RURITAGE
Heritage for Rural Regeneration

RURITAGE Resource Ecosystem

D5.3

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1. Table of Contents

2. Background Information

Table 1: technical Information

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		Revised draft (RV)	
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		Confidential, only for members of the consortium (CO)	

Table 2: List of abbreviations

API	Application Programming Interface
ARs	Additional Replicators
A&DRs	Additional & Digital Replicators
CNH	Cultural Natural Heritage
D	Deliverable
DSS	Decision Support System
DRHH	Digital Rural Heritage Hub
FAIR	Findable, Accessible, Interoperable, Reusable
GDPR	General Data Protection Regulation
ICT	Information and Communication Technology
KPI	Key Performance Indicators
M	Month
R	Replicator
RM	Role Model
RRE	Ruritage Resource Ecosystem
SOA	Service Oriented Architecture
WP	Work Package
WS	Web Service

3. Executive Summary

This deliverable describes the whole Ruritage Resource Ecosystem (RRE), which is a distributed software platform establishing data ecosystem and open standards for information management aiming at providing different services and applications to address the needs of the different identified end-users. All data are made Findable, Accessible, Interoperable, Reusable (FAIR). The RRE has been designed to be deployed even into cloud systems compliant with the Infrastructure-as-a-Model paradigm. The platform is available online at the URL https://www.ruritage-ecosystem.eu/

The RRE is conceived as the shared digital common environment of the RURITAGE project for the storage, the development and the dissemination of RURITAGE knowledge on Heritage-led regeneration. The RRE hosts and integrates all the RURITAGE digital tools that are Atlas, Decision Support System (DSS), Digital Rural Heritage Hub (DRHH), Replication Toolbox, My Cult Rural Kit, Monitoring platform. To set up, populate and develop the RRE, thus, a strong collaboration with the other tasks of WP5 as well as WP1 (RM actions and Lesson learned and ATLAS), WP2 (Digital Rural Heritage Hub and knowledge sharing methods), WP3 (Replicators Action Plans and main methodology), WP4 (monitoring platform) and WP7 (photo contest photographs, website and dissemination and communication) were established, as they identified the main potential end-users and provided the main requirements for its design and development. In particular, WP1 defined the inputs (information sources, documents types and structure, data visualisation and data management and main semantic organization); WP2 provided the functional approach (community and capacity building approach for end users); WP3 provided Replicators with the needed tools for developing and implementing the Regeneration plan; WP4 registered and made available the results of the monitoring activities; WP7 provided crowdsourcing and communication (photographs collected by photo contest open concourse and further introduction with access from the project web site). The REE is also strictly linked with WP6 since its functioning will be maintained also after the end of the project, thus allowing the establishing and scaling up of the RURITAGE brand.

The deliverable also provides a synthetic overview of the tools integrated in the RRE. In particular, it reports more extensively about the RURITAGE Atlas technical architecture that has been also developed by Polito as part of Task 5.1. The Atlas is a WEB GIS platform with a synthetic and interconnected data representation and management available at the URL https://www.ruritage-ecosystem.eu/Atlas. It includes georeferenced information, a digital archive, a digital library. On the matter of the Atlas, this deliverable is to be linked to the complementary Atlas creative mapping (Task 1.3) with its development in WP1 delivered in D 1.3. 'RURITAGE Atlas.'

The RRE has been conceived and designed for creating a strong integration of the tools which have been included. Although the tools have diverse finalisations and diverse developers, they **re-use data** and information developed by the project and made available via RRE.

The RRE is designed, in fact, as the integrated digital environment for enabling functionalities of the RURITAGE project. It is conceived within RURITAGE as the main platform where to collect, store, analyse, show, select and use the data collected and analysed and usable information generated within the project for the scope of heritage-led regeneration in rural territories. By doing so RRE enables and makes available for all kind of end users the knowledge generated by the research, its methodologies and achievements. RRE creates the shared digital environment for developing, addressing and exploiting the project approach and methodologies among research partners; moreover, it is the digital environment whereother final users can interact for easily grasping understandings on RURITAGE rural areas and actioning their regeneration processes thanks to the data and tools made available. For this purpose, it allows directly access specific and crosscutting functions for visualizing effective systems of data description, exchanging knowledge, supporting decisions, surveying assessing, monitoring and finally replicating the RURITAGE methodology with a proper knowledge.
RRE, firstly, has been developed in strong collaboration with all other partners developers of digital tools that have been integrated in the platform. The developer partners are: ALMENDE (DSS), TECNALIA (Replication Toolbox), Plymouth (My Cult Rural Kit), Cartif (Monitoring platform), while the Atlas and Digital Rural Heritage Hub (DRHH) have been developed by POLITO. The guidelines and graphical improvements of RRE to provide a user-friendly

access to the RURITAGE digital environment with its functions are under development (Task 5.5) by UNESCO and will be delivered at Month 48 (D. 5.5). All these partners are the contributors of this deliverable.
RRE, secondly, with its shared digital environment has capillary supported the project development through its diverse development in its WPs since its beginnings and will continue to provide this support through the maintenance. Beyond the technical and the facilitator partners, the main users of the RRE are the Replicators (Rs) and also the Additional Replicators (ARs) and the Additional & Digital Replicators (A&Rs) as well as the Role Models (RMs). Facilitator partners, Rs, ARs, A&DRs, RMs are the main test-bed for this platform and its functions to be made available to all kind of end users.

During the development, we adopted the Agile methodology [2]. Agile is an approach to the project management which helps to respond to the unpredictability of building software through incremental, iterative work cadences, known as sprints. Agile development methodology provides the opportunity to assess the direction of a project throughout the development lifecycle. It does it through an iterative cycle to build and test followed by an assessment by the user/business until they are satisfied with the product. Thus, by focusing on the repetition of abbreviated work cycles as well as the functional product they yield; agile methodology could be described as iterative and incremental. Thus, following this methodology, software components of the RRE are periodically updated for bug fixing and/or new feature release. For this reason, T5.1 will guarantee the maintenance of the whole RRE, by ensuring consistence and usability of the platform across the whole duration of the project. A quality check on the integrity of the data will be performed, also considering that new data will be continuously generated and processed by the various tools of the ecosystem. The maintenance will include stability and resiliency checks performed on the distributed software infrastructure.

The deliverable is organized as follows. Chapter 4 describes the RRE distributed software infrastructure as a whole. Chapter 5 introduces the main ICT enabling technologies i) to develop the RRE platform, ii) to store heterogeneous information into flexible databases and iii) to share information among the actors in the systems by exploiting standard data-formats. It is worth noting that such technologies are agnostic w.r.t. the specific dataset and information to be post-processed, stored and exchanged. Chapters 6 to 11 introduce the main interoperable software components developed for the different tools in the RRE. Finally, Chapter 12 provides the concluding remarks.

4. Ruritage Resource Ecosystem as a Distributed Software Architecture

This section presents the Ruritage Resource Ecosystem (RRE) as a whole, which is a distributed software platform establishing data ecosystem and open standards for information management aiming at providing different services and applications to address the needs of the different identified end-users. All data have been made Findable, Accessible, Interoperable, Reusable (FAIR). The platform is available online at the URL https://www.ruritage-ecosystem.eu/

RRE is a digital open platform that hosts and integrates all RURITAGE digital tools developed in WP5 through diverse tasks that are Atlas, Decision Support System (DSS), Digital Rural Heritage Hub (DRHH), Replication Toolbox, My Cult Rural Kit, Monitoring platform. Tools are described in the following chapters. RRE has been conceived and designed for creating a strong integration of these tools that have diverse finalisations. The RRE architecture enables **to exchange and re-use data** and information developed by the project. By doing so the RURITAGE knowledge is made available via RRE.

To set up, populate and develop the RRE, thus, a strong collaboration with the other tasks of WP5 as well as WP1 (RM actions and Lesson learned and ATLAS), WP2 (Digital Rural Heritage Hub and knowledge sharing methods), WP3 (Replicators Action Plans and main methodology), WP4 (monitoring platform) and WP6 (photo contest), and WP7 (website and dissemination and communication) were established, as they identified the main potential end-users and provided the main requirements for its design and development. In particular, WP1 defined the inputs (information sources, documents types and structure, data visualisation and data management and main semantic organization); WP2 provided the functional approach (community and capacity building approach for end users); WP3 provided Replicators with the needed tools for developing and implementing the Regeneration plan; WP4 registered and made available the results of the monitoring activities; WP6 provided crowdsourcing (photographs collected by photo contest open concourse).

The platform integrates and enables RURITAGE tools for describing and characterizing existing conditions of rural regions (e.g. the Atlas and the Monitoring platform, the Replication Tool Kit), supporting actions for their enhancement (DSS, Replication toolbox) and networking rural stakeholders (DRHH). The integrated digital tools have been developed by RURITAGE technical partners within the scope of WP5. The RRE with all its tools enables the RURITAGE approach and methodologies for building an articulated systemic knowledge through Systemic Innovation Actions (SIA) and a strong structured knowledge exchange between RMs and Rs (during the project development added by A&R) supported by facilitator partners. RRE thus makes available useful understandings, information and tools for local stakeholders to undertake rural regeneration process. The platform allows this integration through a unified digital environment for the project as a whole. It allows thus end-users easily interacting with RURITAGE project methodology and outputs. RRE enables them to grasp understandings on the wide range of rural regions and use the diverse functions created by RURITAGE for supporting regeneration processes.
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For this purpose, it has been designed and developed following the Service Oriented Architecture (SOA) design pattern, allowing to develop a highly distributed software where each component exploits the Internet to enable the data exchange. In this view, a *Service* is a discrete unit of functionality or a set of software functionalities that can be accessed remotely and acted upon and updated independently. Hence, different software entities, acting as clients, can reuse the *Service* for different purposes. A *Service* can exchange information with other *Services* through communication interfaces over the Internet. As an example, Figure 1 depicts two services cooperating together: i) *Service Producer* provides data, making them available over the Internet; ii) *Service Consumer* retrieves data from the *Service Producer* for further analysis or visualizations.

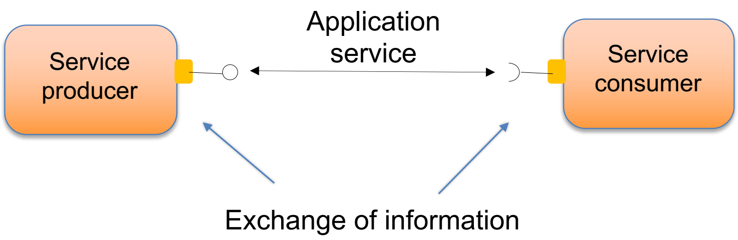

Figure 1. Data exchange among services.

Thus, the resulting RRE software infrastructure addresses the following main requirements:

- **Interoperability** among heterogeneous systems and technologies.
- **Scalability** to handle:
  - a large number of users
  - a large volume of data stored
  - a large volume of information exchanged and processed.
- **Reliability** to avoid or prevent possible failures and overloads.
- **Evolution over the time** by supporting rapid modification and enhancement with low cost and small architectural impacts.
- **Modularity** by designing the system as a collection of interoperable components that communicate through lightweight mechanisms.
- **Extendibility** to be capable of adding new functionality and supporting software updating, bugs correction, security policies and permissions updating.
- **Decentralization** to ensure that each service may implement its functionalities using the most appropriate technology. Thus, software components perform autonomously.
- **Flexibility** on supporting heterogeneous services with different characteristics and requirements.
- **Standardization** to foster data exchange by exploiting common interfaces and open data-formats.
- **Security** to guarantee authentication, data access, confidentially and privacy.

As shown in Figure 2, the REE consists of three-layered architecture with i) a *Data-source Layer*, ii) a *Distributed Core Components Layer* and iii) an *End-users Applications Layer.*

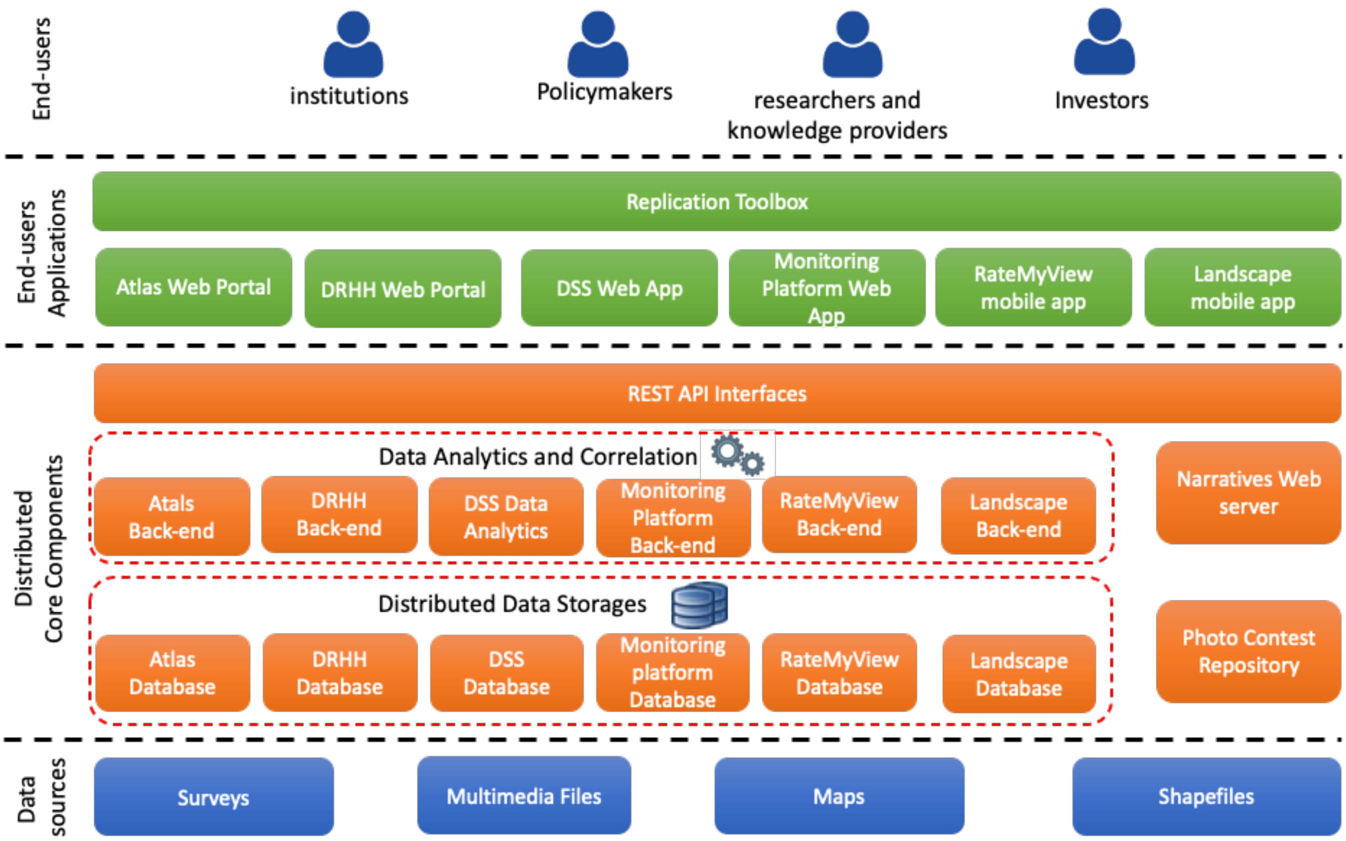

Figure 2. Schema of the Ruritage Resource Ecosystem Software Architecture

The *Data-source Layer* collects all the heterogeneous information that has been identified and analysed including audio/images, maps, shapefiles and alpha numerical documents. Most of the *Data Source Layer* is obtained in WP1 (especially see D1.3). In addition to this complementary relation between this deliverable and D1.3, also WP4, WP6 contribute to this layer. Please also refer to D1.1, D1.2, D1.3, D1.4 and D4.1 for more details.
Data sources *Layer al*so exchanges and integrates other data with other tools in RRE such as data coming from Rate my view App developed as part of the My Cult Rural Kit (Task 5.2 D. 5.2).
It is worth noting that all the data stored and managed in the RRE are compliant with European *General Data Protection Regulation* (GDPR) as well as FAIR data principles (findable, accessible, interoperable and reusable). Furthermore, Data sources *Layer* also links and integrates external data coming from other external data sources and namely Natura 2000 (https://www.minambiente.it/pagina/rete-natura-2000), Copernicus Land Monitoring Service (CORINE) Land Cover (https://land.copernicus.eu/pan-european/corine-land-cover).

The *Distributed Core Components Layer* provides developers with a set of *Services* designed exploiting the SOA approach. As mentioned above, each *Service* exposes its functionalities and data over the Internet. This layer aims to i) allow interoperability across heterogeneous technologies, ii) store and make available all the data available in the *Data Source Layer*, iii) post-process, correlate and analyse the heterogeneous data and iv) provide tools and Rest Web Services (see Chapter 5.1) to develop distributed applications.

The *End-users Applications Layer* represents the highest layer of the proposed infrastructure. It consists of a set of applications for the final end-users. At this level, interoperability is enabled between low-level heterogeneous technologies. A comprehensive analysis of potential end users of the RRE is foreseen within Deliverable 5.5 which includes identifying user groups based on a detailed knowledge and needs assessment, determining how specific user needs can be met via available platform components and functionalities, and improving engagement and interaction with the RRE tools. The platform interface has been optimized to increase user-friendliness and navigability of the RRE which is of particular benefit to first-time users without prior knowledge of the RURITAGE project. In addition, as part of Task 5.5, user guides and trainings will be developed to build capacities of key stakeholders to comprehensively utilize the RRE and ensure its sustainability (more details will be provided in D5.5 "Guidelines for the RURITAGE Resources Ecosystem sustainability" due to M48). The user evaluation will build on previous project outputs and deliverables, such as Deliverable 3.1 focused on the stakeholder identification and engagement strategy within the RURITAGE Rural Heritage Hubs (RHH). Primary stakeholders of the RHH defined within D3.1 (i.e. regional and local governing bodies & institution, universities & research institutes, schools & other education and training centres, NGOs/civil society organizations, key service providers in rural areas, peculiar representatives of SIAs relevant for RMs and Rs, public & private investors and local residents) will serve as a starting point for the identification of potential user groups of the RRE. Based on concrete use case examples, the added value of the platform will be assessed for various stakeholder groups. Additional groups may be added as relevant target audience/end users of the RRE.

As shown in Figure 2, thanks to the software interoperability among the different services (i.e., the blocks) different tools have been developed by RURITAGE technical partners as follows:

- **Atlas** allows an interactive navigation in the Ruritage territories and searching for some specific features to learn about Role Models' and Replicators' cultural and natural heritage and their territories and be provided by the tuned georeferenced data (see Chapter 6);
- **Digital Support System** (DSS) is a system to support end-users in discovering and composing possible heritage-led regeneration scenarios by taking into account previous initiatives and providing suggestions and possible programmes to be implemented at replicating sites (see Chapter 7);
- **Digital Rural Heritage Hub** (DRHH) aims to allow knowledge sharing related to the Systemic Innovation Areas of the RURITAGE project by providing a virtual forum for discussions (see Chapter 8);
- **RateMyView** (which is part of the **MyCult Rural Kit**) allows text and images to be collected and georeferenced by end-users using smartphones or tablets 9
- **Landscape Connect** (which is part of the **MyCult Rural Kit**) allows in-the-field user data collection by end-users using smartphones or tablets. Such information will be used as input for further data analysis by researchers and workshop facilitators. Textual data is elicited through questionnaires presented to the mobile user. The researcher can create questionnaires of any degree of simplicity or complexity, using the main conventional survey question types (see Chapter 9);
- **Monitoring Platform** enable users to monitor their implementation process on rural development. This tool provides evidence of the role of cultural and natural heritage as a driver for sustainable growth in rural areas (see Chapter 10);
- **Replication ToolBox** offers a tailored step-by step guide to the tools and resources generated within the RURITAGE project (see Chapter 11).

Finally, the whole RRE has been developed considering possible future extensions, that could also include the development of new applications and the interoperability even with third-party software. For example, the current version of the RRE already integrates Natura 2000 and CORINE Land Cover which are datasets provided by the Copernicus Land Monitoring Service. CORINE Land Cover is a part of the Pan-European component whereas Natura 2000 is a part of the local component of Copernicus and both are coordinated by the European Environment Agency. Thus, data are autonomously retrieved by their respective software platforms.

To develop each service (i.e., each block) in Figure 2, we followed the Service Lifecycle depicted in Figure 3, which consists of five different phases organized in a loop [1]:

- **Service Definition**: the service is described highlighting the main features and functionalities.
- **Service Design**: requirements are analysed and functions, features, interoperability with other entities are identified. Then, different service functions and requirements should be allocated to different system entities by modelling concrete use cases under different scenarios.
- **Service Implementation**: information exchange and interactions among system entities are ensured through service integration, verification & validation and proper testing methodologies.
- **Service Delivery**: service is continuously monitored to ensure meeting pre-set software KPIs (Key

Performance Indicators). Potential service improvements are identified that can enhance the service itself or become new service(s).

- **Service Decommission:** this phase includes activities related to disposal or replacement of service or service components.

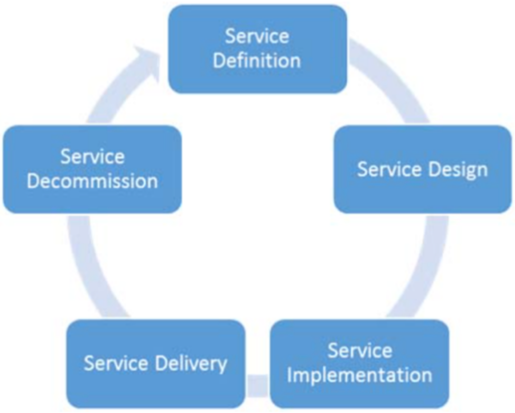

Figure 3. Service Lifecycle

After a first iteration, the Lifecycle loop starts again for updating the service. A re-definition of the service could be needed based on potential improvements resulting from previous phases.

5. Enabling Technologies

This Chapter briefly presents all the key ICT enabling technologies involved in the development of the RRE and its tools. In particular, we employed:

- REST Web Services to make the platform distributed across different servers and, even, cloud systems. Thus, the various Services (i.e. software components in Figure 2) can interoperate by autonomously exchanging information over the Internet following the REST directives to establish Machine-to-Machine communications.
- MongoDB as main database management system to store heterogenous information following the Document-Oriented schema which is more flexible w.r.t. traditional Entity-Relation databases.
- JSON and GeoJSON as two main data-formats to exchange data over the Internet. GeoJSON is a variant of JSON that reports also georeferenced information

The rest of this chapter will provide more details on these technologies.

5.1 Web services for Machine-to-Machine communications

Web services are open standard based web applications that interact with other web applications to enable Machine-to-Machine communications for data exchange over the Internet. Web services are self-contained, modular, distributed, dynamic applications that can be described, published, located, or invoked over the network to create products, processes, and supply chains. These applications can be local, distributed, or web based. Web services are built on top of open standards such as TCP/IP, HTTP, HTML, and JSON.
The advantages to adopt a Web Service architecture are summarized as follow:

1. **Exposing Business Functionality on the network** - A web service is a unit of managed code that provides some sort of functionalities to client applications or end users. Nowadays all applications are on the internet which makes the purpose of Web services more useful. That means the web service can be anywhere on the internet and provide the necessary functionalities as required.
2. **Interoperability among heterogeneous applications** - Web services allow various applications to talk to each other and share data and services among themselves. All types of applications can talk to each other. So instead of writing specific code which can only be understood by specific applications, developers can program generic code that can be understood by all applications
3. **Standardized Protocols** - Web services use standardized industry protocol for the communication. All the four layers, i.e. Service Transport, Messaging, Service Description, and Service Discovery layers, uses well-defined protocols in the web services protocol stack.
4. **Reduction in cost of communication** - Web services strongly use the HTTP protocol for data exchange. Thus, the existing Internet can be fully used to implement distributed software infrastructure.

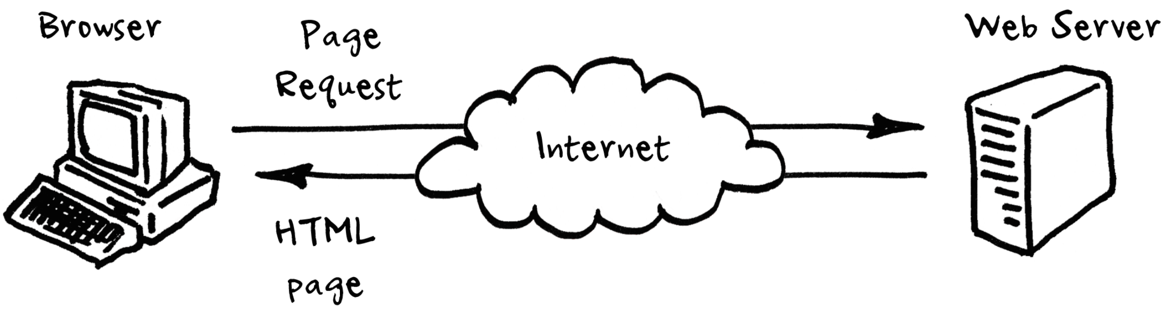

Figure 4. General Web Services architecture

Figure 4 shows a view of how a web service works. The *client* (i.e. Browser in this example) requests to a *web server* a series of web services (i.e. Page Request in this example). These requests are made through what is known as remote procedure calls. Remote Procedure Calls (RPC) are calls made to methods which are hosted by the relevant web service.

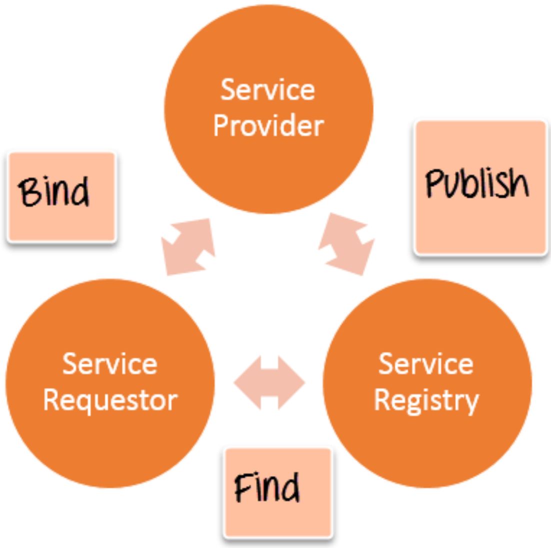

Figure 5. Web Services architecture

As shown in Figure 5, the main software entities involved in a distributed software infrastructure based on Web Service design pattern are:

1. The **Provider** creates the web service and makes it available to client application who want to use it.
2. The **Requestor** is the client application that needs to contact a web service. The client application can be in any language-based application which looks for some sort of functionality via a web service.
3. The **Broker** is the application which provides access to the Universal Description Discovery and Integration (UDDI). The UDDI enables the client application to locate the web service.

Figure 5 also shows the three main interactions among the above-mentioned software entities:

1. **Publish:** a provider informs the broker (service registry) about the existence of the web service by using the broker's publish interface to make the service accessible to clients.
2. **Find**: the requestor consults the broker to locate a published web service.
3. **Bind**: with the information it gained from the broker (service registry) about the web service, the requestor is able to bind, or invoke, the web service.

5.1.1 HTTP – REST

Representational State Transfer (REST) is an architectural style to develop web services defining uniform interfaces for data exchange over the Web. REST allows to develop distributed systems guaranteeing to the whole software infrastructure: i) good performance, ii) scalability, iii) modularity, iv) flexibility, v) extendibility, vi) evolution over the time and vii) decentralization. In the REST architectural style, data and functionality are considered resources and are accessed using Uniform Resource Identifiers (URIs) (typically links on the Web). The resources are acted upon by using a set of simple, well-defined operations. The REST architectural style constrains an architecture to a client/server architecture and is designed to use the HTTP (Hypertext Transfer Protocol), which is a stateless communication protocol. In the REST architecture style, clients and servers exchange representations of resources by using a standardized interface and protocol.

The following principles encourage REST applications to be simple, lightweight, and fast:

- **Resource identification through URI**: A REST web service exposes a set of resources that identify the targets of the interaction with its clients. Resources are identified by URIs, which provide a global addressing space for resource and service discovery.
- **Uniform interface**: Resources are manipulated using a fixed set of four create, read, update, delete operations. To this purpose, REST defines how to properly use the main HTTP methods: PUT, GET, POST, DELETE and PATCH. PUT creates a new resource, which can be then deleted by using DELETE. GET retrieves the current state of a resource in some representation. POST transfers a new state onto a resource. PATCH performs a partial update of an existing resource.
- **Self-descriptive messages**: Resources are decoupled from their representation so that their content can be accessed in a variety of formats, such as HTML, XML, plain text, PDF, JPEG, JSON, and others. Metadata about the resource is available and used, for example, to control caching, detect transmission errors, negotiate the appropriate representation format, and perform authentication or access control.
- **Stateful interactions through hyperlinks**: Every interaction with a resource is stateless; that is, request messages are self-contained. Stateful interactions are based on the concept of explicit state transfer. Several techniques exist to exchange state, such as URI rewriting, cookies, and hidden form fields. State can be embedded in response messages to point to valid future states of the interaction.

Figure 6 summarizes the main interaction between Clients and a REST API, for instance, in managing a user account.

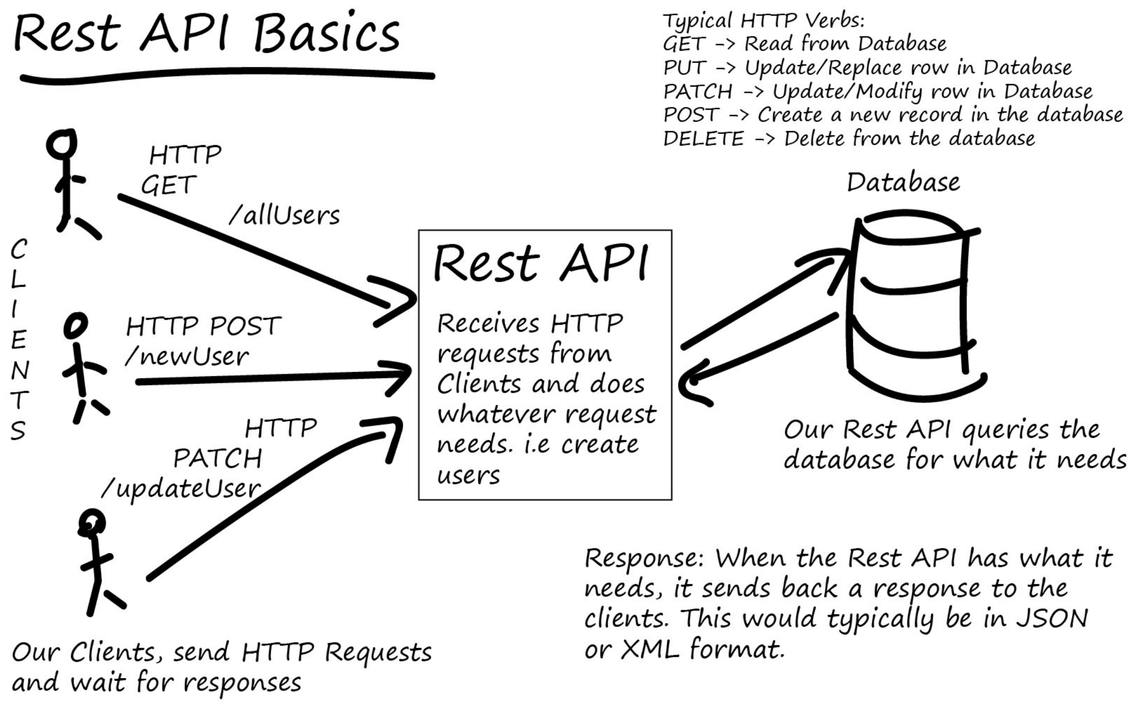

Figure 6. Example of a RESTful application for user management

5.2 The JavaScript Object Notation (JSON) data format

The JavaScript Object Notation (JSON) is a standard text-based format for representing structured data based on JavaScript object syntax. It is a hierarchical (i.e. values can contain lists of objects or single values) self-describing data-format human and machine readable. JSON uses typed objects. In ICT applications, this lightweight data-interchange format is commonly used for transmitting data in web applications (e.g., sending some data from the server to the client, so it can be displayed on a web page, or vice versa). All these properties make fast both coding and decoding the information. Even though it closely resembles JavaScript object literal syntax, it can be used independently from JavaScript, and many programming environments feature the ability to read (parse) and generate JSON. Nowadays, JSON is becoming the de-facto standard for data-format in web environments.

JSON is built on two structures:

- **A collection of name/value pairs**: in various languages, this is realized as an object, record, struct, dictionary, hash table, keyed list, or associative array.
- **An ordered list of values**: in most languages, this is realized as an array, vector, list, or sequence.

As described above, JSON is a string whose format very much resembles JavaScript object literal format. JSON includes the same data types as the JavaScript object: strings, numbers, arrays, booleans, and other object literals. This allows to construct a data hierarchy, like so:


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{
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      "Code": "RM2",
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      "DriveUrl": "1iDznYM-hHuSJgeMJ2vytMMtSxDnzotNy",
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      "Title": "Two ways",
      "_id": 123456
    },
    {
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      "Code": "RM2",
      "Description": "The empty saddle from Sumuleu Ciuc, Transylvania. Every year, hundreds of thousands pilgrims come here to see the celebration of the Eucharist. In the year of 2020, because of the pandemy, the pilgrims could not came. The picture was taken a week before the event should have been.   ",
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        "DATA_IN_AU": "POLITO_AS",
        "DA_R_IM1": null,
        "NAME": "Harghita Tours office in Odorheiu Secuiesc",
        "NOTES": null,
        "QR": 0,
        "RM_R_CODE": "RM2",
        "RM_R_IM1": "HCC_Q7_TouristicGuide.pdf",
        "RM_R_WEBSI": "https://www.ruritage.eu/RHH/maria",
        "TYPE": "TI",
        "id": 2
      },
      "type": "Point"
  }]
}
```


To access data down the hierarchy, we have to chain the required property names and array indexes together. For example, we can access the attribute *Description* in the first entity in *photocontest* as follows:

photocontest[1][‘description’]

5.2.1 GeoJSON: dataformat for georeferenced information

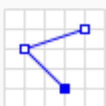
GeoJSON is a geospatial data interchange format based on JSON that is an open standard format designed for representing simple geographical features. Generally, these features include:

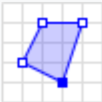
- **Points** to represent addresses and locations.
- **Line strings** to report streets, highways and boundaries.
- **Polygons** to represent countries, provinces, tracts of land.
- **Multi-part collections** of these types.

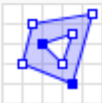
Primitive geometries are represented as follows:

Type	Geometries	

Point		{
		"type": "Point",
		"coordinates": [30.0, 10.0]
		}

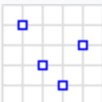
LineString		{
		"type": "LineString",
		"coordinates": [
		[30.0, 10.0], [10.0, 30.0], [40.0, 40.0]
		]
		}

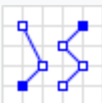
Polygon		{
		"type": "Polygon",
		"coordinates": [
		[[30.0, 10.0], [40.0, 40.0], [20.0, 40.0], [10.0, 20.0], [30.0, 10.0]]
		]
		}

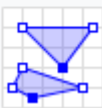
		{
		"type": "Polygon",
		"coordinates": [
		[[35.0, 10.0], [45.0, 45.0], [15.0, 40.0], [10.0, 20.0], [35.0, 10.0]],
		[[20.0, 30.0], [35.0, 35.0], [30.0, 20.0], [20.0, 30.0]]
		]
		}

Instead, more complex geometries are handled as follows.

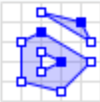
Type	Geometries	

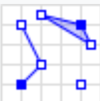
MultiPoint		{
		"type": "MultiPoint",
		"coordinates": [
		[10.0, 40.0], [40.0, 30.0], [20.0, 20.0], [30.0, 10.0]
		]
		}

MultiLineString		{
		"type": "MultiLineString",
		"coordinates": [
		[[10.0, 10.0], [20.0, 20.0], [10.0, 40.0]],
		[[40.0, 40.0], [30.0, 30.0], [40.0, 20.0], [30.0, 10.0]]
		]
		}

MultiPolygon		{ "type": "MultiPolygon", "coordinates": [[[[30.0, 20.0], [45.0, 40.0], [10.0, 40.0], [30.0, 20.0]]], [[[15.0, 5.0], [40.0, 10.0], [10.0, 20.0], [5.0, 10.0], [15.0, 5.0]]]

		] }

		{
		"type": "MultiPolygon",
		"coordinates": [
		[
		[[40.0, 40.0], [20.0, 45.0], [45.0, 30.0], [40.0, 40.0]]
		],
		[
		[[20.0, 35.0], [10.0, 30.0], [10.0, 10.0], [30.0, 5.0], [45.0, 20.0], [20.0, 35.0]],
		[[30.0, 20.0], [20.0, 15.0], [20.0, 25.0], [30.0, 20.0]]
		]
		]
		}

GeometryCollection		{
		"type": "GeometryCollection",
		"geometries": [
		{
		"type": "Point",
		"coordinates": [40.0, 10.0]
		},
		{
		"type": "LineString",
		"coordinates": [
		[10.0, 10.0], [20.0, 20.0], [10.0, 40.0]
		]
		},
		{
		"type": "Polygon",
		"coordinates": [
		[[40.0, 40.0], [20.0, 45.0], [45.0, 30.0], [40.0, 40.0]]
		]
		}
		]
		}

5.3 Database Management Systems

A database is a collection of information that is organized so that it can be easily accessed, managed and updated. Computer databases typically contain aggregations of data records or files. Databases have evolved since their inception in the 1960s, beginning with hierarchical and network databases, through the 1980s with object-oriented databases, and today with SQL and NoSQL databases and cloud databases.
Databases can be classified according to content type: bibliographic, full text, numeric and images. In computing, databases are sometimes classified according to their organizational approach. There are many different kinds of

databases, ranging from the most prevalent approach. To develop the RRE, we employ MongoDB which is a NoSQL database suitable to store heterogeneous data.

5.3.1 Introduction to MongoDB

MongoDB is an open source, document-oriented NoSQL database used for high volume data storage. As a NoSQL solution, MongoDB does not require a Relational Database Management System (RDBMS), so it provides an elastic data storage model that enables users to store and query multivariate data types with ease. This simplifies database management for users and also creates a highly scalable environment for cross-platform applications and services. Instead of using tables and rows as in the traditional relational databases, MongoDB makes use of *Collections* and *Documents*. Documents consist of key-value pairs which are the basic unit of data in MongoDB (Figure 7). Collections contain sets of documents and functions which are the equivalent of relational database tables. MongoDB documents or collections of documents are the basic units of data. Formatted as JSON, these documents can store various types of data and be distributed across multiple systems. Since MongoDB employs a dynamic schema design, users have unparalleled flexibility when creating data records, querying document collections through MongoDB aggregation and analysing large amounts of information.

In general, the advantages to exploit MongoDB can be summarised as follows:

- Each database contains collections which in turn contains documents. Each document can be different with a varying number of fields. The size and content of each document can be different from each other.
- The document structure is more in line with how developers construct their classes and objects in their respective programming languages. Developers will often say that their classes are not rows and columns but have a clear structure with key-value pairs.
- The documents do not need to have a schema defined beforehand. Instead, the fields can be created on the fly.
- The data model available within MongoDB allows to represent hierarchical relationships, to store arrays, and other more complex structures more easily.
- Scalability – The MongoDB environments are very scalable.

The below example in Figure 7 and Figure 8 shows how a document can be modelled in MongoDB.

1. The *_id* field is added by MongoDB to uniquely identify the document in the collection.
2. The *Order Data* (OrderID, Product, and Quantity) contains different information characterizing an hypothetical order of a product. Such information is stored as an embedded document in the collection itself. This is one of the key differences in how data is modelled in MongoDB w.r.t. traditional RBMS where information normally is stored in a separate table.

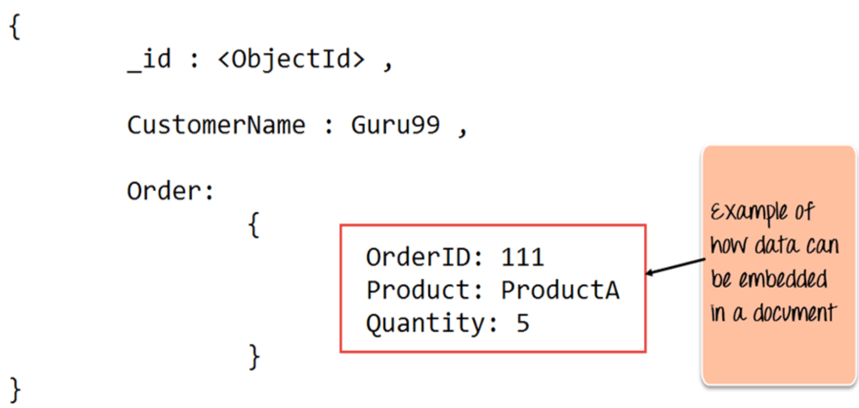


Figure 7. MongoDB document modelling

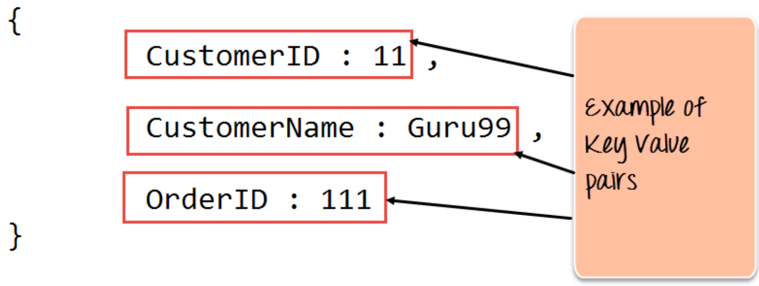


Figure 8. Example of Key-Value pairs

6. Atlas

Atlas is an interactive tool that allows navigating in the Ruritage territories and searching for some specific features to learn about Role Models' (RMs) and Replicators' (Rs) cultural and natural heritage (CHN). It enables rich insights into their places, experiences, territories, and stories. In particular, this deliverable is to be considered complementary to the Atlas creative mapping (Task 1.3) as part of the output of WP1 delivered by Polito with D 1.3. 'RURITAGE Atlas", that provides a complete detailed description about the data and information provided and the ways to visualise the different features. After the first period review, and following the reviewers' feedbacks, the user-friendliness of the Atlas has been increased through a new graphical user interface (GUI) and more data were integrated within the Atlas; the updated deliverable D1.3 has been submitted in September 2020. Moreover, as anticipated in the D1.3 final release, further improvements in its functionalities and also in its creative mapping have been undertaken, conceiving the Atlas as a dynamic living tool within the REE, that acquire, organise and visualise data also coming from the development of the project through the work done in other tasks. Therefore, this deliverable includes the new updates undertaken after September 2020.
The Atlas is available online at https://www.ruritage-ecosystem.eu/atlas.

Atlas integrates human-landscape interactions, historical and topographic representations, images and 3D representations, factors of hybridization of rural regions by cross-elements, etc. and it defines integrated rural/urban attributes. Atlas enables a number of applications, both for further research activities and providing a service for rural communities willing to undergo a process of heritage-led rural regeneration. Practically, the Atlas ensures interoperability with existing platforms by using web-service based access and open APIs. As a result, the Atlas integrates both existing data by exploiting a spatial approach supported by a webGIS tool as well as data gathered by including local stakeholders and data generated by RURITAGE project for providing keys of interpretation of the rural landscapes and heritage. The aim of the Atlas is to bridge the gap between a static lands representation of the state of the art and the continuous change that occurs locally, and to make available new data gathered and existing data in order to produce a novel usable knowledge by an innovative - scientific and social - approach to rural landscapes aimed to provide evidence of the human-landscape interactions, making people able to interact in a proper effective way with rural areas for enhancing economic growth (i.e. for planning, preserving developing, enhancing rural regions). RURITAGE Atlas thus aims to offer to local communities a very effective instrument for checking, monitoring and planning local developments in a European vision.
After the final submission of D1.3, further developments have been included for Replicators including narratives for enhancing understanding and appreciating the cultural and natural heritage of territories to enable keys of interpretation of rural landscapes.
Furthermore, 17 additional Replicators (ARs) have been added to the Atlas, with descriptions that outline the main rural characteristics of their areas. As explained in the paragraph 3.1. (Data analysis objectives and methodology: from raw data to processed data) of the D1.3 Ruritage Atlas, ARs data also have been processed with a consideration of aspects of sensitive data and copyright. All data both gathered and collected through a desk research, have been checked by the pertaining local stakeholders that are partners of RURITAGE project (RMs, Rs, ARs).
The Atlas also allows visualizing the Photo-contest outputs (Task 7.4) consisting in 482 photographs of 25 territories (12 RMs, 6 Rs, and 7 ARs).

6.1 Objectives

Atlas technical function development has coherently supported and provided the ICT expertise for the fulfilment of the RURITAGE Atlas creative mapping (Task 1.3). RURITAGE Atlas aims at achieving an integrated vision of the Role Models (RMs) and Replicators (Rs) assets, by combining the physical natural features with the human and cultural interactions with those territories over time. Furthermore, it aims to a comprehensive descriptive approach combined with an analytical vision to create layers of local knowledge for the coherent development of the RURITAGE Atlas as a structural component of the RURITAGE Resources Ecosystem.

The RURITAGE Atlas approach is based on the cultural landscape concept of human interactions with natural areas, that has created a cultural integration through several factors. The Atlas also includes demographic data and economic and social factors that are able to underline those anthropic, economic and social potentials that can push resilience and social cohesion in the territories. It also provides evidence of all heterogeneous data that can be useful for better describing and identifying characterisations and needs of rural territories. For this purpose, the Atlas creative mapping gathered and collected new data and linked other important existing data that are generally scattered and difficult to integrate and address to specific rural regions. Its functionality allows managing and displaying these integration

Therefore, the Atlas collect, addresses, manages and makes available information generated by data sources of the project as well as other data coming from external data sources.

The Atlas environment provides these data in an organised and spatialised representation to be immediately linked to local territories. It addresses specific features, indeed, in the aim of stressing the features of the regeneration processes through the end-user's participation in data providing. The mapping has underlined the characteristics of the places and their potentials together with providing narratives about historical and cultural layers of landscapes, historical dynamics of this landscape creation,

The Atlas is conceived to provide information based on RMs and Rs territories' potential, points of strength and capability to improve by replicating and tailoring the good practices that have been identified. The landscape mapping – and consequently the data gathering – is conceived in a conceptual framework aimed at the identification of: i) Resources and their Exploitation, ii) Identities and the Sense of place, iii) Temporal and Spatial Dynamics. For Replicators, some specific negative gaps in landscape perception have been stressed.

6.2 Technical Architecture

Figure 9 describes the data exchange flow by highlighting logical functions and main RRE software components.

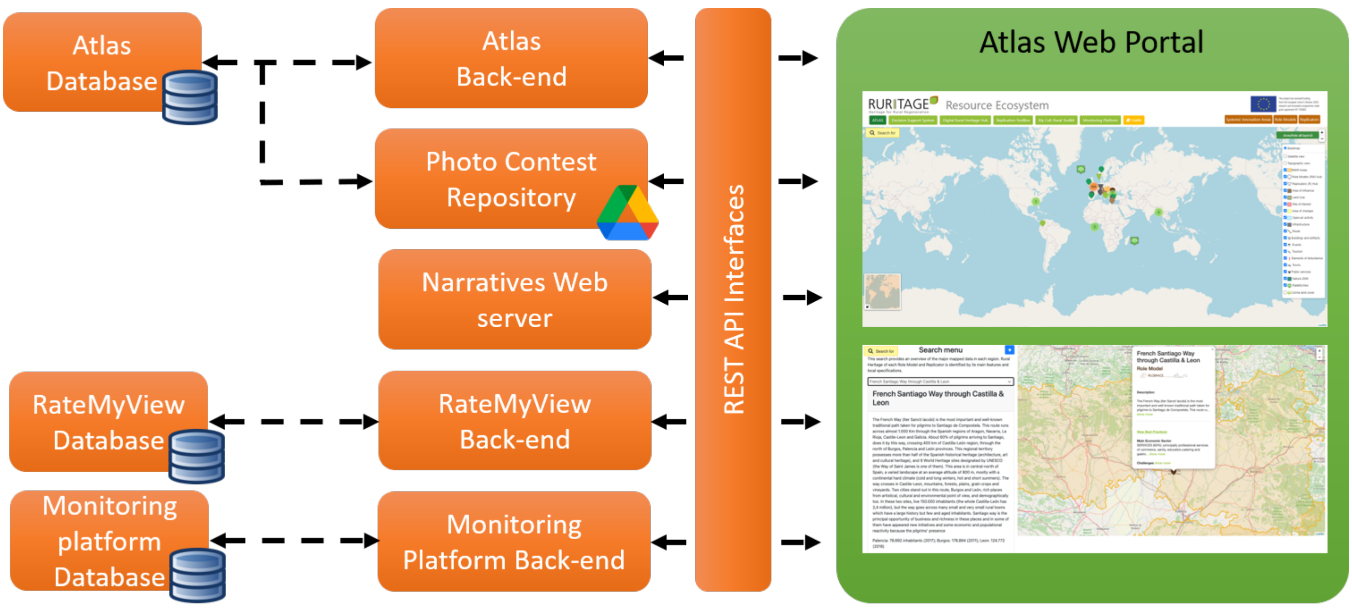


Figure 9. Communication flows of the Atlas

The Atlas structure has been shaped according to the holistic approach of the RURITAGE Resource Ecosystem, which inspired a synthetic and interconnected data representation and management. The Atlas includes georeferenced information, a digital archive, a digital library, and can be explored by navigating the map or by entries organised in a menu.

All data collected have been linked to each RM and R territory by georeferencing them in the Atlas map. Georeferenced data refer to physical features and intangible contexts of the RURITAGE Territories. Following this approach, they have been organised by two main layers - RURITAGE Territories and Rural Contexts – each of them containing sub-layers. They identify the structure of the Atlas georeferenced database. Moreover, the Atlas also stores the visual, audio and textual documentation received from RMs and Rs as well as searched as desk works. This documentation has been organised, linked to each RM/R territory and collected into digital archives. Apart from the data mapped and its archive, the Atlas also offers visual narratives. By using the data collected as a starting point, these narratives have been developed as a new elaboration and provide interpretations of the RURITAGE territories, features and contexts. The data georeferenced amount to more than 1,800 items.

The platform has been designed by using mainly:

- **Flask**, a web framework written in Python
- **Leaflet**, a JavaScript library which allowed georeferenced data to be manipulated
- **MongoDB**, a NoSQL database using JSON-like documents

The rest of this Chapter will describe in detail all the main software components in Figure 9.

6.3 Atlas Database

Atlas Database component leverages upon MongoDB collecting information following the GeoJSON data-format (see Chapter 5.2 and chapter 5.3). The georeferenced system has initially been developed by using QGIS free open-source system. It is composed of a list of Layers consisting of points, polygons or lines on the map and each of them is composed of several Attributes. Follows is a summary of the structure:

COLLECTION	TYPE	DESCRIPTION
RMS /RS AREA	Polygon	It refers to the main area of each RM and R. Its attributes identify the main characterization of the area, including documentation about the site (such as the most recent and the oldest cadastral maps; digital inventories; videos, phone applications, etc.).
INFLUENCE_AREA	Polygon	It refers to the influence area of each RM and R according to the SIA they belong to (pilgrimage, sustainable food production, migration, art&festival, resilience, landscape).
LAND_USE	Polygon	It refers to the functional distribution of land and land use within RM and R area. Its attributes identify and describe, among others, the type of functions and production (agriculture, industrial, commercial, residential, touristic, public, etc).
SITE	Polygon	It refers to any site characterising the RMs and Rs territories, such as heritage sites, archaeological remains, naturals sites, and historical settlements, and areas under the risk of natural disasters. Its attributes identify and describe the legal registration status of the site (UNESCO, national conservation area, local conservation area, not registered etc); the status of master/conservation/management plan (planned, continuing, historical, recent); the type of site (gorge, lake, falls, park, mining site, park, settlement, village, archaeological site, rural production site, craft production site, vineyard, altar, crossing, statue, beauty spot, asset, monument, archaeological remains), the level of popularity of the site (recently popular, historic, in literature, in media, traditional storytelling) and other information.

INFRASTR	Polygon	It stands for infrastructures. It refers to relevant infrastructural elements within RM and R area. Its attributes identify, among others, the infrastructure's category (transport, water, electricity, sewage/canalization, energy, public service); the infrastructure's type (highway, street, trail, square, travel hub, bridge, railway, railway station, long-distance bus station, river, canal, wind/solar energy source, municipality, hospital).
BUILDINGS	Point	It refers to monuments, historic buildings, and other significant buildings within RM and R area. Its attributes identify and describe the function (museum, religious, governmental, residential, public, commercial, residential, industrial, military, tourism); the building type (city hall, priesthood, centre, castle, chapel, shelter, monastery, church, complex, prison, palace, museum, hermitage, tower, house, barn, jurisdictional roll, washtub, cell, mill, observatory, bath, farm); if the building is a heritage asset, if the building is rehabilitated, the reason for rehabilitation (cultural activities, activities related to art and festival, migrants hospitality, public authority headquarters, tourism, private uses), rehabilitation date/temporal frame; the status of conservation (planned, continuing, historical, recent); and other info such as the building date, the architect, etc.
ELEMENTS OF DISTURBANCE AND INTERFERENCE	Point	It refers to elements of disturbance within R areas. Its attributes identify the type of elements: telecommunication (base stations for mobile phones, radios, TVs); transportation (highways, canals, tunnels); technological (gas pipeline, power plant); electrical infrastructural elements (electric cables, poles); implantation for renewable energy (solar panels, photovoltaics, wind farms); instalment of elements potentially movable that change the perception of the landscape (large advertisement panels, large LCD screens, etc); commercial, industrial or agricultural settlements with their services; quarries (active, underused, dismissed); waste facilities (active, underused, dismissed); attraction areas (amusement parks, camping/picnic areas); buildings or groups of buildings that affect the character of the landscape (e.g. sprawl); new buildings that contrast with the cultural natural landscape because of typology, color, material, decontextualization; improper street pavement (asphalt in natural area, improper finishing); recurrent collective events that contrast with the landscape (carousel, circus); new collective events that contrast with the landscape (e.g. parties).
OPEN_AIR	Polygon	It refers to relevant open-air activities within RM and R area. Its attributes identify and describe, among others, the temporal frame/periodicity and seasonality of the activities, the type (open air markets, weekly or monthly antiquities markets, etc., cultural activities, etc.).
ROUTE	Line	It refers mainly to pilgrimage itineraries within RM and R area. Its attributes identify and describe also the type of itinerary (religious/natural/historical etc.); the legal registration status of the itinerary; the status of the conservation/management plan; relevant temporal frame; buildings/sites/towns of the itinerary and related characterization/description.

EVENT	Point	It refers to relevant large events (such as festivals that take place in multiple locations within the RM and R area). Its attributes identify the name of the events, the type of the event (art, cultural, food and wine, natural, brand creation, development project, economic agreement, delimitation of protected area, other); temporal frame/date/seasonality; description of the event and other information.
CHANGE	Polygon	It refers to areas interested by changes, that suffered destruction processes etc. Its attributes identify and describe, among others, the type of change occurred and the temporal frame/date.
TOURISM	Point	It refers to tourism related buildings/kiosks/info points within RM and R area. Its attributes identify their type (tourist information, information panel, etc) and other info.
NEAR_URBAN_AREAS	Point	It refers to the closest urban area. Its attributes identify, among others, the name and numbers of closest urban areas and the existing relation between the RM/R rural area and the identified urban area (no relevant relation, if the rural area is self-sufficient; limited relation, if the relation is limited to bureaucratic processes and governance actions; intermediate relation, if residences go to urban areas for major needs such as hospitals, municipal registrations; strong relation, if majority of residences go to urban areas on a daily basis).
N_TOWN_BLDG	Point	It stands for 'buildings in nearby urban areas. It refers to buildings in nearby towns relevant for the social and cultural life and administrative organisation and accordingly to rural regeneration process. Its attributes identify, among others, the type of buildings (cultural organization, educational, local authority, public service, infrastructural); their legal registration status and other information.
N_RELEVANT_FUNCTIONS	Point	It stands for 'relevant infrastructures in nearby urban areas. It refers to relevant infrastructural buildings in the closest urban areas that increase the dependence of RM and R on the closest urban areas. Its attributes identify, among others, the infrastructure's category (transport, water, electricity, sewage/canalization, energy, public service); the infrastructure's type (highway, street, trail, square, travel hub, bridge, railway, railway station, long-distance bus station, river, canal, wind/solar energy source, municipality, hospital).
BEST PRACTICES	Point	It refers to successful heritage-led rural regeneration models from a holistic and multidisciplinary perspective, considering the objectives, motivation, needs and overcome barriers of the successful regeneration schemes.
LESSON LEARNED	Point	It refers to innovative solutions extracted from the BEST PRACTCES, which are replicable operational heritage-led rural regeneration schemes, taking into account the processes and procedures that each RM has followed to achieve their successful heritage-led rural regeneration.
NATURA 2000	Polygon	It refers to sites that have been designated specifically to protect core areas for a sub-set of species or habitat types listed in the Habitats and Birds Directives. Only the sites included inside the RURITAGE Territories have been included in the DB.

CORINE	-	It refers to the detection and monitoring of the characteristics of land cover and land use, with particular attention to the needs of safeguarding. Its attributes identify five high-resolution layers related to soil sealing, forests, grasslands, wetlands, and water bodies. This is a raster layer that is provided to Atlas via Rest Web Services.
PHOTOCONTEST	-	It refers to the set of images produced by users within the Photo Contest event. Its attributes identify the image itself and all related metadata (i.e. author name, title, description, place, keywords)

The database structure is shaped for creating consistent information on RMs and Rs, their main multifaceted features on the matter of CNH. It identifies their main tangible and intangible aspects by focusing on punctual (identified by points) or linear (line) or extensive (polygon) characterisations.
The structure organises both the collection for data management and the visualisation of heterogeneous data provided by the mapping work developed in WP1 Task 1.3 (**RMS /RS AREA**, **INFLUENCE_AREA, LAND_USE, SITE, INFRASTRUCTURES, BUILDINGS, ELEMENTS OF DISTURBANCE AND INTERFERENCE, OPEN_AIR, ROUTE, EVENT, CHANGE, TOURISM, NEAR_URBAN_AREAS, N_RELEVANT_FUNCTIONS N_TOWN_BLDG** , D. 1.3) and also coming from other outcomes of the RURITAGE project, and properly in Task 1.1 and Task 1.2 (**BEST PRACTICES, LESSON LEARNED, D 1.1 e D. 1. 2**) and WP7 Task 7.4 (**PHOTOCONTEST** Deliverable 7.4 draft version M36, final version due at M. 48), and from data coming from other datasets (**NATURA 2000, CORINE Land Cover).**
The database structure has been shaped to organise the heterogeneous and discontinuous data of each Rms and Rs under a common perspective and reading. It allows both checking a comparable information and linking rural regions' tangible and intangible characterisations to a spatial data representation. The layers of this structure have been shaped to take into account in a synthetic but articulated description the wide range of CNH provided by RURITAGE project with its SIA at different scales and with diverse tangible and intangible characterisations. **RMS /RS AREA**, **INFLUENCE_AREA** structure includes the co-mapping developed with RMs and Rs for the identification on a topographic map of the rural territories and the influence that they perform/should perform; **LAND_USE** mainly refers to information about functions and production; **INFRASTRUCTURES** layer refer to territories and includes relevant physical infrastructural elements especially concerning accessibility and mobility; **ELEMENTS OF DISTURBANCE AND INTERFERENCE, CHANGE** refer to some problematic human/territories interactions that could be removed or created a relevant change**; SITE, BUILDINGS , ROUTE** properly refer to CNH and with a distinction among delimited areas, crosscutting areas identifying itineraries, and buildings and include heritage cultural and natural characterisations and areas under risks; **OPEN_AIR, EVENT** mainly refer to intangible heritage with its experiences and enhance the wide range of CNH according to RURITAGE SIA; **TOURISM** includes those human/territories interactions to enhance cultural tourism; **NEAR_URBAN_AREAS, N_RELEVANT_FUNCTIONS N_TOWN_BLDG** consider the rural/urban interactions with the main needs of rural territories dislocated in nearby urban areas; **BEST PRACTICES, LESSON LEARNED, PHOTOCONTEST** allow visualising as immediately referred to the territories data from developments of the project; **NATURA 2000, CORINE Land Cover** refer to external data from other projects.

By considering that the Photocontest also includes ARs, a new additional mapping for including the ARs in the RURITAGE Atlas has been undertaken and developed to include the photographs referring to their territories. As a result, the ARs have been included in the Atlas with basic information.

Since now more than 1,800 tangible and intangible features have been mapped; while the highest numerosity refers to the tangible assets, many other important functions and activities are also included.
The final data have been stored in GeoJSON (see Section 5.2.1). Each feature stored in the Atlas corresponds to an object with a structure of this format. Each object has a list of record of the type of key/value: to each key, represented by a word that is unique inside the object, corresponds a value that may be a word, a number or a list of words/numbers. This kind of format has been chosen for 2 main reasons: it is a standard GIS software and is easily manageable from the tool we use to display the map and the features. Using this data format, we stored

more than 1,200 buildings, 300 sites, 10 areas affected by changes, 100 infrastructures, 50 open air activities, 20 itineraries, 30 tourist information points with the relative associated information.

Here is an example of a georeferenced Atlas object:


```
{
  "_id":{
    "$oid":"5e26f57046a2de4a362ec844"
  },
  "type":"Point",
  "properties":{
    "O_NAME":"Yıldırım Mosque",
    "layer":null,
    "ITIN_HIST":null,
    "PATRON":"sultan yıldırım bayezid",
    "BUI_TYP":"Other",
    "INSC_YEAR":null,
    "NOTES":null,
    "AU_R_IM1":null,
    "DATE_PRE":{
      "$numberInt":"1399"
    },
    "N_NAME":"Bergama Great Mosque",
    "LINK":null,
    "NOTES2":null,
    "path":null,
    "ARCH":null,
    "id":{
      "$numberInt":"8"
    },
    "NOTES_2":null,
    "INSC_AUTH":null,
    "BUI_DESCRI":"Mosque",
    "REHAB_MOTI":"OT",
    "RM_R_CODE":"R6",
    "ACTIVITY":"RE",
    "CP_R_IM1":null,
    "TEMP_STA":"YE",
    "CAMPAIGN":{
      "$numberInt":"2"
    },
    "RM_R_IM1":null,
    "RM_R_WEBSI":null,
    "SIT_SIA_CO":null,
    "PERIOD":{
      "$numberInt":"14"
    },
    "N_FUNCTION":"RE",
    "REHAB":{
      "$numberInt":"1"
    },
    "SIT_STATUS":"C",
    "O_FUNCTION":"RE",
    "ITIN_NAME":null,
    "TOWN_NAME":"Bergama, İzmir",
    "BLDG_INS_Y":null,
    "TOWN":"İzmir",
```

```
    "REHAB_YEAR":"1952/01/01",
    "TEMP_MESI":"GEDI",
    "ITIN":null,
    "BLDG_STATU":null,
    "REG_STATUS":"N",
    "DA_R_IM1":null,
    "PERIODIC":"O",
    "DATA_IN_AU":"PelinBolca",
    "DATA_DATE":"2019/05/18",
    "CP_R_IN1":null
  },
  "coordinates":[
    {
      "$numberDouble":"27.179412438755488"
    },
    {
      "$numberDouble":"39.12508886899209"
    }
  ]
}
```


6.4 Atlas Web Portal

As described above, RURITAGE Atlas aims to integrate information about human-landscape interactions, historical and topographic representations, demographic data, images and 3D representations, factors of hybridization of rural regions by cross-elements and it defines specific but integrated rural/urban attributes.

To do this, the user can interact with the Atlas Web Portal. After the first period review, a new graphical user interface (GUI) for the Atlas Web Portal has been developed which enables a new kind of research in the ATLAS for querying and visualizing features contextually (see chapter 5 of D1.3). In addition to these new developments, further developments have been enabled to render the GUI easier to use.
The landing page of the Atlas Web Portal provides a navigable map with the most relevant information. For a guided and more advanced researches, with the 'Search for' button, the users can select any RM o R and with the highlighted colours, they can follow which RM o R they are searching through and select among 4 main conceptual areas of contents: Places, Experiences, Rural territories, Stories.

As show in in Figure 10 , the user must first select a Role Model or Replicator. The selection, using a dropdown selector, triggers a query to the Atlas Database. This query generates a response GeoJSON containing all the information for the different categories for the selected Role Model or Replicator.

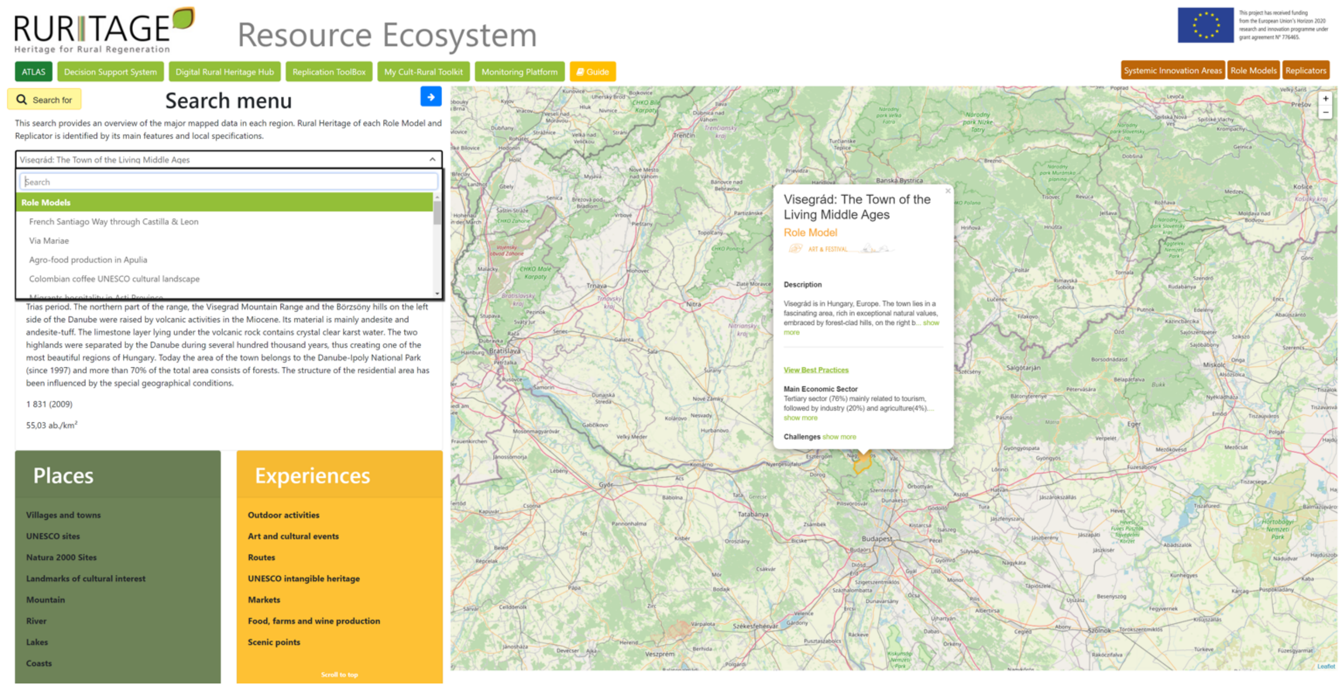


Figure 10. ATLAS GUI – Role Model or Replicator selection

Once the RM or R is selected, the content of the GeoJSON response populates the menu and map. Figure 11 shows how the left menu bar populates the title of the selected RM with its description and the map centred on the physical location of reference.

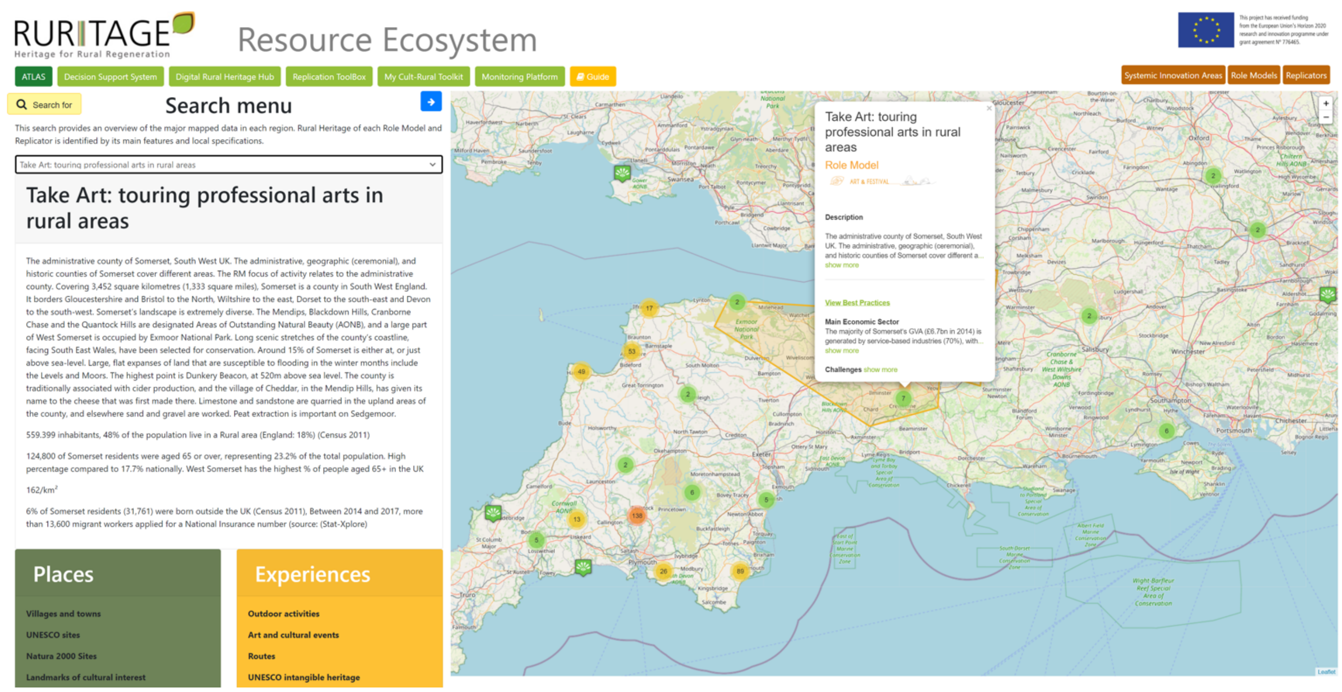


Figure 11. ATLAS GUI – Role Model or Replicator selected

At this point, the user can use the menu, placed on the left to interact with the functionalities that Atlas provides. Figure 12 describes, in detail, all the functionalities.

Figure 12. ATLAS GUI – Menu functionalities

Atlas thus groups functionality into 4 macro-categories:

- Places;
- Experiences;
- Rural territory;
- Stories.

The menu Places aims navigating physical locations. Experiences allows users to know all the experiential events. Instead, Rural Territory menu allows to explore the areas of the RURITAGE project and their main point of interaction with the territories that surround them. Finally, Stories aims to give an overview on the history of the territories by using conceptual maps, topographic maps, videos, historic and recent photos, 3D models.
Texts, images, narratives in the functions “Places”, “Experiences”, “Territories”, “Stories” have been checked and improved with special consideration for Replicators regarding their geographical, economical and demographical

information has been improved. Each R have contributed to this improvement by revisions and suggestions. This information is currently available on ATLAS.

Figure 13 depicts the interaction with the Place menu. In the figure, for example, the user wants to know all the villages and towns in the selected Role Model.

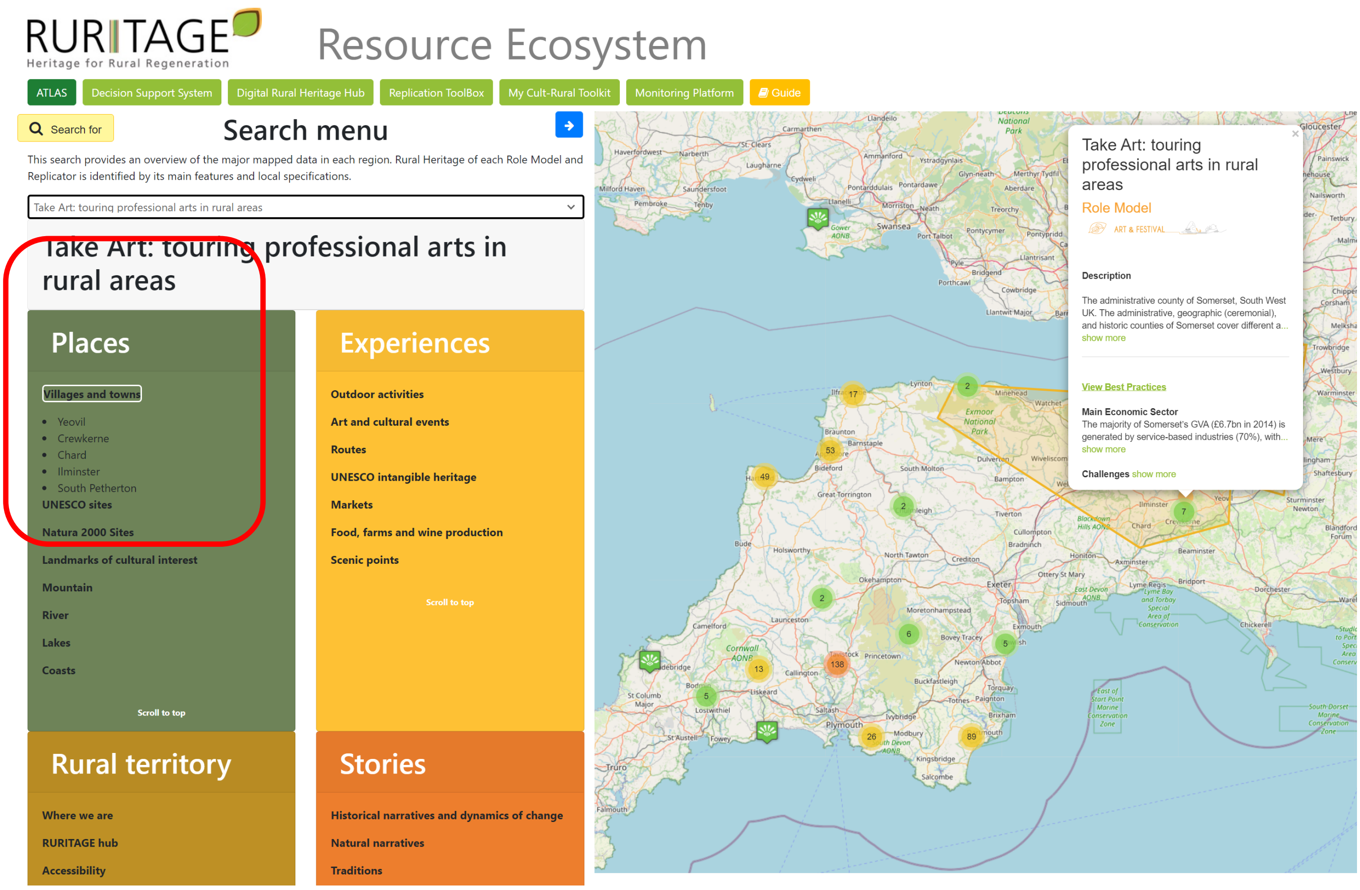


Figure 13. ATLAS GUI – Example of menu interaction

As Described in Section **Errore. L'origine riferimento non è stata trovata.**, generally the geo-referenced data contained in Atlas refers to 3 geometries:

- Polygons;
- Lines;
- Points.

Figure 14 reports all the managed categories and their visualization modes (i.e. type and colour).

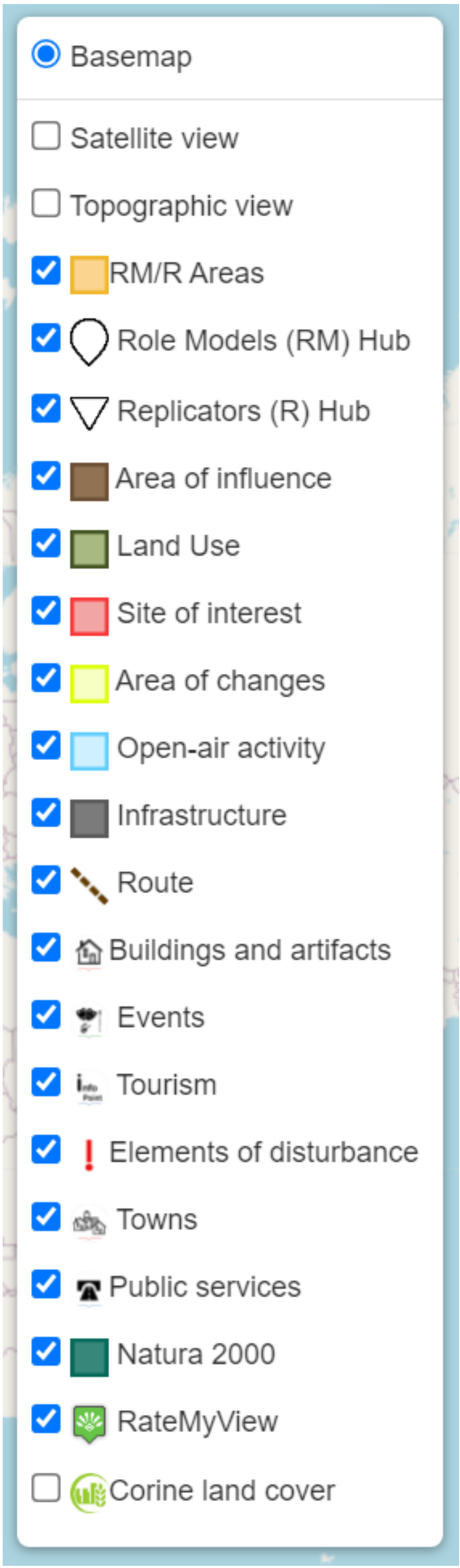


Figure 14. Atlas Legend

Figure 15 depicts an example of Polygon. This example shows the *Site of interest* area of the selected RM.

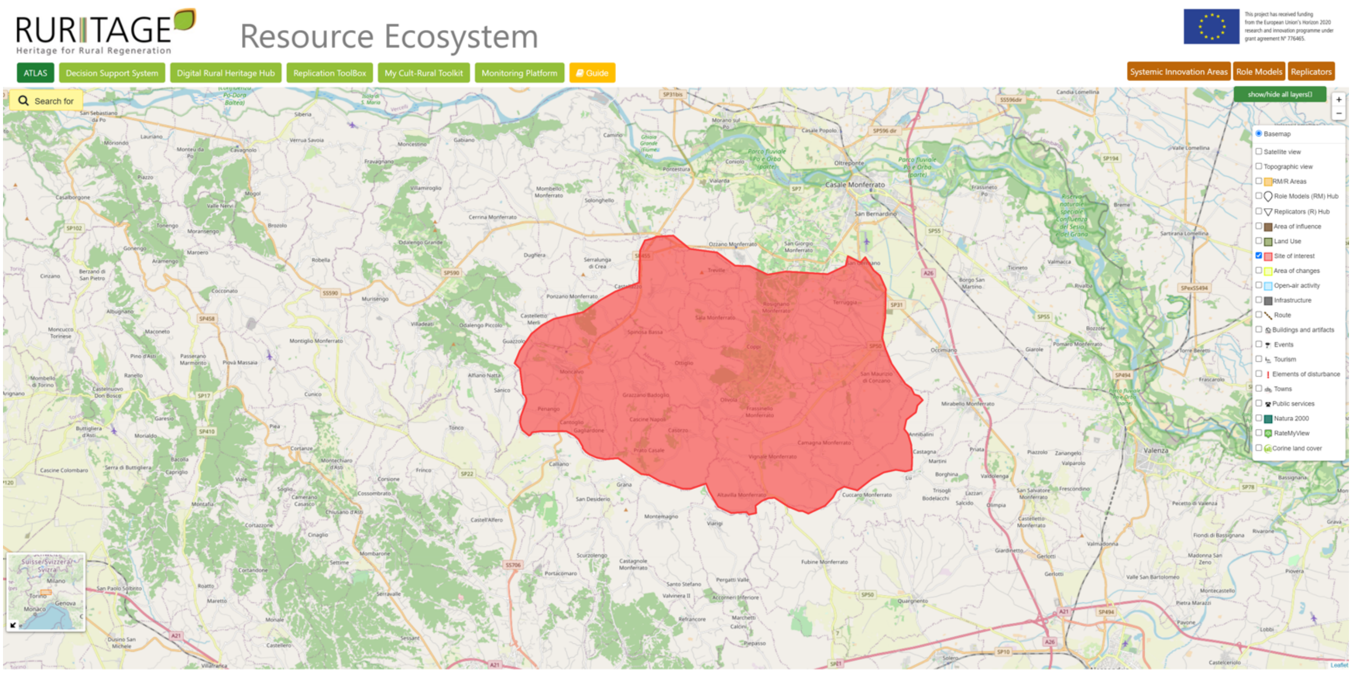


Figure 15. Example of Polygon

Figure 16 depicts an example of Line. This example shows the *Routes* of the selected RM.

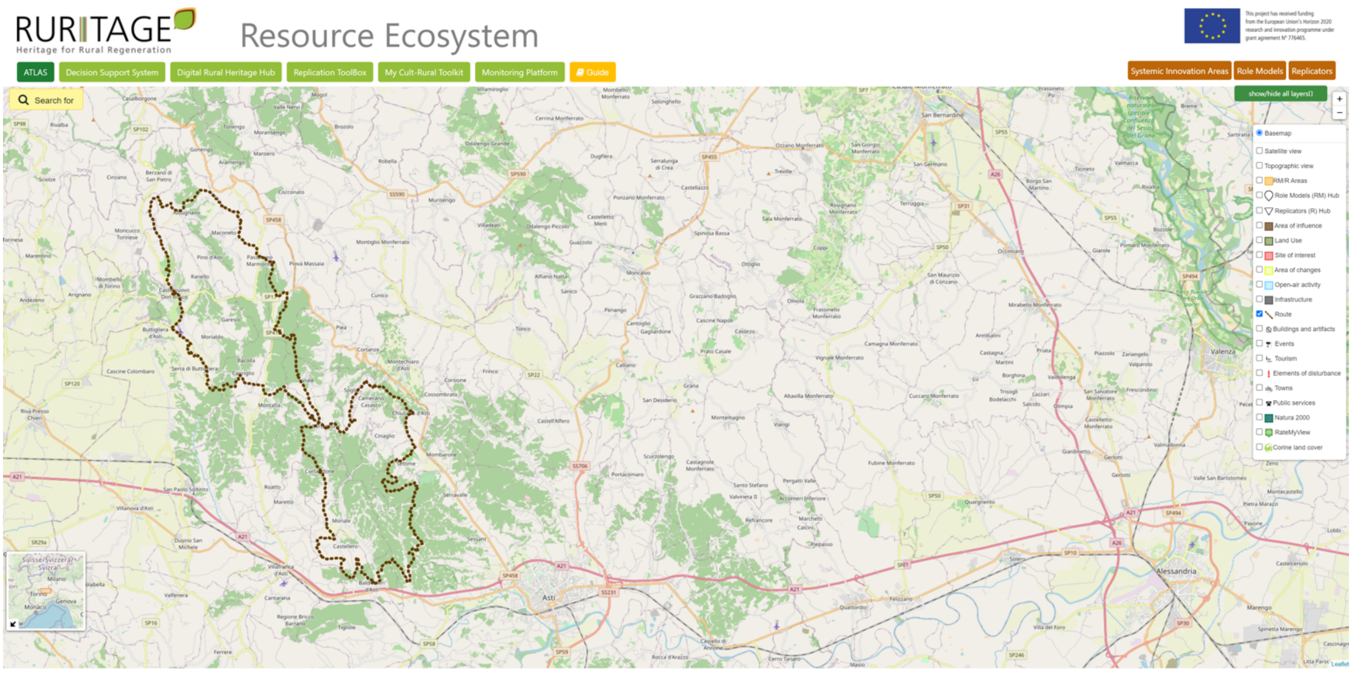


Figure 16. Example of Line

Finally, Figure 17 depicts an example of Points. This example shows all the *Towns* of the selected RM.

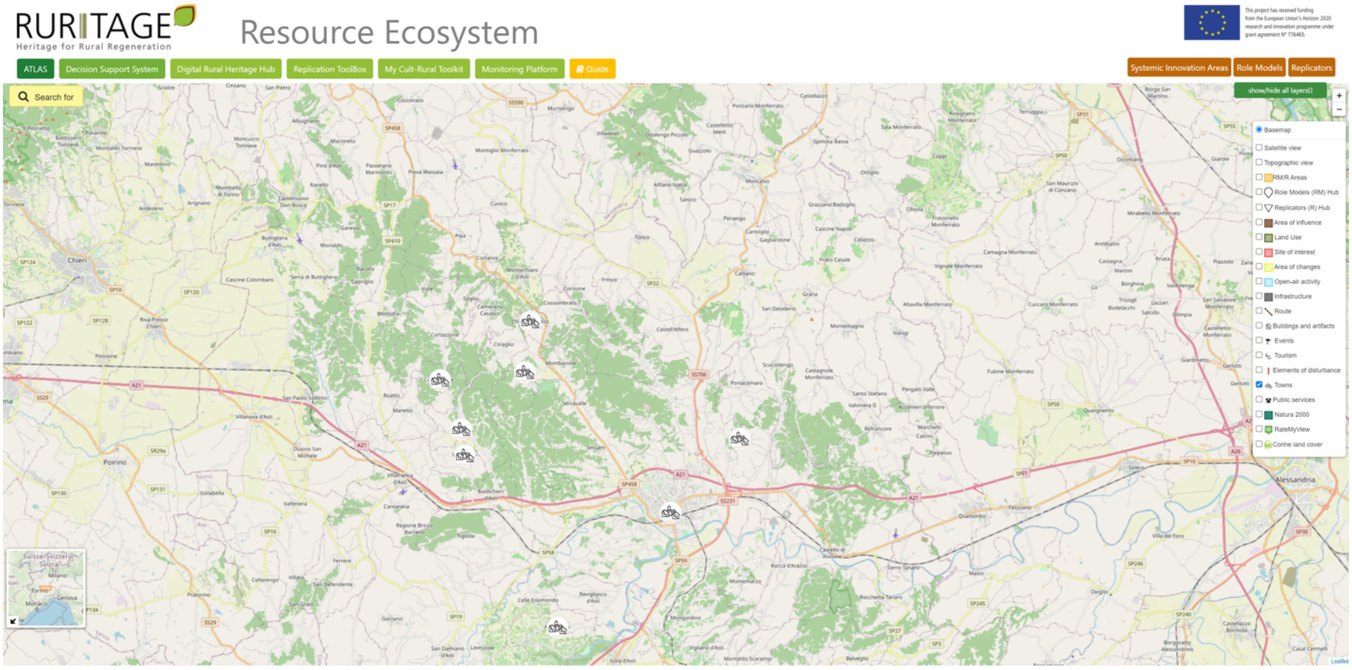


Figure 17. Example of Points

All the information visualized in the previous Figure 10 - Figure 17 are stored in the Atlas Database (see Figure 9). In addition to the baseline map visualization in Figure 18, the Atlas Web Portal provides both Topographic and Satellite views, see Figure 19 and Figure 20, respectively.

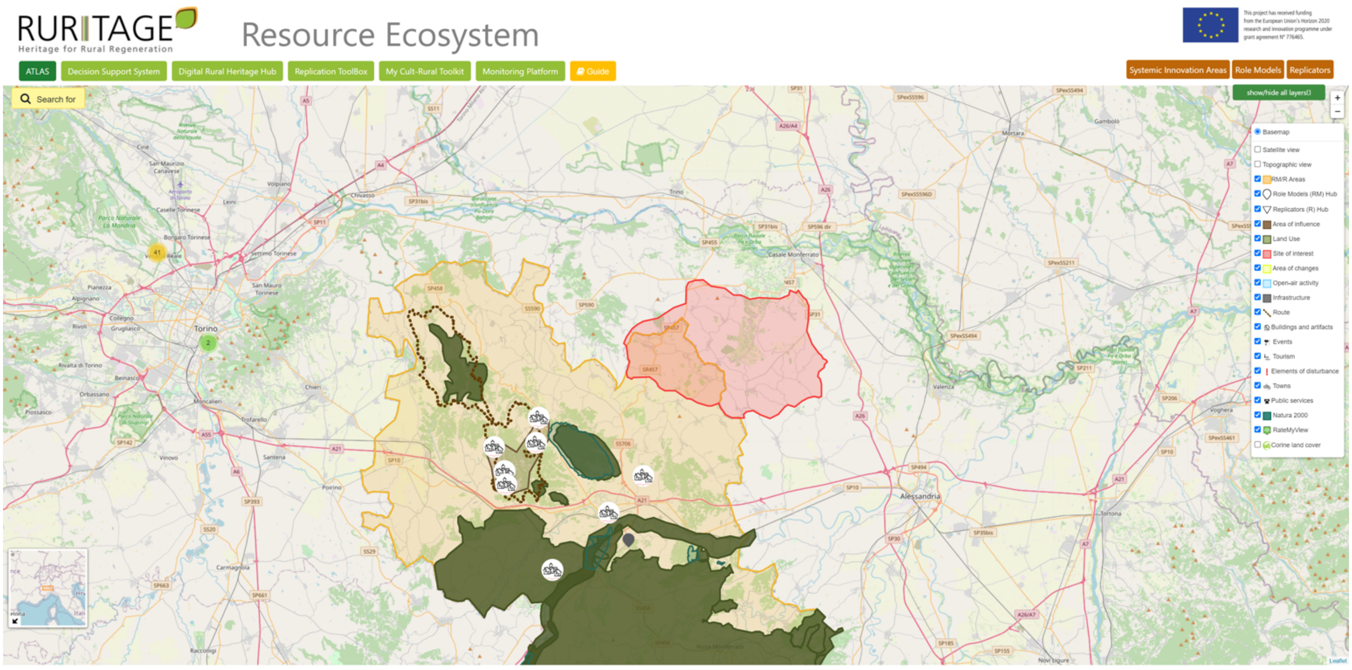


Figure 18. Baseline map visualization

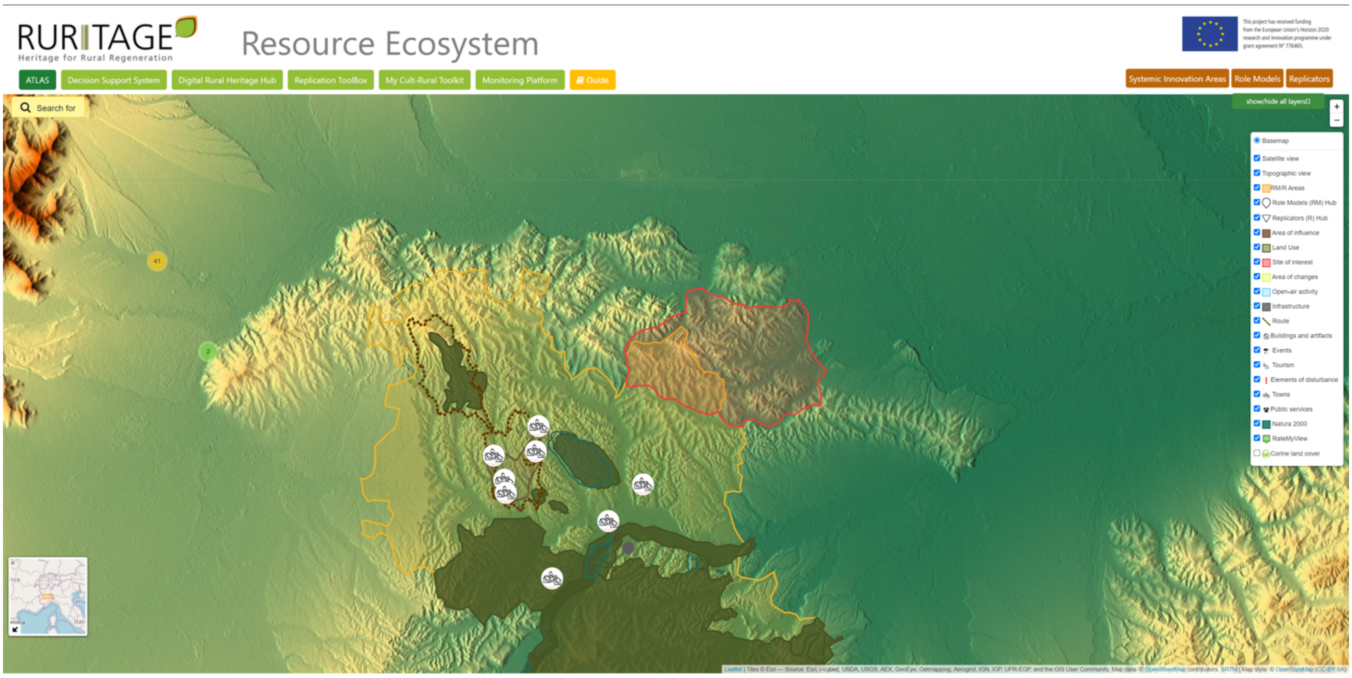


Figure 19. Topographic map visualization

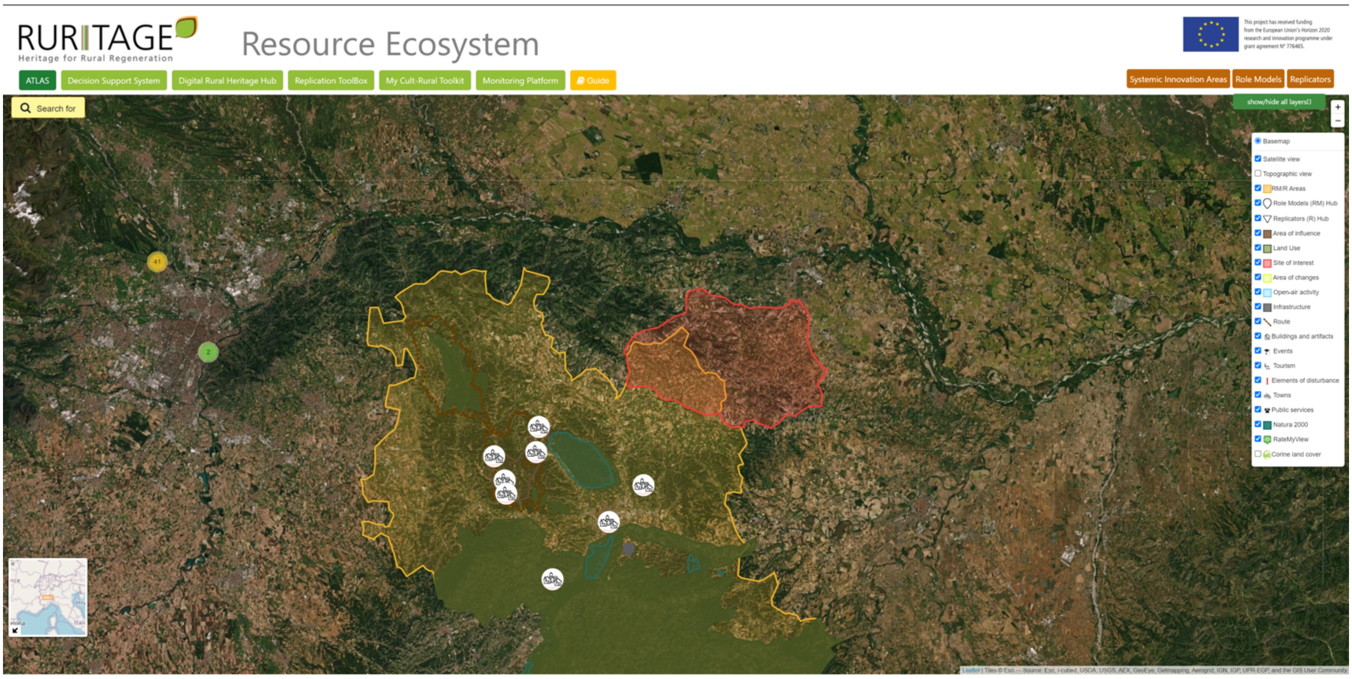


Figure 20. Satellite map visualization

The Atlas-Backend is a specific software component that interfaces the Atlas Database to the web, by exposing unified REST Web Services (see Chapter 5.1). In addition, the Atlas-Backend engine combines the heterogeneous information and creates the final documents that will be sent to and visualised in the Atlas Web Portal. As expected, these final documents will contain the information according to user inputs and/or actions. These documents are compliant with JSON and GeoJSON data-formats (see Chapter 5.2).

6.4.1 Photo Contest

As shown in Figure 21, the Photo Contest repository is the true holder of the images taken by users in Photo Contest events organized in RURITAGE territories. These images are anonymized and stored in a web server folder. These images are mapped into the PHOTOCONTEST collection of the Atlas Database, so when the Atlas-Backend functionality calls one or a sub-set of images, it queries the Atlas database to know the id of the images to make available in the Atlas Web Portal.

The reference stack is summarized as follows:

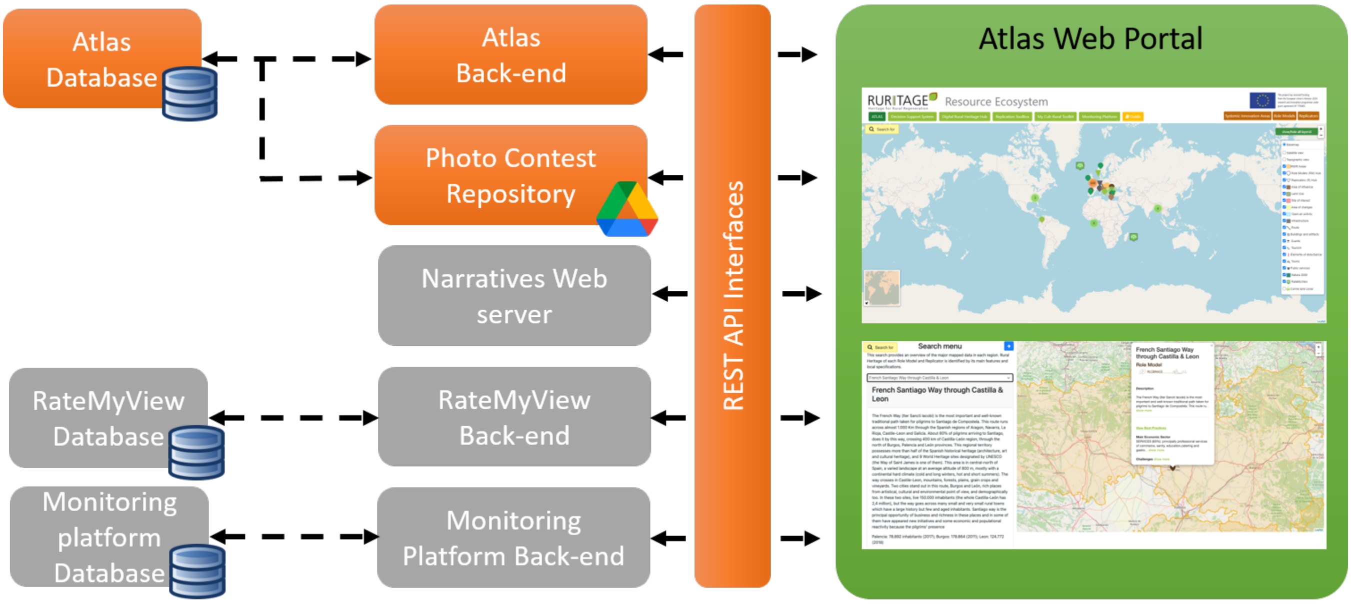


Figure 21. Main software components for Photo Contests

In the following, it is reported an example of a Photo Contest JSON document containing information retrieved from the Atlas Database, post processed by the Atlas-Backend and sent to Web Portal. Figure 22 shows the final visualization.


```
{
  "_id":{
    "$oid":"60647e00a050fc2e3d35d1d1"
  },
  "Author":"Mulleady",
  "DriveExtendedUrl":"https://drive.google.com/open?id=1FOrgcSDVp3ufJYWbJ09Na8UTosWKabmm",
  "DriveUrl":"1FOrgcSDVp3ufJYWbJ09Na8UTosWKabmm",
  "Title":"Carraig MacDiarmada",
  "Description":"A fine September evening, Lough Key was like glass which reflected the setting sun exquisitely. The park was thriving this evening with the jetty's full of cruisers and the lake teaming with activity from, kayakers & paddle-boarders all surrounded by wildlife from swans and ducks. Bliss!",
  "Place":"Hidden Heartlands (Ireland)",
  "Code":"R07",
  "Keywords":"Landscape, Resilience, Nature"
}
```

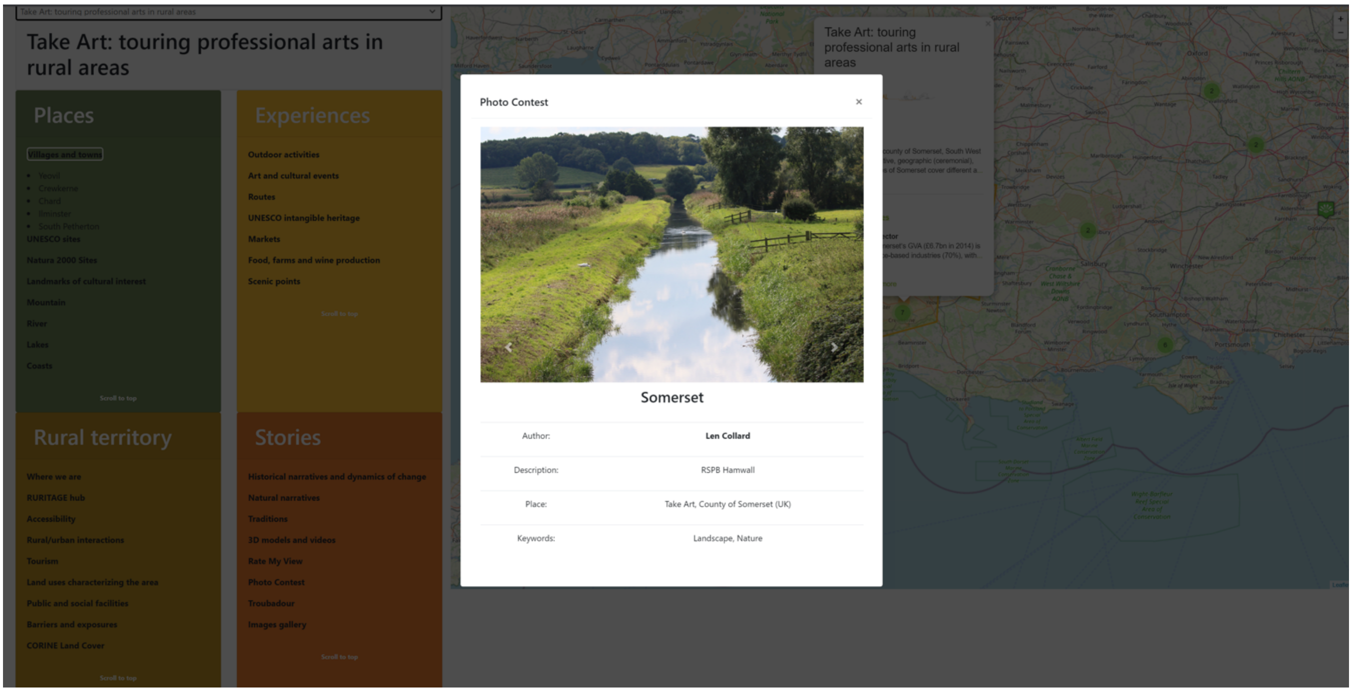


Figure 22. Example of Photo Contest Picture visualization

A total number of 482 photos have been selected from the submissions to the photo contest. These photos are related to Rs, RMs, and ARs and they will be visualized through the ATLAS.

6.4.2 Narratives and 3D models

The Narratives and the 3D models developed in deliverable and D1.3 are made available as static content through a web server. This approach enables developers to embed these contents on the Atlas Web Portal by using a simple REST Web Services providing either JSON documents or HTML pages.

The reference stack is summarized in Figure 23. Figure 24 shows the final visualization.

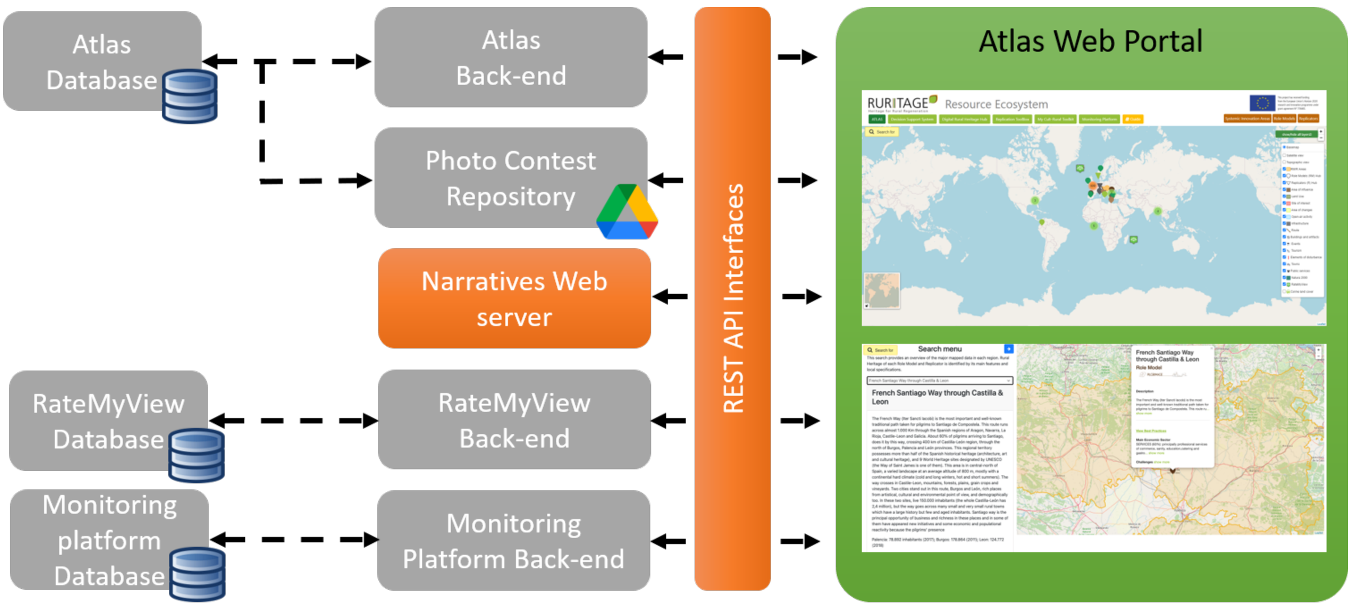


Figure 23. Main software components for Narratives

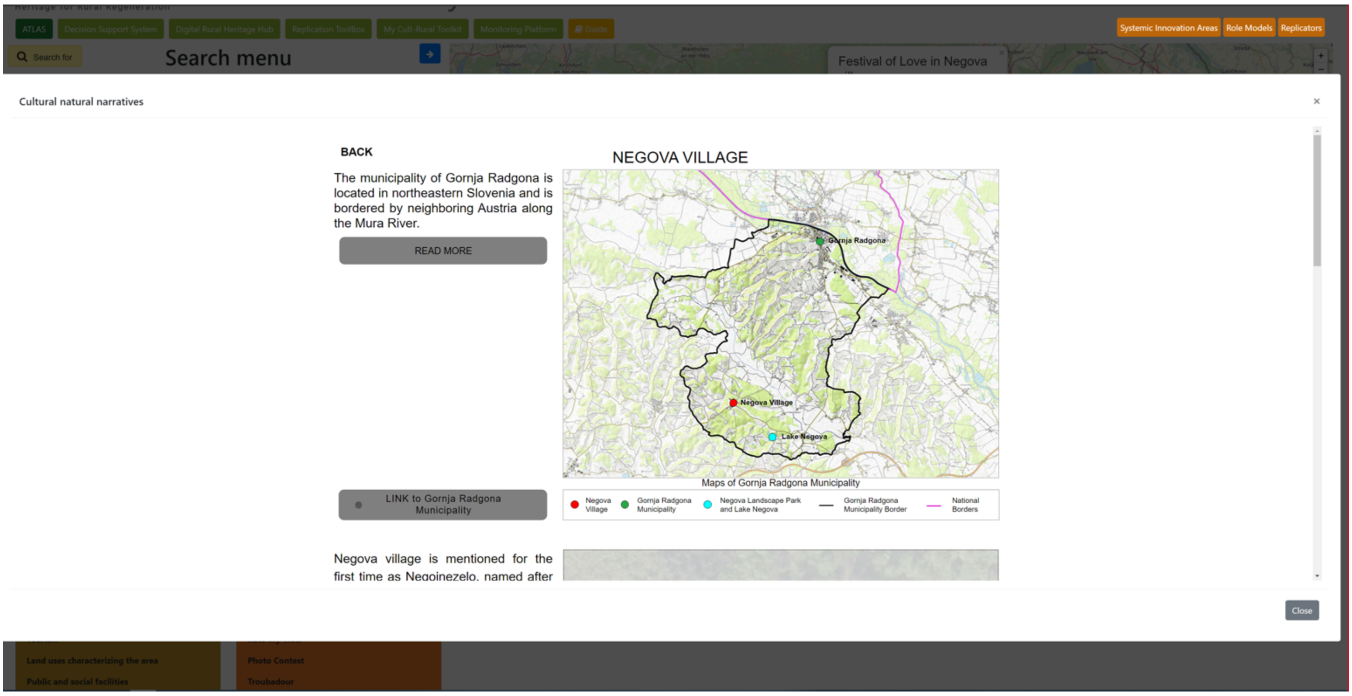


Figure 24. Example of Narrative visualization

With respect to the *D1.3 RURITAGE Atlas* (see the paragraph 2.2.3) the functionality of natural and historical narratives and information have been further developed and integrated with the Atlas, in particular, concerning Intangible heritage. Each replicator had contributed to the finalisation of the identification of intangible heritage assets regarding their own areas. The finalised list is as follows:

COUNTRY	YEAR	Rs CODE	NAME	REGISTRATION STATUS	INTERESTED COUNTRIES	DESCRIPTION	NOTE
AUSTRIA		R1	Easter Custom	National	Austria	It is an old custom that associations, farmers and experts connect the spring greenery each year in various bundles. The bundles from Bad Eisenkappel are by its size and beauty, known far beyond the borders of the country.	https://www.geopark-karawanken.at/en/geopark-experience/cultural-heritage/customs.html
GERMANY	2013	R3	Lorsch Pharmacopoeia	UNESCO	Germany	The Lorsch Pharmacopoeia (Msc.Med.1) in the Bamberg State Library is the earliest, reliably datable compendium of classical remedies in the Greco-Roman tradition from the (Latin) Early Middle Ages in Europe.	http://www.unesco.org/new/en/communication-and-information/memory-of-the-world/register/full-list-of-registered-heritage/registered-heritage-page-5/lorsch-pharmacopoeia-the-bamberg-state-library-mscmed1/

GERMANY	2009	R3	Song of the Nibelungs	UNESCO	Germany	It is a heroic poem in Middle High German. It tells the story of dragon-slayer Siegfried from his childhood days and his marriage to Kriemhild to his murder and culminating in the extinction of the Burgundians or Nibelungs at the court of the Huns.	http://www.unesco.org/new/en/communication-and-information/memory-of-the-world/register/full-list-of-registered-heritage/registered-heritage-page-8/song-of-the-nibelungs-a-heroic-poem-from-mediaeval-europe/#c183708
ITALY	2013	R5	Mediterranean diet	UNESCO	Cyprus, Croatia, Spain, Greece, Italy, Morocco, Portugal	It involves a set of skills, knowledge, rituals, symbols and traditions concerning crops, harvesting, fishing, animal husbandry, conservation, processing, cooking, and particularly the sharing and consumption of food.	https://ich.unesco.org/en/RL/mediterranean-diet-00884
TURKEY		R6	Laces and Embroideries	National	Turkey	It is a knitting technique made by using various yarns and various tools such as needle, crochet, shuttle, hairpin. In time, materials such as sequins, beads and fabrics were added to this technique.	https://izmir.ktb.gov.tr/EN-240857/laces-and-embroideries.html
TURKEY		R6	Camel wrestling	National	Turkey	It is an important tradition that provides mobility in Aegean, Mediterranean and Marmara regions for three or four months by attracting the attention of local and foreign tourists during the stagnant period outside the tourism season.	https://izmir.ktb.gov.tr/EN-240860/camel-wrestling.html
TURKEY		R6	Felt Works	National	Turkey	The felt, which has an old and deep-rooted history, has survived by transferring from the Huns to the Gokturk, from the Seljuks to the Ottomans through centuries of tradition.	https://izmir.ktb.gov.tr/EN-240815/felt-works.html
TURKEY		R6	Beledi weaving	National	Turkey	It is one of the oldest cotton weavings. The weaving that emerges on these looms is a double layer and very durable type of weaving.	https://izmir.ktb.gov.tr/EN-240814/beledi-weaving.html
TURKEY		R6	Evil Eye Talisman	National	Turkey	It is produced by iron sticks. It Heated with pine wood and melted at traditional ovens. It is only	

						produced at Menderes-Gorece (Boncuk KOy) and Kemalpasa (Nazar Koy) villages.	
TURKEY		R6	Goat Clipping Ceremonies	National	Turkey	It is a ceremony of bringing people together, have fun and eat together when Shepherds cut their animals hair to protect them from the harmful effects of summer.	
TURKEY		R6	Rabab Constructio n	National	Turkey	It is made by cutting the neck of the calabash tree and putting on leather. It has a soft and impressive sound color which can accompany Zeybek games and Teke region sounds.It is common in Aeagean and Akdeniz region.	
TURKEY		R6	Turkish Cuisine	National	Turkey	Vegetables, herbs and fish dishes tasted with olive oil at first glance in Izmir cuisine and Mediterranean culinary specialties are noteworthy.	https://izmir.ktb.gov.tr/EN-240810/turkish-cuisine.html
TURKEY		R6	Menemen Pottery	National	Turkey	Pottery obtained by shaping the soil with hand and by cooking it with high temperature is called pottery. 55-60 pottery enterprises were operating in Izmir Menemen District in the 1960s. Today, only 10 of them continue their activities.	https://izmir.ktb.gov.tr/TR-91165/comlekcilik.html
TURKEY		R6	Wire Wrapping	National	Turkey	It is a technique that applied with silver wire on sparsely knitted and non-stiff fabrics. Wire Wrapping embroidery is technically made as straight wrapping, diagonal wrapping, and other types. It can be seen across Izmir, Bergama and Karaburun.	
TURKEY		R6	Mahya-Charity	National	Turkey	It is a colorful ceremony which includes prayers, wealth, friendship, unity and fun. It Can be seen at Tire, Kinik, Dikili, and Bergama. It is also called 'village charity'.	

6.4.3 Integration with RateMyView and Monitoring Platform

The distributed design pattern based on REST Web Services (see Chapter 5.1) and adopted to design the whole RRE made easiest the integration of both RateMyView and Monitoring Platform into the Atlas. Indeed, the Atlas web portal integrates and invokes the REST Web Services provided by both tools their web services to autonomously visualize the contents output of their computations, respectively (see Figure 25). This approach avoids data inconsistency since information are retrieved as GeoJSON documents directly from the original data source without any duplication. RateMyView and Monitoring Platform will be described in next Chapters 9 and 10, respectively.

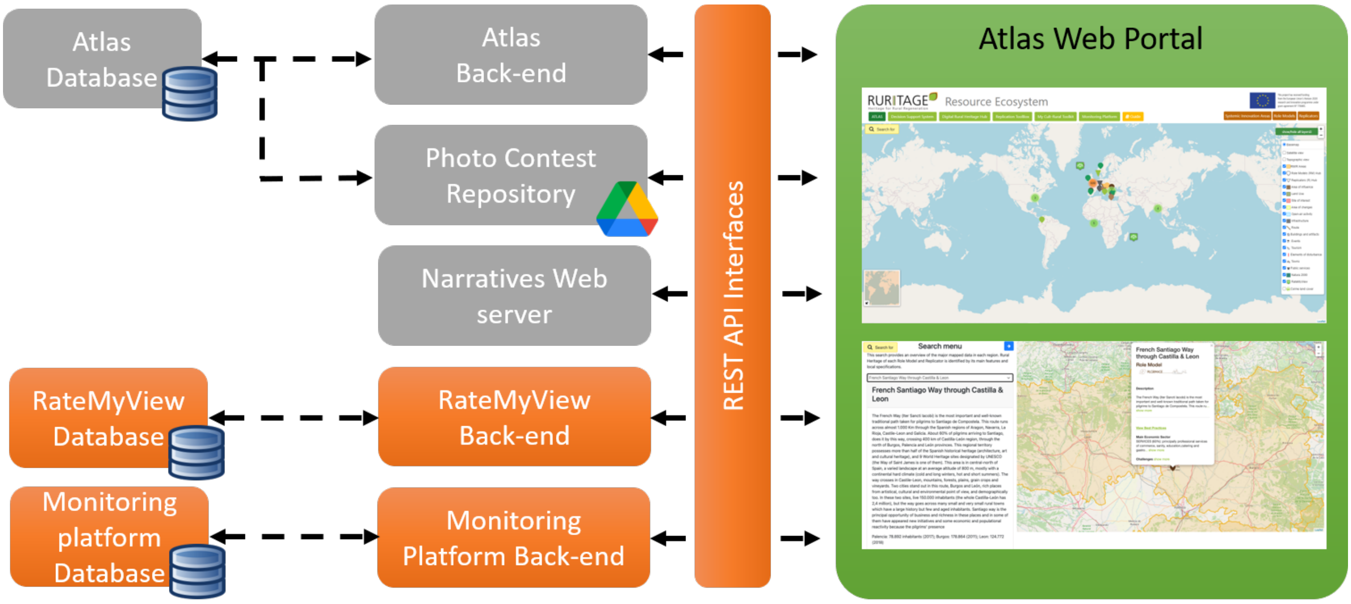


Figure 25. Integration of RateMyView and Monitoring platform into the Atlas

7. Decision Support System

The RURITAGE Decision Support System (DSS) is a system for supporting the discovery and composition of possible heritage-led regeneration scenarios, which considers previous initiatives and provides suggestions for combining good practices and Lessons Learnt from various Role Models, allowing the choice of comprehensive programmes to be implemented at replicating sites.

The DSS is a tool part of the RURITAGE ecosystem. An initial deliverable of the DSS, "D5.1 - DSS light version", has been submitted at the month 12. Since then, new software developments have been periodically released and it is planned to continue until M48 where a final deliverable will take place containing all achievements that have been accomplished during the RURITAGE project.

The DSS is available online at https://www.ruritage-ecosystem.eu/dss

7.1 Technical Architecture

The DSS architecture approach consists of "Docker"-based services, orchestrated through common REST Web services (see Chapter 5.1). These services run together in a single Docker environment where each Docker container represents a service. Because of the messaging mechanism that allows them to connect to each other, each service can be addressed from any part of the environment. Those services and environment are all running and living on a web server. The process of deployment and orchestration of the modules is made by using Docker Compose and Unix-scripts. Thanks to the service-oriented architecture design pattern, new modules with new functionalities can be added, replaced and easily integrated into the system as required through its development.

Currently, the DSS consists of four main components, the Data Manager, the Text Analysis Module (these two services compose the DSS Back-End), the DSS Database and the DSS Web Portal, as shown in Figure 26. The DSS also interacts with both Atlas and DRHH Back-Ends through REST Web Services in order to get data from them. Figure 26 shows the schema for the entire DSS. A description of each DSS module and how it interacts with the resources are described next.

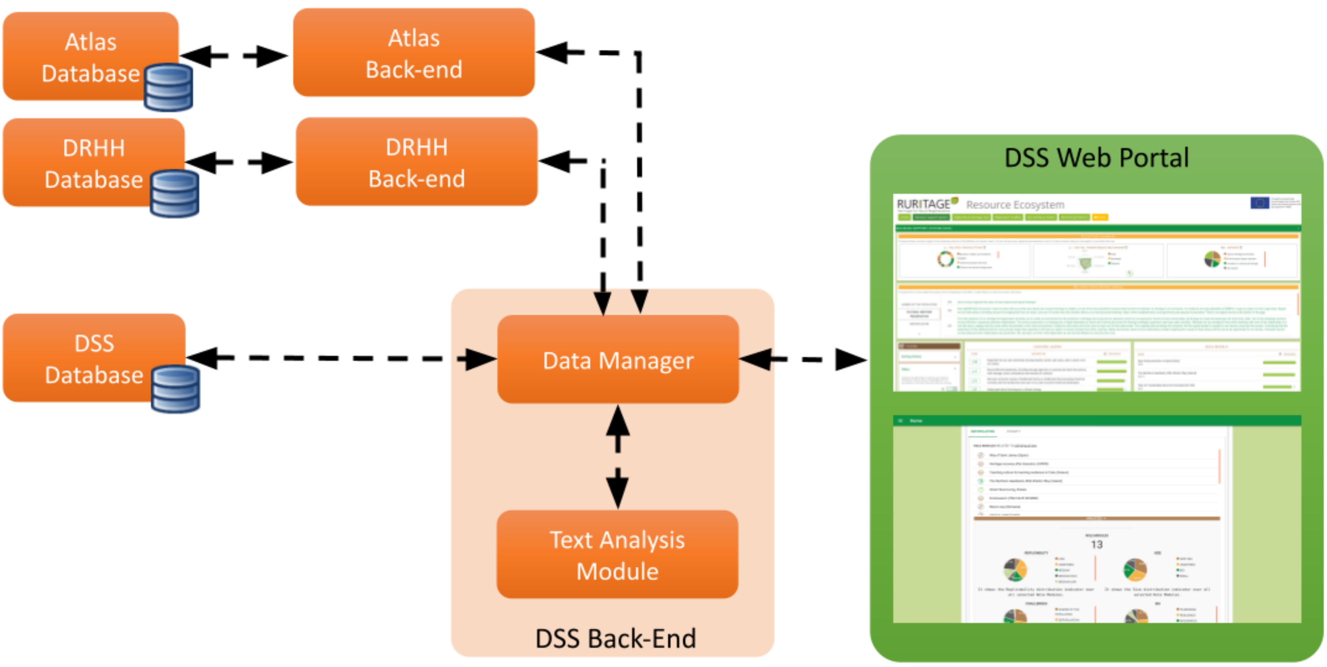


Figure 26. Communication flow of the DSS Modules and External Resources

7.2 DSS Web Portal

The DSS Web Portal is a module designed to allow users to interact with the DSS through a web service page. Here the users are able to explore RURITAGE data and make use of the multiple functionalities that it provides. All the information that the DSS collects and processes is displayed through this interface.
The core technologies used to develop this module are Javascript, Reactjs, React Router, Material UI, Visjs and ApexChart.

Currently, the DSS Web Portal is structured into three main pages, as described below. A menu is also provided to facilitate the navigation through the tool.

Landing Page
The Landing page (see Figure 27) is the first page that users interact with. It is an informative page designed to welcome the users and provide an overview of the DSS functionalities and where to find it. It is a starting point where the users will decide what they want to do next.

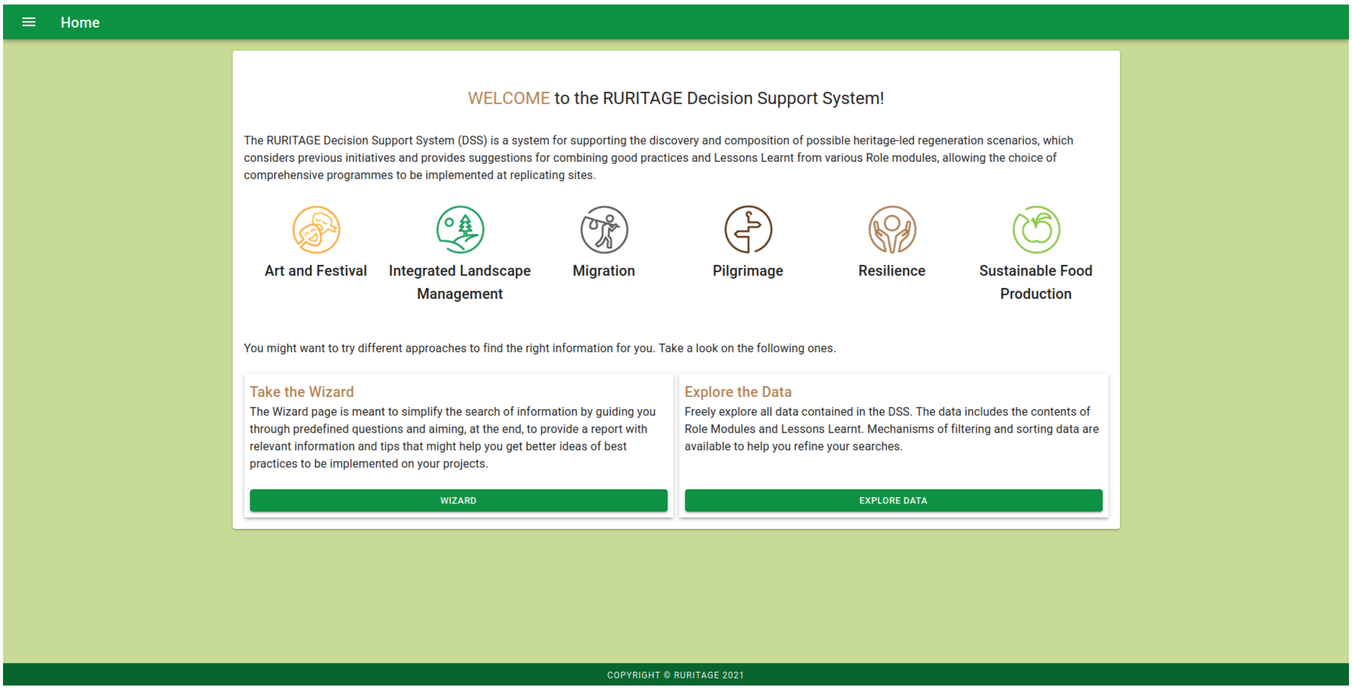


Figure 27. DSS Landing Page

Explore Data Page
The Explore Data page (see Figure 28) is where the users can freely explore all data contained in the DSS. The data includes the contents of Role Modules and Lessons Learnt. Mechanisms of filtering and sorting data are available to help users refine their searches
During the filtration process, the DSS keeps processing the remaining collections of data and presents its insights in a form of graphs and tables. It is meant to immediately provide a general overview of the current collection, helping the user understand it. In some cases, it is possible to use these representations to further filter parts of the data.
During the filtration process, the DSS also tries to find the most related discussions that people are having in the DRHH. The DSS provides links directly to these discussions expanding this way the possibilities for the users finding more relevant information or even finding people to contact.

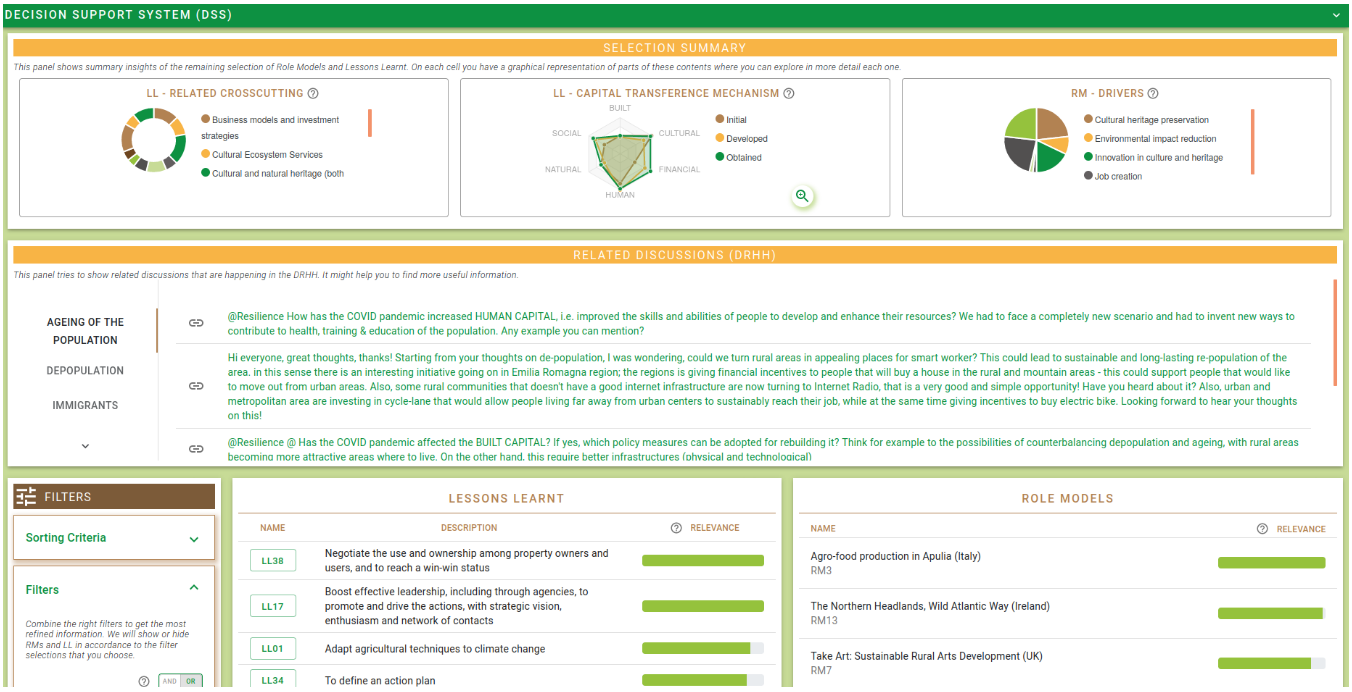


Figure 28. Explore Data Page

Wizard Page

The Wizard page (see Figure 29) is meant to simplify the search of information by guiding the users through predefined questions and aiming, at the end, to provide a report with relevant information and tips that might help the users get better ideas of best practices to be implemented on their projects. Through a process of internal filtration and modulation of the DSS data, the Wizard is capable of making smart selections bringing the best recommendations to the user. Also, statistics of collections are provided to help users better understand the data and even explore further from there (see Figure 30).

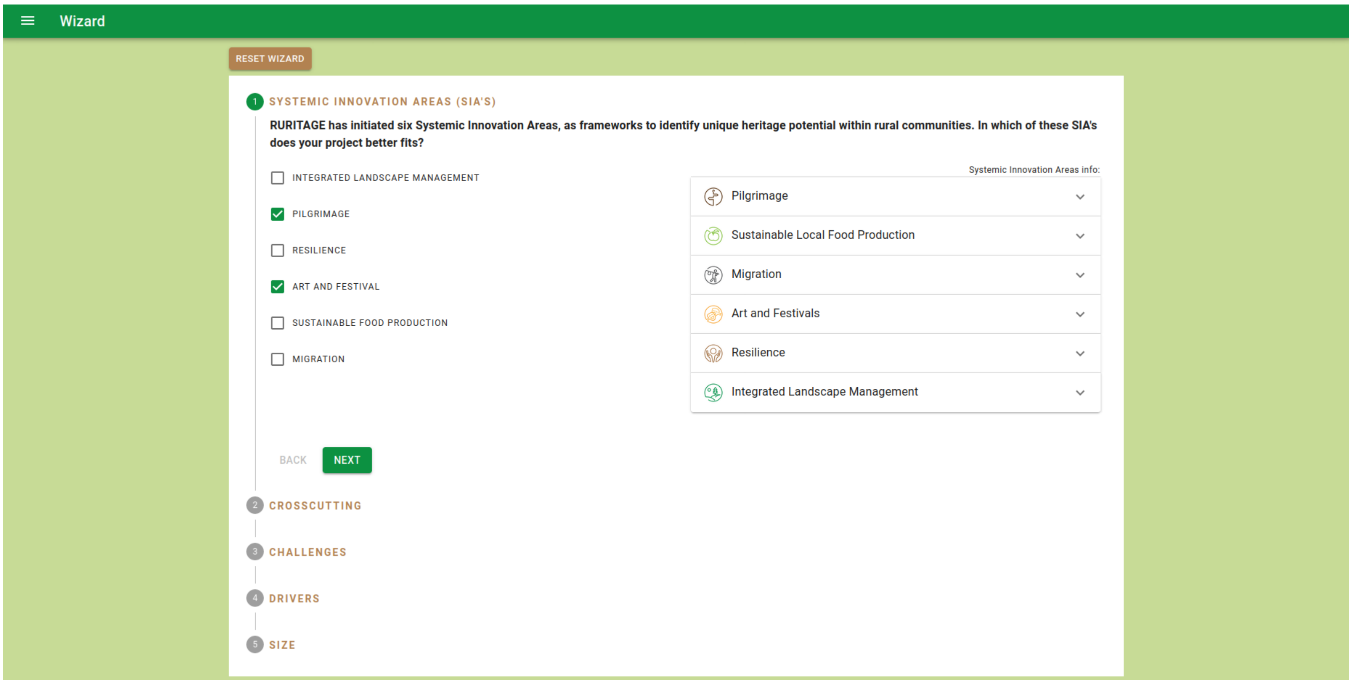


Figure 29. Wizard Questionnaire

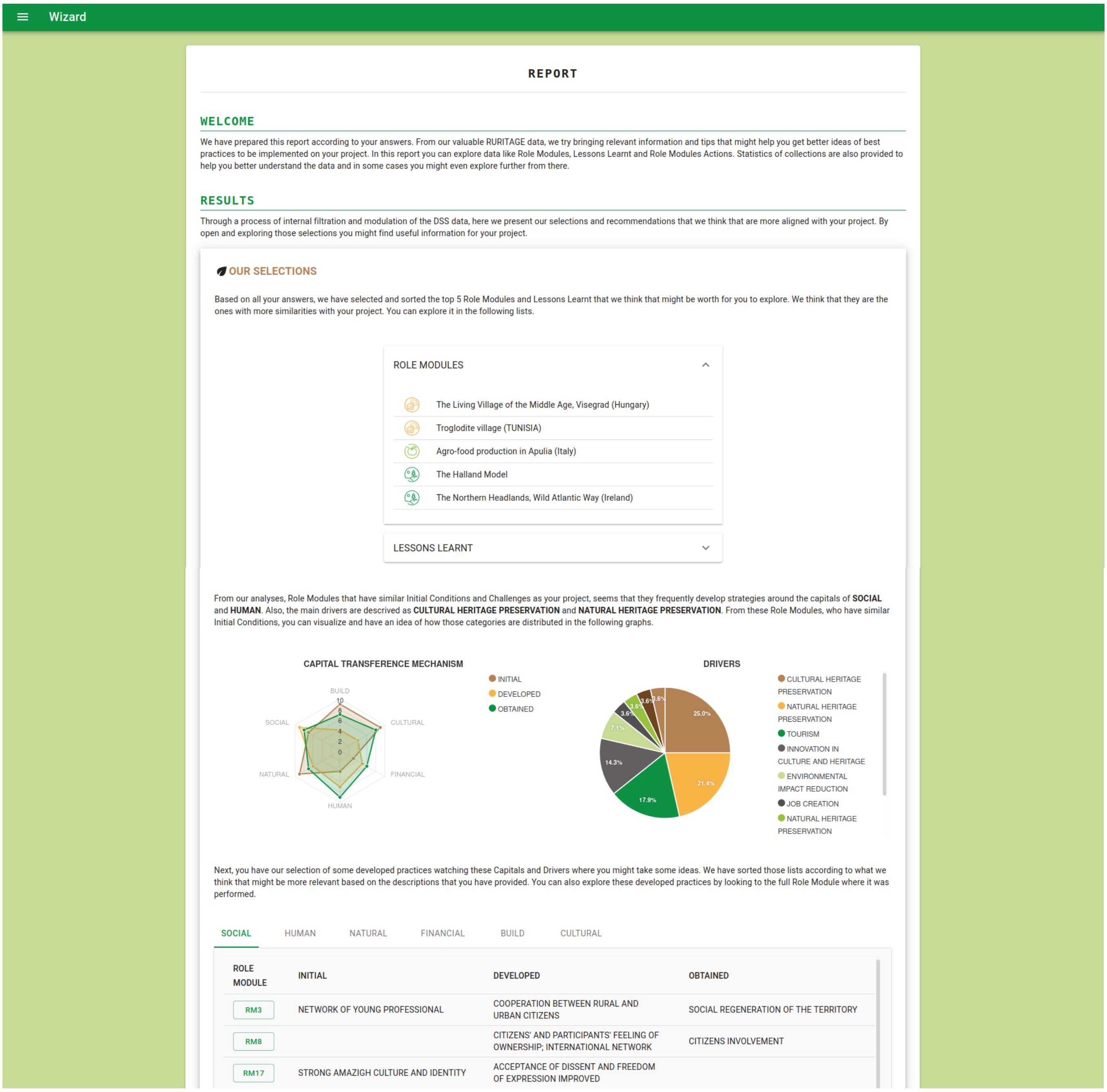


Figure 30. Wizard Report with recommendations and statistics

7.3 DSS Back-End services

As shown in Figure 26, the DSS Back-End is a macro-module consisting of two distributed services, the Data Manager and the Text Analysis Module.

Text Analysis Module

Due to the amount of text data presented in the RURITAGE project, these components were developed to help the needs of text analyse and processing. Machine Learning plays a role in this module with special focus on Natural Language Processing techniques that are more sophisticated for text analysis than traditional methods. As an example, these techniques introduce the ability to perform semantic text analysis. They help to correlate different sentences and try to find which ones are semantically closer. They are used to, for example, match the users' inputs (as text) with some Role Model fields to better retrieve the most relevant ones for the user to explore.

Data Manager

The Data Manager makes the bridge between the systems where the acquisition of data is required. It is responsible for organizing data, collecting it from multiple sources and making some processing before sending it upon request. The Data Manager interacts with the DRHH and the Atlas exploiting the REST APIs provided, respectively, by their back-ends. The interaction with the Atlas is purely to collect all data related to the Role Models and Lessons Learnt. More information about this data is explained further in this document. To keep some data up to date, the Data Manager periodically asks the DRHH for new data, performs analyses on it using the Text Analysis Module and stores the processed data into the DSS Database. Finally, the Data Manager prepares the information that will be provided to the DSS web portal according to end-user's inputs.

DSS Database

Due to the relatively intensive processing power and time consuming that it is required to make evaluations using the Text Analysis Module that performs some Machine Learning techniques, some of the processed data is also locally stored in the file system. This way, when a new request matches with an already pre-processed one, instead of reprocessing that information again, it immediately retrieves the stored processed data. Using this technique, it increases the efficiency and speed of the operations on the overall system.

The core technologies used to develop the Data Manager module are Javascript, Nodejs and Node Express. Whilst the Text analysis Module is developed in Python exploiting both Flask and Tensorflow.

7.4 Integration of DRHH and Atlas services

The main focus of the DSS is to present valuable data to its users. To make that possible, gathering data and transforming it are required tasks to be performed. The data collection can be extended to accommodate multiple data-sources where the Data Manager has an important rule on this process. Currently, data is coming from two other data-sources, the DRHH database and Atlas Database. Those sources are described below.

DRHH

The DRHH data contains public discussions from users of the Digital Rural Heritage Hub (see Chapter 8). These discussions are related to RURITAGE topics and are a valuable source of information to present to the DSS users. The DSS retrieves such information as JSON documents (see Chapter 5.2) by exploiting the REST Web Services provided by the DRHH Back-End.

Atlas

The Atlas database contains information related to the deliverables "D1.1 - RURITAGE Practices Repository'' and "D1.2 - RURITAGE Inventory of Lessons Learnt". At the beginning of the RURITAGE project, that data was initially collected and stored in a spreadsheet, by TECNALIA, and then, in order to make it available in a usable format for the DSS, Almende has extracted and transformed that information, creating multiple files containing the data structured in GeoJSON format. After that extraction, these files are stored in the Atlas database. Such information is by far the most used data in the DSS and it is retrieved by the DSS exploiting the REST Web Services provided by the Atlas Back-End.

8. Digital Rural Heritage Hub

The Digital Ruritage Heritage Hub (DRHH) aims to be a forum for discussion to allow knowledge sharing related to the Systemic Innovation Areas (SIA) of the RURITAGE project. The different coordinator of the local hub and their stakeholders are able to access the forum with a moderator of the discussions. All the user registered to the DRHH can share and exchange ideas on possible actions to be implemented during the co-development phase of the heritage-led regeneration plans.
Among the various content, the DRHH also includes multiple educational and capacity building activities through a series of webinars on the topic of each SIA.

The DRHH is available online at https://www.ruritage-ecosystem.eu/drhh

To reach the objective mentioned above we studied different opens source tools to find the best solution fitting requirements from stakeholders. The result of this analysis is summarized by the table below.

Name	bbPress	Wordpress	Discord	NodeBB
Pros	Easy to use Open source	Easy to install and manage Easy to use Customizable by installing different plugins Plugins for webinar	Easy to use Customizable good for chats and calls	Easy to install Open source Customizable appearance Easy to add additional function
Cons	Complex to customize Outdated interface	Quite unresposive when a lot of content is present Hard to add custom additional functions	Does not have the "forum" structure	

Given this preliminary analysis the DRHH has been created using the open-source application NodeBB. It is a modern discussion platform that utilizes web sockets for instant interactions and real-time notifications. NodeBB forums have many modern features out of the box such as social network integration and streaming discussions. Starting from the bare minimum installation, we customized Graphical User Interface in order to satisfy the original requirements. We also extended the NodeBB functionalities by developing new REST Web Services (see Chapter 5.1) to fully integrate the DRHH into the whole RRE. Thus, the raw and post-processed information can be easily shared with the other software components and tools over the Web. Figure 31 shows the DRHH software schema.

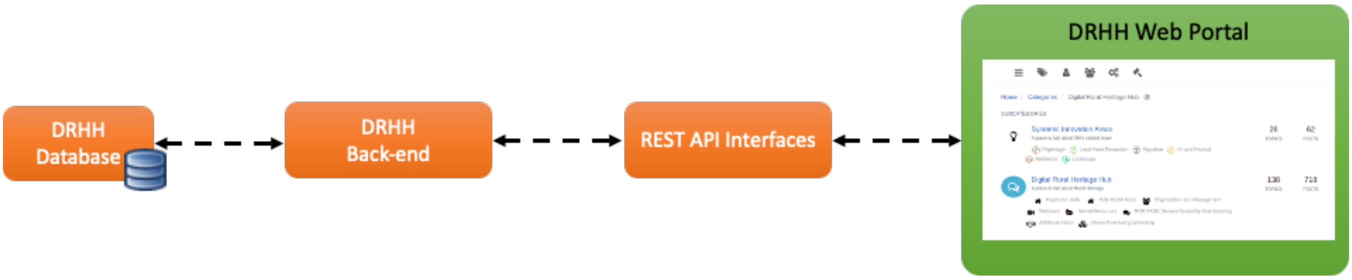


Figure 31. DRHH communication flow

8.1 DRHH Web Portal

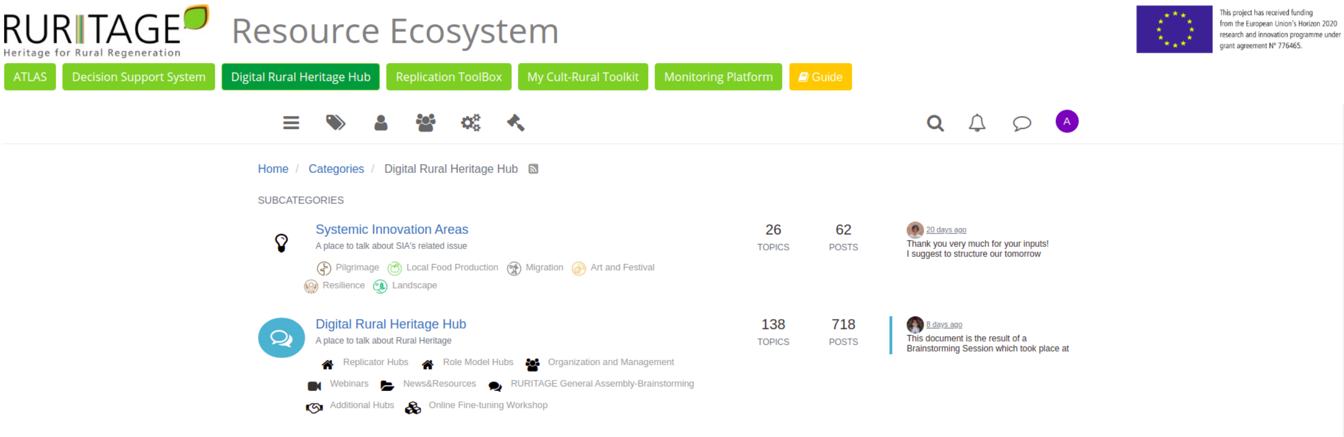


Figure 32. Categories defined into the DRHH

As shown in Figure 32, the DRHH's forum is divided into different categories, each of them contains topics related to a particular argument:

1. Systemic Innovation Areas
    a. Pilgrimage
    b. Local food production
    c. Migration
    d. Art and festival
    e. Resilience
    f. Landscape
2. Digital heritage hub
    a. Role models hub
    b. Replicators hub
    c. Organization and management
    d. Webinars
    e. News and resources
    f. RURITAGE General Assembly-Brainstorming
    g. Additional Hubs
    h. Online Fine-tuning Workshop

Excluding 2.a and 2.c, all the categories are accessible for all the user registered to the platform that can create and reply to other user's topic. The Role Models hub and the Replicators hub are instead different from the other categories: each of them is respectively divided in additional categories one for each Role models and Replicator, respectively. Thus, their structure is the following:

1. Role models hub
    1.1. Camino de Santiago Francés en Castilla y León
    1.2. MÁRIA ÚT
    1.3. DARe Puglia
    1.4. Colombian coffee UNESCO cultural landscape
    1.5. Migrants hospitality in Asti Province
    1.6. Migrants integration in Lesvos Islands Global UNESCO Geopark
    1.7. Cultivate at Take Art
    1.8. Visegrád, az élő középkor városa
    1.9. Μουσείο Φυσικής Ιστορίας - Πανεπιστήμιο Κρήτης
    1.10. KATLA JARÐVANGUR
    1.11. Austrått and Ørland landscape
    1.12. Duero Douro: patrimonio para el desarrollo

1.13. Wild Atlantic Way

2. Replicator hub
    2.1. Geopark Karavanke/Karawanken
    2.2. Magma Geopark
    2.3. Migrants integration in Geo-Naturpark in Germany
    2.4. Festival Ljubezni v Negovi
    2.5. Comune di Appignano del Tronto
    2.6. Izmir Geopark in Gediz-Bakircay Basins

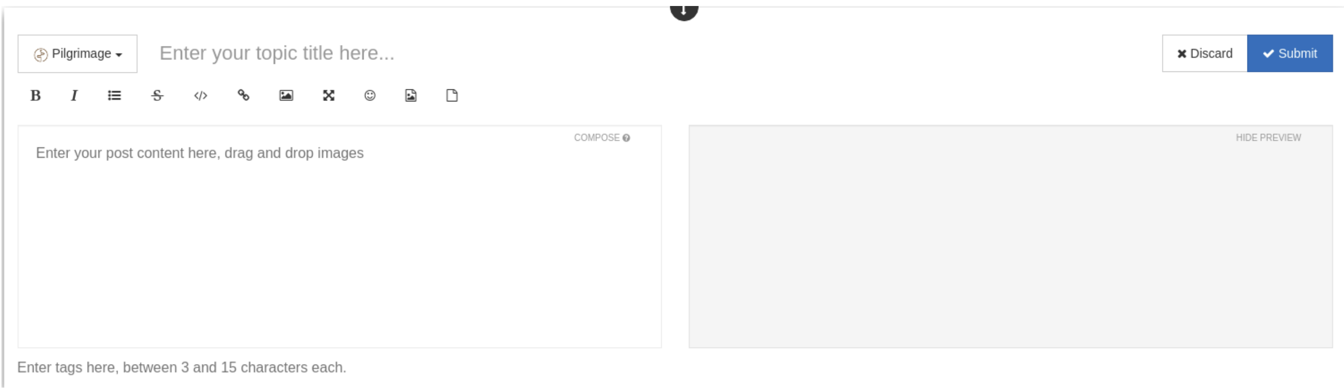


Figure 33. Insert a new post on the DRHH

As shown in Figure 33, users are able to create their posts through a simple text box. Users can format text following Markdown rules or by clicking on the styling buttons on top. Users can also and include images and links.

8.2 DRHH Backend and Database

The DRHH Backed is powered by Node.js and supports the integration of multiple database management systems. To make the whole DRHH more flexible in storing information with no predefined data structure, we exploited MongoDB (see Chapter 5.3). DRHH Backed allows instant interactions and real-time notifications and it has many features out of the box such as social network integration and streaming discussions. The DRHH Backed stores data into the database as JSON document (see Chapter 5.2). Every single document in the database has its own unique identifier:

- uid - user id user:<uid>
- cid - category id cateogory:<cid>
- tid - topic id topic:<tid>
- pid - post id post:<pid>
- mid - message id message:<mid>
- nid - notification id notifications:<nid>
- eid - event id event:<eid>

For example, each user's document is stored in an object with a unique key in the form user:<uid> where <uid> is the unique user identifier.
Given this database structure we designed and developed additional REST Web Services to provide new functionalities to support other tools in the RRE in accessing always updated information, even in (near-) real-time, if needed, such as the DSS (see Chapter 7.4). Custom REST Web Services to provide contents filtered by categories and retrieved from the DRHH Database.

9. My Cult-Rural Toolikit

My Cult-Rural Toolkit has been designed and developed to assist and build capacity within Replicator communities to assess the impact of locally driven actions. The toolkit employs both ubiquitous technologies and community workshops, to extend the reach of engagement. The kit consists of three physical tools, two digital tools and a social media monitoring tool. The physical tools are: (1) Mini-Landscapes, (2) Object Mapping and (3) Walking Maps. The digital tools are: (4) Landscape Connect and (5) RateMyView.

Tools 1-3 of the toolkit focus on three bespoke participatory research tools that utilise local and raw materials to co-create temporary installations outside. During the co-creation, each tool stimulates discussion and once made, the installations are recorded using visual and qualitative methods. Tools 4-5 are mobile phone applications (apps) that are free to download and allow text and images to be collected and georeferenced using smartphones or tablets. Both *Landscape Connect* and *RateMyView* allow in-the-field user data collection, combined with a server-based back end that allows real-time data analysis by researchers and workshop facilitators.

Tools 4-5 are available online at https://www.ruritage-ecosystem.eu/culttool

On the one hand, *Landscape Connect* collects images and textual data linked to the geo-referenced location of the mobile user. Textual data is elicited through questionnaires presented to the mobile user. The researcher can create questionnaires of any degree of simplicity or complexity, using the main conventional survey question types. Collected data is uploaded to the server in real time allowing for facilitated workshops where results can be analysed and used for discussions during the course of a workshop. Collected data is cumulative, mapped (geo-located), and downloadable allowing for longer-term data gathering exercises and more complex off-line data analyses. On the other hand, *RateMyView* app is free to download and allows text and images to be collected and georeferenced using smartphones or tablets. It uses GPS technology to pinpoint the end-user's location and also detects the direction the user is facing. Images and text are cached on user's devices and then automatically uploaded to the *RateMyView* database when the internet connection in the smartphone is available. A full description of the tool kit is provided in Deliverable 5.2 "My Cult-Rural Toolkit" submitted in November 2019. Tools 4-5 are part of the RRE, their main software components shown in Figure 34 are described below.

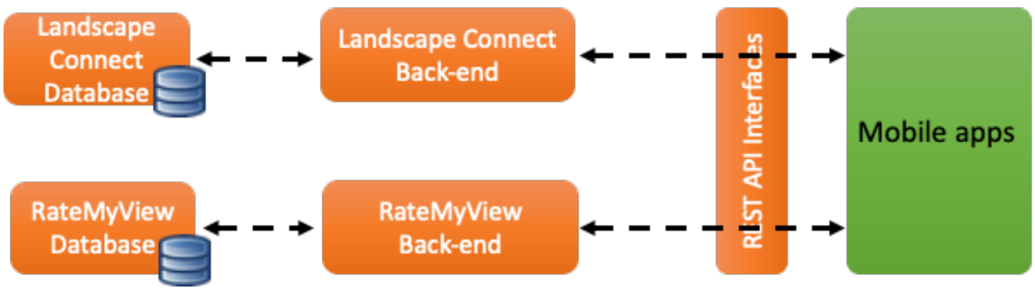


Figure 34. Schema for Landscape Connect and RateMyView

At the core of both Landscape Connect and RateMyView are four main distributed software components: i) *Landscape Database,* ii) *Landscape Back-End,* iii) *RateMyView Database* iv) *RateMyView Back-End*.

Both *Landscape Database* and *RateMyView Database* are based on MongoDB (see Chapter 5.3), which differs from traditional relational database systems as it is a document database - chiefly comprised of complex objects allowing a rich data object. MongoDB was selected as it allows very simple schema changes, only being enforced in application code, and offers excellent geographical extensions. The software natively supports querying WGS84 lat/long points with complex queries, including geoWithin, allowing database-level support for enforcing geographical constraints on submissions areas. *Landscape Database* stores mainly georeferenced alphanumerical information. Whilst *RateMyView Database* stores also photos together with alphanumerical data. All these information is stored and sent following either JSON or GeoJSON (when georeferentiation is needed) data-formats (see Chapter 5.2).

Both *Landscape Back-End* and *RateMyView Back-End* are software written in Node.js, the server-side framework for running JavaScript. It is a feature-complete software library and ecosystem for writing fast performant web servers. It supports third party libraries and allows fast-paced development. The server code runs on the Heroku platform, a hosted Platform as a Service (PaaS) system. This system simplifies the maintenance of the system and supports very high uptime requirements as every part of the infrastructure is virtualised. Both *Landscape Back-End* and *RateMyView Back-End* were designed and developed to foster interoperability with other remote services, including third-party platforms, thus, allowing future extensions. The main Application Programming Interface (API) consists of REST Web Services (see Chapter 5.1), accessible over HTTPS, to retrieve information. Such REST Web Services are also used by the Atlas to retrieve information from RateMyView.

Landscape Mobile App exploits the REST Web Services provided by *Landscape Back-End* to download and uploads questionnaires and responses that are stored in the *Landscape Database*. JSON is the data-format chosen to manage information within the questionnaires. The *RateMyView Mobile APP* uses a static set of questions programmed in the iOS and Android app. These are then uploaded as JSON documents with the picture taken by the end-user to the *RateMyView Database* by exploiting the REST Web Services provided by *RateMyView Back-End* (see Figure 35).

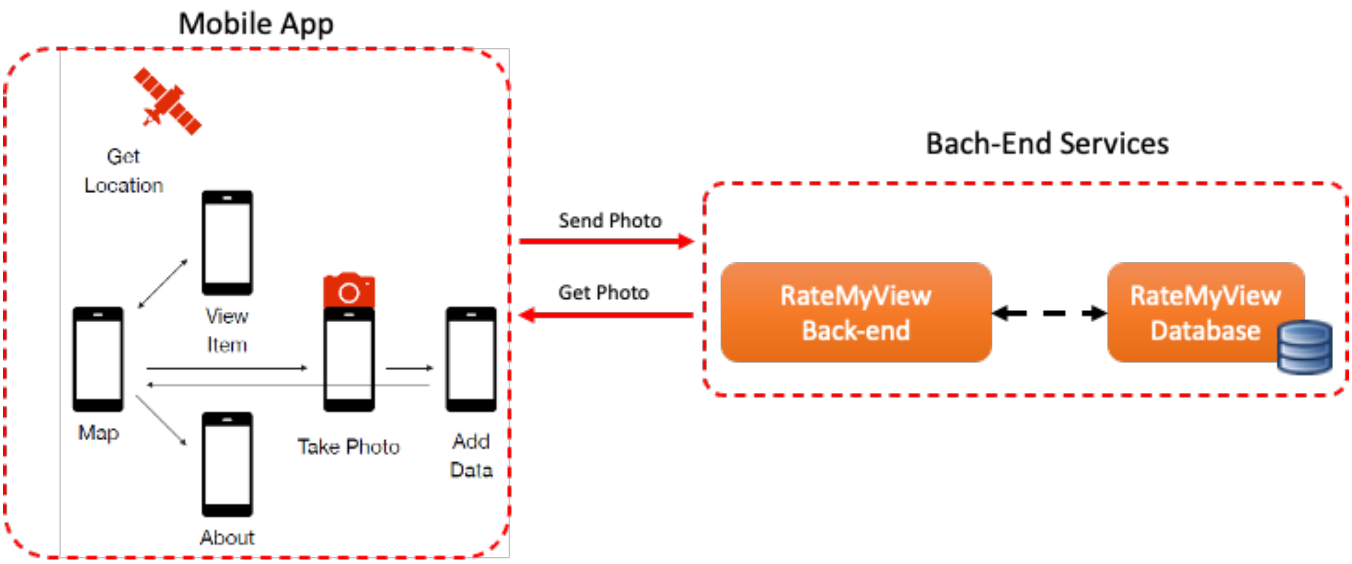


Figure 35. RateMyView communication flow

10. Monitoring Platform

The main objective of the Monitoring Platform is to enable users to monitor their implementation process on rural development. This tool provides evidence of the role of cultural and natural heritage as a driver for sustainable growth in rural areas. The Monitoring Platform has been previously described in Deliverable 4.1 (KPIs definition and evaluation procedures) and Deliverable 4.2 (Monitoring programme and procedures).
The Baseline analysis made in Deliverable 1.4 (Replicators' baseline assessment report) can be seen as a showcase for the Monitoring Platform, highlighting its full capabilities.

The Monitoring platform is available online at https://www.ruritage-ecosystem.eu/kpi

Figure 36 shows the main software components of the Monitoring Platform. The *Monitoring Platform database* implements a Mongo DB (see Chapter 5.1) to store values of the indicators provided by the Replicators. These values are used by the Monitoring Platform Back-end and are the base to obtain the KPIs, the Community Capitals values and, finally, the Global Performance Index that summarises the evolution of the rural development process. All this information can be provided to the Monitoring Platform Front-end, and to other tools such as ATLAS and DSS, through the REST Web Services (see Chapter 5.1).

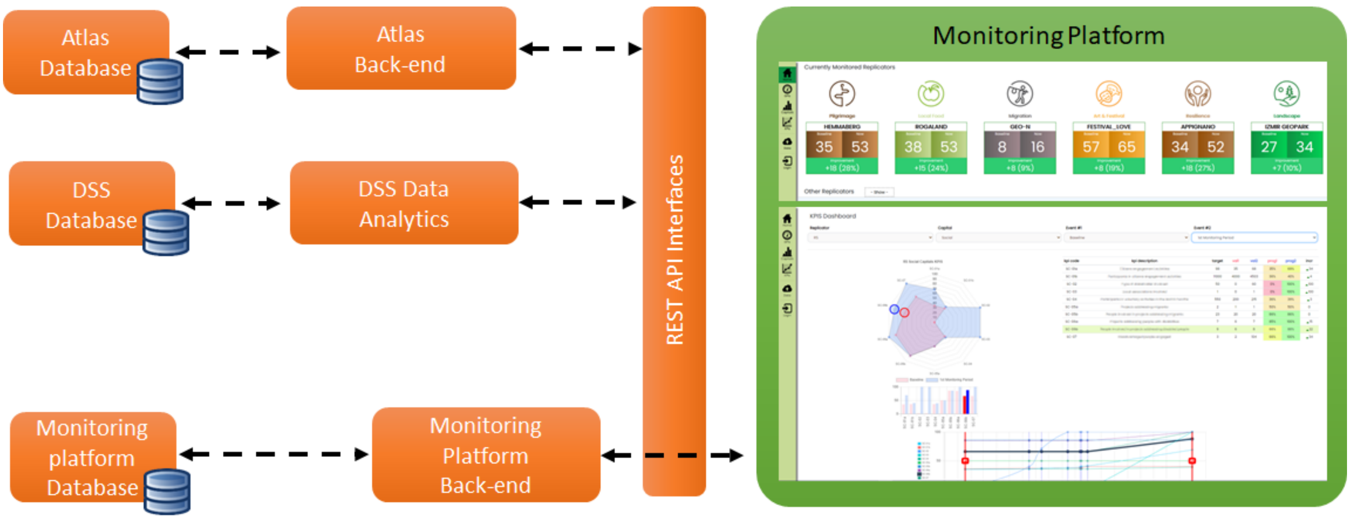


Figure 36. Software components of the Monitoring Platform

Figure 37 shows the description of the Monitoring Platform Open API according to the OAS3 standard. The OpenAPI Specification (OAS) defines a standard, language-agnostic interface to REST Web Service which allows both humans and computers to discover and understand the capabilities of the service without access to source code, documentation, or through network traffic inspection.

Figure 38, Figure 39 and Figure 40 show a detailed description of every tag, highlighting inputs, outputs and data formats.

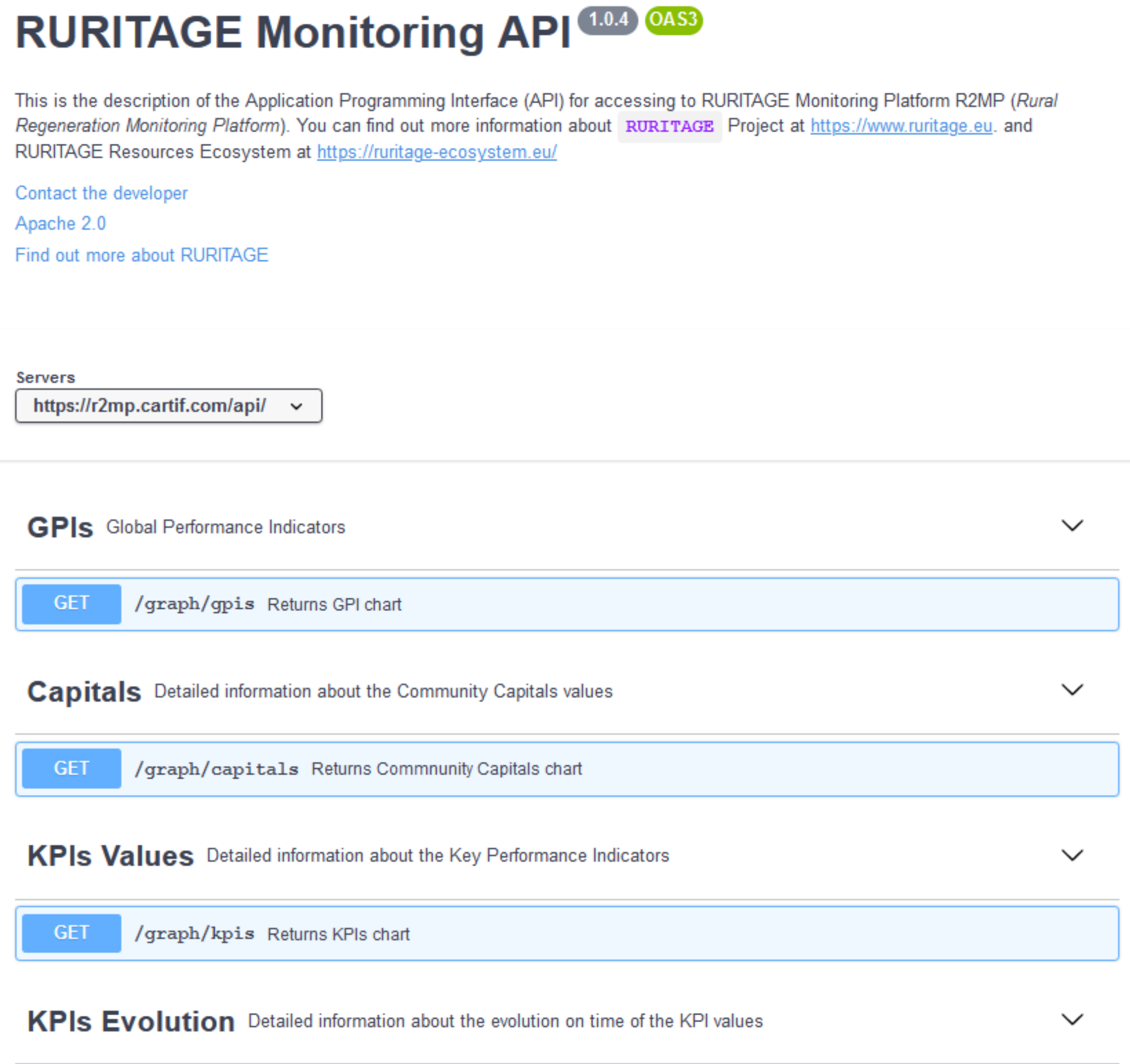


Figure 37. Monitoring Platform Open API

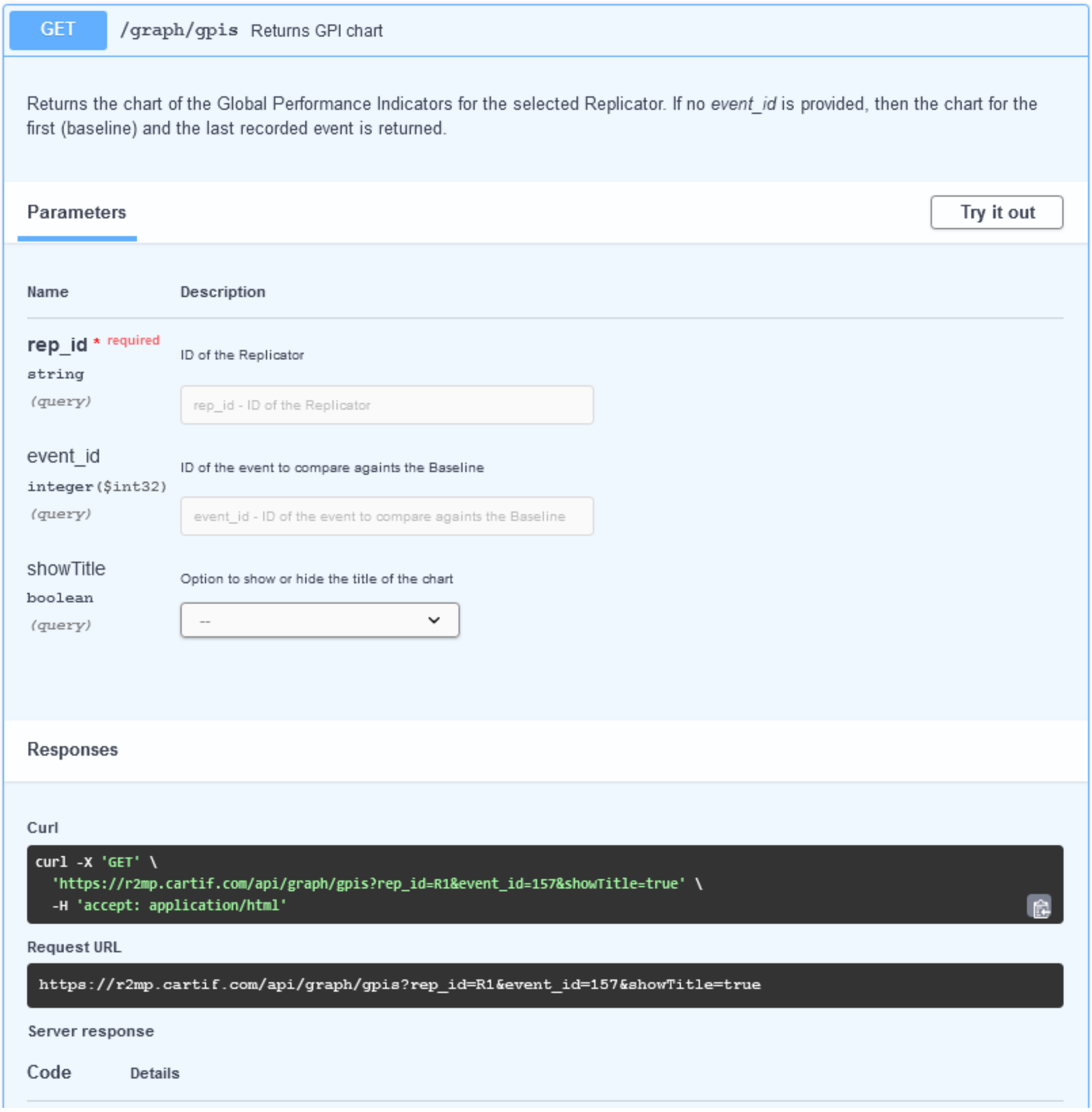


Figure 38. Monitoring Platform Open API for Global Performance Index.

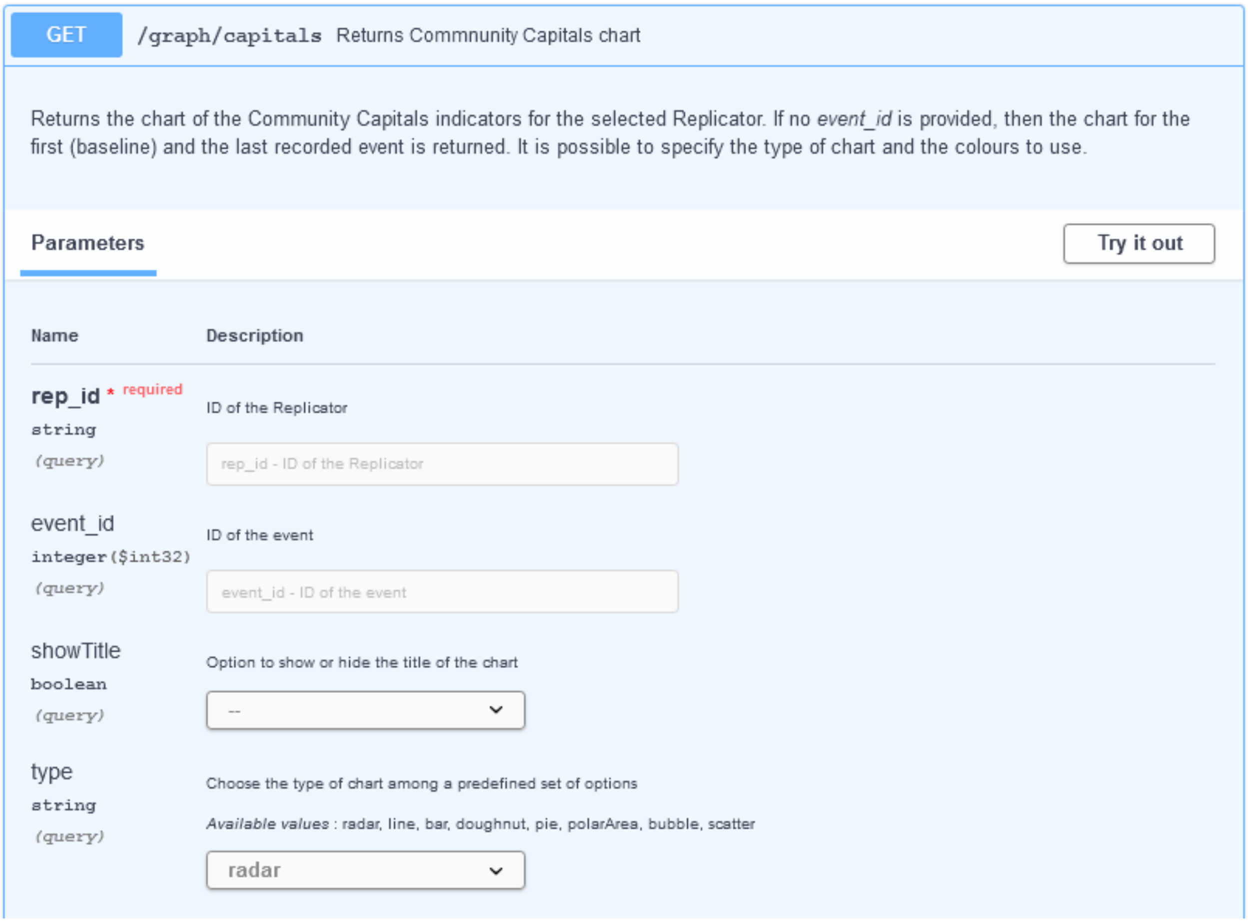


Figure 39. Monitoring Platform Open API for Community Capitals

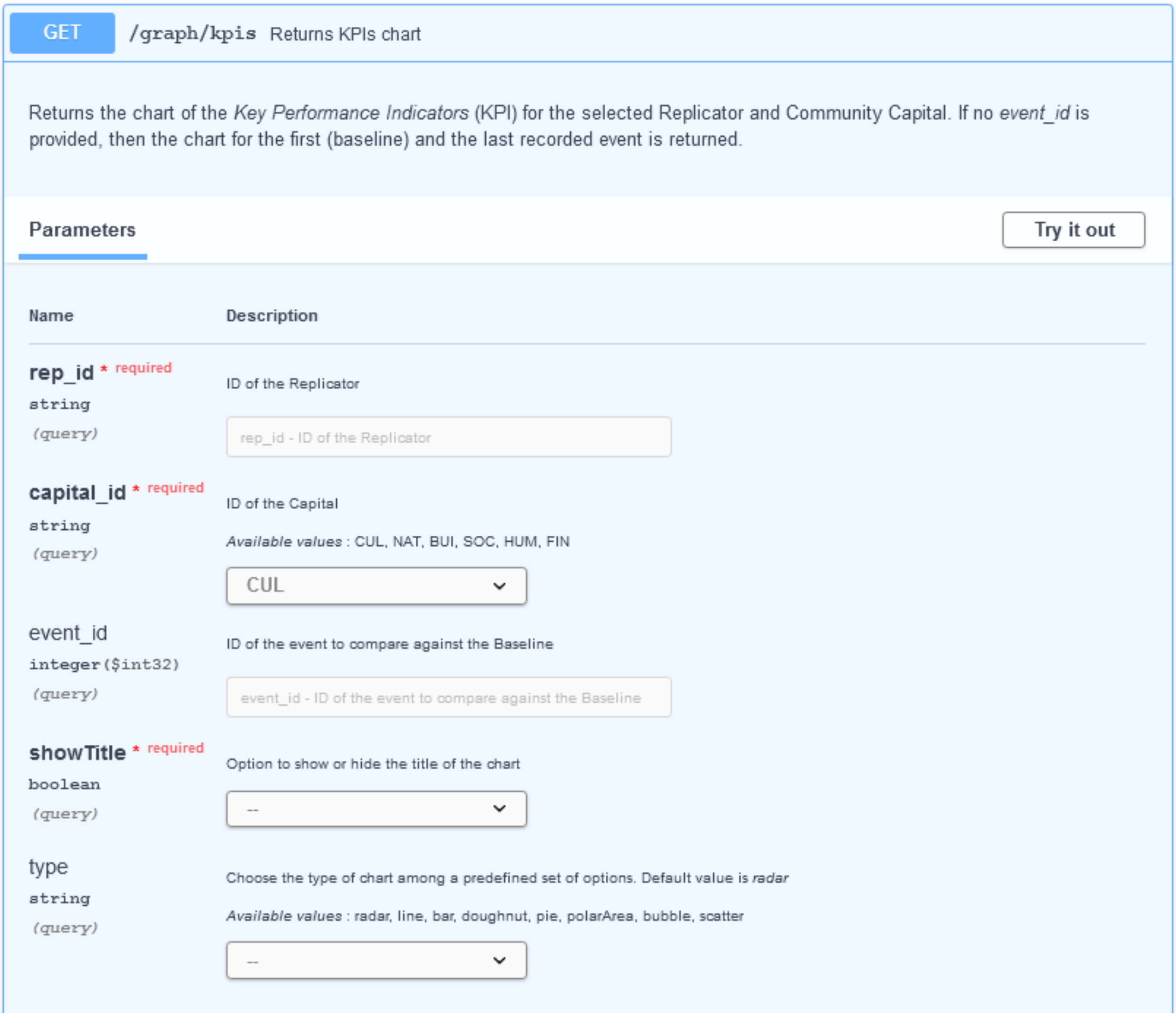


Figure 40. Monitoring Platform Open API for Key Performance Indicators

11. Replication ToolBox

The main objective of the Replication toolbox is to offer a tailored step-by step guide to the tools and resources generated within the RURITAGE project. In the moment of the development of this report the tool is under construction. It has been structured under the WHAT-WHO-HOW Framework, as it can be seen in Figure 41.

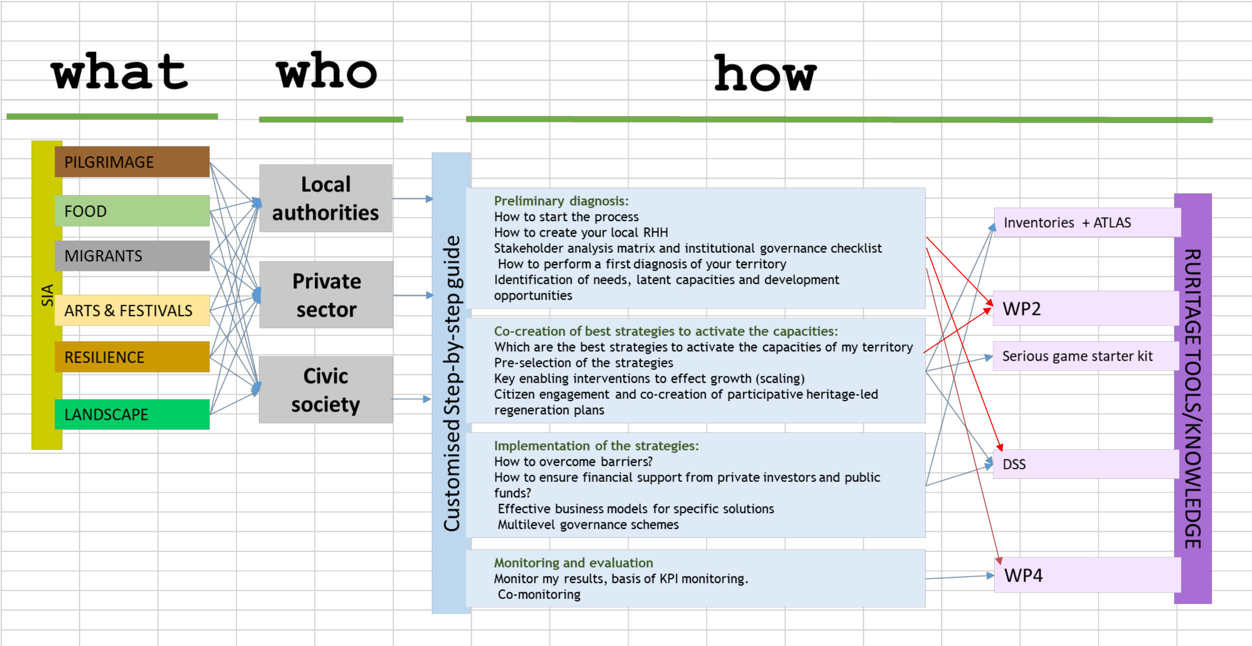


Figure 41. WHAT-WHO-HOW Framework for the Replication Toolbox

The toll will be fully integrated within the RURITAGE Resource Ecosystem and will guide interested rural areas in the development of their heritage-led rural regeneration processes. It will enable rural communities to perform an initial assessment of the possibilities, in order to start the discussion and planning processes, by including and creating interactive relations among the following contents:

- RURITAGE Practices Repository (Task 1.1)
- RURITAGE Inventory of Lessons Learned (Task 1.2), updated with the Solutions experimented within the Replicators (WP3) and assessed in WP4
- RURITAGE Serious Game kit (Task 2.2)
- Step by Step Regeneration Guidelines in the form of an e-learning book, developed within this Task
- RURITAGE DSS, developed in Task 5.4

Figure 42 shows a mock-up for the Replication toolbox. More details on the Replication toolbox will be provided in D5.4 “RURITAGE Replication ToolBox” due to M48.

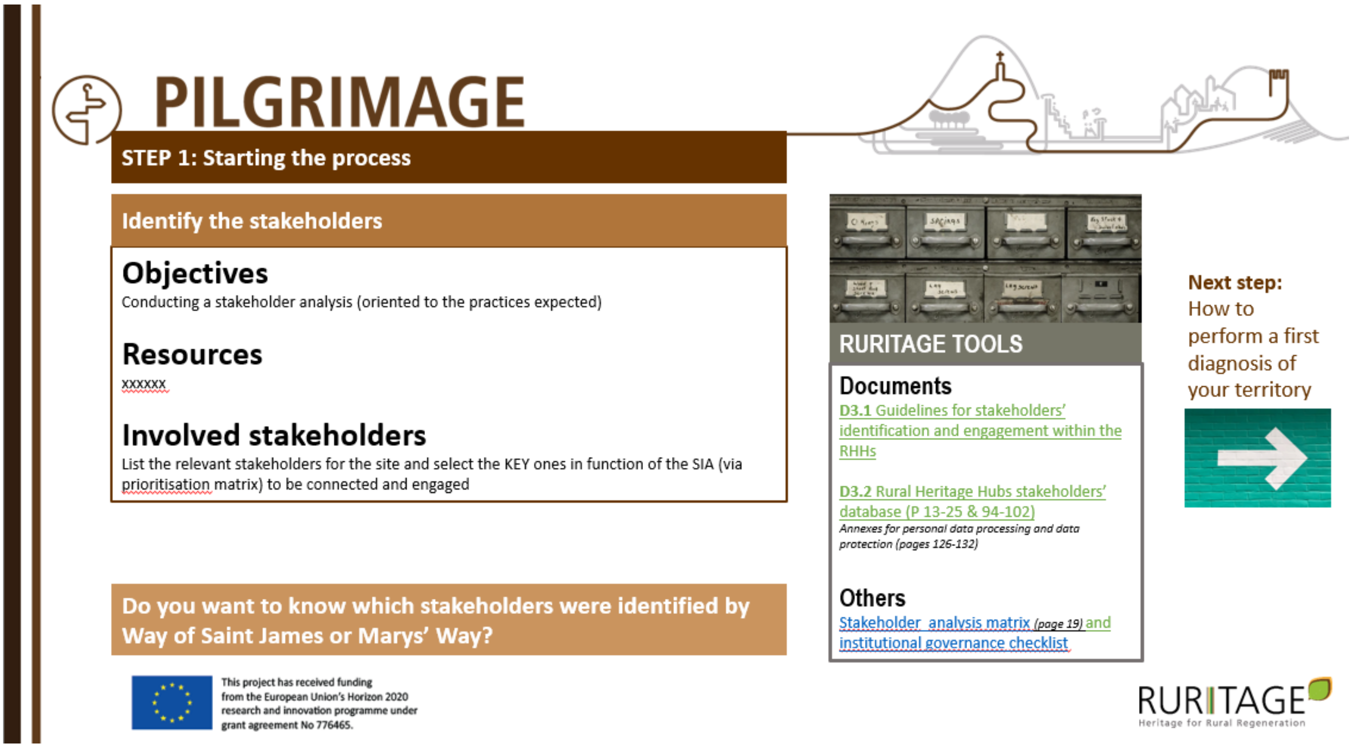


Figure 42. Mock-up for the Replication Toolbox

12. Concluding remarks

In this deliverable we presented the Ruritage Resource Ecosystem (REE), which is a distributed software infrastructure. The RRE has been designed to be highly flexible, scalable and modular in order to foster development of future applications and integration of third-party software. Together with the main software components, the RRE provides the following tools: i) Atlas, ii) Decision Support System, iii) Digital Rural Heritage Hub, iv) My Cult-Rural Toolkits, v) Monitoring Platform and vi) Replication toolbox. It is worth to highlighting that the RRE can be deployed either in cluster of computers or in Infrastructure-as-a-Service cloud systems.

As we followed the Agile methodology for its development, software components of the RRE are periodically updated for bug fixing and/or new feature releases. In this view, one of the main activities of T5.1 consists of software maintenance of the whole RRE, by ensuring consistence and usability of the platform across the whole duration of the project. A quality check on the integrity of the data will be performed, also considering that new data will be continuously generated and processed by the various tools of the ecosystem. The maintenance will include stability and resiliency checks performed on the distributed software infrastructure.

As highlighted in previous sections, a strong collaboration with WP1, WP3, and WP4 were established, as they identified the main potential end-users and provided the main requirements for its design and development.

13. References

[1] Ahmed Hefnawy, Abdelaziz Bouras, Chantal Cherifi: *IoT for Smart City Services: Lifecycle Approach*. DOI: http://dx.doi.org/10.1145/2896387.2896440

[2] https://www.ftms.edu.my/images/Document/IMM006%20-%20RAPID%20APPLICATION%20DEVELOPMENT/Chapter%203%20RAD%20Notes.pdf

14. Annex I

14.1 List of Illustrations