



## **Co-designed Citizen Observatories Services for the EOS-Cloud**

*H2020 programme: Research and Innovation action*

### **Deliverable 4.3**

## **Experts portal for environmental data validation**

November 29th, Version 1



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Horizon 2020 Programme (2014-2020)

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Type		
R	Document, report excluding the periodic and final reports	
DEM	Demonstrator, pilot, prototype, plan designs	X
DEC	Websites, patents filing, press & media actions, videos, photos, etc.	
SOF	Software, technical diagrams, etc.	
OTHER	Flyers, etc.	

Dissemination level		
PU	Public, fully open.	X
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified	

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## Authors

Marisol Parrilla López, Robin Giles Ribera, Santiago Martínez de la Riva

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## Executive Summary

Based on deliverable D4.1 General purpose integration platform (in which we carry out the implementation of a general purpose architecture) and deliverable D4.2 Expert Platform for Biodiversity Data Validation, and taking into account the feedback received from the experts in different co-design sessions of both services, we present [Cos4Env](#), a service whose main mission is to create an ecosystem that experts studying Environmental variables related to Citizen Science can use to carry out searches and downloads quickly and in a standardised way, generating data sets from different sources of information, such as citizen observatories.

The main objective throughout the development process of this service - and within this deliverable - has been to reuse the base of the general purpose Experts Portal and Cos4Bio service - thus demonstrating the validity of the work already carried out and the success of implementation. With these foundations, we have built a service, which contains the following minimal functionalities conceptualized at the beginning of the Cos4Cloud project, and defined within the framework of the Minimum Viable Ecosystem (MVE):

- Login service
- Internationalization service, which allows users to translate the platform into different languages
- Observation search service
- Results geolocated on a map
- Observation filtering service
- Download service
- Presentation of the detail of an observation
- Feedback service.

However, these requirements were merely a starting point, and throughout the process we have taken expert opinions on board, received during the course of several co-design workshops which were carried out in order to create a service adapted to user needs. In this way, following user requirements, we have included a set of new functionalities, adaptations and modifications that make the Expert Portal for Environmental data validation a service currently available in the EOSC Marketplace: <https://marketplace.eosc-portal.eu/services/Cos4Env>.

Additionally, throughout this process, we have developed our own interoperability layer, based on the Darwin Core terms standard, which is: easy to integrate by future citizen

observatories, close to the context of environmental measurements, widely used by the community, compliant with standardization rules, and allows us to create a service compatible with FAIR principles, which must be followed in order to publish our service in the EOSC.

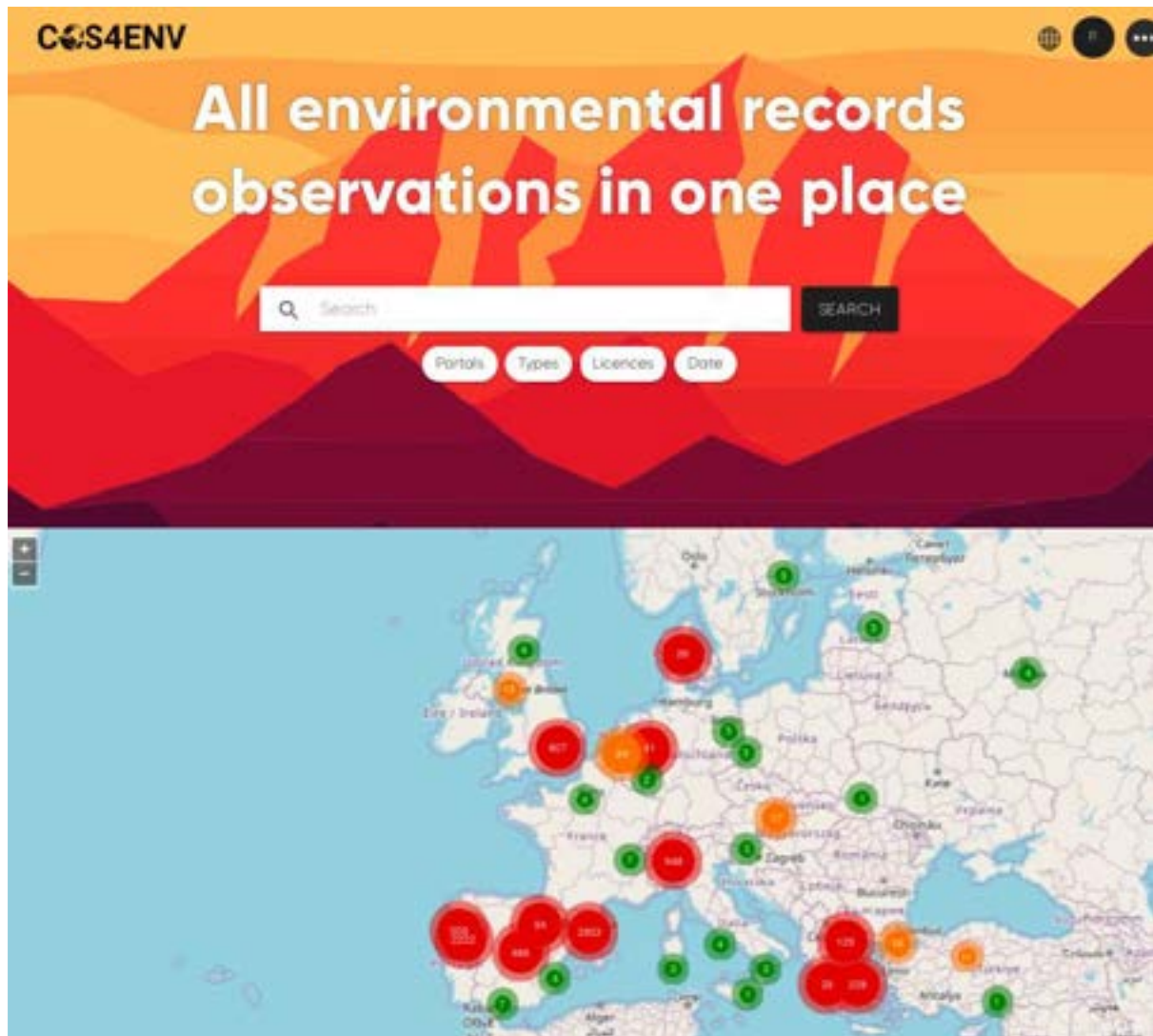
### **Conceptualization of the name**

The name 'Cos4Env' arises from various concepts that are intrinsic to the service itself, such as integration, cooperation, community, life and environment. These concepts are represented with the image of earth instead of using the letter "O" in the anagram of Co4Env.



The earth in the global context allows us to represent that Cos4Env takes multiple environmental variables into account, including: water, temperatures, odours, CO<sub>2</sub>, humidity, pressure, relief, wind speed, tides, topography and landscape, soils and surface erosion. All of these variables interact, generating new information that is very important for experts to analyze, particularly to predict future behaviors.

The leaf that appears, is also another important and crucial aspect of the design of the logo, since the reason for representing this image is because there is a close relationship between Cos4Env and Cos4Bio services - due to the relationship between the environment and biodiversity - , and in the future we would like to create a new portal that represents the interaction of these elements.



Home page of Cos4Env <https://cos4env.eu>

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## 1. Methodological approaches

This deliverable outlines the implementation of Cos4Env, which followed the same implementation procedures that we carried out for the General Purpose Platform and Expert Portal for Biodiversity Data Validation (Cos4Bio), which we detail in point [2. Analysis](#).

Again, during the implementation of this service, we have made an additional effort to note requirements from experts through the co-design meetings. The objective from the beginning has been to make a platform tailored to the needs of experts in environmental variables. For this reason, more meetings have been held in which new procedures have been used that allow experts to provide information in an easy and more precise way, and developers to better capture the ideas provided for their subsequent implementation.

Following this new process, and always respecting the [Agile Methodology](#), we generated a Decision [Backlog table](#) that would allow us to list and analyse all the suggestions provided by experts, study their feasibility, prioritise them, and include them in the planning of Cos4Env.

We have to consider that at this point, Cos4Env has adopted much of the functionalities that we implemented in the Cos4Bio service. In addition, we passed the co-design phase in which we were able to receive many suggestions that could imply significant changes in the initial architecture that were proposed in the general purpose platform and in the Cos4Bio architecture, so each of them were addressed as a User Story in a separate sprint.

For example, Cos4Env is not as visual as Cos4Bio, since Cos4Env does not show any images of observations, so the experts suggested we include a new map functionality to show the geographical location of the environmental observations; a functionality that we didn't contemplate in Cos4Bio. Including a map would involve dedicating more time to develop the service, that is a fact, but it would also be an improvement in new iterations of Cos4Bio.

Also we have to take into account that we have had to improve the API that we defined at the beginning of the project as it did not support environmental variables, so we had to include a new extension of darwin core called Measurement or Fact. This exercise allowed us to demonstrate how optimal the API that we developed is, because with very little change we were able to create an extension of the API that is viable for the

Environmental Portals, and that in the future will be useful to create a unique portal that merges Biodiversity and Environmental observations, the perfect combo!

For this reason, once again, it was essential to rely on a continuous development system using Agile methodologies, as we did for the General Purpose Platform and with Cos4Bio which would allow us to carry out the implementation of Cos4Env, which can be accessed from the following link: <https://cos4env.eu>

## 2. Analysis

### 2.1 Introduction

The analysis process carried out for the implementation of Cos4Env, or Portal of Experts for Environmental Data Validation, has been based on the same methodology used during the development of the general purpose Platform and Cos4Bio called Design Thinking:

"Design Thinking: Empathise, define, devise, prototype and test".

This methodology is divided into four phases that we have been developing throughout this block, adapted to the specific needs of the expert portal service for Environmental variables - Cos4Env:

- Empathise: research users' needs
- Define: users and their needs.
- Ideate: challenge assumptions and create ideas.
- Prototype: create solutions.
- Test: test solutions.

But before we can carry out each of the phases, we carry out detailed work in the co-design sessions to collect the suggestions of the experts who were not present in the initial architecture. Based on the list of suggestions, we were able to implement a Backlog decision table and on the whole, carry out the Design Thinking process now applied to the new Cos4Env service.

Below we refer to the meetings held during this second period and the suggested inputs to comment on each of the stages.



## 2.2 Co-design inputs

### Co-design activities implemented for Cos4Env









- Sci&Tech meetings: bimonthly since April 2020.
- Co-Design workshop (October 2021): experts and citizen scientists.
- General meeting (June 2021): interoperability integration.
- Annual meeting (November 2021): key performance index for services and EOSC publication.

Thanks to the feedback received, we made a new list of requirements as a Backlog table (Table 1) in which we specified the following columns:

- Id: Identifier of the suggestion.
- User 's feedback: suggested by an expert.
- Decision: Internal decision of whether or not to carry out the task, followed by the explanation column.
- Explanation: decision field justification.
- Priority: Low / Medium / High / Very High.
- Status: Done / Working on it / Discarded.

	<b>Id</b>	<b>User's feedback</b>	<b>Decision (yes/no)</b>	<b>Explanation (reason why we could do it or not)</b>	<b>Priority</b>	<b>Status</b>
	1	Map service	Yes	That service could be interesting to show the geographical situation of the environmental observations	Very High	Done
	2	Aggregation system	Yes	Be able to show all the environmental variables in the same place in the aggregation way, that help to the expert focus in the information in the	Very High	Done

				best way		
	3	Represent in the API information of environmental variables	Yes	Include a new extension of darwin core, measurement or facts, that help us to include the needed information for the environmental observation represented in the different CO.	Very High	Done
	4	Include a form with the reason for downloading information.	Yes	To understand why experts find the data useful.	Medium	Done
	5	Include searches by place.	Yes	We checked in the co-design session that it can be searched by places. They ask us to also search by place.	High	Done
	6	Registration system.	Yes	The experts want to see the information associated with their contribution, so we have to create a profile for the experts.	Medium	Done
	7	Download history.	Yes	Let us show the experts all the datasets downloads that they did.	Medium	Done
	8	Search history.	Yes	Help the experts if they want to repeat previous searches.	Medium	Done
	9	Include terms of use.	Yes	GDPR	Medium	Done
	10	Include privacy policy.	Yes	GDPR	Medium	Done
	11	Notice if you want to receive notifications.	Yes	GDPR	Medium	Done
	12	Frequently asked questions that explain the use of	Yes	Support documentation.	Medium	Done

		the service.				
	13	Feedback form.		To improve Cos4Env service.	High	Done
	14	Dashboard with service statistics.	Yes	General dashboard, interesting to demonstrate how this service is useful.	Medium	Done
	15	Give the option to the expert to share his profile on Cos4Env.	Yes	Visibility.	Medium	Done
	17 6	Show results in table mode.	No	Presenting the results in this format is a design that has become obsolete in terms of usability. In addition to this, it does not affect the execution of the service so we discard it.	Low	Discard ed
	17	Filters by date range	Yes	To create more advanced filters that allow you to filter your observations by date range.	High	Done
	18	Filters by CO	yes	Important to discriminate the information that the expert wants to show on the map.	High	Done
	19	Filters by environmental observation	yes	We, aligned with the CO, have included odour type, odour intensity, hedonic tone, pm1, pm2.5, pm10, temperature, humidity and pressure.	High	Done
	20	Filters by License	yes	We included the licenses of Cos4Env and a new one to include the license from	High	Done

				OdourCollect.		
●	21	About page	Yes	A page that provides more information about the project.	High	Done
●	22	Download functionality	Yes	The experts want to download the information on the standardized format.	Very High	Done
●	23	Include the i18n of the service at least in English and Spanish	yes	Important to be able to have more engagement in the community.	High	Done

Table 1. Backlog table.

## 2.3 Stages

### 2.3.1 Empathize

The conclusion of deliverable 4.1 General purpose integration platform was that we needed to carry out the implementation of an interoperability layer easier to integrate by the Observatories; easy to integrate, based on standards already known by the community such as Darwin Core Terms, and supported by international organisations such as GBIF or TDWG. This development helps us to create an easy way for COs to integrate allowing more COs to join the Cos4Env Service, and now in this context we also have to take into account the representation with this standard information related to environmental observations. As a result, a new iteration of this interoperability layer will be developed during the implementation of this service.

During this third period of development, as well as including more services and functionalities as advised by the co-designers, we have developed this new interoperability extension based on these widely known standards which have been validated by the International Community. The interoperability extension has been implemented through a Mapping model based on these standards that we explain in section [API DWG](#). Below we can see the diagram of the proposed Model.

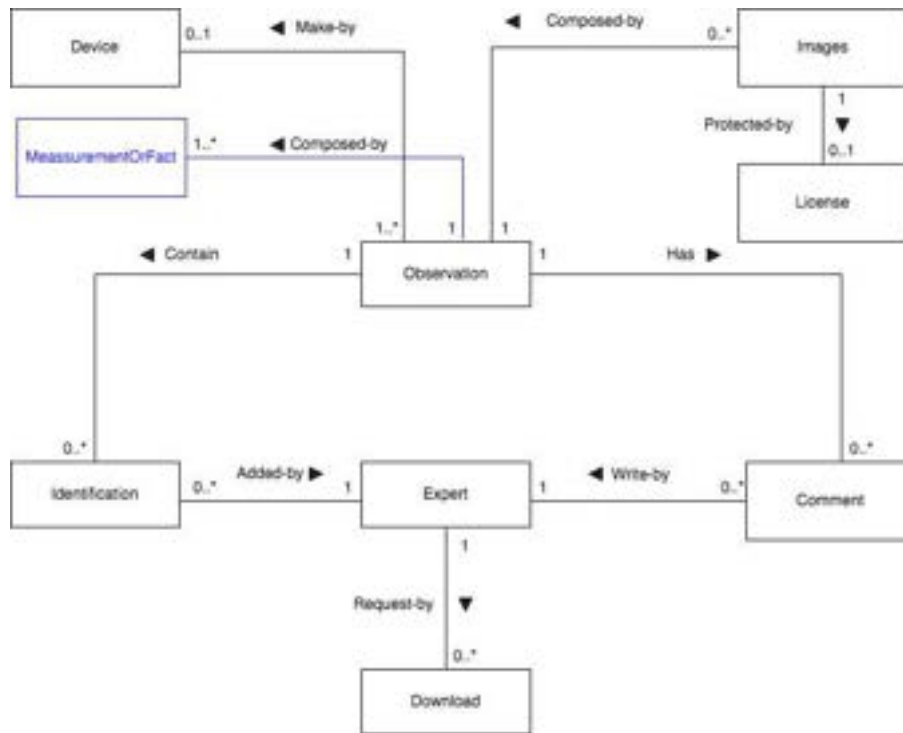


Figure 1. Data model diagram based on Darwin Core standard with new MeasurementOrFact class.

### 2.3.2 Define

Once we finished the analysis stage, we defined with the experts who might be the potential users for Cos4Env. We established that users will mainly be experts capable of commenting on the observation, but they will also consist of citizens involved in citizen science, interested in learning more about environmental variables.

These are the user profiles that will be involved in Cos4Env:

Table of users	
Role	What will they find on the platform?
New user	Authentication using single sign service. Accesible. With support information. Ease to understand how the platform works.
Expert user	Well classified information. Easy access to information. Easy to see news.



New expert	Intuitive actions. Similarity to known platforms. Simple learning process.
Senior expert	Easy export of information in standardized format. Quick access to information. Well classified and filtered information. Geographical representation and well located.
Citizen Observatory	API easy to integrate Include the filters available on their systems Include the variables manage on their systems

*Table 2. Table of users.*

On the other hand, we defined the typical user of our platform, which could be a person with the following profile:

- Approximate age between 25 and 65 years.
- Interested in citizen science, biodiversity, environmental variables and sustainability.
- And with advanced knowledge about the identification and validation of biodiversity observations and environmental measurements.

### 2.3.3 Ideate

In this stage, we begin to shape the user flows and sitemap of the platform represented with several diagrams that help us better understand the objectives, functionalities and flows defined during the different technical meetings before going to the next stage.

- [Flow Diagram](#)
- [Task Flow Diagram](#)
- [UI Flow Diagram](#)
- [Site Map Diagram](#)
- [Wireframes](#)

All of these diagrams also helped us to identify improvements in information flows, detect useless functionalities and make sure that we take all relevant aspects of the service into account.

2.3.3.1 Flow Diagram

The objective of the flowchart is to represent the actions that users will be able to take to complete the different processes covered by the Cos4Env platform.

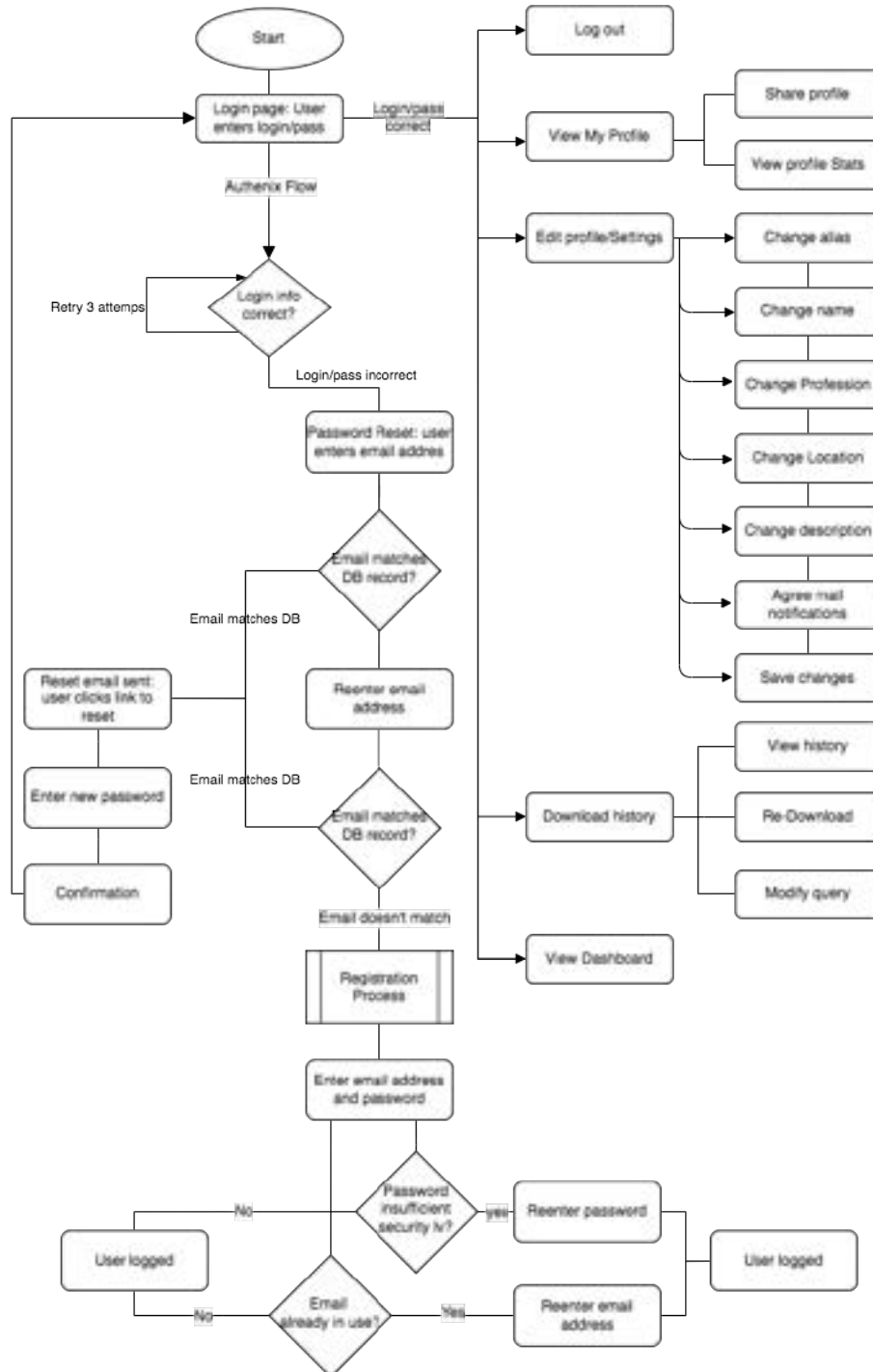


Figure 2. Flow Diagram representing the actions that users will be able to take to complete the different processes covered by the Cos4Env platform.

In this first flowchart - unlike the flowchart of the general purpose platform implemented in D4.1 General purpose integration platform - we see that there is a space reserved for each expert that allows them to provide, if they deem it appropriate, their personal information: aliases, name, profession, location, description. On the Cos4Env Terms of Service page, they can see the use that we will make of this information. Through their profile dashboard they can also see the contributions they have made in the form of statistics, and can even share their profile with the scientific community, valuing their help and knowledge.

In addition, so that you can exhaustively track your queries and downloads, we have included a search cache system and a history of the downloads made by each user, in which you can see the search parameters and filters that have been used. This way experts can re-execute these queries and even modify these parameters to repeat them in, for example, another date range. In this way, Cos4Env can reduce experts' consultation times, improve their research, increase the contribution of identifications and increase the visibility of the work they have carried out.

Once again, we rely on another of the Cos4Cloud services, Authenix (SSO service), integrated into the base of the general purpose platform and used as the foundation of Cos4Env so users can use a federated and secure authentication system.

It is important to mention two aspects:

1. These changes, as we have seen in the Co-Design section, were promoted thanks to the feedback provided by the experts in each workshop.
2. The use of agile methodologies and having an architecture based on the development of the General Purpose Platform and Cos4Bio has helped us to reduce implementation times and demonstrate the value of the work done captured in D4.1 General purpose integration platform and D4.2 Expert Platform for Biodiversity Data Validation

In addition to these new aspects, we have improved the visualization service of the observation used within Cos4Bio to be more suited for Cos4Env by using a map service and including an aggregation system, eliminating all aspects related to species flow and adding the new ones related to environmental observations, as can be seen in the second flow diagram:

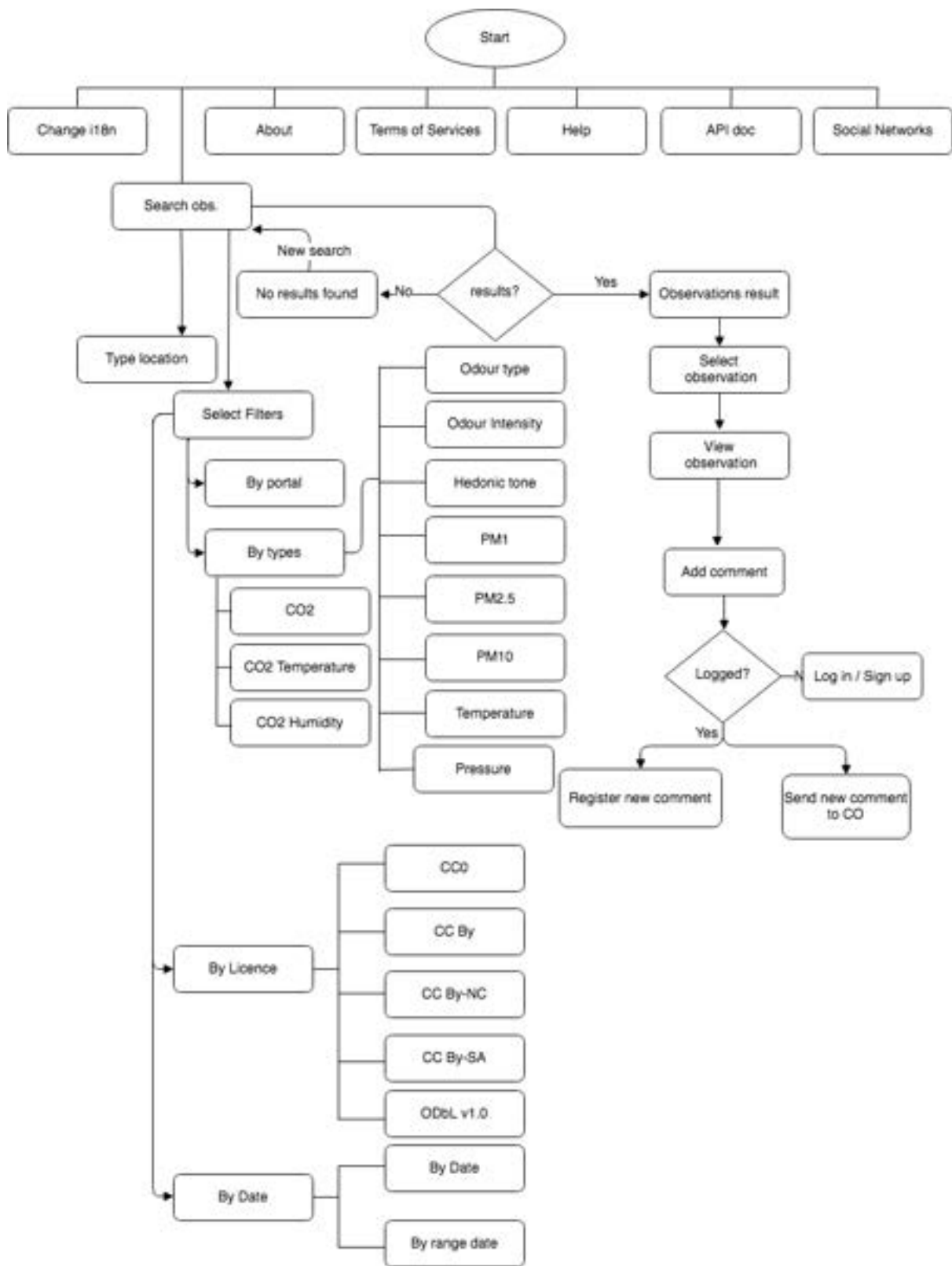


Figure 3. Flow Diagram demonstrating the search processes, the filtering system, and the information provided in Cos4Env.

The search location service can be supported by the improved filtering system with respect to the base implementation of the general purpose platform, focusing on useful filters to look for environmental information such as:

- Filters by portal.
- Filters by type
- Filters by licence.
- And filters by date or date range.

Again some of these features came to light thanks to input from experts. These contributions also allowed us to delve into the value of filter types:

We have also incorporated the internationalization system that allows the language of the platform to be translated into six languages: English, Spanish, Catalan, French, German and Swedish.

### 2.3.3.2 Task Flow Diagram

The task flows are focused on how users travel through the platform while performing a specific task. They generally show only one path and don't include multiple branches or pathways like a traditional user flow might. These are best used when the task being analyzed is accomplished similarly by all users. When using task flows, it is assumed that all users will share a common starting point and have no variability in the way the task is carried out.

Each of the Task Flows is presented below, taking into account the changes made and the new functionalities implemented for the Cos4Env service.

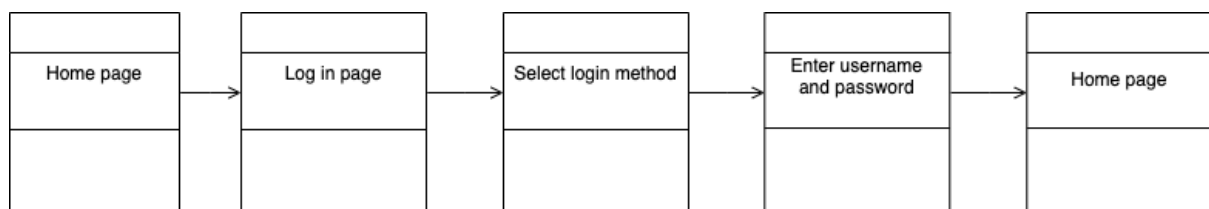


Figure 4. Login. Task Flow.

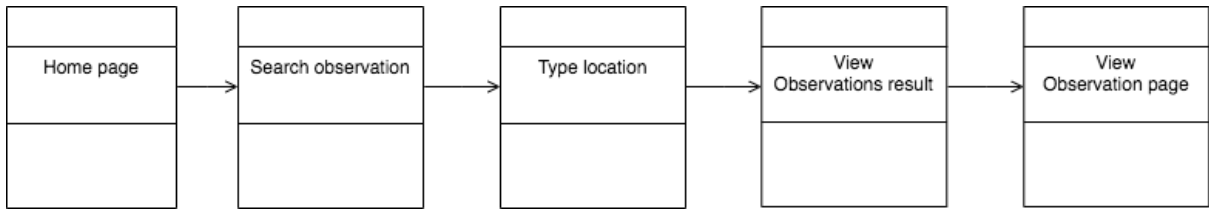


Figure 5. Search by location. Task Flow.

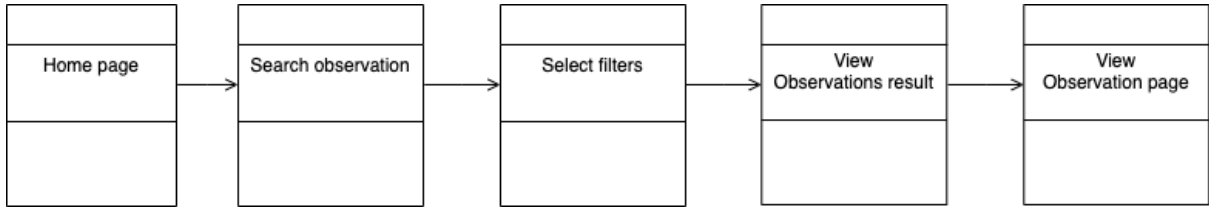


Figure 6. Search using filters. Task Flow.

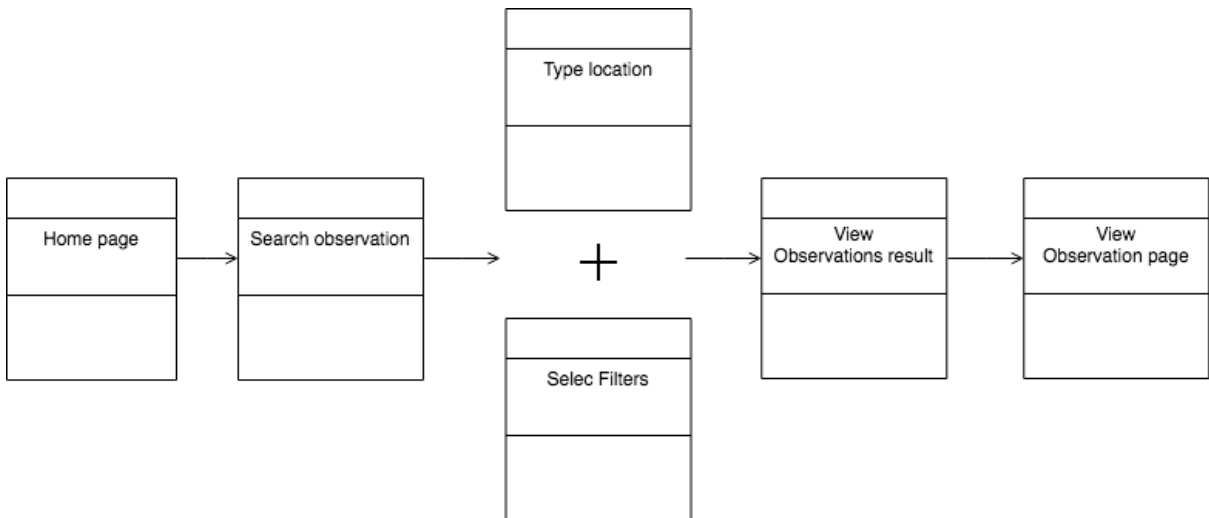


Figure 7. Search by location and filters. Task Flow.

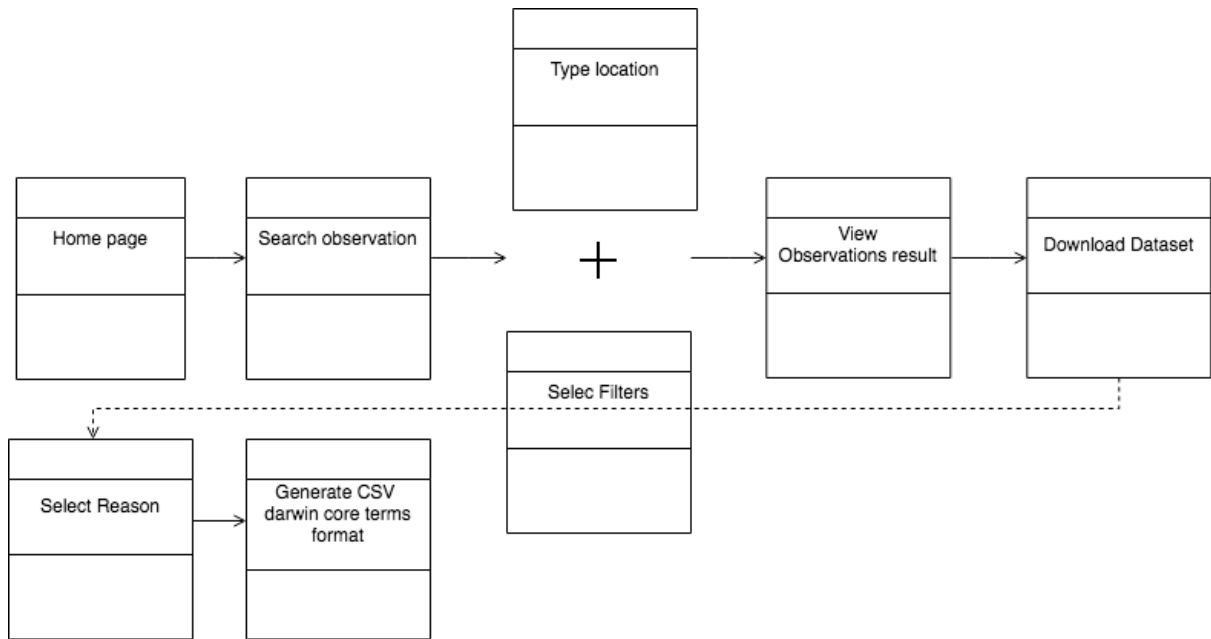


Figure 8. Download dataset searching by location and applying filters. Task Flow.

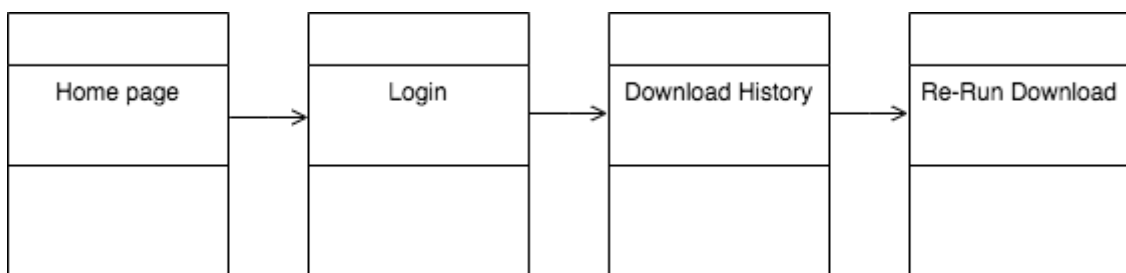


Figure 9. Download dataset searching by location and applying filters. Task Flow.

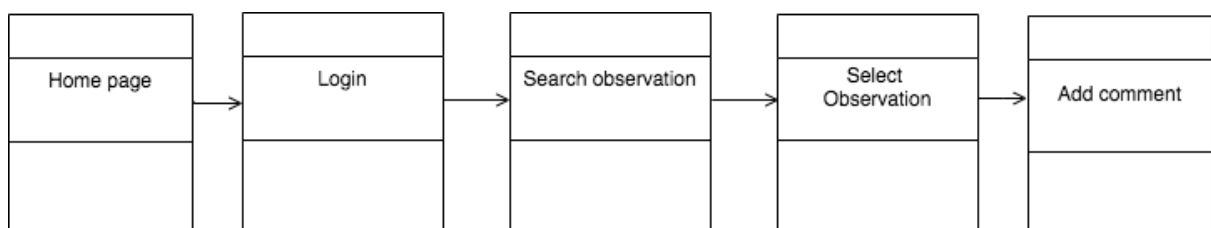


Figure 10. Add a comment. Task Flow.

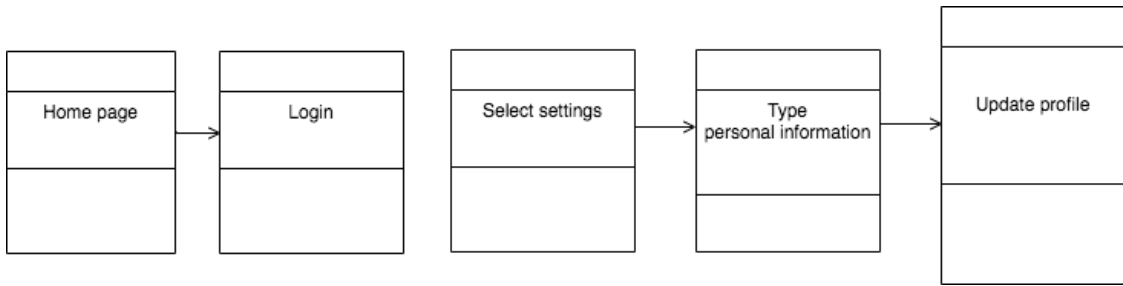


Figure 11. Update profile. Task Flow.

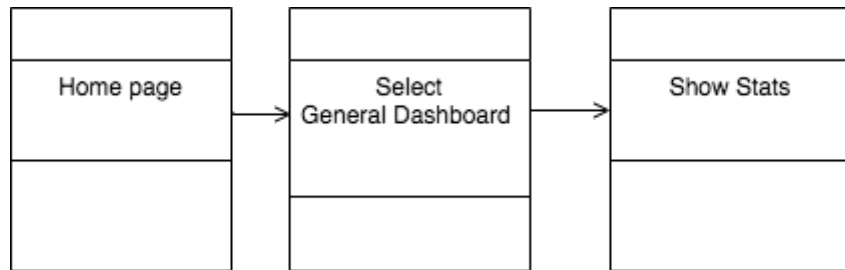


Figure 12. Show general dashboard. Task Flow.

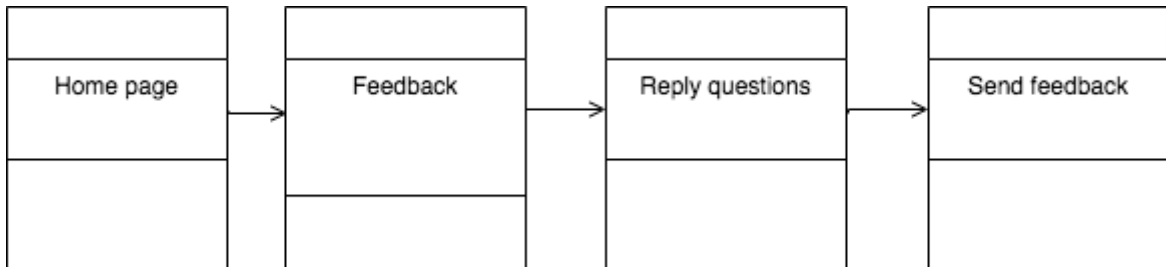


Figure 13. Send feedback. Task Flow.



### 2.3.3.3 UI Flow Diagram

User interface flow diagrams are typically used for two purposes. First, they are used to model the interactions that users have with the software, as defined in a single-use case. For example, it can refer to several screens and provide an insight into how they are used. Based on this information, we are going to develop a user interface-flow diagram that reflects the behavioral view of the single-use case. Second, they enable us to gain a high-level overview of the user interface for the Expert Portal.

This overview is effectively the combination of all the behavioral views derived from our use cases, the result is called the architectural view of the interface.

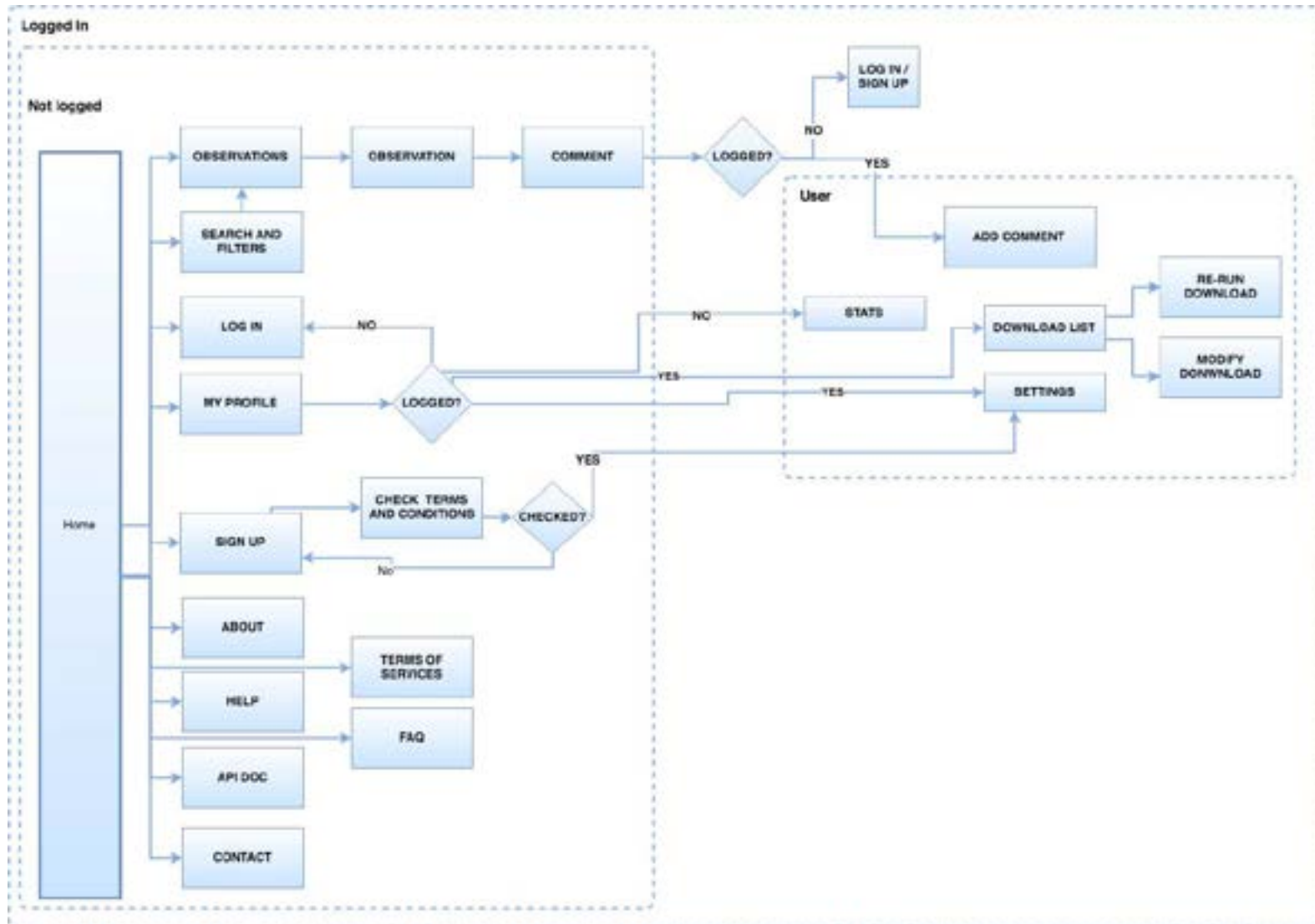


Figure 14. UI Flow diagram.

### 2.3.3.4 Site Map Diagram

A sitemap is a list or diagram that helps to plan out a website. It should contain all the pages of a website in a way that shows how the user will access them, starting with the homepage and branching out to include all the subpages.

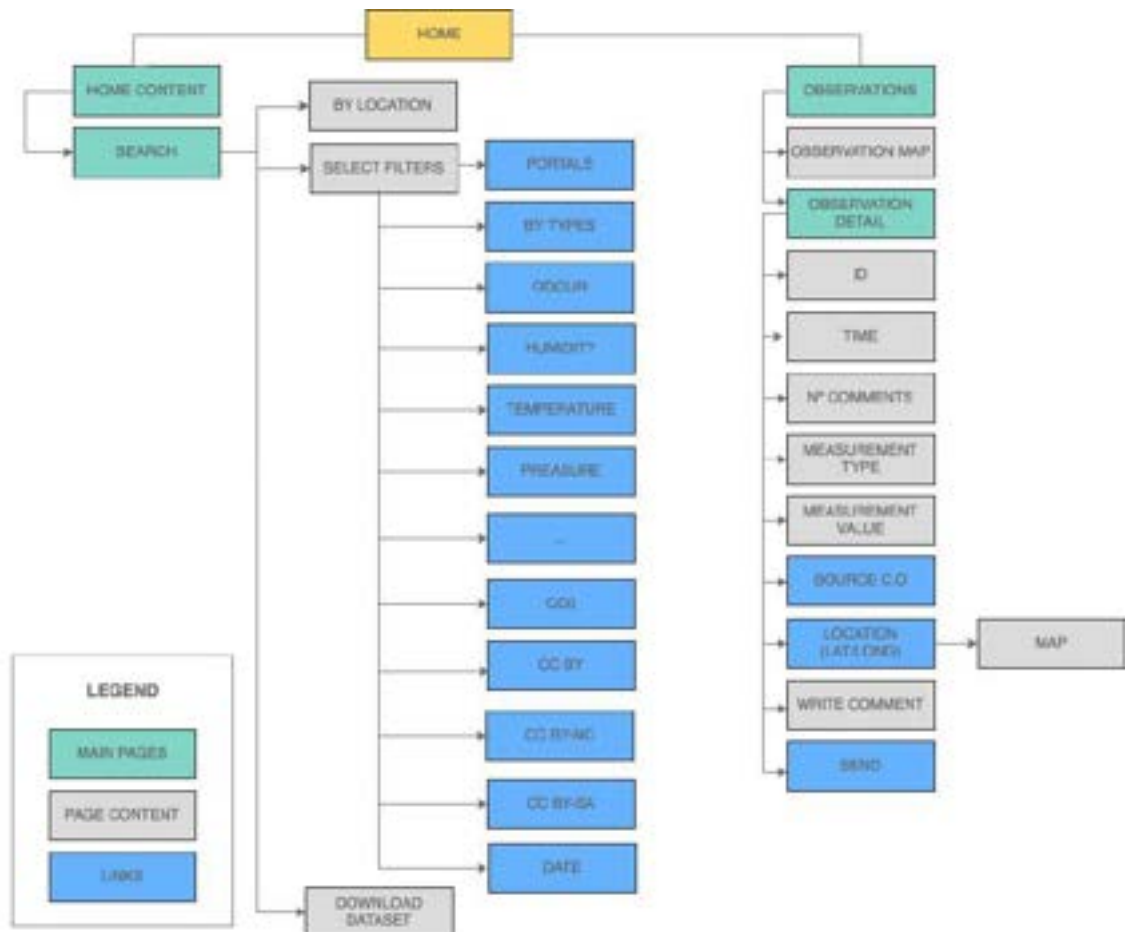


Figure 15. Site Map diagram.

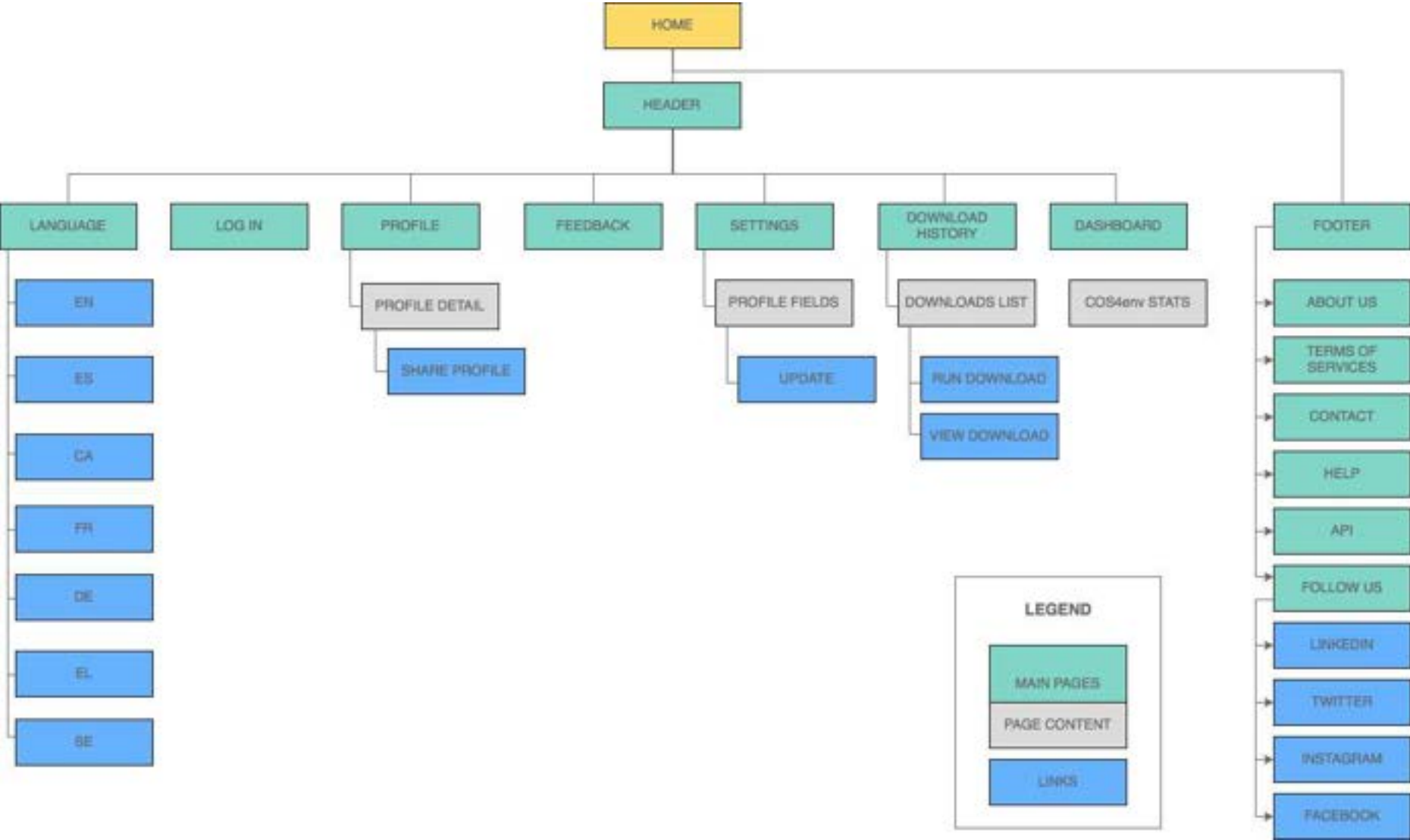


Figure 16. Site Map 2.

### 2.3.3.5 Mockups

Mockups are a visual guide that represent the design of a website. They include the navigation structure and design elements in detail and help to visualise ideas and concepts. Following, we can see the different mockups that compose Cos4Env. (<https://cos4env.eu>)

**Figure 17:** In this mockup, we can see the Cos4Env header section with: the logo, the language selector, the user profile icon, and the menu options. Then the cover text, followed by the search bar and the filter options. At the bottom of this section, we can see the records of geolocated environmental variables on the map.



Figure 17. Mockup. Home view with header, search/filters section and map.

**Figure 18:** In figure 18, we see the footer with the following sections: About, Terms of Service, Contact, Help, API and the links to social networks. In addition to a text highlighting that the project is part of an H2020 and EOSC logo.



Figure 18. Footer of the home page of Cos4Env.

**Figure 19:** In the upper right, we can see three icons, the language selector appears first, followed by the login button and the menu.

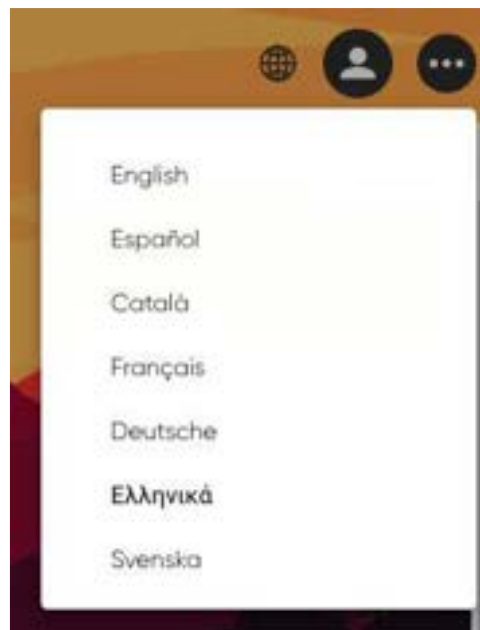


Figure 19. Choose language options.

**Figure 20:** By clicking the “login” button you can log in or visit the Authenix website if you need more information about the Authenix service.

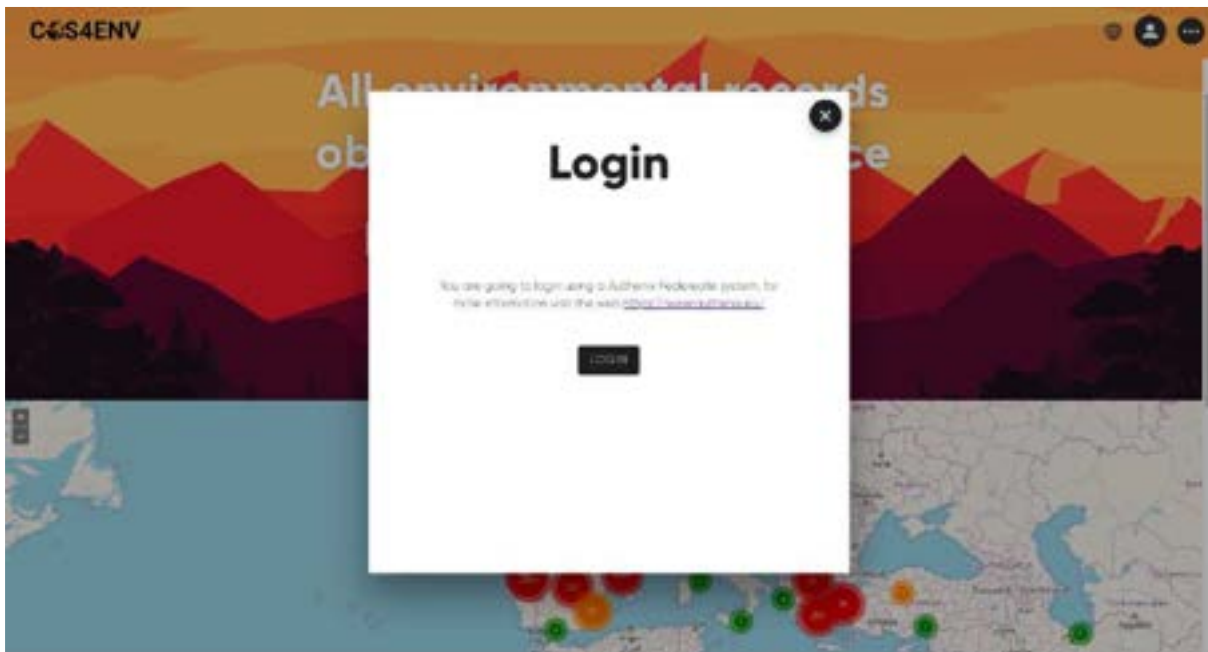


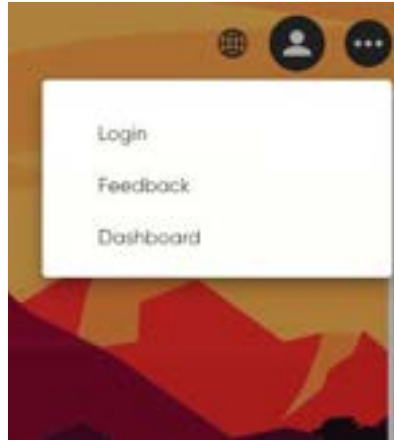
Figure 20. Login in Cos4Env.

**Figure 21:** If you select login you can find your login provider in Authenix.



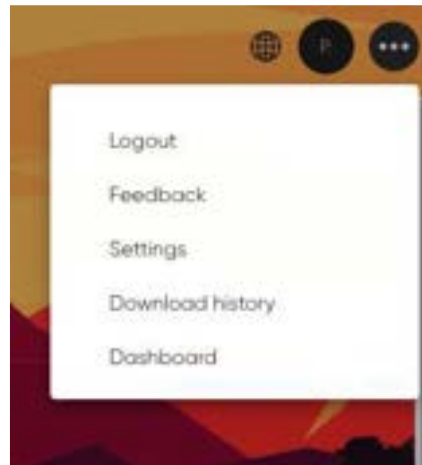
Figure 21. Log in Authenix site.

**Figure 22:** These are the menu options that we can see before logging in: “Login” by Authenix, “Feedback” of Cos4Env, and “Dashboard” with general indicators of Cos4Env.



*Figure 22. Menu options before login in Cos4Env.*

**Figure 23:** Once we have logged in, the options that we can find in the menu are: “Logout”, “Feedback”, “Settings”, “Download history”, and “Dashboard”.



*Figure 23. Menu options when you are already logged in.*



**Figure 24:** Download history made by a user, with the possibility of repeating the same searches or reusing them by modifying any of the filters.



*Figure 24. Download history.*

**Figure 25:** In the next figure we can see the global dashboard of Cos4Env that includes several charts showing the usage of the service which helps us to demonstrate how useful this service will be: (<https://Cos4Env.eu/dashboard>)

In the first chart we can see the number of comments made in Cos4Env (this information also can be seen in more detail in the graph below). The total number of data downloads and the number of users who are part of Cos4Env are also shown.



Figure 25. Cos4Env global dashboard with the information of count of comments, number of downloads, Users, and Time series of Comments.

**Figure 26:** Next, In the Cos4Env global dashboard, we can see two charts with “Comments by Portal” and “Download history by date”.

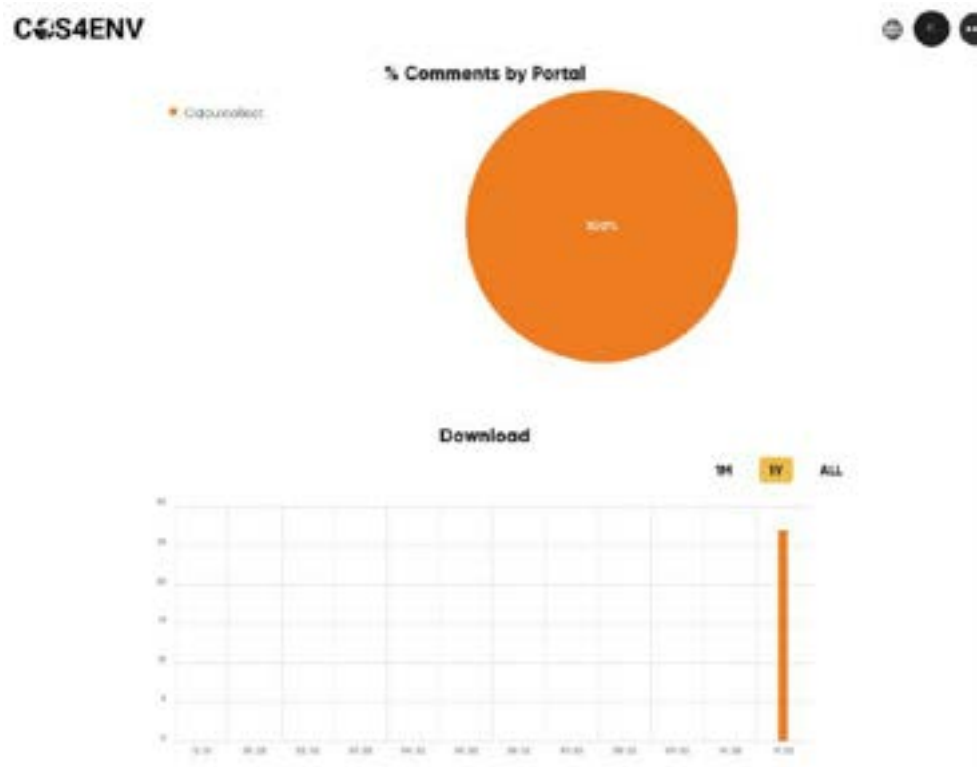


Figure 26. Comments by Portal and Download history by date.

**Figure 27:** Also we can see a chart with the download reason.

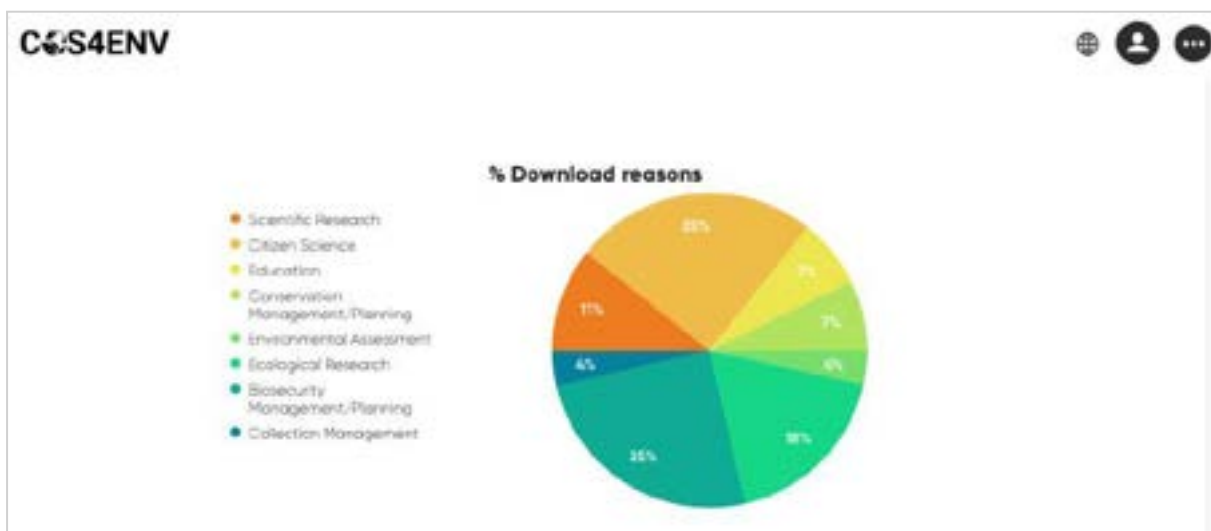


Figure 27. Download reason.

**Figure 28:** Finally we can see a graph with the number of Cos4Env users and another with the professional profile of the users that are part of Cos4Env. This information will help us to know our audience better and create new marketing campaigns in the future, more focused on the people who are most interested in the Cos4Env service.



Figure 28. Professional profile of the users that are part of Cos4Env.

**Figure 29:** If the experts want to see their profile page, they just click on the user profile icon, which we show in the following image. On this page each user can read the public information of each expert such as: the profile image and user's description, followed by global counts such as total number of comments and total number of downloads done by the expert.

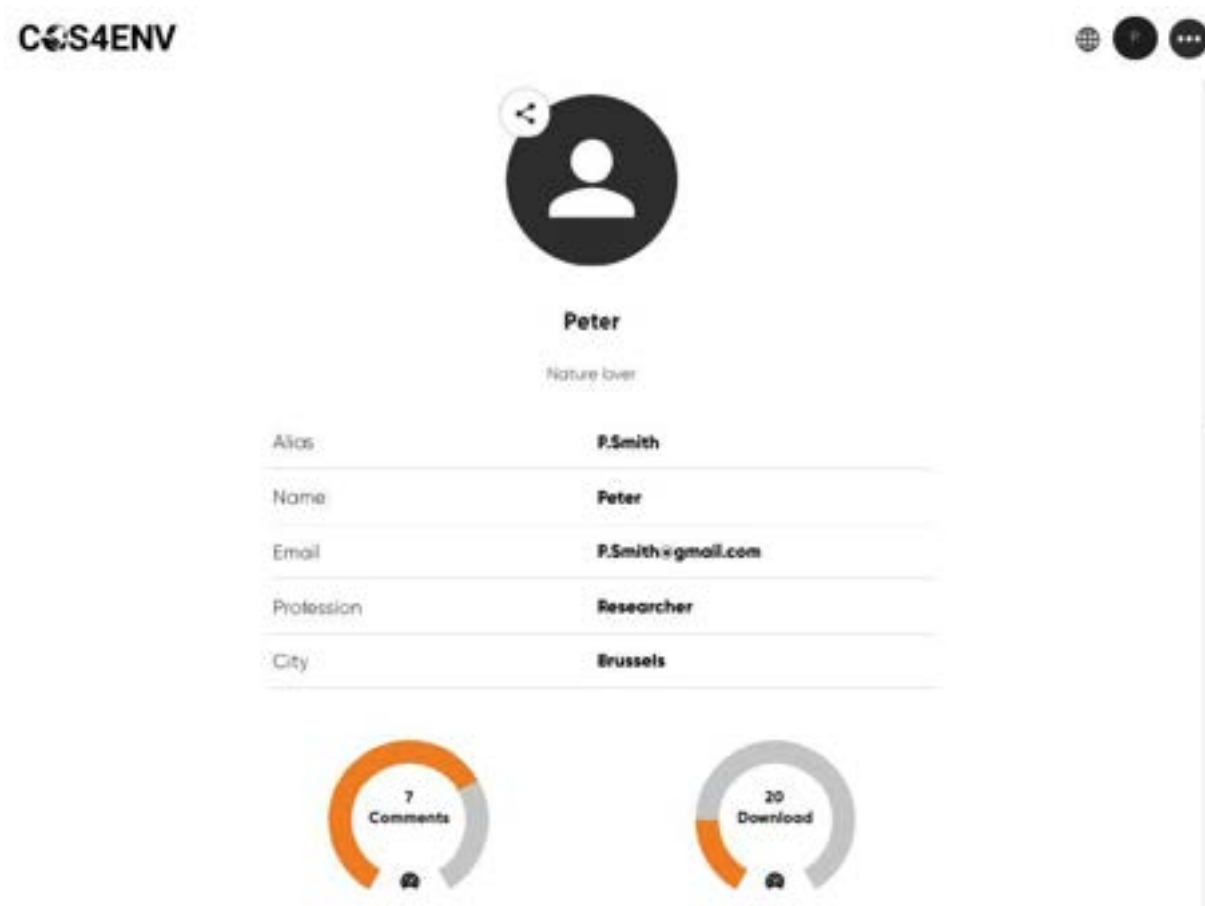


Figure 29. User profile information and contribution charts.

**Figure 30:** Below on the profile page, each user can also see more charts related to their number of contributions by month, year or all time, and the percentage of contributions per Citizen Observatory. This information will let us know which users make the most contributions and which platform receives the most contributions and when. This allows us to be able to visualise any kind of correlation with events such as holidays or weekends and better understand the behaviors of our experts.

COS4ENV



### Comments

1M **1Y** ALL



### % Comments by Portal

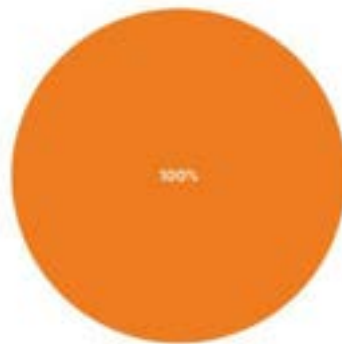


Figure 30. User comments contributions time series and Comments by Citizen Observatory.

**Figure 31:** Besides previous charts, each user can also see the information graphs related to the downloads: number of downloads by month, year or all downloads, and the percentage of download reasons. All of this information helps us to understand when the datasets are more requested and why.



Figure 31. User data download information.

**Figure 32:** On the main page of Cos4Env, we can see two of the main services, that are search and filter services. The experts can filter the information by different criterias, as we can see in the image below.

- By Portal: with the observatories that have been integrated into Cos4Env.
- By Type: odour type, odour intensity, temperature, CO2...
- By Type of licence: CC0, CC-BY...
- By Date or range of Dates.

All of these filters can be used independently or combined with each other.

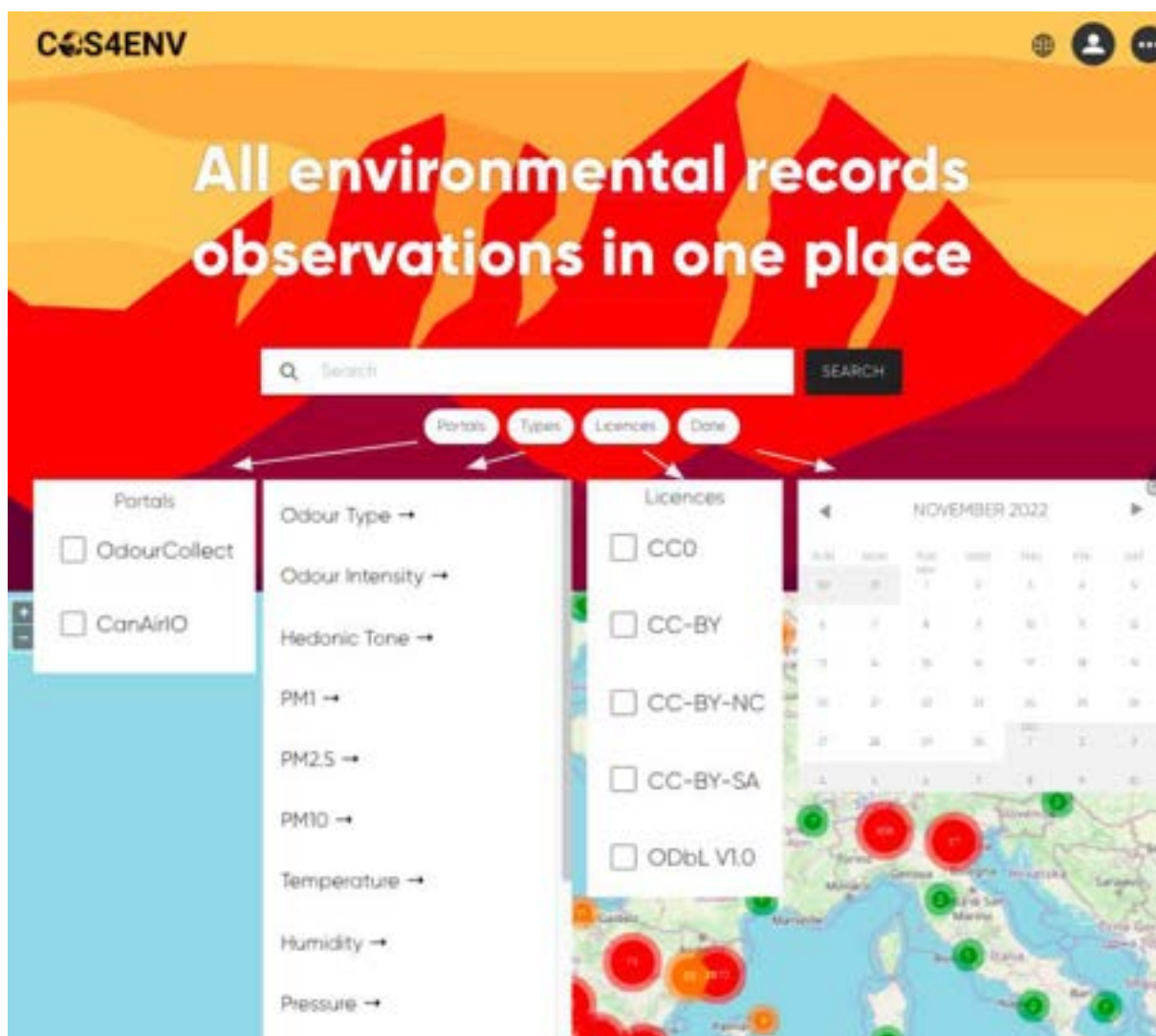


Figure 32. Cos4Env Filters by portal, types, licences and date.



**Figure 33:** The first thing that we find on the main page is the search service. The experts can use this service to find observations in some specific location or area. Besides this we have implemented a history of searches that the user has carried out recently, in case that they want to repeat the search using the same terms, as we can see in the next image:

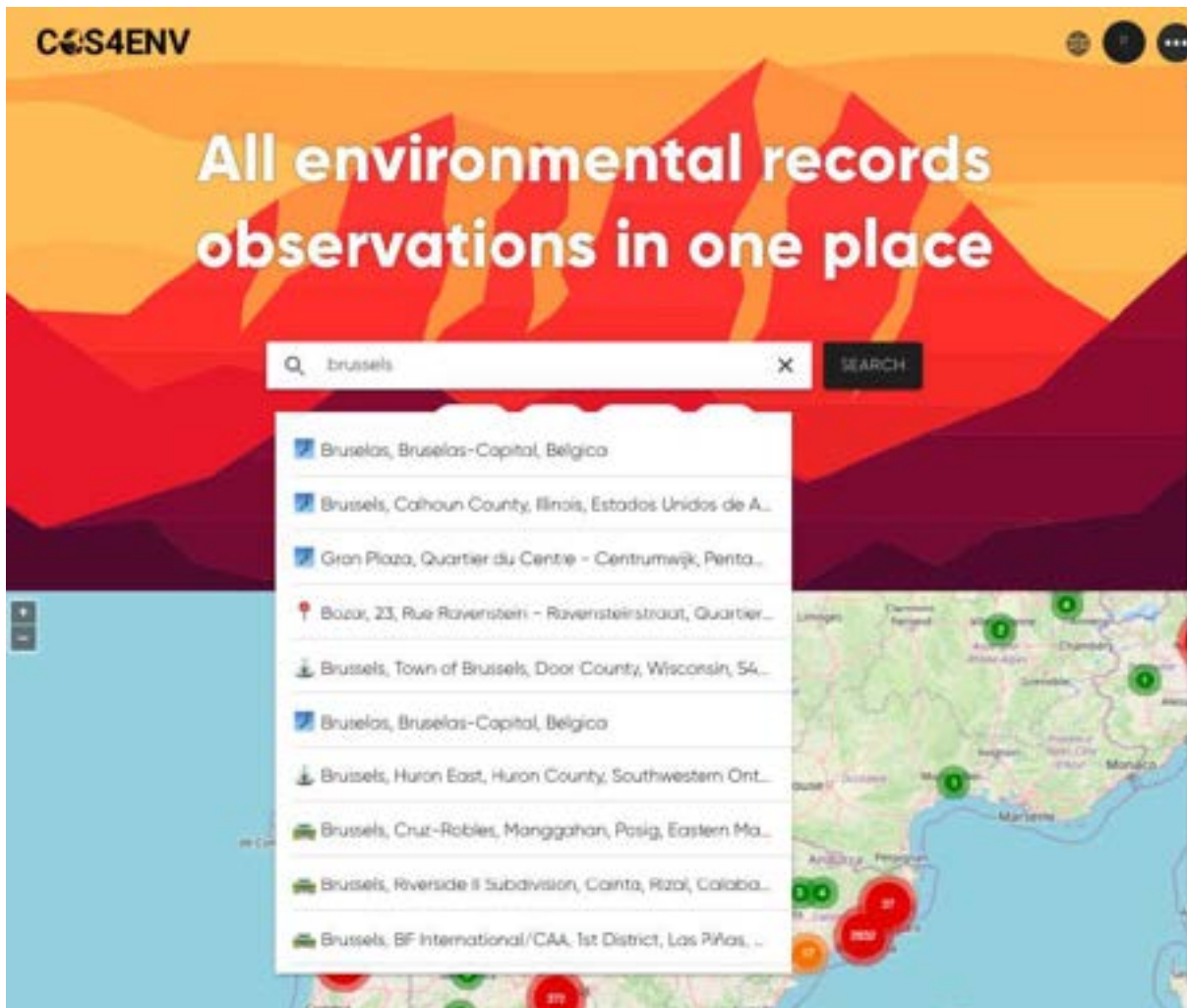


Figure 33. Search service by location, and history of recent searches.

**Figure 34:** Once we have carried out a search or have filtered the information, we have the option of downloading the data that meet the criteria that we have applied in [CSV](#) (Comma-separated values) format.

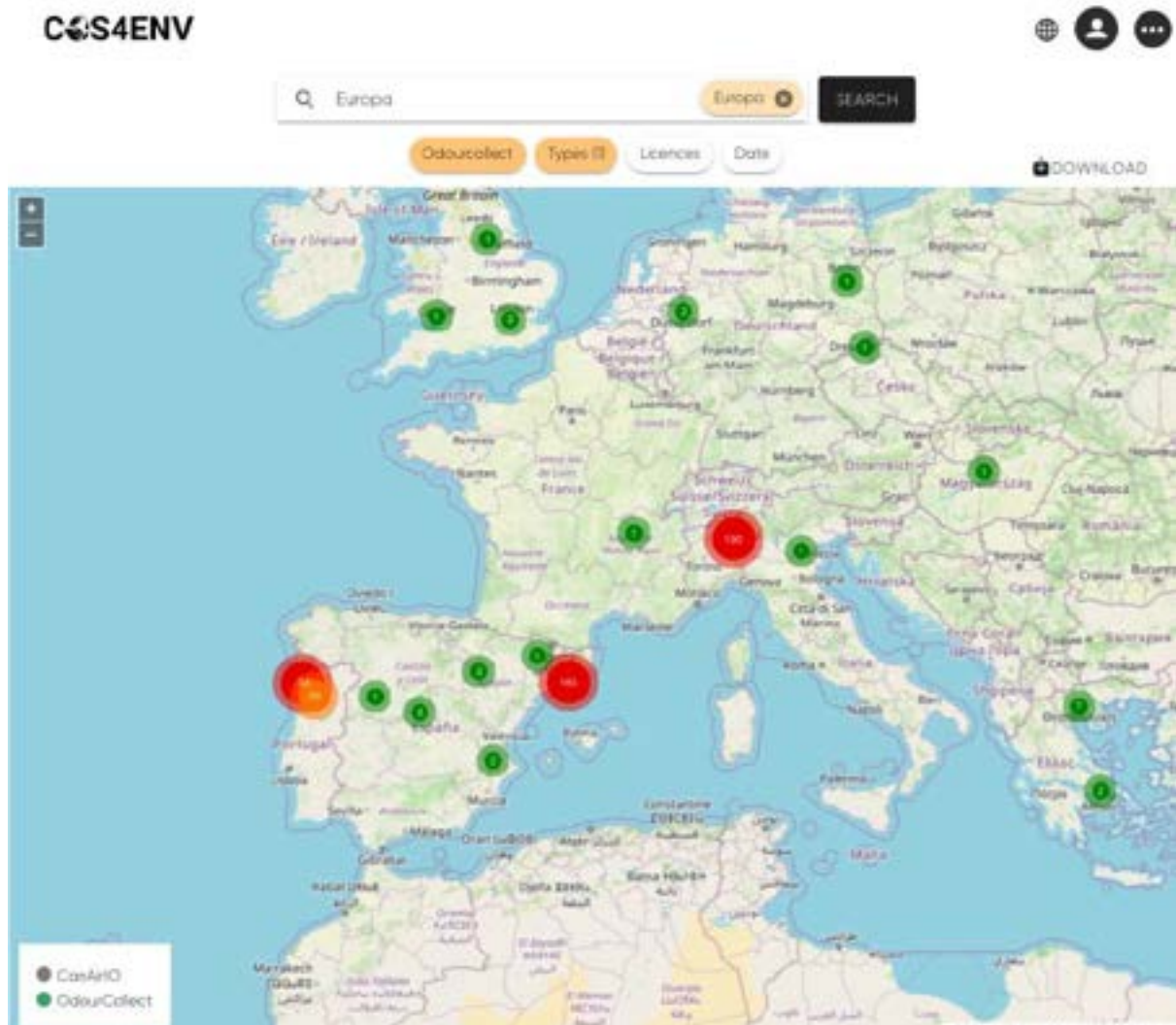


Figure 34. Download information to a csv file.

**Figure 35:** In this mockup, we can see the detail of an Observation where the following information appears: id, time, source CO, comments, measurement type, latitude and longitude where the record was made and measurement value. We also can add new comments if we click on the comments button.

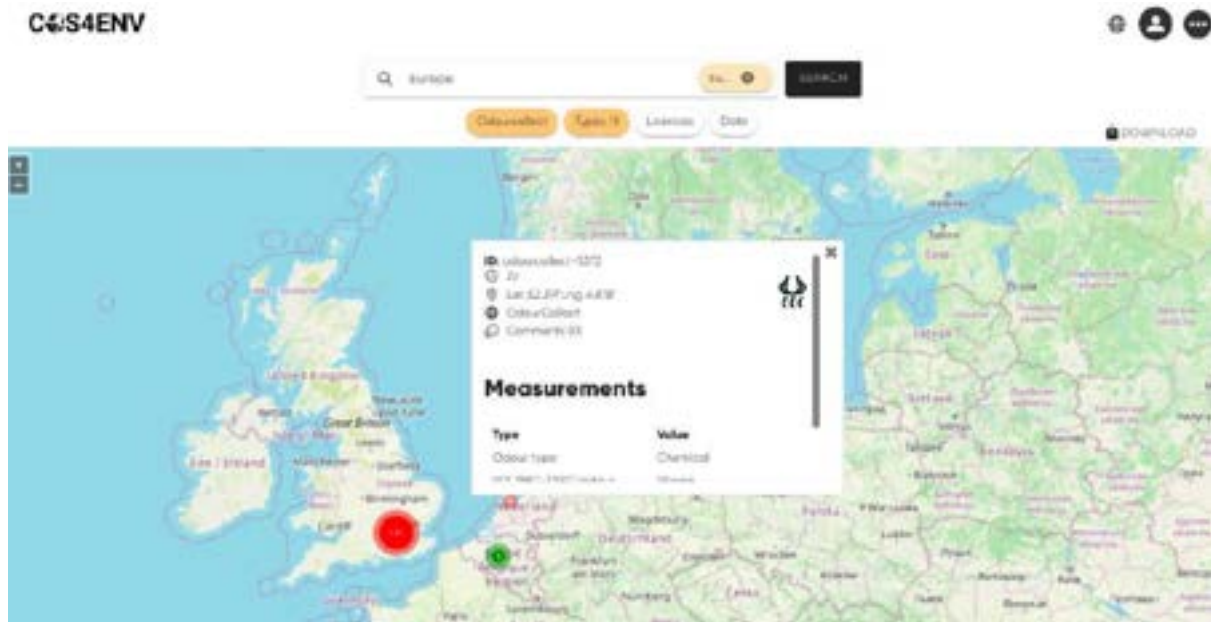
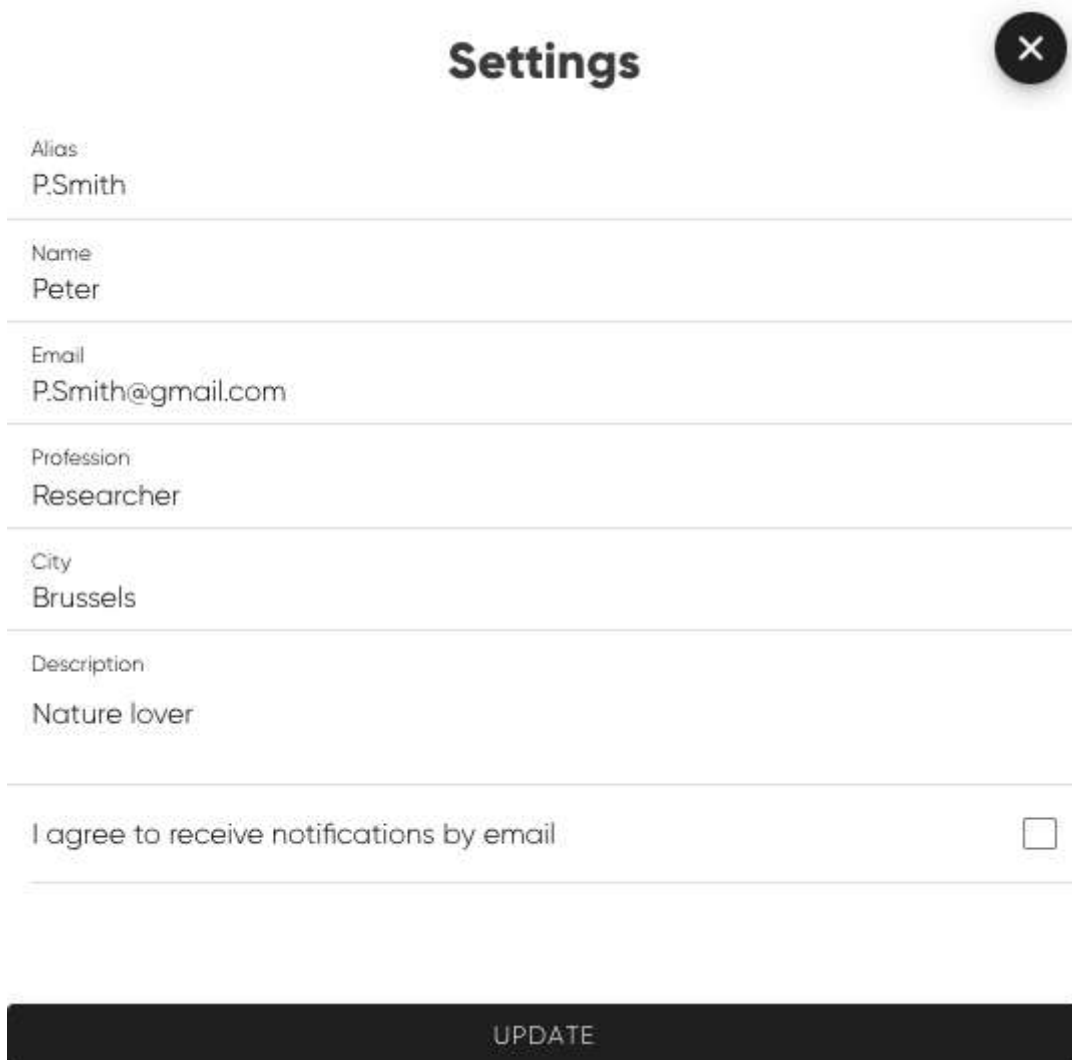



Figure 35. Observation detail.

**Figure 36:** The user has the possibility to update the information of his profile from the "settings" option that he will find in the menu.



**Settings** 

Alias  
P.Smith

---

Name  
Peter

---

Email  
P.Smith@gmail.com

---

Profession  
Researcher

---

City  
Brussels

---

Description  
Nature lover

---

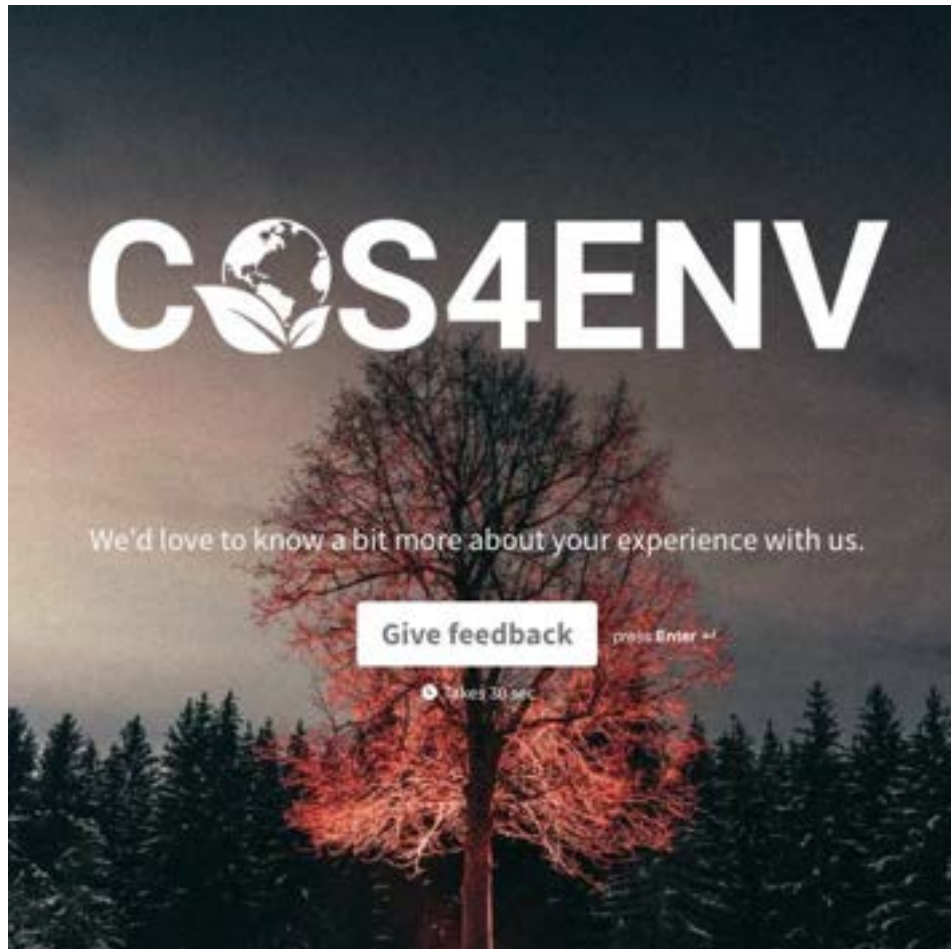
I agree to receive notifications by email

---

**UPDATE**

*Figure 36. Settings.*

**Figure 37:** Cos4Env users can give their feedback on the service by selecting the feedback option in the menu.



*Figure 37. Feedback.*

### 2.3.4 Prototype

As a result of the diagrams presented and the agreements reached during the different co-design meetings, we were able to make an initial prototype, which could be tested by both internal experts and the experts of the Co-design group. Once reviewed, we were able to go to the next phase, the implementation phase, which we describe in section [3. Development](#). The prototype implemented during this phase is available at the following public link <https://Cos4Env.eu>

## 2.3.5 Test

In this section we detail which requirements were tested in the scope of Cos4Cloud, how testing has been implemented and how it was applied throughout the project.

### 2.3.5.1 Test implementation

The next steps hopefully will help to give answers on what requirements are actually put under test in the scope of Cos4Env, how testing has been implemented and how it was applied throughout the project.

1. What are the **relevant user stories** developed for Cos4Env?
2. What **criteria have to be fulfilled** in order to consider the user story as done?
  - a. What testable criteria can "prove" that the business requirement described by the story is implemented?
  - b. Each user story shall have a list of acceptance criteria which have to be tested and re-tested respectively.
3. Give a hint on the **maturity context**: Under what TRL the user story is considered important?
  - a. What readiness-level the output will have in terms of [EU TRL](#) (See [Annexe: TRL Calculation Cos4Env](#))
  - b. Story may span multiple levels but ideally a story is tailored to match a particular one.
4. Under what **level of detail** tests have been performed (see the test pyramid)?
  - a. Gives an idea of the granularity under which testing took place.



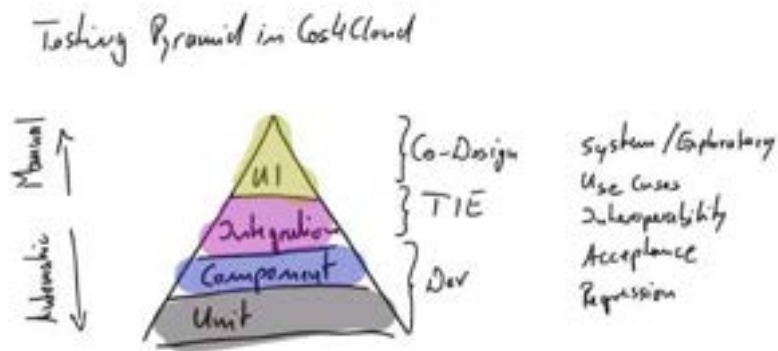


Figure 38. Testing Pyramid.

5. What aspects have been tested (**functional and non-functional**)?
  - a. *non-functional* it covers all quality aspects and boundary conditions
6. How testing has been **implemented and is applied** (tools, workshops, continuous integration testing, manually following a checklist, ...)
  - a. When: automated tests, manual tests, during each build/deployment, before each release, ...
  - b. How: see the list in functional and non-functional for some tooling
  - c. Context: use Co-Design sessions, datathons, hackathons, ... to test certain aspects
7. Is there relation to other Cos4Cloud services? What are testable use cases when **integrating with other services**? For example
  - a. A cross-point in the [Technical Integration Experiment \(TIE\)](#) table that we describe below in Table 3: Technical Integration Experiment.

User Story	Relevance to Cos4Cloud	Relevant TRL (s)	Acceptance Criteria	Testing Granularity (see the test pyramid)	Access to be Tested	How to Verified/Tested?	Integration Test (e.g. TIE)
<p>Experts search, filter, download and comment observations from other CO using Cos4Env.</p>	<ul style="list-style-type: none"> <li>- UX/UI implementation.</li> <li>- Service implementation.</li> <li>- Interoperability.</li> </ul>	<p>TRL-1 TRL-2 TRL-3 TRL-4 TRL-5</p>	<ul style="list-style-type: none"> <li>- Accessible and Easy interface.</li> <li>- Be able to search by specific location or area.</li> <li>- Include more filters.</li> <li>- Be able to share their profile.</li> <li>- Include a section for the experts.</li> </ul>	<ul style="list-style-type: none"> <li>- API test.</li> <li>- Component.</li> <li>- Service.</li> </ul>	<p>Functional:</p> <ul style="list-style-type: none"> <li>- Login.</li> <li>- Logout.</li> <li>- Search service location.</li> <li>- Filter service.</li> <li>- Map service.</li> <li>- Download service</li> </ul> <p>Non-Functional</p> <p>Queries take no longer than 5 seconds.</p>	<ul style="list-style-type: none"> <li>- Unit test.</li> <li>- API Test.</li> <li>- Co-Design sessions.</li> <li>- OdourCollect integration.</li> <li>- Canario integration.</li> </ul>	<p>References implementation: <a href="https://github.com/Bineo-Consulting/Cos4Env">https://github.com/Bineo-Consulting/Cos4Env</a></p>
<p>Canario integration.</p>	<ul style="list-style-type: none"> <li>- Interoperability.</li> <li>- Platform collaboration.</li> <li>- FAIR compliance.</li> </ul>	<p>TLR-6 TRL-7</p>	<ul style="list-style-type: none"> <li>- Include the MVE fields needed to be able to publish environmental observations following Darwin core terms.</li> <li>- Don't affect a lot the model already exists in Natusfera.</li> </ul>	<ul style="list-style-type: none"> <li>- Service.</li> <li>- API test.</li> <li>- Integration test</li> <li>- Include the minimum fields needed to be able to publish environmental observations following Darwin core terms.</li> </ul>	<p>Functional:</p> <ul style="list-style-type: none"> <li>- Mapping with terms of DWC and extension of measurementOrFact:</li> <li>- Search by location.</li> <li>- Filters by types of measurement.</li> <li>- Filters by licences.</li> <li>- Filters by date</li> <li>- Continuous data loading.</li> <li>- Client consuming data.</li> </ul> <p>Non-Functional:</p> <ul style="list-style-type: none"> <li>- Fast response times.</li> </ul>	<ul style="list-style-type: none"> <li>- Unit test.</li> <li>- Co-Design session.</li> <li>- Cos4Cloud project in Natusfera.</li> <li>- API Test.</li> </ul>	<p>Canario DWC API: <a href="http://api.canair.io:8080/DWC/stations/">http://api.canair.io:8080/DWC/stations/</a></p>



<p>OdourCollect integration.</p>	<ul style="list-style-type: none"> <li>- Interoperability.</li> <li>- Platform collaboration.</li> <li>- FAIR compliance.</li> </ul>	<p>TRL-6 TRL-7</p>	<ul style="list-style-type: none"> <li>- Include the MVE fields needed to be able to publish environmental observations following Darwin core terms and extension of MeasurementOrFact.</li> <li>- Don't affect the model that already exists in OdourCollect.</li> </ul>	<ul style="list-style-type: none"> <li>- Service.</li> <li>- Integration test.</li> <li>- API test.</li> <li>- Include the minimum fields needed to be able to publish environmental observations following Darwin core terms standard.</li> </ul>	<p>Functional:</p> <ul style="list-style-type: none"> <li>- Mapping with terms of DWC and extension of measurementOrFact:</li> <li>- Search by location.</li> <li>- Filters by types of measurement.</li> <li>- Filters by licences.</li> <li>- Filters by date.</li> <li>- Continuous data loading.</li> <li>- Client consuming data.</li> </ul> <p>Non-Functional:</p> <ul style="list-style-type: none"> <li>- Fast response times.</li> </ul>	<ul style="list-style-type: none"> <li>- Unit test.</li> <li>- Co-Design session.</li> <li>- API Test.</li> </ul>	<p>OdourCollect DWC API: <a href="http://18.192.45.133:3000/api/v1.0/observations/">http://18.192.45.133:3000/api/v1.0/observations/</a></p>
<p>EOSC publication.</p>	<ul style="list-style-type: none"> <li>- EOSC compliant.</li> <li>- Production environment.</li> </ul>	<p>TRL-9</p>	<ul style="list-style-type: none"> <li>- The service is accessible to users outside its original community.</li> <li>- At least one service instance is running in a production environment.</li> <li>- Public Research data which is Findable, Accessible, Interoperable and Reusable. Release notes and sufficient documentation are available.</li> </ul>	<p><a href="https://Cos4Env.eu">https://Cos4Env.eu</a></p> <p><a href="#">About, Definition of Terms of Service, Deliverables, infographics, FAQ, Contact service, Feedback service, production environment, API based on Darwin core to apply FAIR rules, API documentation</a></p>			

Table 3: Technical Integration Experiment

## 3. Engineering software design

### 3.1. Introduction

In this section we present the Cos4Env Software Engineering analysis that will allow us to understand each and every one of the use cases present in the system, the interaction diagrams and the resulting domain model.

### 3.2. Vision

The main mission of Cos4Env is to create an ecosystem that experts in Environmental variables related to Citizen Science can use to carry out searches and downloads quickly and in a standardised way, generating data sets from different sources of information, such as citizen observatories. Beyond this, we wanted Cos4Env to be more than a multi-data repository, and for experts to be able to contribute their knowledge and help the community by adding new knowledge in the form of comments. We also wanted users to be able to share their profile with the statistics generated, thus demonstrating their contribution to the community.

#### **What are the differentiating elements and advantages?**

The principal advantages that we find in Cos4Env are:

- A new way to increase the number of comments/feedback for the CO.
- Reduce the time in which observations are validated.
- Increase the quality of contributions.
- Increase the number of experts participating.
- Be able to manage standardised information.
- Reduce the time that the experts have to spend to find information.
- Now with Cos4Env, the experts can measure their impact at a global level about the contributions made by themselves in the different COs.
- The experts also can download all the Citizen Science information from a single site in a standardised format DWC.
- Intuitive and simple interface.

**Are there products or services that offer something similar?**

In the context of Environmental variables, we don't know of any public platform with this capacity.

**Is there an equivalent product or service?**

We don't think so.

**Is there a workaround that people are using that is good enough but not perfect?**

Up until now we do not know a service that performs the work we are carrying out, so we can say that Cos4Env is an innovative system at a Global level.

**What are the strengths and weaknesses of the competition?**

In our opinion, Cos4Env can become a benchmark because we don't know of any service like it. In collaboration with the CoNNect group of Cos4Cloud, our main goal is to be able to develop a powerful marketing strategy that will enable us to reach more portals with environmental information, so that we can create a portal similar to GBIF, but focused on environmental knowledge.

All these positive aspects will allow us in the future to define together with the CoNNect Group (consisting of WPs 5, 6, 7 and 8) a sustainability and leadership strategy for the Cos4Env.

In terms of the main disadvantages, the innovative nature of the service means we are currently in a phase that hasn't been worked on, so you should expect that this prototype will undergo many changes and improvements over time.

### 3.3. Use Case Diagram

Use cases are functional requirements that indicate what the system will do. They are the main mechanism for the discovery of these requirements and their definition, in a way that they define the way in which the system will behave.

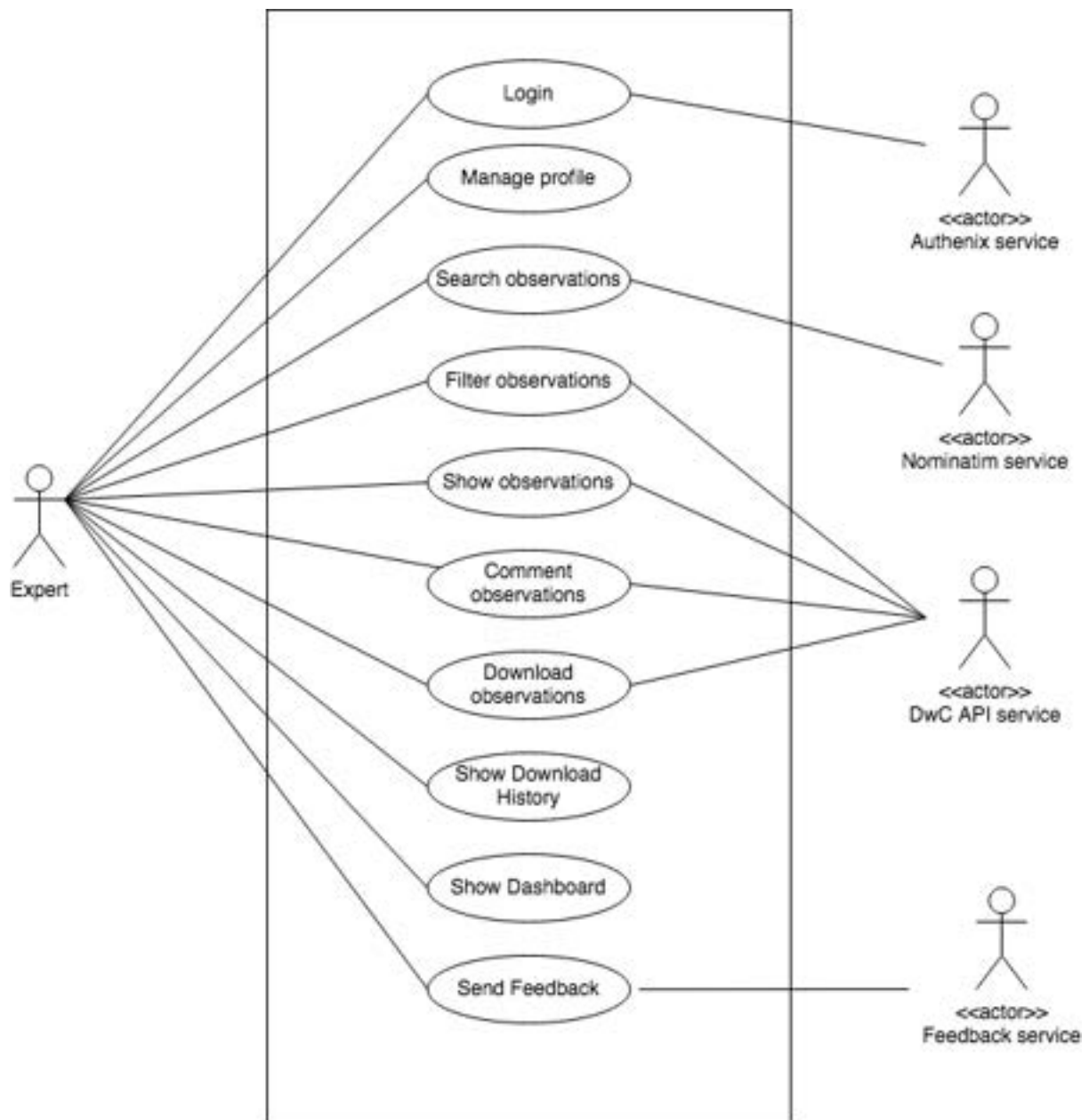


Figure 39. Use Case Diagram.

## 4. Development

### 4.1 Introduction

In the development section, we will explain the technology that we have used based on the Agile Methodology and Co-design. We will also provide an explanation and an analysis from the point of view of the Frontend and Backend, to finally show an image of the system architecture.

### 4.2 Methodology

Additionally to Agile and Co-design methodology, we focus on reaching achievable milestones in short sprints to close the stages towards each objective. To reach a milestone, we follow three basic principles: Simplicity, Communication and Feedback.

- **Simplicity:** The fewer elements disperse the attention of the objective, the easier it is to achieve.
- **Communication:** This principle is indispensable. Each difficulty, doubt, comment or change is put in common language to assess whether the final goal is achievable or what elements are prioritised over others.
- **Feedback:** The team seeks constant feedback from those responsible for the project, both when solving doubts, as well as to comment on positive points, strengths of the project, elements for improvement or possible changes. Thus, the team advances with confidence and with a clear objective.

### 4.3 Technology

In the technology section, we explain at the Frontend and Backend level the decision making regarding the methodologies used in the development and the choice of each one of them.

### 4.3.1 Frontend

The frontend is designed with a component-based methodology. All modern component-based frontend frameworks make project management easy, which in turn helps to make it a long-term, easy-to-maintain project.

The main factor of a component-based methodology is to reject pieces of code that are intended for multiple uses, and clearer application architecture, and generally have a unified development process.

We have created 4 levels within the methodology:

- **Atom or Component:** They are the smallest blocks of the project, individual legos. We refer to text styles, buttons, icons, input fields, check boxes, etc. It does not depend on any other component or external agent to function.
- **Molecules or set of Components:** When we create a more complex component, and we need to reuse other components, this pattern of "molecules" arises. Like atoms, they do not depend on an external factor to function. For example, a search bar, or a grid of images.
- **Services:** They are pieces of code that aim to organize and share business logic, data and functions with different components and parts of an application. They provide very useful functions that help to divide the prototype into different small logical units that can be reused and that can be called from anywhere in the application, but strictly, it is each page that makes use of these services. For example, get data from a portal, add a comment, get credentials from an external service, etc.
- **Pages:** Pages are the modules that encompass and organize the previous levels. They are made up of multiple components and services. The main function is to organize and present the flow of data between services and components for its correct presentation.

These levels are reflected in the organisation of the interface source code:

```
/components
  /pages
    HomePage
    MapPage
    ObservationsPage
    ProfilePage
    DashboardPage
    HistoricDownloads

/modals
  Login
  Map
  Comments
  Download
  Settings
  Share

/shared
  CommentsComponent
  DownloadComponent
  GridComponent
  SearchComponent

/services
  MappingService (API endpoint)
  PlaceServices (Nominatim)
```

This organisation offers us better communication and implementation with the team. Having a naming convention and interface organisation play an important role in the success of a project. This results in less misunderstandings and much better implementation of designs and developments.

It is important to choose mature technologies because they are reliable. We have to understand that all technologies have a life cycle, so we need future-proof technologies.

The questions we must ask ourselves are:

**What companies sponsor the development of the technology in question?**

When large corporations are behind a technology, this means that in the short term it is difficult for the company to decide to abandon their support (although it can happen in some cases)

**How big is the community?**

The larger the community, the greater the chance that things will stick around for quite some time, and also give us continuous support and development updates of the tools and platforms.

**What is long-term support like?**

In this case, we care about long-term support.

Below we summarise a list of frameworks used for creating web applications with their main characteristics:

**React**

React is maintained by Facebook. Large companies have incorporated this framework into their stack: Netflix, Dropbox, Pinterest, etc.

**Advantage:**

- React enjoys a large community.
- It stands out for its performance.
- It is easy to use.

**Disadvantages:**

- It has too many updates.
- Two ways to develop (Classes and Functional "hooks").



## Vue

It is maintained by the community. Like React, large companies use it: Alibaba, Nasa, Gitlab, Nintendo, Amazon, etc.

Advantage:

- Flexible and simple to use.
- Stands out for its performance.
- Has great long-term support.

Disadvantages:

- The community is much smaller.
- It is not maintained by a large corporation.
- Two ways to develop (the classic and the "hooks").

## Angular

It is maintained by Google. Some examples of companies that use them: Microsoft, Udemy, Paypal, etc.

Advantage:

- By default it uses TypeScript.
- It has a very stable and complex architecture (beneficial for large teams).

Disadvantages:

- The weight of the applications is enormous.
- The performance is worse than the previous ones.
- Version support is 6 months up to a maximum of 18 months.

## Stencil

Stencil is a frontend framework maintained by Ionic (a leading company in the development of mobile applications with Javascript). What stands out about this company is its total focus on the sector. Some companies that use it: Apple, Amazon, Porsche, etc.

**Advantage:**

- It is the union of the best of the 3 previous frameworks.
- It uses TypeScript by default.
- Great performance.
- Very light.
- Future proof, as it generates standard web components.

**Disadvantages:**

- It is too new.
- The versioning policy is unknown (although we know it is a long term one).

For Cos4Env, it has been decided to use Stencil, since it brings together the best of the most popular frameworks and does not lack any technology:

- Web Component-based.
- Asynchronous rendering pipeline.
- TypeScript support.
- One-way Data Binding.
- Component prerendering.
- Simple component lazy-loading.
- JSX support.
- Dependency-free components.

**Implementations:****Filters adapted to new context of environmental variables**

Now that every portal is talking in the same language, we added more filters to the portal. The list of filters are:

- **Portals:** The list of available portals at the moment are OdourCollect and CanAirIO.
- **Types:** The complete list of observations types are:

- Odour type
  - Odour intensity
  - Hedonic tone
  - PM1
  - PM2.5
  - PM10
  - Temperature
  - Humidity
  - Pressure
  - CO2
  - CO2 Temperature
  - CO2 Humidity
  - Battery voltage
- **Licences:** "[ODbL v1.0](#)", "[CC0](#)", "[CC-BY](#)", "[CC-BY-NC](#)", "[CC-BY-SA](#)" and "[ODbL V1.0](#)"
  - **Date:** We can filter by the event date in a range of min and max periods. So this filter needs a calendar to be really useful, for the calendar we add a lightweight library called "**When**".

### Nominatim service

Nominatim uses OpenStreetMap data to find locations on Earth by name and address, so allow us to type free-form queries ("Paris, New York ") in any language. In this way, we can filter occurrence by the bounding box area of the place requested.

### 4.3.2 Backend

We need a backend to be able to map the observations of the different portals, perform the CSV download and verify the credentials of the users using Authenix service. We could define the backend as the data access layer.

For this case we have used a very popular stack (Node - Swagger - Express - Docker):

- **Node:** We choose this framework because it is lightweight and is the same language as the frontend.

- **Swagger:** We need an API that maps the different portals (OdourCollect, Canario, ...) for this we have documented the API with the Swagger specification.
- **Express:** Very popular node microframework, high performance and stable since 2012.
- **Docker:** Users can download the docker virtual container/image to install locally and make changes or customise the software when needed.

## Interoperability layer

### API DWC

In the backend we implemented a mapping service that is based on Darwin Core terms, so every portal should speak and understand these terms in order to be able to be included in the expert portal.

At the moment the origins like OdourCollect and CanAirIO had implemented their API service based on Darwin core.

The client sends a request to the Node API, and the DWC controller processes the request and determines which origins should be fetched in order to build the response, so we define the origin file "origins.js" for the endpoints of every origin. After queried the origin(s), the mapping function takes place, and it returns the mapping result.

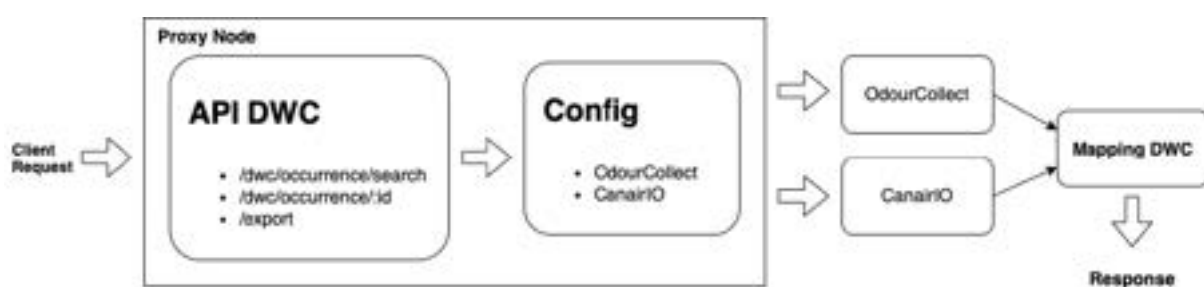


Figure 40. API DWC.

The mapping task consists of merging the response that comes from every origin (each Citizen Observatory) and finding the equivalent terms in the Darwin core standard Terms as shown in Table 4. Mapping terms table:

- **Terms:** the terms that we can find in the Citizen Observatories.
- **Value:** The possible values that the terms could have
- **Map DWC:term:** the term in DWC that we use to map with the term in the Citizen Observatory.
- **Description:** is the description of the DWC term.

Term	Value	map DWC:term	Description DWC
basisOfRecord	HumanObservation, MachineObservation, Taxon, Occurrence	<a href="http://rs.tdwg.org/DWC/terms/basisOfRecord">http://rs.tdwg.org/DWC/terms/basisOfRecord</a>	Additional information that exists, but that has not been shared in the given record.
type	Event, Text	<a href="http://purl.org/dc/elements/1.1/type">http://purl.org/dc/elements/1.1/type</a>	The nature or genre of the resource.
language	en, es	<a href="http://purl.org/dc/elements/1.1/language">http://purl.org/dc/elements/1.1/language</a>	A language of the resource.
licence	<a href="http://creativecommons.org/publicdomain/zero/1.0/legalcode">http://creativecommons.org/publicdomain/zero/1.0/legalcode</a> , <a href="http://creativecommons.org/licenses/by/4.0/legalcode">http://creativecommons.org/licenses/by/4.0/legalcode</a>	<a href="http://purl.org/dc/terms/license">http://purl.org/dc/terms/license</a>	A legal document giving official permission to do something with the resource
rightsHolder	The Regents of the University of California	<a href="http://purl.org/dc/terms/rightsHolder">http://purl.org/dc/terms/rightsHolder</a>	A person or organisation owning or managing rights over the resource.
accessRight	not-for-profit use only	<a href="http://purl.org/dc/terms/accessRights">http://purl.org/dc/terms/accessRights</a>	Information about who can access the resource or an indication of its security status.

id	298381	<a href="http://rs.tdwg.org/DWC/terms/occurrenceID">http://rs.tdwg.org/DWC/terms/occurrenceID</a>	An identifier for the Occurrence (as opposed to a particular digital record of the occurrence). In the absence of a persistent global unique identifier, construct one from a combination of identifiers in the record that will most closely make the occurrenceID globally unique.
occurrenceStatus	PRESENT / ABSENT	<a href="http://rs.tdwg.org/DWC/terms/occurrenceStatus">http://rs.tdwg.org/DWC/terms/occurrenceStatus</a>	A statement about the presence or absence of an observation at a Location.
user	José E. Crespo. Oliver P. Pearson   Anita K. Pearson (where the value in recordNumber OPP 7101 corresponds to the collector number for the specimen in the field catalog of Oliver P. Pearson).	<a href="http://rs.tdwg.org/DWC/terms/recordedBy">http://rs.tdwg.org/DWC/terms/recordedBy</a>	Name of people, group, or organization responsible for recording the original Occurrence. The primary collector or observer, especially one who applies a personal identifier (recordNumber), should be listed first.
licence	<a href="http://creativecommons.org/publicdomain/zero/1.0/legalcode">http://creativecommons.org/publicdomain/zero/1.0/legalcode</a> , <a href="http://creativecommons.org/licenses/by/4.0/legalcode">http://creativecommons.org/licenses/by/4.0/legalcode</a>	<a href="http://purl.org/dc/terms/licence">http://purl.org/dc/terms/licence</a>	A legal document giving official permission to do something with the resource.
description	text	<a href="http://rs.tdwg.org/DWC/terms/occurrenceRemarks">http://rs.tdwg.org/DWC/terms/occurrenceRemarks</a>	Comments or notes about the Occurrence.
		<a href="#">LOCATION CLASS</a>	
decimalLatitude	41.3280161881	<a href="http://rs.tdwg.org/DWC/terms/decimalLatitude">http://rs.tdwg.org/DWC/terms/decimalLatitude</a>	The geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location. Positive values are north of the

			Equator, negative values are south of it. Legal values lie between -90 and 90, inclusive.
decimalLongitude	2.1092162071	<a href="http://rs.tdwg.org/DWC/terms/decimalLongitude">http://rs.tdwg.org/DWC/terms/decimalLongitude</a>	The geographic longitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location. Positive values are east of the Greenwich Meridian, negative values are west of it. Legal values lie between -180 and 180, inclusive.
eventDate	2021-04-10	<a href="#">EVENT_DATE</a>	The date-time or interval during which an Event occurred. For occurrences, this is the date-time when the event was recorded. Not suitable for a time in a geological context.

OdourCollect field	Value	mapd DWC:term	Description DWC	API
measurementType	odour	<a href="http://rs.tdwg.org/DWC/terms/MasurementOrFact">http://rs.tdwg.org/DWC/terms/MMeasurementOrFact</a>		measurements:measurementType
measurementUnit	Odour type	<a href="http://rs.tdwg.org/DWC/terms/MMeasurementOrFact">http://rs.tdwg.org/DWC/terms/MMeasurementOrFact</a>		measurements:measurementType

measurementValue	Waste truck	http://rs.td wg.org/DW C/terms/M easurementOrFact		measurements:measurementType
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Table 4: Mapping terms table

### 4.3.3 Architecture

The result of this structure of the Expert Portal is represented graphically as we can see below:

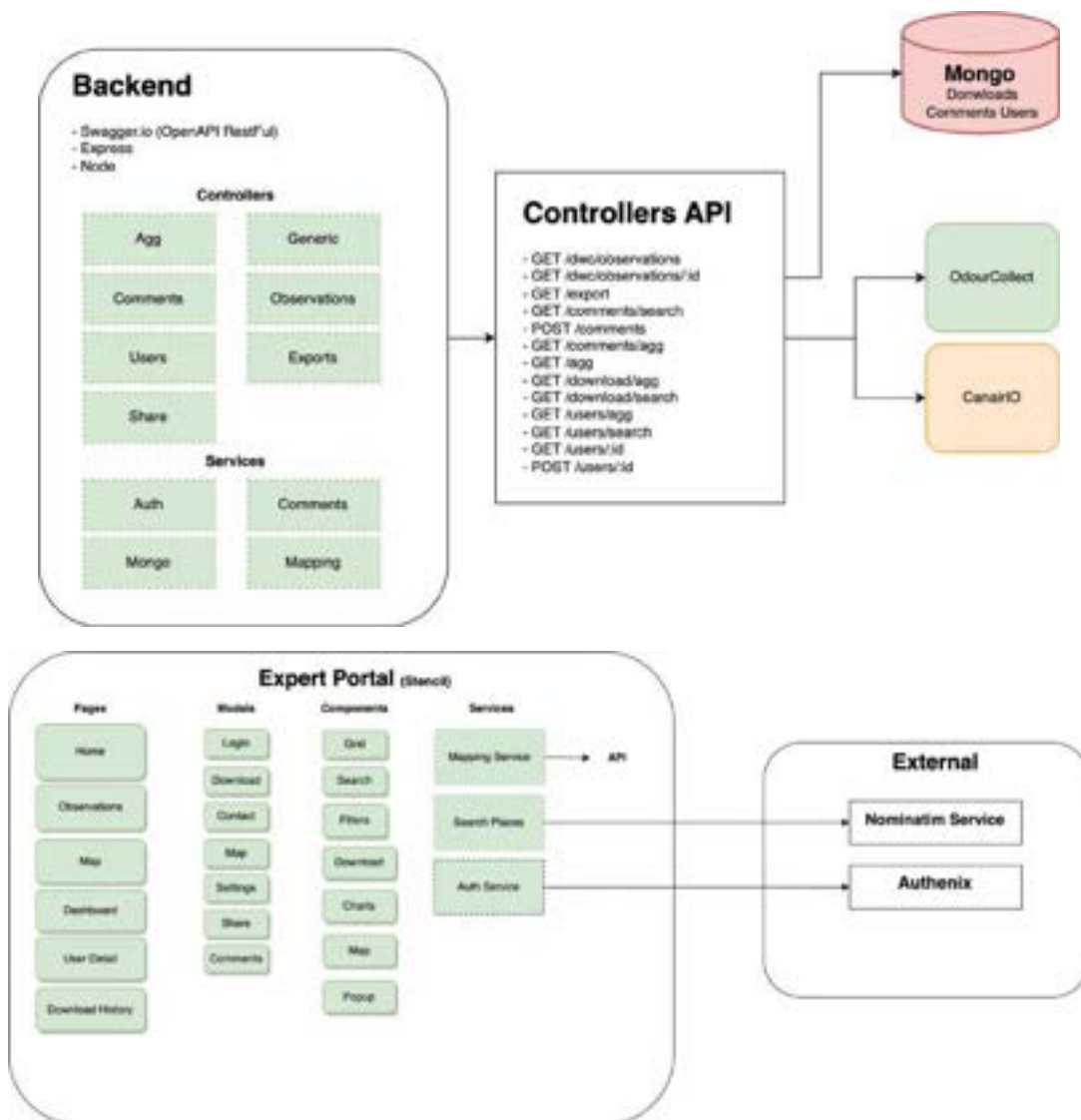


Figure 41. Architecture Expert Portal.



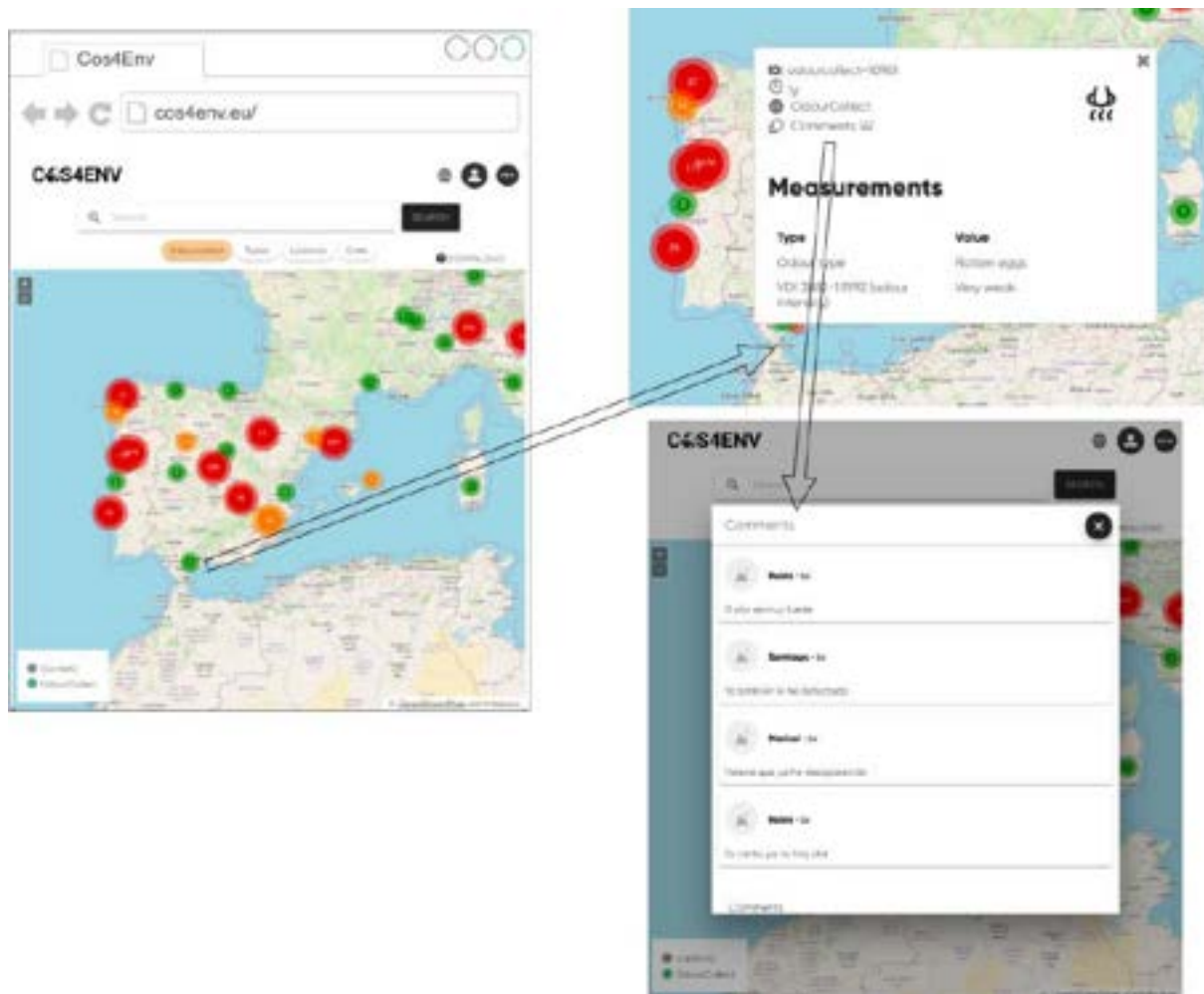


Figure 42. Data Flow between Environmental Portal and Comments.

## Stats and Mongo Database

We have chosen MongoDB for the following reasons:

- It is NoSQL and document-based and stores data in JSON-like structures.
- Since we are using NodeJS as a backend, the most used architectures with Node and Mongo are MERN (Mongo Express React Node.js) or MEAN (Mongo Express Angular Node.js), which suits us like a glove.
- It has a powerful syntax for querying and grouping.
- Lastly, and most importantly, it is open source.

Apart from the API, we have the need to integrate a database for statistics purposes and substantially enhance the functionalities implemented before, like the export service and the comments:

Mongo helps us build this list of features:

- We store information about downloads, so we can show information about historic downloads for each user.
- We store user information that comes from Authenix service, this helps build the profile for each user. Also, with this information we show stats like charts and counters in each user profile.
- Every comment made from the portal is stored in mongo. This helps us build stats for comments and to show comments in portals that don't have comments features like Canario.
- The information stored in Mongo helps us build a global Dashboard. This dashboard consists of a list of counters (comments, download and users) and a series of charts (Pie and Bars) showing data of the Portal.

The architecture of the API that consume the Mongo database consists in three concept endpoints:

- We have 3 models stored: Users, Comments and Downloads
- Each model has a generic endpoints:
  - `/${model}/id`
  - `/${model}/search`
  - `/${model}/agg`
- `/:id` return an specific document by the id
- "Search" it lists all the rows of the models stored
- "Agg" lists stats grouped by Months and by type.

## **Download/Export**

Because each portal offers the possibility of responding to queries in the same format (DarwinCore terms), now it is easier to export information in CSV. Also for each user we ask the reason for each request download, so we stored this information and also we offer a download history.

The reason why the user needs to download the information is that it needs to be saved. This data collection is necessary to understand the reasons and to be able to represent it in the user's profile and the general dashboard. The reasons are listed below:

- Biosecurity management/planning
- Citizen Science
- Collection management
- Conservation management/planning
- Ecological research
- Education
- Environmental assessment
- Restoration/Remediation
- Scientific investigation
- Test
- Other

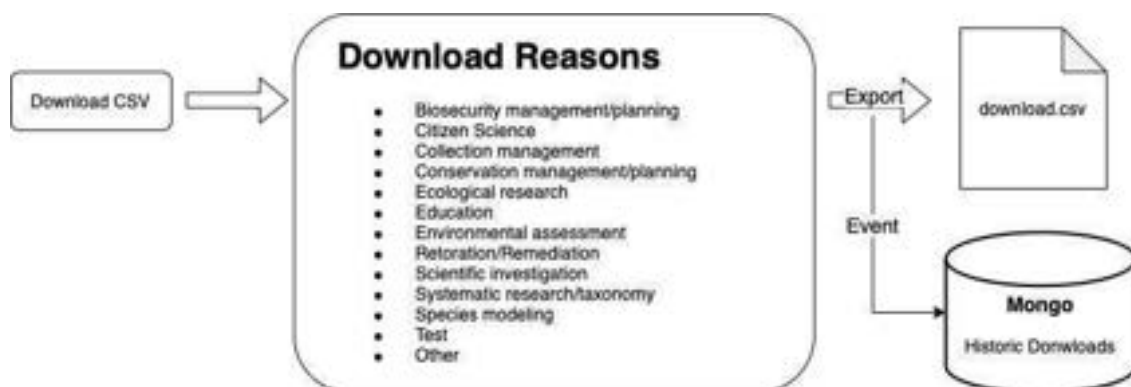


Figure 43. Architecture download reason.

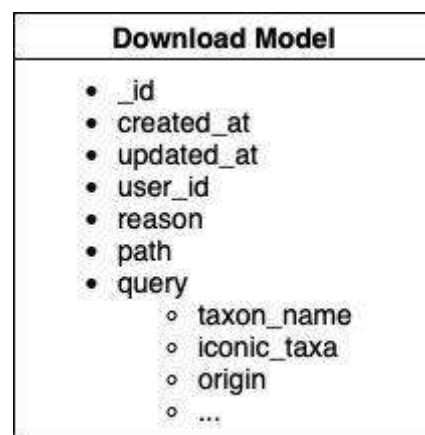


Figure 44. Download model.

The fact that we save the event and the reason for the download allow us to offer a download history for each user. The user in his list of downloads can consult and can re-execute his previous downloads.

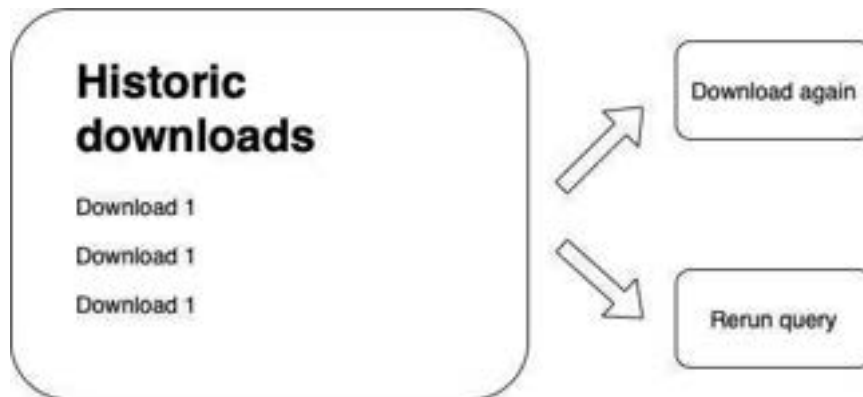


Figure 45. Historic downloads.

## Map

We create a component Map to build ModalMap and MapComponent based on Openlayers.

### OpenLayers

OpenLayers is an open-source JavaScript library for displaying map data in web browsers. It provides an API for building geographic applications similar to Google Maps, Leafletjs and Bing Maps.

### Ol-ext

We extend the features of Openlayers with ol-ext, a set of extensions, controls, interactions to improve Openlayers

- Clusters: Openlayers doesn't have an easy way to build this kind of features natively, the extension ol-ext provides these kinds of strategies for visualization in spiral.



Figure 46: Clusters

Popups are ways to show information of features on the map. Openlayer offers this feature natively but the extension ol-ext makes it easy to handle and offers an easy API.



Figure 47. Popups observations on map

## 4.4. Code

At this moment we all the code is available on a public GitHub repository:

<https://github.com/Bineo-Consulting/Cos4Env>

## 5. Future work

Once the implementation has been tested and validated by experts and the Cos4Env service has been published in EOSC, the future work has focused on several aspects that we detail below:

- Continuous maintenance of the system.
- A follow-up of the identifications made by the experts.
- Integrate new Citizen Observatories, such as FreshWater Watch and AireCiudadano.
- To be in contact with the Scientific Community.
- Carry out communication work to make the service better known with the help of the Connect Group.
- Resolve possible incidents that may occur.
- Continue collecting comments from experts.
- Integrate Cos4Env with more Cos4Cloud services such as DUNS.
- Think about adding new features.
- Plan and think about ways of sustainability for the future.

## 6. Conclusions

Cos4Env has been a rewarding challenge. The possibility of being part of a European project has allowed us to collaborate with many partners throughout the implementation process, which is reflected in different aspects:

- Collaboration with other citizen observatories.
- Integration of other services of Cos4Cloud, such as Authenix or the Plant Identification Service.
- Application of the defined agile methodology.
- Creation of an interoperability layer that complies with the FAIR criteria.
- Learn from many experts thanks to Co-Design meetings.
- Improve in each cycle through technical meetings every 15 days.
- Join the EOSC community.

All these factors have resulted in a service that is simple to understand and at the same time powerful due to the opportunities it creates for experts and the world of citizen science.

It has also allowed us to demonstrate the value of the general purpose platform, which we developed during the first period, which with the inclusion of suggestions from experts and with several architecture modifications that, with the use of agile methodologies, has served as a stable base on which we have been able to build Cos4Env. But the potential of this platform does not end here, since we are carrying out the development of Cos4Env on it.

Still, we know the job is not done yet. We hope that Cos4Env will be a benchmark at European level as a central repository of citizen science data, that it will be a service used by all scientists to analyze data from many platforms and to which they can also contribute their knowledge.

But in order to get here, we will have to get a lot of support, work with the communications service, and get more partners to make Cos4Env a sustainable service in the future, continue including new features, continue listening to experts from the

scientific community, to continue improving, contributing and making Cos4Env a service for the Future.

## Glossary

Term	Description
Cos4Env	It's the name that we have defined for the service of Expert Portal for Environmental data validation.
Cos4Bio	It's the name that we have defined for the service of Expert Portal for Biodiversity data validation.
Expert Platform	Prototype that integrates data from various citizen observatories, allowing the experts who access it to perform various operations such as: searches, downloads, identifications, comments, with the benefit of reducing the investment of time when finding data on which to investigate, and that allows increasing the degree of participation of experts in the processes of identification of the observations made by citizens.
Citizen Observatory (CO)	Web Portal that allows the interaction between Citizens and Scientists in obtaining data, be it data on flora, fauna, odours, temperatures, precipitation measurements, emissions ..., and that involves an identification process , validation, quality and study.
Observation	It is the element observed by a person or device, be it Flora, Fauna or an Environmental Variable.
Identification	When the observations are not known by the citizens, they are presented in a random state, not identified, since they lack the scientific knowledge to be able to define the observation with precision. For example: In the case of a magpie, it would be identified when a user identified it as Pica Pica, and defined it through its correct scientific name.



Casual status	An observation is accidental when it has received an identification, but this has not yet been validated by any expert in its corresponding Citizen Observatory.
Research grade status	An observation is scientific grade, when it has been identified and in turn has been validated by an expert.
Citizen	Person who participates in Citizen Observatories sharing their observations related to biodiversity or environment context that can be used by the scientific community.
Expert	Person with sufficient knowledge to be able to carry out identifications or scientists dedicated to the world of Biodiversity or the Environment.
Standard	It is a common framework validated by the community, in this case it applies to the use of communication protocols, the representation of information, the visualization of images and procedures.
Interoperability	We can define it, within the project, as the layer that allows the data from the different Citizen Observatories to coexist in the same environment. This layer allows the Expert Portal to understand the information in each portal, performing a mapping task and showing it to the end user in a unified and standardized way.
<a href="#">FAIR</a>	FAIR are data which meet principles of findability, accessibility, interoperability, and reusability. A March 2016 publication by a consortium of scientists and organizations specified the "FAIR Guiding Principles for scientific data management and stewardship" in Scientific Data, using FAIR as an acronym and making the concept easier to discuss.
Actor	it is something with behaviour, such as a person, identified by a role, computer system or organization.
Scenario	Specific sequence of actions and interactions between the actors and the system under study.
SSD	In software engineering, a system sequence diagram (SSD) is a sequence diagram that shows, for a particular scenario of a use case,

	the events that external actors generate, their order, and possible inter-system events. (wikipedia)
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## Annexe

### Cos4Cloud TRL Calculation

#### Service:

#### Cos4Env: Expert Portal for Environmental Data Validation

#### TRL 1: Basic principles observed

##### Question

##### Criterion fulfills (yes/no)

Is there a research hypothesis defined guiding the development of the service?	yes
Are the basic algorithms needed for the implementation defined?	yes
Is there a document (specification, publication) describing the ideas of the service?	yes

#### TRL 2: Technology concept formulated

##### Question

##### Criterion fulfills (yes/no)

Is there an initial design description of the service?	yes
Did you define the users stories to be implemented?	yes
Did you identify the research and development activities necessary for developing your service?	yes
Did you perform first tests with example data?	yes

#### TRL 3: Experimental proof of concept

##### Question

##### Criterion fulfills (yes/no)

Did you define the main components of your service?	yes
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Is there an overview design of your service available (e.g. component diagram)?	yes
Did you define performance criteria (e.g., number of users, amount of data) for your service?	yes
Did you establish a test environment for component tests (e.g., tools for conducting unit tests)?	yes
Are the individual components of your service implemented in a preliminary version?	yes
Did you test the core functions of the service?	yes
Did you document your first tests?	yes

#### **TRL 4**

##### **Question**

##### **Criterion fulfills (yes/no)**

Is there a detailed design of the components of the service available?	yes
Did you complete the first running on an internal system (development machine)?	yes
Did you define the environment in which the service will be operated?	yes
Did you successfully complete the testing of the integrated components?	yes
Are the test results of the integrated components documented?	yes

#### **TRL 5: Technology validated in relevant environment**

##### **Question**

##### **Criterion fulfills (yes/no)**

Did you determine the requirements for scaling your service (e.g. from test users to a public audience)?	yes
Did you establish a testing environment similar to the later operational environment?	yes
Did you successfully demonstrate your implementation in a testing environment?	yes
Did you conduct tests with consortium partners?	yes
Are the test results from the test environment documented?	yes

#### **TRL 6: Technology demonstrated in relevant environment**

##### **Question**

##### **Criterion fulfills (yes/no)**

Are the system requirements finalised?	yes
--	-----

Is the operating environment fully defined?	yes
Are the necessary implementations of a prototype that takes into account the requirements of the operational environment?	yes
Did you conduct tests with selected external users (e.g. as part of hackathons)?	yes

### **TRL 7: System prototype demonstration in operational environment**

<b><u>Question</u></b>	<b><u>Criterion fulfills (yes/no)</u></b>
Is there a fully integrated prototype available that was demonstrated in an operational environment?	yes
Did you verify the performance of the system?	
Did you conduct tests within a broader community with previously unknown users?	yes
Is all software testing completed?	yes
Does your service provide value on its own?	yes
Is your documentation available in the English language?	yes
Did you specify privacy statements, terms of use and Service Level Agreements?	yes
Is there a help desk available?	yes
Is there a plan established for ensuring regular updates of your service?	yes

### **TRL 8: System complete and qualified**

<b><u>Question</u></b>	<b><u>Criterion fulfills (yes/no)</u></b>
Did you define a life cycle for your software? Is there a clear plan on how to handle the end of life?	yes
Did you make your service available via the EOSC portal?	yes
Did you fix all known open issues/bugs?	yes
Is there a full documentation of your service available?	yes
Has the qualification test on EOSC been passed?	yes

### **TRL 9: Actual system proven in operational environment**

<b><u>Question</u></b>	<b><u>Criterion fulfills (yes/no)</u></b>
Is your service operational in the EOSC?	yes

Is there continuous support for your service available?	yes
Did you finalise all related documentation?	yes
Does your software meet all specified requirements?	yes
Are all user stories successfully implemented?	yes