennetz/

3.2.1 de3mo videos

The work on de3mo videos was mainly a scoping exercise and related to two main areas, an inventory of videos and an analysis to produce recommendations for where other videos could be made or encouraged.

The first was an initial desk study of some 50 online videos[28] to understand what videos stakeholders were making related to INSPIRE (in general or for specific components such as metadata) and if there were any videos being made related to software tools. Some of this work had already taken place in the creation of the first version of the ***Tools Inventory*** to see if there were any videos about open source software tools.

The videos were catalogued according to the following elements:

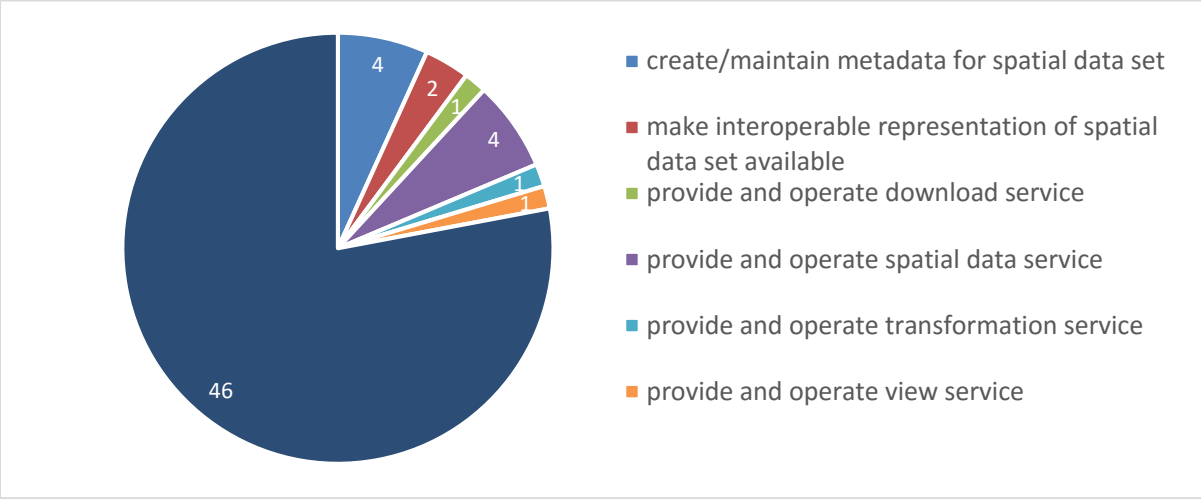
- **Title**: the given title of a video
- **Language**: the (mainly European) languages that the video is available in
- **Subtitles**: where present if there are subtitles for a particular video
- **Link to video**: hyperlink direct to the video (including a specific section if the video is part of a longer video, where appropriate)
- **Description**: a short description of the video in any (European) language
- **Duration**: total length of the video (Lasting 1 minute to 90mins and averaging around 23 mins, with 13 of the examples lasting 5 mins or less, 15 examples 6-20 mins, 10 examples 30-60mins and 4 examples over an hour)
- **INSPIRE Tasks** (and Label): analysis of where the video could be positioned in terms of implementation tasks, which also helps to filter between more general and specific videos
- **Comment**: any specific comments related to the video, such as it being part of a playlist or any clarification related to the INSPIRE Tasks

Other details were explored, including if there was any link to software or applications but, as noted above, it was decided to explore such links from the application/tools perspective. It was also suggested to create a preview thumbnail for any implementation of this inventory but this will be, where appropriate, implemented based on existing technologies the platform is being built on (see below). We also explored if videos should be classified into different types of content such as animations or actual online videos but this separation does not currently seem to be necessary.

The second area related to an analysis and proposals for a ***de3mo films plan***. The review showed that films are being made available, including to audiences less familiar with INSPIRE and its related concepts. Based on keyword searches in different European languages, many of the examples found and explored are available in English. One suggestion, therefore, from this work is to see how subtitles could be crowdsourced and added, for example in YouTube, to relevant existing videos. Although some effort was made to try to associate the videos with implementation tasks, this was found to be not readily mapped and many examples were providing more general aspects of INSPIRE, including how to access best practices, general introductions, descriptions of INSPIRE-compliant entities, INSPIRE challenges in particular areas or tutorials as part of training activities. As shown below (see Fig. 2), this study showed that we could expect to find some films related to the key technical high-level INSPIRE tasks.

[28] From YouTube, Vimeo and Dailymotion

Figure 2: Number of videos mapped to the INSPIRE implementation Vocabulary



Following this scoping and the analysis discussed above in the ***e3xpo***, it was decided that this inventory would not be directly implemented in the platform. Nonetheless, it would provide content to the overall ***Knowledge Base***, where it relates to the general activities of INSPIRE and be a metadata element of the **Tool Inventory** by solution providers and, potentially, the **App/application Inventory** by application providers.

3.2.3 INSPIRE Projects

The second area related to the ***de3mo*** involved exploring ways of describing projects that either directly are helping to implement INSPIRE or develop tools that could support implementation or use of the infrastructure. The motivation for this work was to offer a unique online location where INSPIRE projects could be identified and potentially promoted. No previous work took place in ARE3NA relating to this topic except for a range of meetings with European funded projects to help promote each other's work, explore synergies or gather some initial evidence. There had been, however, some earlier examples of online project databases as part of the development of INSPIRE, its archive[29] and the INSPIRE Forum[30]. The opportunity that this work would bring would be to select a core reference set of metadata for projects, to engage with new projects emerging related to INSPIRE and to provide a context for other work that would explore project outputs that could be registered in other inventories, such as those for tools and apps/applications.

In exploring the creation of a new inventory, again based on a desk study, the *Asset Description Metadata Schema* (ADMS[31]) was also explored, as it could be used to describe any relevant material to interoperability. The whole detail of ADMS is too long to report here but the work allowed us to see not only how projects could be mapped to ADMS but also how various assets, tools and other resources could be within the scope of ADMS. It also offered some materials that could be better-placed within the ***Apps/applications inventory***.

A mapping also took place with some of the project details being created by other activities in the JRC[32] and with the original online INSPIRE databases for projects, noted above,

[29] http://inspire.ec.europa.eu/index.cfm/pageid/6/list/3

[30] https://inspire-forum.jrc.ec.europa.eu/pg/pages/view/1668/funded-projects#annotation-1869

[31] https://joinup.ec.europa.eu/asset/adms/home

[32] Including the JRC Open Data Project and the Danube Reference Data and Services project

alongside ADMS to aim for a minimum and common set of metadata elements (see ***Table 5***)

Table 5: Extract of Mapping Table for Project Minimum Details

Label	Description	JRC Open Data project details (July 15)	ADMS property
Title	Name of the project	Project title	dct:title
Project owner	Name of the coordinator of the project		dct:publisher
Landing page	Hyperlink to project homepage	Project landing page	dcat:landingPage
Start date	Date when the project started	Project start date	schema:startDate
End date	Date when the project is due to end or when it ended	Project end date	schema:endDate
Description	Short description of the project	Project Description	dct:description
Keywords	Free text keywords to label the project		dcat:keyword
Tools	*Software tools used and/or developed in the project*		
INSPIRE Tasks	*A selection of relevant tasks and/or assets from the above-noted vocabularies*		

The **Tools** element was added as a means to initial identify a project and then explore how project owners could add details to the ***Tools Inventory***. Other elements were chosen to be easily maintained or potentially harvested/filtered from existing sources, such as the new open data related to the CORDIS database of EU-funded projects[33]. Another aspect related to this work was to consider not only European level activities but where there were opportunities for national or sub-national level projects developing SDIs and INSPIRE, following the work of, for example, eSDI-NET+[34].

For these reasons, and as the initial work had served its purposes, it was decided to currently select a minimum set of details about projects (based on the above table) and to include such content in the ***INSPIRE Knowledge Base*** and not the platform.

Overall, therefore, the work of the de3mo is likely to focus on content in other inventories or be contained in other platforms and will not, therefore, be continued as a discrete part of the reference platform.

[33] See http://cordis.europa.eu/projects/result_en?q=contenttype%3D%27project%27

[34] http://www.esdinetplus.eu/

3.3 The *live3tutorial*

The work of the ***e3xpo*** and ***de3mo*** involved creating structured, and at times interlinked, lists of relevant content to help explain and support tools and activities related to INSPIRE implementation. As noted above, one of the main tasks of this work was to define a set of vocabularies that could help label and link the content, in particular related to a generic view of the INSPIRE implementation tasks. The ***live3tutorial***, on the other hand, has been designed to perform much more interactive and complicated ways of sharing implementation related content.

The main feature of this work was to take inspiration from other work in ISA related to another ISA Action (4.2.4), the *European Federation of Interoperability Repositories* (EFIR[35]), and notions of how to contextualise any particular interoperability assets, be it software or semantic assets. This notion of context was also further articulated by considering training and capacity building needs, the development of e-learning tools that allow learners to structure their own learning paths and the idea of helping to share good practice and show how a given software solution is being used in practice. An important aspect of this work is, again, not to replicate other platforms but to add a new perspective on processes that provide structure to the use of interoperability solutions. A focus is the practices being undertaken, the software used and the outputs created in support of a particular policy (in this case INSPIRE implementation) to show solutions acting in their policy context. Another European example that informed the concepts behind this work was the EEA's Reporting Obligation Database (ROD[36]), as it acts as a tool to support Member States in their environmental policy reporting tasks and the ***live3tutorial's*** task list could be seen as a similar guide alongside tools managed by the EEA to support monitoring and reporting of the INSPIRE Directive[37].

In essence, the ***live3tutorial*** allows INSPIRE implementers to document how they are addressing implementation tasks according to their processes in a series of steps that make-up a complete 'workflow' of an implementation in a particular organisation and, in most cases, for a particular dataset or annex theme, and, in turn, the associated supporting technologies. The creation of initial descriptions are then made accessible to others as 'reusable' descriptions to help document additional examples or to offer a workflow for those with less implementation experience to evaluate and, potentially, follow. The work has been very much experimental and it has been important to run the platform prototype to aid in the incremental development of this part of the platform. It is this part of the platform that mainly fills the gap between what the Directive, IRs and TGs are requesting and how people are addressing them in practice, with a view to also provide examples for others to follow or discuss.

The work for the ***live3tutoral***, therefore, followed three main phases involving different types of content: design, generic views and specific implementations.

3.3.1 live3tutorial design

An important initial step in the creation of the *live3tutorial* was an overall design document, outlining how the implementation vocabulary would be developed following INSPIRE documentation. It also set out the concepts for how the workflows could be represented (including graphically) that would eventually impact on the choice of software and its components for the prototype platform. Key concepts that were setting up the high-level tasks related to key INSPIRE components (establishing metadata and services, creating interoperable datasets, setting licence and sharing conditions, reporting on progress etc.)

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[35] http://ec.europa.eu/isa/actions/04-accompanying-measures/4-2-4action_en.htm

[36] http://rod.eionet.europa.eu/

[37] http://inspire.ec.europa.eu/index.cfm/pageid/5022

and the need to have a generic workflow, or 'control' flow, between tasks (outlined below). The live3tutorial was also recognised as a support tool to implementers to assess where they were in the process, including the creation of a checklist.

In order to provide consistency between tasks, workflows and a checklist a unique model was created primarily governed by the list of implementation tasks and, therefore, this main vocabulary. In order, however, to offer flexibility to implementers to document their workflows (and create reusable examples for others) the notion of 'steps' was added to the design, so that groups of tasks could be associated with real activities in public administrations or individual tasks explored in more detail (and connected together as a series of workflow steps) and, in both cases, tools associated with the steps to help others understand the roles they could perform in supporting implementation, ideally at the right level of granularity.

Tasks were recognised to be hierarchical and relate to details from several sources. In order to raise awareness about this work and ensure our understanding of tasks and their position was valid, a review was undertaken (based on Excel templates) internally in the JRC, and with Member State representatives and colleagues in the EEA and DGENV. This marked an important step in the development of the platform, as it would allow other design activities to be quickly implemented.

Following workshops to focus on the initial design for the prototype, the platform's main elements were put in place for the e3xpo and live3tutorial.

As a consequence of this development, already other projects are benefitting from the discrete details of tasks that the implementation vocabulary offered, including some early testing of the ideas in the European Union Location Framework (EULF) Marine Pilot[38] where implementation tasks and terminology were explored with pilot partners.

Following this initial work it was also possible to further test the platform development with real implementation material.

3.3.2 live3tutorial generic views

The first initial test was based on a particular example of an INSPIRE implementation where data harmonisation took place at the European level rather within LMOs, and specifically the transformation of the Common Database on Designated Areas (CDDA) data to conform with INSPIRE data specifications. The idea of documenting this example, in particular, was to provide a guideline for reuse for similar spatial data transformation contexts, as well as testing the concepts of the workflow and vocabulary.

The example focussed, therefore, on the follow steps and generic tasks (see **Table 6).**

Table 6: CDDA Example Steps and Tasks

CDDA Documented Step	Related Implementation Task
Set up mapping from CDDA to INSPIRE PS [Protected Site] model	Identify and document transformation to INSPIRE spatial object types
Implement identifiers	Implement identifier management and life-cycle rules
Check that transformation to GML is feasible	Use encoding specified in technical guidance

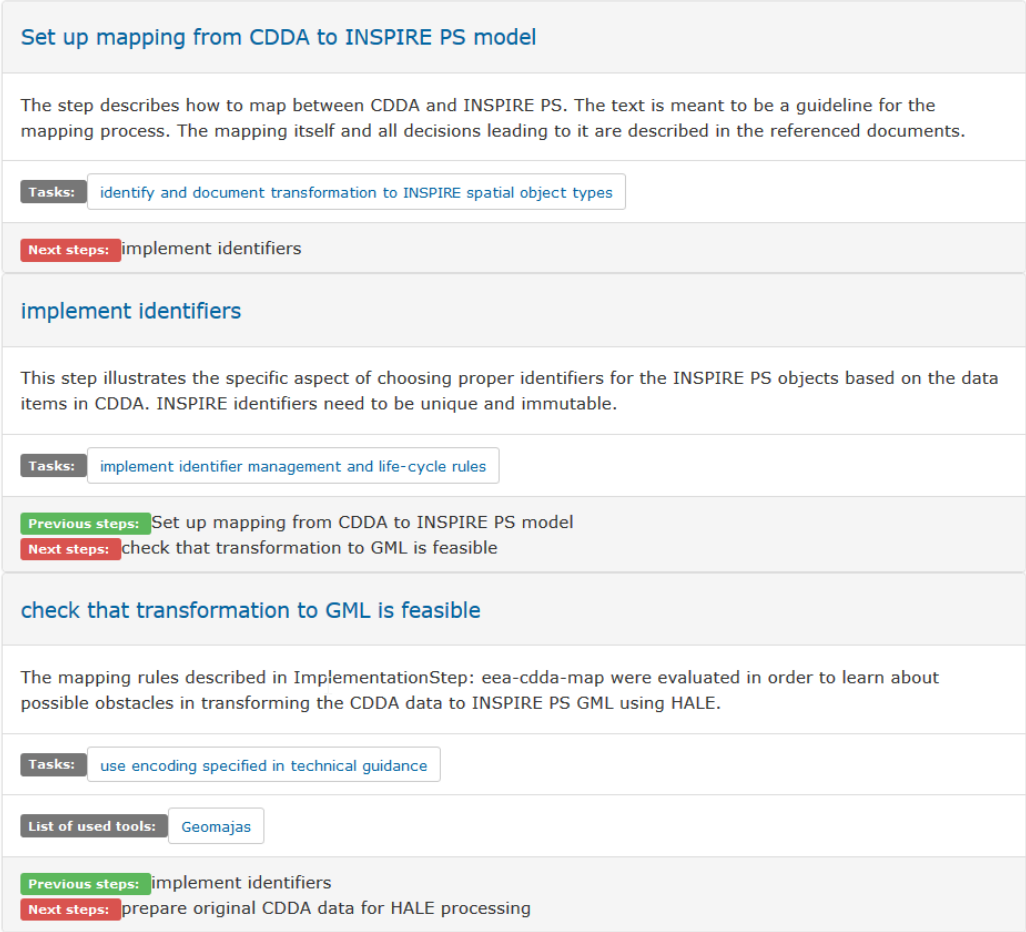
[38] http://inspire-marine.jrc.ec.europa.eu/

Prepare original CDDA data for HALE processing	Transform spatial data set in an ETL process
transform prepared CDDA data using HALE	
Analyse ATS [Abstract Test Suite] for INSPIRE PS	Validate Spatial Data Set
Validate CDDA INSPIRE data	

At the highest level, this example only deals with one task: "Make interoperable representation of spatial data set available" and does not cover all the levels of detail present in sub-tasks but, importantly, allows these to be related and explored for more detail if there were demand in the future. The example also shows in two cases that two steps are being tied to one task, offering examples of where preparation is needed before execution (either as pre-processing or as analysis).

It is also worth mentioning that the approach taken with this part of the prototype platform is focussing on function before considering presentation and form, by using a standard Bootstrap design and elements of the newly developed INSPIRE Knowledge Base (See Fig. 3).

Figure 3: Extract of CDDA Example Layout in the prototype platform



As noted above, understanding the right level of granularity of tasks and steps is an important aspect of this work which is being tested and refined with other documented examples.

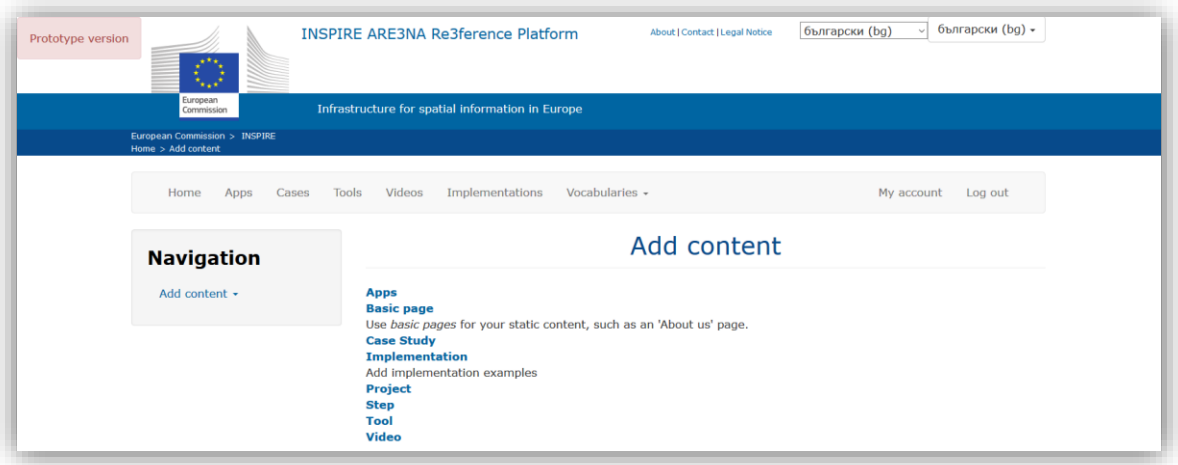
3.3.3 live3tutorial specific implementations

Following the CDDA example, members of the MIG-T were asked to volunteer to document implementation examples. The key task in this phase of the development of the platform is to try and document both implementation examples that are using open source and proprietary tools and, currently, three examples are being produced presented further below.

In this section we also present some of the current tools that logged-in users have to help submit platform content, including for documenting live3tutorial examples.

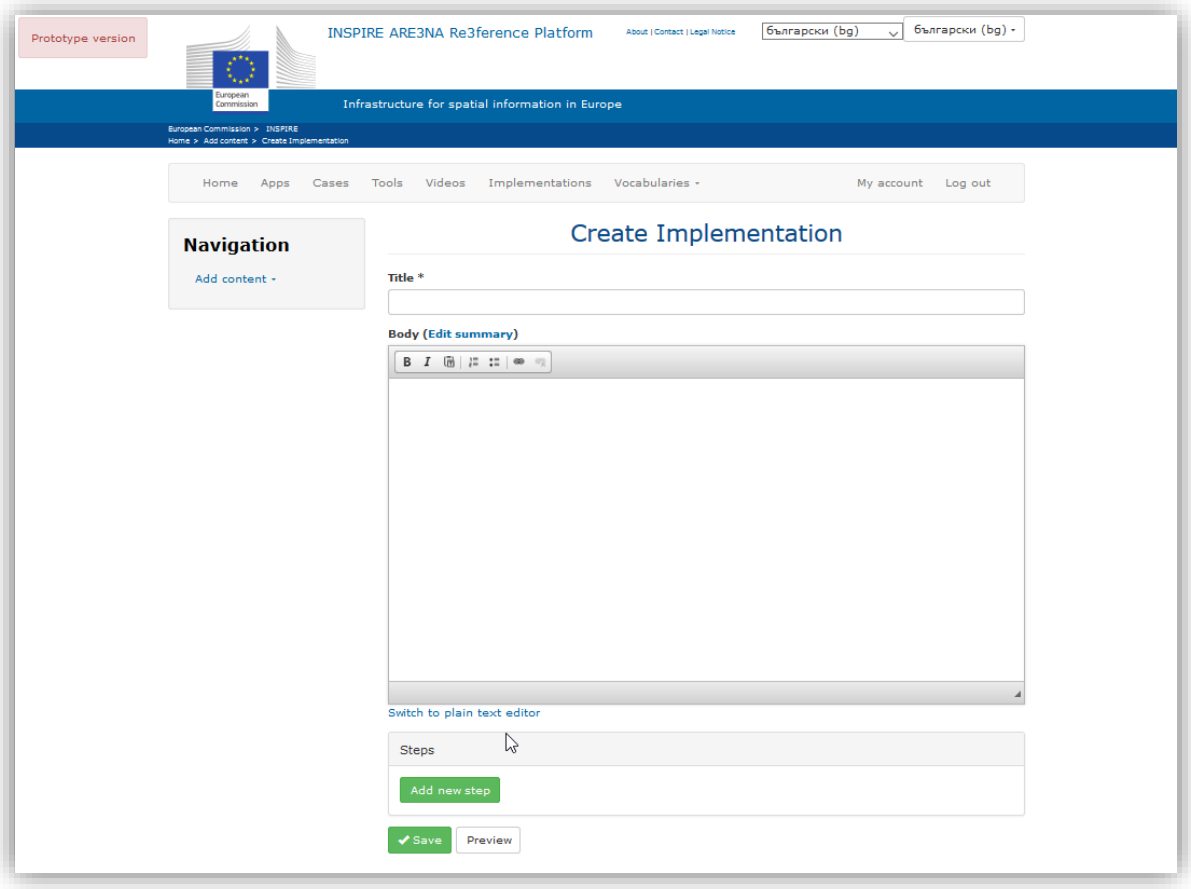
The first screen presented to users is a request to submit content (See Fig. 4). The example below contains details for a 'super user' to help manage the entire site and includes the current content types for Apps/applications, developing the platform's 'About us', a section for case studies (not active), Implementation example, projects (not active), a means to add a specific step independent from an implementation example (not available for most users), details of software for the Tool Inventory and details for videos (not active). Although multilingual functions are in place they have not been enabled, as all work is currently taking place in English.

Figure 4: Super User Platform Entry Screen



Selecting the implementation link takes a user to the following section (see Fig. 5).

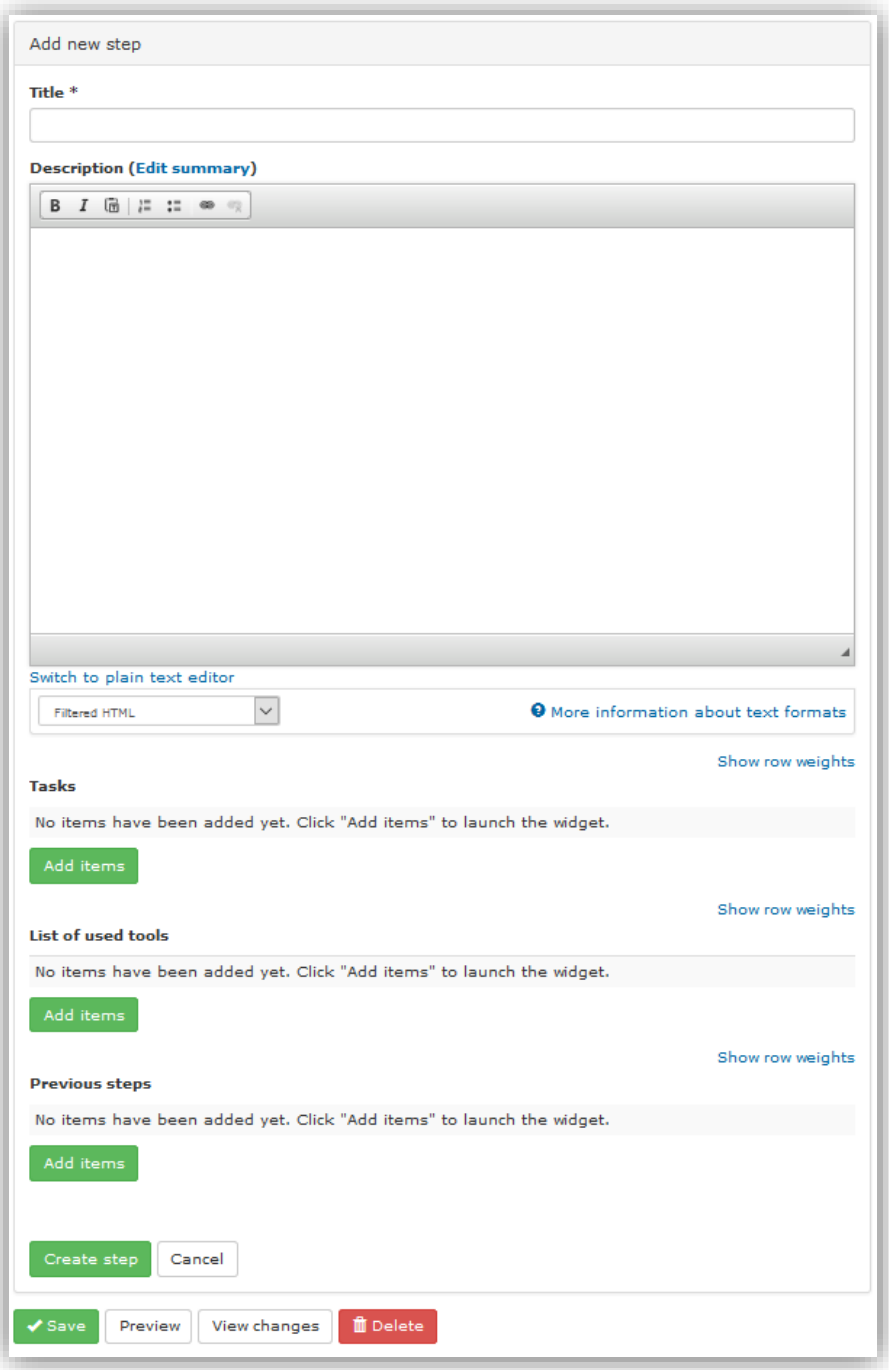
Figure 5: Catalogue details for an Implementation Example



To create the entry in the database and initiate the workflow, users need to provide some basic details about their implementation example: a title and a short description (in the "Body" section). The existing examples in the platform help users to understand how much detail is needed for this description but any length is allowed. As this is a generic tool in the platform, the "Add new step" button is present but should not be used until the example details on this page are saved. Users can also preview a draft of their entry in case they have used any of the text editing tools in the "Body" section.

When a user edits their entry they can then add a first/new step with the following features (see ***Figure 6***). This is one of the key elements of documenting examples in the Live3Tutorial.

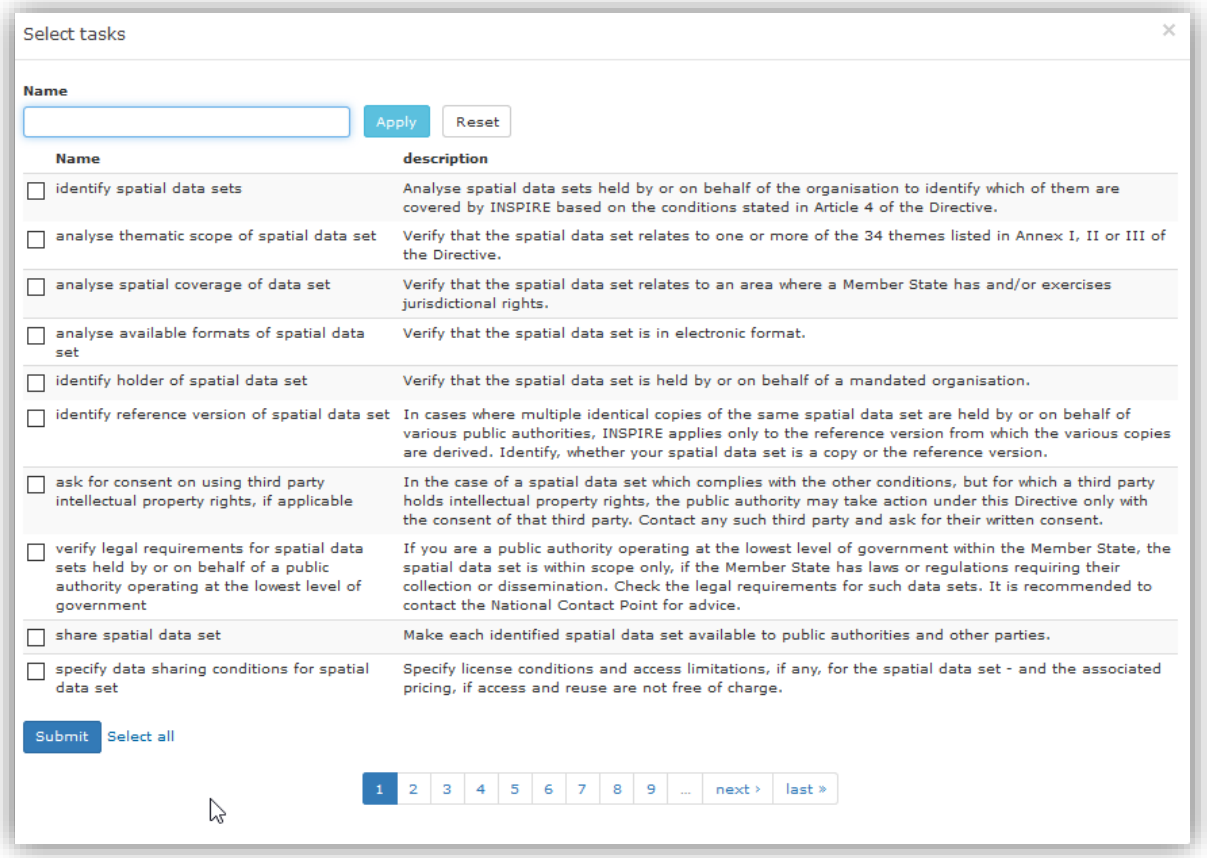
Figure 6: Step Description Features



Someone providing an example needs to give a name to their step (as seen above in Table 6), as well as a short description of the step. Again the length of the description is not limited but existing examples can help users to understand the amount of information being sought. In order to offering references to other information or sources, users are encouraged to submit links to external materials in the "Description" section.

As noted above, each step needs to be associated with one or more tasks. By selecting the "Add items" button in this section a current flat list of tasks is provided to the user (see Fig. 7).

Figure 7: Task List Pick Tool



Select tasks

Name

Apply Reset

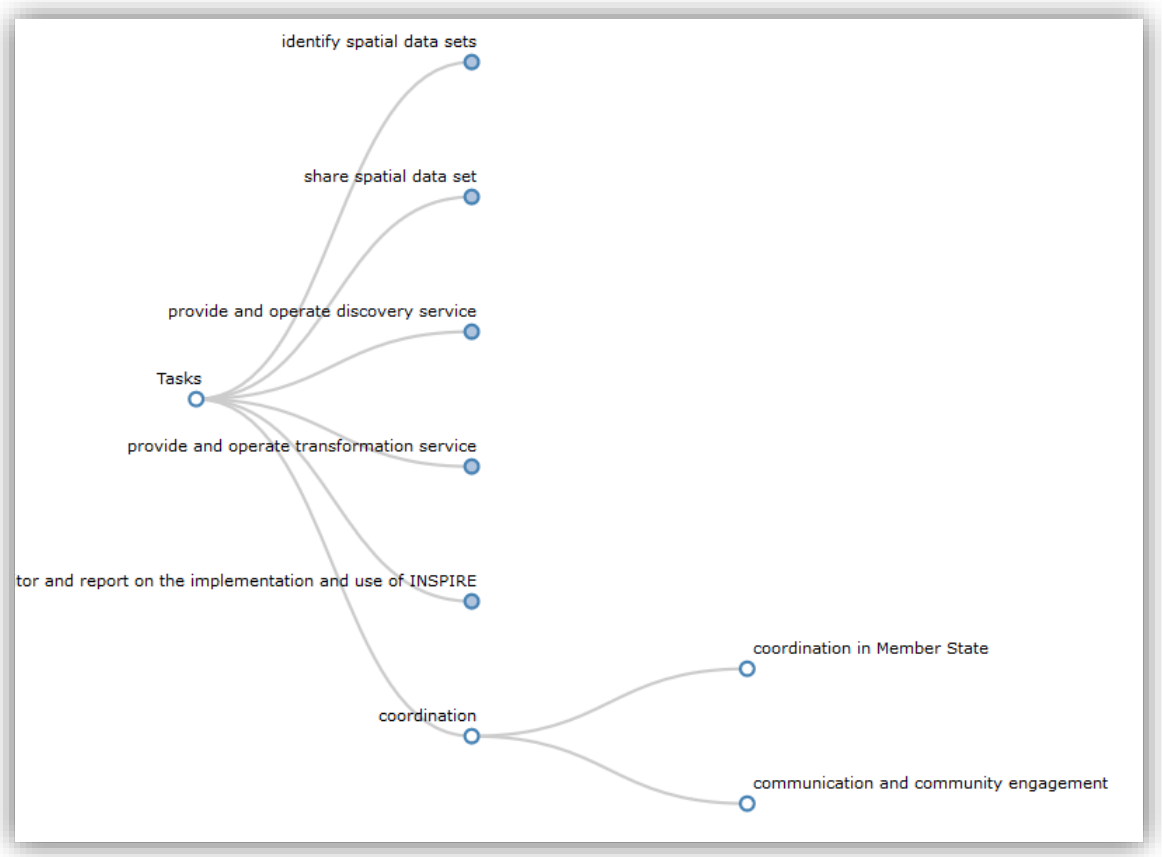
Name	description
identify spatial data sets	Analyse spatial data sets held by or on behalf of the organisation to identify which of them are covered by INSPIRE based on the conditions stated in Article 4 of the Directive.
analyse thematic scope of spatial data set	Verify that the spatial data set relates to one or more of the 34 themes listed in Annex I, II or III of the Directive.
analyse spatial coverage of data set	Verify that the spatial data set relates to an area where a Member State has and/or exercises jurisdictional rights.
analyse available formats of spatial data set	Verify that the spatial data set is in electronic format.
identify holder of spatial data set	Verify that the spatial data set is held by or on behalf of a mandated organisation.
identify reference version of spatial data set	In cases where multiple identical copies of the same spatial data set are held by or on behalf of various public authorities, INSPIRE applies only to the reference version from which the various copies are derived. Identify, whether your spatial data set is a copy or the reference version.
ask for consent on using third party intellectual property rights, if applicable	In the case of a spatial data set which complies with the other conditions, but for which a third party holds intellectual property rights, the public authority may take action under this Directive only with the consent of that third party. Contact any such third party and ask for their written consent.
verify legal requirements for spatial data sets held by or on behalf of a public authority operating at the lowest level of government	If you are a public authority operating at the lowest level of government within the Member State, the spatial data set is within scope only, if the Member State has laws or regulations requiring their collection or dissemination. Check the legal requirements for such data sets. It is recommended to contact the National Contact Point for advice.
share spatial data set	Make each identified spatial data set available to public authorities and other parties.
specify data sharing conditions for spatial data set	Specify license conditions and access limitations, if any, for the spatial data set - and the associated pricing, if access and reuse are not free of charge.

Submit Select all

1 2 3 4 5 6 7 8 9 ... next › last »

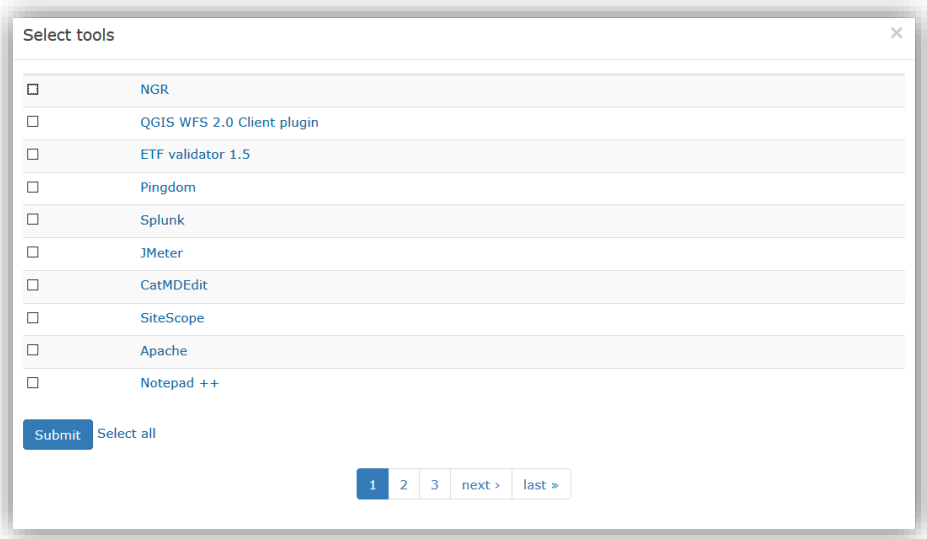
As noted above, the list of tasks is hierarchical and unless users are familiar with the task vocabulary it is not easy for them to navigate through this content. For this reason, the platform contains the vocabulary representation and users are advised to familiarise themselves with this material before entering content. This could be an area of further development to allow better navigation and selection of this content. Two developments have already been put in place to help users. The first is the search box "Name" and the "Apply" button, where a keyword can be inserted to help narrow-down the list of possible tasks. The second is a graphical visualisation of the task list (see Fig. 8) based on the D3 library, that is being applied in other tools related to the reference platform, such as the software supporting the Interactive Data Specification Toolkit (see Section 5). The development of this tool in Drupal is currently being assessed as reusable software to submit back to the Drupal core. Depending on user demand, additional features could be added to these tools to make it easier for implementers

Figure 8: Sample of D3-based Infographic for the Implementation Vocabulary



As noted above, the steps also act as containers to associate any related software tools. Again, the "Add items" button brings up a checklist of tools based on the content of the Tools Inventory (see Fig. 9).

Figure 9: Select Tools Function and Tool Inventory



Again, this is a flat list of items and could be filtered based on the most frequently selected examples once more implementation examples are documented. In addition, currently users with a tool not mentioned in the Tool Inventory need to add this material to the Inventory before selecting it in the step they are documenting. Both these areas could be improved if there is user demand.

The last main feature of this step definition tool is the means to link to a previous step or steps. This has three notable features. The first is that if there is a step in another organisations implementation, then the documented example can be linked to it. Secondly, if more than one person is involved in an implementation (for example, if there is a team involving data modelling expertise and the management of web services) then the people with the most experience can work together and add their details to the platform and connect to the relevant steps of their colleagues. Lastly, depending on how implementations are organised, it is possible that the workflow may involve several parallel activities being linked back to a specific step. This functionality allows this potential variation to be represented.

The documentation of examples through the creation of steps is carried out in the same way. Users can save and edit their steps at any time and the JRC and contractors are currently offering support and feedback to help document the current examples, which include:

- A detailed example of the implementation of the Buildings Theme in the Czech Republic's national mapping and cadastral agency, covering many of the implementation tasks and providing examples of new tools.
- A partial example of an implementation in Spain of Administrative Units Theme and the creation of an INSPIRE Compliant WMS, helping to show a best practice for tools associated with INSPIRE View Services.
- A detailed example of how the Dutch Cadastral Parcels dataset (PDOK) has been implemented and harmonised, covering most of the major tasks, including monitoring and reporting and assessing the quality of INSPIRE network services.
- A draft of the work being currently undertaken in the EULF Marine Pilot

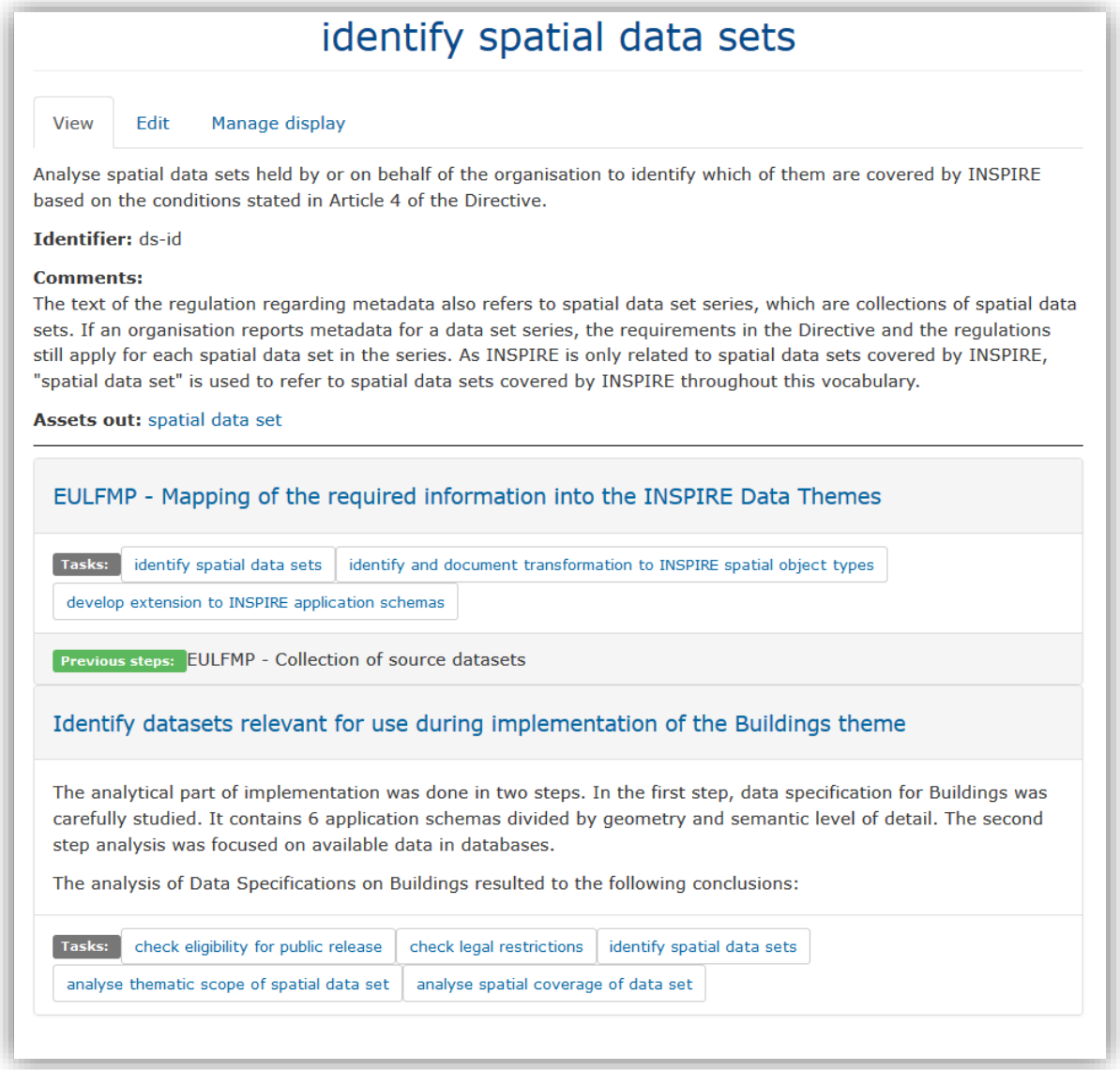
3.3.3 Navigating across live3tutorial examples

By using Drupal it is possible to create different collections of any given item in the platform. For example, as finding out what data is in scope is an important activity for many organisations (see also Section 5), we would expect to see a number of entries in the platform associated with this task.

Currently, for each entry in the task list, there are not only details about the tasks (including their associated output assets) but also a title and some initial content about all the connected steps that implementers have documented (see Fig. 10)

In the future, it would be possible to see which tasks have not been selected or where there are few examples. Similarly, the Tool Inventory has a similar list of associated steps. Similarly, future work could involve providing better search and display functions if the platform receives a large number of entries and received demand from end-users.

Figure 10: Example of connected Tasks and Steps



There is already the possibility to also visualise tool entries that have been associated with a specific implementer's Steps in their workflow and, in turn, the implementation tasks tools are supporting, importantly in practice. Similarly, solution providers will be asked to map to implementation tasks and assets, showing what their solutions are offering. Contrasting the two will provide new insights into the matching of 'supply' and 'demand'/usage of tools via the platform.

Overall, the development of this prototype is helping to show both the possibilities of such a platform and to ensure developments are made that are useful to stakeholders, following the living lab approach, mentioned above. Currently an evaluation is taking place with the pilot group of users and initial feedback is very positive, not only indicating a demand for the tool to be widely used so that implementers can learn from each other but also benefits for the organisations themselves, such as being able to document approaches in a clear way for new staff joining the team or where there could be a change of contractors/suppliers.

4 Technical and Operational Development

The implementation of the platform has been based on in-house developments using Drupal v7.0. This has included sharing ideas, data and draft documents on a Confluence wiki. Creating the platform has involved iterative steps to be able to engage end-users early in the development process and show progress, where we have adopted an agile process to maintain data updated and to transpose them in the final software product. As a small development team, the process has also been supported by using an issue queue system with a Kanban dashboard to monitor the progress and status of the work.

The source code of the platform has been created through internal developments but also through the reuse of existing Drupal modules. The software itself is hosted on a Stash repository (Git) connected to the Confluence wiki. Further development of the platform will also be shared through the ISA Programme's JoinUp platform.

The technical development and operation of the platform involves three environmental servers:

- Virtual machine on local operating system: The development (DEV) environment
- Virtual private server on an internal cloud system: The test (STAGE) environment
- Virtual private server on an external cloud system: The production (PROD) environment

The servers are deployed from a Vagrant file that allows us to describe the type of machines required for the project and how to configure and provision them, so that we can create a new environment when the need arises.

All these servers are built using free and open software including CentOS 7, a Linux distribution at the base of our stack which it is composed of: Apache (webserver), MySql (database) and PHP. Other installed tools include Git (for version control), Composer (for dependency manager for PHP) and Drush (a command line tool for Drupal).

Our platform is built from the 'vanilla' Drupal 7 distribution, where we create a *make* file to add many *contrib* modules from the official Drupal.org repository and from our custom personalisation (modules and features) from the internal Stash repository.

Below is a list with some example of libraries and the standards that have been adopted:

- Bootstrap: the twitter library to build custom user interfaces
- ECAS: European Central Authentication Service to give access to the private area of the platform
- Piwik: to visualize statistics data about visitors of the site
- D3.js library: to expose data with graphs
- OEmbed: a standard to embed media contents from socials or video sites
- Feeds Drupal Module: to import contents, taxonomies and other data (such as the vocabularies) from CSV files or other formats
- Entity API and Entity Reference Drupal Modules: the core of our implementation, that have been used to build all the relationships and interactions of the objects that make up the platform
- Taxonomy Drupal Standard module: we use the standard taxonomy module with the addition of some custom fields to manages our vocabularies and integrate them with the Entity Reference Module

The feedback from stakeholders in the open development approach is also managed through internal processes to improve the platform features and to fix some bugs. Always considering the agile methodology, we have insert the relevant ones into an issue tracker and manage them in the current development cycle, involving the beta testers in every new release.

5 Step 1: Interactive Data Specification toolkit software

In parallel to the development of the Reference Platform, work has been undertaken partly in ARE3NA to develop the software that powers the Interactive Data Specification toolkit. The focus of these tools is to support INSPIRE data providers with their implementation tasks related to identifying what data needs to be transformed according to the common data models and helping them to carry out the process of data transformation using an Open Source software transformation tool, the Humboldt Alignment Editor (HALE)[39]. Another objective of the Toolkit involves helping users to access and better use of the huge amount of technical reference material (i.e. over 4000 pages of the Technical documentation related to the INSPIRE data specifications). The software has been developed using the Stripes framework, based on JAVA technologies such as annotations and generics, connected to an object-relational Postgres database management system. Overall this work offers a direct support to the "Analyse thematic scope of spatial data set" sub-task that the Implementation Vocabulary has defined[40]. The landing page for the toolkit is shown below (see Fig. 11)

Figure 111: Data Specification Theme Comparison

The first application "Read/Compare Technical Guidelines" helps implementers, once they select a data theme(s) (see Figure 12), to navigate, read/study technical recommendations for the implementation of the legal requirements related to INSPIRE data and services. It also offers a comparison function where users can compare the

[39] https://www.wetransform.to/products/halestudio/

[40] See https://inspire-reference.jrc.ec.europa.eu/taxonomy/term/2479

same Sections from two Technical Guidelines, for example to see the list of Use cases identified/defined during the development of the Data specifications see Figure 13.

Figure 12: Data Specification Theme Selection

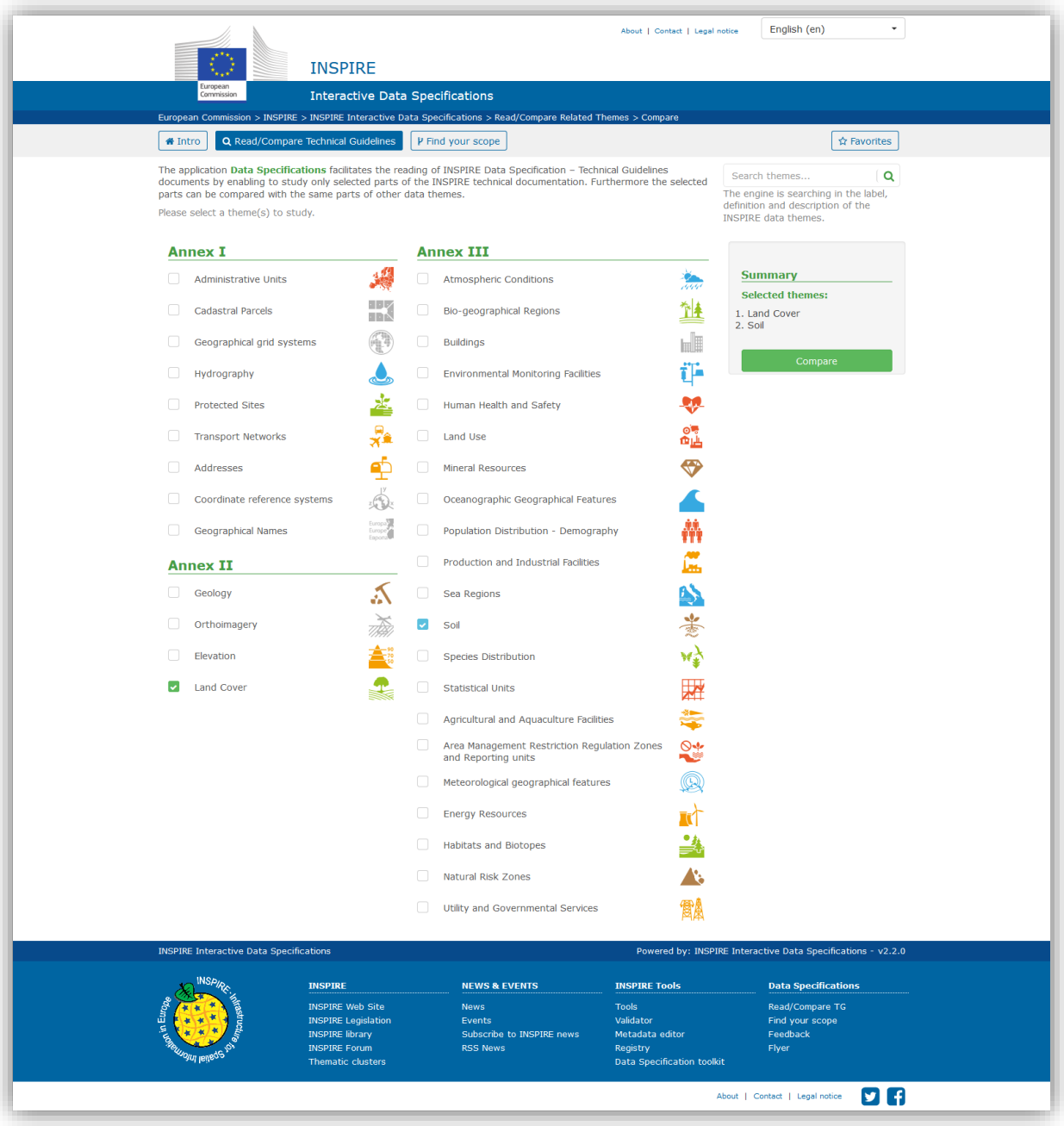
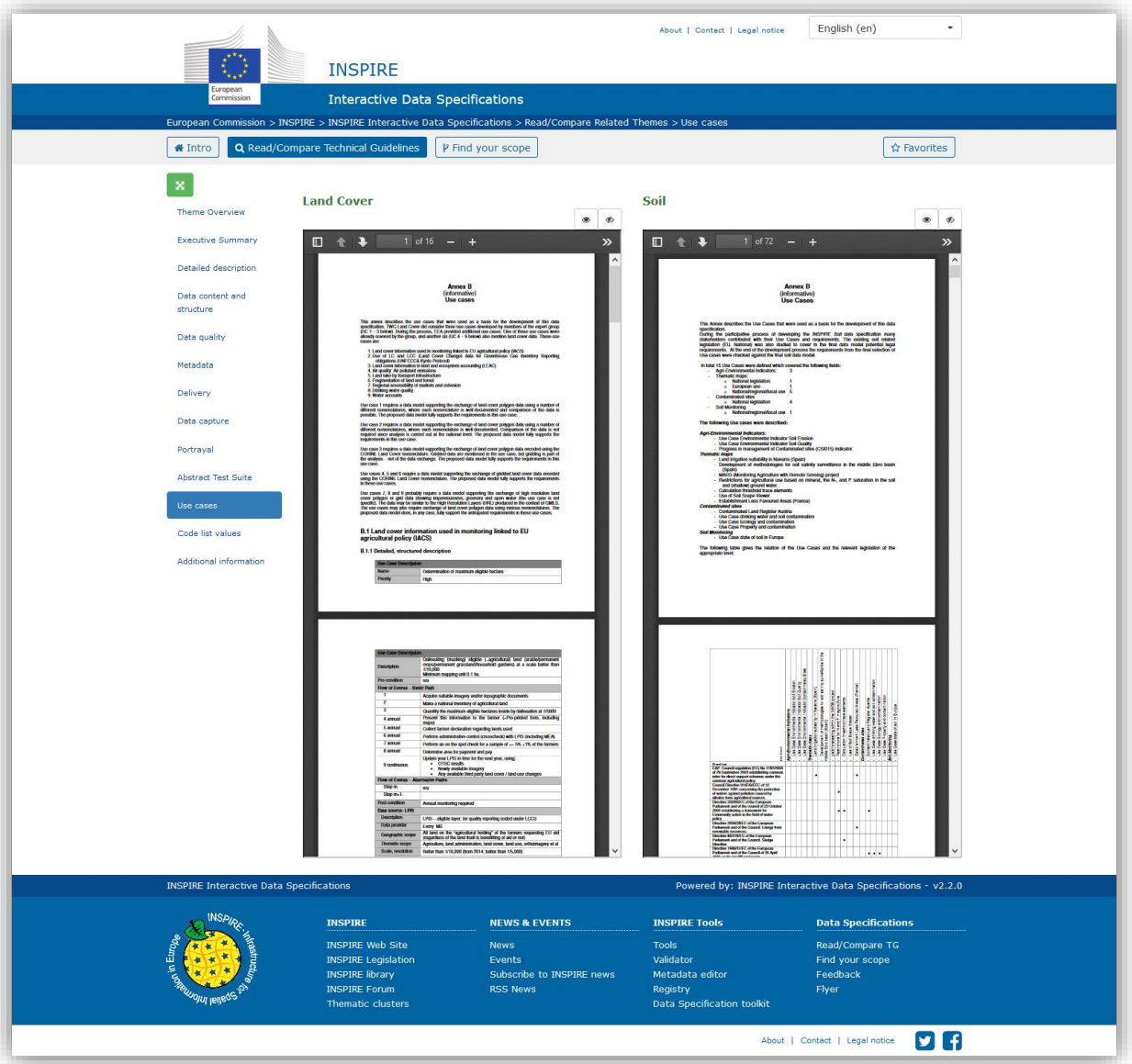


Figure 133: Data Specification Theme Comparison



For a potential implementer, reading the guidelines is a helpful step in understanding if INSPIRE applies to them. The best way of establishing this, however, is by understanding the actual data objects the infrastructure requires. To do we have developed the **Find Your Scope** application (set of tools) see Figure 14.

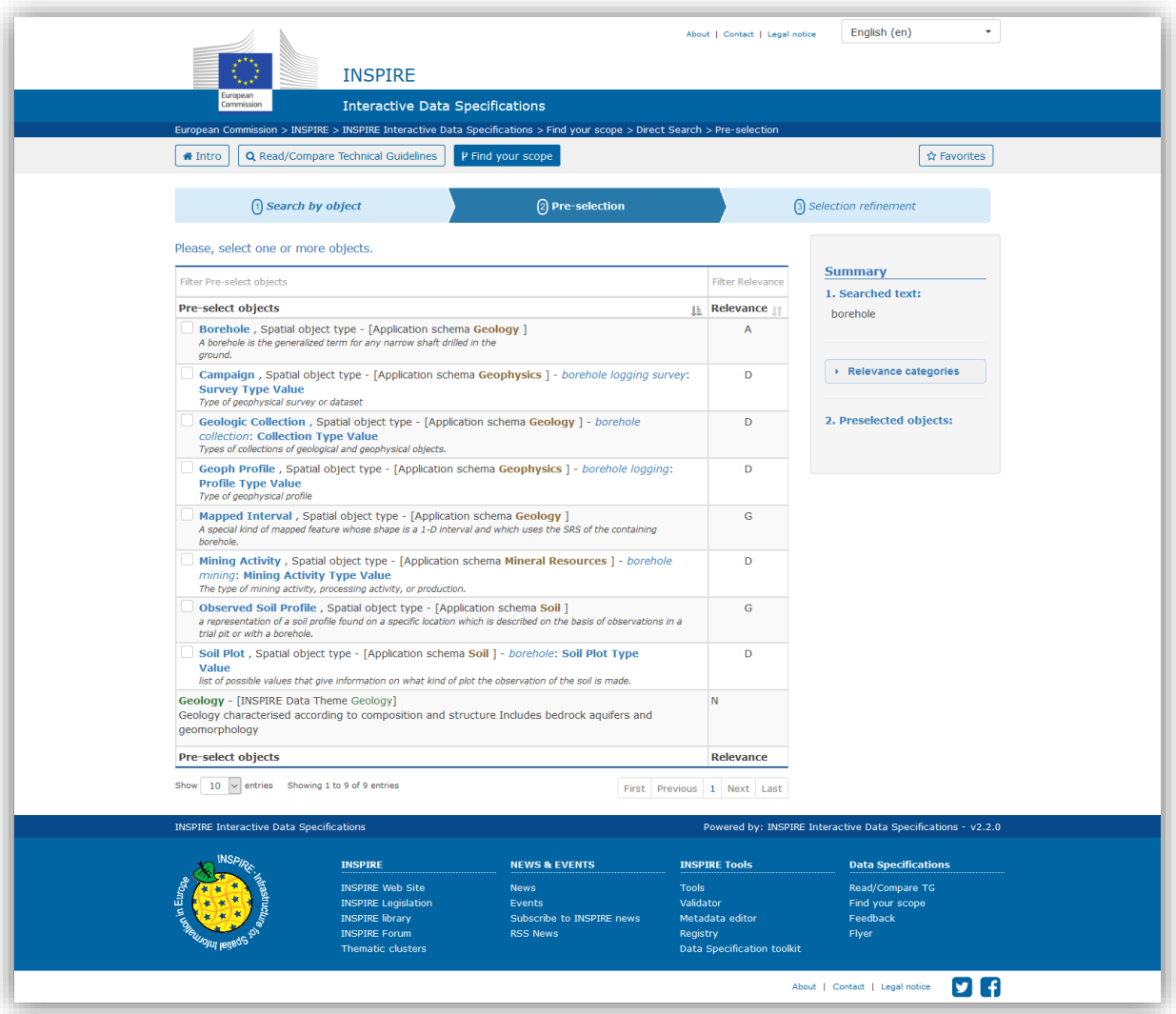
The application offers three different ways to search for data concepts defined by INSPIRE (over 800) that are relevant for the data the implementer is administrating and, therefore, is obliged to transform.

Figure 144: Data Object Search Tools

These "finding/scoping tools" offer a range of advantages to implementers rather than potential reading across several data specification documents. In particular, the **Direct Search** tool allows users to input keywords (in English) that represents the data that they have in their databases to be able to find the related objects defined by INSPIRE.

For example, water management and geological studies involve mapping and collecting details about boreholes. Putting this as a search term in the Direct Search produces outputs that illustrate in which INSPIRE objects this term occurs, including related code lists and their values, spatial object types, application schemas etc. (see Figure 15).

Figure 155: Direct Search results for Borehole



The next step is to select the relevant spatial object(s) from the list and continue with the refinement of the selection. Once the spatial object(s) have been selected the complete property (i.e. definitions and descriptions of the attributes, multiplicity etc. see fig. 16) of the selected objects are displayed including the associated objects taken from the UML diagrams (see Figure 16).

Figure 166: Borehole Entry

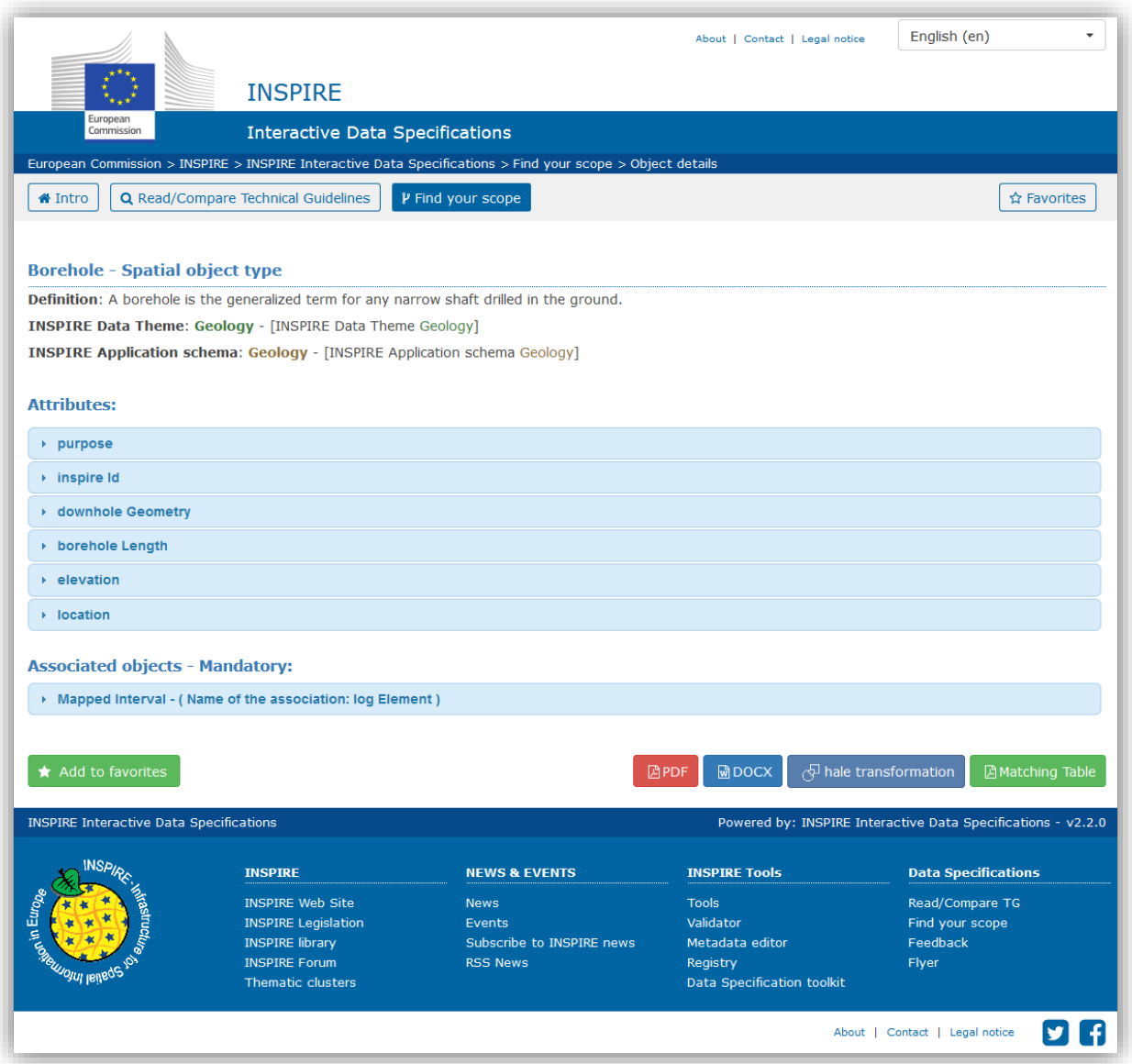
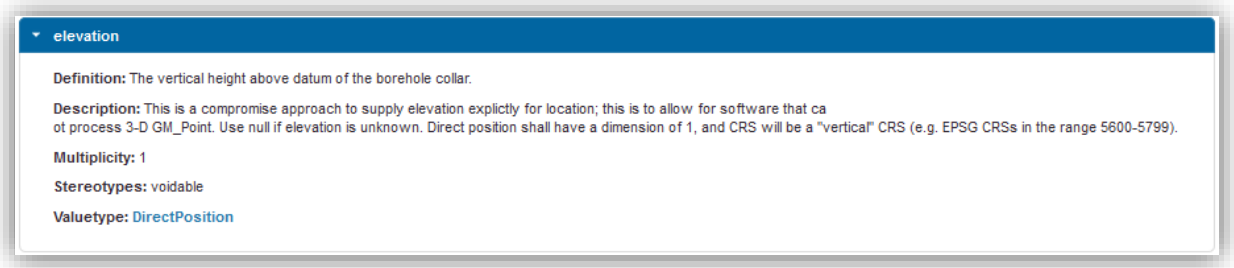


Figure 177: Attribute example: elevation



All the information provided about each of the preselected spatial objects helps users to select only the relevant objects i.e. by adding them to a 'shopping basket' as "favourites". The final list of favourites can then be downloaded as structured text in Adobe Acrobat files (pdf) or MS Word (.docx) that can serve as the technical documentation for data

managers to see the scope of the required data transformation. Matching tables (in .xlsx) offer another output option that supports the process of transformation through data concept mapping. Currently, the last available output option is the direct integration of the results of the mapping (i.e. a list of selected INSPIRE spatial objects) into HALE's transformation tools. The selected list of INSPIRE spatial objects represent the Target Transformation Schema into which the user's data need to be transformed. This step significantly helps implementers to transform their data and share it through INSPIRE Network Services.

One of the advantages of this application is that it is showing how reusable INSPIRE can be for geospatial data modelling, where various project teams have been using the tool to define INSPIRE-like data models in examples within and beyond the environment domain. Moreover, anyone looking to build applications based on INSPIRE can better understand what data should be available across borders from the infrastructure, offering some means to explore the demand and supply of geospatial data in Europe. In addition, the development of this tool has also helped us to explore some of the workflow concepts that the Live3tutorial is implementing and to already consider some consistent look-and-feel of the user interface across INSPIRE platforms and tools (see Fig. 14).

6 Conclusions and further work

This report has provided an overview of the software and services being developed in ARE3NA to support INSPIRE implementation as part of the new INSPIRE Knowledge Base. It has focussed on the process of developing the concept and the prototype of the ARE3NA Reference Platform and closely related developments of the Interactive Data Specification toolkit software.

By developing this platform we have been able to take a living lab approach and engage with stakeholders in its creation and testing. The platform can be seen, therefore, as a collaborative process in its creation and as a means to support collaboration between INSPIRE implementers and those offering tools to support collaboration, alongside those wanting to showcase the applications that SDIs can support. This approach has allowed us to invest in the most important sections of the platform and to understand where best to position some materials for the INSPIRE Knowledge Base coming from our research and studies.

Our platform can be seen to perform two main functions: it helps to clarify what INSPIRE involves in terms of technical tasks and reference materials and to support the sharing of good practices in a defined policy-related context. We believe that our approach and the tools we offer are innovative and that there are not likely to be any other examples supporting EU policy today, although this is worth further investigation.

The reference platform is powered by inventories of related content (in the e3xpo and de3mo) where our data-gathering approach within the project has helped us to refine the design of the platform before approaching stakeholders to ensure we are asking for the most pertinent and easy to obtain information from stakeholders who will populate the platform. The range of metadata has been contrasted with other standards (e.g. ADMS) and this analysis will help to provide a more focussed data collection effort over the next year. The live3tutorial has been a successful experiment and current feedback from pilot partners has identified not only the value of documenting implementation approaches as workflows (based on the implementation tasks) but also offers a means for organisations to readily document their approach for their own purposes, helping with the sustainability of their infrastructure where there is organisational or staff change. Such benefits are being currently explored further while we investigate the sustainability of our platform.

The related developments of the Interactive Data Specification toolkit software are both helping to inform the concepts of workflow representation in the reference platform and the look and feel of its future development. Moreover, this tool is supporting key processes

in implementation, especially the scoping of INSPIRE data providers data and the inputs to matching tables that will support transformation of this data to INSPIRE data models. The key aspect that this work supports is much improved navigation and usage of the content of INSPIRE's data specification documentation, offering opportunities to better explore INSPIRE's semantic interoperability assets related to data specifications, both within and outside environmental policy.

From a technical perspective, the reference platform may migrate to Drupal v.8, which would follow the development of the new version of the JoinUp platform. We could also consider introducing the RDF standard under the hood of the contents of the platform in order to improve Search Engine Optimisation (SEO) performance and introduce the principles of sematic web into our reference terms. Similarly, the work on the Interactive Data Specification toolkit is considering expanding its multi-disciplinary and multi-lingual searching, so that searching for "well" could lead to semantically similar objects such as "borehole".

The next key steps for the reference platform is to adjust the structure (and hand-over the components that will not feature in ARE3NA), load all the relevant inventories and engage with stakeholders to further populate the baseline content we have established in the last year. Gathering feedback about user experience across the platform will also help us to improve the visualisation and navigation of content.

Work is already underway to expand the concept of the live3tutorial to not only include implementation tasks but also ways of explaining how INSPIRE can be used, bridging a perceived gap between SDI and GIS/Geo-ICT/Mobile App technologies and, thus, creating a 'total INSPIRE' view of the technical aspects of the data infrastructure from data sources to end-user products and services.

Work on these tools can also be seen as offering potential for the reuse of INSPIRE in other sectors, a key ambition of the ISA Programme to support cross-border and cross-sector interoperability. In particular, the work on the vocabulary can already offering potential for managers to estimate the effort and skills needed in performing tasks and current plans are in place to develop a checklist from the vocabulary to help navigate through the tasks but also offer some project management tools (e.g. estimated timescale/effort, progress achieved, financial resources needed etc.). Similarly, the terms, if widely adopted, could support procurement, where organisations and service providers can agree more discretely where work can take place. Moreover, as reference material, the platform's vocabularies and the work on the Interactive Data Specification Toolkit could support the assessment of ICT Implications of New Legislation (led by DIGIT), in support of Better Regulation. In particular it can help determine where INSPIRE's data and interoperability solutions could be redeployed, helping to reuse the investments in the infrastructure and ensure that public administrations and not being required to share the same data in different ways without clear motivations. This work will be explored further through ARE3NA in establishing the ISA^2 Programme's Action 4.1, European Location Interoperability Solutions for E-government (ELISE) being established by the JRC.

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