e-shape

EuroGEO Showcases: Applications Powered by Europe

# D4.4 Capacity Building Best Practice Guide

**e-shape**

The e-shape project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 820852

# Abstract

Besides the pilot-development focused activities, e-shape, through its work package 4, seeks to **actively engage the community** by providing:

- the tools (i.e. best practices),
- methodologies (EO maturity indicators),
- resources (EOWiki 2.0), and
- practical support (training sessions)

necessary to cultivate better interactions and exchanges between EO services suppliers and their respective users. In that regard, WP4 seeks to nurture a broader access and participation within the community and finally contribute to an improved uptake amongst new and established audiences. Within this framework, the **Capacity Building Best Practice Guide** (deliverable D4.4.) was developed in consultation with various WP leaders and partners after the careful consideration of:

- the project goal, lifespan and resources available;
- capacity building objectives at work package level;
- the envisaged targeted audience: the project 's pilot developers, their potential users and the greater EO community;
- the specific users' needs as extrapolated based on 1) experience acquired amongst the WP leaders and 2) direct communication with the pilots as undertaken under WP3; and finally
- the broader context (policy & regulations, main actors, maturity level, etc).

In light of the above, 4 capacity building modules were proposed and pursued as part of this deliverable:

1. Presenting and finding EO services online (curated by EARSC)
2. Introduction to co-design (curated by ARMINES)
3. Data Discoverability (curated by NOA)
4. Assessing the maturity of EO activities at country level (curated by EVF)

A modular approach was favoured to enable the e-shape pilots and/or the wider community to use these tools according to need - individually or together - when undertaking capacity building activities internally, for themselves, or with their users. It is important to note that the current iterations are intended **(i)** as working documents to be further tested and improved throughout the project lifetime and, ultimately, **(ii)** to serve in awareness raising campaigns under more user friendly designs or as video training materials. As such, the content of each module is to be fine-tuned following interaction with the pilots (and through them their users). Once final, the content of each module (presented in the form of leaflet, webinar, video, etc.), will be accessible through the dedicated capacity building page of the e-shape website. Depending on need and resources available, other modules could potentially be developed. The final versions, expected in August 2022, will be laid-out materials to be used within and beyond e-shape.

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| **AUTHORS, REVIEWERS** | | | | |
|---|---|---|---|---|
| AUTHOR(S): | Valentina BALCAN (EVF) overall coordination and language review<br>Lefteris MAMAIS (EVF) technical content and language review<br>***Data Discoverability Module***: Alexia TSOUNI, Katerina KYRATZI (NOA)<br>***Presenting and finding EO services online Module***: Emmanuel PAJOT (EARSC)<br>***Pedagogical intro to co-design Module***: Raphaëlle BARBIER, Pascal Le MASSON, Benoît WEIL (ARMINES)<br>***Assessing the maturity of EO activities at country level:*** Stefka DOMUZOVA, Lefteris MAMAIS (EVF), Mónica MIGUEL-LAGO (EARSC) | | | |
| AFFILIATION(S): | EVF, EARSC, NOA, ARMINES | | | |
| FURTHER AUTHORS: | | | | |
| PEER REVIEWERS: | PMT | | | |
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| VERSION NUMBERING | |
|---|---|
| v0.x | draft before peer-review approval |
| v1.x | After the first review |
| v2.x | After the second review |
| Vfinal | Deliverable ready to be submitted |

| STATUS / DISSEMINATION LEVEL | | | |
|---|---|---|---|
| STATUS | | DISSEMINATION LEVEL | |
| S0 | Approved/Released/Ready to be submitted | **PU** | Public |
| S1 | Reviewed | **CO** | Confidential, restricted under conditions set out in the Grant Agreement |
| S2 | Pending for review | | |
| S3 | Draft for comments | **CI** | Classified, information as referred to in Commission Decision 2001/844/EC. |
| S4 | Under preparation | | |

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# EC Review Comments to be considered in the further development of the proposed modules

| DRAFT PROJECT REVIEW REPORT<br>Ref. Ares(2020)3764743 - 16/07/2020 | ENVISAGED ACTIONS |
|---|---|
| Related to D4.4 "capacity building best practice guide", this will be reopened for revision. The usefulness of some parts of the deliverable are not clear.<br><br>[…]<br><br>So this deliverable is reopened to clarify the positioning of this deliverable within e-shape and in full alignment with other work packages and specifically WP3. What is the purpose of this deliverables: are these best practices to be used by the pilots? | In line with the Grant Agreement page. 33 ANNEX 1, part A: *"Development of Capacity Building Best Practices*<br><br>*The aim of this activity is to compile a set of best practices related, for example, to the access to services on different platforms (in collaboration with WP3), the methodologies for integration of certain products in operational workflows of users, the preparation of metadata for uploading of service description on eoMALL etc. The outputs will be combined within an overarching guide and made available to pilot partners and the greater community."*<br><br>The Capacity Building Best Practice Guide is set to build on and capture results and expertise acquired throughout the project lifetime which is likely to address the needs and interests of (1) established and potential users of the individual pilots and (2) the wider EuroGEO community to thus ultimately encourage user uptake and participation.<br><br>As such, this kick off version of the Capacity Building Best Practice Guide aimed (I) to identify outputs of potential interest as developed within e-shape (could be expanded if the need arises and resources allow it*) and (II) establish a sufficient background to enable interaction with users so as to ensure that the future, refined versions – to be submitted no later than August 2022 - carefully consider and address those needs.<br><br>As the project unfolds, depending on need and resources available, other relevant "lessons learned" could potentially be harnessed under the umbrella of the Capacity Building Best Practice Guide; the team being actively coordinating with all WP leaders (WP3 included) to that end. |
| E.g. the introduction to the co-design is copy-paste from deliverables of WP2 and is mainly | As this work is expected to mature throughout the project life cycle, a tested, step by step, approach intended to assist future and potential users (parties who could not benefit from direct support) will become |

| | |
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| theoretic i.e. hard to understand for many users. | available via the dedicated capacity building page of the e-shape website closer to the project end but no later than August 2022. |
| Related to the section to the challenge of finding sufficient and reliable data, it is unclear what this brings on top of the WP3 deliverables on FAIR data and the GEO data management principles, and which is addressing wider aspects that D4.4.<br><br>It is unclear why in D4.4 a lot of publicity is made for the GEO-CRADLE regional data hub & the GEO-CRADLE energy pilot SENSE, where in WP3 more emphasis is on GEO Portal & NextGEOSS. The latter seems more suited for e-shape as wider in scope. WP3 deliverables and D4.4 are hence not fully clear on the positioning of NextGEOSS, the GEO Portal of the GEO-CRADLE system, and how this all relates to each other.<br><br>D4.4 contains duplicate information, which could be better moved to updated WP3 Guidelines in the future. Also the description in §2.1 of how to upload metadata in the GEO-CRADLE system is very detailed, but NextGEOSS and GEO Portal or not discussed. This gives the impression that e-shape promotes the use of the GEO-CRADLE system by their pilots, which is not confirmed in WP3. Furthermore, it is not clear why the explanation in §2.2 of the VITO pilot in NextGEOSS is included. | This module is intended to reach out and 1) raise awareness amongst users in general and the pilot's users in particular that by contributing their own data they can increase the value they get from the resulting services and 2) inform on the technical steps to be untaken by those users willing to openly contribute their data so that this value is realised. The user's perspective and needs shall be in focus in an effort to promote user owned (historical, self-developed or self-collected) data discoverability and subsequently enable EO product customisation (output refinement) for the benefit of the pilots and EO service providers in general.<br><br>In its first iteration, the module presented different portals and hubs as an example of how this could work – in future iterations the points raised by the reviewers shall be taken into consideration during the refinement efforts which are to be undertaken in collaboration with users. The updated module shall be made available (no later than August 2022) on the dedicated capacity building page of the e-shape website.<br><br>**Reply by module author - NOA:**<br><br>Indeed this section is interconnected with the WP3 deliverables on FAIR data and the GEO data management principles, and could contribute to them as well. It was included in the D4.4 because the access to sufficient and reliable data is also crucial for the capacity building. Similarly, co-design is addressed in detail in WP2 deliverables, but it's included here as well because of its importance.<br><br>The GEO-CRADLE Regional Data Hub is presented as an example of available geodata portal on the national and regional level (1.4.A), followed by the example of INSPIRE and NextGEOSS on the interregional level (1.4.B), and the example of GEO Portal on the global level (1.4.C). Each example covers one page, while GEO-CRADLE further promotes the GEO Portal anyway.<br><br>In Section II two examples of real world applications are presented which illustrate the principles of data discoverability and accessibility for the benefit of those willing to contribute their data and results on regional and national portals. The first example is the GEO-CRADLE Energy pilot SENSE which is presented in 2.1, and the second example is the NextGEOSS Vito Agriculture pilot which is presented in 2.2. The reason that these two pilots were selected was because of their relevance to the e-shape project: amongst others, the first one is a successful pilot which constitutes the base for the e-shape Pilot 3.1: nextSENSE, and the second one is a best practice of how to exploit and make publicly available EO-based outputs. |

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| Furthermore, the document content raises questions, as e.g. related to data management only a subset of tools is discussed compared to WP3. The document, a public deliverable, gives the impression to promote only certain tools from certain partners. | The description in §2.1.1 Uploading metadata and data at the GEO-CRADLE Regional Data Hub is indeed detailed (2 pages). In the last paragraph of this description there is reference to both NextGEOSS and GEO Portal, with reference to Section 1.5 where details are provided.<br><br>Regarding §2.2, please see the feedback above. |
| Also on the maturity of EO activities at country level, there is a lot of repetition of information available in other deliverables. | The purpose of this module is to assist and empower future and potential stakeholders (parties who could not benefit from direct support) in carrying out an EO maturity assessment. The module shall be mindful of the most frequent challenges stakeholders face and propose potential solutions as identified and tested throughout the project lifetime. The advanced draft version of this module together with a first introductory workshop were made available via the dedicated capacity building page of the e-shape website. Any future updates, including the final deliverable itself shall also be published on there - no later than August 2022. |
| Consider also having an online document which can be iteratively updated, instead of a deliverable as PDF. | Addressed: a dedicated "capacity building" page is now hosted on the e-shape website. As work is ongoing on most of the modules, only the most advanced content was made available i.e. the **Assessing the maturity of EO activities at country level** module. |
| Note that there are some issues in the Table of Content, which is a detail but as this deliverable is public, please correct this as well. | Fixed. |
| [Impressing assessment framework.]<br><br>How all these existing resources, EOwiki, EO pages, EO mall, will be integrated into the e-shape platform is not clear. Furthermore, it is not clear whether the EARSC website is (partly) restricted to members only? Also the e-shape branding and acknowledgement should be addressed. | **Reply by module author – EARSC:**<br><br>These resources are integrated in e-shape as this project offers an opportunity to acquire and pass on knowledge of importance to the community, facilitating the user-provider interaction:<br><br>Eowiki is open and accessible to everybody from and through EARSC website. Users can reach eoWIKI also from the e-shape website under the "Sustainability" section. WP4 is currently working with the WP6 Communication team to implement a dedicated "eoWIKI for e-shape" page, integrating accordingly the e-shape branding. This page is currently under construction in the "EO projects" area and will be enriched through cross-fertilisation and syndication with ongoing activities run by EARSC.<br><br>EoMALL is also embedded in the e-shape website and users can reach it from the "Sustainability" section. Eligible e-shape pilots will be invited to increase their visibility on this platform. |

| | |
|---|---|
| | EARSC website: it has a member login for the portal, a gateway to information and knowledge for members of EARSC. |
| It is not clear who are the target audience for the Capacity Building Best Practice Guide.<br><br>Also whether it will be available in interactive form as well on the e-Shape platform? | Target audience: EO solutions providers and final users, be they from the industry, government/public users, or researchers.<br><br>The content of the different modules will be uploaded progressively - but no later than August 2022 - onto the dedicated capacity building page. Once final, the Capacity Building Best Practice Guide will be laid out (and made available for use as needed) as well as developed into webinars in an effort to reach as wide an audience as possible. |

# Introduction

Through its sheer scale (partners, pilot's users and associated entities) and objectives, **e-shape offers an unique opportunity to acquire and pass on knowledge of importance to the community**; as such most work packages include a "lessons learned"/documentation component aimed at enabling **replication and scalability**. However, **this same parameter - scale - poses a significant challenge** when considering the type of capacity building activities that could realistically be supported. Therefore, as already indicated in the project's proposal/Grant Agreement, the aim of the capacity building activities, to be carried out as part of work package 4 - Users' Uptake, Capacity Building and Liaison, is to **produce easy-to-follow capacity building modules of universal value which could further trigger deeper capacity building interactions between Earth Observation solution providers and their established and potential users**.

Consequently, after thoughtful consideration of **(i)** the project lifespan, resources available and overall capacity building efforts, **(ii)** the targeted audience, its specific needs and the available engagement channels, as well as **(iii)** the broader context: policy and regulations, main actors, maturity level etc., **four main topics**[1] were identified as relevant and pursued collaboratively. A short *raison d'être* of the proposed modules is included below as an introduction into the work to be further carried out and refined alongside the pilots (and through them their users) in order to make sure the future materials will satisfactorily meet the capacity building needs of their intended audiences. Further, to encourage distribution and use, these materials will be both laid-out and developed into video trainings. Once final (no later than August 2022), the modules (leaflet & video content) will become accessible through the dedicated capacity building page of the e-shape website which, in the meantime, shall strive to promote the outcome of this task.

1. **Presenting and finding EO services online (curated by EARSC)**

The market for Earth Observation services is undergoing a profound transformation; it is moving from its traditional bespoke character to an online presence, whereby users can browse, access, and consume services from the various available platforms. Whilst this presents an enormous opportunity for both providers (who can expose their services to larger audiences) and users (who can select from a wider range of available services) it also brings significant challenges. The environment of EO platforms is rather complex with multiple, seemingly similar, vendor propositions, different metadata structures, functionalities, etc. It may therefore be hard for providers to know what the appropriate way to present their services is or for users to find what best suits their purposes. In that regard, the European Association of Remote Sensing Companies (EARSC) has developed two complementary online resources, eoPAGES and eoMALL aimed at facilitating the *user-provider* web interaction. This module focuses on introducing these resources and explaining how to make the most of them thus also supporting other e-shape activities: WP2 (co-design), WP3 (pilot implementation), WP5 (Market penetration support).

[1] Depending on resources available, additional modules may be developed during the project should the need arise following **(i)** pilot interaction and / or **(ii)** in light of the work carried out by the various partners so as to ensure the project's main "lessons learned" are captured for replication. The latter may likely apply to the outputs of WP3. A 5th module looking at a Decisional Data Source Checklist had been designed but will no longer be developed due to direct COVID-19 implications.

**2. Introduction to co-design (curated by ARMINES)**

Perceived as highly technical, EO data, and to a certain extent derived services, remain largely underutilised despite their accuracy and therefore capacity to enable decision-making. Co-design addresses this barrier by promoting open dialogue between the interested parties thus, ultimately, ensuring the design and delivery of products meet user needs. This module is therefore devised to provide a step by step, pedagogical introduction into the co-design process condensing the knowledge accumulated through WP2 and making it easily digestible. This module was devised to support other e-shape activities such as: WP2 (co-design), WP3 (pilot implementation).

**3. Data Discoverability (curated by NOA)**

EO product customization (output refinement) and the community overall would greatly benefit from being given access to user owned data be these historical, self-developed or self-collected. Therefore, the proposed module is intended to 1) raise awareness amongst users that their own data could potentially contribute and 2) inform on the technical steps to be untaken by those users willing to openly contribute their data. This module was devised to support other e-shape activities: WP2 (co-design), WP3 (pilot implementation).

**4. Assessing the maturity of EO activities at country level (curated by EVF)**

Understanding one's operational environment is essential for any business; consequently, this module will introduce the EO maturity assessment methodology and the tools it uses in measuring and monitoring the country-wide Earth Observation and geo-information capabilities and its apparent direction (projection and prospects). This module was devised to support other e-shape activities: WP4 (EO Maturity Indicators), WP5 (Market penetration support)

# Presenting and finding EO services online (curated by EARSC)

**# shopping for Earth Observation-based products made easy!**

## I. EO SERVICES IN THE "PLATFORM" ERA

Driven by demand, EO based services have improved and diversified significantly along with the acquisition capabilities of both the public and the private sectors. This has given rise to a very dynamic ecosystem undergoing rapid change over the last few years. One such noticeable change, bearing great development potential for the community and individuals alike, was the **establishment of numerous platforms that form part of a "tiered" landscape delivering resources, exploitation tools and information**. Each tier addresses specific needs through their services, as shown in the table below.

| IDENTIFIED NEED | SERVICE |
|---|---|
| *RESOURCES :*<br>**RESOURCES TIER** | **Infrastructure:**<br>A) cloud processing,<br>B) storage.<br>**EO data:**<br>A) free and open provenance such as Copernicus data through DIA,<br>B) commercial data,<br>C) In-situ observations and non-EO data (e.g. socio-economic),<br>D) other intermediate data provided by platforms such as GEOSS managed by GEO |
| *TOOLS*:<br>**EXPLOITATION TIER** | Convert data into geo layers to be integrated in the user's/customer's environment |
| *COMMUNICATION AND VISIBILITY:*<br>**INFORMATION TIER** | EO-solution awareness |

***Table 1** Service tier overview*

The **resource tier** has seen large sets of constellations lift off and become operational while more are planned for the near future. Large, international ICT players are now providing services to the EO industry

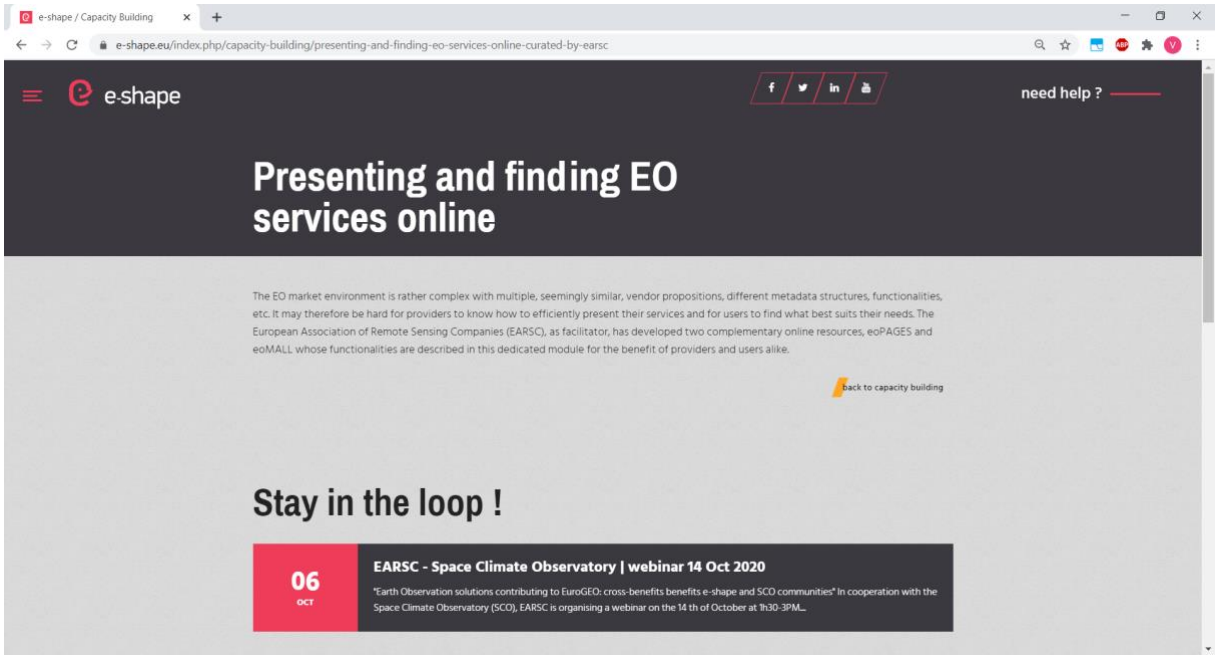
which is becoming a significant market (e.g AWS provides Ground station as a service). Subsequently, solution providers and publicly funded (EC and ESA) projects have developed tools that convert data into geo-information layers to be integrated in the user's/customer's environment progressively growing the **exploitation tier**. With the advent of new processing solutions (Artificial Intelligence, Deep learning, Machine learning, Big Data) the way data is analysed, and information is being delivered to the user, has massively changed too. All these developments are eventually exposed to the final users (be they from the industry, government/public users, or researchers) through the **information tier**.

The role of these platforms is all-the-more vital considering the globalization of the EO market and that 94% of the companies in the EO industry are micro or small companies. Platforms having developed software and tools can be a game changer for solution providers struggling with IT limitations. At the same time, platforms can serve as marketing tools amongst users from different market segments; as the market has grown more specialized and segmented, limited time and capital saw solution providers focus their efforts on market segments they knew best. Consequently, customers belonging to different segments such as "oil exploration" and "petroleum refining" or customers having similar needs yet active in different markets e.g. "linear infrastructure monitoring in the gas transportation and the railway network" may remain unaware solutions catering to their specific needs were developed. As such, platforms may help popularize EO solutions provided that products are suitably described. In that regard, it is widely known that (1) the vocabulary technicians use may differ from that of users and 2) product developers, used to focus more on the technicalities, may now struggle with striking the right balance between just enough information to instil trust and keeping their presentation generic in order to reach a wider audience.

Nevertheless, despite the intelligence and tools made available via these platforms promoting their use remains a challenge. A study made in 2018 by EARSC and BHO Legal concluded that technically advanced potential users are aware of these platforms, but few use them claiming:

- Difficulty finding them (42% of respondents);
- Lack of transparency regarding offer terms of use (58% of respondents considered that accessing the terms and conditions of EO platforms prior registration is not straightforward and offers are not immediately apparent);
- Challenging user interfaces (83% of respondents considered EO platforms to be difficult to navigate)

In light of the above, EARSC has developed and maintains three communication and visibility platforms all promoting the use of EO technology and in particular European companies offering EO-related products and services. This module shall focus on two of these platforms, namely eoPAGES and eoMALL. Currently undergoing refinement, this module shall be made available (no later than August 2022) on the dedicated capacity building page of the e-shape website pictured below.




# II. MAKING THE MOST OF EOPAGES AND EOMALL

EARSC is managing three platforms dedicated to raising awareness around EO capabilities (**Error! Reference source not found.**), two of them, eoPAGES and eoMALL are designed to the promotion and the sale of EO services. The 3rd, eoWIKI offers generic information on multiple subjects; it will be fine-tuned in the course of e-shape[2] and is not the main focus of this module. Nontheless, all platforms are presented in the table below. This is followed by a dedicated description of eoPAGES and eoMALL and how to make the most of them in the effort to effectively present (for providers) or find (for users) EO services.

| INFORMATION TIER | | |
|---|---|---|
| **PLATFORM** | **PURPOSE** | **USER PROFILE** |
| eo wiki | eoWIKI delivers key information regarding:<br>- EO services,<br>- Use cases,<br>- Best practices,<br>- News on Technology, and<br>- Market and the EO Ecosystem.<br>contributed by either EARSC or its project partners. eoWIKI provides links to external platforms or websites seeking to increase | • The general public, people who may have heard about EO and are searching for information to understand how it is currently used.<br>• EO specialists who need a quick, neutral overview of the news in the EO Industry and EO Research community. (Note: this section is currently under development and will available in June 2020).<br>• The research institutes or company representatives who want to publish content, e.g. a Success Story, to promote a |

[2] The eoWIKI 2.0 will be described in the deliverable D4.5 and shall be updated throughout Q2 2020

| | | |
|---|---|---|
| | awareness and popularise the activity of public or private solution providers.<br><br>The success stories represent an important navigation path of the platform displaying numerous case studies and links to projects and solution providers. | solution implemented in a specific market or thematic. This category could be defined as the eoWIKI "provider". |
| eoPAGES | eoPAGES (https://www.eopages.eu/) is a brokerage platform, where service providers can advertise their products to users in search of suppliers. Users can filter their search by market or service. eoPAGES is free for companies registered within EU and Canada. | • Potential customer: people presumed knowledgeable regarding EO developments and already in the process of identifying a provider which is why the platform is dedicated to bespoke products/services.<br>• Service provider: EO companies seeking to increase their outreach via a neutral and free platform. As of May 14th 2020, eoPAGES had been accessed by 262 companies from 28 countries and delivered 405 bespoke services. The platform also hosts a few success stories. (*the illustrations in this document are based on mockups as the eoPAGES will be update mid-April 2020)* |
| eoMALL | eoMALL (https://eomall.eu/) is a web platform dedicated to promoting online services. eoMALL makes use of case studies to engage the web-user. | • Potential customer: someone presumed to be an advanced user or customer of EO solutions. The platform enables service compare and access the selling points.<br>• Service provider: EO companies seeking to increase their outreach. As of May 14th 2020, 13 companies were promoting their services via eoMALL. |

***Table 2** EARSC managed platforms dedicated to cultivating EO capabilities awareness*

## 2.1 eoPAGES

Depending on their profile, the web-users could find the eoPAGES (https://eopages.eu/home) either while attending a conference or event, via flyer or business card hand in or through organic web search.

### *2.1.1 Are you a user?*

#### *First interaction*

The first time a web user lands on the eoPAGES, a small window pops-up (Figure 1) inviting them to answer three short questions. Drop down lists, based on EARSC's taxonomy (i.e. the thematic classification of sectors in which EO services are used), will enable them to quickly indicate market (1), challenges faced (2) and where they need to use the solution (3). If the user does not want to use this pop-up window, it can be closed.

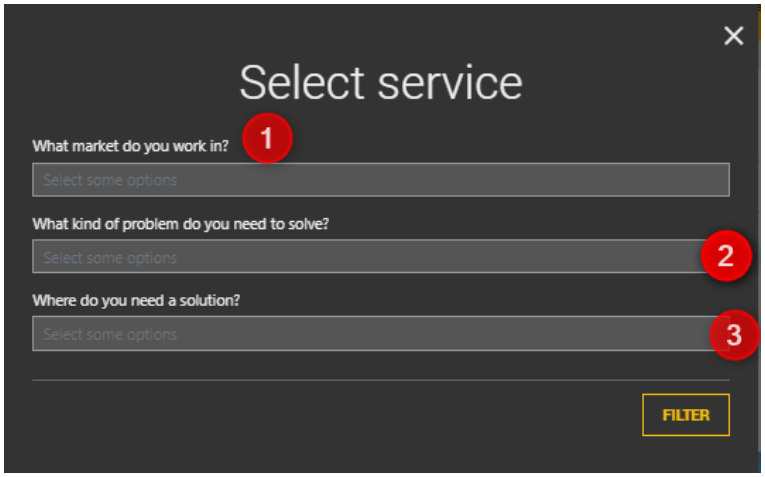



***Figure 1.*** *eoPAGES pop-up window*

This step is meant to help customise the first interaction; after clicking the filter button, the home page displays relevant content.

### *Main Page*

The eoPAGES landing page enables access to key content via 4 main navigation paths (Figures 1, 2, 3, 4).

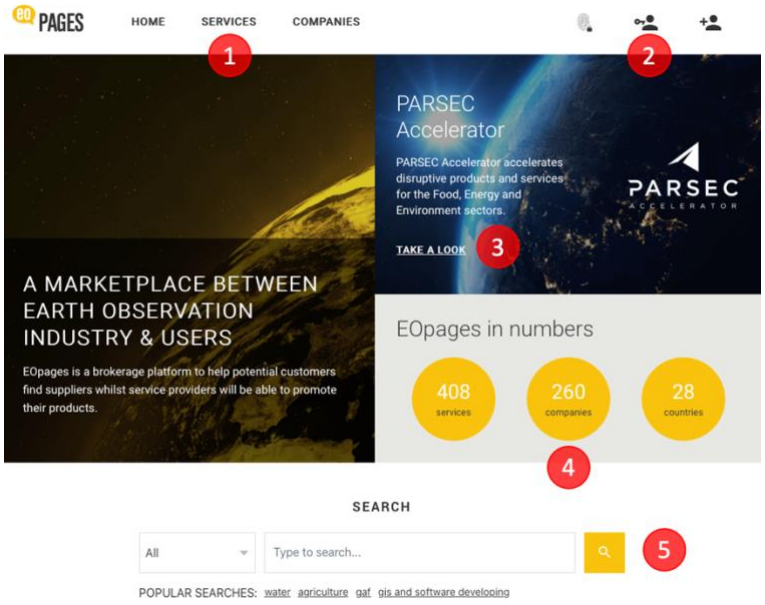



***Figure 2.*** *Top section of the eoPAGES landing page*

The top menu allows navigation towards a wide set of functions facilitating access to most content:

- The header navigation (1) Home, Services, Companies always redirects to the main pages
- Login and registration (2) allow use of ESA COIH or classic login (email and password)

  After registering, the user will have viewing rights only. Should the user wish to register a company, the EARSC operator is to be contacted. Company specific pages will only be available once EARSC grants the required access rights.

- News section (3) promotes specific content e.g. PARSEC web site
- eoPages counters (4) provides live stats on content available on the eoPAGES, numbers being updated each time a company joins or updates its content:
- Search engine functionality (5) redirects users towards a search page where they are given the option of filtering based on company, services or success stories.
- A set of EO case studies are displayed to engage the user explore the portal (Figure 3).

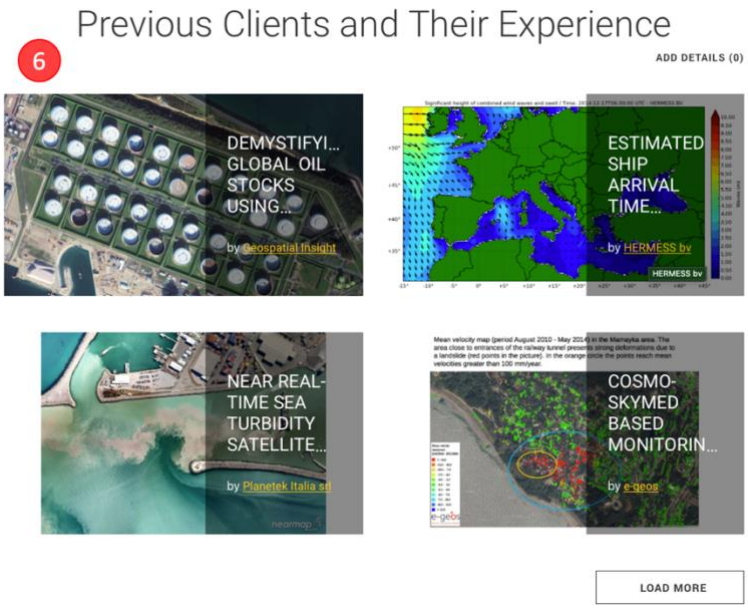



***Figure 3.*** *Success stories/case studies as displayed on the eoPAGES*

- Then EO Services (7), Companies (8) and news (9) are displayed (Figure 3).

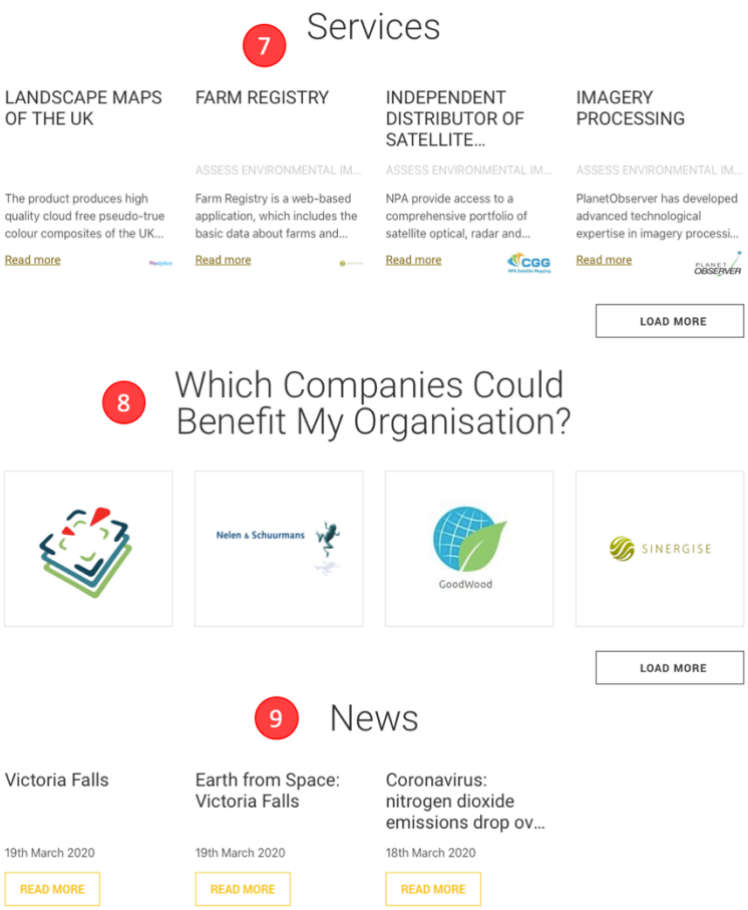



***Figure 4.*** *Services and companies as displayed on eoPAGES*

- The last section includes a contact form (10) which enables communication with the eoPAGES operator or a specific company

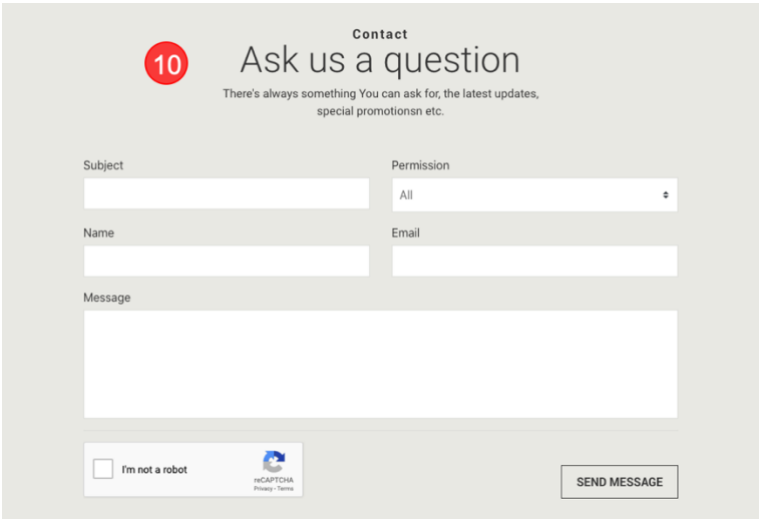



***Figure 5.*** *eoPAGES Contact form*

### *Success Stories*

Each Success Story page (Figure 6) provides key elements illustrating who used the service, the context and the value.

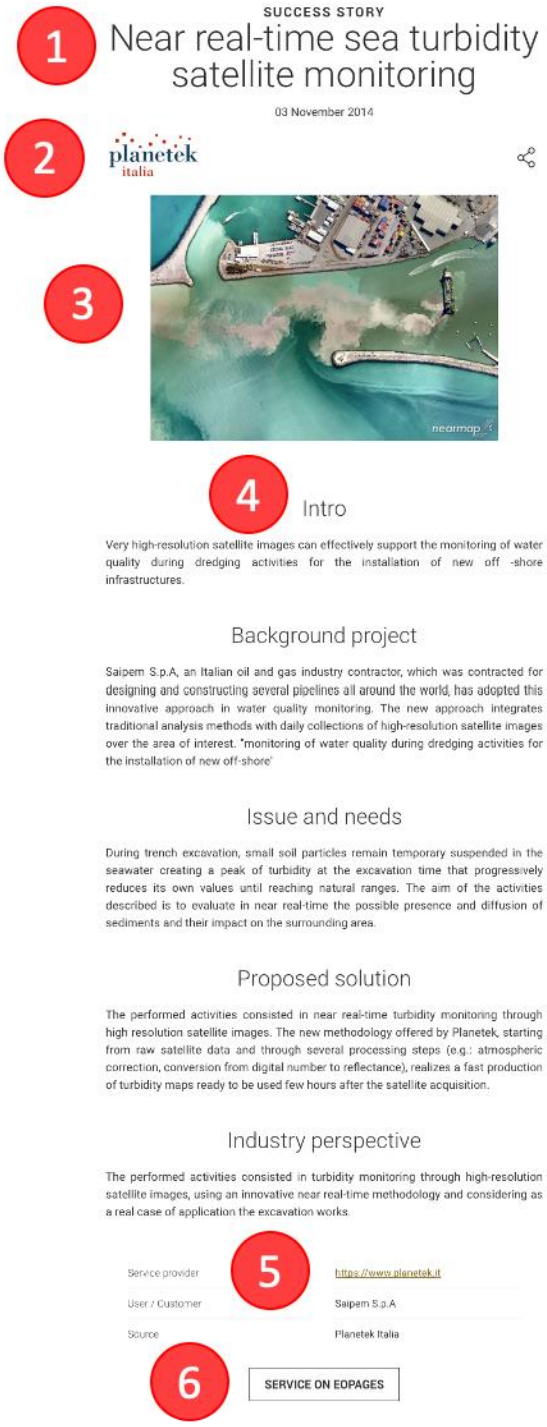



***Figure 6. S**uccess story page on eoPAGES*

These standardised sections collect and provide information on:

- Success Story name (1): A brief title as assigned by the Service provider
- Success Story logo (2): stories are associated and listed under a service provider's logo
- Main image (3)
- Success Story text (4) follows a template (Introduction, Background, Issue and needs, Proposed solutions, Industry perspective
- Success Story info (5) details the service provider and user
- Button (6) redirects to the service page

### *Service Page*

The service pages (Figure 7) are designed to provide users with relevant key elements.

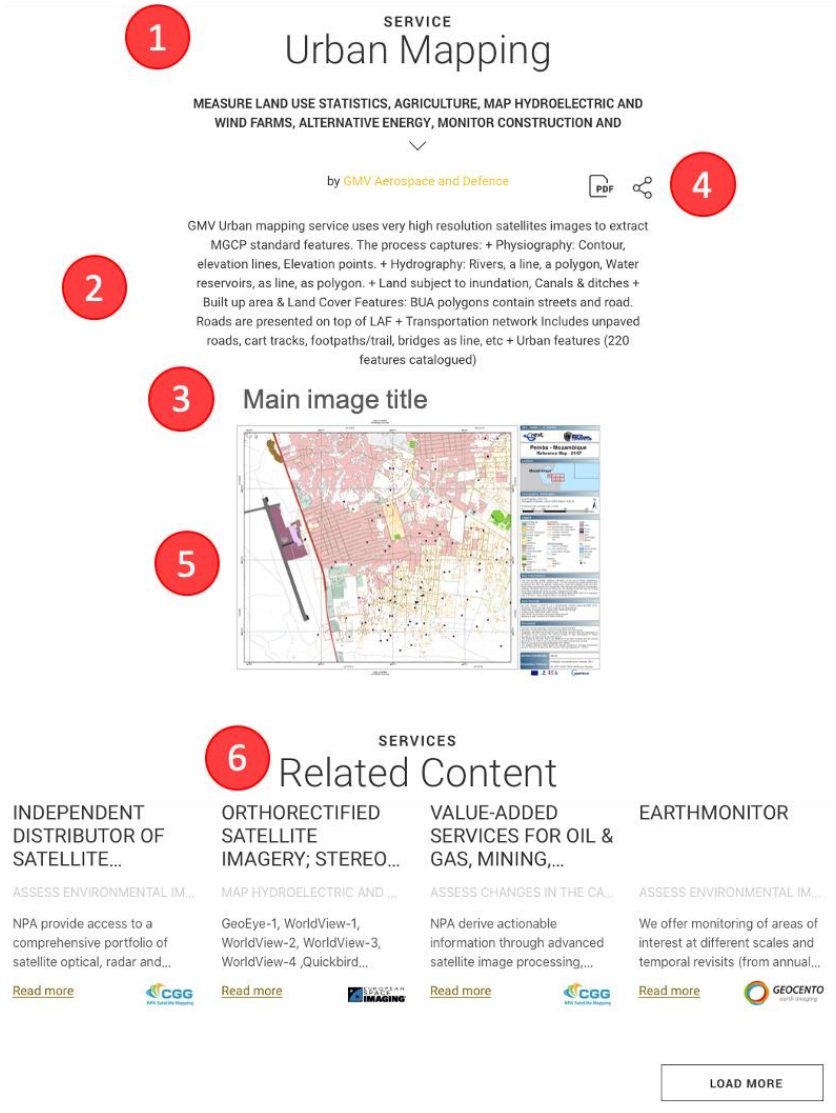



***Figure 7.*** *Service page on eoPAGES*

The standard sections collect and provide information on:

- Service name (1) defined by the Service provider.
- Service description (2)
- Image title and subtitle (3)
- Tool to share the page on Social media (Facebook, Linkedin, Twitter) and create a PDF (4)
- Service image (5)
- Related content and taxonomy (6)
- Services are interlinked by way of taxonomy

### *Company Page*

The company pages (Figure 8) are templated sections filled in by the service providers themselves.

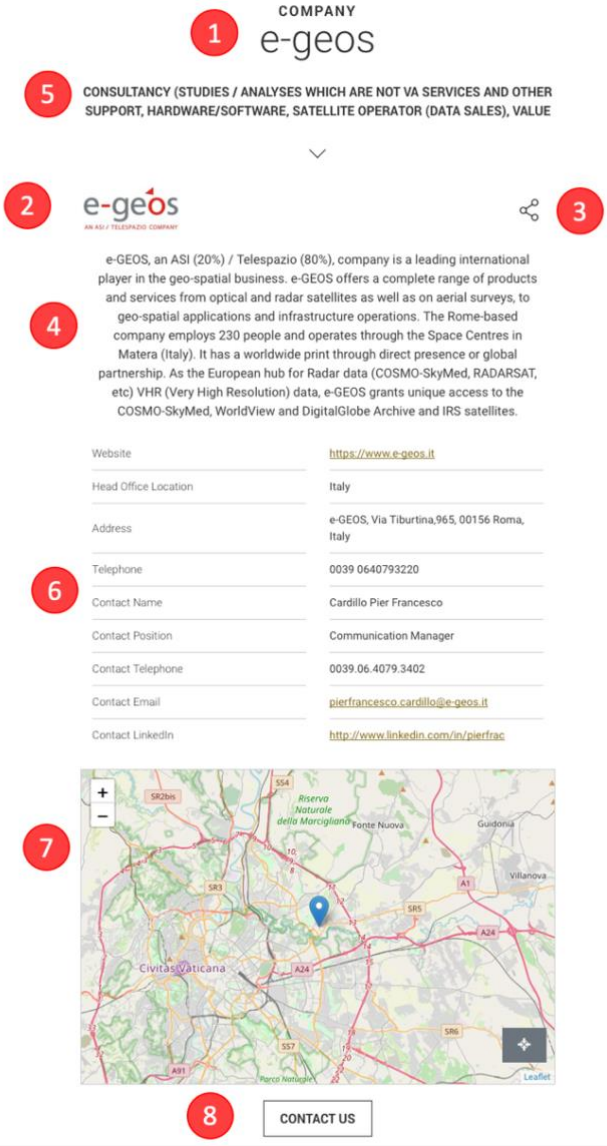



***Figure 8.*** *Company page on eoPAGES*

The standardized available sections collect and provide information on:

- Company name (1)
- Company logo (2)
- Share button (3)
- Short description (4)
- Company taxonomy (5)
- Company basic information (6)
- Company map location (7)
- A direct link to contact the company

### *Company Address Book*

By clicking on Company, the user can access the Company Address Book page (Figure 9). The user can filter companies selecting the first letter from the company title.

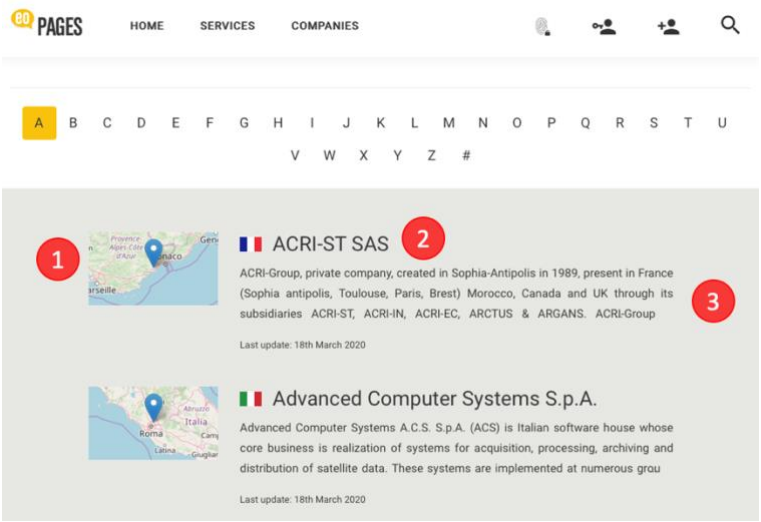



***Figure 9.*** *Company Address Book on eoPAGES*

The standardised available sections collect and provide information on:

1. Company map (1)
2. Company name (2)
3. Company description (3)

### *Search Page*

By clicking Search, top right corner, the user can access the Search page (Figure 10). Results can be sorted according to preference (Relevance, Newest, A-Z, Z-A)

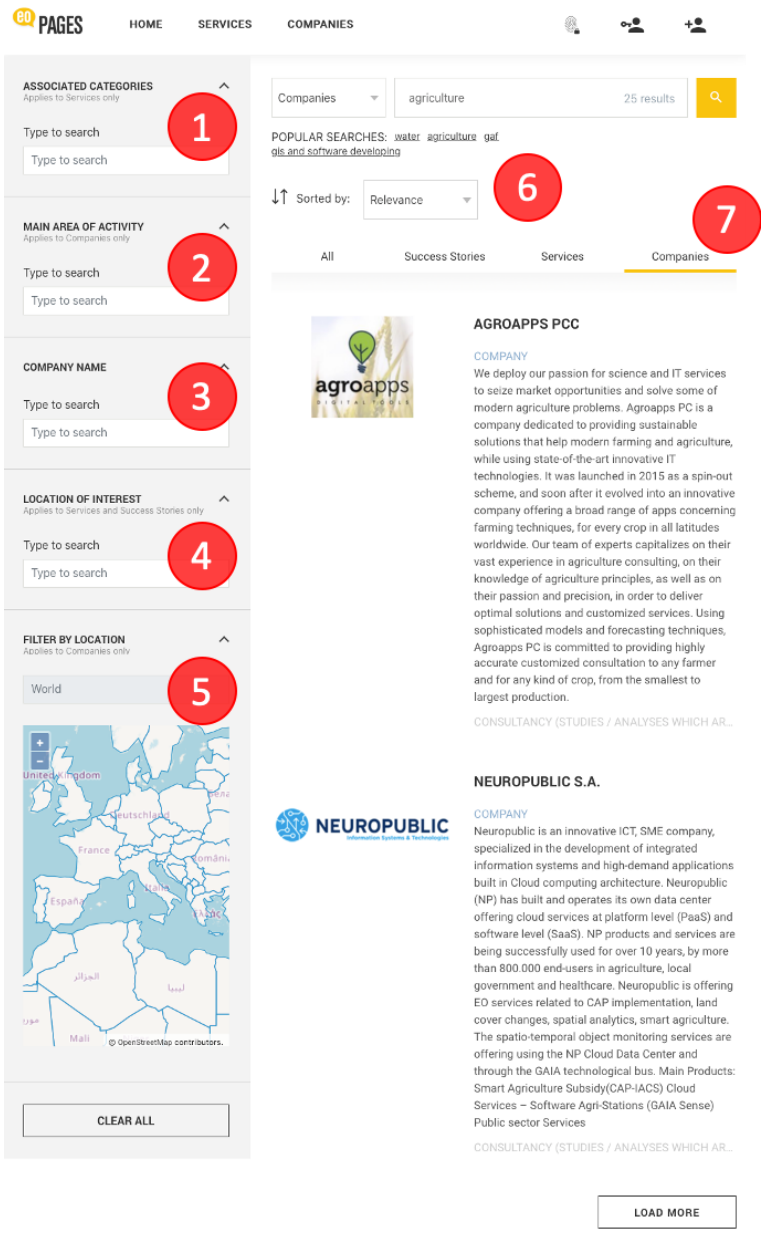



***Figure 10.*** *eoPAGES search page*

The standardized template includes the following filters:

- Associated categories (1)
- Area of Activity (2)
- Company name (3)
- Location of interest (4)
- Filter by location (5)
- Sorting results (6)
- Type of content (7)

### 2.1.2 Are you a service provider?

#### Access to the backend

As soon as the service provider contacts eoPAGES via the Contact form providing due information on affiliation and eligibility, the eoPAGES operator shall 1) provide a Service Provider Guide and 2) grant backend access (Figure 11) rights so that the service provider can create its own page.

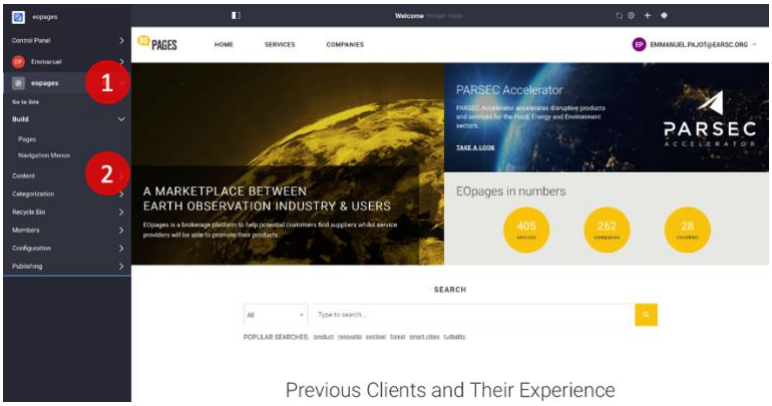



***Figure 11.*** *Access to the eoPAGES backend*

Service providers only have access to their "own" space (1) on the eoPAGES backend enabling them to manage their own content (2) (company page, service page).

## 2.2 eoMALL

Depending on their profile, the web-users could find the eoMALL (https://eomall.eu) either while attending a conference or event, via flyer or business card hand in or through organic web search.

### 2.2.1 Are you a user?

#### First interaction

The first time a web user lands on the eoMALL, a small window pops-up (*Figure 12*) inviting them to answer two short questions: what type of organisation they belong to (1) and what type of content they are interested in (2). Drop down lists, based on EARSC's taxonomy (i.e. the thematic classification of sectors in which EO services are used), will enable the user to quickly navigate towards the most relevant website sections. If the user does not want to use this pop-up window, it can be closed.

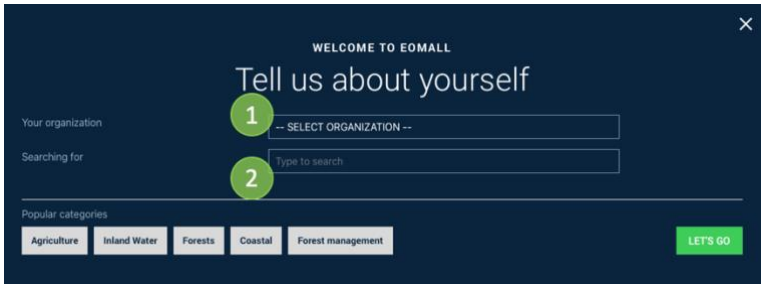



***Figure 12.*** *eoMALL pop-up window*

## *Main Page*

The eoMALL landing page provides access to 4 main sections of content (*Figure 13*, *Figure 14*, *Figure 15* and *Figure 16*).

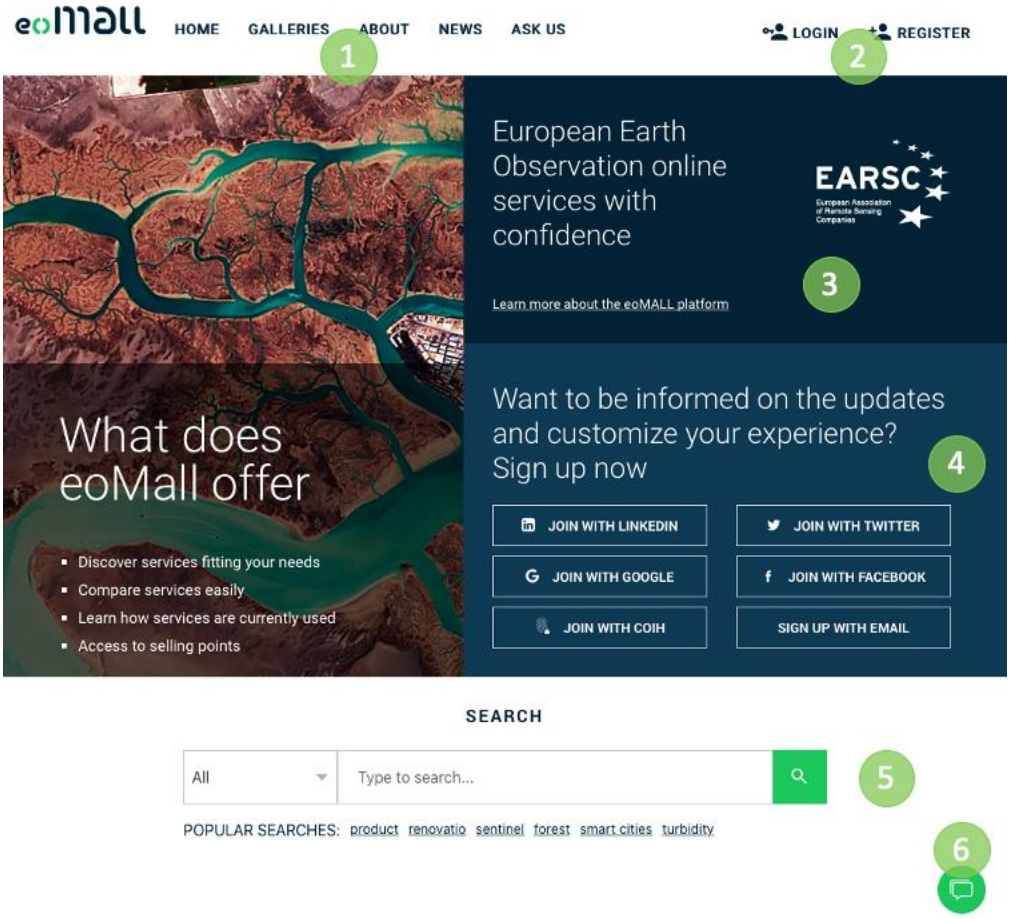



***Figure 13.*** *Top section of the eoMALL landing page*

The top menu allows navigation towards a wide set of functions facilitating access to most content:

- The header navigation (1) ensures the shortest access to the indicated specific pages
- Login and registration (2) allow use of ESA COIH or classic login (email and password)

After registering, the user will have viewing rights only. Should the user wish to register a company, the EARSC operator is to be contacted. Company specific pages will only be available once EARSC grants the required access rights.

- Highlight section (3) promotes specific content
- Authentication tools (4)
- Search engine functionality (5) redirects users towards a search page where they are given the option of filtering based on company, services or success stories.

A set of EO cases studies are displayed under the section "What can Earth Observation do for my organisation?" to entice the users explore the portal (*Figure 14*).

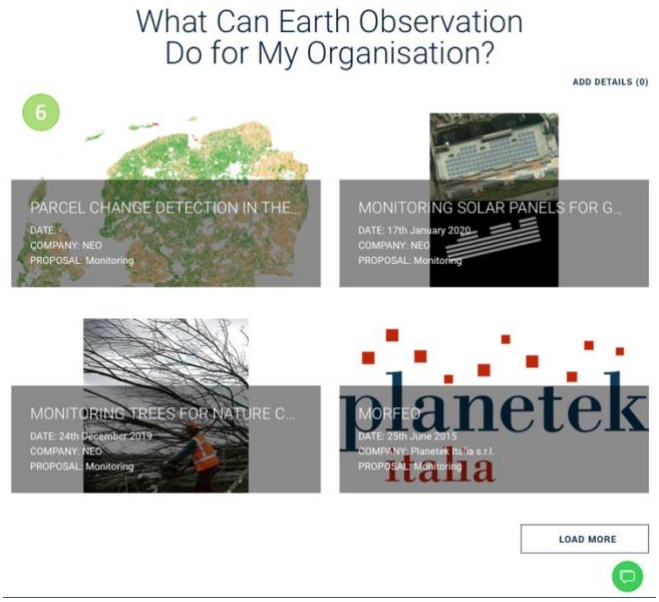



***Figure 14.*** *Success story/Case study page on eoMALL*

The second section (*Figure 15*) displays Services (8) and Companies (9) showing options and providing a comparison tool (7).


***Figure 15.*** *Service and Companies section on eoMALL main page*

The last section includes a contact form (*Figure 16*) which enables communication with the eoMALL operator or a specific company

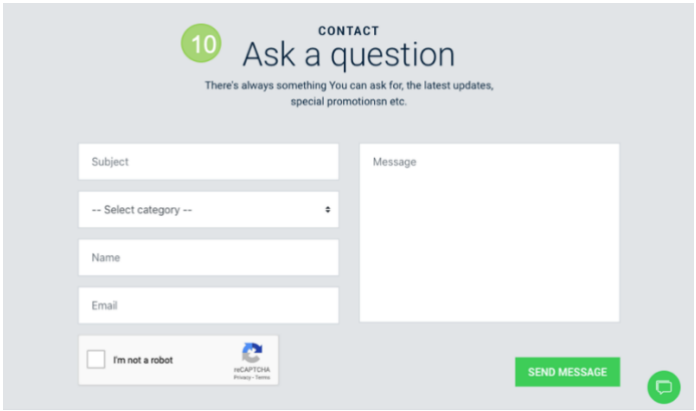



***Figure 16.*** *Contact form on eoMALL main page*

## *Success Stories*

Each Success Story page (*Figure 17*) provides key elements illustrating who used the service, the context, and the value. To promote content through the Success Stories section, the user must have Provider rights and access to the Admin panel.


***Figure 17.*** *Success story page on eoMALL*

These standardised sections collect and provide information on:

- Success Story Name (1): A brief title as assigned by the Service provider
- Success Story taxonomy (2) keywords
- Service provider logo (3) stories are associated and listed under a service provider's logo
- Main image (4)
- Illustration of the success story landscape (5)
- Description of the user (6)
- Description of the identified need and how the presented solution addresses it (7)
- Illustration describing the service in the context of the success story (8)
- Success Story benefits (9)
- Success Story benefits graphic in the user environment (10)

### *Service page*

The service pages (Figure 18) are designed to provide the user with the relevant key elements in understanding the technical aspects of the services.


***Figure 18**. service page on eoMALL*

The standard sections collect and provide information on:

- Service Subcategory (1)
- Service name (2)
- Service abstract (3)
- Service taxonomy (4)
- Service provider's logo (5)
- Link to page (6) if the customer wants to purchase the service
- Link to a sample if available (7)
- Main service image (8)
- Service description (9)
- Service benefits (10)
- Common parameters shared by all services on eoMALL (11)
- Payment information (12)
- Technical specification (13)

### *Company Page*

The company pages (Figure 19) are templated sections intended to provide basic information on the service provider.


***Figure 19.*** *Company page on eoMALL*

The standardized available sections collect and provide information on:

- Company name (1)
- Company mission (2)
- Company Logo (3)
- Main company image (4)
- Company description (5)
- Company taxonomy (6)
- Company basic information (7)
- Company location map (8)

### *Search Page*

The Search page (Figure 20) provides a set of parameters most likely to help the users identify suitable services.

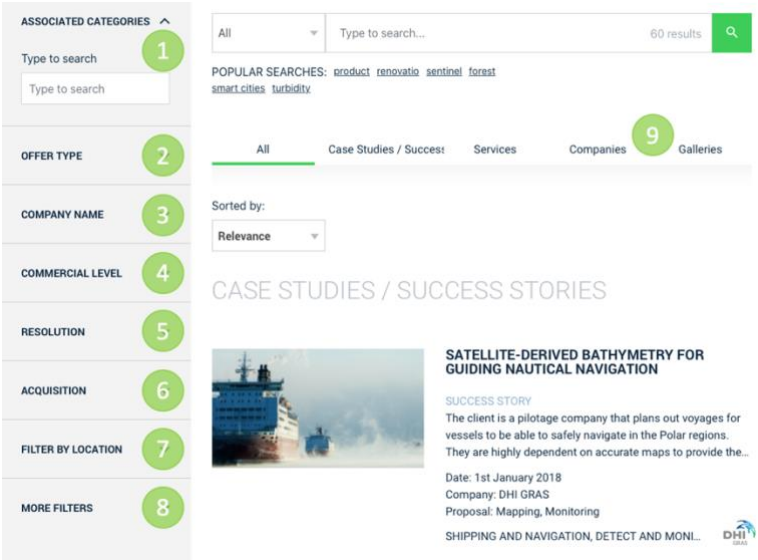



***Figure 20.*** *eoMALL search page*

The standardized template includes the following filters:

- Selection of categories of service (1) drop down lists based on EARSC's taxonomy will enable the user quickly reach the sections of most interest
- Offer type (2) lists "Remote Sensing / GIS", "Mapping," "Feature extraction" or "Monitoring" as built in choices
- Company name (3)
- Commercial level (4) enables users to explore both commercially available and free services
- Resolution (5) the user can indicate the minimal resolution required (spatial, horizontal, or vertical)
- Acquisition (6) the user can indicate desired data acquisition start and end date to be incorporated within the service
- The user can filter services based on a start and end date
- Filter by location (7) allows the user to select, for example, a certain country on a map
- More filters (8) provides access to a set of additional potentially useful for the user (licence type, licence duration, lifecycle status and status)

## 2.2.2 *As a service provider*

As soon as the service provider contacts eoMALL via the Contact form providing due information on affiliation and eligibility, the eoMALL operator shall 1) provide a Service Provider Guide and 2) grant backend (*Figure 21*) access rights so that the service provider can create its own page.

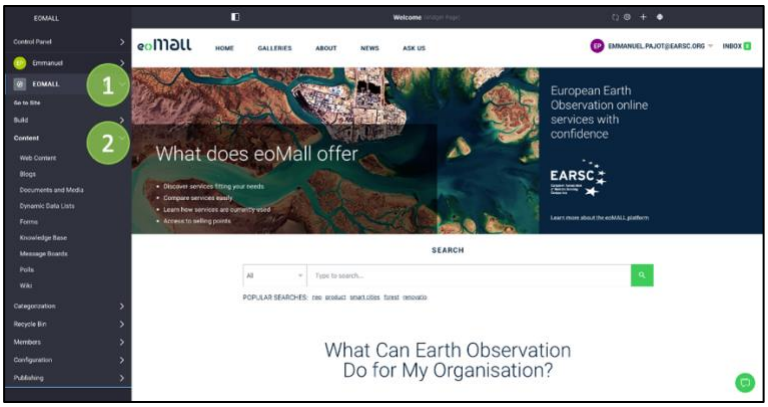



***Figure 21.*** *eoMALL backend*

Service providers only have access to their "own" space (1) on the eoMALL backend enabling them to manage their own content (2) (company page, service page).

# III. REFERENCES AND MORE LEARNING MATERIALS

EARSC Industry Survey 2019, (http://earsc.org/library/).

MAEOS Study - Creating a European marketplace for EO services, Feb. 2016, EARSC Position paper, (source: http://earsc.org/library/)

**E**arth **O**bservation **4** **O**il & **G**as Industry (EO4OG): guide to 100 geospatial products using EO data dedicated to meeting the 224 needs, or challenges, of the Oil & Gas Industry. It includes a set of 19 cases studies. (https://earsc-portal.eu/display/EO4/EO4OG+Home)

**SE**ntinel **B**enefit **S**tudies (SEBS): series of currently 13 case studies gathering evidence on the usage of Copernicus data provides an effective and convenient support to various market applications source: http://earsc.org/Sebs/, project under the assignment from the European Space Agency funded by the European Union as part of the Copernicus Programme

The Ever Growing Use of Copernicus Across Europe's Regions": NEREUS publication showcasing 99 user stories that describe how public administrations across Europe are using Copernicus data and information to address their challenges and how it is positively impacting the lives of citizens (source, http://www.nereus-regions.eu/copernicus4regions/publication/, project under the assignment from the European Space Agency funded by the European Union as part of the Copernicus Programme.

# Introduction to co-design
# (curated by ARMINES)

**#your tool in developing customer driven, sustainable services**

Perceived as highly technical, Earth Observation (EO) data, and to a certain extent derived services, remain largely underutilised. Co-design aims to address this barrier by promoting open dialogue between the parties involved in the interest of developing user-fit products with direct impact in their evolution long-term. This module is therefore devised to provide an easily digestible, step by step, pedagogical, introduction into the co-design process as refined whilst implementing WP2.

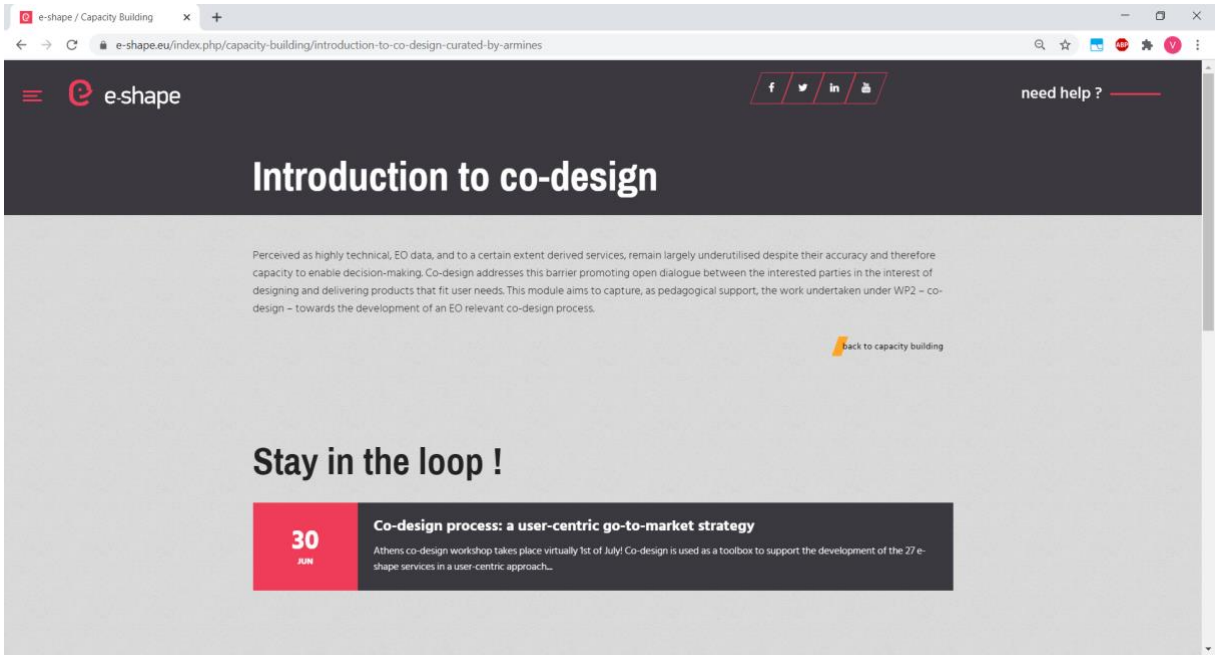
## I. WHY USE CO-DESIGN TO DEVELOP EO-BASED SERVICES?

EO data has the potential to provide significant benefits to a large variety of stakeholders: research communities, public authorities, private companies, academia, citizens. **However, EO data, and to a certain extent derived services, remain largely underutilised.** And, indeed, developing services based on Earth Observation data might be perceived as particularly challenging, because of:

- The **high level of technical expertise** needed, involving a combination of data processing knowledge and a good understanding of the various fields of application;
- The **variety of actors to be involved** to ensure the successful development of user-centric services; it's not just the users themselves, but also, potentially, every other actor in the ecosystem: researchers for modelling, platform owners, IT developers, regulation authorities etc.

**"Co-design" addresses these issues specifically aiming to develop user-centric EO-based services and support their evolution in a long-term perspective.** Co-design can be defined as a collaborative design process involving heterogeneous actors. Various methods are available in the dedicated scientific literature, however their applicability to the EO context is not guaranteed and needs to be further examined. To this end, the e-shape project includes dedicated tasks whereby a co-design model adapted to EO specificities is being progressively designed and tested within the project as per the most recent advances of design theory. This model shall then help determine which of the existing methods and tools could potentially be relevant in the co-design process. As such, the set of methods adapted to the EO context considers: (1) reusing existing methods if assessed as valid for the EO context, (2) modifying some others to make them well-suited to EO context, or (3) creating new original methods.

As this work is expected to mature throughout the project life cycle, a tested approach will become available on the dedicated capacity building page (pictured below) of the e-shape website closer to the project end but no later than August 2022.




## 1.1 General principles

### *1.1.1 Co-designing with who and for what?*

Co-design refers to the process whereby users are involved at product development stage so as to make sure that their needs and specific context are understood and addressed. In the EO context, the user and the service provider cannot be reduced to single actors but need to be described as two complex ecosystems:

- **The service provider's ecosystem**, includes the actors in charge of: 1) operating and maintaining the services, commercializing them in some cases, 2) building the scientific models required to transform data into information, 3) providing required IT infrastructures, etc. One or several actors can ensure these different functions, depending on the context and their respective capacities and resources.
- **The user's ecosystem**, including first-tier "service users" (users directly interacting with the service provider), that can possibly develop their services for their own users, and so on, up to the "final users"; and all the other stakeholders interacting with these successive users.

Consequently, **many configurations of co-design might ensue to involve some of the actors active in these two ecosystems**. It is interesting to note that, depending on the status of the service development, co-design might not involve the service users or the service operators but rather other stakeholders of the ecosystem (for instance focusing on improving the interaction between scientific model builders and IT developers). Therefore, **understanding the specific co-design needs of the EO environment requires the codification of a systemic and thorough "diagnosis process"**. This leads to the first general principle:

***General principle #1: Adapting co-design to the EO context will need to include a first phase of "diagnosis process", based on a well-codified analytical framework, to identify the co-design needs, i.e. "with who and for what purpose" co-design actions might be relevant.***

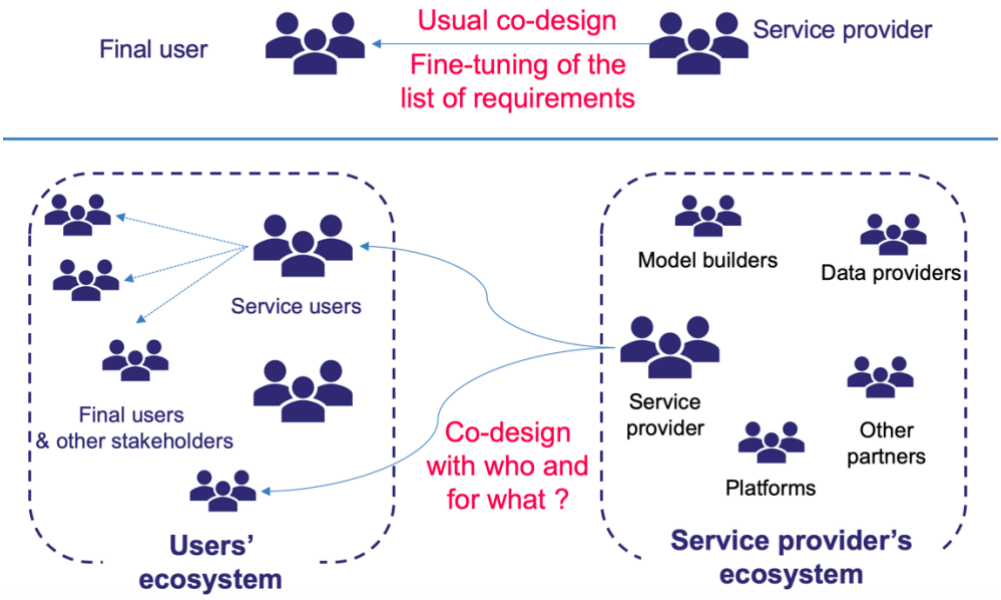



***Figure 1.*** *Comparison of settings for co-design: most common context (upper part), and EO context (lower part)*

### 1.1.2 *From a "service provider" perspective to a "design environment provider" perspective*

In a co-design perspective, the actors taking part in the process are put in a **designer** position, as they are involved in the development phase of the service. Indeed, the features of the service and its possible usages are still to be designed.

Regarding the users, even when involved in the process, they might not have the means to effectively contribute or take part in the design process, due to a lack of understanding of EO data and its potential usefulness. Therefore, **the service provider's role in the design process is to provide users with a set of elements to support a shared development of both the service and its usages.** This set of elements is labelled **"design environment",** building on the "development environment" concept in computer science, and refers to a collection of procedures and tools helping developers build, test and debug applications or programs. The elements to be integrated in this "design environment" are highly dependent on the users' know-how, competencies and possible needs. **For the pilot, creating this "design environment" takes the form of a long-term supporting role, involving several types of actions**. Based on the analysis of e-shape pilots, three main types of actions were proposed and are briefly synthesized below (see Barbier et al 2019b. for further details):

1. **"Ecosystem's capability" action: i.e. building an ecosystem of skilled users that can handle EO-based services and take part in their development.** To build this ecosystem, many different approaches might be considered, such as:
    a. *Building supporting tools/toolkits adapted to each user,* to bridge the gap between **(i)** the users' skills and usual working usages and **(ii)** the expertise needed to use/build innovative services;
    b. *Improving the skills of the users by training them*, so that they are able to use the service developed by the pilot, and take part in the present and future development of EO-based services;

   c. *Working on the structure of the ecosystem*, possibly by identifying intermediary users with higher skills, and in a longer-term perspective, by building interactions with these actors to ensure a continuous evolution of both users' and pilot's skills**.**

2. **"Norm" action: i.e. establishing the legitimacy of the services, by meeting or creating norms.** The objective is to build a **shared reference system - in which the service, its properties and advantages are understandable and acknowledged by potential users.** It might involve:
   a. *Expressing EO-based information in a shareable and understandable language* for a community (for example by implementing standards related to the type of information or exchange protocols)
   b. *Ensuring that potential users can see the advantages brought forth by the proposed service and acknowledge its legitimacy* (for example development of adapted performance indicators or best practices, possibly to be validated by specific authorities)
3. **"Promise" action: i.e. enhancing the underlying promise pledged by the services in a long-term perspective.** The objective is to **stimulate the stakeholders' interest to have them join the development efforts in the long run.** It might involve working on the content of this promise (suggesting perspectives to be pursued by current or future services in an evocative way), how to showcase it (using demonstrators, or other means) and making it evolve over time.

It is important to note that the level of efforts required to build such a design environment is highly dependent on the considered user's competencies, resources, and willingness to take part in the long-term advancements. As suggested by the variety of actions involved**, this "design environment" might require large resources to be built**, and thus needs to be carefully taken into account when considering the expansion of EO-based services. It is important to identify the good enrichment level of this "design environment", to ensure that:

- **Information can effectively be integrated** in the user's operational workflows (either existing or future); but
- **the costs and efforts of building this design environment are not overwhelming for the service provider**, especially in a long-term perspective with possibly multiple users to be addressed.

Furthermore, different actors will need to be involved in building this "design environment", both data providers and users, and possibly external actors (standardization bodies for example). Therefore, these actors' roles and interactions will need to be closely examined.

A second general principle of EO adapted co-design could be formulated as follows:

***General principle #2: Building EO-based services calls for a shift in perspective from "service provision" to "design environment", thus moving from a one-shot transactional mindset to a long-term relational mindset. The co-design process will help define and build the sets of elements necessary in a "design environment" and identify the actors, their roles and expected interactions.***

It is interesting to note that describing **the "service provider" as a "design environment provider", with a long-term supporting role** also suggests a new understanding of co-design. It should not only ensure a collective design of the product itself, but rather **the design of a cooperation convention**. This point will be further elaborated in the next stages of the project.

The following section will focus on the co-design process as developed based on these two general principles.

## 2.1 Co-design process and related tools

As mentioned above in *General principle #1*, there is first a need to clarify *with who and for what purpose* co-design might be helpful. Thus, the EO adapted co-design is carried out in the two subsequent phases:

1. **Phase 1: a diagnosis process establishes the co-design needs and the actors to be involved;**
2. **Phase 2: the implementation of co-design actions based on this diagnosis**.

To support these two phases, the specific tools currently under development are briefly presented in the following paragraphs.

### *2.1.1 Tools supporting phase 1 - "diagnosis process"*

**Each new service to be developed is based on a certain context and history**, with existing elements on the data-information-usage chain. **The development of a service can be described as the expansion of an existing data-information-usage pipe**, in one or several dimensions. To give a few examples, the development might focus on:

- Going from an existing user community (often there is at least the scientific community using information with low level of customization) towards new user communities that might need other types of design environments;
- Improving the models and therefore the reliability and accuracy of information, provided to the same existing users;
- Improving the operationality of the service towards a 24/7 delivery, new partners could be potentially involved to reach this objective.

These are only a few examples of design efforts. The "diagnosis process" is meant to clarify **what aspects would most benefit co-design efforts**, short-term and possibly longer-term.

*"Data journey" representation*

To have a clear and shared understanding of the situation, the following frameworks are proposed to represent the "data journey" from data to information, up to usages, and the actors involved in the different transformation processes: at an initial stage - beginning of the co-design process (*Figure 3)*, and at expected stage - targeted expansion of the service (*Figure 4)*. The need for design efforts can then be pinpointed more accurately within the "data journey" framework.

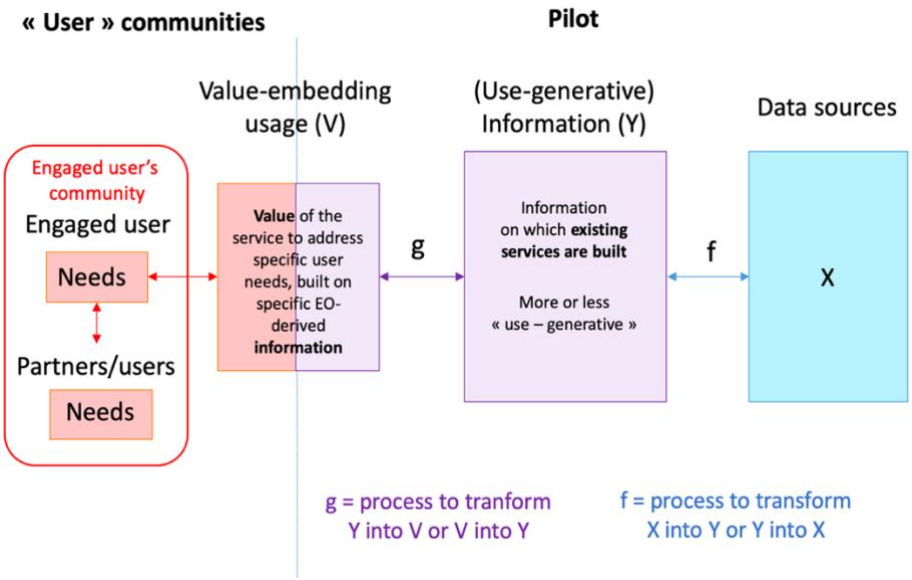



***Figure 2.*** *Representation of the "data journey" for the initial stage based on the data-information-usage framework: data (in blue), information (in purple), usage (in purple-red), function "f" linking data and information, function "g" linking information and usage, addressing a certain users' community (in red).*

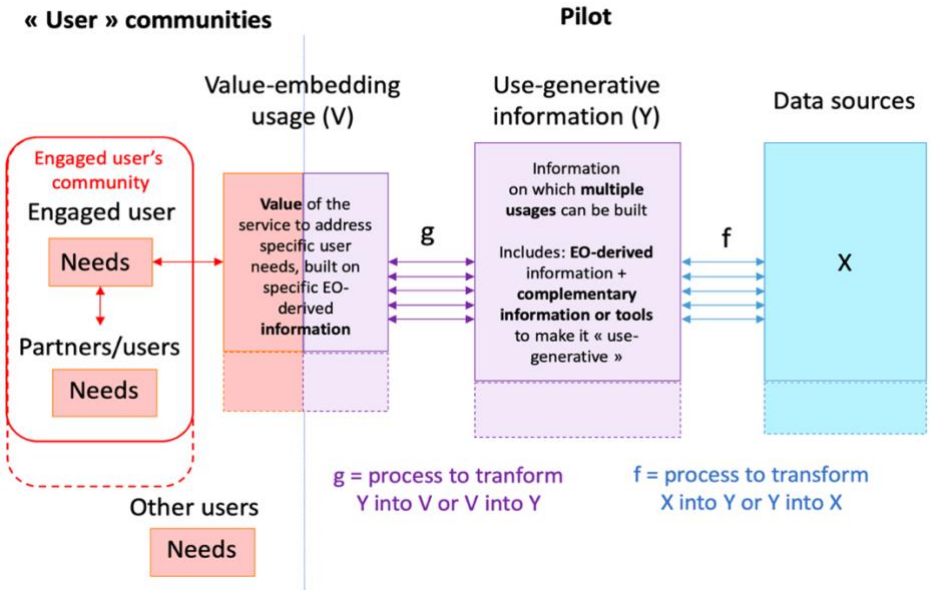



***Figure 3.*** *Representation of the "data journey" for the targeted stage based on the data-information-usage framework: data (in blue), information (in purple), usage (in purple-red), function "f" linking data and information, function "g" linking information and usage are the different constitutive elements of the service, addressing a certain users' community (in red)*

*Classification of co-design needs*

Analysing the e-shape pilots a certain variety of design efforts were identified and then classified in four main types of co-design, as described below.

- **Usefulness,** i.e. the user is able to see the advantages of using EO data for its existing or future operations;
- **Usability,** i.e. EO data can be effectively integrated in the user's operations and can be easily used.

The several types of co-design are differentiated depending on the status of the usefulness and usability of EO data for a given user, and the interaction between the service provider and this user:

- **Co-design type 1 - *Usefulness & usability assessment and enhancing:*** instances where usefulness is not clearly established but the user is interested and willing to take part in the development of the service.
- **Co-design type 2 – *Usefulness identification***: instances where usefulness is not clearly established, AND the user is problematic (impact of EO data on his actions is not clear, difficult interactions, etc.)
- **Co-design type 3 - *Extensive usefulness & usability realization***: instances where usefulness is already established, but there is a need to implement it and make the service operational and robust in compliance with the established requirements. This might involve extending the network of partners to ensure this process.
- **Co-design type 4 - *Usefulness re-invention***: instances where usefulness is already established, but it might be interesting to go towards a longer-term strategy and explore new types of usefulness, new users etc.

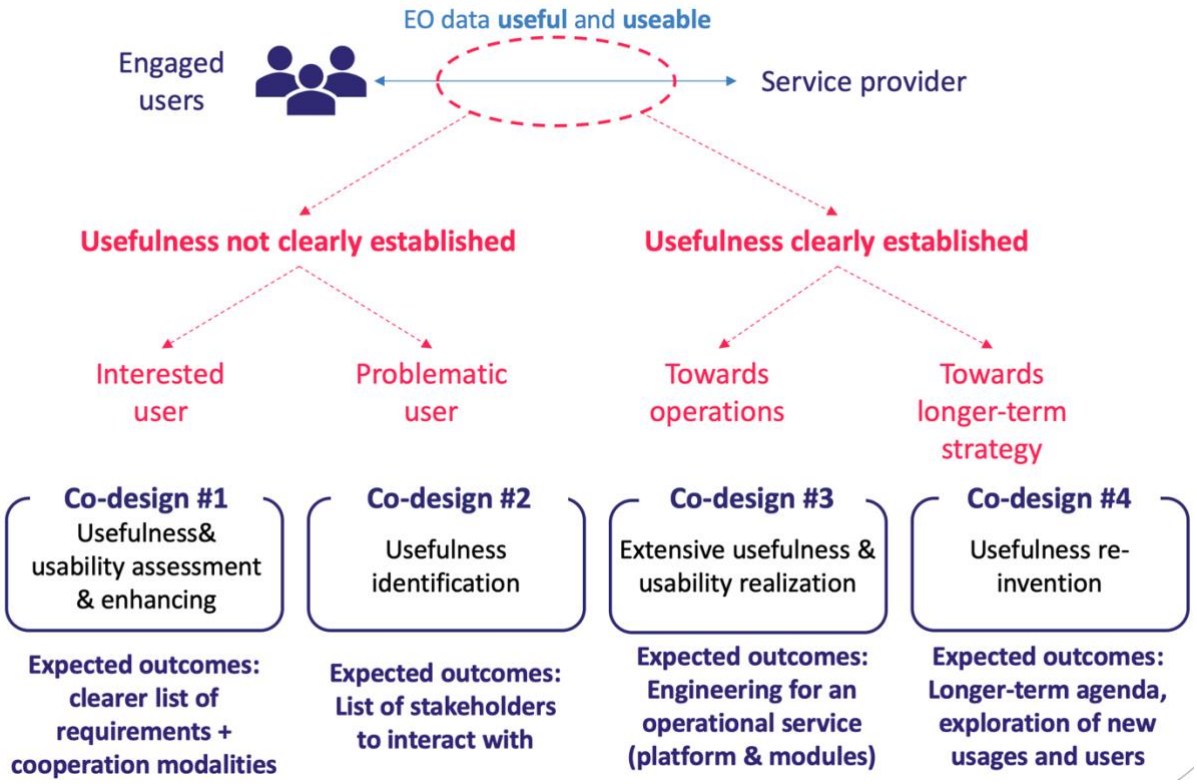



***Figure 4.*** *Classification in four co-design types*

It is worth highlighting that **co-design is not a "one-shot" process**. Three aspects are worth taking into account:

1. At any given time, pilots might pursue **several types of co-design**. As the co-design type depends on the relationship the pilot has developed with a given user community, pilots catering to several user communities which each exhibiting different levels of interactions will have to pursue **several types of co-design**.
2. This "diagnosis" of co-design needs must be considered in a **dynamic perspective**: one can expect that **each pilot goes through different co-design types throughout their development**, adapting to accommodate the issues faced.
3. **The order in which co-design types can occur in the life of the pilot might differ from one pilot to another** (to be noted that the numbers #1, #2, #3, #4 of the classification do not correspond to the order in time). However, it appears that **these co-design types are linked in certain ways, that would need to be clarified**. For example, implementing a co-design type 3 implies having already run a co-design type 1 (not necessarily within e-shape's timeframe but in the pilot's history), as it starts with a clearly defined usefulness. This one example suggests that the different possible transitions from one type to another need to be further examined.

Thus, co-design could be **rather described as a strategic tool to support the expansion of the EO ecosystem.** Its objective should **not be reduced to designing the services and providing them in a transactional mode.** But it should rather be described as **designing the collaboration conventions between the different actors,** in order to ensure an intertwined and long-term development of research topics and a range of services based on these scientific advances.

### *2.1.2 Tools supporting phase 2 - "implementation of co-design actions"*

*To be updated after experimentation in e-shape*

# II. REAL WORLD APPLICATION AND ADDED VALUE

*To be updated after experimentation in e-shape*

# III. REFERENCES AND MORE LEARNING MATERIALS

*To be progressively completed*

## 3.1 Co-design adapted to EO context

Further information of the co-design approach progressively built within e-shape project can be found in WP2 deliverables, so far:

Barbier R, Le Masson P, Weil B (2019a) *Deliverable 2.1 : Initial model for e-shape co-design.* Deliverable for e-shape project.

Barbier R, Le Masson P, Weil B (2019b) *Deliverable 2.2 : Revised model for e-shape co-design.* Deliverable for e-shape project.

## 3.2 Design theory and innovation management methods

This specific co-design approach relies on recent advances of design theory developed in the Chair of Teaching and Research “Design theory and methods for innovation”

Le Masson P, Weil B, Hatchuel A (2017) *Design Theory - Methods and Organization for Innovation*. Springer Nature.

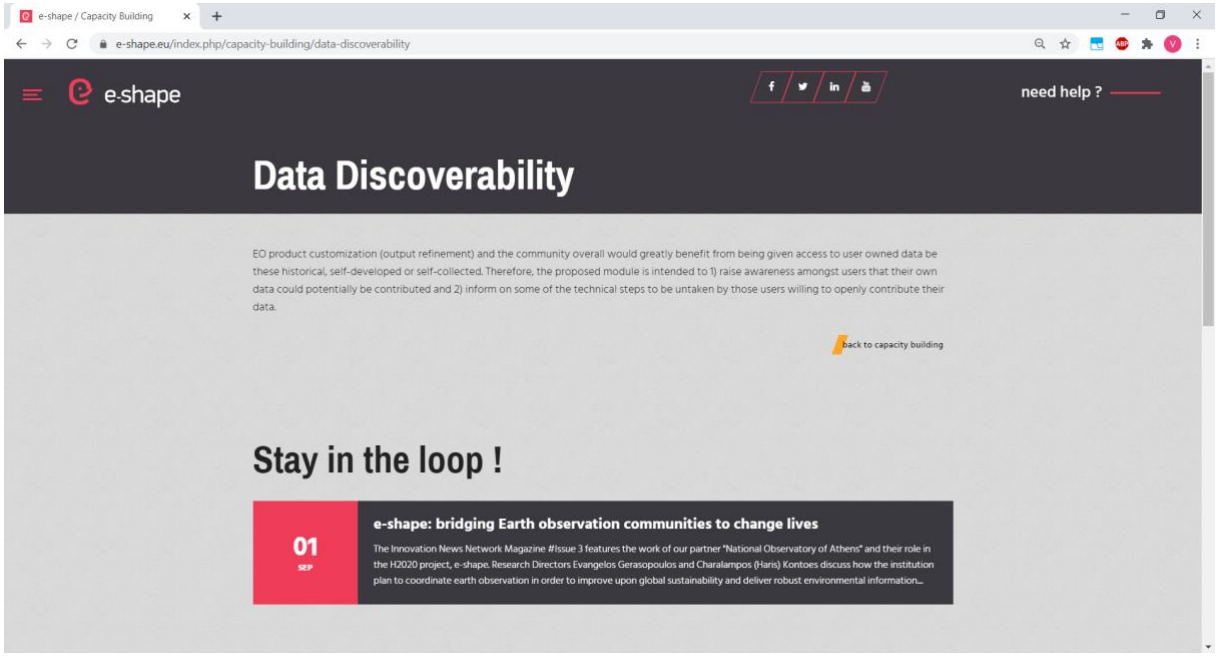
# Data Discoverability (NOA)

**#Incentivising users – the opportunity in harnessing user collected data**

## I. THE CHALLENGE OF FINDING SUFFICIENT AND RELIABLE DATA

Technological and or scientific development and innovation are largely dependent on data availability and quality. All sectors and stakeholders - be these universities and research centres, private companies, or governments - use data analysis to take informed decisions. Geodata are crucial in the society's efforts to tackle challenges such as climate change, ocean and biodiversity preservation, clean and safe energy, food security, etc., as they enable evidence-based innovation policies. Yet, Earth Observation holds so much more promise! Scientists, decision makers, citizens, and entrepreneurs should all be able to exploit these data and the ever-increasing volume of information their manipulation allows.

To enable this very thing, geodata management principles and standards were developed to ensure proper data storage, curation, and preservation, data discoverability, accessibility, interoperability, and reusability. This module will focus mainly on data discoverability and EO product customization (output refinement) through the incorporation of user owned data be these historical, self-developed or self-collected – a topic of particular interest for the wider community. The intention is to 1) raise awareness amongst users that their own data could potentially contribute and 2) inform on the technical steps to be untaken by those users willing to openly contribute their data. Currently undergoing refinement, this module shall be made available (no later than August 2022) on the dedicated capacity building page of the e-shape website pictured below.



## 1.1 Data Discoverability and Metadata

The first step of any analysis is to acquire enough reliable data. Consequently, **improving Data Discoverability (through a combination of standardized metadata and centralizing libraries) is likely to reduce search time and improve the final outputs**. Locating the relevant data, making sense of them, and evaluating whether they are trustworthy, or not, remains a challenge. In practice, should one seek to conduct a research over a specific area, they would either need to collect their own (dependant on infrastructure capabilities) or search for already collected data made available by other entities monitoring their specific area of interest over whatever period(s) of time are assumed to ensure variability and representation. For instance, in the case of meteorological data, researchers would need to know where to go search for data related to their area and parameters of interest as collected over relevant periods of time. Such searches may return multiple datasets, it is therefore essential to be able to quickly and accurately identify acquisition year, what every number represents and the measuring units (i.e. temperature in C°, wind speed in km/h etc.) in order to select the most suitable datasets. Same principles apply to practically all other types of data used in the development of Earth Observation-enabled information products and services. In all cases, **metadata is vital** at this stage of the filtering process.

Metadata are, as the name implies, data about data. They describe the properties of a dataset and can cover various types of information. Metadata determine whether a certain dataset will be easily discoverable within a database or online. When great attention is paid to providing the best possible descriptive summary, users are more likely to identify the datasets needed and further evaluate which of the returned items are relevant in the context of their respective study. Most commonly, metadata would include title, summary about the data, information and contact details of the owner, acquisition date, location, accuracy, restrictions associated with their use or sharing, important processes in their life cycle such as generalizing features and much more.

Metadata are created, maintained, and published using metadata catalogues as their main purpose is to facilitate file discovery and cataloguing. **Using metadata also facilitates interoperability between systems provided that they use the same type of metadata structures and encodings**. To ensure metadata are useful to different users as well as “machine readable”, several standards have been developed. Standards ensure the generation of consistent and qualitative metadata as further discussed in section 1.5.

## 1.2 Data Accessibility

Data repositories bring value by making the data they harbour discoverable therefore enabling analysis, knowledge extraction and dissemination. Still, not all discoverable data can be accessed freely, if accessible at all. Sometimes data are protected by embargoes, access controls, permissions or licenses deriving from confidentiality, reuse permissions, commercial interests etc.

The sharing of raw and secondary research data has long been practiced among research communities. What often occurred through informal means was made increasingly easy with the advent of the internet and associated tools: email, ftp sites, etc. (Farnel and Shiri, 2014). The rise of open data and open science data movements, in conjunction with the increasing implementation of data management and sharing policies by funding bodies, governments and journals, has led to an **explosion in the number of research data services created to serve institutions, association members, and research communities** (Farnel and Shiri, 2014). Scientific journals are increasingly praising and now often demanding open access to analyses, raw data, and even software code through online repositories, such as Dryad and GitHub.

Governmental funding agencies have made concentrated efforts over the past few years to make federally funded data discoverable and accessible by the scientific community and the general public (Culley, 2017). Some service providers developed capabilities to enable the storage of data and associated metadata, while others focused on identifying and "cataloguing" through relevant metadata the existing data repositories. Alongside, (geo)data management principles and frameworks were developed to enable data accessibility and interoperability for both users and machines, as discussed further in paragraph 1.5.

## 1.3 Why is data discoverability and accessibility important?

As technological advancements came to enable large-scale data acquisition, momentum built towards making these vast resources publicly accessible to ensure their full potential would eventually be reached. Contributing to data discoverability and accessibility is highly beneficial as demonstrated below:

- ***Data permanency and prevention against loss***
  Storing data in public repositories is the ultimate way of ensuring it will not get lost over time. Accidents can happen which is why established repositories, like GitHub, store their data off-site, in secure locations, taking full advantage of cloud computing capabilities.
- ***Improving research reproducibility and reliability***
  Provided they want to, users in all sectors should be able to recreate the original analyses and thus test their reliability or even broaden their scopes for the benefit of their community(ies). In order to do that they need to have access to the exact same raw data used during the study, their associated metadata and the tools used in analysing it – computer programmes, etc
- ***Increasing the visibility and citation of research***
  There is evidence that compared to traditional publications, articles with accompanying publicly accessible data sets generate higher citation rates – an increase of around 20%, depending on the discipline (Dorch, 2012).
- ***Contribution to future research***
  Data published today are intrinsically valuable and they can also have a long-term added value, as is the case in, for example, long-term studies that have only been possible because the original data were available to later generations of researchers. Therefore, storing the data used in long-term studies into a permanent repository ensures that a study can continue for generations to come or that the results can be combined with other data in novel ways to answer questions that cannot even be anticipated today (Culley, 2017).
- ***Attracting new partnerships with researchers, businesses, policy and broader communities***
  Organizations can greatly benefit by making their data discoverable and accessible (even partially). Besides potential monetary gain, such a decision would lead to an increased visibility of its R&D efforts within the community, and beyond, with a potential to attract new partnerships and create synergies.
- ***Using new innovative research approaches and tools***
  As science is progressing, new links between research fields could be explored. Access to data, know-how and technology will either encourage or limit such initiatives therefore influencing scientific and societal progress.

## 1.4 Where to find/upload (meta)data?

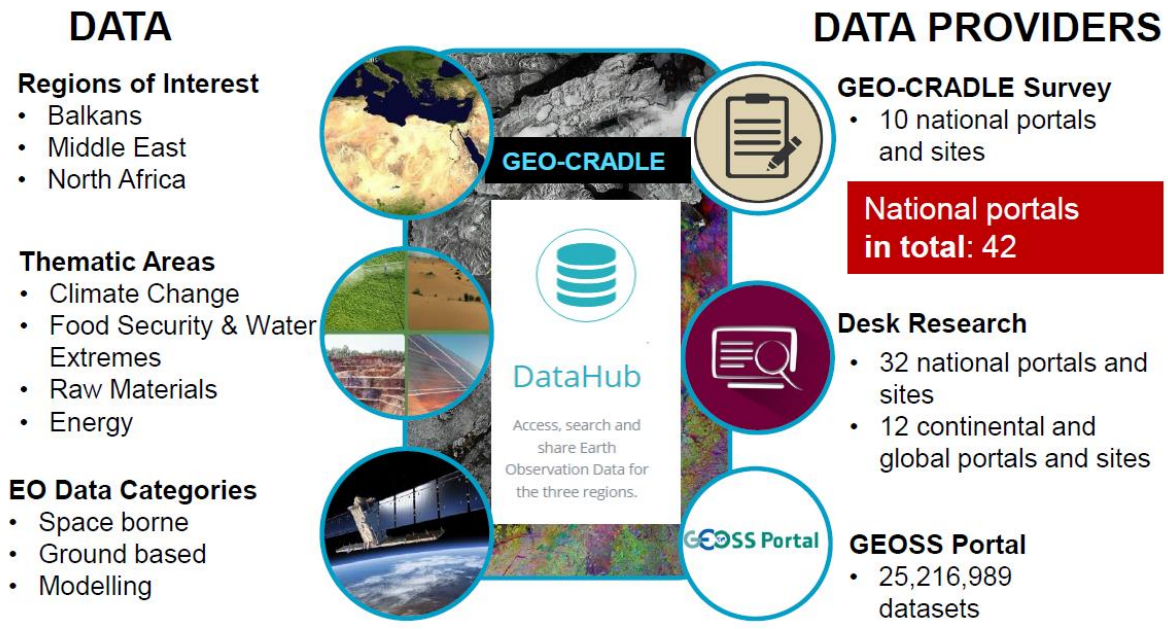
Data owners interested in contributing their data for the greater benefit of the community, must understand where best to upload their resources and accompanying metadata. To choose from the

various options available (databases, online repositories, catalogues and portals) the user could browse through their specific resources in search of data and metadata from their own field of study (i.e. astronomy, geology, biology etc.). For convenience, examples of available geodata portals and their level of reach are presented below:

**A. National and Regional level – e.g. GEO-CRADLE Regional Data Hub**

The GEO-CRADLE Regional Data Hub (GCRDH) is an open data web management tool / portal (developed using web technologies such as PHP, HTML5, JavaScript, CSS, etc.) that provides access to both region-related datasets, portals and services developed by a regional network of raw data providers, intermediate users/service providers, end-users from Industry, Academic and Public Sector from the Region of Interest, and also datasets and services directly fed from the GEOSS-portal. Moreover, being the centralized gateway for regional data providers to contribute easily and timely their products to GEOSS, the Regional Data Hub is designed to become the focal node in the region in the context of GEOSS and Copernicus implementation. The GCRDH facilitates the access to downloadable files of Space-borne data from real-time EO satellite missions acquisitions; data from Airborne campaigns performed in the region; In-situ data; and Models such as Atmospheric and Climate.

The GEO-CRADLE Regional Data Hub (GCRDH) is an open data web management tool / portal (developed using web technologies such as PHP, HTML5, JavaScript, CSS, etc.) that provides access to both region[3]-related datasets, portals and services developed by a regional network of raw data providers, intermediate users/service providers, end-users from industry, academia and the public sector, and also datasets and services directly fed from the GEO-portal. Moreover, being the centralized gateway for regional data providers to contribute easily and timely their products to GEO, the Regional Data Hub is designed to become the focal node in the region in the context of GEO and Copernicus implementation. The GCRDH facilitates the access to downloadable files of Space-borne data from real-time EO satellite mission acquisitions; data from Airborne campaigns performed in the region; In-situ data; and Models such as Atmospheric and Climate




[3] The Regional Data Hub has a strong focus on the Balkans, Middle East and North Africa regions, but additional datasets from other regions in the world are also linked and accessible.

*Figure 1. The GEO-CRADLE Regional Data Hub concept*

### B. Interregional level – e.g. INSPIRE, NextGEOSS

The INSPIRE Portal is a central European access point to the data provided by EU Member States and several EFTA (e European Free Trade Association) countries under the INSPIRE Directive. The Geoportal allows: monitoring the availability of INSPIRE data sets; discovering suitable data sets based on their descriptions (metadata); accessing the selected data sets through their view or download services. The metadata used in the Geoportal are regularly harvested from the discovery services of EU Member States and EFTA countries. The status of harvesting is available here.

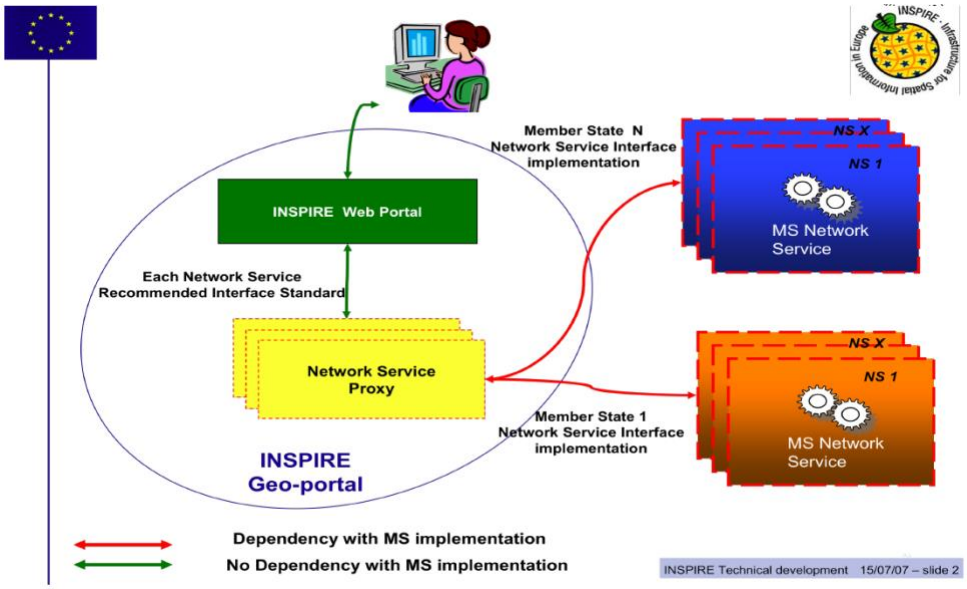



*Figure 2. The INSPIRE Portal architecture*

The NextGEOSS project, a European contribution to GEO, strives to develop the next generation European data hub and cloud platform for Earth Observation data so that the users can connect, access data, and deploy EO-based applications. The concept revolves around providing the data and resources to the user communities, together with Cloud resources, seamlessly connected to provide an integrated ecosystem for supporting applications. A central component of NextGEOSS is the strong emphasis put on engaging the communities of providers and users with the aim of bridging the space between them. The project has a special focus on encouraging and stimulating data exploitation by businesses.

The data hub is based on the Open Source solution for data portals CKAN. The data hub harvests a lot of different sources with data from satellites and in situ (on earth). Harvesting means that the metadata (data provider, license, data format, attributes, location of the resources (raw data)) are stored in the hub. They are made available for web access and programmable interfaces, e.g. through an OpenSearch interface. The data hub feeds some pilot projects which it promotes, and may have information, applications to download or applications to run in the cloud.


***Figure 3**. The NextGEOSS Data Hub and Platform concept*

### C. Global level – e.g. GEOSS Portal

GEOSS is a set of coordinated, independent Earth observation, information and processing systems that interact and provide access to a variety of information for the benefit of a broad range of users in both the public and the private sectors. GEO links these systems to strengthen the monitoring of the state of the Earth whilst facilitating the sharing of environmental data and information collected by the different observing systems managed by its member countries and organizations. Further, GEO ensures that these data are accessible, of identified quality and provenance, and interoperable to support the development of tools and the delivery of information services.

This 'system of systems', through its GEO Platform (former GCI), proactively links together existing and planned observing systems around the world and supports the need for the development of new systems where gaps exist. It promotes common technical standards so that data from the thousands of different instruments can be combined into coherent data sets.

The 'GEO Portal' offers a single, online, access point to users looking for data, imagery and analytical software packages relevant to all parts of the globe. It connects users to existing data bases and portals and provides reliable, up-to-date and user-friendly information – vital for the work of decision makers, planners, and emergency managers.

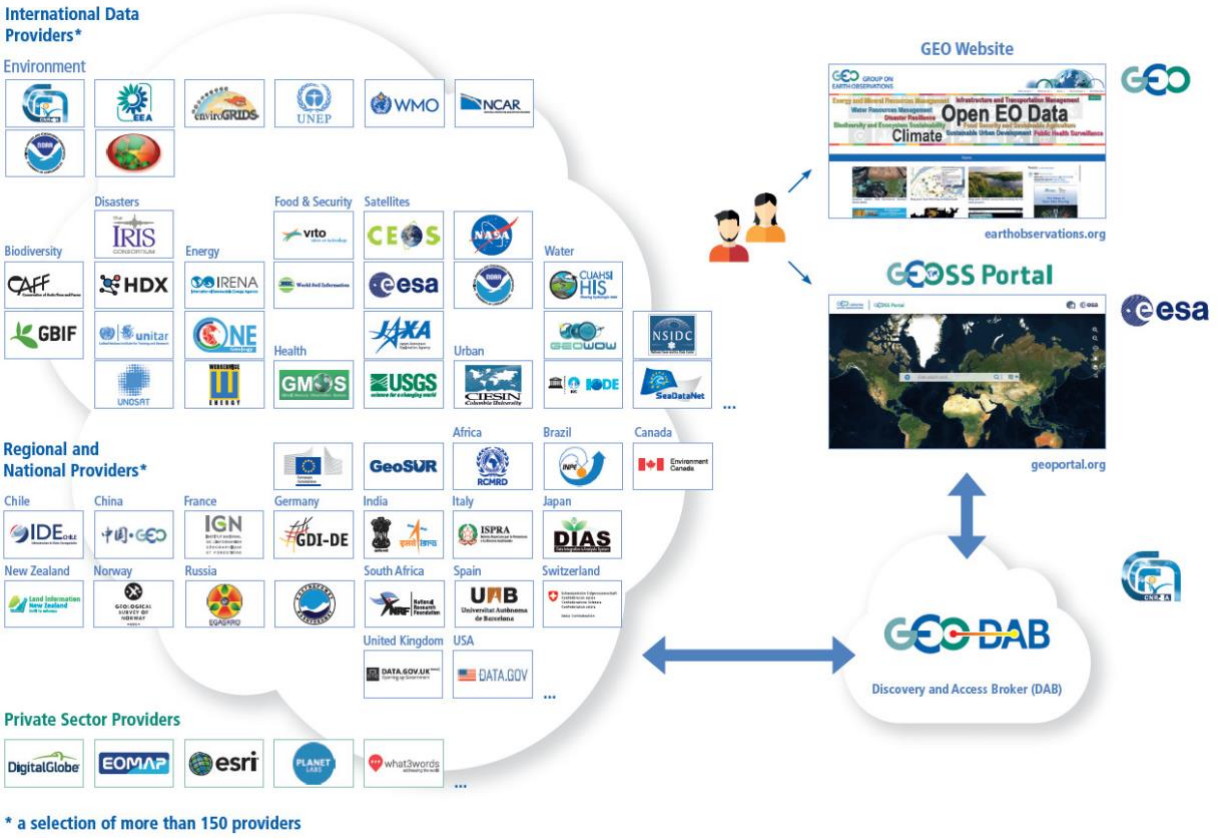



***Figure 4.*** *The GEOSS Portal structure*

## 1.5 What Standards and Technical Steps are required?

### *1.5.1 What are metadata standards?*

Metadata constitute the documentation/explanation of data, serving the purpose of making data discoverable, easy to use and plausible (e.g. type, location, timespan etc.). Put simply, the purpose of metadata is to describe datasets so as to allow other users to:

- Find specific data;
- Understand the information encapsulated by the presented data;
- Determine quality and content;
- Screen similar datasets, and
- Uncover other pertinent descriptive information.

In response to these needs, a number of initiatives sought to collect metadata according to a variety of formats: NASA's "DIF, 1988; U.S. FGDC, 1992-1994; ANZLIC, 1996; ISO 19115, 2003 & rev. 2013; and several extensions to the ISO standard (adding new elements). An important milestone was the release of the XML implementation schema for ISO 19115 (ISO 19139:2012) which includes Geographic Metadata for imagery and gridded data.

### 1.5.2 Why are they needed for?

The prevalence of geographical data and the plethora of new raw data (e.g. new satellite missions; in-situ networks etc.) forced all communities and the public sector in particular (e.g. INSPIRE Directive in Europe and Geoplatform Activity in US) to document and manage the acquired geospatial data, through the use of metadata, as an essential and integral part of the process.

### 1.5.3 Who are the core contributors?

**OGC** has long worked on standards for the creation and use of metadata, setting up major initiatives and working groups to discuss and evaluate the evolution of geospatial metadata (e.g. from XML schemas to JSON and RDF).

**INSPIRE**, as an European Directive, has shared specific Implementing Rules on Metadata (IRs), making use of EN ISO 19115 and EN ISO 19119 standards.

**W3C**, as the main international standard organization for the World Wide Web, has also contributed to the conversation alongside OGC. W3C has raised specific concerns regarding the ISO 19115 & ISO 19139 standards which are yet to be solved.

**GEO**, Group on Earth Observation and the GEO portal, supports a wide range of standards providing the GEO community with full, open and unrestricted access to data through the dynamic collection of data (GEO Data-CORE - GEO Data Collection of Open Resources for Everyone). GEO Data-CORE supports many metadata standards such as ISO 19139, OpenSearch, NetCDF, DIF and many others.

### 1.5.4 Tools for metadata generation/transformation

Many open and proprietary solutions were developed to enable the viewing and editing of geospatial metadata. Among these, ESRI's ArcGIS Desktop, Autodesk's AutoCAD Map 3D, QGIS's metatools plugins offer desktop s/w tools allowing the handling of geospatial metadata.

Besides the above, great many other metadata tools are available, as listed below:

| | |
|---|---|
| GeoNetwork opensource | A free and open source s/w solution that allows the management and publishing of geospatial metadata and services all the while adhering to international metadata and catalogue standards. |
| GeoCat Bridge | GeoCat Bridge is a proprietary extension for ESRI ArcGIS and QGIS, designed to enable the process of publishing geospatial data on the internet. Both desktop solutions allow users/data owners to easily publish geographic data and metadata on the internet via an open source server platform.<br>GeoCat Bridge permits users using either of the two above mentioned desktop software to edit, validate and directly publish metadata onto GeoNetwork (and generic CSW catalogues) and publish data as map services on GeoServer, thus supporting several metadata profiles. |
| pycsw | Pycsw is an OGC CSW Server fully compliant with the OpenGIS Catalogue Service Implementation Specification (Catalogue Service for the Web) and supporting the publishing and discovery of geospatial metadata via numerous APIs (CSW 2/CSW 3, OpenSearch, OAI-PMH, SRU). Existing repositories of geospatial metadata can also |

| | |
|---|---|
| | be exposed, providing a standards-based metadata and catalogue component of spatial data infrastructures. |
| CatMDEdit | CatMDEdit is an OpenSource project which provides a metadata editor to facilitate resource documentation focusing primarily on geographic information resource descriptions. This tool enables metadata generation for different data formats (e.g. Shapefile, DGN, ECW, FICC, GeoTiff, GIF/GFW, JPG/JGW, PNG/PGW) and adheres to many different standards in XML and RDF (ISO19139/ISO19115 metadata standards defined by U.S. FGDC, encoding rules for Dublin Core in RDF, SDIGER - Dublin Core Metadata Application Profile for geographical data mining, XML-Schemas established in the OGC Catalogue Services Specification, MARC21 metadata standard- ISO 2709). |
| MEtadata Editor (MEE™) | MEE is a tool which creates, edits and optimizes metadata files in ISO19115 and ISO19139 standards. Licence of use is GNU Library or Lesser General Public (LGPLv2). |
| Mapbender | The open source software Mapbender is a content management system for geospatial data services and map applications. Among its features, the MapBender's geoportal framework allows the management of standard map and feature services while providing all tools needed to edit, manage and publish associated metadata. |
| DCLite4G | DCLite4G – "Dublin Core Lightweight Profile for Geospatial" is a minimal information model for metadata about geospatial data. The vocabulary is defined in RDF and OWL. |
| MIG EDITOR | The MIG Editor is a geographical metadata editor which implements a subset of the 19115, 19119 and 19139 ISO standards. This editor was based on the Portuguese Metadata Profile and the INSPIRE requirements. |
| EUOSME | The European Open Source Metadata Editor (EUOSME) is a web application for creating INSPIRE-compliant metadata in any of the 22 European languages. It has been developed by the Joint Research Centre as part of the EuroGEO project. |
| GIMED | Greek INSPIRE Metadata EDitor (GIMED) is a metadata editor dedicated to geospatial data and providing metadata compliant with both ISO19139 and the INSPIRE directive. |
| Metatools | Metatools is a QGIS plugin that allows the creation, editing and viewing of metadata in the ISO19115/ISO19139 format. |
| INSPIRE Metadata Support in GRASS GIS 7 | The GRASS 7 is an add-on package for creating and editing metadata according to ISO19115. The GUI based module offers advanced tools for the management of metadata. Additionally, the package includes a specific module for searching and browsing through the metadata catalogue (csw). Advanced users are provided with a few modules on establishing and handling the pycsw server. |
| pygeometa | Pygeometa is a Python package used to generate metadata for geospatial datasets, allowing users to easily create geospatial metadata in standard-based formats using simple configuration files. Developers are provided with a Pythonic API allowing them to integrate metadata generation within their systems and further into |

| | |
|---|---|
| | metadata production pipelines. pygeoapi is open source and released under an MIT license. |
| GeoDCAT-AP | GeoDCAT-AP is a metadata profile aiming to provide an RDF-based representation of geospatial metadata compliant with the DCAT application profile of European data portals (DCAT-AP), specifically designed to enable the sharing of geospatial metadata, in particular those available via the INSPIRE infrastructure. |

Various other additional and/or customized tools are available as open source and/or proprietary. **Before proceeding with metadata file generation, users and/or developers should do a quick analysis of the available options to understand which of the above better serve their needs** (e.g. one of metadata extraction; automatic generation of metadata based on new product delivery etc.).

### *1.5.5 Technical Steps*

Although there is no one procedure to generate and share data, data providers need to undertake a series of important technical steps to successfully share and exploit their datasets. EC/JRC (INSPIRE), OGC and W3C work together in workshop-like settings to jointly identify best practices addressing as wide an audience as possible (https://www.w3.org/TR/dwbp/).

**Most data owners agree that the full advantage of datasets can only be harnessed if data is made discoverable and reusable**. To this end, metadata and catalogues are vital, enabling a wider range of users and third parties to search, discover and retrieve the available datasets. Consequently, metadata generation is an essential part and a must in dataset publishing on the Web in order to enable retrieval by unfamiliarised data consumers.

The technical steps necessary can vary with the type of data (e.g. one-off dataset, dataset resulted from a processing chain frequently/on-demand etc.). To illustrate, a brief overview highlighting the steps involved such as accessing raw data, establishing a processing chain, creating products, storing new products, updating of a metadata catalogue, exposing new datasets, is provided below (Figure 2).

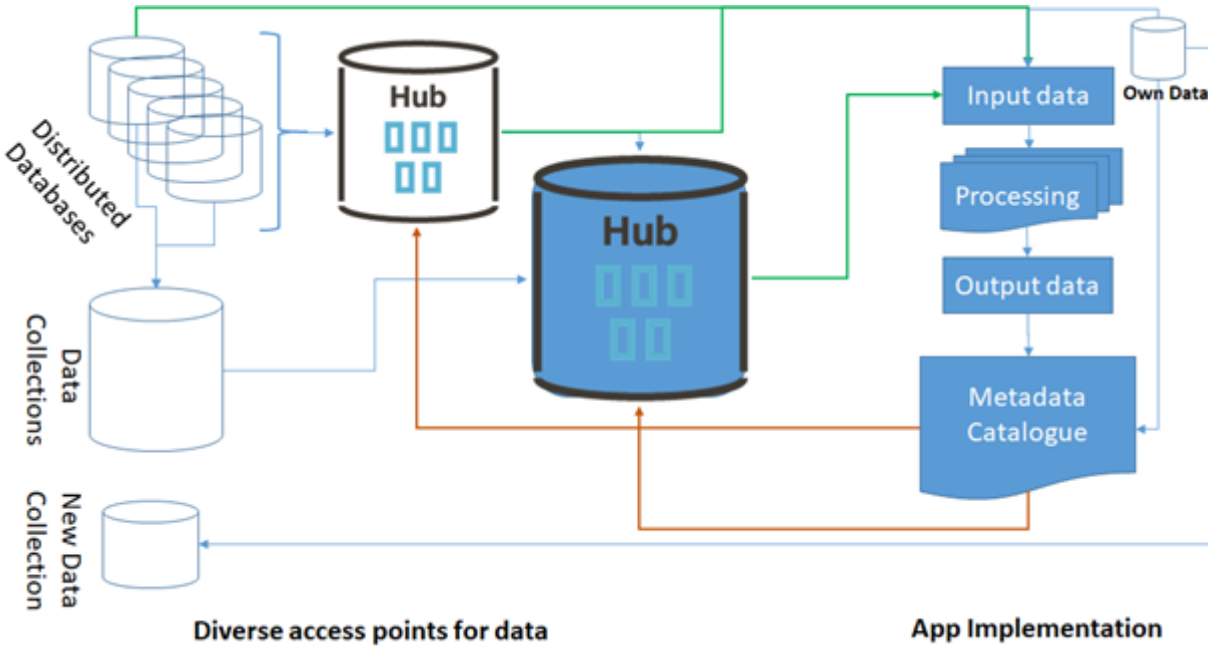



***Figure 5.*** *Data sharing concept*

The above figure illustrates how data sharing could be followed by the involved stakeholders. There is a "jungle" of discoverable and accessible databases and collections of data. Besides these, data brokers (Data Hubs) harvest and register data collections or distributed databases acting as centralising data access points, whilst also ensuring that the original source of the data is clearly visible and accessible.

Specific applications could potentially incorporate and rely on data made available by other parties (accessible through data access points) and/or on own data from in-situ stations and/or ground receiving antennae. In most cases, different levels of new data can be produced. Therefore, for each dataset, corresponding automatic metadata (as per specific metadata standards) shall be generated and registered in the catalogue (e.g. using GeoNetwork). Last but not least, the catalogue could deliver new products and analysis results (processed by the processing chain) back into the data hubs.

Following the steps demonstrated above, data owners and/or data/information generators can leverage their sharing capacities in various ways: to gain visibility and expertise, or even seek new collaborations. Equally, the role of single access points of datahubs (extensively described above in section 1.4) is extremely vital to the ecosystem.

# II. REAL WORLD APPLICATIONS AND ADDED VALUE

The below two examples of real world applications are meant to illustrate the above described principles of data discoverability and accessibility for the benefit of those willing to contribute their data and results on regional and national portals in compliance with the mentioned standards and data management frameworks mentioned.

## 2.1 GEO-CRADLE Energy pilot application – SENSE

In the framework of the EU-funded projects BEYOND, GEO-CRADLE and e-shape, a novel Solar Energy Nowcasting SystEm (SENSE) was designed, developed and tested on a pilot scale as part of the efforts

undertaken towards coordinating, improving and supporting the development of regional EO infrastructures and capabilities in Europe, North Africa and the Middle East in the “access to energy” sector. This feasibility study assessed the operational viability of a satellite-driven, real-time system for solar energy applications.

The SENSE pilot, supporting SDGs 7 and 9, takes advantage of the free Copernicus data and services, innovative modelling and state-of-the-art, real-time, solar energy calculating systems, and generates reliable, high resolution, solar Atlases as well as broader climatology studies. The pilot also extrapolated and proposed strategic methods to integrate a solar energy nowcasting system into a wider, global, GEO driven system.

More specifically, SENSE combines Radiative Transfer Model (RTM) simulations, Machine Learning Computing Architectures (MLCA), and real-time atmospheric data made available by Earth Observation providers (e.g. Copernicus and EUMETSAT). Consequently, the resulting solar energy products and services come in high spectral, spatial and temporal resolutions (1 nm, 0.05 x 0.05 degrees, 15 min). SENSE incorporates an online validation procedure with support from the new Greek National research infrastructure: PANhellenic infrastructure for Atmospheric Composition and Climate Change (PANACEA).

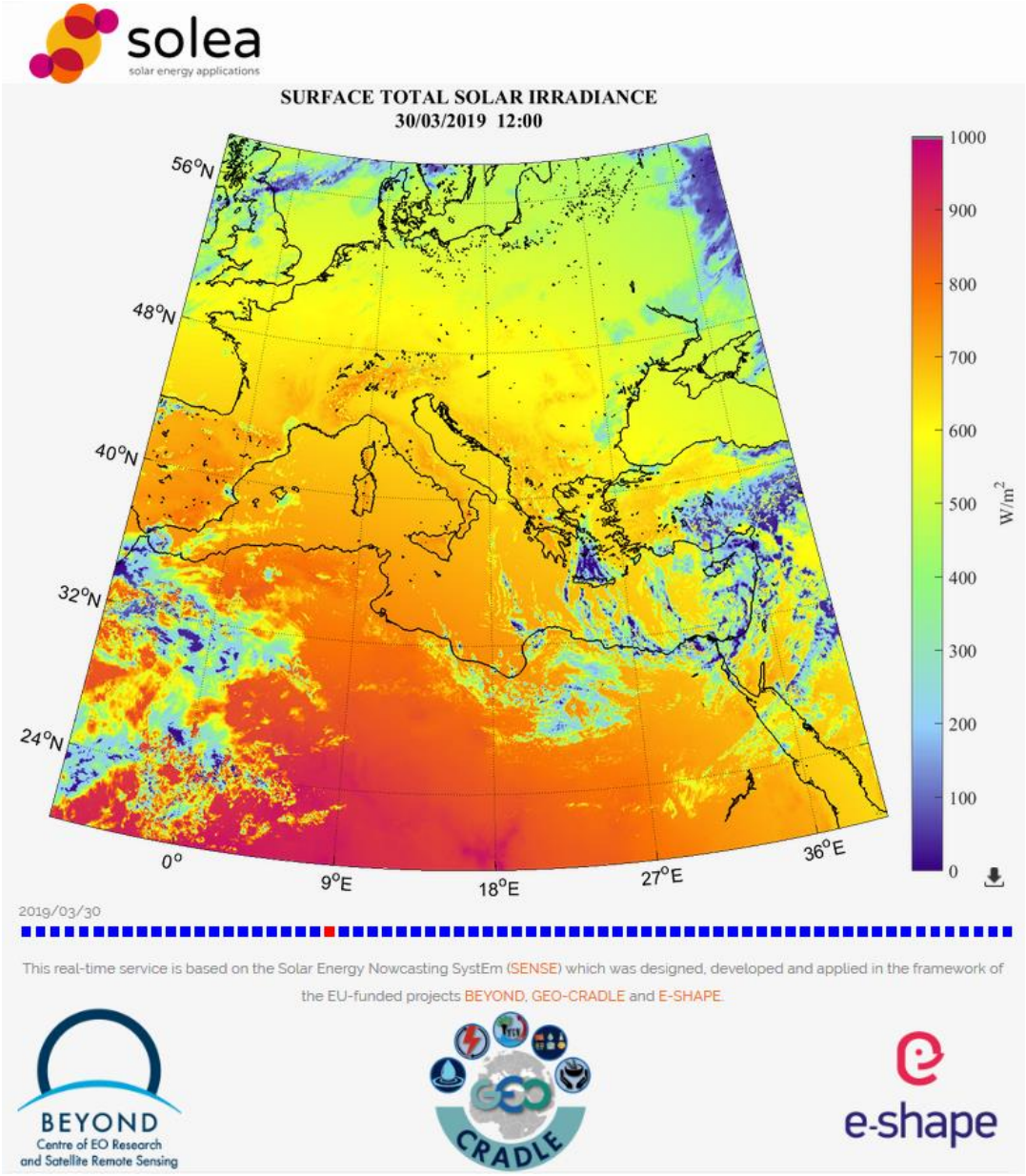



***Figure 6.*** *Solar Energy Nowcasting SystEm (http://solea.gr/real-time-service/)*

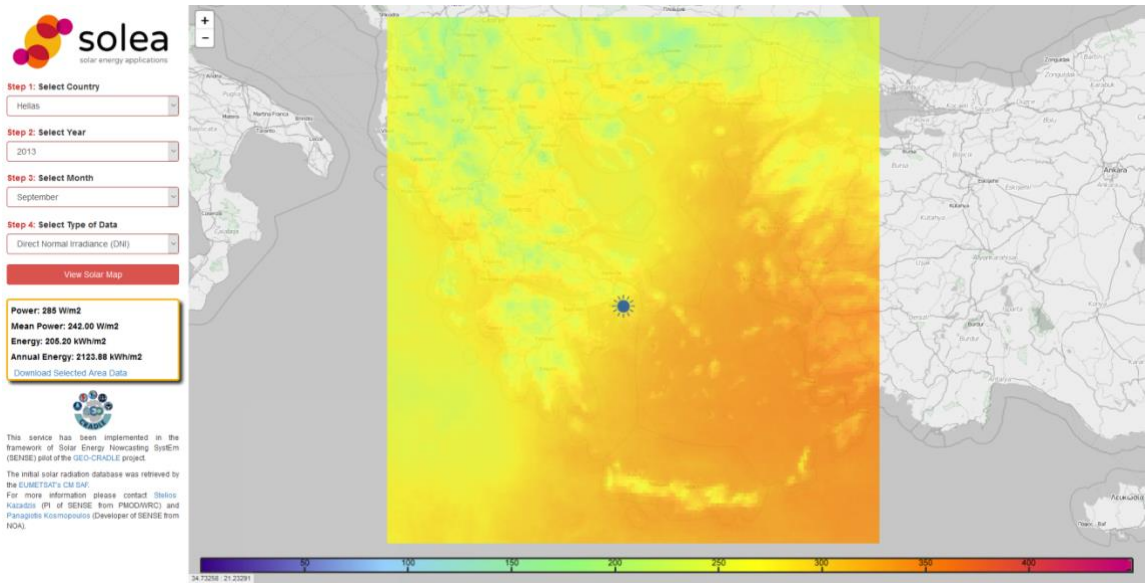



***Figure 7.*** *Solar Atlas Service (http://www.beyond-eocenter.eu/solarapp/)*

Making use of the GEO-CRADLE and e-shape networking platforms, **SENSE succeeded in stimulating interest among key energy stakeholders**, decision makers and solar energy investors from both the public and the private sectors such as the Egyptian Ministry of Electricity and Renewable Energy, the Greek Power Transmission and Distribution System Operator, the Attica Group and various scientific communities (research institutes, universities, the health sector).


***Figure 8****. End-users*

*"We find that the idea of the Solar Energy Nowcasting SystEm (SENSE) pilot in order to produce (i) the analytical solar energy Atlas of Egypt mainly for the efficient solar energy exploitation and (ii) the nowcasting of the solar energy potential in real time in order to support the Egyptian energy authorities to better plan solar energy demands, is of great and absolute importance. It is also a clear example of successfully building a value chain through a partnership between innovation and capacity building provider, GEO-CRADLE team, working with the Ministry and associated Renewable Authority, to deliver the Solar Atlas and the dynamical output, hopefully to meet the mandate of the investors and fund providers resulting in better schemes of energy production and hence in customer satisfaction."*

***Figure 9.*** *Mr Mohamed Shaker El-Markabi, Minister of Electricity and Renewable Energy, Egypt*

SENSE has a definite contribution in the planning of large scale solar farm projects (photovoltaics and concentrated solar power plants) as well as in the efficient control needed for electricity balancing and distribution (in support to the TSOs and DSOs), achieved by incorporating the produced energy of the solar farms into the electricity grid. At the same time, the surface solar radiation of different spectral regions offers insights into spectrally weighted outputs such as the UV-index, the Vitamin D deficiency and a number of agriculture and ocean specific processes.

SENSE's developed capacities were transformed into EO-based SOLar Energy Applications (SOLEA) and are provided as open access services and databases. In Egypt, the Ministry of Electricity and Renewable Energy has integrated the dedicated Egypt SENSE application into its official website, anticipating the needs of potential solar investors. This includes nowcasting and solar atlas services providing evidence-based insights necessary for the efficient planning and management of solar energy infrastructure using Earth Observation data and technologies in Egypt.

Unsurprisingly, the official Solar Atlas, created for the needs of the Ministry of Electricity and Renewable Energy, helped in the identification of 29 specific locations which were selected for the construction of new solar farm projects. One of these was Benban, where a 1.8 GW solar farm was commissioned at the end of 2019, one of the largest in the world, providing green energy to more than 80K houses, an active contributor to Egypt's energy grid. The Madgi Yacoub Heart Foundation in Aswan has also used the SolarHUB service to determine proper energy production monitoring solutions to use at an under construction photovoltaic park intended to cover the energy needs of the hospital and adjacent residential area, i.e. almost 15K people. High rank officials such as the Minister of Electricity and Renewable Energy, the Minister of Immigration and Egyptian Expatriate Affairs and the Minister of State for Military Production openly praised the contribution of these services to the society.

**In all these cases, the availability of openly accessible data (e.g. from Copernicus Atmosphere Monitoring Service, meteorological data, etc.) has played a crucial role in developing services that deliver significant value to different stakeholders. Similarly, the outputs of these efforts (e.g. Solar Atlas), by becoming available on different data portals, empower other stakeholders to develop solutions.**

***Figure 10.*** *The solar farm in Benban, Egypt*

In the framework of e-shape, the nextSENSE pilot (solar energy nowcasting & short-term forecasting system 3 hours ahead) aims to actively support smart solar energy planning and management. Climate data, compiled in solar atlases, guide the way to energy planning solutions providing critical information for both existing and new solar farm installations and investments. Real-time and short-term forecasting data on solar irradiance determine the energy management tools controlling the solar based electricity production, transmission and distribution, and therefore the renewable energy market. The data production is 90 Gb / day.

### *2.1.1 Uploading metadata and data at the GEO-CRADLE Regional Data Hub*

The above analysis of the SENSE pilot shows how useful and important is the dissemination, discoverability and availability of the project's data and results through open access services and databases. They could be the base on which other projects will build new scientific knowledge or even enable public authorities and various stakeholders with decision making. Below given a step-by-step guide is to organisations that want to make their data discoverable on how to upload metadata and data (optional) at the GEO-CRADLE Regional Data Hub.

#### *Step 1*

Go to the GEO-CRADLE Regional Data Hub web-page (http://datahub.geocradle.eu/), select the Datasets tab (Figure 11) and click Register (Figure 12).

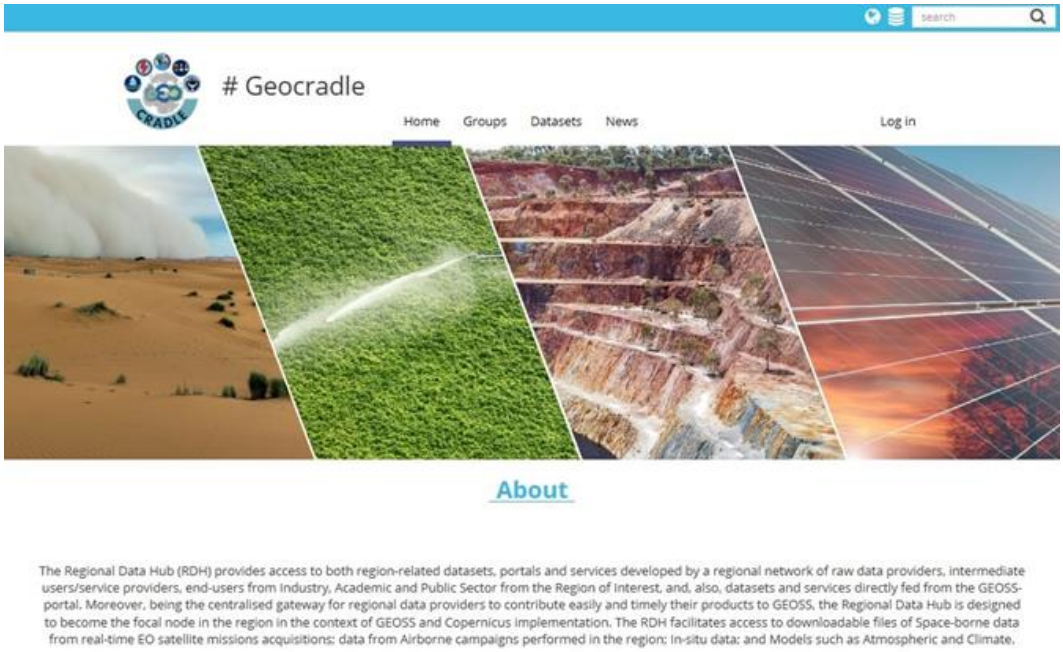



***Figure 11.*** *Select the Datasets tab*


***Figure 12.*** *Select Register*

### *Step 2*

The user is prompted to register a username, e-mail and password. After that the user has to fill in the requested fields in the best possible and accurate way in order to describe the metadata and the data (if chosen to be also uploaded). Figure 13 shows an example of what information is visible for a discoverable dataset, after the dataset itself and its metadata have been published in the Data Hub. It is important to

notice once again that if a user does not want to make the data themselves downloadable or wants them to be downloadable under a certain license; then can choose not to upload them at the Data and Resources field or publish them under a certain license (shown at the Dataset's License widget) respectively.

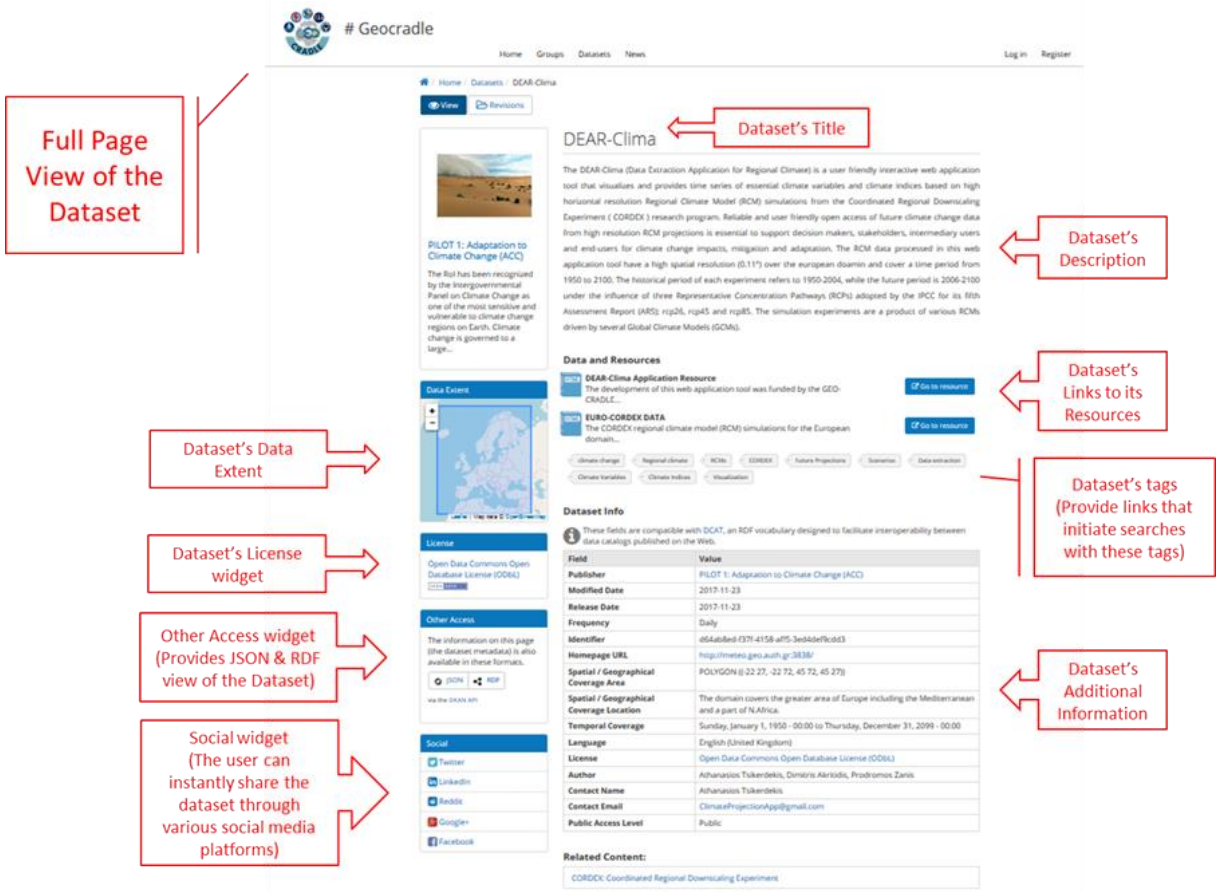



***Figure 13.*** *Fields of information that accurately describe the dataset*

In any of the two cases, the process to make the data discoverable through the GEO-CRADLE Regional Data Hub is user-friendly and time efficient without having to go through long bureaucratic authorization procedures (e.g. understand the ISO standard and the relevant fields' content). On the contrary, in order to make a dataset discoverable in an automatic process that many other data hubs require, such as the NextGEOSS portal or the GEOSS portal, users and/or data owners need to perform technical steps to generate metadata compliant with ISO standards (such as those described at paragraph 1.5 of the present analysis) and make them available through a data catalogue (please see paragraph 1.5). In case a user and/or data owner aims to publish metadata or data in a completely automated process, then they have to either be or find a tech expert and establish the communication with the tech experts of the relevant data hub (creating corresponding harvesters).

## 2.2 NEXT-GEOSS Vito Agriculture pilot

The Copernicus Sentinel-2 mission is vital for crop monitoring, making field-based monitoring possible. The VITO led pilot aims to demonstrate how NextGEOSS facilitates the use and processing of Sentinel-2 data in order to enable crop monitoring:

1. Easy access to the data via the NextGEOSS data hub;
2. Ensuring temporally dense profiles as required for close crop monitoring (merging data provided by both Sentinel-2 and Proba-V - Copernicus contributing mission, as Sentinel-2 data is insufficient);
3. Tutorials explaining how to establish a processing chain for Sentinel-2 L1C data on vegetation indices to be transformed into crop information. Also, a web-based dashboard is being developed to allow users explore whereas, subsequently, this information is fed into specialised commercial web-based dashboards, e.g. WatchItGrow. Steps are being taken towards adding weather data;
4. A phenology layer integrating Sentinel-2 data via the NextGEOSS cloud is available on the dashboard;
5. Crop monitoring products are defined in collaboration with the industry and the GeoGLAM (Group on Earth Observations Global Agricultural Monitoring Initiative) community;
6. Synergies with other initiatives - results from this NextGEOSS application flow into the ESA sponsored project TEP Food Security;

Application overview:

- **Leading organization**: VITO
- **Geographical area**: Belgium and Mali.
- **Data**: Sentinel-2; Proba-V 100m; Meteo Data (rainfall, temperature, …)
- **Context**: To support Food Security, and agriculture monitoring in particular, this application demonstrates how the NextGEOSS platform can unlock the enormous potential of high-resolution data (e.g. Sentinel-2), whereas, traditionally, crop monitoring was done mainly using medium resolution data from various satellite missions and the vegetation parameters from Copernicus Global Land.
- **Target Community**: This application addresses existing demands from the Agro industry, as well as insurance/re-insurance companies, organizations such as FAO, JRC, and others, who show a clear need for these tools. The application will be promoted inside GeoGLAM which can benefit significantly.
- **Expected outcome**: Vegetation products, including phenology, are derived on-demand from Sentinel-2 on a cloud platform. Efforts are undertaken to address bottlenecks regarding access to different sources of EO-data varying from medium resolution (but high temporal resolution) to high resolution (high spatial resolution), which are scattered. Consequently, data fusion between Sentinel-2 and Proba-V is being explored.

VITO is leading this application which adheres to ISO 19139 metadata standard: https://catalogue.nextgeoss.eu/agriculture_monitoring.xml

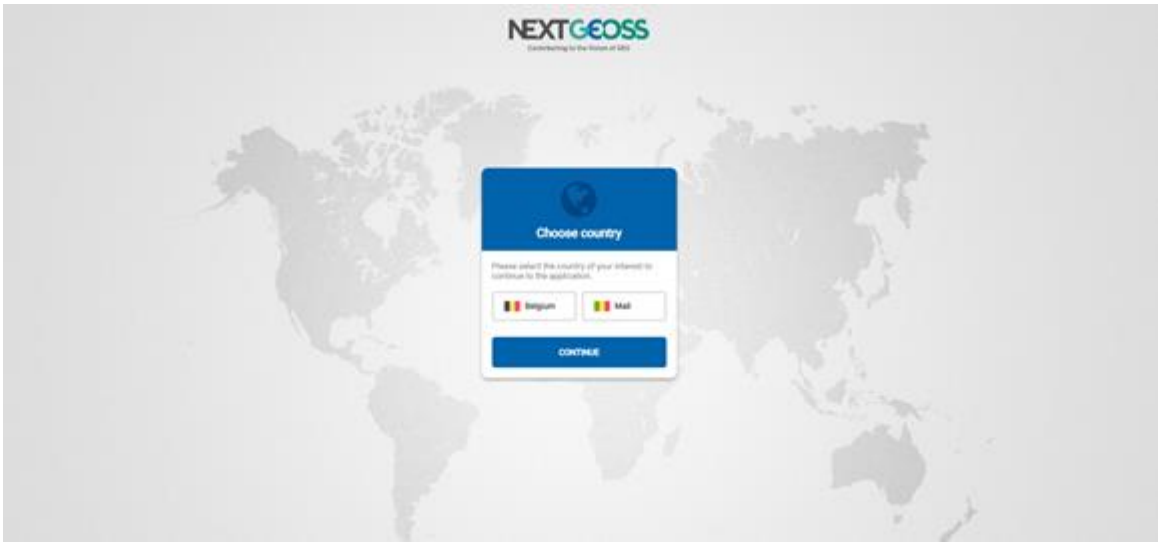



***Figure 14.*** *Intro page User Interface*

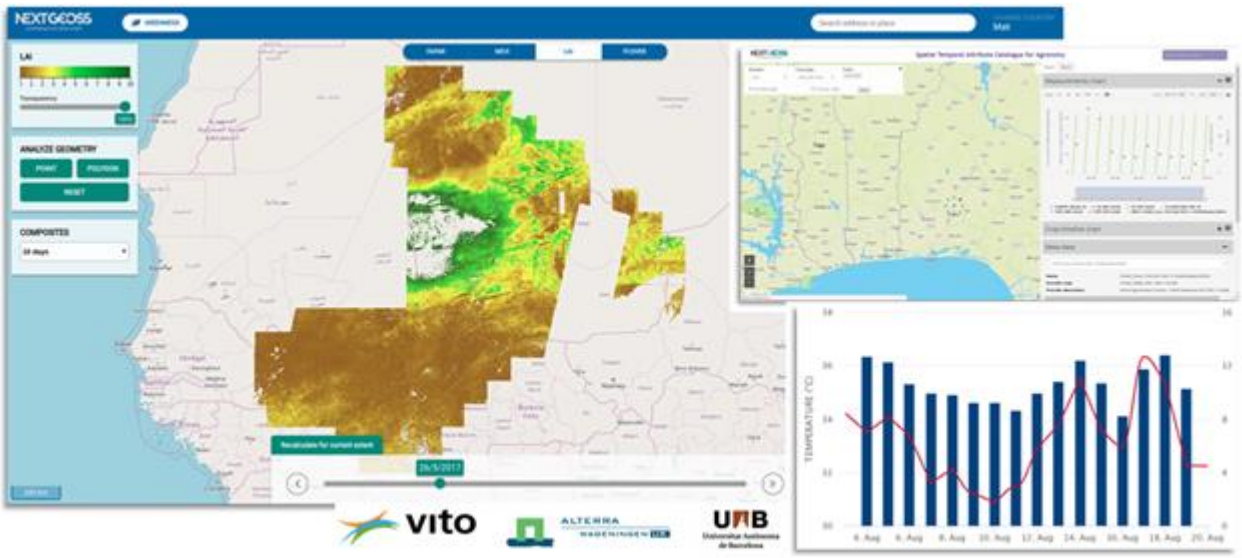



***Figure 15.*** *User Interface*

All metadata generated for these applications are being catalogued and harvested by NextGEOSS Data hub.


***Figure 16.*** *Metadata as shown in NextGEOSS Data hub*

In addition to the above-mentioned tailored datasets; all available datasets, catalogued to VITO's infrastructure, have been harvested from NextGEOSS Data hub.

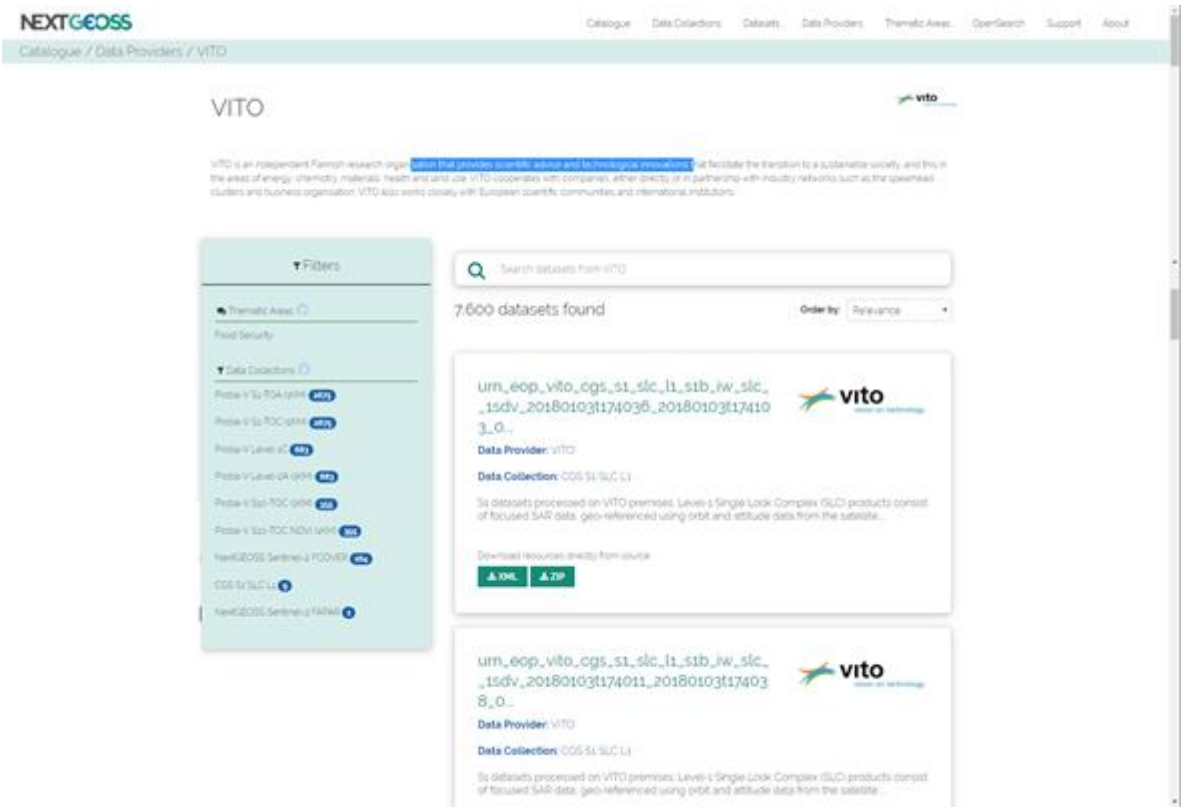



***Figure 17.*** *VITO as data provider to NextGEOSS Data Hub*

The below sequence of illustrations provides the complete chain of information starting from the data owner's catalogue being harvested by a data broker hub (NextGEOSS Data hub). **Analysing this process, an overall understanding of how discoverable data (although sometimes not fully open) can be exploited**. Such processes encourage and ensure data maintainability and synergies.

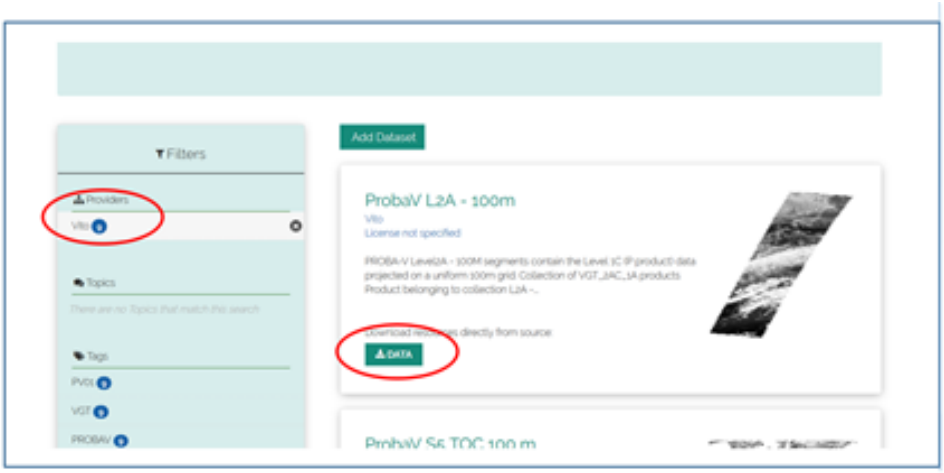



***Figure 18.*** *Locate needed dataset on NextGEOSS Data hub*


***Figure 19.*** *Prompt to the actual data source portal/data catalogue*


***Figure 20.*** *Download the requested dataset*

***Figure 21.*** *Download metadata data sets*

# III. REFERENCES AND MORE LEARNING MATERIAL

## 3.1 References

Culley, T.M., 2017. The Frontier of Data Discoverability: Why We Need to Share Our Data. Applications in Plant Sciences 5, 1700111. https://doi.org/10.3732/apps.1700111

Dorch, B., 2012. On the Citation Advantage of linking to data: Astrophysics. 2. https://hal-hprints.archives-ouvertes.fr/hprints-00714715v2

Farnel, S., Shiri, A., 2014. Metadata for Research Data: Current Practices and Trends 9.

## 3.2 Learning material

- OGC Standards Technical Documents
- INSPIRE Metadata Regulation and Technical Guidelines
- GEO-CRADLE Initiative Pilots
- LinkedIn SlideShare "Open Data Portals: 9 Solutions and How they Compare", 2015
- LinkedIn SlideShare "Research Life Cycle for GeoData 2014", Carly Strasser, 2014
- LinkedIn SlideShare "Aiming towards Accessibility of Geodata", Julia Neuschmid, 2011
- "The GEO-CRADLE Regional Data Hub tool: Utilizing the GEO DAB APIs for easy access and discovery of regional EO data." Presentation of Mr. Vassilis Tsironis (NOA) at the 2nd GEO-Data Providers Workshop
- "GEO-CRADLE; Addressing regional needs through DataHub" Presentation of Dr. Panagiotis Kosmopoulos (NOA) at the 3rd GEO-Data Providers Workshop

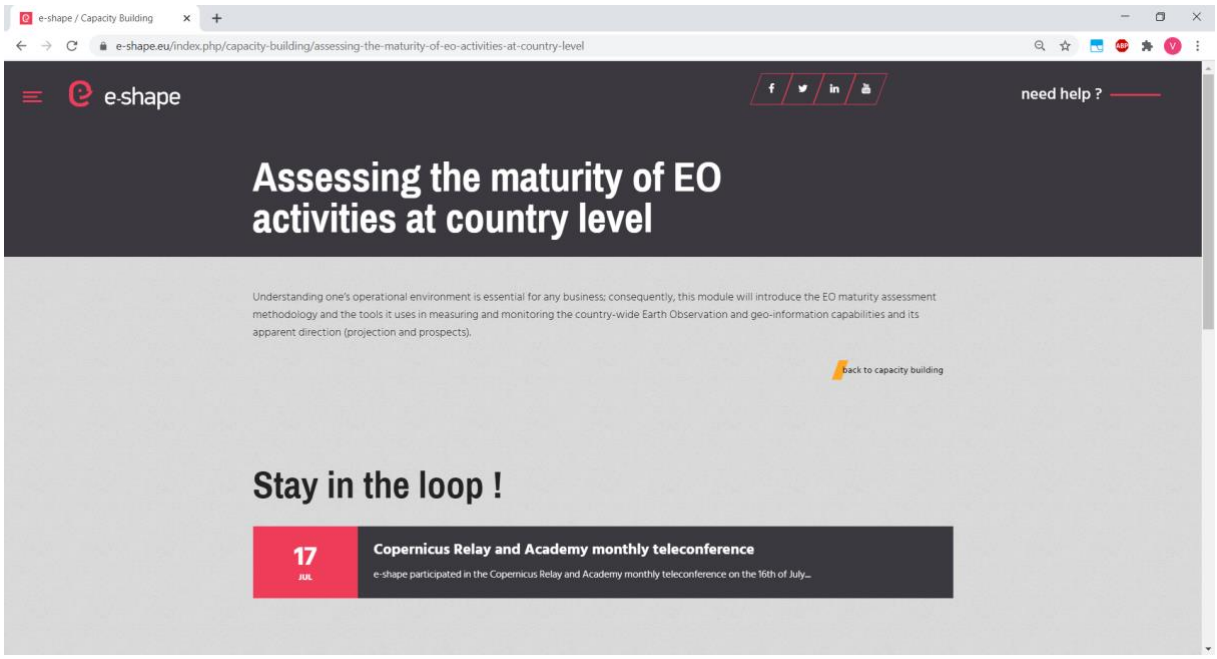
## 3.3 Conferences and Workshops

- GEOSS Data Providers Workshops
  - 1st (http://www.earthobservations.org/sevent.php?id=503). The agenda and presentations are available here.
  - 2nd (http://www.earthobservations.org/me_201704_dpw.php). The agenda and speaker's presentations can be found here.
  - 3rd (http://geocradle.eu/en/3rd-geo-data-providers-frascati/). The agenda and speaker's presentations can be found here.
- INSPIRE Conference 2018 (https://inspire.ec.europa.eu/conference2018)

# Assessing the maturity of EO activities at country level (EVF)

**EO Maturity Indicators – in a nutshell**

Earth Observation (EO) is increasingly used across the globe in support of key economic and societal challenges. To maximise its impact, decision makers and other actors along the value chain (e.g. research institutes, companies, user communities), require reliable data regarding the state and progress of different aspects of EO activities in their country. The **EO Maturity Indicators Methodology** is a robust tool that empowers these actors to design, develop and exploit EO activities on the basis of a solid understanding of current strengths, weaknesses and gaps. In developing a good level of "knowing thyself" around EO activities, one needs to have a good grasp of how advanced the **stakeholder ecosystem** is, how well developed the enabling **infrastructure**, how widespread the level of **uptake** across different domains, how well established are **partnerships** with other actors, and, finally, how well structured the **innovation** environment. These are precisely the (pillars?) parameters assessed by the EO Maturity Indicators Methodology. Its application yields a powerful visualisation (maturity cards) that can help EO actors understand their countries' capacities and act towards their enhancement. Being quite advanced, the draft version of this module can already be visualised and / or downloaded by accessing the dedicated capacity building page of the e-shape website pictured below:



# I. MONITORING THE STATUS OF EO ACTIVITIES – WHY IS IT IMPORTANT

## 1.1 Why is it important to know the current state-of-play of EO activities?

Earth Observation (EO) data and services can support the informed implementation of numerous policies, help in addressing key societal challenges, and boost economic prosperity, competitiveness and growth. The **key to unlock the wide range of benefits EO data enables**[4] **and build a more prosperous future**, **lies in understanding where we are today.** Thus, understanding the needs on the demand side helps to develop the capacity of the supply side to meet them; understanding the capabilities of the supply side helps to build the capacity of the demand side to make the most out of them. This dynamic process requires **constructing a full picture of the current state-of-play of EO activities at national level and a solid monitoring approach on how they progress over time**. Eventually, by identifying gaps, the competent stakeholders at national and international level can efficiently mobilise resources to address them.

## 1.2 Who benefits from this knowledge?

Having a solid understanding of a country's current level of EO maturity, as well as of how it evolves over time, can be empowering for various stakeholders as described below:

- **Policy/Decision Makers:** By drawing a full picture of the EO and related capabilities within their country, policy/decision makers can develop informed plans driving investment. Externally, the output of the assessment can serve as a "business card" of the country abroad – providing insights and inviting investments. Periodical assessment of the indicators can help show how the overall EO maturity of a country, or its various components, progress over time.
- **"Country partner" implementing the EO Maturity assessment:** The organisation designated to perform the assessment has the opportunity to acquire an immense amount of valuable insights on the local EO scene. The liaisons with local experts (part of the methodology) shall contribute to broadening the existing knowledge and provide networking opportunities.
- **Stakeholders in the national ecosystem (research institutes, private sector**): Gaining a solid view of the current status of the EO landscape in their country, as well as its evolution, can inform their strategies, concentrate their efforts (e.g. to address gaps) and make the most of opportunities.
- **International organisations:** Looking at the complete picture of EO activities maturity in a given country, but also at specific dimensions (e.g. uptake of data) can help international organisations draw plans and mobilise resources towards addressing existing gaps or leveraging a particular country's strengths.
- **Other stakeholders outside the national ecosystem (research institutes, private sector) -** can use the insights into the local EO market to gain access and build collaborations.

[4] See for instance the Sentinel Benefits Study: http://earsc.org/Sebs/

The list of possible beneficiaries can be expanded further, as the relevant indicators, and the combination of them, provide insights of interest for potentially very different stakeholders.

## 1.3 How can EO Maturity be assessed?

The **EO Maturity Indicators Methodology** has been designed[5], and fine-tuned (after a few cycles of implementation), to produce an assessment of the current state and the relative progress over time of EO activities in a given country. This is done against a set of pre-defined indicators and levels, corresponding to five thematic pillars: stakeholder ecosystem, infrastructure, uptake, partnerships, innovation.

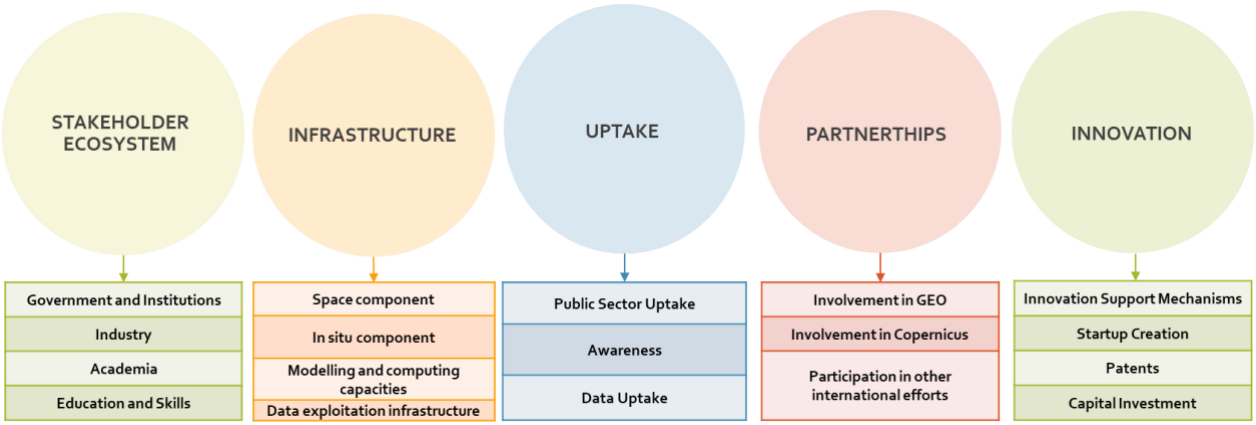



***Figure 1.*** *Thematic pillars within e-shape and underlying groups of indicators*

These pillars and the indicator groups they refer to should provide a comprehensive picture of the current EO maturity. However, **the methodology is modular**; each implementing country can choose[6] to only assess some of the proposed pillars or even individual indicators, and in some cases, it is possible to slightly adapt the pre-defined indicators and levels to the specificities of the country's profile.

The Methodology is implemented for each country by a qualified local actor – "**Country partner**" - a research institution, public service body or leading EO company within the country. The implementation itself consists of gathering data on the maturity of different EO indicators, as stated by their description and matching the outcome to one of the five levels for each indicator. The levels reflect quantitative (e.g. number of EO companies) or qualitative (e.g. existence or not of EO-focused venture funding) aspects. The qualification of the different levels is shown below.

| 0 – Initial | 1 - Basic | 2 – Intermediate | 3 - Advanced | 4 – Optimised |
|---|---|---|---|---|

**Within e-shape[7], the country partners will be assisted in their efforts to carry out an assessment by the "e-shape EO maturity team", consisting of members from Task 4.2 Leaders Evenflow and WP4 Leaders EARSC.** Thus, the whole data-gathering and data-analysis process will be supervised by the e-shape EO maturity team, who shall provide any support, clarifications, and help – e.g. by supplying initial explanations, help identifying national experts to assist with the implementation, and continuously reviewing and validating the gathered data.

[5]The maturity indicators methodology was developed under the GEOCRADLE project: http://geocradle.eu/en/regional-capacities/maturity-level/

[6] During e-shape implementation a full assessment will be pursued.

[7] For organisations interested to implement the methodology outside e-shape, the EO maturity team can provide guidance and instructions, but cannot be involved in the implementation of the different steps of the methodology.

The present guidelines aim to present briefly and concisely the best practices in implementing the EO maturity methodology, and to provide a step-by-step guide to be used by future implementing country partners. These guidelines are complementing the *Maturity Indicators Expansion* report (produced as deliverable D4.3 under e-shape). The guidelines will be followed by a dedicated webinar that will be produced under e-shape.

# II. STEP-BY-STEP APPLICATION OF THE METHODOLOGY

It is recommended that the EO maturity methodology is carried out in the following manner:

## 2.1 Introducing the methodology to the country partner

**Once the country partners are solicited (step 1)**, they are in charge of the implementation process, and it is necessary for them to acquire a deep understanding of it. Following a thorough reading of the guidelines provided here, the country partner will hold a 1st virtual meeting with the e-shape EO maturity team. The latter will, then and there, **explain the main principles of implementation (step 2)**, provide tools (e.g. excel sheets, presentations illustrating the methodology and its implementation), discuss and solve doubts and prevent potential misconceptions of the country partner. There shall be discussion over the indicators of interest for the country in question, as well as what the specific aim of the assessment is for the country, so that the e-shape maturity team can provide tailored support and orientation, if needed. It is possible that the ountry partner is not in a position to indicate the country's priorities; in such event it is encouraged that national experts are included already in this first meeting, so that such matters can be tackled.

If this has not been done before, national experts - additional experts whose competences the country partner may want to make use of, will be identified, at the latest, during this first meeting. Ideally, both experts from the private and public sector will be involved as early as possible in the implementation. The country partner can nonetheless make use of other experts to discuss one or more specific problems.

## 2.2 Carrying out of the assessment

Their overall EO specific knowledge and experience within a country, positions the "country partners" best for leading the implementation of such an assessment. Therefore, their ability to access data, analyse them, and synthesise the findings is heavily relied on.

It is up to them to **select the most appropriate methods for data gathering (step 3)**, which can vary and be complementary to each other. Some instances of data gathering methods that have been used in past EO maturity assessments are desktop research, surveys, interviews, workshops, etc. Combining these methods would yield the optimal result and ensure that the **necessary data is collected (step 4a)**. This step further entails the **identification of gaps (step 4b)**. For this, it is essential that the e-shape EO maturity team provides support and guidance when the country partner requests it: to discuss appropriate means for assessment of a problematic indicator, to ask for further clarifications and to jointly address potential challenges. The e-shape EO maturity team will also help with putting the country partner in contact with national experts, if needed.

Regular discussions (at least monthly) and reporting on the progress of the assessment shall occur between the e-shape maturity team and the country partner (and national experts, if needed) in order to ensure smooth progress.

## 2.3 Completing the first assessment and validating the results

Once all available data is collected and gaps are identified, a **first assessment of all pillars** (or a subset thereof) **can be implemented (step 5)**. In practice, this means that the country partner, with guidance from the e-shape maturity team when needed, fills in the information against each indicator on the provided spreadsheet and ventures into a preliminary assignment of levels. In this process, the support of national experts is critical as they can quickly identify potential outliers and direct the country partner to additional sources which could help fine-tune the assessment. Once **additional data is included (step 6)**, a critical analysis of the full assessment can be carried out. This allows a **final validation of the results (step 7)** which is done by the country partner, together with national experts and the e-shape maturity team.

## 2.4 Finalising and visualising findings

Moving from the first to the final assessment of maturity is carried out in an iterative process. Adding and validating the collected data as described above enables the consolidation of the findings and their **visualisation in the form of maturity cards (step 8)**.

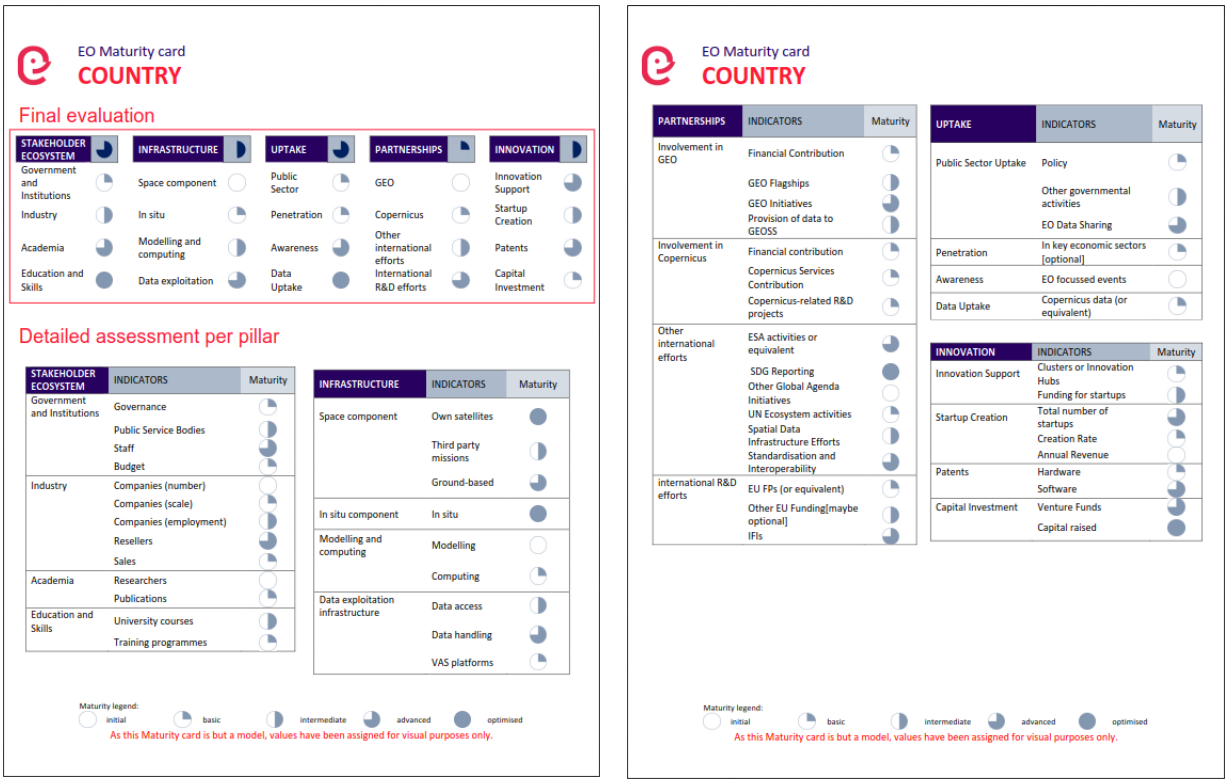



***Figure 2.*** *e-shape maturity card*

With the maturity cards in hand, the e-shape maturity team together with country partners (ideally from multiple countries that carried out the methodology) can carry out a contextualisation of the findings. This might result in small fine-tuning exercises in order to reflect appropriately comparative results based on the collected information. Once this is done, the **final assessment is concluded (step 9)** and the **results can be published (step 10).**

The steps described previously form part of a complete workflow which is visualised below.

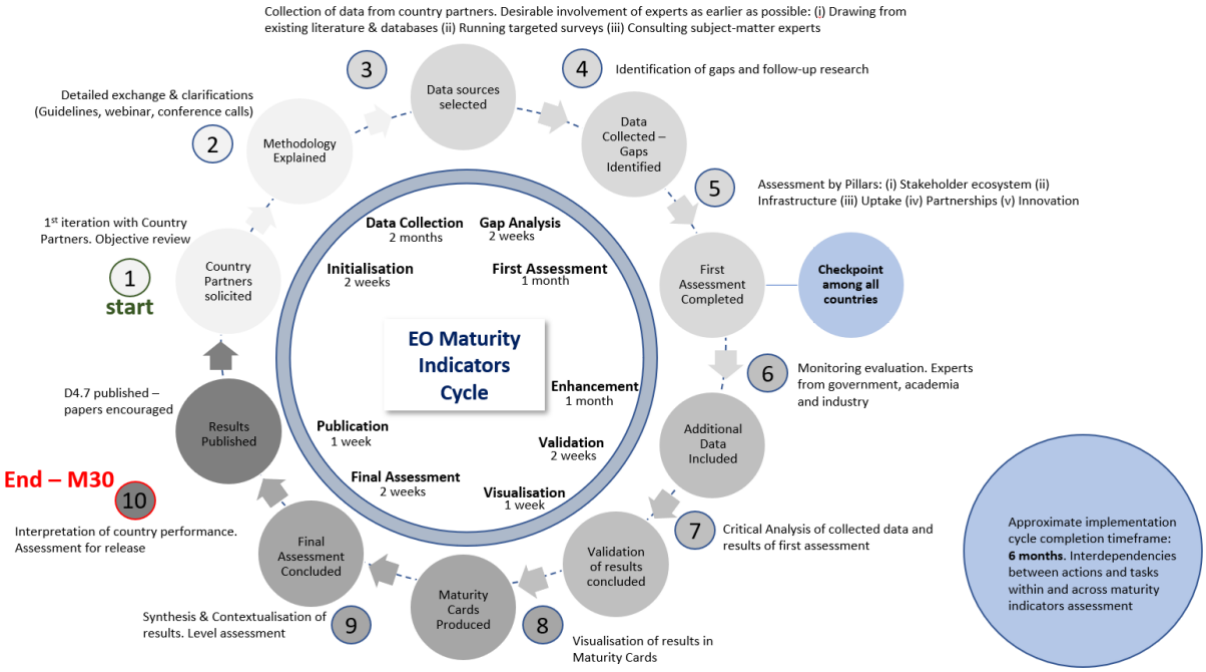



***Figure 3.*** *EO Maturity assessment workflow*

All the steps described in this guideline are essential for the implementation of the EO Maturity Indicators Methodology and the production of the Maturity cards. Additional details on each of these steps will be provided – within e-shape – to country partners via a dedicated webinar that will be produced and via the direct teleconferences organised with each of them. At this stage, it is useful to conclude these guidelines by recalling the responsibilities of different actors against the different workflow steps. This is done in the table below.

| Phase | Step | Activity | Involvement by: Country Partner | | National Experts | | e-shape Maturity Team | |
|---|---|---|---|---|---|---|---|---|
| Initialisation | 1 | Solicit Country Partners | | NA | | NA | | Based on report D4.3 |
| | 2 | Explain Methodology | | Read guidelines | | Participate in 1-1 conference if agreed | | Using guidelines, webinar, 1-1 conference |
| Data collection & Gap analysis | 3 | Select Data Sources | | Decide data gathering method | | Consult country partners wrt to available info | | Support country partners where needed (e.g. surveys) |
| | 4 | Collect Data and identify gaps | | Perform data collection | | Assist in gap identification | | Provide guidance where needed |
| First Assessment | 5 | Complete first assessment | | Carry out first assessment | | Consult country partners and eMT | | Assist country partners in concluding first assessment |
| Enhancement | 6 | Provide additional data | | Carry out data gathering where enhancement is needed | | Direct country partners to additional sources | | Suggest areas for enhancement |
| Validation | 7 | Validate results | | Provide feedback to experts and eMT for validation | | Carry out validation of results | | Perform ad hoc validations with desk research/critically review process |
| Visualisation | 8 | Produce Maturity Cards | | Provide inputs for the generation of maturity cards | | NA | | Generate maturity cards |
| Final Assessment | 9 | Conclude final assessment | | Carry out final assessment with assignment of levels per indicator | | Provide final views on final assessment | | Contextualise results and propose small fine-tuning where needed |
| Publication | 10 | Publish results | | Support the production of deliverable | | NA | | Produce e-shape deliverable with all results for all countries |

Legend
- Leading activity
- Supporting activity
- Providing assistance
- No involvement

***Table 1*** *Responsibilities of the implementing actors throughout the EO Maturity Indicators Cycle*

# III. REFERENCES AND MORE LEARNING MATERIALS

## 3.1 References

- The present document contains the implementation guidelines to the EO Maturity Indicators Methodology, as developed in, and described by **the e-shape deliverable *D4.3 EO Maturity indicators expansion***[8]
- The methodology has initially been developed and applied under the H2020 GEO-CRADLE project (now a GEO Initiative). For deeper background understanding of the methodology (now revised and upscaled within e-shape) see related **GEO-CRADLE deliverable**[9] and **publication**[10].

## 3.2 Attachments

- **EO Maturity level assessment grid** containing the full list of indicators and corresponding levels can be found under Annex I

[8] Available on the e-shape website under "WP4": https://e-shape.eu/index.php/resources

[9] *D3.4 – Maturity Indicators and country (G)EO Profile (II),* GEO-CRADLE: http://geocradle.eu/wp-content/uploads/2016/07/D3.4.pdf

[10] M. Miguel-Lago, L. Mamais, H. Kontoes, A. Tsouni - *Assessing the maturity of EO activities at national level Based on the GEO-CRADLE Maturity Indicators Methodology:* http://earsc.org/file_download/509/IAF2018+Assessing+the+maturity+of+EO+capacities+at+national+level_vf.pdf

# *Annex I – EO Maturity level assessment grid*

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| **Stakeholders Ecosystem** | Government and Institutions | 1 | Governance | Maturity and strength of the governance model at country level | Unspecified governance model. | Formally designated authority. | Formally designated authority, with geospatial departments present in in other ministries as well. | Clear agenda is implemented between authority and ministries-without international involvement and impact. | Clear agenda is implemented between authority and ministries - with international involvement and impact. |
| | | 2 | Public Service Bodies | Number of entities at national, regional, local level using or producing EO data | Less than 5. | 6 - 20 | 21-50 | 51- 100 | Over 100. |
| | | 3 | Staff | Employment numbers of people working on EO-tasks in governmental agencies and associated institutions | Less than 25. | 26-200 | 201- 500 | 501- 1000 | Over 1000. |
| | | 4 | Budget | Volume of annual public investment in EO-related activities (upstream, downstream, mid) | Less than EUR 10 M | EUR 10-50M | EUR 50-100 M | EUR 100-300 M | Over EUR 300 M |
| | Industry | 5 | Companies (number) | Number of companies active in acquiring and supplying EO data and/or delivering geo-information | No private companies in the EO domain [no companies on EO] | 1-5 companies in the country serving any category in the EO value chain [between 1-5 companies] | 6-25 companies serving at least 3 categories covering the EO value chain [between 6-25 companies] | 26-50 companies serving at least 3 categories covering the EO value chain | Over 50 companies representing all the categories covering the EO |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | | | | services/products suitable | | | | [between 26-50 companies] | value chain. [> 51 companies] |
| | | 6 | Companies (scale) | Composition of industry base with regards to company size:(micro <10, small<50, medium <250) | [no comparable] | Micro companies only | Micro and small companies | Micro, small and medium companies [SMEs] | All types of companies spread all over the country. Note: usually the EO companies are the small size ones. They have around 2-10 employees [all types industry] |
| | | 7 | Companies (employment) | Estimated total employment among industry | Private sector employment up to 10 employees [up to 10 employees] | Private workforce between 10-50 employees. Note: usually the EO companies are the small size ones. They have around 2-10 employees/company [10-50 employees] | Private task force between 51-150 employees [51-150 employees] | Private task force between 151-300 employees [151-300 employees] | Private task force more than 300 employees [>300 employees] |
| | | 8 | Resellers | Percentage of companies who operate only as resellers of international companies | Only resellers, not companies members of international specialised groups. [only resellers] | Over 60% resellers | Between 60% and 30% and resellers | Between 30% and 10% resellers. | Less then 10% resellers only |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | | 9 | Sales | Volume of sales (as documented in their annual revenues) by companies incorporated in the country | Less than EUR 1 M | EUR 1-5 M | EUR 5-50 M | EUR 51-100 M | Over EUR 100 M. |
| | Academia | 10 | Researchers | Number of researchers working on Earth Observation topics | No significant number of researches in the EO domain [no significant EO staff] | Less than 50 EO researchers | 50-250 EO researchers | 250-500 EO researchers | > 500 EO researchers |
| | | 11 | Publications | Number and impact of relevant scientific publications within the last 5 years *(e.g.: indexed in Elsevier's Scopus and Compendex, publications in journals ranked in JRC among the top 30% of journals in the (G)EO field)* | no papers published [no EO publications] | 1-25 papers published at department level (from those at least 10 paper citations who have an impact factor)[1-25 papers] | 25-100 papers published that will provide some excellence of the research resulting from national projects related to EO funded by Government or other EU funding (from those at least 25 paper citations who have an impact) [25-100 papers] | 100-500 scientific papers (+ thesis research) produced by research organizations and universities on innovative topics (from those at least 50 paper citations who have an impact. [100-500 papers] | Over 500 between number of theses and scientific papers produced by research organizations and universities with impact in prestigious magazines or presented in high level conferences; [>500 papers] |
| | Education and Skills | 12 | University courses | Dedicated or tightly linked to EO courses offered at university level | No specific EO courses. | Sporadic EO dedicated courses within various curricula. | Multiple EO dedicated courses within various curricula with proven impact and peer recognition. | At least one EO dedicated recognised and renowned curriculum. | More than one EO dedicated recognised and renowned curricula. |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | | 13 | Training programmes | Training programmes focussed on the development of EO-related skills | No known EO training programmes. | Rare instances of EO training programmes by local and international actors. (e.g. summer schools, seminars) | Sporadic EO training programmes by local actors. | Periodic EO training programmes by local and international actors. | Systematic (i.e. multiple annual) EO training programmes by local and international actors, serving coherent agenda (s) |
| **National infrastructure** | Space component | 14 | Operation of own satellites | If the country itself operates own satellite missions (public and private) | No missions, no technical readiness. | Technical readiness but no EO mission in course | At least one EO mission. | 1-5 EO missions | > 5 EO missions |
| | | 15 | Access to third party missions | Not owned nor operated by the country. Either a satellite operator or 3rd party mission/ including meteo. | No access to other missions [no access missions] | Access to less than 5 third party missions. | Access to 5-10 third party missions. | Access to 11-25 third party missions. | Access to over 25 third party missions. |
| | | 16 | Ground-based facilities | Number of stations. | No capacity for ground-based control elements of EO spacecraft system [no ground-based capacity] | 1 ground station | 2-5 ground stations | 6-10 ground stations | >11 ground stations |
| | In situ component | 17 | In situ monitoring networks | Number of in situ networks within the country or providing data to international networks. | 0 in situ networks. | Up to 5 in situ networks. | Up to 10 in situ networks. | Up to 20 in situ networks. | Over 20 in situ networks. |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | Modelling and computing capacities | 18 | Modelling | Measuring both number and quality of models (i.e. models for atmospheric modelling, what those are, what is the status). | No modelling capacities | TBD | TBD | TBD | TBD OR internationally renowned/ standardized models have been developed within the country. |
| | | 19 | Computing | Availability of computing processing capacities (high-performance computers: HPC), assessing who these belong to (i.e. total number of organizations with computing capacities) and how advanced they are. | No HPC [no computing capacities] | One institution with HPC facilities for their executions with multiprocessing systems and large external memory units. [one HPC] | Multiple computing resources for the processing and exploitation of EO data for one or more institutions. [between 2 to 10 modelling capacities] | TBD | TBD |
| | Data exploitation infrastructure | 20 | EO Data portals and gateways (data access) | Number of data portals originating from the country. | No data portals. | One generic data portal. | Up to 5 (including thematic ones). | Between 6 and 20 (including thematic ones-some serving different communities). | Over 20 (including thematic ones-some serving different communities). |
| | | 21 | Data handling (incl. data cubes) | Tools for data-handling available through portals in the country | Raw data only. (level 0-1A*) | Capability to query and gather various types of data. (level 0-1B*) | Capability to query and gather various types of data and additional tools to ingest additional data. (level 2*) | Capability to do develop services on the portal. (level 2*) | Capability to do develop services on the portal. (level 2*). Data cubes available as well. |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | | 22 | Value-added services exploitation platforms (services/advanced products level) | Number of existing VAS exploitation platforms (access to thematic products or services) | No existing platforms. | Up to 5 existing platforms. | 6-15 existing platforms. | 16-30 existing platforms. | Over 30 existing platforms. |
| Uptake | Public Sector Uptake | 23 | EO for policy making | Exploitation of EO as a policy making and policy monitoring tool | EO not used for policy-making and policy-monitoring. | One public service body using EO data for the monitoring status of policies. | 2-5 public service bodies using EO data for the monitoring status of policies. | 6-10 public service bodies using EO data for the monitoring status of policies. | Over 10 public service bodies using EO data for the monitoring status of policies. EO explicitly mentioned in legislation. |
| | | 24 | EO for operational public activities | Use of EO in operational activities of governmental agencies (including local and regional, excl. policy) | EO not used for public operational activities. | At least two public service bodies using EO data for operational activities. | 5-10 public service bodies using EO data for operational activities. | 11-20 public service bodies using EO data for operational activities. | Over 20 public service bodies using EO data for operational activities. |
| | | 25 | EO Data Sharing | Level of adoption of data sharing practices | Not adopted. | Intra-ministry. | Inter-ministry. | Data sharing between central and regional. | Between any public and private. |
| | Awareness | 26 | EO focused events | Occurrence of events allowing both awareness (for general audiences) and networking (for specialised audiences) around EO | No data for organised EO events. | Sporadic EO events without clear link or overall agenda. | EO events organised in a focused way to promote specific agendas. | One renowned (at least regionally) periodic EO event. | More than one renowned (at least regionally) periodic EO events. |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | Data Uptake | 27 | Uptake of Copernicus data (or equivalent) | Volume of Copernicus/Sentinel (or equivalent) number of product downloads per year | Less than 1000 products. | Between 1000 and 10 000 products | Between 10k and 500k products | 500k-1 million products | Over 1 million products. |
| **Partnerships** | Involvement in GEO | 28 | Financial Contribution | Financial contribution to GEO or to projects/initiatives which are linked to GEOSS | 0 | <EUR 1k | EUR 1-25k | EUR 26-100k | Over EUR 100k |
| | | 29 | GEO Flagships | Involvement in GEO Flagships | No involvement in Flagships. | Involvement in 1 flagship. | Involvement in 2 flagships. | Involvement in 3 flagships. | Involvement in 4 flagships. |
| | | 30 | GEO Initiatives | Involvement in GEO Initiatives | No involvement in GEO initiatives. | Involvement in 1 or 2 initiatives. | Involvement in 3-8 initiatives. | Involvement in more than 8 initiatives. | Leading at least one initiative (and involvement in at least 3 other initiatives) |
| | | 31 | Provision of data to GEOSS | Volume and quality of datasets contributed to GEOSS | No provision of data to GEOSS. | Plans for provision of data to GEOSS at country level (plans for sharing metadata brokered directly through the GEODAB) [plans for data to GEOSS] | Provision of one to five metadata types brokered directly through GEODAB [1-5 datasets to GEOSS] | Provision of 5 to 15 metadata types brokered directly through GEODAB [6-15 datasets to GEOSS] | Provision of more than 15 metadata types brokered directly through GEODAB and ideally [provision >15 datasets to GEOSS] |
| | Involvement in Copernicus | 32 | Financial contribution | Financial contribution to the Copernicus programme | None. | Agreement in place. | EU Member State, not contributing through ESA. | EU Member State, and contributing less than EUR 200 M per year through ESA as well. | EU Member State, and contributing over EUR 200 M per year through ESA as well. |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | | 33 | Contribution for Copernicus Services Provision | We look into involvement into Copernicus Services for services provision as carried out by public or private organisations within the specific country. | No organisations from the country is involved in provision to Copernicus service component(s). | Less than 5 companies from the country are involved in provision to Copernicus service component(s). | Over 5 companies from the country are involved in provision to Copernicus service component(s). | Over 5/10? companies from the country are involved in provision to Copernicus service component(s), with a clear focus on one of the components. | At least one company from the country is leading the provision for at least one service component. |
| | | 34 | Copernicus-related R&D projects | Participation into Copernicus-related R&D projects (*within the past 3 years*) | No projects using data from Copernicus [0 projects using Copernicus data] | 1-5 projects using data from Copernicus [1-5 projects using Copernicus data] | 6-25 projects using data from Copernicus [6-25 projects using Copernicus data] | 26-50 projects using data from Copernicus [25-50 projects using Copernicus data] | Over 50 projects using data from Copernicus. [< 50 projects using Copernicus data] |
| | Participation in other international efforts | 35 | Involvement in ESA activities or equivalent | Level of involvement implied by the status of ESA member state or ESA cooperating state, and the information beyond these terms. | No involvement. | Involvement through a general Cooperation Agreement. | European Cooperating State. | ESA Member State contributing less than EUR 500 million/year. | ESA Member State contributing more than EUR 500 million/year. |
| | | 36 | Involvement in SDG Reporting | Exploitation of EO as a tool to support SDG reporting (*within the past 3 years*) | No use of EO in monitoring/reporting of SDG´s [no SDGs actions] | Use of EO in reporting on at least in one SDG´s [1 SDGs action] | Use of EO in reporting on more than one action in SDG´s [2-10 SDGs actions] | Active use of EO for reporting on to different actions in SDG´s [11-25 SDGs actions] | Active use of EO for reporting on different actions in SDG´s in the last 3 years [over 25 SDGs actions] |
| | | 37 | Involvement in other Global Agenda Initiatives | Exploitation of EO as a tool in relevant Global Agenda initiatives and conventions (other than SDGs) | No national strategy to tackle it. | | Use of EO in reporting. | | Specific EO mention in consolidated country roadmap. |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | | 38 | Involvement in UN Ecosystem activities | Country participation to UN EO-focused programmes and relations with UN institutions (UNITAR, UNOSAT, UN-OOSA, UN-SPIDER, UNEP, etc.). | No membership of UN bodies related to Space activities nor participation in UN activities [no participation UN bodies] | Participation in at least one UN [EO activity (events w/g´s) [at least 1 active participation in UN agency/organisation] | Participation (between 2-5 activities) or plans for links to reference UN sites to focus international efforts, facilitate traceability and enable the establishment of measurement 'best practices' and active participation at one of the UN offices [participation in 2-5 UN agencies/organisations] | Active participation in more than 6 of the UN offices [participation in >6 UN agencies/organisations] | Active participation or membership of more than 6 UN bodies / offices related to space activities: in the last 5 years [participation >6 UN agencies/organisations/10 years] |
| | | 39 | Involvement in Spatial Data Infrastructure Efforts | Involvement with Infrastructure for Spatial Information (INSPIRE or other. Possibly monitoring of n. of reports about the implementation and use of their infrastructures for spatial information) | TBD | TBD | TBD | TBD | TBD |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | | 40 | Involvement in Standardisation and Interoperability Efforts | Country participation in other international organisations dealing with interoperability, standards, etc such as OGC | Not following programmes on standardisation processes: compatibility, interoperability, safety, repeatability [no engagement with Standardization discussions] | One public or private organisation participating in one of other international organizations dealing with standardisation, interoperability…etc [one organisation engaged with Standardization discussions] | 2-5 public or private organisations in the country have fully implemented and developed technical standards for EO [2-5 organizations engage with Standardization discussions] | 6-10 public or private organisations participating in an international organisations dealing with standardization, interoperability…etc [6-10 organizations engage with Standardization discussions] | Over 10 public or private organisations are leading standardisation processes [> 10 organizations engage with Standardization discussions] |
| | Involvement in International R&D efforts | 41 | IFIs (World Bank, Regional Development Banks, etc.) | R&D funds from IFIs implemented on the country's territory within the past 3 years | None. | Up to 5 projects, all of them small.(<100k) | Small projects and at least two over EUR 250k. | At least two medium projects (>EUR 1 M) present as well. | At least two big projects (>EUR 3 M) present as well. |
| | | 42 | Other funds | Other Projects executed by national actors funded through national or international institutions (other than IFIs) within the past 3 years. | None. | Up to 5 projects, all of them small(<EUR 50k) | Small projects and at least one of them over EUR 100k. | At least two medium projects (>EUR 500k) present as well. | At least two big projects (>EUR 1M) present as well. |
| **Innovation** | Innovation Support Mechanisms | 43 | Clusters or Innovation Hubs | Number of clusters and innovation hubs in a country | No concentration of business activities around EO information [no clusters] | At least one ICT cluster and hubs which could promote innovation and technological development [1 cluster] | 2-5 professional cluster and hubs organisations involved in technological transfer and innovation [2-5 clusters] | 6-10 clusters and hubs in more than one thematic (EO sector-specific). one cluster with silver impact [6-10 clusters] | Over 10 clusters and hubs in more than one thematic[1] including silver impact and at least |

| Pillar | Group of indicators | # | Indicators | Description | 0 - initial | 1 - basic | 2 - intermediate | 3 - advanced | 4 - optimised |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | one with golden [>10 clusters] |
| | | 44 | Funding for startups | Amount of available funding for startups | None. | TBD | TBD | TBD | TBD |
| | Startup Creation | 45 | Total number of startups | Number of existing startups (*created within the last 3 years*) | 0 | 1-5 | 6-10 | 11-20 | Over 20 |
| | | 46 | Creation Rate | Creation rate of startups (*for the past year*) | 0 | 1 | 2-5 | 6-10 | Over 10 |
| | | 47 | Annual Revenue | Average annual revenue of startups | Less than EUR 10k | EUR 10-50k | EUR 51-250k | EUR 251k - 1 M | Over EUR 1 M |
| | Patents | 48 | Hardware | Number of patents registered for hardware innovation | No patents registered. | TBD | TBD | TBD | TBD |
| | | 49 | Software | Number of patents registered for software innovation | No patents registered. | TBD | TBD | TBD | TBD |
| | Capital Investment | 50 | Venture Funds | Existence of available venture funds | None available. | Less than 3 generic innovation -research related. | 4-10 generic innovation -research related. | Over 10 generic innovation -research related. | Over 10 generic innovation - research related. Dedicated EO funds as well. |
| | | 51 | Capital raised | Amount of investment raised by national players in the space sector | Less than EUR 100k | EUR 100k-1 M | EUR 1-10 M | EUR 10-50 M | Over EUR 100 M |

Optional:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Uptake | Penetration | | Uptake of EO in key economic sectors [optional] | Operational use of EO in key economic activities within a specific sector (*e.g. agriculture*) | *No uptake.* | *Government uses it for basic activities (Land-cover and land use)* | *Offering access to the private sector via a platform.* | *Prolific use by private sector of the platform.* | *Prolific use by private sector of the platform and building on top of it.* |

# Next steps

As already indicated, the Capacity Building Modules proposed and developed as part of this deliverable were the result of internal consultations for the purposes of identifying gaps to be addressed under this task. The current iterations were developed to the best of our collective understanding of and assumptions regarding what is needed and potentially useful. The draft versions of these modules are to be introduced to and tested by the pilots so as to make sure they bring added value. The fine-tuned iterations are then to be laid-out (M40) and made available for distribution and use via the dedicated capacity building page of the e-shape website. In line with this same philosophy, webinars will further develop these topics to ensure a maximum exploitation of the available communication channels. A timeline of the envisaged next steps is provided below, for convenience, to help with the visualisation of the remaining efforts.