The EVER-EST Virtual Research Environment (VRE): outcomes and solutions for Earth Science

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The EVER-EST Project

The EVER-EST project aimed to develop a generic **Virtual Research Environment** (VRE) tailored to the needs and validated by the **Earth Science** domain. Real use cases, taken from pre-selected communities covering different Earth Science research scenarios led the implementation of the system's services and capabilities. The ISMAR-CNR represented the Sea Monitoring Virtual Research Community (VRC) has to do with: information fragmentation, lack of formalized methodologies, lack of a unique platform where the community can work together and with powerful tools.
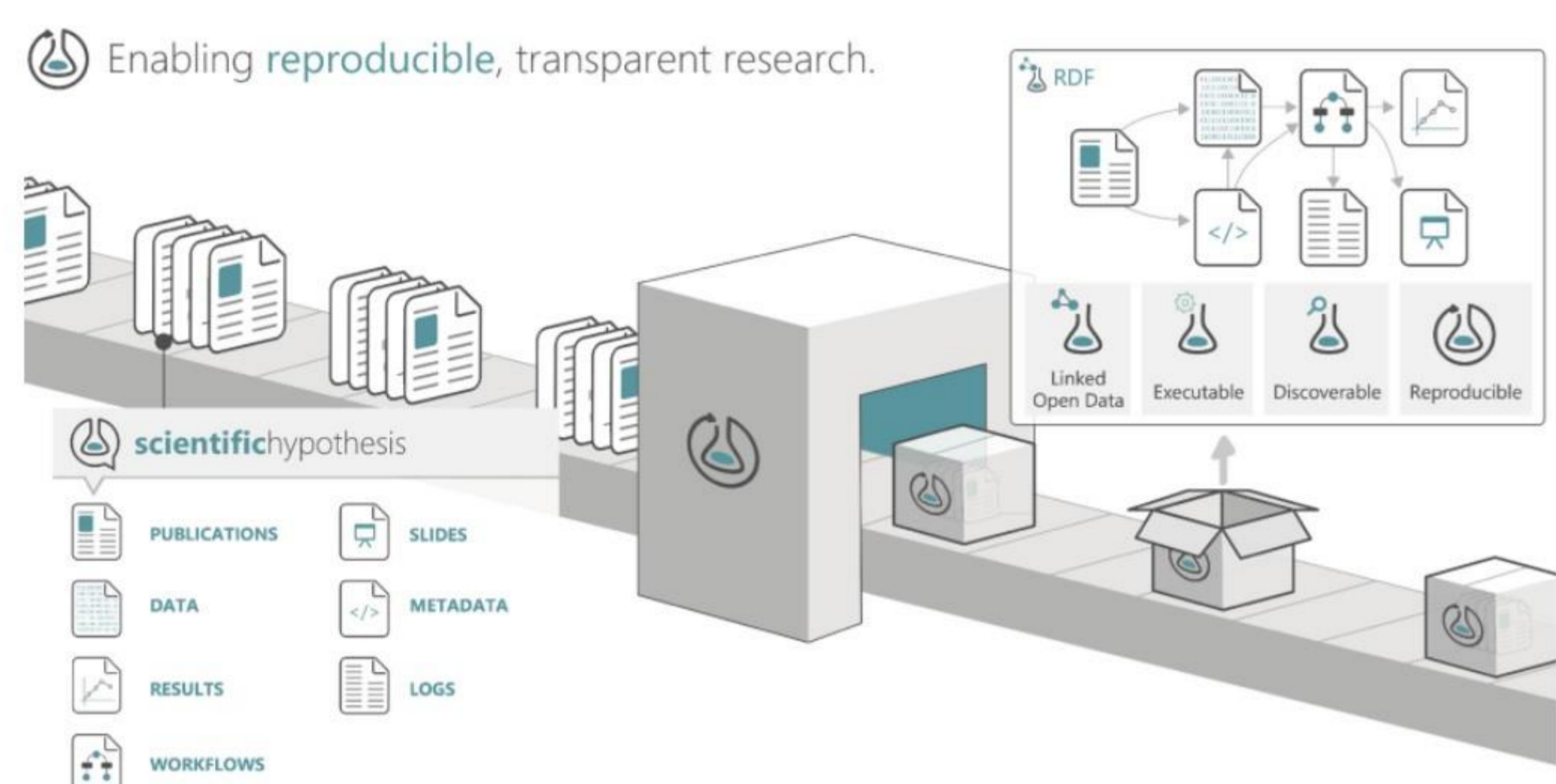

Fig. 1. High-level view of the Research Objects concept graphically.

Fig. 2. High-level overview of the EVER-EST VRE architecture.

Central to this approach is the concept of **Research Object** (RO): a semantically rich aggregations of resources that bring together data, methods and people in scientific investigations. ROs enable the creation of digital artifacts that can encapsulate scientific knowledge and provide a mechanism for sharing and discovering assets of reusable research (Fig. 1).
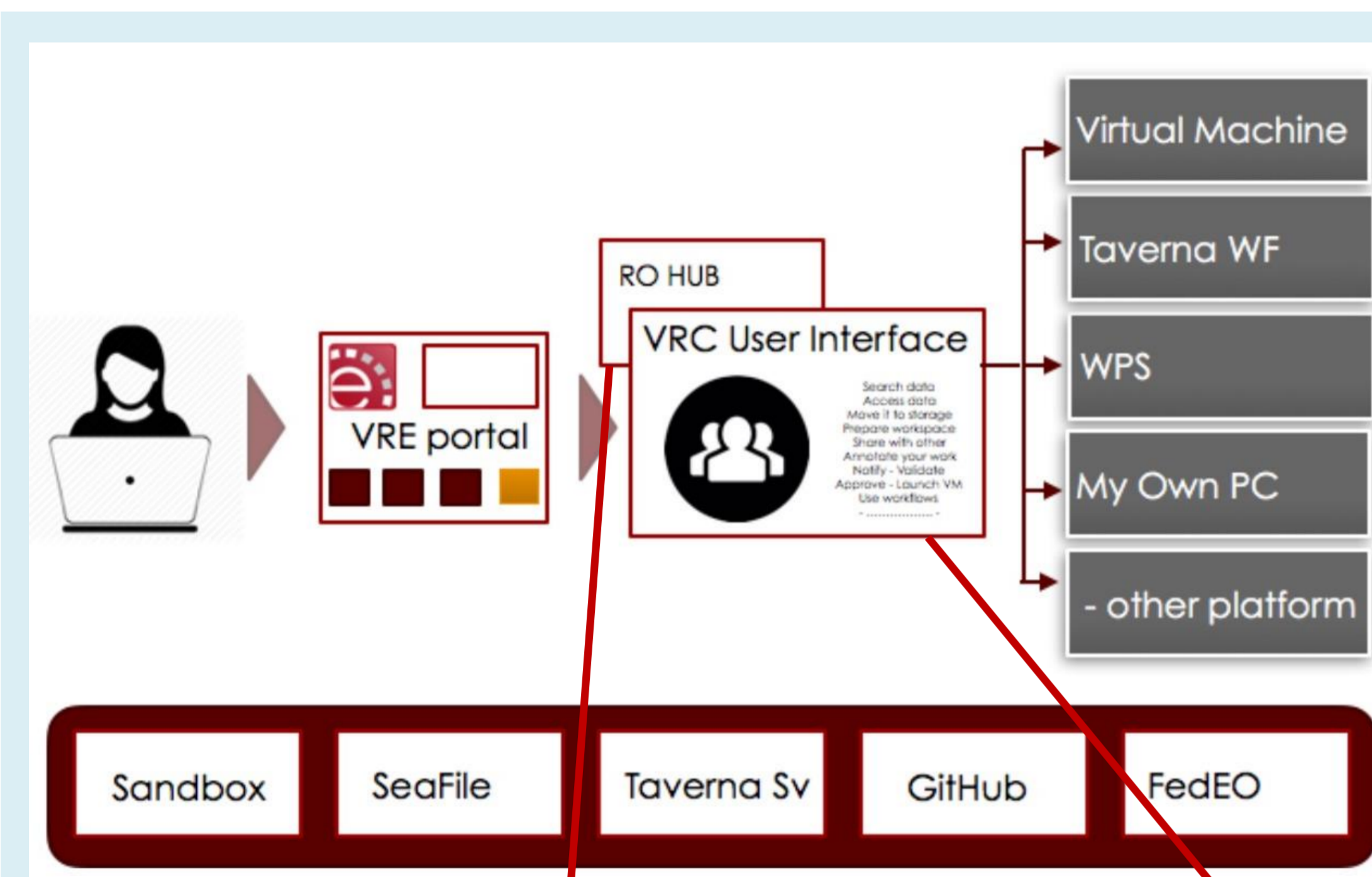
The EVER-EST e-infrastructure

The **EVER-EST VRE** (Fig. 6) allows users to create, **manage** and **share** Earth Science ROs, to discover, access and process data, to visualize data relying on OGC standards (OpenSearch, WCS, WPS, WMS), to execute remote workflows. The VRE enables scientists to collaborate in different modes and to communicate throughout the research lifecycle (**e-collaboration functionalities**); the portal provides access to training materials and online courses (**e-learning functionalities**) to guide future data scientists to overcome the daily challenges and support their ability to curate the information.

The VRE integrates different tools:

- **Collaboration spheres**, a user-oriented interface for the visualization of correlation between similar objects based on collaborative filtering and versatile keyword content-based recommendations (Fig. 4);
- **Jupyter Notebook**, for capturing the whole computation process, developing, documenting, and executing code, as well as communicating the results;
- **ROHub**, a digital library system supporting the storage, lifecycle management, sharing and preservation of research findings via ROs (Fig. 5);
- **SeaFile**, a repository for the personal data storage that guarantees file synchronization, version control, public link sharing, desktop client and web API;
- **Virtual machines**, a powerful shared environment for create workflows and process data.

Fig. 3. Approach adopted for the design, implementation and integration of both the VRE Graphic User Interface design (GUI) and the specific VRC GUI's.
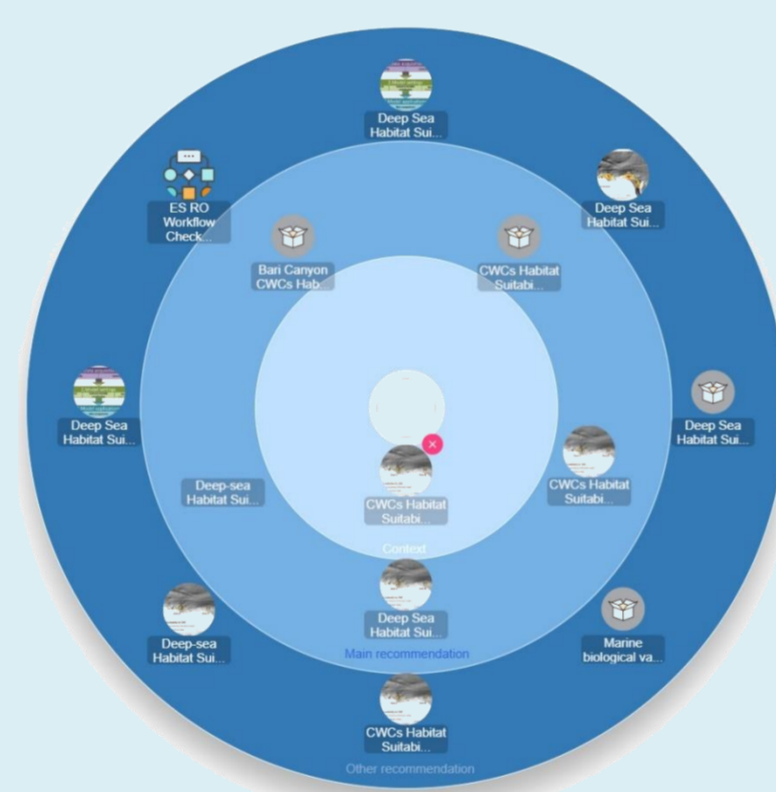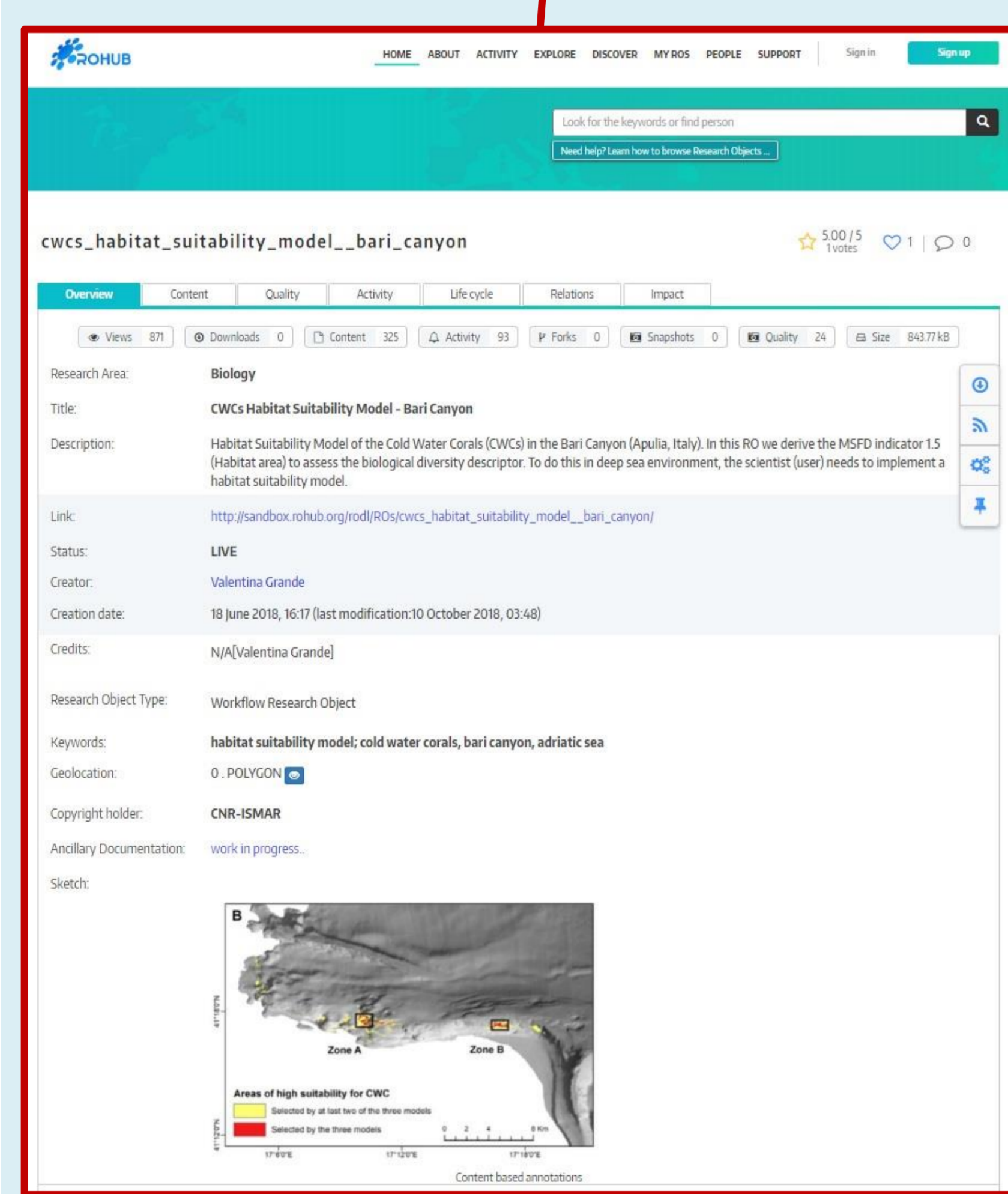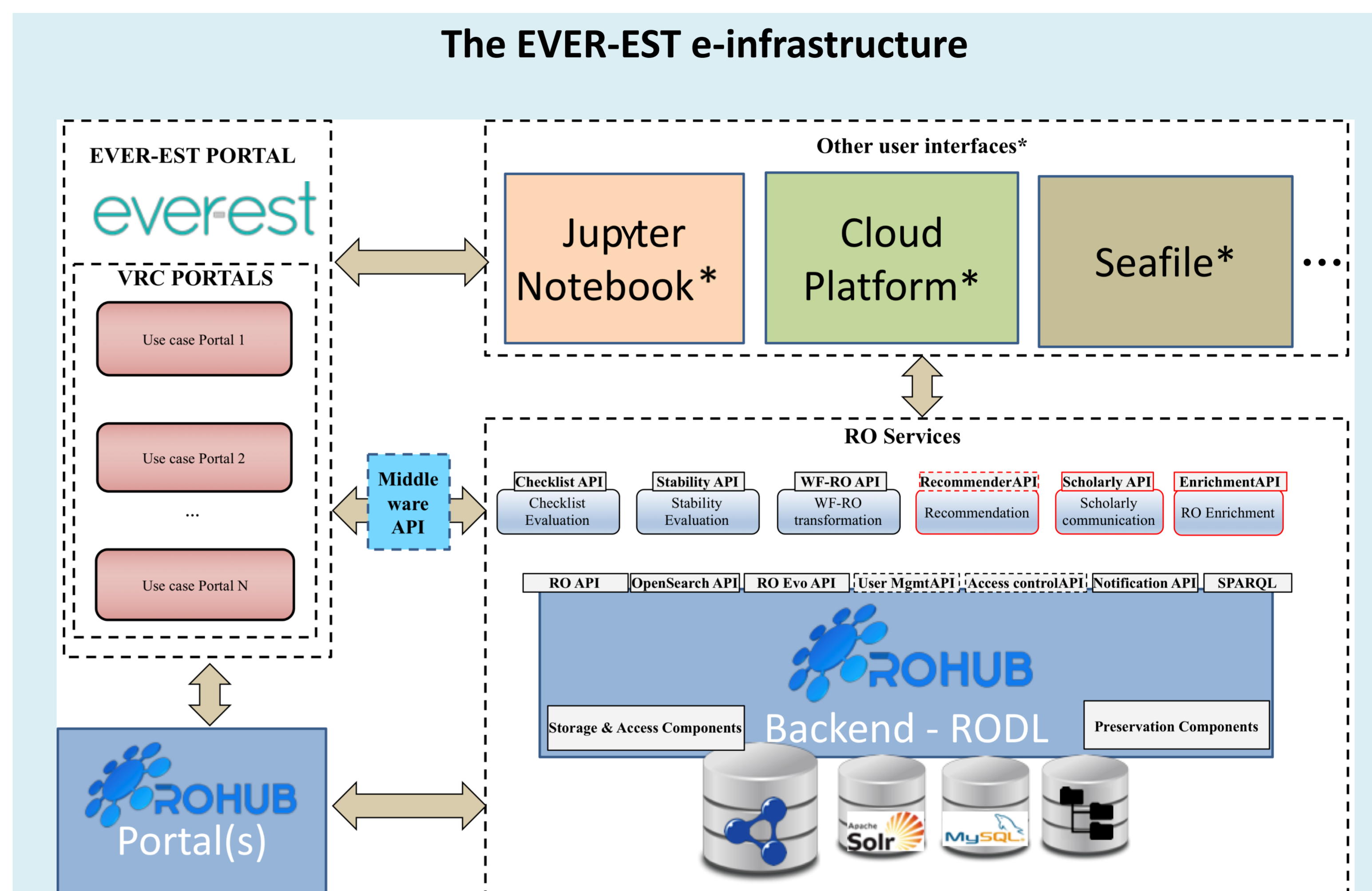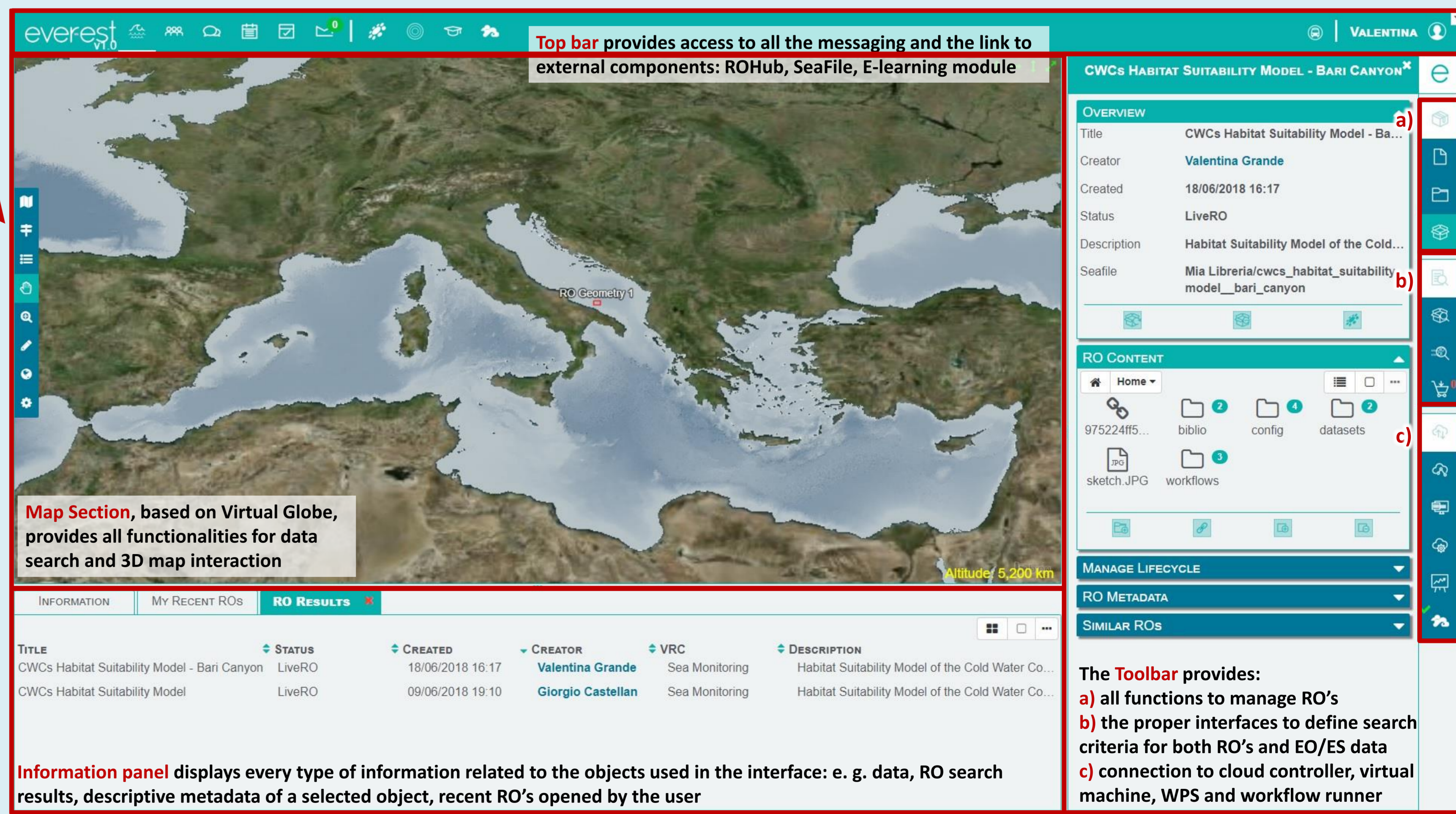

Fig. 4. Collaboration spheres.

Fig. 5. ROHub portal (http://www.rohub.org).

Fig. 6. Sea Monitoring VRE (https://vre.ever-est.eu/seamonitoring/).

Top bar provides access to all the messaging and the link to external components: ROHub, SeaFile, E-learning module

Map Section, based on Virtual Globe, provides all functionalities for data search and 3D map interaction

Information panel displays every type of information related to the objects used in the interface: e. g. data, RO search results, descriptive metadata of a selected object, recent RO's opened by the user

The Toolbar provides:
a) all functions to manage RO's
b) the proper interfaces to define search criteria for both RO's and EO/ES data
c) connection to cloud controller, virtual machine, WPS and workflow runner

Conclusion

The Sea Monitoring user had to change his mentality about different aspects of the scientific daily life. The most relevant work concerned in formalize the scientific lifecycle, moving from a conceptual to an executable workflow, in fact, the VRC spent more time in implementing and orchestrating different codes and scripts re-executable. We organized the scientific researches to make them entirely sharable and open to other scientists.

The EVER-EST approach allows the users to:

- **saving** time in data processing;
- having **more storage space** and higher **powerful computer capabilities;**
- easily **exchange** data and processing methodologies;
- better and quick **communicate**;
- **access** remotely data, software, research results, and documentation;
- organize a **scientific workflow** in a single digital object, findable and reusable;

- increase the number of publications and **visibility** from public;
- **document** scientific work;
- maintaining attribution through **DOI placement**;
- publish **grey literature**;
- ensure **long term preservation** of research work;
- **re-use**, **preserve** and **share** both data and scientific processes.