



envision
environmental services infrastructure with ontologies

Deliverable D2.1

Environmental Semantic Web Portal Architecture specification

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Executive Summary

The ENVISION project develops an infrastructure for deploying semantic web services and environmental models to given geographic information communities. The objective of this document is to present the architecture and software components required for the ENVISION Portal which is the single web based entry point for the ENVISION Infrastructure.

This document is therefore the basis for the implementation of the different software components from the different work packages. From technical high level concepts and identified requirements, it identifies the different modules and services to be developed. Standards and technologies to be implemented are also discussed and modules developed by BRGM are described more precisely.

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1 Introduction

This section introduces the architecture specification of the Environmental Semantic Web Portal. While section 1.1 gives an overview of the document, section 1.2 explains the context in which the architecture is elaborated by referring to different European initiatives that influence the design of the portal.

1.1 Overview

The main objective of the ENVISION project is to provide an ENVironmental Services Infrastructure with ONtologies for semantically enhanced multilingual discovery and adaptive composition of environmental services for users without ICT skills.

The Environmental Semantic Web Portal, herein and after named “ENVISION Portal” is the front end application for the different users of the infrastructure. This document defines the ENVISION Portal architecture.

The foundations of the architecture are described in section 2, while standards and technologies to be used for implementation are discussed in section 3. Modules to be developed by BRGM are listed in section 4. Section 5 concludes the deliverable.

1.2 Context

There are several European and international initiatives that provide architectural guidelines relevant in the scope of the ENVISION project¹.

At European scale, SEIS² (Shared Environmental Information Space), SISE³ (Single Information Space in Europe) and GMES⁴ (Global Monitoring for Environment and Security) are different important initiatives taken by the European authorities to collect and share environmental information for the benefit of a global society. The INSPIRE⁵ directive provides a legal framework for the proliferation of geographic information in the European member states

At a global scale, the purpose of GEOSS⁶ (Global Earth Observation System of Systems) is to achieve comprehensive, coordinated and sustained observations of the Earth system, in order to improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the behaviour of the Earth system.

These different initiatives are proposing federative concepts. The key principles referred to by the INSPIRE directive for example about data management are:

- Data should be collected once and maintained at the level where this can be done most effectively.
- It must be possible to combine spatial data from different sources across the EU seamlessly and share it between many users and applications.
- It must be possible for spatial data collected at one level of government to be shared between all levels of government.
- Spatial data needed for good governance should be available on conditions that are not restricting its extensive use.
- It should be easy to discover which spatial data is available, to evaluate its fitness for purpose and to know which conditions apply for its use.

For more information about resulting architectural guidelines, relevant documents may be consulted from:

- The INSPIRE website ⁷
- The Earth observation group website ⁸

The ENVISION Portal architecture described in this document is in line with these architecture principles, among them the data sharing principles, service oriented approach, interoperability, and is taking full advantage of the previous works.

2 Architecture foundations

This section identifies the overall architecture of the ENVISION Portal. The ENVISION Portal is used by non ICT-Skilled users to produce dedicated websites, embedding web service compositions implementing environmental models. For the demonstration of the infrastructure's capabilities, as described in the Description of Work⁹, we will at least produce one website per pilot during the project. (i.e. one for the landslide pilot and one for the oil spill pilot).

The two pilots and their resources are not described in this document, but in the WP1 deliverables. D1.1¹⁰ presents the definition of the use cases while D1.2¹¹ gives the requirements specification.

Because the ENVISION Portal is a generic solution to be used for different modeling domains, we have to provide a community based system, relying on clear actors and role definitions, which will be developed objective of the 2.1 section. High level user requirements and technical requirements are then listed in section 2.2. Resulting technical architecture principles for the ENVISION Portal are then exposed in section 2.3.

Complementary information and more details about architecture may be found in the other work package related documents:

- D3.1¹²: MaaS Composition Portal – Architecture specification.
- D4.1¹³: Ontology requirements analysis.
- D5.1¹⁴: Deployment of the OGC Catalogue.
- D6.1¹⁵: ENVISION Adaptive Execution Infrastructure – Architecture specification.

2.1 A community and role based system

The ENVISION Portal is the web-based entry point for all potential users of the ENVISION Infrastructure. It aims at making existing and new environmental models available as a service. In addition, it allows composition of these and other services and the design of dedicated websites to use these compositions. The described functionality will be specific to dedicated communities of users interested in a specific domain.

This requires the option to manage separate information communities for different scientific domains. Referring to the two pilots defined in the project, we consider two different information communities: one interested in modelling the probability and impacts of landslides and one interested in predictions of the distribution and effects of spilled oil on sea.

The ENVISION Portal's security (authentication and authorisation) will be based on roles. The following primary user roles are considered in the ENVISION Infrastructure. One user can take up multiple roles.

- **End-User**: uses Scenario Websites.
- **Designer**: uses the ENVISION Portal to design a service composition and a scenario website to be published for a given community.
- **Manager**: uses the ENVISION Portal to manage resources involved in the ENVISION Infrastructure.

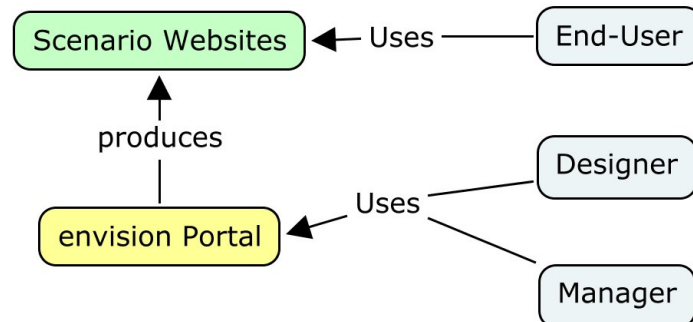


Figure 1 – User Roles

These primary user roles may be specialized as below when needed:

- The designer :
 - scenario website designer
 - service composition designer
- The manager :
 - semantic catalogue manager

2.2 Identified requirements

2.2.1 High level user requirements

This section focuses on the high level requirements of the ENVISION Portal from the designer and manager point of view. These requirements are generic functionalities the ENVISION Portal will provide for designers and managers. They are derived from the DoW and will be detailed in the D1.2 documents "Requirements specifications" through the pilots' uses cases and activities description.

General

- The ENVISION Portal is the web-based unified access point for all users of the ENVISION Infrastructure.

Scenario Website designer

- Design a website (e.g several web pages) with existing components using a graphical interface.
- Discover existing Web Services from the catalogue
- Select a Web Service to be exposed in the website
- Set up the Web Service with given parameters and inputs
- Publish the website for a given community
- Administrate the members of the community

Service Composition designer

- Create a new service composition
- View /Edit an existing service composition
- Discover existing resources from the catalogue and combine them in the service composition
- Select what parameters/inputs may be modified at run time
- Run the composition for testing purposes
- Deploy the resulting composition into the catalogue to make it available as a MaaS

Semantic Catalogue manager

- Publish/Unpublish resources (Data Services, Processing Services, Sensors Services)
- Do administration and maintenance activities

2.2.2 Technical requirements

- The ENVISION Portal is a web-based integrated and harmonised user interface. This implies that all user interfaces are developed using the same technology.
- The catalogue service conforms to the OGC¹⁶ CSW interface and the catalogue implementation may be changed to any other OGC CSW compliant catalogue.
- The implementation of the ENVISION Portal is based on standardised technology.

2.3 Architecture overview

As the ENVISION Project is a multi-partner project, the different software components developed by the partners will not be hosted at the same place. We will have to deal with a physically as well as logically distributed architecture as described in 2.3.1.

Because the ENVISION Portal is an integrated portal, it requires a strategy about technologies used and must be based on well defined components, with a high level software organisation, as described in 2.3.2.

Section 2.3.3 lists the different modules to be developed. This list reflects the status at month 6 of the project and may evolve during the project.

Section 2.3.4 lists the different services to be developed. In the same way, this list is the status at this stage of the project and may mature during the next periods.

2.3.1 A distributed infrastructure

Partners implementing services are also responsible for deployment and maintenance of these implementations. Each partner will host the service(s) he develops, the ENVISION Portal will access them through the Internet.

The following figure illustrates the different services and the partner responsibilities.

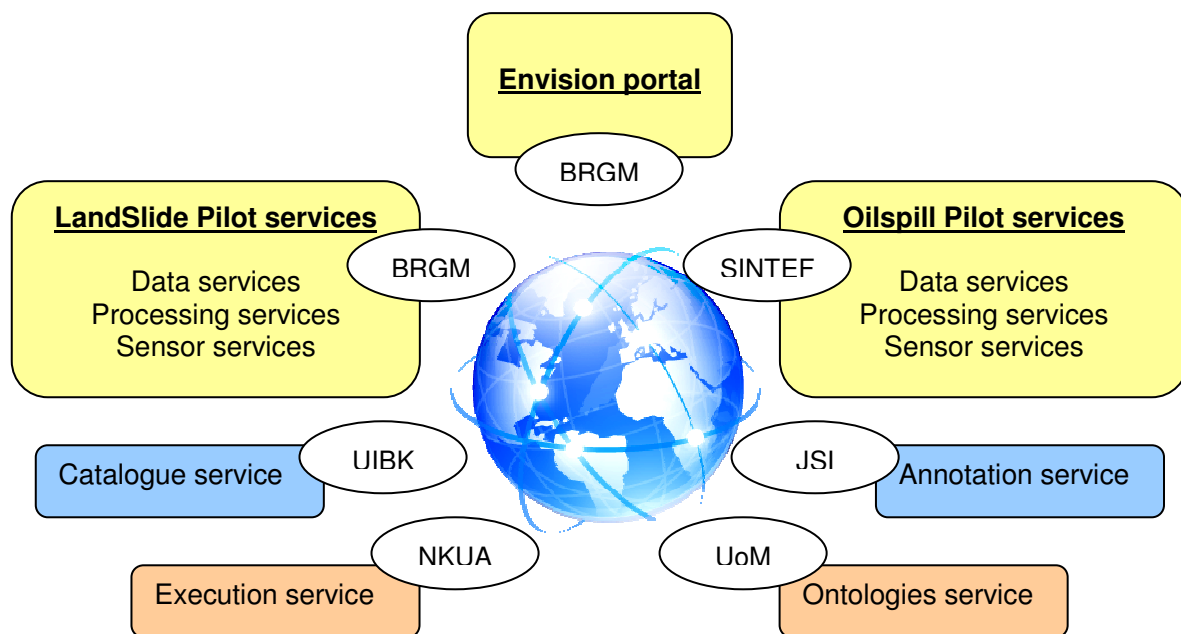


Figure 2 – ENVISION Infrastructure: distributed organisation

2.3.2 High level software organization

To produce the Scenario Websites, the designer uses the ENVISION portal. The ENVISION portal is composed of several *software modules* hosted on the ENVISION Portal server.

These modules have:

- a server-side part to manage specific processing made by the module
- a client side part to manage interaction with the user (Graphical User Interface)

The modules may also interact with ENVISION services (web services) hosted on separate servers in case of specific heavy processing (annotation with huge amount of data for example).

These different levels of software are illustrated with the following figure.

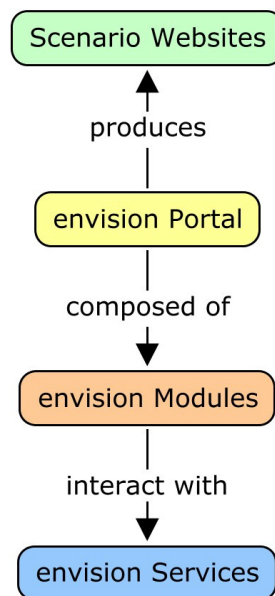


Figure 3 – High level organization

The pilot dedicated data services and processing services involved in the composition are provided by the pilots themselves (work package 1) and are not part of the ENVISION Infrastructure delivered in other work packages.

2.3.3 The Modules

The ENVISION portal is providing a set of functionalities to the designers: semantic composition functionalities, semantic annotation and discovery of resources, etc. They are all composed of different modules which may be used at different positions in the ENVISION Portal or even the scenario websites. For example a given Module may be used for semantic annotation and semantic composition.

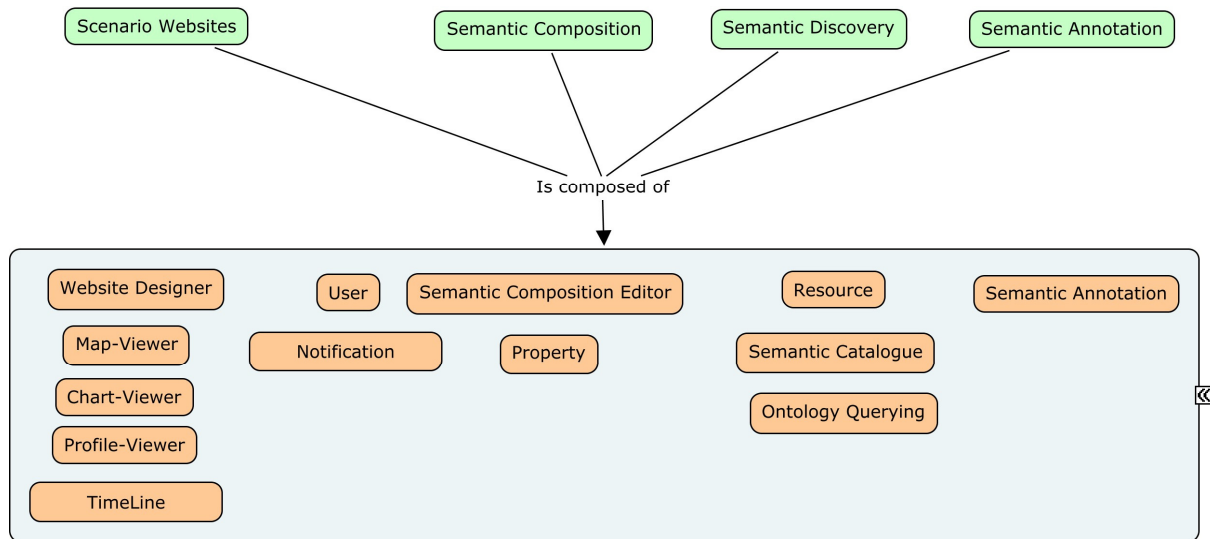


Figure 4 – Modules usage

The table below identifies and describes the different key modules to be developed to full fit the ENVISION "Portal technical requirements and the pilots' uses cases requirements.

Module Name	Author	Key requirements description
User	BRGM	<ul style="list-style-type: none"> Allows a visitor to log in, register. Allows a user to manage his account. Allows the manager to assign communities to user, to create new communities.
Website Designer	BRGM	<ul style="list-style-type: none"> Is used to make the composition/model available to an end user community. Allows the Website Designer to create a new website based on a composition. Allows the Website Designer to set up the composition with some data specific to its domain. Allows the Website Designer to add some pages (e.g. with a wiki or a forum) with some useful information for understanding the computer model and its results.
Map-Viewer	BRGM	<ul style="list-style-type: none"> Is a map with standard interaction techniques like panning, zooming Has map actions with a set of extended tools for changing the content of the map module, e.g. to change the displayed variables, or adjust the time. Has a legend that displays information depending of the current content of the map
Chart-Viewer	BRGM	<ul style="list-style-type: none"> Enables to view features displayed as charts
Profile-Viewer	BRGM	<ul style="list-style-type: none"> Enables to view profiles displayed as 2D profile maps
Notification	BRGM/UoM	<ul style="list-style-type: none"> Allows for subscribing to the available information sources.
Resource	BRGM	<ul style="list-style-type: none"> Allows to browse/search resources Allows context-dependent actions such as publishing/un-publishing.
Timeline	BRGM	<ul style="list-style-type: none"> Allows to navigate within scenario and/or time steps
Property-Viewer	SINTEF	<ul style="list-style-type: none"> Allows for editing the properties of the currently selected item in the workflow view.
Service Composition Editor	SINTEF	<ul style="list-style-type: none"> Allows a designer to graphically create & test a composition using a modeling notation
Semantic Catalogue	UIBK	<ul style="list-style-type: none"> Supports searching for OGC Web services using thematic, spatial, and temporal search criteria Allows for browsing through registered services Allows formulation of semantic queries
Semantic Annotation	JSI	<ul style="list-style-type: none"> Is used for the semantic annotations of resources; supports ontology maturing through user feedback. Allows viewing and graphical navigation into Ontologies
Ontology Querying	JSI	<ul style="list-style-type: none"> Is used to search for Domain Ontologies, related or not to given resources

Table 1 – List of Modules

2.3.4 The Services

The ENVISION portal modules are made to work with web services. It allows the portal to be installed anywhere and to access remote services for doing the processing. The table below identifies the different services. These services are detailed in the other work packages related documents (D3.1, D4.1, D5.1, D6.1).

Service Name	Author&Hoster	Description
catalogue	UIBK	The open source catalogue is used as a registry/repository for various services that will be provided to other components in the project. We will use an open source implementation of the OGC Catalogue Service. This catalogue will be populated through the different modules that will be used by the various use cases.
ontologies	UoM	This service exposes methods to retrieve relevant parts of the ontologies. These services consist of software components to be accessed by the different modules of the ENVISION Portal.
annotations	JSI	This stateful service holds the information about the user's annotation environment (i.e. session) reflected on the client side. The service is responsible for loading, grounding, and layouting domain ontologies and answering search, browse, and complex natural language queries.
execution	NKUA	The goal of this service is to expose a scalable infrastructure that supports the distributed execution of adaptive service chains, including efficient ontology-based run-time data mediation.

Table 2 – List of Services

Each of these services will have a clear and well documented Application Programming Interface to allow other partners to properly use the corresponding services in the different modules when needed.

3 Standards and technologies

This section focuses on standards (section 3.1) and Technologies (section 3.2) to be used in the ENVISION Portal.

3.1 Standards

As often as possible, The ENVISION Portal services will rely on standards. More specific, when dealing with Geospatial Web Services, the following OGC standards will be targeted:

- **WMS** (<http://www.opengeospatial.org/standards/wms>)

Specification for a web service interface serving map images generated on the fly.

- Versions 1.1.1 and 1.3.0 shall be supported

- **WFS** (<http://www.opengeospatial.org/standards/wfs>)

Specification for a web service interface serving spatial features encoded in the Geography Markup Language (GML).

- Versions 1.0.0 and 1.1.0 shall be supported

- **WCS** (<http://www.opengeospatial.org/standards/wcs>)

Specification for a web service interface serving coverages (raster data).

- Version 2.0 shall be supported

- **WPS** (<http://www.opengeospatial.org/standards/wps>)

Specification for a web service interface serving geoprocessing capabilities handled by a processing server.

- Version 1.0.0 shall be supported

- **WCPS** (<http://www.opengeospatial.org/standards/wcps>)

Specification for a web service interface serving coverage geoprocessing capabilities.

- Version 1.0.0 can be supported

- **CS/W** (<http://www.opengeospatial.org/standards/specifications/catalog>)

Specification for a web service interface serving repository over the web.

- Version 2.0.2 shall be supported

- **SOS** (<http://www.opengeospatial.org/standards/sos>)

Sensor Observation Service Interface Standard (SOS) provides an API for managing deployed sensors and retrieving sensor data and specifically “observation” data. Whether from in-situ sensors (e.g., water monitoring) or dynamic sensors (e.g., satellite imaging), measurements made from sensor systems contribute most of the geospatial data by volume used in geospatial systems today. This is one of the OGC Sensor Web Enablement (SWE) [<http://www.opengeospatial.org/ogc/markets-technologies/swe>] suite of standards.

- Version 1.0.0 shall be supported

- **ISO19115 (Reference)**

For resources cataloging activities, the metadata ISO 19115 standards will be used.

It is a component of the ISO 191xx standards. ISO 19115 defines how to describe geographical information and associated services, including contents, spatial-temporal purchases, data quality, access and rights to use. The standard defines more than 400 meta data elements, 20 core elements.

3.2 Technologies

The ENVISION Portal will take advantage of a “on the shelf” Enterprise Portal technology.

Following the definition at Wikipedia, an enterprise portal, also known as an enterprise information portal (EIP) is a framework for integrating information and processes across organizational boundaries. It provides a secure unified access point, in the form of a web-based user-interface, and is designed to aggregate and personalize information through application-specific portlets.

The fundamental features provided are:

- **Integration** — the connection of functions and data from multiple systems into new components/portlets with an integrated navigation between these components.
- **Customisation** — Users can customise the look and feel of their environment. Customers who are using EIPs can edit and design their own websites which are full of their own personality and own style; they can also choose the specific content and services they prefer. Also refers to the ability to prioritize most appropriate content based on attributes of the user and metadata of the available content.
- **Personalisation** — Personalisation is more about matching content with the user. Based on a user profile, personalization uses rules to match the "services", or content, to the specific user. To some degree, you can think of the two like this: customisation is in hands of the end user, personalization is not. Of course actual personalization is often based on your role or job function within the portal context.
- **Access Control** — the ability for portal to limit specific types of content and services users have access to. For example, a company's proprietary information can be entitled for only company employee access. This access rights may be provided by a portal administrator or by a provisioning process. Access control lists manage the mapping between portal content and services over the portal user base.
- **Search** — search community content
- **Single Sign-On** — enterprise portals can provide SSO capabilities between their users and various other systems. This requires a user to authenticate only once.

At implementation time, we will target “Liferay” Portal. All modules have then to be implemented using the portlets approach. Portlets have to be developed using JDK6 for JRE1.6 and have to be in compliance with JSR286 standard.

4 Modules developed by BRGM

This section gives more details about the modules to be developed by BRGM. While section 4.1 gives an overview of how the modules may be combined together by giving typical mock-up, the following sections (from 4.2 to 4.9) present the different modules.

4.1 Overview

As illustrated in figure 4, one module may have several usages and may occur in different pages, either for the scenario websites or the ENVISION Portal.

A dedicated website (for example landslide website or oilspill website) should be understood as one particular instance, a custom-made configuration of different modules to fulfil one certain objective for one given information community. The figure below illustrates a mock-up of a typical example of such a website.

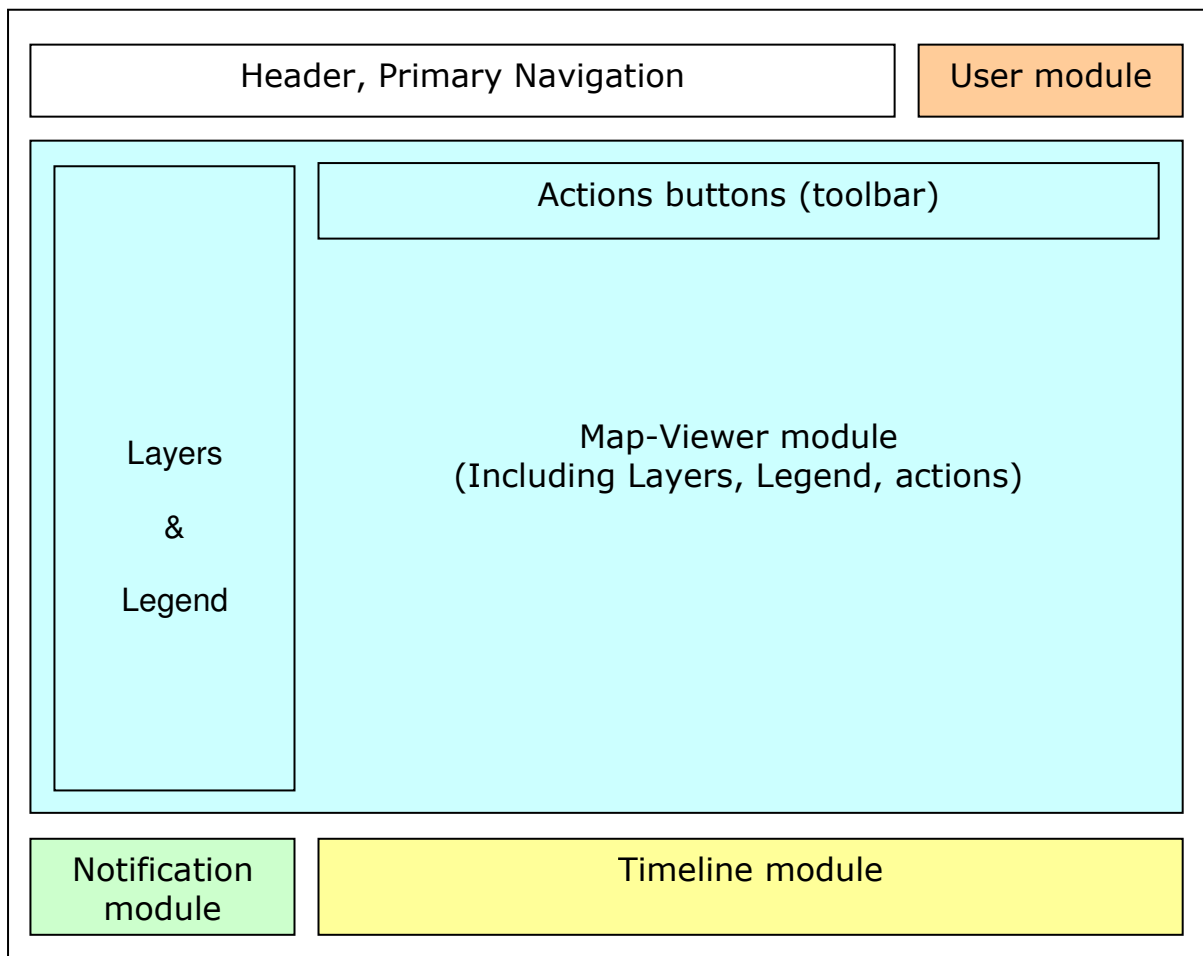


Figure 5 – End-user website mock-up

The ENVISION Portal is capable of creating websites as collection of modules and it is itself a collection of modules. These modules are either designer oriented or manager oriented. A possible mock-up for an ENVISION portal (Service Composition page) is sketched out below.

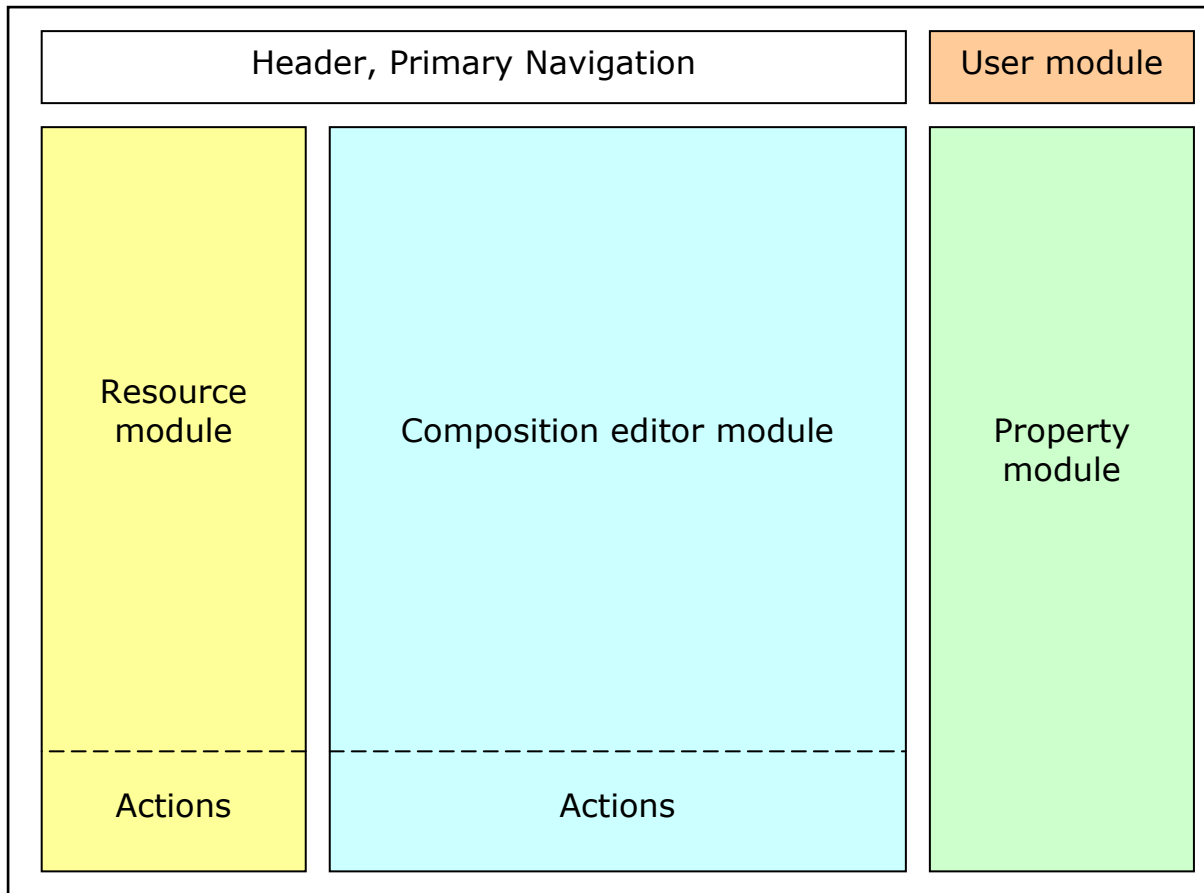


Figure 6 – Service Composition page mock-up

4.2 The User module

The user space allows for logging in (if not yet happened), or performing the user actions such as editing his profile, logging out,.

In the end-user website view, the User Module is minimized: it is similar to a menu which allows an end-user to go to the home page, to go to the entire module, to sign out and to switch to another website.

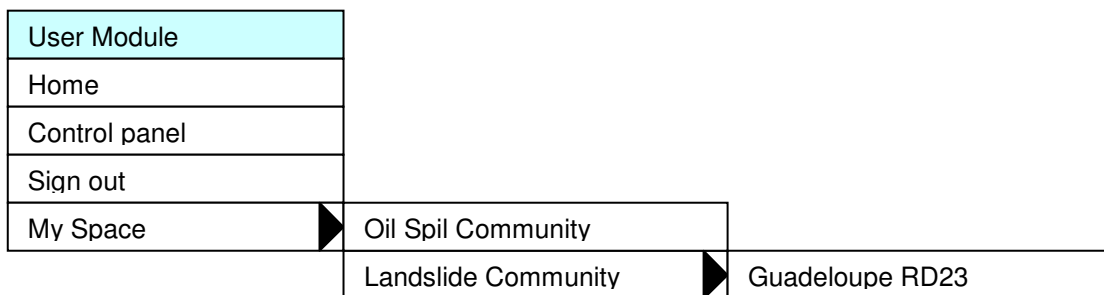


Figure 7 – User Module view by end-user

When the user goes to the control panel, he can edit his account (user information and identification), see communities in which he is member and join/leave a community.

For a Website Designer, the User Module has additional actions like managing websites pages or communities.

4.3 The Website Designer module

The Website Designer module is a key module of the ENVISION Portal. It will allow the user to create new websites dedicated to a domain. Such functionalities are part of Enterprise Portal Technologies and in our particular case, we will rely on the liferay capabilities.

The visualised content in the scenario websites are based on the environmental models (service compositions). The first step for the user is to select a model. He searches in the catalogue for the appropriate web service, and selects the one that corresponds to the subject of the website he wants to create.

The next step is to configure the service composition, adjust parameters, and define the input data.

Once the service composition is configured, the designer will start to configure the website. One website is composed of one or more pages. The designer is able to add pages and configure their content. For each new page, he will define the name of the page and then its layout.

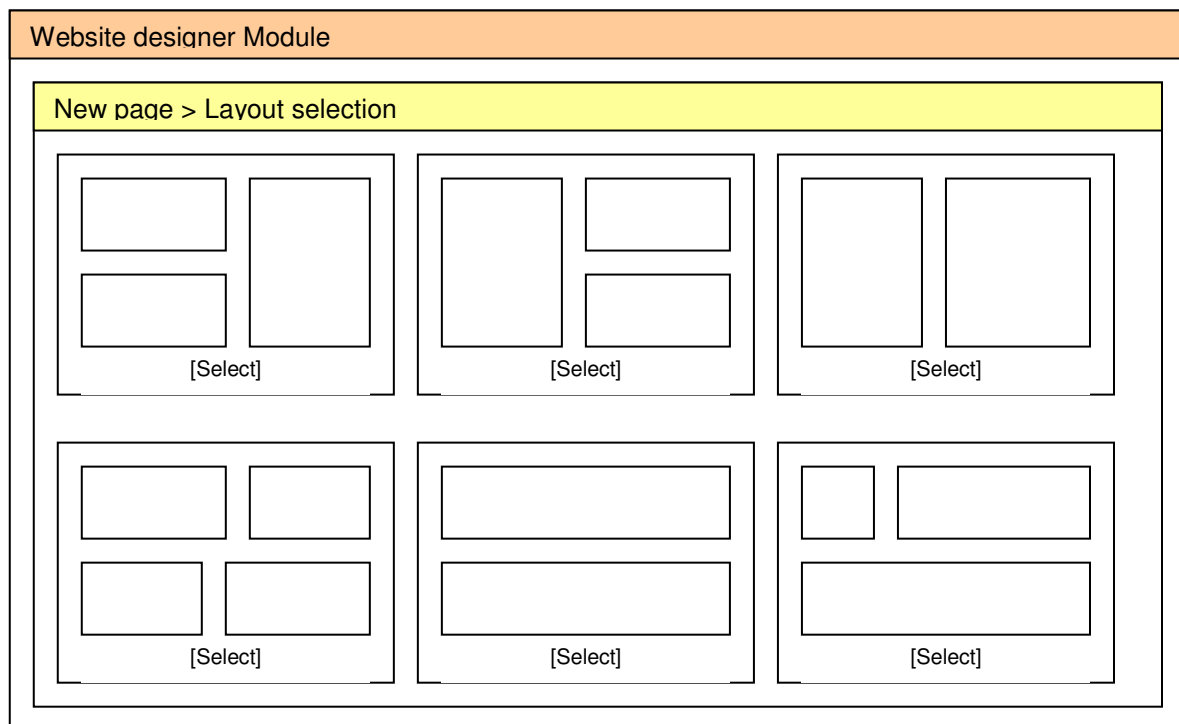


Figure 8 – Website designer - Layout selector

Once the layout is selected, the designer adds content to his new page. For this operation, he lists the available modules he can add to this new page. He selects modules from this list and puts them to empty spaces in the page by dragging and dropping them. For each module, he has the possibility to remove it again, to move it to another free space, or to configure it (for example for the map module, he will be able the change the default view, for the text module, he will be able to change the text displayed).

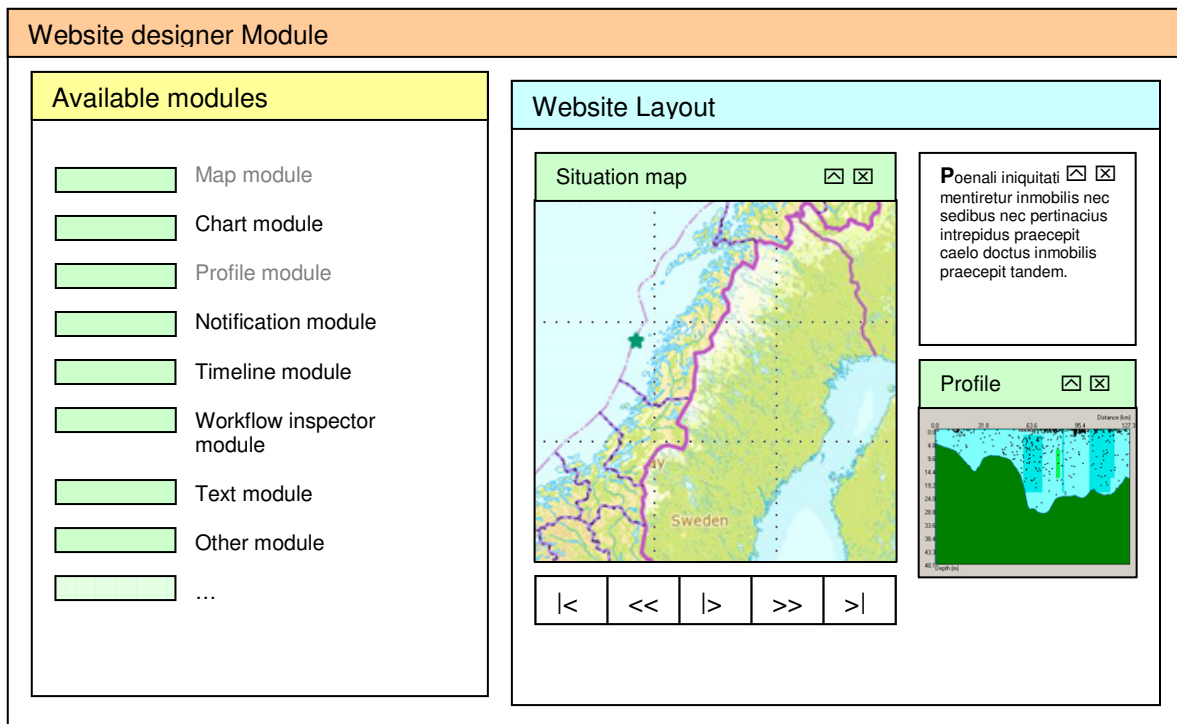


Figure 9 – Website designer - Content

4.4 The Map-Viewer module

In its default view, this module always visualises a base map and some basic interaction tools (navigation, zoom...). Depending on the context, certain actions allow for changing the currently visualized content.

In the oil spill scenario, the following actions should be supported: “drawing a line” feature, where the user can draw a line through the oil slick to show the water column along that line. The cross section is then visualized in a dialogue (popup).

This module also contains a layer switcher with which a user can then select or remove certain information from the map. In the case of the oil spill scenario, this could be winds, currents or mass balance for example. And for each of these a legend is displayable as part of the map module.

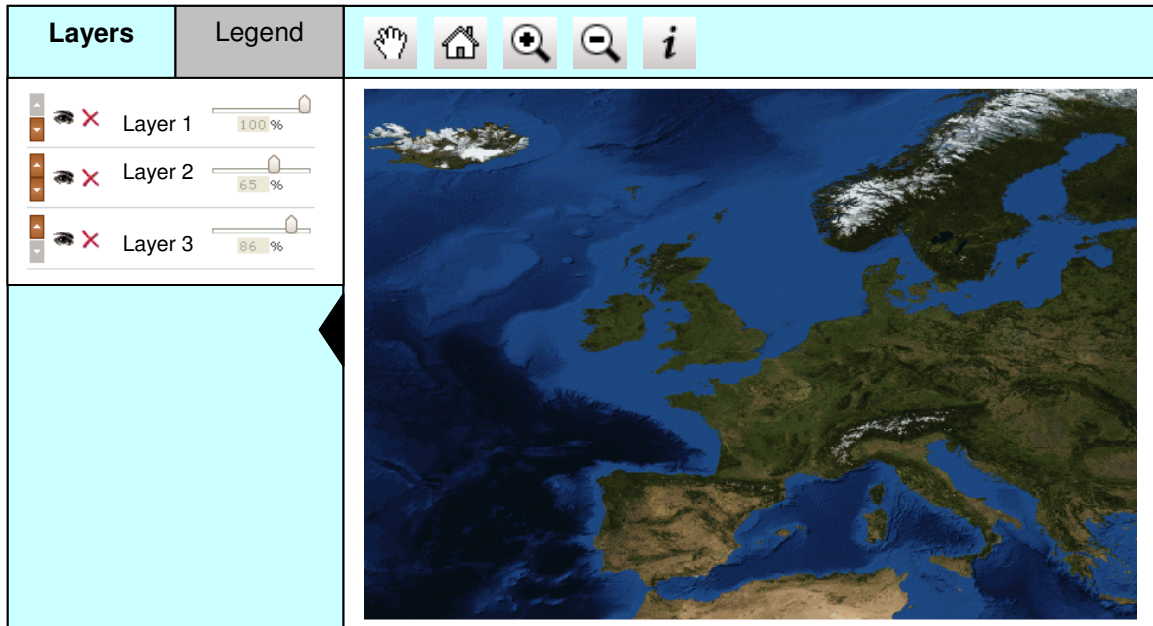


Figure 10 – Map-Viewer Module

4.5 The Chart-Viewer module

This module will be used to display data series as a chart. If a composition needs to display data series, this module will include a table with the data of the series and a chart that graphically displays the series. For the case of the landslide pilot, the rainfalls can be considered as series (with more than one series if we consider more than one location).

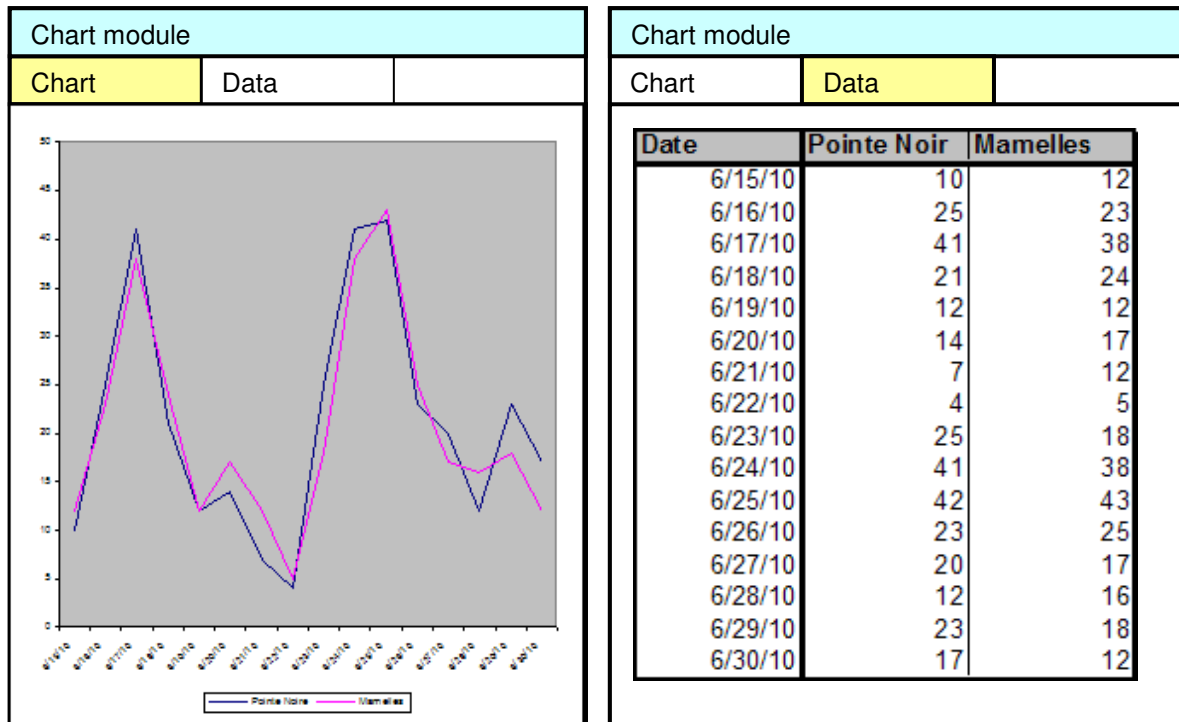


Figure 11 – Chart-Viewer module

4.6 The Profile-Viewer module

This module can visualise a cross section within three-dimensional data. It will be used in the oil spill pilot. It allows visualising vertical cross sections when a user draws a line on the map.

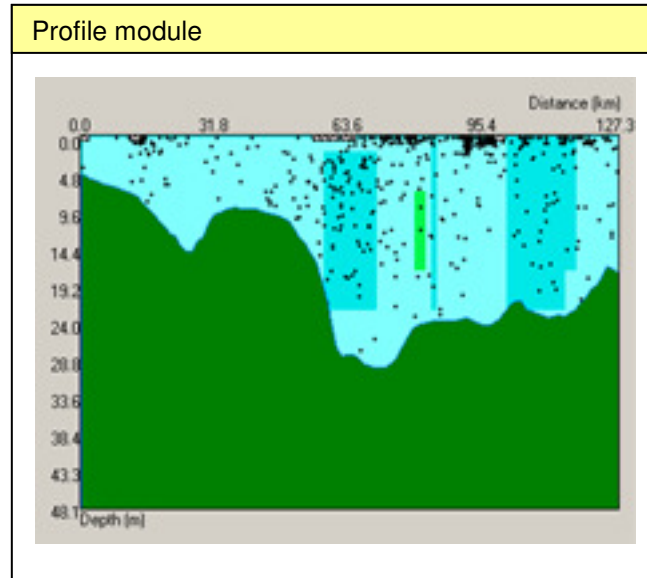


Figure 12 – Profile-Viewer module

4.7 The notification module

The environmental models produce critical and up-to-date output. Users may want to get notified once certain conditions (e.g. the risk of a landslide above 70%) are reached. The Notification module allows for subscribing to certain environmental models.

During the configuration of this module, the Website Designer can select which parts of the model output may be used for the subscription, and what the thresholds are (once a threshold is reached, a notification will be send out). The Website User will be able to subscribe (if he is authenticated), and select, if available, one of the offered notification channels (e.g. RSS feeds, Mail, SMS alerts).

The notification module also allows a user to see and manage all the subscriptions he already made.

Notification Module
<p>My subscriptions:</p> <ul style="list-style-type: none"> ▫ Rainfalls: <ul style="list-style-type: none"> Current: 90mm (2010/06/31@9:33am) Maximum: 120mm (2010/06/12@5:43pm) [unsubscribe] ▫ Landslides risk: <ul style="list-style-type: none"> Current: 60% (2010/06/31@9:35am) Maximum: 80% (2010/06/13@6:25am) [unsubscribe] <p>Available subscriptions:</p> <ul style="list-style-type: none"> ▫ Oil Spill propagation: <ul style="list-style-type: none"> [subscribe] ▫ Wind speed: <ul style="list-style-type: none"> [subscribe]

Figure 13 – Notification Module

4.8 The resource module

For a given authenticated user, the resource module lists all resources in the user collection. The collection itself is stored at a remote and is therefore always synchronized across the different pages.

For the scenarios, we support common OGC Web services (WFS, WCS, SOS, WPS ...) and possibly also W3C-compliant Web services (based on WSDL/SOAP). Since the service compositions are also exposed as OGC Web services, they are also listed here.

A user collection can potentially include a very large number of resources; the resource module will always only display resource relevant for the current context.

The default will be a list of recent items. At the top, a search will enable the user to find older resources as well.

A resource can have different states:

- published
- Un-published
- Un-complete (e.g. no annotations, no data quality metadata)
- draft (unfinished composition)
- broken

Several actions are available for the authenticated user:

- Change the state of the selected resource (publish, un-publish, annotate)
- Add new resource
- Delete a resource (only unpublished resources).
- Search and organize her collection

4.9 The timeline module

The timeline module allows changing the current date of visualisation. It allows visualizing historic information or simulation results.

For example, in the landslide scenario, it is possible to see the observations and measurements made from sensor systems (e.g. water monitoring) day after day thanks to SOS Web service. In the oil spill scenario, the timeline module allows to see the moving of an oil spill, results of a simulation.

From the graphical user interface point of view, this may appear as a time slider, a date-time picker (calendar) or a button toolbar (Previous/Next/Begin/end).

5 Conclusion

This deliverable describes the ENVISION Portal architecture baseline.

It serves as a strong basis for further work in this work package, as well as other technical work packages of the project. By identifying the software modules and services, it clarifies the responsibilities of the partners involved in the software development.

The other work packages shall be able to better understand how they contribute in WP2 and how they integrate their different components into the ENVISION portal.

In the next phase of the work in the work package, we plan to focus on the implementation of the different modules and services BRGM is in charge of, and also integrate the components from the different partners.

Appendix A: Common Terminology

The following table contains the definition of the main terms used in the project

Term	Description
The Infrastructure ENVISION Infrastructure	Terms the hardware and software set up in order to fullfillthee project objectives.
The Pilots ENVISION Pilots	Terms the demonstrations that will be set up during the project to illustrate the capabilities of the infrastructure.
The Portal ENVISION Portal Environmental semantic Web Portal	Describes the front-end application of the infrastructure
Website User Website Scenario Website	A Website produced by the portal for a dedicated purpose and a given community. During the project, we will produce dedicated Websites for the 2 pilots (landslide and oilspill).
Page	One particular view rendered in the browser is one page. One page consists of multiple modules.
Module	A user interface module is used to perform a certain task, or to convey a certain message. A module has a standard view, and can be configured through dialogs. Changing the content of module can (but does not have to) have an effect on the content of other components.
Service Web Service	Web services are typically a web API that are accessible via HTTP and executed on a remote system hosting the requested services
Dialogue	A Dialogue is a new frame in the view (a pop up), which allows for additional interaction modes for the selected component.
Composition	The executable combination of existing web services. A Web service by itself.
Model Computer Model	Computer simulation of real world processes to make forecasts of a certain behaviour of natural phenomena.
Model as a Service (MaaS)	A model made available as a web service. A composition the user can interact with.

Appendix B: Acronyms

BPEL	Business Process Execution Language
BPMN	Business Process Modelling Notation
CAP	Common Alerting Protocol
CSW	Catalogue Service for the Web
EIP	Enterprise Information Portal
FTP	File Transfer Protocol
GCI	GEOSS Common Infrastructure
GeoDRM	Geospatial Digital Rights Management
GeoRSS	Geospatial RSS
GEOSS	Global Earth Observation System of Systems
GML	Geography Markup Language
HTTP	Hyper-Text Transfer Protocol
ICT	Information and Communication Technologies
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
MaaS	Model as a Service
OGC	Open Geospatial Consortium
Open-LDAP	Lightweight Directory Access Protocol
OWS	OGC Web Services
RM-ODP	Reference Model of the Open Distributed Processing
RSS	Really Simple Syndication
SEIS	Shared Environmental Information System
SISE	Single Information Space in Europe for the Environment
SoA	Service Oriented Architecture
SOS	Sensor Observation Service
SPS	Sensor Planning Service
UML	Unified Modelling Language
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
WPS	Web Processing Service
WSDL	Web Service Description Language

Appendix C: References and Bibliography

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- ¹ ENVISION Project <http://www.envision-project.eu/>
 - ² SEIS <http://ec.europa.eu/environment/seis/>
 - ³ SISE http://ec.europa.eu/information_society/eeurope/i2010/single_infor_space/index_en.htm
 - ⁴ GMES <http://www.gmes.info/>
 - ⁵ INSPIRE <http://inspire.jrc.ec.europa.eu/>
 - ⁶ GEOSS <http://www.earthobservations.org/>
 - ⁷ INSPIRE Web Site <http://inspire.jrc.ec.europa.eu/>
 - ⁸ Earth observation group web site: <http://www.earthobservations.org/>
 - ⁹ Description of Work ENVISION Project (FP7, N° 249120) Description of Work
 - ¹⁰ D1.1 Definition of pilot cases
 - ¹¹ D1.2 Requirements specifications
 - ¹² D3.1 MaaS Composition Portal – Architecture specification
 - ¹³ D4.1 Ontology requirements analysis
 - ¹⁴ D5.1 Deployment of the OGC Catalogue
 - ¹⁵ D6.1 ENVISION Adaptative Execution Infrastructure – Architecture specification
 - ¹⁶ OGC Open Geospatial Consortium: <http://www.opengeospatial.org/>