# eENVplus: a framework to support eEnvironmental services and applications

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**Abstract**

eENVplus (www.eenvplus.eu) is a ICT-PSP -Pilot A project, started on January 2013.
The eENVplus key objective leads to support the implementation of INSPIRE and SEIS, engaging environmental data (many INSPIRE Annex I-II-III Data Themes) managed by the involved national/regional environment agencies and other public and private environmental stakeholders through the integration and harmonisation of existing services.
Starting from the results of previous European experiences (funded projects, best practices, EU/national/local experiences) eENVplus integrates existing infrastructures into an operational framework able to overcome cross-border and languages barriers. eENVplus provides not only the ICT infrastructure but also the description and the support how to make this infrastructure operational and profitable through the provision of an organisational model and a tutored training framework.
eENVplus interoperable infrastructure provides Members State and Geographic Information Communities with:

1. A comprehensive, open and scalable infrastructure able to integrate existing infrastructures according to the INSPIRE requirements, open standards and interoperable innovative services;
2. A set of innovative added value interoperable web services aiming to facilitate the development of innovative environmental applications;
3. A common Environment Thesaurus Framework, supporting the integration of existing thesauri relevant to the environment via Linked Data and providing added-value services for its integration and exploitation in pilot applications
4. A comprehensive tool-kit for data harmonisation and validation supporting Members States during INSPIRE implementation;
5. A Training Framework to support, with eLearning tools, the development of the necessary capacities and knowledge to keep operational the eENVplus infrastructure.

It is intended to implement 9 environmental scenarios in 10 pilots (BE, CZ, EL, FR, HU, IS, IT, PT, SI, SK), in order to offer the actual eENVplus outcomes implementation in a variety of different situations and user needs. The pilots with their scenarios will allow to better streamline the tools available to the project into the main flow of INSPIRE compliance, with evident implications on interoperability among applications, existing or planned.

## 1. Project objectives

### 1.1 Overview

**eENVplus**, "eEnvironmental services for advanced application within INSPIRE", is a European Commission co-funded project in the frame of the ICT-PSP programme driven by the DG CONNECT. The project coordinator is GISIG, Geographic Information System International Group, and the consortium involve the 18 partners coming from 13 different European including technological partners (6), research partners (2), standardization body (1) and National Environmental Agencies (8).

[1] GISIG, Geographic Information System International Group, via Piacenza 15, Genova (Italy)

## 1.2 Rational and background

Several local, national and European initiatives are promoting better monitoring and management of environment data at local, national and European level. The rules and the related implementing guidelines are mainly based on a set of environmental indexes mostly based on geo-spatial information that need to be monitored and shared across borders, ideally without languages constraints through a suitable interoperable infrastructure. The INSPIRE EC Directive has addressed this issue by establishing an infrastructure for spatial information in Europe to support Community environmental policies or activities which may have an impact on the environment.

The aim of eENVplus is to support the INSPIRE implementation at a European and National level with a far-fetching system approach that anticipates and integrates such a process with the Shared Environment Information System for Europe (SEIS).

The ICT solutions to be deployed by eENVplus follow both a top-down philosophy, by deploying operational implementation requirements for sharing environmental information according to the European ICT policy context, and a bottom-up philosophy, by re-using and making interoperable, existing solutions for environmental data-sharing already developed by recent projects and initiatives.

More specifically, the top-down approach refers to the priorities of current initiatives by the European Commission regarding information-sharing within public agencies and government.

At the EU level, several initiatives try to maximise the benefits interoperability at multi-levels:

- A set of Directives in the context of the European Interoperability Strategy (EIS), drive appropriate governance, organisation and processes in line with the EU policies and objectives, through trusted exchange of environmental information based on the EIS.
- The European Commission Programme on Interoperability Solutions for European Public Administrations (ISA) focuses on the development of e-Government in Europe with a particular focus on solutions supporting Community policies and activities removing barriers to interoperability across borders.
- The Public Sector Information (PSI) Directive has introduced a common legislative framework regulating how public sector bodies should make their information available for re-use in order to remove barriers such as discriminatory practices, monopoly markets and a lack of transparency.
- Digital Agenda for Europe (2010-2020) aims to deliver sustainable economic and social benefits from a digital single market based on ultra-fast Internet and interoperable applications.
- The INSPIRE Directive has introduced a common interoperable framework regulating how public sector bodies should make their geospatial information available in order to remove cross-border and cross-languages barriers to support a shared environmental information infrastructure.

In eENVplus, such a top-down definition of criteria will be coupled to grassroots (bottom-up) approach to support concrete projects addressing real examples, to test guidelines against concrete needs. For this, eENVplus has identified existing services/tools, developed by other EC-funded projects, which will be re-used and integrated to provide operational and interoperable added value services in order to satisfy the needs and the requirements of the local, national and European environmental directives and policies.

To ensure interoperability between the components of the infrastructure, significant attention will be paid to compliance to standards by:

- Selecting relevant protocols and guidelines,
- Providing strict validation services and
- Contributing to the revision of the standards and implementing rules based on the feedback gathered by the operational implementation those standards.

## 2. Project objectives

The wider objective of eENVplus is to support, at European and national levels, the implementation of INSPIRE[2] (Infrastructure for Spatial Information in Europe) and SEIS[3] (Shared Environment Information System for Europe) through deployment and integration (to ensure interoperability) of value-added eEnvironment services and applications available at national level or through past/on-going key EC-funded project.

With regard the latter, eENVplus largely leverages on experience and technologies built, by the partners, in previous ICT-PSP, eContent*plus*, FP7 projects, GMES and Leonardo projects, namely:

- NESIS, which has brought to the definition of ICT Guidelines for the ICT Implementation of SEIS, through the involvement of several National Environment Agencies.
- NATURE-SDIplus, OneGeology Europe and SEIS CAFE that have contributed to the INSPIRE data specifications of, respectively, nature conservation, geology and air quality reporting themes.
- BRISEIDE, which has developed an open source framework for ingestion, access and processing of spatio-temporal data through interoperable standards.
- HUMBOLDT, which has developed an open source framework for data modelling, transformation and processing services.
- smeSpire, a FP7-SA which is helping European SME benefit from the INSPIRE implementation process, and, in general, from the use of large environmental data pool.

In addition, eENVplus leverages on existing projects and applications developed at a National or Regional level by developing a set of software layers that allow interoperable communication of existing (non-standard) applications with the rest of the framework.

In a nutshell, eENVplus provides Members State and the GI Communities, with tools addressing a **multi-level interoperability stack**:

- **System-of-systems interoperability**, through a comprehensive open, scalable infrastructure able to link to existing infrastructures developed through international or national-level initiatives (e.g. the INSPIRE portal).
- **Application-level interoperability**, through a set of software component that allows communication, through interoperable standards, between existing legacy applications and the eENVplus service ecosystem.
- **Inter-service interoperability**, through development of daisy-chained services to allow creation of high-level functionalities from interconnection of interoperable lower-level services.
- **Service interoperability**, through a set of innovative on-line pre-built services facilitating the development of innovative applications.
- **Semantic interoperability,** through a Common Environment Thesaurus Framework, supporting via Linked Data the integration of existing Thesauri for environmental application, which facilitates data sharing through a common understanding of the meaning of terms and concepts.
- **Data interoperability**: through a comprehensive toolkit for data harmonisation and validation to support the Members States in the application of the INSPIRE implementation rules, with guidelines and examples.

Building on the aforementioned achievements, eENVSplus creates a working environment that includes scalable services for harmonisation of environmental data and of environmental spatial data infrastructures

[2] According to the Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

[3] According to the Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - Towards a Shared Environmental Information System (SEIS) (COM/2008/0046).

at a wider scale (e.g. cross-border), therein considering also problems deriving from operating within multi-language context through shared multilingual thesauri. eENVplus will leverage on existing technologies to provide a variety of ancillary service ensuring features including, but not limited to, ingestion, workflow management, validation, processing etc.

In particular, the various projects, funded by different programmes, have produced a number of services (the clouds in the center) that need to be interfaced to national and international infrastructures (left). This may require adaptation to ensure compliancy to standards (right). The resulting eENVplus infrastructure will be then complemented (bottom) by a portal, a harmonised set of data and services that can connect to further international initiatives (e.g. INSPIRE portal) through interoperable exchange protocol.

A Training Framework will complement the aforementioned technology providing eLearning courses on how to operate with INSPIRE and SEIS.

Such an articulated infrastructure will be eventually deployed and assessed within 10 pilots addressing environmental aspects, such as air quality, water, nature conservation, environmental risk, and ecological land use planning.

## 2.1 eENVplus methodology

In short the overall methodology proposed by eENVspire could be summarised as follows:

1. Starting from the experience of European funded projects in the context of the environmental management and from the experience of the national /regional environmental infrastructure, eENVplus will **analyse existing operational processes** to identify best practices and bottlenecks.
2. eENVplus will then **collect existing technologies** from key past and on-going key EC-funded projects.
3. Concurrently the project will **collect data** from EU agencies involved in the project and will
4. **harmonise data** according to the European and national guidelines, the INSPIRE guidelines and implementing rules and the interoperability standards.
5. eENVplus will then **make existing technology interoperable**, be this services, applications or systems, in order to provide an operational support to the implementation of the environmental policies and related processes
6. The full set of harmonised software component will be available through the **release of the open source toolkit** available to further stakeholders for them to deploy and extend it.
7. The project will then **deploy the pilots and assess them** in real operational applications, demonstrating their use in a series of different scenarios that require services harmonisation to enable compliancy with INSPIRE at the different levels.
8. eENVplus will provide not only harmonised and interoperable services but also operational implementations through the training framework. This will be used to **train staff** on how to use the tools available through the pilots and to help new stakeholders join the infrastructure.
9. The project will then **define recommendations** and best practices based on experience from the pilot phase.
10. Last, but not least, eENVplus will **implement long-term sustainability mechanisms** to ensure that results of eENVplus can last beyond the EC funding.

The active involvement of a series of national environment agencies is intended to ensure a continuous control of quality and fitness to the individuated needs and as well an efficient dissemination and exploitation of the project achievements.

# 3. eENVplus infrastructure

## 3.1 Infrastructure design

eENVplus is an infrastructure which is based on proper blocks solution which are represented into the following picture:

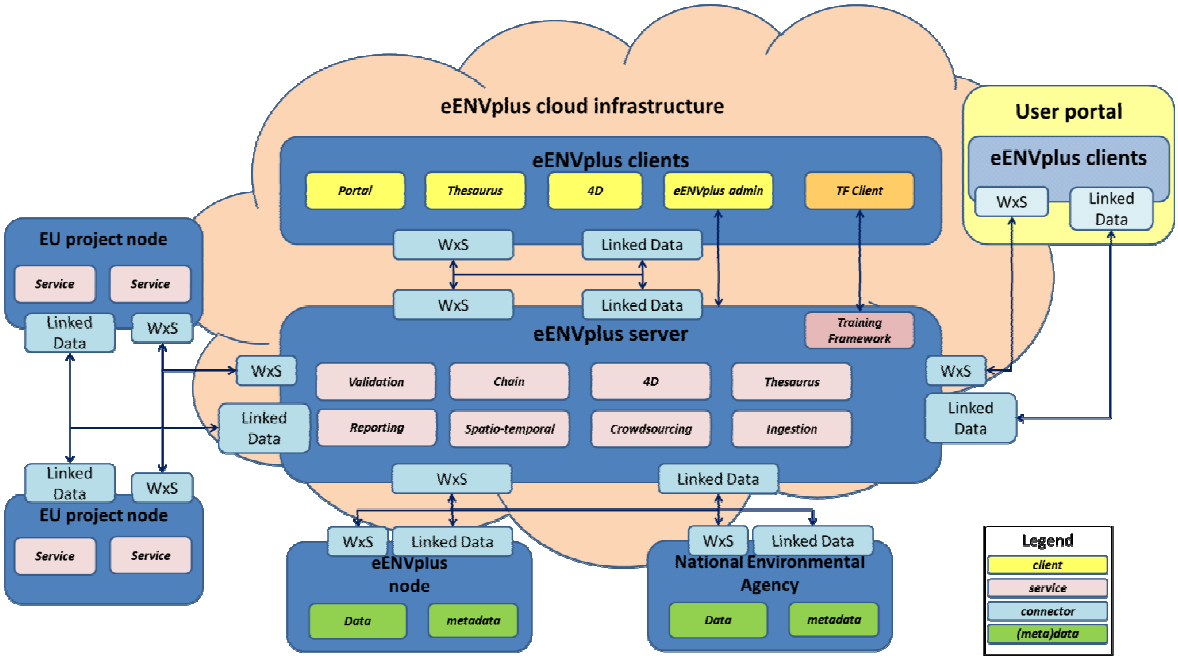


Figure 1: eENVplus Infrastructure

The overall eENVplus infrastructure will result by the set of nodes publishing harmonized and interoperable services. It is based on a mixed infrastructure based on SOA (Service Oriented Architecture) and linked data. Each services providers involved into the project will be a node of the infrastructure:

- The National Environmental Agencies and the other involved data/service providers
- The infrastructures and the related services exposed by EU funded projects
- The eENVplus cloud infrastructure exposing the harmonized and interoperable added values services (eENVplus server)
- eENVplus portal including the clients to configure, manage and consume the eENVplus added value services (eENVplus clients)
- Data/service providers which will use the eENVplus project outcomes to expose proper data and services (eENVplus node)
- Other User Portals which will exploit the eENVplus added value services and will integrate the eENVplus clients into proper portal to configure, manage and customize the eENVplus services to expose specialized interoperable applications (in the project these are represented by the pilot applications).

The harmonized specialized services delivered by the EU funded projects will be integrated into the eENVplus cloud infrastructure contributing to expose the added value components of the infrastructure (eENVplus server). This server side will be exposed in a cloud infrastructure to guarantee the availability and the affordability of the overall infrastructure.

A set of clients will be put at disposal:

- to exploit the eENVplus infrastructure with the overall data and services published by the involved data providers
- to manage some specialized services which it's possible to configure to provide added value services and/or chaining services (service publishing manager, chaining service manager, validation service manager)
- to consult the thesauri framework in a multi-langauge environment

A discovery service for data and services recovering will be setup and will be increased by the integration of the thesauri framework services.

A Training framework will be provided to support new stakeholders in understanding the provided outcomes and also in building new infrastructure nodes based on eENVplus infrastructure components.

Each eENVplus infrastructure component will be available to all potential stakeholders according to the OSS policy, leaving the possiblilty to re-use and upgrade the code completely free of charge.

The core component of eENVplus infrastructure is the open and scalable eENVplus server constituted by several blocks (services) following described.

## 3.2 Harmonisation and validation

In terms of harmonisation, a set of transformation services will be made available in the eENVplus cloud infrastructure, enabling the users to run data and metadata remodelling processes, performing a remapping from the single different data/metadata source schemas to the respective target schemaa, which for the datasets are the INSPIRE gml application schemas and for the metadata are the INSPIRE metadata profiles, relevant to the specific data theme concerned.

In terms of validation, a set of validation services will be made available in the eENVplus cloud infrastructure, enabling the users to run data and metadata validation processes necessary to claim the compliance against the applicable specifications. In particular, for the validation of the metadata and data encoding, the following steps are covered:

- Schema Validation: validation of the metadata or data document (xml or gml, respectively) against the corresponding XML schema
- Schematron Validation: the validation of non-syntactic requirements using semantic rules defined in Schematron.

Thanks to the use of proper validation reporting templates, the users are able to iteratively run the validation service after fixing the validation errors reported until a full compliance is achieved.

## 3.3 Common Thesaurus Framework

One of the project building blocks is the Common Thesaurus Framework in order to face with multilingual issue in data sharing. The framework will address the needs of different user communities in sharing digital spatial information at cross border level: i.e. concept interoperability and concept multi-languages availability is needed in metadata compilation and information discovery.

eENVplus approach is not to provide a unique multilingual thesaurus for the environment but a framework of federated thesauri which harmonises and integrates the different available terminological resources already recognised by the different communities working on the Environment .

It will be developed starting from the thesaurus framework built in the frame of Nature-SDIplus project. This common thesaurus framework represents a solution for an integrated view of available terminologies covering the different data themes of INSPIRE. It is designed as an open environment where it is possible to add, assemble and share in a frame general purpose thesauri and specific domain nomenclatures.

Currently the framework contains different thesauri: general purpose thesauri such as the GEneral Multilingual Environmental Thesaurus (GEMET), the Environmental Application Reference Thesaurus (EARTh), and specific data theme vocabolary such as EUNIS Species and Habitat for sharing recourses of four data themes (Protected Site, Biogeogeographical region, Habitat and biotopes and Species distribution). It will be extended integrating other thesauri like ACROVOC (covering topics related to food, agriculture, fisheries, forestry, environment and other related domains) and OneGeology-Europe (vocabularies and ontologies available in 16 European languages.)

The final concrete outcomes will be:

1. to advance the thesaurus framework content for a more efficient framework based on other available multilingual thesauri (e.g. resulting from existing project outcomes) and by establishing semantic interoperability between them.
2. a set of advanced services permitting the thesaurus framework exploitation for data access activity (e.g. providing added value web services to index, search and access geographic resources)

## 3.4 Environmental services

A set of added value services, coming from past and running EU-funded projects and integrated within the eENVplus infrastructure, will allow achieving the interoperability-driven objectives above detailed.

### 3.4.1 Ingestion and workflow services

Within this task it will be extended the existing batching components developed by the project BRISEIDE, on top of the existing GeoBatch platform. The current platform will be extended to support customisation of workflows from a XML-based configuration mechanism, which means:

- Verification of data integrity.
- Pre-processing for successive data.
- Archiving (via interaction with the dissemination services).
- Cataloguing (via interaction with the cataloguing services, see Task 5.7).

One important datasource for basic environment related geographical information is the INSPIRE network of services, and access to the related Member States' catalogues is bundled in the European INSPIRE Geoportal. This central node will provide not only a Web UI but also a back-office, CSW-based access to the harvested metadata.

A set of validation services will be made available in the eENVplus cloud infrastructure, enabling the users to run data and metadata validation processes necessary to claim the compliance against the applicable specifications.

Thanks to the use of proper validation reporting templates, the users are able to iteratively run the validation service after fixing the validation errors reported until a full compliance is achieved.

### 3.4.2 4D data access services

eENVplus framework will totally integrate and re-use the BRISEIDE toolkit to provide access, via OWS, to spatio-temporal data via WMS, WFS and WCS with support for time. The available technology will be deployed and configured to provide time-based access to spatio-temporal repositories available by the various environmental mapping agencies.

### 3.4.3 Processing services

With regard to this particular issue the project eENVplus will re-use the spatio-temporal processing services library developed by BRISEIDE to include new spatio-temporal processing capabilities required by the final pilot applications. The processing services will be developed as WPS (Web Processing Service) to ensure interoperable access. Wherever available existing processing functionalities from the environmental mapping agencies will be wrapped, in software terms, of a thin web-service abstract layer ensuring communication through WPS. The implementation will also be based on the developments experienced in BRISEIDE project for processing services wrappers with WPS implementations. This way eENVplus will benefit of any existing functionality already developed by the partners in the context of previous initiatives.
Service orchestration will be based on a mechanism for service chaining, allowing complex data processing services to be composed from simpler ones in order to achieve larger tasks. In this way, new, value-adding services for data fusion, aggregation, combination and enrichment can be implemented on top of existing ones.
Service chaining enables users to combine data and services in ways that are not pre-defined by the data or service providers, and the provider of a single service does not necessarily need to know the way, in which his service may be used in a scenario with service chaining, as long as the interfaces are well-defined.
Service-orchestration functionalities will be built on top of BRISEIDE orchestration toolkit which will be extended to account for the new services available within eENVplus.
To be able to best benefit from this modular architecture a workflow management system will be deployed for the configuration and orchestration or choreography of the corresponding processing chains using the Business Process Execution Language (BPEL), as standard language.

### 3.4.4 Reporting services

A set of harmonised services will be developed in order to integrate the collected information exposed by environmental services into the recently developed e-reporting schemas. These will be designed to cover the requests of the pilots related to the air quality reporting scenario; the service will consider the recent outcomes of the pilot study - still in-progress - of the EEA in terms of Air Quality e-reporting (http://aqportal.eionet.europa.eu/).
This activity will exploit the services exposing the environmental data, the validation services (which will be enhanced to supply the data quality processes) and the service orchestration, designing those processing components needed to implement the EEA e-reporting obligations, which will come into effect on 1 January 2014 (COMMISSION IMPLEMENTING DECISION 2011/850/EU).
In detail, the reporting services will provide server components to collect, process and organise the information recovered by the existing data services and to integrate the processed information according to predefined template for reporting. To customise and manage this process, a back-end application will be designed to configure the services. This activity will be applied and tested for the two pilots of the Air Quality scenario (BE and IT).

### 3.4.5 Crowdsourcing services

A number of server components will be developed to allow for collection of relevant data from distributed, unstructured repositories through crowdsourcing. This will include deployment of configurable services that can interface to web or mobile applications to collect data from people through a series of templates (including template data model and interface layout). This will allow environmental mapping agencies to create their own crowdsourcing through simple processes (as Wizards) from the eENVclient and have them deployed within a server infrastructure. Crowdsourcing services for mobile applications will focus on standards to allow developers (and users) to interact and manage linked open (geo) data. A mobile client will also be developed to allow user-friendly access to available data made available through the eENVplus framework.

## 3.5 Training framework

eENVplus consortium considers the development of competencies in GI community in the context of INSPIRE of great importance. For this, a specific action has been planned. Competencies are built on a combination of knowledge, skills and behaviour.

The eENVplus Training framework will be designed as a cornerstone of the project to make available existing knowledge and transfer developed skills to the target groups of users. In this context, training activities strictly compliment and support dissemination and exploitation.

In particular, the project Training Framework will provide to the National/Regional Environmental Agencies the advanced skills (in the form of training modules) required to cope with the INSPIRE implementation process, knowledge related to the new ICT dimension of the environmental data (e-environment) and the documentation and the necessary means to interact, benefit and adopt the eENVplus Infrastructure.

Training will be implemented through an open source e-learning platform offering a training package based on specific and thematic vocational training curricula and different learning paths aiming at maximising the re-use of existing tools and training materials successfully tested in the frame of previous EU funded projects.

The training material on the e-learning platform will be available in a variety of formats appropriate to the nature of the lessons: Presentations with voice, screen casts, plain text lectures, role play exercises, etc. The use of the e-learning platform, including appropriate learning monitoring systems will be included.

The eENVplus Training Framework will be structured according to the following schema that includes the eENVplus Training Package (on lines Guidelines with all the relevant information about the training modules and the way to access them), the eLearning platform and the training modukes.

# 4. Conclusion

The implementation of scenarios in the pilots is intended to offer actual examples of how the eENVplus outcomes can be of help in a variety of different situations and users' needs. The pilots with their scenarios will allow to better streamline the tools available to the project into the main flow of INSPIRE compliance, with evident implications on interoperability among applications, existing or planned, in order to create a more complete thematic (integration among complementary issues) or regional example (integration among adjacent of cross border cases).
The pilots cover the needs of the involved National Environmental Agencies demonstrating the operational implementation of a shared environmental information framework on the base of the INSPIRE infrastructure as driven by the SEIS initiative.