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soils4med

Unveiling the Key Deliverables of Our Project

THE PROJECT

The "**SOIL health monitoring and information systems FOR sustainable soil management in the MEDiterranean Region**" (SOILS4MED) project has been funded under the Partnership for Research and Innovation in the Mediterranean Area (PRIMA). In the Mediterranean Region (MR), there is an urgent need to improve the availability and accessibility of soil data and information, and to harmonize methodologies to develop standardized soil information systems. The limited use and quality of soil data and information pose a significant barrier to sustainable land management and the development and implementation of policies to protect, restore, and enhance soil health. To address it, the project goal is to engage a large platform of scientists, stakeholders, and final users in the co-design of scientifically sound, sustainable, and policy-relevant integrated **soil health monitoring** and **information systems** adapted to the specificities of the MR soils and environments and to demonstrate the multiple societal benefits deriving from increased investment in soil data and information.

Deliverables 5.1 Soil Information Systems (SIS) design and 5.2 Deployment of the first SIS prototype

Please note: this is a Project Deliverable summary designed for dissemination and communication purposes, not the official final deliverable

Work Package 5 (WP5)
Harmonized Soil Information Systems (SIS) tool for the Mediterranean Region

The WP5's objective is to develop a harmonized Soil Information Systems (SIS) tool for the Mediterranean Region (MR), considering the activities ongoing under relevant international initiatives including FAO's GLOSIS (Global Soil Information System) and INSII (International Network of Soil Information Institutions).

This Work Package:

i) Co-designs the SIS, with the project partners and with the final users (identified host institutions in each country/region), as a country-based system adhering to the data ownership and accessibility regulations of each country, and enabling different levels of data access and visualization for data managers and users.

ii) Enables data sharing among the partners' SIS and the establishment of a virtual centralized MR SIS thanks to the common API and to the Web GIS interfaces, Open Geospatial Consortium (OGC) compliant, including the publication of Open Access SDI via WEB and the sharing of selected SDI with third parties (e.g., feeding into third party portals).

iii) Deploys the SIS at each host institution providing technical assistance and capacity development support.

PURPOSE OF THE DELIVERABLES

These deliverables aim to **describe the design of the Harmonized Soil Information Systems (SIS) tool** and its **first prototype**.

The SIS has been designed in order to:

- enable in-country management and protection of country owned soil data and information (SDI);
- grant data access to users and third parties according to the access policy;
- secure open access to selected project-generated data;
- provide a WEB-GIS workspace with harmonized data and map visualization rules to users;
- have an access policy for the public;
- enable interlinking and data sharing among countries and towards third parties through common Application Programming Interfaces (APIs).

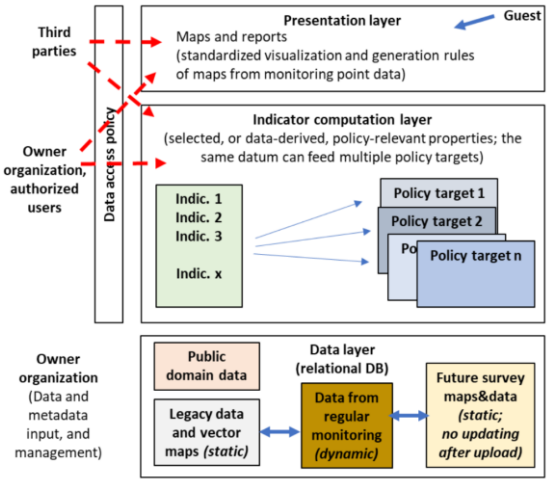

Figure 1. Schema of the SIS components to be installed in the host institutions.

TECHNICAL SOLUTION AND SYSTEM ARCHITECTURE

The technologies used to implement the SIS are:

- **PostgreSQL/PostGIS**, a powerful, open-source object-relational database. It is the database management system (DBMS) that will ensure the persistence of the SIS data.
- **Geonode**, a geospatial content management system, a platform for the management and publication of geospatial data.
- **Geoserver**, designed for interoperability, publishes data from any major spatial data source using open standard such as Web GIS Services (WMS, WCS, WFS, WTs, WPS).
- **Django Web Framework**, a free and open-source web framework used to implement the Geonode web application.
- **Django Rest Framework**, a free and open-source web framework used to implement the APIs.
- **React**, a JavaScript library for building dynamic and interactive web user interfaces.

Docker Compose is a tool for defining and running multi container applications. It simplifies the control of the entire application stack, making it easy to manage services, networks, and volumes in a single, comprehensible YAML ("YAML Ain't Markup Language") configuration file. Then, with a single command, users can create and start all the services defined in their configuration file.

As shown in the Figure 2, the **SIS prototype is a Docker Compose Multi Container Application** consisting of eight containers and seven volumes.

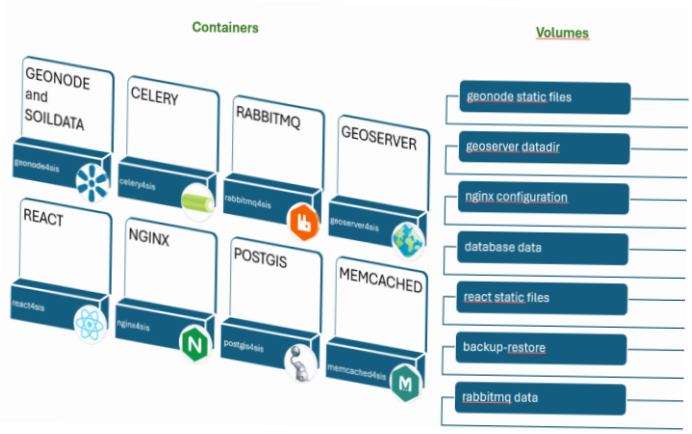

Figure 2. Container and Volumes of the SIS Prototype Docker compose Multi Container Application.

The core components of the prototype are:

- **GEONODE** and **SOILDATA** container: implements the "SIS Catalogue" (GEONODE) and the "SIS Back Office" back-end (SOILDATA).
- **GEOSERVER** container: provides Web GIS services for the "SIS Catalogue".
- **REACT** container: implements the "SIS Back Office" front-end.
- **POSTGIS** container: manages databases using a PostgreSQL/PostGIS DBMS.
- **NGINX** container: acts as reserve proxy server, enabling secure HTTPS access to GEONODE, GEOSERVER and REACT web applications.

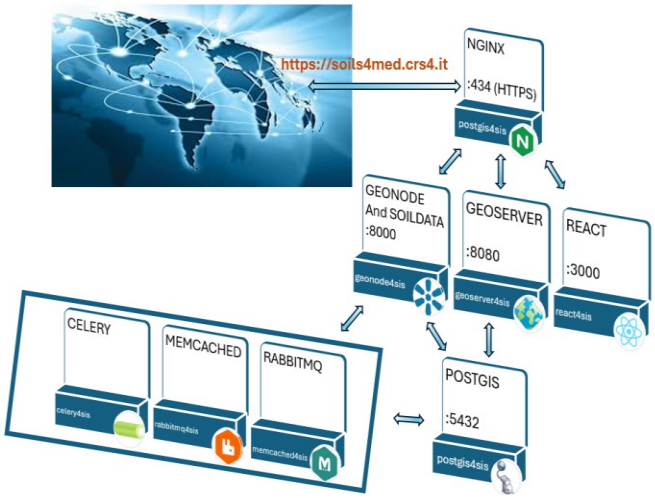

Figure 3. SIS Prototype Docker Compose Multi Container.

Users

The SIS prototype implements three user base groups with distinct access levels and responsibilities:

- Administrators: ICT experts, responsible for managing the whole system.
- Data Manager: responsible for overseeing the development and management of data within the SIS Catalogue and Back Office.
- Registered Users: any user registered in the SIS.

Only administrator can create new users or add users to the Data Manager group.

Data

Two types of data are managed in the SIS:

- SIS Catalogue Resources: includes Maps, Datasets, and Documents governed by the Geonode Resource Data Model within the SIS Catalogue.
- SIS Back Office Soil Data: managed through the Django GeoApp SOILDATA (back-end API) and React Web App S4M REACT (front-end user interfaces) within the SIS Back Office.
  Django Object-Relational Mapping (ORM) models are used in the SOILDATA GeoApp to store and retrieve objects from the PostgreSQL/PostGIS database, named SOILDATA. The ORM model is structured according to the latest World Reference Base for Soil Resources 2022 (WRB2022).

SIS SOIL DATA MODEL

Soil data can be classified into three categories:

- ❖ Soil Profiles: A full conventional soil profile description, including site and soil surface features, profile's layers characteristics, and soil laboratory analyses related to each layer.
- ❖ Soil Sample: Soil monitoring data that includes specific site and soil surface descriptions, sample layer features, and soil laboratory analyses, following a defined monitoring protocol.
- ❖ Soil Indicator: Data derived from one or more descriptors or datasets from the other two data models.

SIS CATALOGUE

The SIS Catalogue is a Geonode instance customized by project partner CRS4.
An example of a possible graphical interface for the SIS design is shown in the following figure.

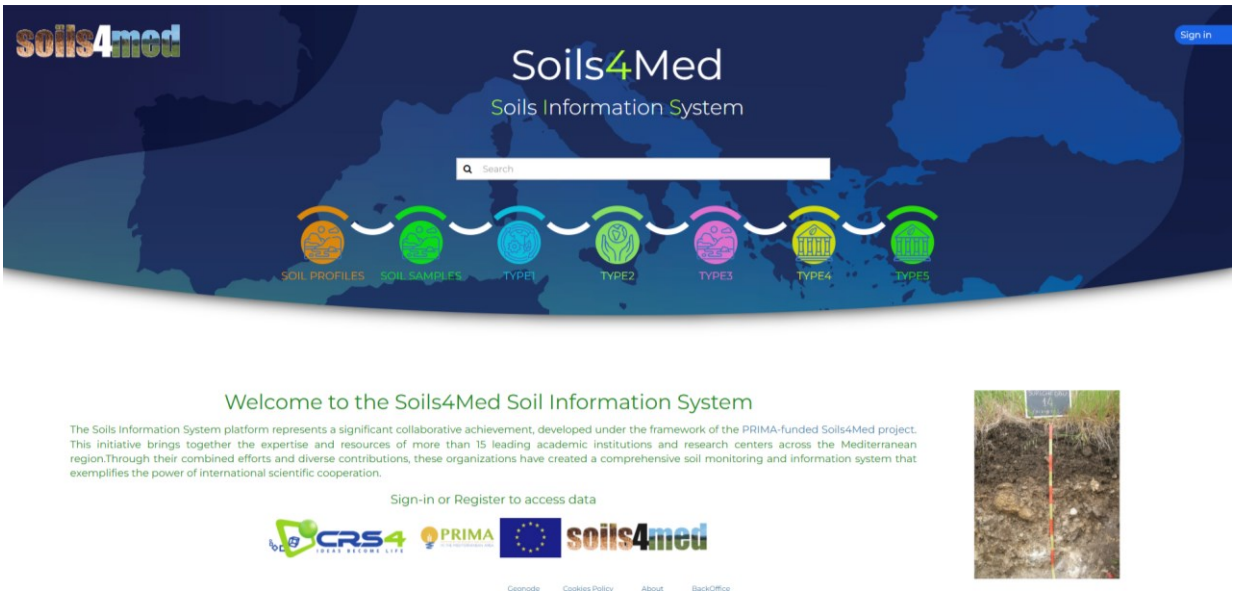

Figure 4. Home of the SIS Catalogue.

Back Office SIS and Cookies, and Data Policy can be accessed from any page of the SIS.

At the top of each web page, the user finds relevant logos, customizable SIS names, a set of icons defining identity themes, and a list of the different resources managed by the system (Figure 5).

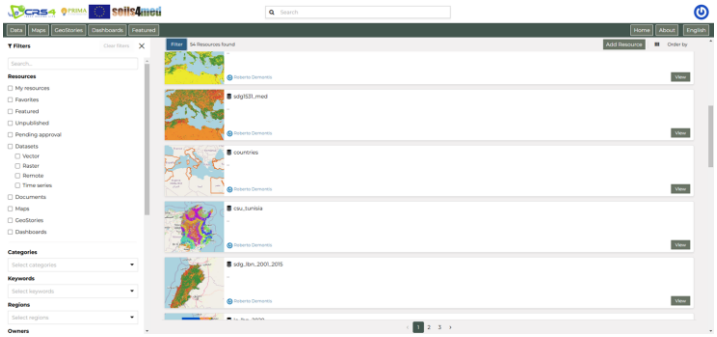

Figure 5. An internal page of the SIS Catalogue.

When a dataset is loaded into the Catalogue, metadata should be completed (Figure 6).
The maps will be created and configured in the Catalogue using GeoNode widgets (Figure 7).

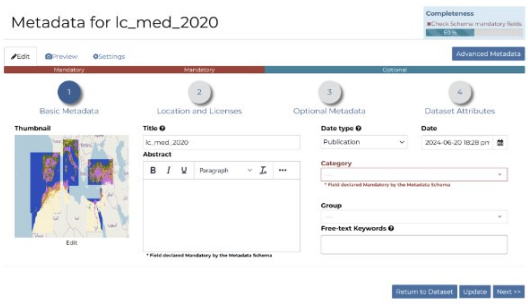

Figure 6. Metadata editing.

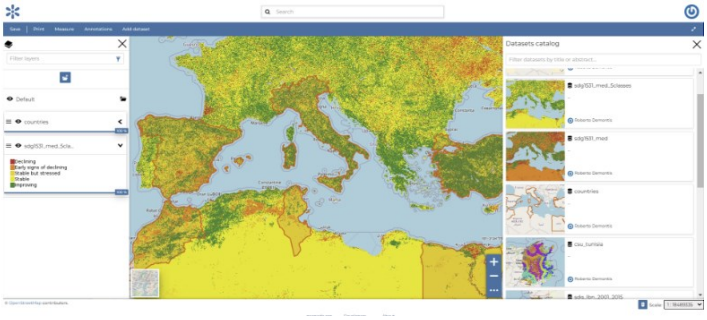

Figure 7. Map configuration.

Data sharing is performed using Geonode resource permissions (Figure 8).

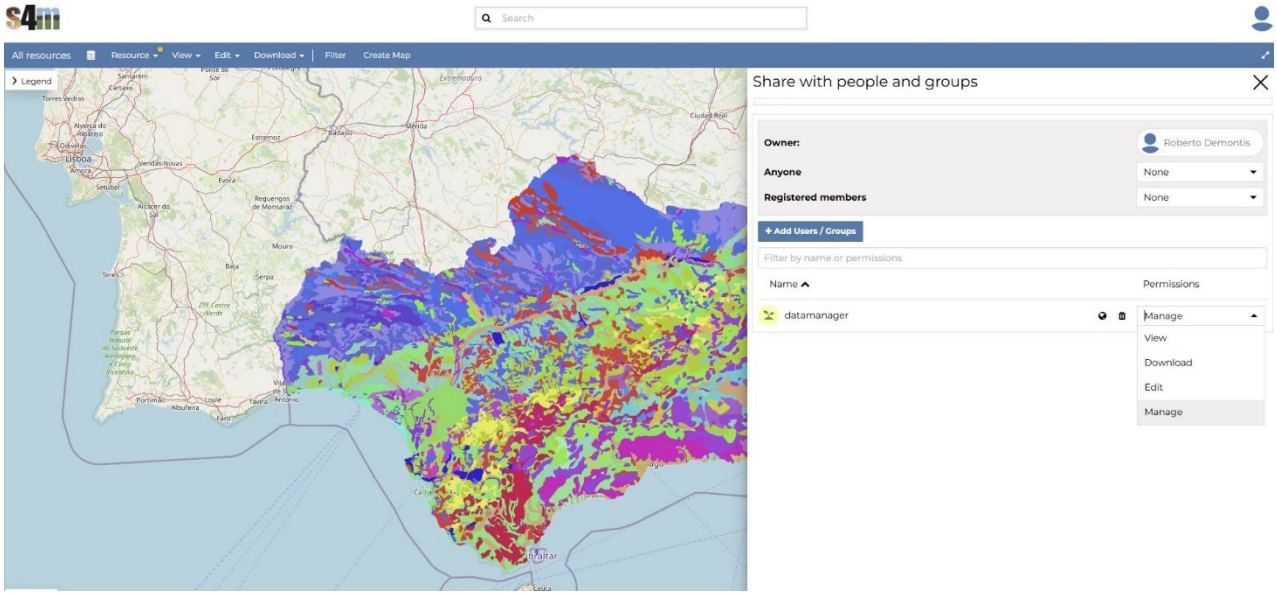

Figure 8. Soil data sharing.

SIS BACK OFFICE

Through the SIS Back Office, users can:

- **Upload** soil profiles and other point soil data ("soil samples") using the XLSX Spreadsheet format purposely developed by the SOILS4MED (in collaboration with Work Package 2) and/or Soil Indicators using Tiff files. Uploaded data are be validated through database constraints and a dedicated support table.
- **Manage** soil profiles, soil samples and soil indicators using standard CRUD operations (Create, Read, Update, Delete). Specific APIs and web pages facilitate user interaction.
- **Publish** GIS data by applying spatial, temporal, and/or alphanumeric filters to the soil data. This allows the publication of a selected subset of Soil Profiles as GIS data within the SIS Catalogue.

SOILDATA Geo Application

The Geonode Geo Application SOILDATA serves as the back-end of the SIS Back Office. It has been implemented using the Django Rest Framework. The application exposes a REST API to manage soil data resources and provide access to data in the SIS Back Office front-end.
Profile, sample, and indicators are the core soil data resources, accessible only to users belonging to the DataManager and Admin groups.
To handle API calls and manage soil resources, three mapping files were created to link an XLSX row to the corresponding ORM models.

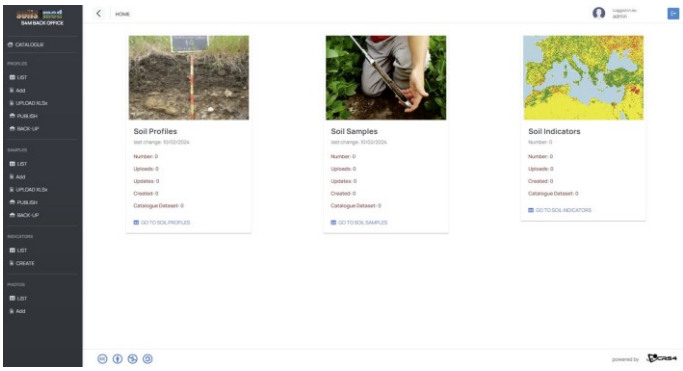

Figure 9. The SOILS4MED React home page.

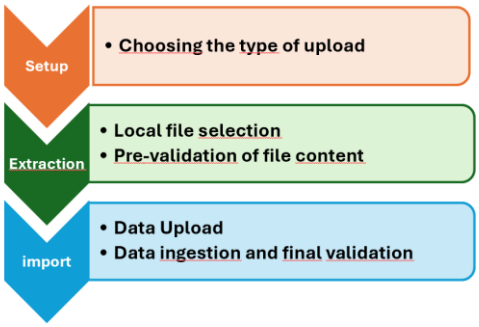

Figure 10. Steps for uploading soil data.

To upload point data, the users should upload a local XLSX file, which is pre-validated by the tool (Figure 11). If no errors are reported, the profiles or samples can be imported to the server. Validation errors are shown in a map and in a table for subsequent verification of the data.
The uploaded data will be accessible only to data managers and administrators and can be used to create new Maps, update the old ones, or generate new Datasets.

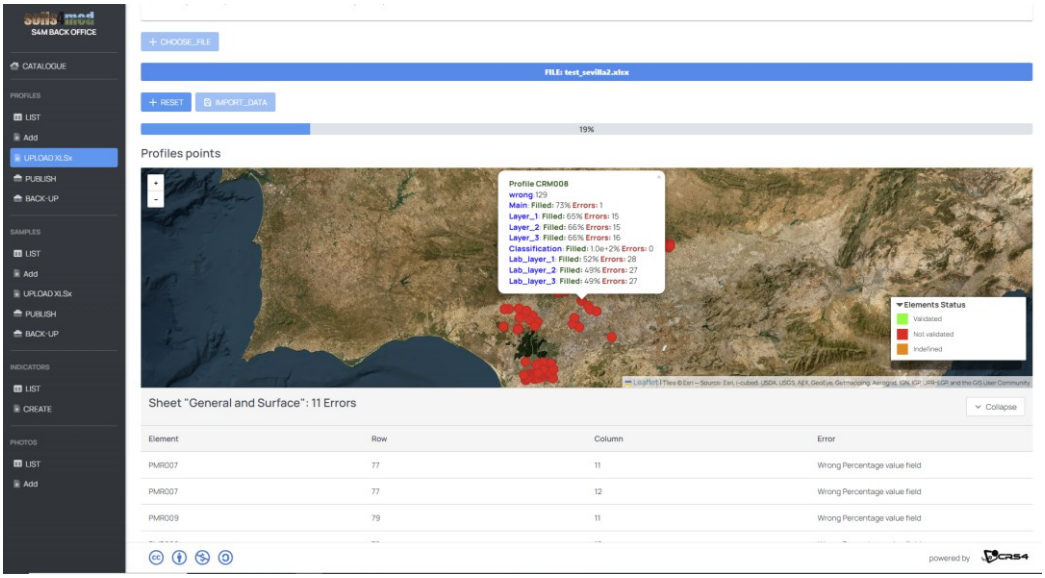

Figure 11. Upload: Pre-validation of the XLSX data.

SOILS4MED DELIVERABLES 5.1 AND 5.2 - SUMMARY FOR DISSEMINATION AND COMMUNICATION: Soil Information Systems (SIS) design and Deployment of the first SIS prototype
Lead author Deliverables 5.1 and 5.2: **Roberto Demontis** (CRS4).
Contributing authors Deliverables 5.1 and 5.2: Eva Lorrai (CRS4), Laura Muscas (CRS4), and Piergiorgio Palla (CRS4).

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FOR MORE INFORMATION

smsl@uniss.it | clzucca@uniss.it
Viale Italia 39, 07100 Sassari, Italy
mel.cgiar.org/projects/soils4med-
facebook.com/SMSoilLandscape
x.com/SMSoilLandscape
linkedin.com/company/smsoillandscape/