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Pegaso Project
People for Ecosystem based Governance in Assessing Sustainable development of Ocean and coast

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GUIDELINES AND TRAINING MATERIAL FOR SDI CONSTRUCTION, GEOPORTAL AND GEONODES FUNCTIONALITIES, INCLUDING DAT A HARMONZATION AND INTEROPERABILITY FOLLOWING INSPIRE P RINCIPLES, SPECIALLY ORIENTED TOWARDS CAPACITY BUILDING WITH PROTOTYPE.

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Abstract

The PEGASO project aims to build a shared ICZM Governance Platform with scientists and end-users, linked with new models of governance. To support this Platform and the integrated assessments that PEGASO has developed for the coastal zones of the Mediterranean and Black Seas, a Spatial Data Infrastructure (SDI) has been constructed. The construction of an SDI involves a collaborative process, which requires a commitment and contributions on behalf of the entire project consortium. The results from surveys within PEGASO partners' institutes on existing technical capacities evidenced interesting opportunities to share data and expertise.

Achieving a common understanding and common view on how the SDI should deliver the objectives of the ICZM Platform, requires a common vocabulary and a shared vision of its components and architecture, but also to define the aspects about how the different components have to be implemented, their relationships and the communication process between the partner nodes and the Central Geoportal. Also capacity building and training are fundamental activities in order to achieve this common objective. .

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Executive Summary

The main goal of the PEGASO project is to construct a shared ICZM Governance Platform with scientists and end-users, linked with new models of governance. The PEGASO ICZM Platform is supported by the Spatial Data Infrastructure (SDI) and the suite of sustainability assessment tools required for making multi-scale integrated assessments in the coastal zone.

An important core of PEGASO partners has the resources required to implement a functional network of geonodes and (local) SDI. However, it is necessary first to achieve a common understanding and common view on how the SDI should deliver the objectives of the ICZM Platform and, ultimately, the strategic objectives of the PEGASO project. The specific implementation of the different components of an SDI, its adaptation to the partner's context, the relationships and connections between the partner nodes and the Central Geoportal, the most important characteristics of the geoservices to be developed which have to be taken into account, and, finally, the important aspects of interoperability and data harmonization, are the topics which are presented in this document, in a progressive approach. A final chapter including the training material used in the training workshops complements and completes the content of the document.

1. Introduction

1.1. Purpose and scope of the guidelines

The PEGASO SDI is one of the main components of the ICZM Platform, and also a core part of the project. The success of the design and development of the SDI is highly dependant on the common understanding of the basic concepts and shared language.

An SDI is a complex infrastructure that encompasses many different components that need to be understood by the partners, in order to develop a common infrastructure under the same principles. Concepts as geoportal, geonode, metadata, geoservices and web map services are presented in the context of the PEGASO SDI. In addition, an overview of the future structure of the SDI within the project is presented.

In the present document a set of concepts and definitions of principal components of the PEGASO SDI are presented to the Consortium, as part of a set of guidelines and training material to build capacity related to the building of the PEGASO SDI.

First of all, an introduction of the project and the SDI building scope is presented, highlighting the need of data sharing between partners and the necessity of sharing a common language to facilitate the common understanding of the SDI concept. After that, an introduction of basic concepts is presented with special attention to the main concepts of the SDI components and its implementation in PEGASO project. These elements include the Geoportal, Geonodes, Geoservices and the SDI itself. After that, other important concepts related to the construction and exploitation of the SDI are presented: data harmonization concept, metadata and catalogues, web services, GIS functionalities and the concept of interoperability.

The PEGASO SDI allows simple GIS manipulation by all users and downloading of relevant data for more detailed local analysis. This requires the interoperability between the different data sources provided by the partners. Interoperability means the possibility for spatial data sets to be combined, and for services to interact, without repetitive manual intervention, in such a way that the result is coherent and the added value of the data sets and services is enhanced [INSPIRE Directive]. Interoperable spatial data is the data which is conformant to the harmonized data product specifications.

Harmonization is a broad topic which involves the adaptation of existing data and services to standards and rules according to the regulations and requirements of an SDI. It represents a main issue for combining of trans-sectorial, trans-lingual and trans-border information originating from different sources.

Capacity building has to be performed, so training is a fundamental piece for the SDI building, and needs to be considered as a component of the SDI. The final part of this document relates on training activities in the PEGASO framework.

1.2. Structure of this document

This deliverable is composed by four main chapters, which have been elaborated in different moments, following the progress and specific needs of the project development.

Part I corresponds to a first document created to introduce all partners in a common understanding about SDI and its development.

Part II specifies technical details about the different services that are part of the SDI, which have to guarantee the correct connections between particular partner's geonodes and the PEGASO SDI.

Part III is oriented to establish the methodology to assure the data harmonization, mainly related with the set of indicators which are created by the different partners in the different CASES, since they have to be combined and used in an interoperability context.

A final chapter collects the training material used in the training workshops to introduce partners to the SDI technologies.

2. Building the PEGASO SDI

2.1. An introduction to basic concepts

(From the PEGASO Project Description):

A key objective of PEGASO is to set up a **Spatial Data Infrastructure (1)** (SDI), where all data and indicators from PEGASO participants can be shared, using the different services which are offered through its **Geoportal (2)**. The idea is to build a functional network of **geonodes (3)** with all partners, supporting capacity in the South countries to co-develop and support existing geonodes and to build local/regional or national geonodes if requested by stakeholders. Data then becomes easily accessible through a web portal that also helps in managing communication and dissemination of results amongst partners and the Shared ICZM platform components. PEGASO supports **harmonization of data (4**) and **metadata (5),** which are key components to build assessment tools (WP4) and to support the regional assessment (WP5).

Thus PEGASO has constructed such an infrastructure by drawing on existing SDIs from project participants, such as SEXTANT from IFREMER and IODE managed by VLIZ, and extends their capabilities via easy Internet access to data. The PEGASO SDI allows simple **GIS manipulation (6)** by all users and the **downloading (7)** of relevant data for more detailed local analysis. In order to further build capacity, special effort has been dedicated in the Project to support SDI and geonode construction amongst the participants, which require it.

The partners of PEGASO are highly involved in network for data harmonization and SDI creation (INSPIRE, GEO-GEOSS, ICAN, EMODNET, EIONET, etc), a network aimed on facilitating data harmonization and as much as possible **interoperability (8).**

2.1. Spatial data infrastructure

2.1.1 Definition, concepts and rationale

The term Spatial Data Infrastructure (SDI) if often used to describe the mechanisms or the enabling environment that supports easy access to, and utilization of, geographical data and information (UNECA, 2005). This definition is quite reductive as it gives the idea that SDIs are essentially technical. The primary objective of SDIs is to provide a basis for geospatial data discovery, evaluation, and application for users and providers within all levels of government, commercial and the non-profit sectors, academia and citizens (GSDI, 2004).

This means that SDIs are more than just data repositories. SDIs store data and their attributes, and their related documentation (metadata), offering a mean to discover, visualize, and evaluate their fitness to different purpose, and finally provide access to the data themselves. In addition to these basic services, there are often additional services or software supporting the use of the data. Finally, to make an SDI work efficiently, it is necessary to include all the organizational agreements needed to coordinate and administer it.

In consequence, following Masser (2005) and GSDI (2004), we can give a more complete definition of what are SDIs:

— “A spatial data infrastructure supports ready access to geographic information. This is achieved through the co-ordinated actions of nations and organizations that promote awareness and implementation of complimentary policies, common standards and effective mechanisms for the development and availability of interoperable digital geographic data and technologies to support decision making at all scales for multiple purposes. These actions encompass the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the national and regional scale are not impeded in meeting their objectives”.

2.1.2 Objectives

Following Masser's definition (2005) and the different considerations highlighted in the previous section we can list different objectives underpinning SDIs:

The overall objective of an SDI is to maximize the reuse of geospatial data and information.

- SDIs cannot be realized without coordination (especially by governments).
- SDIs must be user driven, supporting decision-making for many different purposes.
- SDIs implementation involves a wide range of activities, including not only technical topics such as data, standards, interoperability, and delivery mechanisms, but also institutional arrangements, policies, financial and human resources.

The term infrastructure is used to promote the idea of a reliable and supporting environment, analogous to a road or a telecommunication network, facilitating the access to geoinformation by using a minimum set of common practices, protocols, and specifications (GSDI, 2004). This allows the movement of spatial information instead of goods.

SDI main objective is to encompass the sources, systems, network linkages, standards and institutional issues involved in delivering spatially-related information from many different sources to the widest possible group of potential users.

2.1.3 Components

In order to be used, people need to know that the data exist, and where to obtain it.
- They need to be authorized to access and use the data.
- They need to know the history of the data capture, in order to interpret it correctly, trust it and be able to integrate it meaningfully with data coming from other sources.
- They need to know if the data depends on other data sets, in order to make sense of data.

Consequently, to leverage the full potential of geospatial data, an SDI must be made of different components to allow users to find, discover, evaluate, access and use these data, namely:

- A clearly defined core of spatial data.
- The adherence to known and accepted standards and procedures.
- Databases to store data and accessible documentation about the data, the so-called metadata.
- Policies and practices that promote the exchange and reuse of information.
- Adequate human and technical resources to collect, maintain, manipulate and distribute geospatial data.
- Good communication channels between people/organizations concerned with geodata, allowing the establishments of partnerships and shared knowledge
- The technology for acquiring and disseminating data through networks.
- Institutional arrangements to collaborate, co-operate and coordinate actions.

The main material components are:
- *Catalogue of metadata (of data and services)*
- *WMS Client (viewer to access the geodata, to consult and download it, etc.)*
- *web map server with WMS/WCS/WFS and other functionalities*
- *The network of accessible Web Map Severs, described by services metadata and containing geoinformation described by data metadata*

In order to meet the requirements of all stakeholders involved, an SDI must (Coleman et al., 1997) be widely available, be easy to use, be flexible.

Implementation in PEGASO

Two types of SDI's can be considered within PEGASO:

- **Local SDI's**: Some of the partners already have an operational SDI, and others would have the opportunity to set up their own SDI within this project. The elements that encompass a local SDI are:
  - Their own geoinformation, accessible in web map servers and with WMS/WFS services
  - A WebMapClient connecting to the own information and accessing to other external data sources (geonodes).
  - A Catalogue with the own metadata and metadata from other organization participating in the SDI
  - An organization giving support to the participants in the SDI, promoting several activities and assuring the data updating and the sustainability of the system

These SDI's, in the framework of the project, are running at a local level (for example, VLIZ, IFREMER, UAB, DDNI, etc) but they are also connected to a global or common infrastructure (Pegaso SDI).

- **Global SDI:** Gathering the contributions of all the partners and complementing them with several services and applications available, as a basic component of the ICZM governance platform, a Global or common SDI has been built to match the PEGASO Project requirements.

2.2. Geoportals

A **geoportal** is a web application offered by an organization which allows a standard access to its own geoinformation by means of a WMS Client (viewer), and also to other geoinformation available from external web map servers, that the SDI allows to connect to. It can include a Catalogue of metadata related to its own geodata.

Implementation in PEGASO

A remarkable group of partners were able to create a Geoportal, which ensures accessibility to their information by the WMS/WCS/WFS services through their own WMSClient. This includes the ability to connect to other external data sources, local or international, to be merged and combined with their own data.

In summary, a geoportal requires the following components:

- web map server with OGC WMS/WCS/WFS services to make the data and services available on the Internet
- WMS Client (view and download the provider's geoinformation)
- WMS Client to access external data sources
- Metadata of data and metadata of services
- Web site of the geoportal

Metadata could be stored in an appropriate own Catalogue or be managed in an external Catalogue (for example, the Global SDI PEGASO Catalogue)

Examples: Links to European Geoportals (see catalogues, map viewers, metadata, geoservices, etc,)

www.geoportal-idec.cat/en
www.inspire-geoportal.eu
VLIZ:
    EUROBIS: http://www.marbef.org/data/eurobissearch.php
    EMODNET: http://bio.emodnet.eu/portal/index.php
IFREMER
    www.ifremer.fr/sextant

2.3. Geonodes

Every provider of geoinformation has to offer it by means of an Internet geoservice, which can be achieved by using a web map server, with Standard connections based on OGC Specifications. These services allow the users to access the geoinformation by means of a WMS Client, to visualize it or to download it (under conditions defined by the provider). A provider can have one or more web map servers containing each one several Services. The different services have to be described by the correspondent Services Metadata, which are published in a Web Catalogue.

Every provider of geoinformation has to be considered as a “node” within the network of web MAP Servers which form a particular SDI.

Implementation in PEGASO

It is be desirable that most of the partners build a Geonode, implementing a web map server with the OGC services WMS/WCS/WFS containing the geoinformation used in the generation of the indicators and other information related with their geographical area of responsibility.

This service can be implemented in the same technical environment of the partner or it can be hosted in an external (local) organization, or, when needed, in the PEGASO leader resources (to be agreed and discussed with the partners).

For those partners who create a geonode, a description of the geoinformation provided by their geonodes and related accessibility (visualization and download) services need to be described in the necessary registers of metadata of data and metadata of services, according with the application schema defined for the project.

In summary, a Geonode development needs the following services:

— web map server with OGC WMS/WCS/WFS services to make data & services available
— Creation of Metadata of data and metadata of services

2.4. Data harmonization

“Harmonization is to create the possibility to combine data from heterogeneous sources into integrated, consistent and unambiguous information products, in a way that is of no concern to the end-user” [VILLA2008].

According to INSPIRE definition:
“The process of developing a common set of data product specifications in a way that allows the provision of access to **spatial data** through **spatial data services** in a representation that allows combining it with other harmonized data in a coherent way.”

NOTE: This includes agreements about coordinate reference systems, classification systems, application schemas, etc.

Therefore, in the PEGASO project harmonizing data procedures need to be undertaken. A harmonization guidelines document has been also produced, including technical details such as coordinate reference systems, mapping scale or resolution, recommended extent, administrative units to refer to, etc, and including also the common data models when available. The harmonization process consists in different steps:

— Define common data models for the geoinformation which has to be used
— Define every partner data model for these geoinformations

- Make the mapping between both models. Create matching tables
- Prepare the transformation processes from the partner's data model to the common data model

Examples:
http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2

2.5. Metadata and metadata catalogues

2.5.1. Metadata

Metadata is data about data. Metadata describes how and when and by whom a particular set of data or a service was collected or prepared, and how the data is formatted or how the service is available. Metadata is essential for understanding information stored in a portal and has become increasingly important.

Metadata is structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource. Metadata is often called data about data or information about information.

Metadata is also data about services. Metadata describes the content, quality, condition, and other characteristics of a data set or the capabilities of a service. Creating metadata or data documentation for geospatial data sets are crucial to the data development process. Metadata is a valuable part of a data set and can be used to:

- Organize your data holdings (Do you know what you have?).
- Provide information about your data holdings (Can you describe to someone else what you have?).
- Provide information to data users (Can they figure out if your data are useful to them?).
- Maintain the value of your data (Can they figure out if your data are useful 20 years from now?).

In the geographical domain we can have a description of spatial data (spatial data metadata), a service (service metadata) or a special analysis process (process metadata). Most of the standardization work is done for data metadata, however service and process metadata is becoming increasingly important.
Metadata is used in discovery mechanisms to bring spatial information providers and users together. The following mechanisms are recognized:

- **Discovery:** which data source contains the information that I am looking for?
- **Exploration (or evaluation):** do I find within the data sources the right information to suit my information needs?
- **Exploitation (use and access):** how can I obtain and use the data sources?

Each mechanism has its own use of metadata. The selected standards should fulfil the needs to carry out services using these mechanisms. Metadata is required to provide information about an organization's data holdings. Data resources are a major national asset, and information of what datasets exist within different organizations, particularly in the public sector, is required to improve efficiencies and reduce data duplication. Data catalogues and data discovery services enable potential users to find, evaluate and use that data, thereby increasing its value. This is also becoming important at the European level. In addition, metadata received from an external source requires further information supplied by metadata in order to process and interpret it.

2.5.2. Metadata and Catalogue Standards

The International Organization for Standardisation (ISO) includes ISO/TC 2112, which is an international, technical committee for geographic information. TC 211 has created a strong, globally implemented set of standards for geospatial metadata: the baseline ISO 19115; ISO 19139 for implementation of data metadata and the ISO 19119 for services metadata.

These open standards define the structure and content of metadata records and are essential for any catalogue implementation.

— ISO 19115: describes all aspects of geospatial metadata and provides a comprehensive set of metadata elements. It is designed for electronic metadata services, and the elements are designed to be searchable wherever possible. It is widely used as the basis for geospatial metadata services. However, because of the large number of metadata elements and the complexity of its data model, it is difficult to implement.

The INSPIRE Directive applies these standards and specifications in its implementation. Within the PEGASO project the metadata ISO standards 19115 and 19139 (for data) and 19119 (for services) have been used.

2.5.3. Catalogue services

A Metadata Catalogue Service is a mechanism for storing and accessing descriptive metadata and allows users to query data items based on desired attribute, the catalogue service that stores descriptive information (metadata) about logical data items.
The Open Geospatial Consortium (OGC) has created the Catalogue Service for Web (CS-W) standard to enable discovery from a catalogue node.

Catalogue services support the ability to publish and search metadata for data, services, and related information. Metadata in catalogues can be queried and presented for evaluation and further processing by both humans and software. Catalogue services are required to support the discovery and binding to published web map services.

The CS-W standard is extremely rich. In addition to supporting a query from a user, it can support distributed queries (one query that searches many catalogues) and the harvesting of metadata from node to node.

Example: http://www.inspire-geoportal.eu/index.cfm/pageid/321

2.6. GIS functionalities

A GIS gives the ability to merge different existing information from different sources, facilitating collaboration for creating and analyzing data. Due to these new possibilities of reusing existing data and working on collaboratively greater scale, new challenges arise.

When someone wishes to create a new information layer based on different data sets or different formats, with different terminology, and perhaps different projection, it is quite difficult to bring them together. Harmonizing geodata is a complex, costly and time-consuming task, but could be achieved by agreeing among data capturers before the work begins.

The growing recognition that once a geodata set has been created it could be used for public and private sectors (Ryttersgaard, 2001), reinforces the need to store data into databases that are made accessible for different purposes (Philips et al., 1999). This leads to the concept that geodata could be a shared resource, which can be maintained continuously.

As a result of the previous considerations, the concept of the SDI was developed in order to facilitate and coordinate the exchange and sharing of geospatial data (Rajabifard and Williamson, 2001), encompassing the data sources, systems, network linkages, standards and institutional issues involved in delivering geodata and information from many different sources to the widest possible group of potential users (Coleman et al., 1998).
The vision of an SDI incorporates different databases, ranging from the local to the national, into an integrated information highway and constitutes a framework, needed by a community, in order to make effective use of geospatial data (UNECA, 2005).

Different web applications may be part of the services offered by an SDI, similar to most used and know functionalities that are common in any GIS software (thematic maps, buffering, spatial analysis, etc). Some services providers can also offer other GIS functionalities as Web Processing Services (WPS). These types of services are growing fast in the SDI domain.

2.7. Downloading of data

A key outcome of SDI is that geospatial data become more easily accessed. It is important to understand the traditional workflow involved in using geospatial data in order to appreciate why this outcome offers considerable efficiencies.

A GIS user or business system traditionally receives geospatial data as a file on a DVD or other media. In order to use any of that geospatial data, the whole file has to be loaded onto the user's system. One of the characteristics of spatial information is that it tends to be voluminous so this could involve the transfer of several gigabytes of data. Moreover, the data may have to be translated from the supplier's format into a format understood by the user's system. This can be a time-consuming, processor-hungry activity.

From this, it can be seen that a file download (using a mechanism such as file transfer protocol) offers little advantage over DVD delivery. Indeed, from an ICT perspective, the surge in bandwidth required to download whole files of geospatial information can be seen as a significant disadvantage.

Using a current web services approach, the GIS user or business system can directly connect to the service and thus directly consume the content into their system. This offers a number of advantages. Perhaps most important is that no previous steps are required for using the data which offers the opportunity for the GIS or business system to be used more directly as a tool; the effectiveness is improved. In system terms, the user is able to access just the extent of data required to conduct their task. This reduces processing and bandwidth terms; the efficiency is improved.

The Open Geospatial Consortium (OGC) has worked for many years to establish a range of open standards for the web service delivery of spatial content. A wide range of standards are available for use.

In particular, the OGC WFS (Web Feature Service) is the standard service which allows downloading vector data from any standard web map server, while OGC WCS (Web Coverage Service) is the preferred standard service to deliver raster data. Environmental analyses are usually performed using raster data (e.g. salinity, temperatures, and even habitats or land cover layers are usually preferred in raster format for analysis purposes)

web map service (WMS)
OGC web map service Specification: http://www.opengeospatial.org/standards/wms

The web map service defines an interface that allows a client to retrieve maps of georeferenced data. In WMS context, a map means a graphical representation (jpeg, gif or png files) of a geospatial data meaning that a WMS service does not give access to the data itself. It is used for mapping purposes and can be combined with other WMS services.

Web Feature Service (WFS)
OGC Web Feature Service specification: http://www.opengeospatial.org/standards/wfs

The Web Feature Service defines an interface that allows a client to retrieve and update features of georeferenced data).
The main difference between WMS and WFS is that WFS gives direct access to the geometry and the attributes of a selected geospatial data, meaning that a user can work with a dataset provided by WFS. In brief, the WFS is the specification to access vector datasets.

Web Coverage Service (WCS)
OGC Web Coverage Service specification: http://www.opengeospatial.org/standards/wcs

Web Coverage Service allows a client to access raster datasets. By rasters we mean data that are represented as a matrix of cells in continuous space organized in rows and columns where each cells contains a value. Thus WCS service provides access to different types of gridded data such as Digital Elevation Model (DEM), remote sensing imagery, etc. It must be noted that WCS gives only access to the raw data and does not have transactional capabilities.

2.8. Interoperability

Interoperability is “the ability of a system or a product to work with other systems or products without special effort on the part of the customer” (OGC, 2004). This means that two or more systems or components are able to transmit or exchange information through a common system and to use the information that has been exchanged. Another definition is: “The capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units [ISO 19118]”.

When systems are interoperable, it gives the user the ability to:
- find what is needed,
- access it,
- understand and use it,
- have goods and services responsive to their needs

There are two types of interoperability (OGC, 2004):
- syntactic (or technical): when two or more systems are capable of communicating and exchanging data, they are exhibiting syntactic interoperability. Specified data formats and communication protocols are fundamental. In general, XML or SQL standards provide syntactic interoperability. Syntactical interoperability is required for any attempts of further interoperability.
- semantic: beyond the ability of two or more computer systems to exchange information, semantic interoperability is the ability to automatically interpret the information exchanged meaningfully and accurately in order to produce useful results as defined by the end users of both systems. To achieve semantic interoperability, both sides must refer to a common information exchange reference model. The content of the information exchange requests are unambiguously defined: what is sent is the same as what is understood (i.e. explaining why INSPIRE is producing data specifications).

Services play an essential role in the use of SDI. The selection, presentation, transformation and integration of data are all done by services. A service is a component with a standardized task that communicates by a standardized interface. A simple service is the presentation of a spatial dataset on a standardized way. Services can also be combined to form a new service. This is called service chaining. For the description of a service the ISO 19119 standard is used (service metadata). The OGC has been active in the formulation of implementation specifications for services.

3. Geonode interconnection

3.1. Introduction

The PEGASO Spatial Data Infrastructure (PEGASOSDI) is designed to create a distributed infrastructure of Geonodes that can be accessed either independently or all together from a central Geonode. This infrastructure is being built by integrating existing Geonodes from PEGASO partners and also by creating new Geonodes by partners that were lacking this service. The added value of PEGASOSDI is based on the selection of relevant data for PEGASO project and the availability of those data from a central, coherent service.

Each PEGASO partner can potentially build his own Geonode, which is then interconnected with the central Geonode. In order to successfully interconnect those services, the partner's Geonode should be set up following these guidelines, ensuring the compatibility and providing a homogenous set of services.

In order to successfully implement this infrastructure, the proper architecture has to be chosen, matching the following requirements:

- Include only relevant information
- Make this information easily accessible for partners and users
- Take into consideration existing Geonodes, trying to integrate them in the most efficient way
- Offer different levels of access if some datasets are protected and should only be accessible for partners or some user profiles

3.2. Data services (WMS, WCS, WFS and direct download)

The purpose of the SDI is to feed the map viewer but also to provide access to cartographic datasets for analysis. In order to fulfil that purpose and to maximize the options available for users, **each data set should be delivered using the following services**:

- Visualization service: **WMS**
- Data access service: **WFS** (for vector data), **WCS** (for raster data) and **direct download**

Offering just a WMS services is not enough, as that service is only suitable for visualization purposes, so partners and general public can't perform analysis task using those services. This is the reason to complement WMS with WFS, WCS and direct download services.

Recommendations for WMS, WCS and WFS services

WMS, WCS and WFS services can be configured to offer a set of coordinate reference systems for accessing the layers. The exact set of available reference systems is defined in the service configuration. When accessing a layer, the client is able to choose which reference system will be used (within the set of available reference systems, defined by the server).

Offering several coordinate reference systems makes published layers easier to integrate in Map Viewers and to combine with regional cartography on desktop GIS tools (such as QuantumGIS, gvSIG or ArcGIS).

Therefore, at least the following coordinate reference systems should be available:

Table 1. Coordinate Reference systems

Brief Name	Description	Code on EPSG reference database
ETRS89-LAEA	European Terrestrial Reference System 1989 (ETRS89) datum on GRS80 ellipsoid using Lambert Azimuthal Equal Area projection	EPSG:3035

ETRS89-LCC	European Terrestrial Reference System 1989 (ETRS89) datum on GRS80 ellipsoid using Lambert Conical Conformal projection	EPSG:3034
ETRS89-Geographic	European Terrestrial Reference System 1989 (ETRS89) datum on GRS80 ellipsoid using geographic (latitude-longitude) coordinates	EPSG:4258
WGS84	World Geodetic System 1984 (WGS84) using geographic (latitude-longitude) coordinates	EPSG:4326
Web-Mercator	Spherical Mercator projection, used in popular map services such as Google Maps, Bing, OpenStreetMap, etc.	EPSG:3857
ETRS89-UTM-zoneXX (zones 30 to 37)	European Terrestrial Reference System 1989 (ETRS89) datum on GRS80 ellipsoid using Universal Transverse Mercator for zones 30 to 37	EPSG:25830 EPSG:25831 EPSG:25832 EPSG:25833 EPSG:25834 EPSG:25835 EPSG:25836 EPSG:25837

It is strongly recommended that the metadata record is linked in the layer metadata section of WMS, WCS and WFS services. See Annex III for details on how to properly encode the link to the metadata record.

Recommendations for direct download service

The files offered as direct download should use well-documented, popular data formats that can be opened with (virtually) any GIS tool available in the market. The following formats have been selected:

- Shapefile for vector layers.
- TIFF (GeoTIFF) for raster layers.

Shapefiles are known to have several limitations, but have been anyway selected as there is a wide support on almost every existing GIS tool.

The files should be delivered in ZIPPED format (.zip) to reduce connection bandwidth and to include the datasets and the metadata in a single file.

3.3. Metadata Catalogue

In order to make layers searchable from the central Geonode catalogue, partners are encouraged to set up a metadata catalogue. Metadata contains the description of the data (title, description, spatial and temporal coverage, distribution services, etc), which makes data more useful both for your organization and for other organizations not familiar with your datasets. In this sense, metadata clearly increases the value of your data.

Protocols for metadata access

The metadata catalogue can be accessed using the catalogue webpage, but it should also offer standardized access using **Catalogue Service for the Web (CSW) protocol from OGC**.

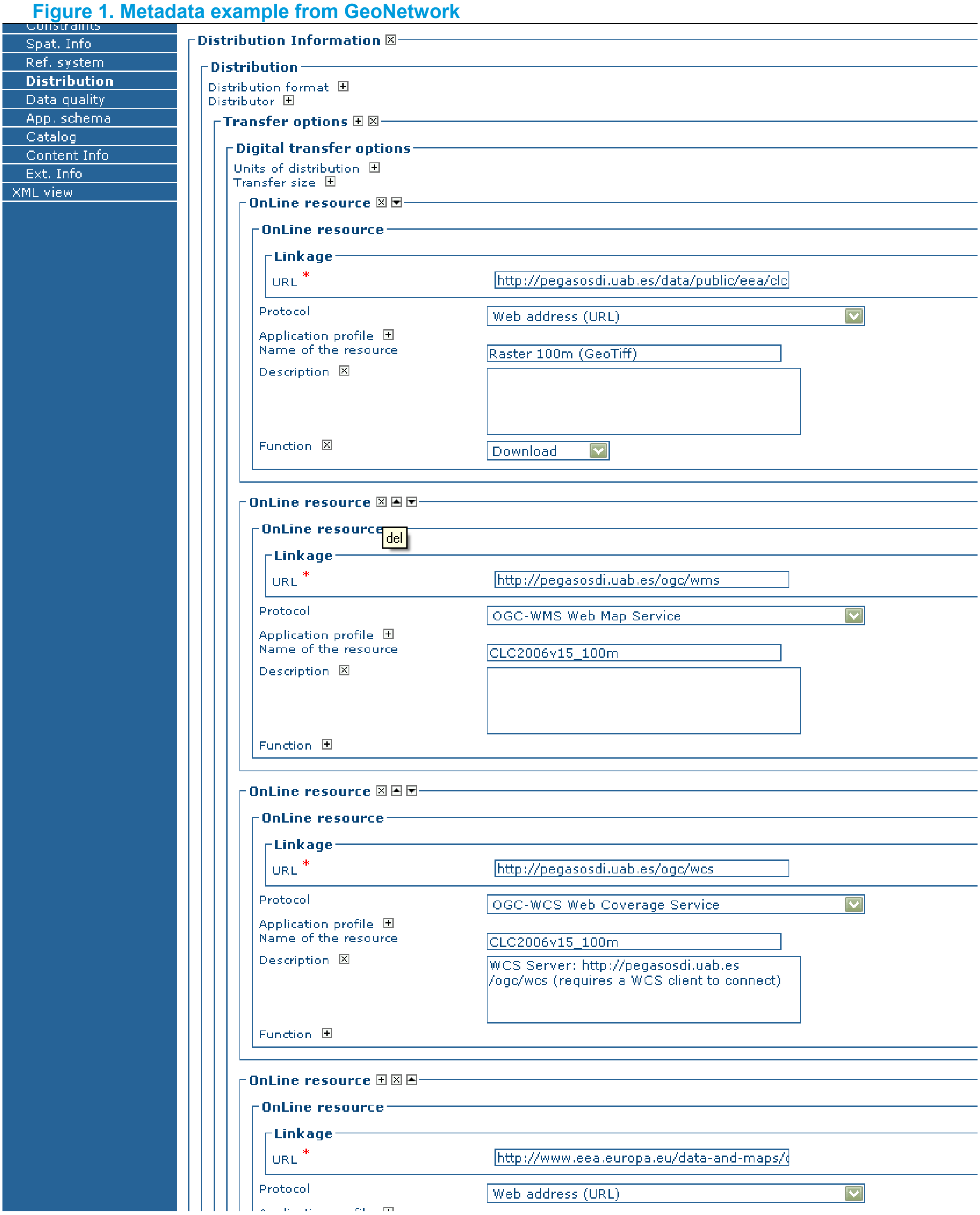
Additional protocols can be also set up to offer maximum interoperability. The PEGASO catalogue software (which is a customized version of GeoNetwork software) can be configured to offer the following protocols: CSW, GeoNetwork and OAI-PMH.

Metadata codification

Metadata records have to be codified on XML files following ISO19139 standard. The records can be generated with any 19139-compatible tool, such as GeoNetwork software. See Annex I for a description of the most relevant metadata fields on ISO19139.

In order to achieve a good integration with the PEGASO Map Viewer and Catalogue, the metadata record should have a link to the WMS, WCS, WFS and download services, under the subsection “Online Resource” of the “Distribution info” section. Using GeoNetwork software, this link can be created within the section Distribution, creating an Online Resource sub-section for each available service, as shown in the snapshot:

Figure 1. Metadata example from GeoNetwork



- For Download Services, the URL must point to the downloadable file, protocol should be set to "Web **Address (URL)", "Na me of the resource" should not be empty, and "Function" must be "download".**
- For WMS services, the URL must point to the WMS server address (e.g. 'http://pegasosdi.uab.es/ogc/wms'), protocol should be set to "OGC-WMS web map service" and the "Name of the resource" should be the "name" of the layer on the WMS service.
- For WCS services, the URL must point to the WCS server address (e.g. 'http://pegasosdi.uab.es/ogc/wcs'), protocol should be set to "OGC-WCS Web Coverage Service", the "Name of the resource" should be the "name" of the layer on the WCS service, and a description should be also including specifying that a WCS client is required to access this service (e.g. 'WCS Server: http://pegasosdi.uab.es/ogc/wcs (requires a WCS client to connect)').
- For WFS services, the URL must point to the WFS server address (e.g. 'http://pegasosdi.uab.es/ogc/wfs'), protocol should be set to "OGC-WFS Web Feature Service", the "Name of the resource" should be the "name" of the layer on the WFS service, and a description should be also including specifying that a WCS client is required to access this service (e.g. 'WFS Server: http://pegasosdi.uab.es/ogc/wfs (requires a WFS client to connect)').

See Annex II for details on the expected contents on the Distribution Information section of the ISO 19139 metadata.

Metadata filtering

Some partners already have working GeoNodes, including a metadata catalogue. However, not all the metadata available on those catalogues is relevant for PEGASO. Therefore, relevant metadata has to be selected by the partner, in order to only include those metadata records on PEGASO SDI.

The selected metadata should be 'marked' or 'tagged' in some special way, so that a filter can be applied on the central catalogue to exclusively show datasets relevant for PEGASO project.

Several options are possible to 'tag' the metadata, depending on the protocol offered by the partner:

Table 2. Example on how to tag metadata

For protocol…	Metadata should be tagged using…
GeoNetwork (option A, preferred)	'pegaso' keyword (using ISO19139 keywords field)
GeoNetwork (option B)	'pegaso' category (using GeoNetwork categories)
CSW	'pegaso' keyword (using ISO19139 keywords field), the keyword should be come available on the CSW 'subject' field
OAI-PMH	'pegaso' category (using GeoNetwork categories)

3.4 Geonode Interconnection

After having successfully implemented the services and protocols described in the previous sections, a geonode is ready to be connected to PEGASO SDI.

In order to enable this connection, the partner will need to contact the central Geonode providing the following information:

- The URL address of your metadata catalogue (if possible, CSW URL)
- The URL addresses of your map services: WMS, WCS and WFS. (Note: these addresses may not be necessary if your metadata catalogue already contains links to WMS, WCS and WFS services, as described on "Metadata Codification" section).

- The web address of your institution, your geoportal web site or your catalogue (as you prefer). There is a section on PEGASO SDI pointing to the web address of the partners that are providing data to the SDI.

4. Data harmonization

4.1. The SDI in the framework of the PEGASO project

One of the goals of the PEGASO project is the implementation of a Spatial Data Infrastructure (SDI), following the INSPIRE Directive, to organize local geonodes and standardize spatial data to support information sharing on an interactive viewer, to make it available to the ICZM Platform. A Spatial Data Infrastructure is where all data and indicators from PEGASO participants can be shared. Data then become easily accessible through a web portal.

PEGASO SDI allows simple GIS manipulation by all users and the downloading of relevant data for more detailed local analysis. And this requires the interoperability between the different data sources provided by the partners. Interoperability means the possibility for spatial data sets to be combined, and for services to interact, without repetitive manual intervention, in such a way that the result is coherent and the added value of the data sets and services is enhanced [INSPIRE Directive]. Interoperable spatial data is the data which is conformant to the harmonized data product specifications.

Harmonization is a broad topic which involves the adaptation of existing data and services to standards and rules according to the regulations and requirements in an SDI. It represents a main issue for combining of trans-sectoral, trans-lingual and trans-border information originating from different sources.

4.1.1. Purpose and scope

For the purpose of creating an SDI, every partner has to identify its available information used within the project (and to describe it by means of Metadata of data and services). The process of data harmonization is addressed to make interoperable the information shared by the different partners according to INSPIRE Directive principles.

This document is one of the deliverables of WP3, within task 3.2, being a part of the Deliverable 3.2B. It is based on previous harmonization initiatives such as EURADIN, NATURE SDI+, Humboldt and INSPIRE keeping in mind the development of harmonized data sharing infrastructure.

These Guidelines aim to provide support for partners, trying to simplify the harmonization process that requires multidisciplinary experts to deal with the context and the technology.

4.1.2. What to harmonize

1. The reference system and coordinates system for the whole project map presentation. In this case it has been agreed to use:

- Reference system: ETRS89.
- Projection: LAMBERT AZIMUTHAL EQUAL AREA [LAEA] (ESPG code 3035)[1].

[1] This is what we previously agreed and what is recommended by INSPIRE for spatial analysis. [See D2.8.I.1 INSPIRE Specification on Coordinate Reference Systems - Guidelines]:
"o Lambert Azimuthal Equal Area (ETRS89-LAEA) for pan-European spatial analysis and reporting, where true area representation is required;
o Lambert Conformal Conic (ETRS89-LCC) for conformal pan-European mapping at scales smaller than or equal to 1:500,000;
o Transverse Mercator (ETRS89-TMzn) for conformal pan-European mapping at scales larger than 1:500,000[...]. For regions outside of continental Europe, for example for overseas MS territories, the MS shall define a map projection they consider most suitable for the purpose."
Note: although we are using a different projection in the MapViewer (Web Spherical Mercator), which is necessary to use Google background imagery, this is not an issue, as we can still use ETRS89-LAEA for area calculations, while still using Spherical Mercator for visualization.

Raw data from any source can be converted from its own system to the new system, by means of the adequate on-line web processing services.

2. Small-scale maps, continuously covering the project areas, mainly used as background for the representation of other data (e.g.: indicators, localization of use cases, widespread administrative limits, etc.). Examples would be the OSM maps, Google Maps.

4.Metadata and Catalogue. See Deliverable ID 3.2.1.

5. Spatial Datasets and Spatial Objects, necessary for the calculation and representation of indicators. This topic will be treated in this document.

6. Portrayals. Symbolization, colour of layers and related aspects should be also harmonized. This topic will be treated in this document.

7. Feature Data. A Feature Catalogue and Feature Concept Dictionary, from INSPIRE resources, should be the basis for the harmonization of concepts, definitions and semantics of spatial objects and geoinformation being managed within the project.

4.1.3. Reference documents

The previous documents related to current one are the following:

4.1.3.1. Internal documents

Deliverable ID 3.2.1. "SDI implementation Guidelines", available on Pegaso Geoportal:
[Link: http://pegasosdi.uab.es/pegaso/reports/3_2_1_Report_Guidelines_for_building_the_PEGASO_SDI.pdf]
Deliverable D.3.1. "Report on the inventory of Participants and main relevant EU Projects data and SDI, with a Quality assessment and identification for needed actions on harmonization tasks". Available on the intranet
[Link: http://pegasosdi.uab.es/pegaso/reports/3_1_INVENTORY_OF_PROJECTS_DATA_AND_SDI.pdf].

4.2 Indicators for PEGASO

4.2.1. Introduction

An indicator is a proxy measure of information that can describe an abstract concept, process or trend. It may be measured in percentages, rates or ratios to allow comparisons. The PEGASO indicators take the form of statistics, state or percentage or combination thereof.

A structured approach to Integrated Coastal Zone Management or ICZM calls for indicators to measure the progress and effects of ICZM policies. Initiating, monitoring or evaluating an ICZM process requires a set of governance, environmental, and socio-economic indicators that should relate to the specific management issues that triggered the initiation of the ICZM process, such as multiple conflicts, ecological degradation, community interest or the need for implementing a specific legislation (IOC-UNESCO, 2006). The ICZM Protocol for the Mediterranean, signed in Madrid in 2008 and ratified in March 2011, represents a milestone for the implementation of ICZM in the Mediterranean region, but also leads by example for other Regional Seas. Furthermore, the Protocol represents a novel approach; being bold, innovative, forward-looking, proactive, comprehensive, and integrated. Regarding the indicators, Article 27 specifically states that the Parties shall:

• *Define coastal management indicators, taking into account existing ones, and cooperate in the use of such indicators;*
• *Establish and maintain up-to-date assessments of the use and management of coastal zones*

The process of selecting, developing and testing a set of core indicators is described in the PEGASO deliverable report 4.1. as well as on the PEGASO website and the Coastal Wiki (coastalwiki.org). The selected indicators are consistently applied in a wide range of spatial scales (i.e. local, national and regional), in line with the multi-scale PEGASO approach. Indicators are also needed or involved in the use of other PEGASO tools (WP4) and products. Examples of methodological integration between the set of indicators and other ICZM WP4 tools:

- The spatially explicit indicators are integrated with the Land and Ecosystem Accounting (LEAC) and the Sea Ecosystem Accounting (SEAC; task 4.2)
- The PEGASO indicator set provides the tool for a DPSIR[2] baseline assessment of current and past coastal and marine system pressures, states and impacts, against which trends can be analysed, and future projections can be assessed through scenario development (task 4.3)
- Economic indicators are a component of the socio-economic evaluation (task 4.5)
- The selection and identification of appropriate indicators for specific CASES should be performed through participatory methods (Participation methods report) (task 4.4)

The indicators are constructed from basic or reference information, which are applied as appropriate calculation algorithms (mathematical operations, weighting, algebraic, etc.) to set the value of the indicator.

In the PEGASO Project, each partner was invited to calculate the indicators that correspond to its area of activity/study/ within the project (CASE, island, river, city, province, county, etc).

Each indicator refers to a specific characteristic that relates to an area or territory. Within each area or territory several "scales" can be identified and calculated resulting in different indicator values. For example, if the scope is the countries' coastal zone, partner/s whose actions unfold along this area draw up indicators at different territorial levels: at the level of cities, coastal municipalities, protection zones, coastal NUTS3, and so on.

The same indicator reaches different values for the different areas considered (cities, counties, biomarine areas....). In this vein it is essential to define:

- The number of ranges of values to consider,
- Colour or colour range for representation,
- Area or region,
- Symbology

The indicators are calculated from a "reference" or basic information, to which an algorithm of calculation (percentage, division, addition, etc...) is applied to determine the value of the respective indicator. This basic information must have the same geographical area or format as the indicator to be calculated.

The time dimension has to be considered: as the reality evolves on time, indicators have to be calculated for different dates in order to capture this evolution of reality. In order to achieve this goal, the basic information from which an indicator is calculated has to be available for several reference dates.

In order to be able to assess the value and correctness of an indicator that has been calculated for a specific region and scale, it is important to carefully record the sources of information, including the reference date, the scale and means of access (web page download, web service, CD / DVD, etc).

The meaning of each indicator should be clear, shared by all partners, so that information is handled with the same semantic content and can be shared and understood among users and over different geographical areas and scales.

- [2] DPSIR is a causal framework for describing the interactions between society and the environment, base don the following components: Driving forces, Pressures, States, Impacts and Responses:

4.2.2. Objectives of the harmonization process

Although in the *Introduction* explicit reference has been made to the need to harmonize the data and services to be provided by different partners through the PEGASO SDI, a brief summary of the objectives and tangible results to be achieved through the implementation of the harmonization process is summarized below:

- To harmonize the meaning and presentation of indicators: same basis of calculation, the same type of basic information and statistics, same symbolic representation (colours, symbols, ranges, etc.).
- To be able to recalculate indicators, from basic information, either to establish new ranges of values, either due to the need of updating such basic information as appropriate.
- To allow the standardization of the indicators in the wide scope of the project, as well as with respect to local areas.
- To achieve clear identification and description of the areas referred to the indicators, and its link to basic information and indicators.
- To provide data to third party users, via SDI, in a standardized way (relationship or similarity to INSPIRE specifications).
- To develop and publish metadata for indicators and basic information (if not previously exist).

Situations to be avoided:

- Lack of homogeneous meaning between indicators created by different partners related to the same topic. This means that comparison between the same indicators would not be possible. All partners have to share the same semantics and concepts related to the same indicators.
- Outdated indicators due to the impossibility of recalculation when the original information changes.

4.2.3. - Harmonization proposal

To harmonize or unify the data model for the basic or reference information and for the indicator itself (reporting information). Determination of the data structure to accommodate the baseline for the indicators applicable to all partners.

Harmonized representation, defining the ranges of valid values for an indicator, colours, symbols and spatial characteristics (polygons, lines or points) of the geographical objects to which the indicator refers.

Implement the INSPIRE specifications on Area Management / restriction / regulation zones and reporting units, particularly those relating to the application schema of Reporting Units.

Use of the INSPIRE Feature Catalogue and feature concept dictionary. Available at: http://inspire-registry.jrc.ec.europa.eu/

4.2.3.1. Harmonization of the Reporting Information Data Model

Development of a Data Model which among other data contains the basic information (or an online reference access to it), the algorithm for calculation, etc. (see model draft) for each indicator. A link to Metadata and Factsheets describing every indicator is desirable.

Use of the INSPIRE data feature dictionary and feature Catalogue, for the definition of basic information to use or, where appropriate, the indicators themselves.

Identifier management following INSPIRE Implementation Rules (IR).

4.2.3.2. Harmonization of presentation / display of results

Each partner may publish his own WMS with the representation of the preferred indicators, while a layer must maintain the characteristics of homogeneity that have been defined for the project (range, colours and symbols). Therefore, one can connect from the hub to the different local nodes while maintaining the same data model and representation.

The indicators developed at the central geonode are also published as WMS services, and thus available for the local nodes.

4.2.3.3. Harmonization of reporting units

Existing spatial objects (indicators and reference information) should be considered and used as much as possible before proposing a new reporting unit.

4.2.3.4. Use of INSPIRE feature catalogue and concept dictionary

The feature concept dictionary allows sharing harmonized definitions and descriptions of all spatial object types, facilitating the cross-referencing harmonization of indicators.

The feature catalogue allows agreeing in the meaning of the spatial object types as well as the properties of these objects.

4.3 Reporting units for spatial representation

The PEGASO indicators refer to zones or geographic areas: Coastal zone, buffer of 10 km of coastline, municipalities or NUTS, sea areas, etc. However, some of them are represented by means of the European geographical grid.

A Reporting Unit can be defined as any collection of spatial objects to which reporting information can be associated or linked to. Consequently, the most appropriate way to graphically represent the indicator values in these areas should be by means of the already described and existing spatial objects like countries, regions, city, national parks, bioregions, etc., that is by georeferencing spatial data to already existing spatial objects. On the other hand, some indicators may refer to specific reporting units not previously defined or available. In this case, the reporting unit has to be defined and created using GIS tools before calculating the indicator.

In this respect, the “INSPIRE Conceptual Model” document states that the *object referencing significantly enables improvements in data integrity and reliability*. However, object referencing has proven to be a complex subject, in particular because the use of object referencing is not widespread today. Most spatial data sets today are data sets that are self-contained; even in cases where geometries are reused from other spatial objects in other data sets; these geometries are often copied instead of referenced usually.

There are many reasons behind this issue being the following the most important:

- GIS tools provide better support for self-contained data sets and spatial objects,
- Limited availability of reference objects via reliable network services,
- Lack of reliable and stable identifiers,
- More complex life-cycle management, and
- Performance concerns.

To some extent, this is similar to the changes from self-contained documents to web (HTML) documents connected by hyperlinks. Therefore, we must distinguish between spatial objects (points, lines or polygons area delimiters) and the information that is represented using them. For example, a 3rd NUTS level indicator can represent and receive vital statistics, political, economic and other indicators. Therefore, the same spatial object (in this case a NUTS polygon) can be used for the spatial representation of many different indicators or background information.

In the PEGASO Project, we propose to use the INSPIRE spatial objects called "**Reporting Units**". The results of PEGASO indicators (and also their input information in some cases) have been represented using such objects, in many cases already defined in the INSPIRE Data Specifications. Since any indicator requires a Zone or Area of representation, it may consist of any Reporting Unit already covered by the Directive or a new spatial object not covered by it. In the first case it is possible that the INSPIRE spatial object does not yet exist at the moment of calculating the indicator. In this case, it has been created by PEGASO. In any case, the generation, application schema and structure of these objects must follow the rules of the INSPIRE spatial specification of the Reporting Units (Currently included in the Draft Document “Area Management, Restriction Zone and Reporting Units Implementation Rule”).

Summarizing, the PEGASO indicators are composed of two objects, the geometry and the value as follows:

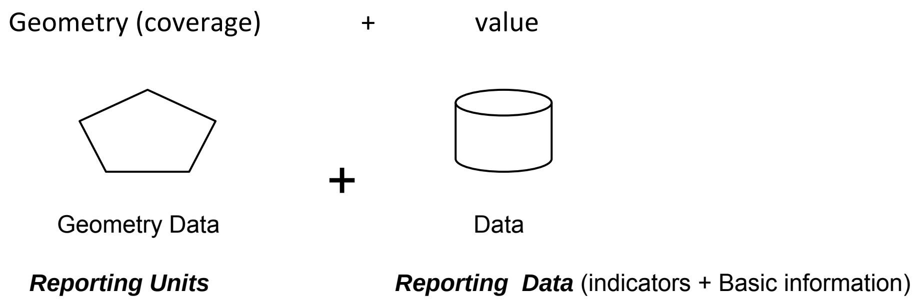


Figure 2. Example of reporting units method

The **Geometry** should be defined following the common application schema and harmonized as stated in the INSPIRE Data Specification for Reporting Units. The **Data** is defined by the data model / schema, and is based on a common application for all indicators + complementary fields according to each type of indicator.

The Reporting Units are seen as spatial objects that provide the spatial extent for related reporting information. Therefore, reporting units can be almost any spatial object from any INSPIRE Annex Theme.

The Reporting Units application schema does not include the details about the spatial object types that form the reporting units. This responsibility relies on the other INSPIRE Annex themes or thematic domains, which can directly include the attributes required for the reporting or can define an application schema for spatial objects that do not correspond to any INSPIRE Annex theme. The Reporting Units application schema provides some other information about the reporting, for which the reporting units have been formed, such as reporting period, reporting obligation and reporting authority.

4.3.1. Narrative description and UML overview of Reporting Units

4.3.1.1. Reporting Units

The Reporting Units spatial object type shall act as a container feature that defines the reporting instance and provide either references to the spatial object being used (from other INSPIRE Annex Theme) or directly include the spatial object. The Reporting Units spatial object type is comprised of the following attributes:

- INSPIRE Identifier: unique, persistent identifier used to identify the reporting units.
- Reporting Unit Name: name of the spatial object type that forms the reporting unit. This is required to enable discovery and selection, where there may be multiple reporting units.
- Reporting Period: time defining the reporting period to which the reporting units are applicable.
- Reporting Authority: Public Authority responsible for submitting the reporting units dataset to the relevant reporting authority; (not applied in PEGASO).
- Begin lifespan version: the spatial objects contained within the unit attribute, represent a snapshot version of the dataset from which they are derived. This property shall be used to capture when this snapshot was generated.

- End lifespan version: date defining when the version of the reporting units dataset was superseded.
- Unit: Reference to or inline encoding of the spatial object representing the reporting unit.
- Reporting Obligation: summary of the reporting obligation that requires the generation of the reporting information for which the reporting units provide the spatial extent; (Not applied in PEGASO).
- Related Reporting Information: this property can be used to link the reporting unit to specific reporting information objects, where known.

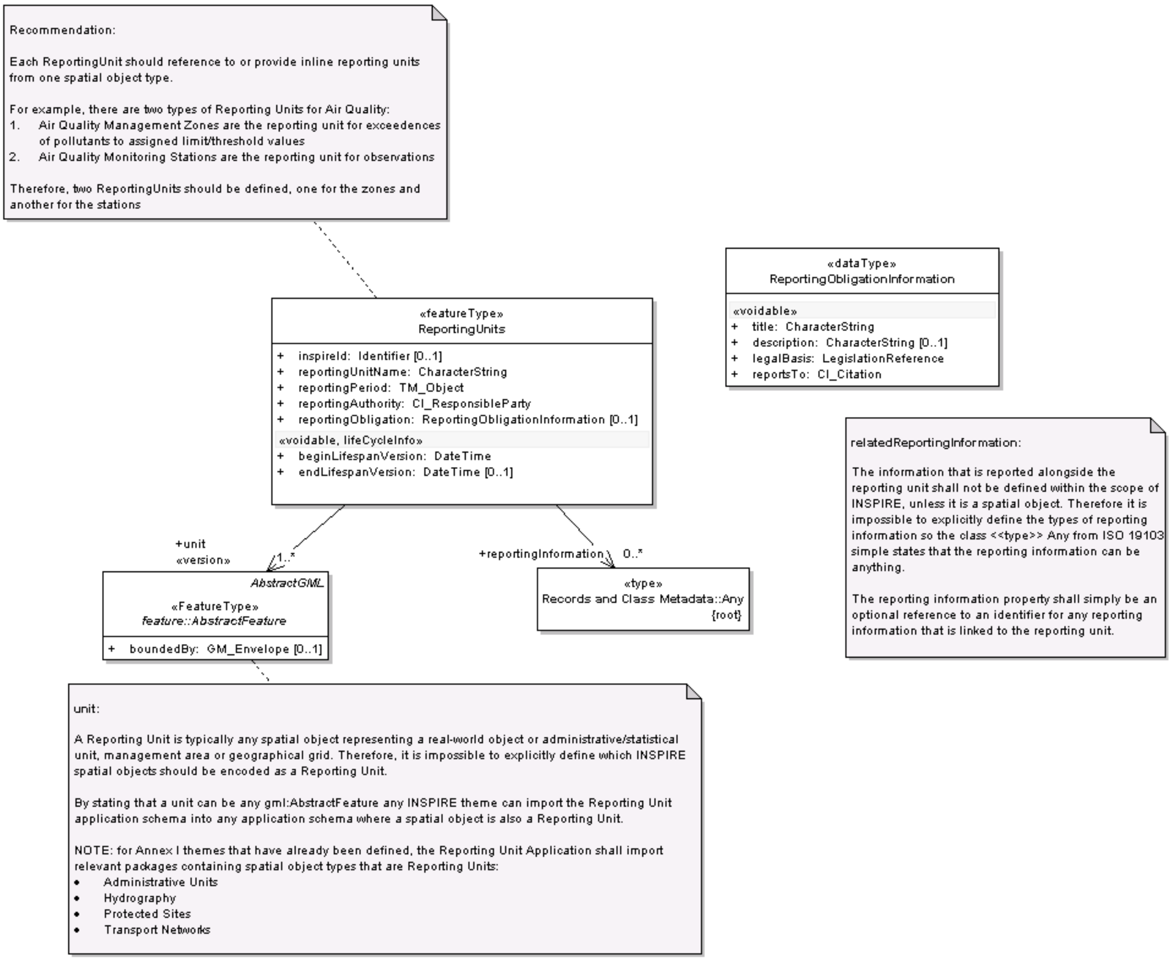
Note that a reporting unit can change over time. It is possible to trace how these units have changed by recording the creation, deletion, modification, aggregation or division of a reporting unit. These changes can be represented explicitly by means or the lifecycle attributes defined on the INSPIRE data specifications.

Whenever it is necessary to create new RUs, because those needed are not available or are not complaint with INSPIRE model, partners or WP3 are responsible to prepare the new files accomplishing the content required and described above. Also new Identifiers should to be created for these spatial objects.

4.3.2. The European grid ETRS89_LAEA_1km as PEGASO Reporting Unit

It is recommended to use the mentioned European grid, as defined in INSPIRE Specification "Geographical Grid systems", to harmonize the results at project level of the so-called "Ecosystem accounting tool" to be developed by the UNOTT, based on the methodology for setting territorial LEAC indicators, and the "Cumulative Impact Index", to be developed by the UAB, based on coastal sea areas, also based on LEAC methodology. The representation of results has been harmonized by using the Grid for both implementations, which has been useful for evaluating multiscale parameters. In all cases, accurate data, and its location and the availability are key factors to enable the implementation of these previous indicators. For this purpose, the Grid is available and can be downloaded (approx. 80 Mb), through PEGASO Catalogue. In addition, the PEGASO Catalogue includes the available Reporting Units, to be downloaded and used by the partners in indicators and tools calculations

Figure 3. Reporting Units Application Schema



Source: Data specification on Area Management/restriction/regulation zones and reporting units

4.3.4. Current Reporting Units considered by INSPIRE and provided by different organizations

4.3.4.1. Statistical units

A statistical unit informs on the statistical data location, the statistical data refer to these objects through their identifier. Statistical units are usually represented as:

- Vector geometries (points, lines, surfaces), mainly surfaces. Area statistical units usually compose a tessellation.

- Grid cells are spatial features (Polygon, Line, Point or Grid cell) that can be used to attach statistical information. Examples are NUTS, LAU1, LAU2, GRIDS, Population Distribution.

4.3.4.2. Sea regions

A sea region is a defined area of common (physical) characteristics. An Oceanographic Geographical Feature represents the (physical or chemical) properties of the Sea Region. Some examples are: Sea, Sea Area, Marine Circulation Zone, Intertidal Area, Shoreline, Shore Segment, (ex. Marine Administrative Zone, Territorial Sea Area, Sediment Cell, Circulation Cell, Seabed Area, Exclusive Economic Zone…), Marine Boundaries, IHO Sea Areas, Marine Ecoregions of the world, ICES Ecoregions.

4.3.4.3. Habitats and biotopes

Geographical areas characterised by specific ecological conditions, processes, structure, and (life support) functions that physically support the organisms that live there. Includes terrestrial and aquatic areas distinguished by geographical, abiotic and biotic features, whether entirely natural or seminatural.

4.3.4.4. Biogeographical regions

Areas of relatively homogeneous ecological conditions with common characteristics. Example: Environmental Stratification Europe, Natural Vegetation Europe.

4.3.4.5. Protected sites

Natura 2000 sites, Biosphere reserve, UNESCO sites, Ramsar Sites.

4.3.4.6. Area management/restriction/regulation zones

Environmental quality, environmental and natural resources, control risk, health, development/spatial planning,

- Protect and improve environmental quality
- Protect environmental and natural resources
- Protect and control risk from natural and man-made hazards
- Protect plant, animal and human health
- Control development/spatial planning

An Inventory and preliminary assessment of the European databases and datasets which can be used as Reporting Units or as georeferencing spatial objects can be found in the Annex V of the Deliverable D.3.1 [Available on Pegaso Geoportal: http://pegasosdi.uab.es/pegaso/reports/3_1_INVENTORY_OF_PROJECTS_DATA_AND_SDI.pdf].

4.3.5. Scales for representation of indicators in PEGASO

From a first overview of the list of proposed indicators provided by WP4 and their characteristics and coverages, it can be said that the different scales of representation present in the project can be summarized on the following list:

Table 3. Principal scales of representation for indicators

Layers
EEZ
Territorial waters
Subnational, Coastal zones
National (country)
Local (municipalities)
Coastal ports
ICZM Protocol compliance reporting

A complete factsheet has been produced for each indicator, defining the reporting units recommended for the calculation of the indicator.

4.3.6. Style representation of the RU

4.3.6.1. Layer representation

The layer representation can be defined as follows:

Table 4. Style for layer representation.

Layer Name	Layer Title	Spatial object type(s)	Keywords
AM.ReportingUnit	Reporting units	<Name of the spatial object type making up the reporting unit	reporting units

Style Abstract

Reporting units with a point geometry are rendered as a square with a size of 6 pixels, with a 50% grey (#808080) fill and a black outline. Reporting units with curve geometry are rendered as a solid black line with a stroke width of 2 pixels. Polygon reporting units are rendered using a 50% grey (#808080), 30% opaque fill and a solid black outline with a stroke width of 2 pixels.

Symbology

See: UserStyle_AM_ReportingUnit_Default.xml (definition of the style) from the INSPIRE document "*Data Specification on Area management/restriction/regulation zones and reporting units"*

4.4 Harmonization of Reporting Information

'Indicator data' are defined as the data directly needed to calculate (and spatially represent) the indicators. The indicator set has been selected and defined by WP4 (task 4.1). This set of indicators is based on ICZM policies, and particularly address the elements and articles from the Bucharest and Barcelona Conventions and from the Strategies focused on delivering ICZM and measuring Sustainable Development in coastal zones.

Indicator sets include:

1) ICZM Progress Indicators, to evaluate the degree of implementation and compliance with the established in the relevant ICZM Policies

2) Indicators of Sustainable Development (ISD) to measure the evolution towards more sustainable coasts (land and sea) according to the goals set in the ICZM Policies

The ISD consists of a core set of indicators, which due to their high degree of relevance for the EU or regional ICZM policies should have a basin-wide application. Next to this core set, a number of additional indicators can be selected from the set of indicators, to fulfil local objectives. The selection criteria for the latter has been based on participative processes involving all CASES/partners, starting from a proposed list/set by the WP4.1 team and validated by members from the wider PEGASO consortium.

A common data model for each one of the indicators has been defined. Two levels of information can be defined:

— *Generic level*: generic characterization of the indicator (conceptual). This has been collected in the Factsheets agreed for every indicator, but also a database containing this generic information can be created in order to allow a better management of the indicators system. The number of records would coincide with the number of the different indicators.

— *Specific level:* concrete instance of the indicator (i.e. a specific application of the indicator on a concrete region, scale and reference date(s), using specific input data suitable for the region, scale and temporal extent), usually related with a partner (responsible of the calculation of the indicator). The basis for the design of the specific level of the data model is be the "indicator fact sheet" (see below).

Table 5. Fact sheet collecting the principal characteristics of indicators

Name of the Indicator	
Nr.	
Objective of the indicator	
Policy context	
ICZM Policy Objective	
ICZM Protocol Article	
UNEP-MAP Ecological Objective	
Inspire ANNEX I-III Data Theme (34)	
CALCULATION OF THE INDICATOR	
Spatial consideration	
Coverage	Resolution – Reporting units
Temporal consideration	
Period	Resolution (time interval or unit)
Parameter(s)	
(i)	
(ii)	
Calculation method	
Steps	Products
1	
2	
Current monitoring	**Data sources**
Assessment context	
Use of the indicator in previous assessments/initiatives	
DPSIR framework	
Link to anthropogenic pressure	
Sustainability target or threshold	
Link with other assessment tools	
Example of integrated assessment	
Scope for future improvements	
Indicator references (i.e. UNEP, EEA, …)	

Figure 4. Physical data model for Generic level indicator (Access table)

Name	Text
PolicyObjective	Text
PegasoIdentifier	Text
Objective	Text
ICZMPolicyObjective	Text
ICZMProtocolArticle	Text
Relevance	Text
EcologicalObjective	Text
ReportingUnitName	Text
ReportingUnitSource	Text
ReportingPeriod	Text
BeginLifespanVersion	Date
EndLifespanVersion	Date
FactsheetLink	Text
NumRanges	Number
BaseColor	Text

Figure 5. Physical /Logical data model for specific level indicator
(one instance for partner, reporting unit, scale...)
(Access tables)

SpecificLevelIndicator *[1:1]* *ReportingUnits*

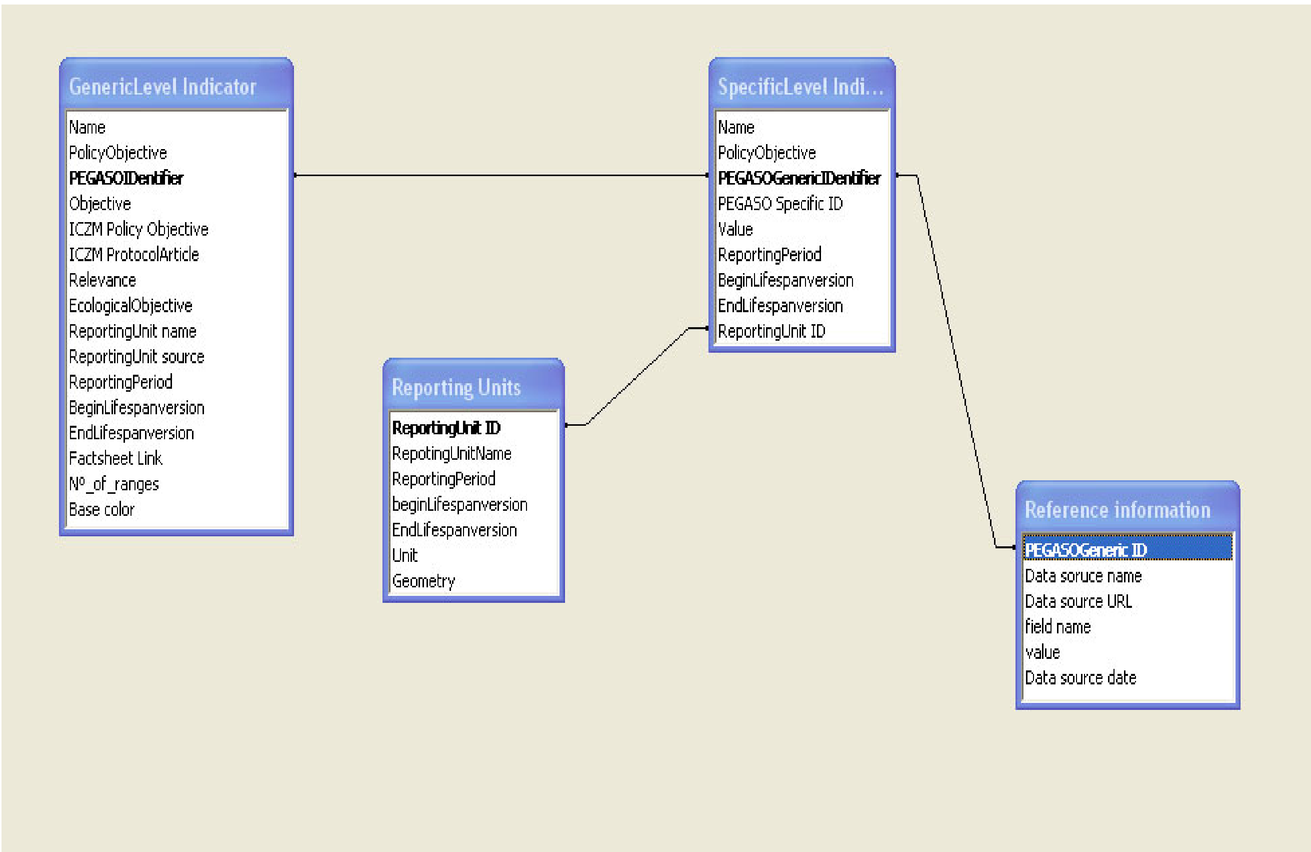
Name	Text
PolicyObjective	Text
PegasoGenericIdentifier	Text
PegasoSpecificIdentifier	Text
Value	Number
ReportingPeriod	Text
BeginLifespanVersion	Date
EndLifespanVersion	Date
ReportingUnitIdentifier	Text

ReportingUnitIdentifier	Text
ReportingUnitName	Text
ReportingPeriod	Text
BeginLifespanVersion	Date
EndLifespanVersion	Date
Unit	Text
Geometry	Geom

ReferenceInformation

PegasoGenericIdentifier	Text
DataSourceName	Text
DataSourceURL	Text
FieldName	Text
Value	Number
DataSourceDate	Date

Figure 6. Data architecture for PEGASO Indicators E-R Diagram based on MS Access DB



4.4.1. Identifiers management

An important issue in the harmonization process is the *Identifier management*. An identifier is a number or code that identifies a spatial object and can be used to differentiate it from other spatial objects. A good management of the creation of identifiers is basic to ensure that each identifier is unique (i.e. the same identifier should not be used to identify different spatial objects). As ruled in INSPIRE, we propose a unique identification of spatial objects, provided by external object identifiers, i.e. identifiers published by the responsible data provider (or, in the PEGASO framework, created by the partners) with the intention that they may be used by third parties to reference the spatial object within INSPIRE.

Identifiers are applicable to the different concepts previously described: the generic level of an indicator (conceptual definition), the specific level of an indicator (specific indicator calculation) and the spatial objects. However, an identifier has a different structure for each of them:

a) The **identifier for the generic level** of an indicator consists on the following structure:

> PI.indicator_code.indicator_subcode, where indicator code and subcode should be taken from Annex VII tables.

Example: PI.09.03. This identifies the indicator "Pegaso Indicator: Percentage of habitat types having a favourable conservation status"

b) The **identifier for the specific level** of an indicator consists on the following structure:

> Generic_level_identifier..partner.reporting_unit_code

Where partner acronym should be taken from Annex IV table, and reporting_unit_code should be either:

- the universally unique identifier (UUID) automatically assigned by GeoNetwork to the metadata record[3] of the reporting unit in use for this indicator. A UUID is a random code (example: b350d9bb-1151-4c7d-a426-da81e99590ed) which can be considered to be universally unique in practical terms.
- any other local code, which should be unique within the namespace (the namespace is the 'PI.02.2.UAB' portion of the identifier). If this option is chosen, the partner is responsible of creating the local code and ensuring it is unique within the namespace.

Example: PI.09.3.UAB.b350d9bb-1151-4c7d-a426-da81e99590ed

In this example, the code 'b350d9bb-1151-4c7d-a426-da81e99590ed' corresponds to the Natura 2000 layer. The meaning of the full identifier would be: the indicator PI.09.3 "Pegaso Indicator: Percentage of habitat types having a favourable conservation status" has been calculated by partner UAB using the Natura 2000 layer as reporting unit.

c) The **identifier for a spacial object** identifies a specific spatial object (i.e. a specific geometry) within the indicator is composed of the following structure:

> Specific_level_identifier.local_code

Example: PI.09.3.UAB.b350d9bb-1151-4c7d-a426-da81e99590ed.FR9310019

The identifier in the example references the Natura 2000 protected area of Camargue (which has a local code of FR9310019) in the context of the indicator PI.09.3 "Pegaso Indicator: Percentage of habitat types having a favourable conservation status" calculated by UAB using Natura 2000 as reporting unit.

The local identifier is unique within the namespace, i.e. no other spatial object carries the same unique identifier. It can be usually be taken from the reporting unit, otherwise it should be assigned by the partner calculating the indicator.

[3] This implies that the metadata record of the indicador has been created at the time of defining the identifier of the indicador. The UUID is visible in the metadata record in GeoNetwork, in the 'File identifier' field within the 'Metadata' section.

4.5 Methodology for creating harmonized indicators

4.5.1. What to define for each indicator

The different scales and related reporting units to be used shall be defined for each type of Indicator (GenericLevel). WP4 task 4.1 defined, in the factsheet of each indicator, these reporting units.

A data management tool (MS Access, for example) can be used to help partners to collect, edit and store data in appropriate files.

Every instance of the partner file should be referenced by an *Identifier*, which is the link to the corresponding Reporting Unit Identifier. The Indicator Identifier should respect the rules described on the previous section for specific level.

- Example: PI.09.3.UAB.b350d9bb-1151-4c7d-a426-da81e99590ed.FR9310019

References (links) to fact sheets and metadata registers are suggested to be included whenever an indicator is published or included on a web site.

4.5.2. How to collect data, how to send it (spatial objects and attributes)

Once the data (indicator) has been created, the file shall be joined with the corresponding reporting unit, and published in the partner's Geonode Services WMS / WCS / WFS. From WFS services the downloading of GML files should be made available, and GML schema as well.

Data to be published encompass the reference data which has been used to calculate the indicator value (or status). These data should be collected in independent files, as indicated in the Data Model.

4.5.3. Creating Factsheets and Metadata

Every file, which corresponds with a specific indicator at partner level, shall be described by a metadata record. The partner services which allow the access to this data have to be described by means of a Service Metadata. Metadata should be published in a standard CSW Catalogue, in the Central Geoportal and, when possible, in the local partner catalogue. The factsheets should be also made available in the Pegaso project platform.

Deliverable ID 3.2.1. "SDI implementation Guidelines", available on Pegaso Geoportal:
[Link: http://pegasosdi.uab.es/pegaso/reports/3_2_1_Report_Guidelines_for_building_the_PEGASO_SDI.pdf]

4.6 Examples of spatial object references

Maritime and Administrative units

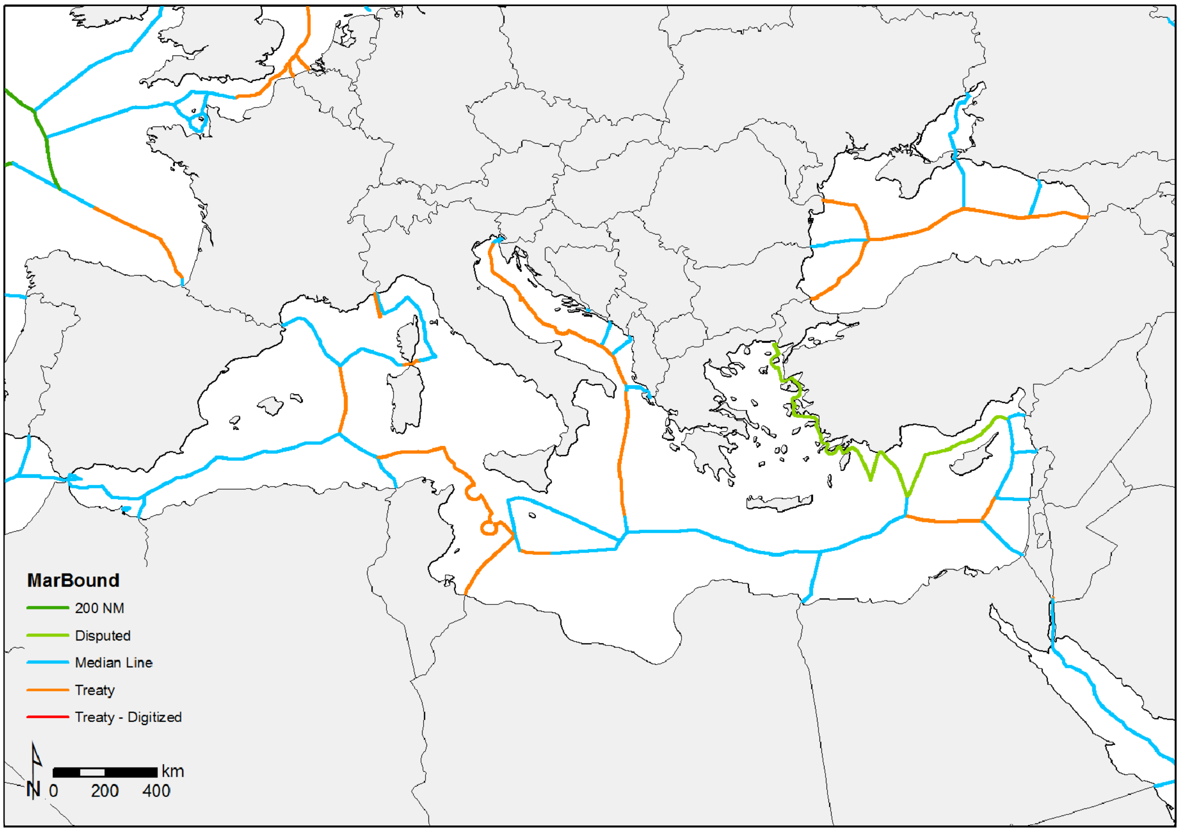
More information and shapefiles can be found on:

http://www.marineregions.org/downloads.php

VLIZ Maritime Boundaries Geodatabase, MarBound

http://www.marineregions.org/downloads.php#eez

This dataset represents Exclusive Economic Zones (EEZ) of the world. Up to now, there was no global public domain cover available. Therefore, the Flanders Marine Institute decided to develop a geospatial database. The database includes two global GIS-layers: one contains polylines that represent the maritime boundaries of the world countries, the other one is a polygon layer representing the Exclusive Economic Zone of countries. The database also contains digital information about treaties.



Known issue: Not all countries in the Mediterranean or Black Sea have claimed an Exclusive Economic Zone. In our geodatabase an EEZ is allocated based on the median line between two countries. Other regulations, like the territorial seas (12 nm) and contiguous zones (24 nm), are not included in the Geodatabase.
Overview of the claims in the Mediterranean and Black Sea in appendix 1 (https://www.cia.gov/library/publications/the-world-factbook/fields/2106.html).

Physical

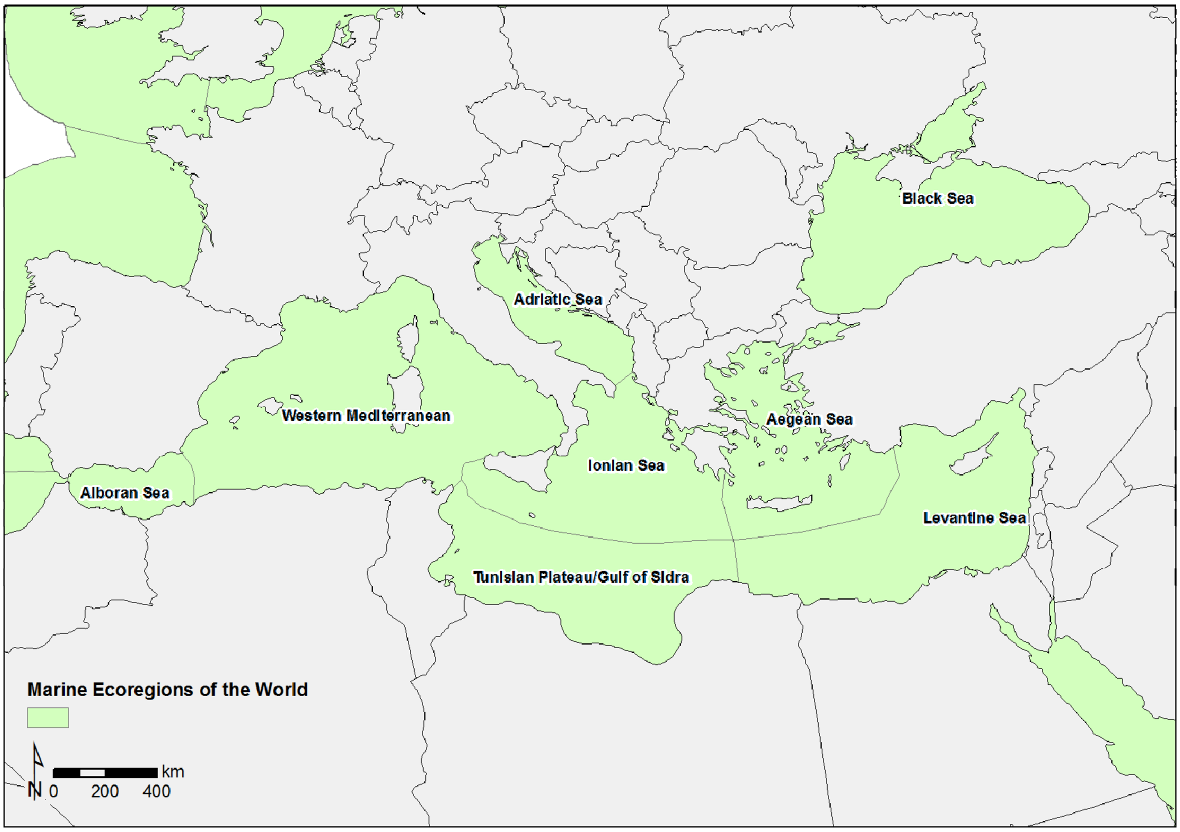
IHO Sea Areas

This dataset represents the boundaries of the major oceans and seas of the world. The source for the boundaries is the publication 'Limits of Oceans & Seas, Special Publication No. 23' published by the IHO in 1953.

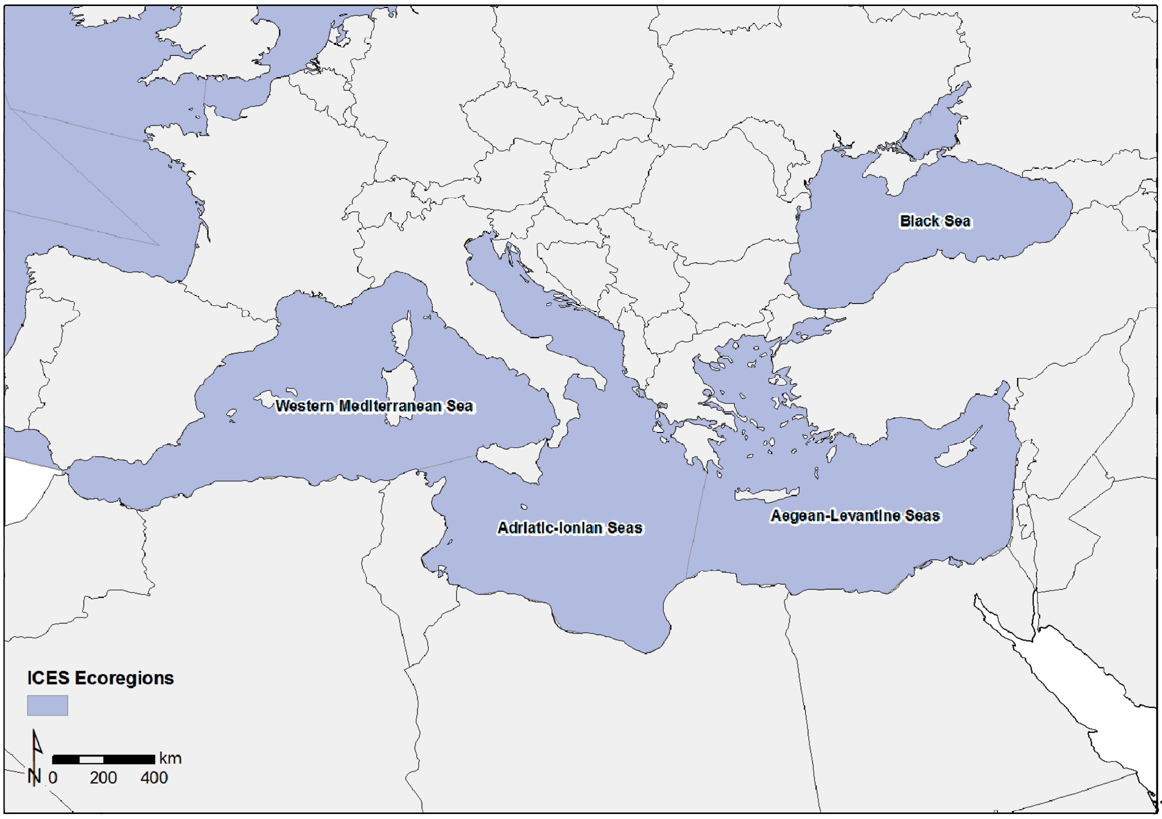
Marine Ecoregions of the World

MEOW is a biogeographic classification of the world's coasts and shelves. It is the first ever comprehensive marine classification system with clearly defined boundaries and definitions and was developed to closely link to existing regional systems. The ecoregions nest within the broader biogeographic tiers of Realms and Provinces.

MEOW represents broad-scale patterns of species and communities in the ocean, and was designed as a tool for planning conservation across a range of scales and assessing conservation efforts and gaps worldwide. The current system focuses on coast and shelf areas (as this is where the majority of human activity and conservation action is focused) and does not consider realms in pelagic or deep benthic environment. It is hoped that parallel but distinct systems for pelagic and deep benthic biotas will be devised in the near future. The project was led by The Nature Conservancy (TNC) and the World Wildlife Fund (WWF), with broad input from a working group representing key NGO, academic and intergovernmental conservation partners. (source: http://www.worldwildlife.org/science/ecoregions/marine/item1266.html)

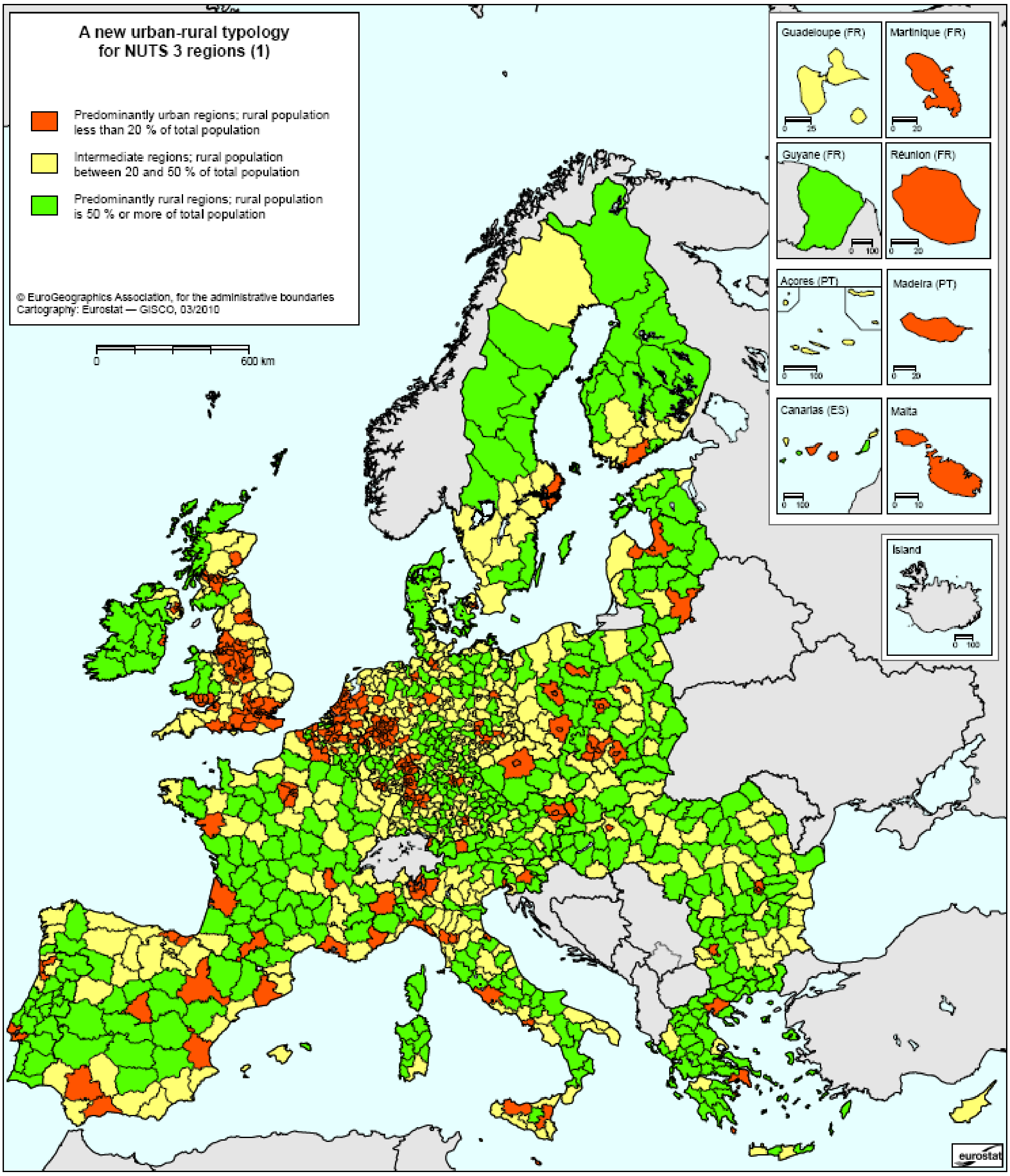


ICES Ecoregions
ICES Ecoregions are large-scale management units for the ICES regional seas and are used in advisory reports to segment advice into the different sea areas. The Ecoregions were first referenced by the predecessor to ACOM (Advisory Committee) in 2004 (source: http://www.ices.dk/InSideOut/mayjun09/j.html).



NUTS 2006 and statistical regions as at the beginning of 2010

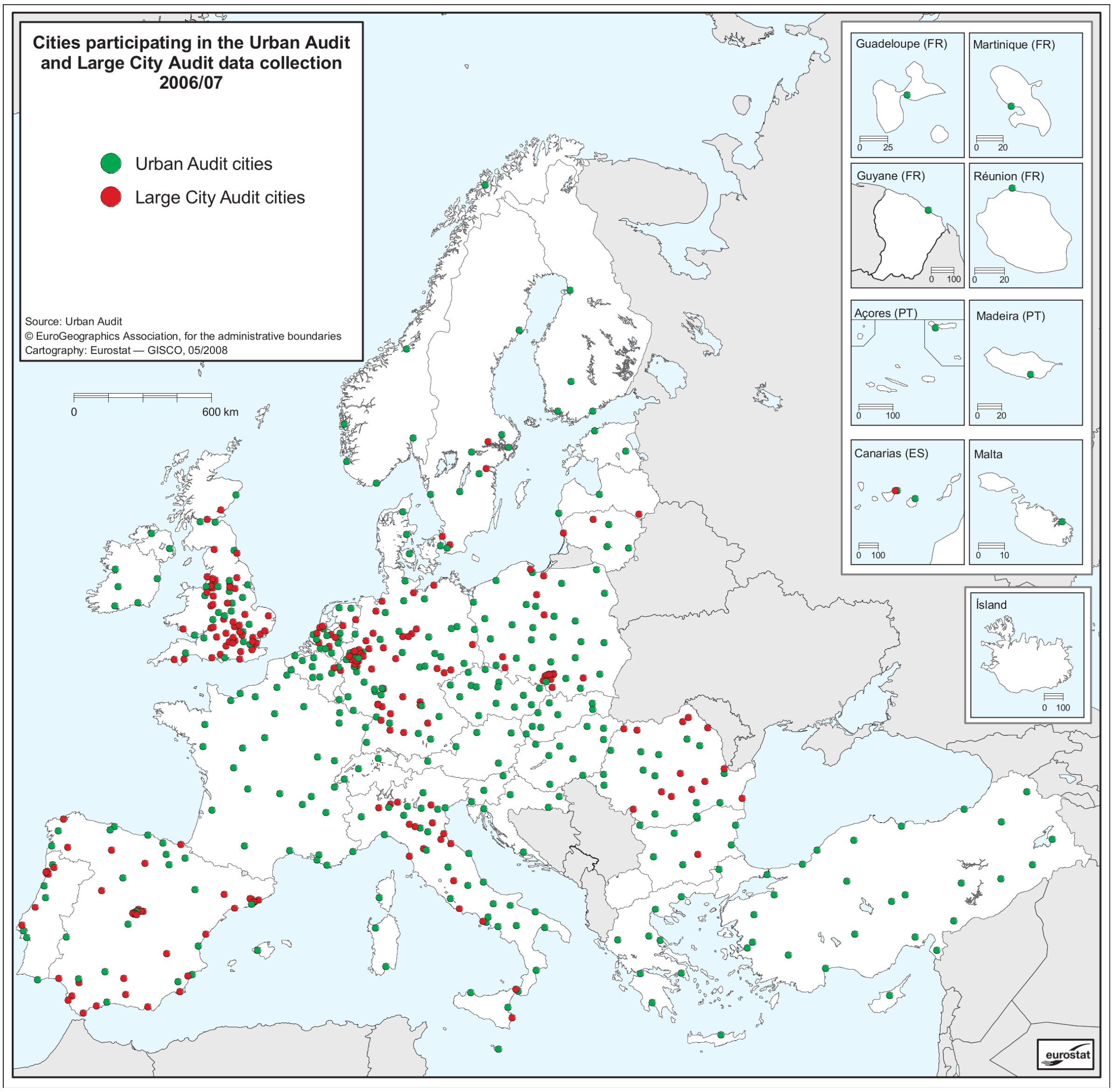
Urban-rural typology of NUTS3 regions



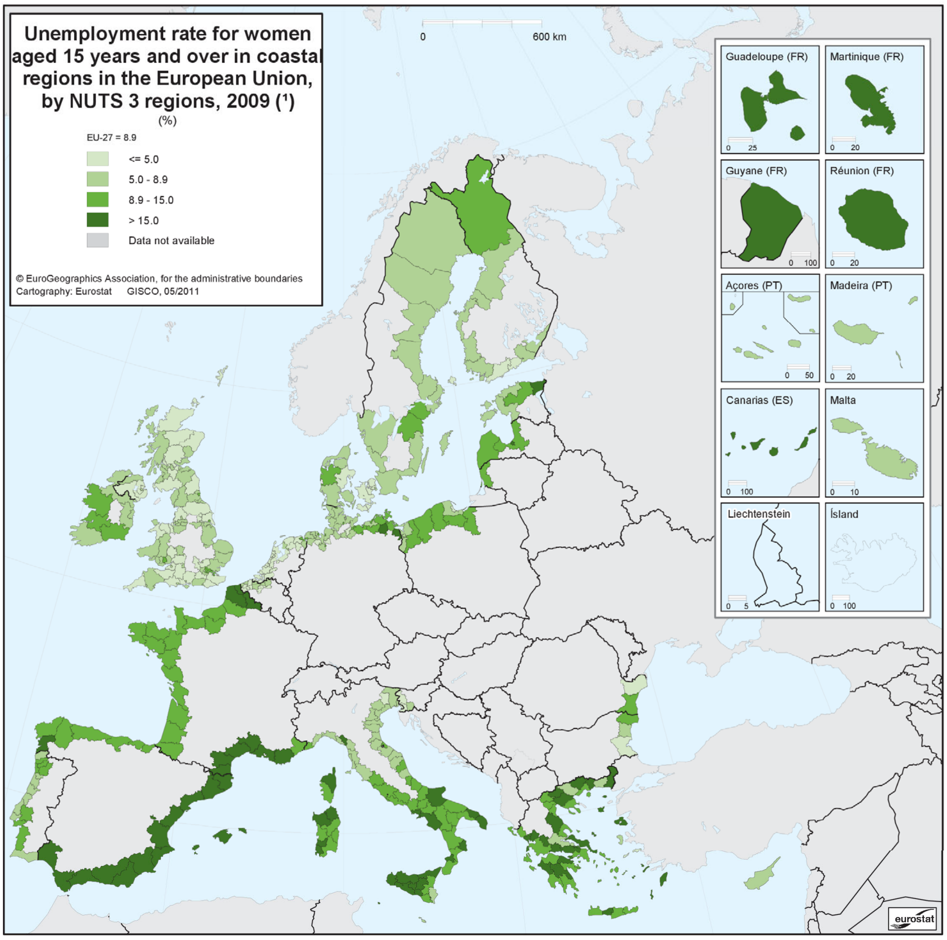
(1) This typology is based on a definition of urban and rural 1 km² grid cells. Urban grid cells fulfil two conditions: 1) a population density of at least 300 inhabitants per km² and 2) a minimum population of 5 000 inhabitants in contiguous cells above the density threshold. The other cells are considered rural. Thresholds for the typology: 50% and 20% of the regional population in rural grid cells.

For Madeira, Açores and the French outermost regions, the population grid is not available. As a result, this typology uses the OECD classification for these regions.

Cities participating in the Urban Audit and Large City Audit data collection 2006/2007



Unemployment rate

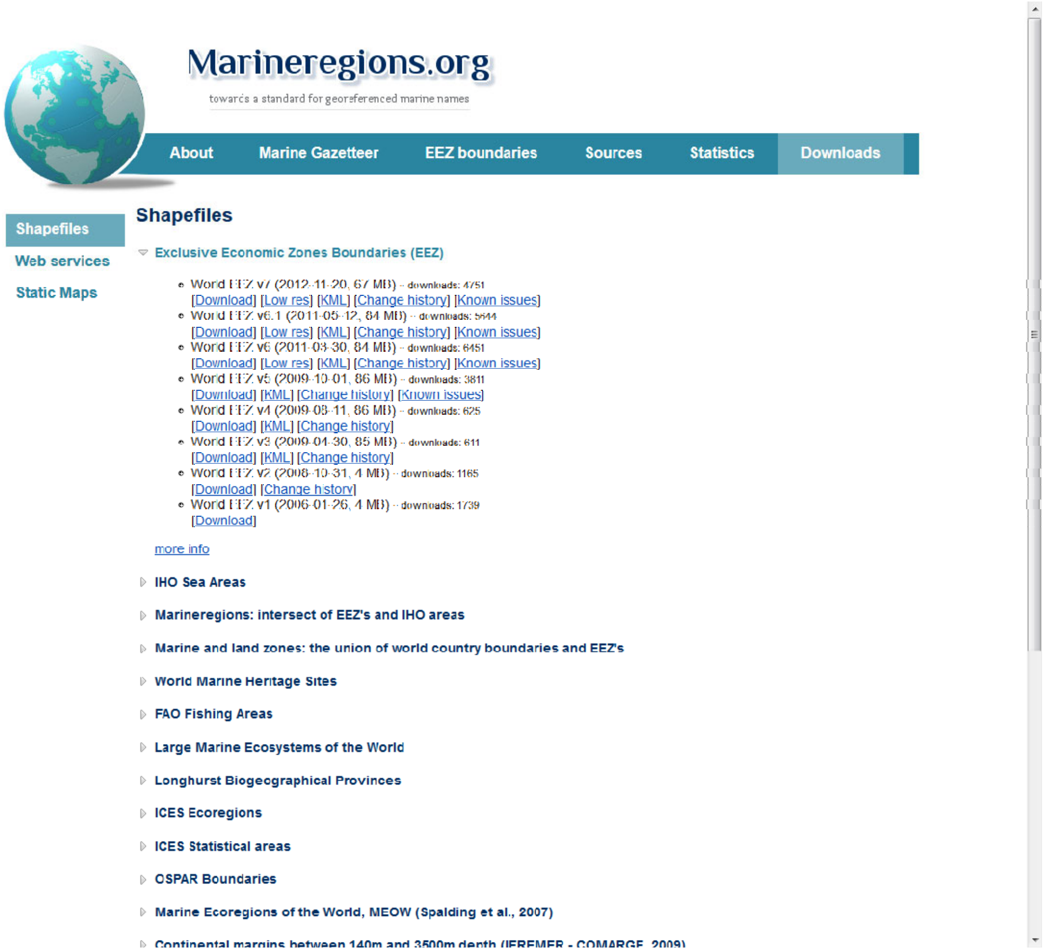


(¹) Bulgaria, Malta and Finland, 2008; Portugal and France, 2007; Belgium, 2006.

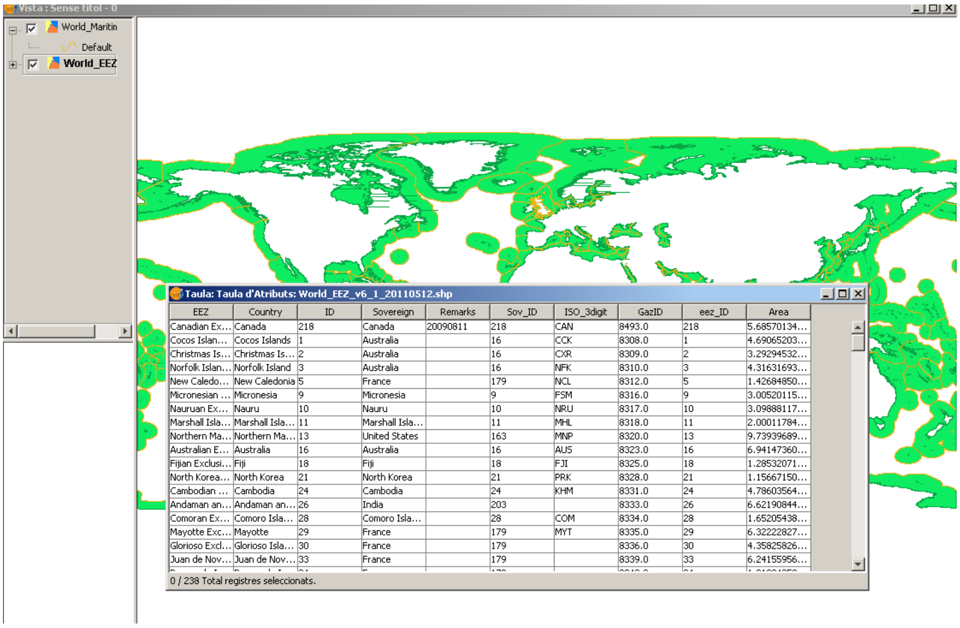
Source: Eurostat (online data code: lfst_r_lfu3rt)

Use cases:

1.- Obtaining sea regions boundaries from IHO data:
Go to this webpage: http://www.vliz.be/vmdcdata/marbound/download.php (from ANNEX V of Deliverable D.3.2.1)
And download the last version of World EEZ



2.- Load the shape file in a GIS software (gvSIG, in this case). Visualize the content



3.- Delete columns of attributes, and create a new column containing a PEGASO ID (PEGASO identifier) as described before, and add several columns for temporal aspects control and others:

PEGASO Identifier *ReportingUnit ID NameSpace + RU ID LocalCode*
Reporting Unit Name *"sea regions"*
Reporting Period *(unknown)*
Begin lifespan version *1994*
End lifespan version

4.- Now you have a file –Reporting Unit, related to the boundaries of sea regions, which can be used (joining files) by different indicators:

Name	RU_ID_Namespace	RU_ID_LocalCode	Geometry	Period	BeginLS	EndLS
Cocos Islands Exclusive Economic Zone	PRU.01.2.13.VLIZ	1	GML Poly		19/11/2008	
Christmas Island Exclusive Economic Zone	PRU.01.2.13.VLIZ	2	GML Poly		19/11/2008	
Norfolk Island Exclusive Economic Zone	PRU.01.2.13.VLIZ	3	GML Poly		19/11/2008	
Australian Exclusive Economic Zone (Macquarie Island)	PRU.01.2.13.VLIZ	4	GML Poly		01/10/2012	
New Caledonian Exclusive Economic Zone	PRU.01.2.13.VLIZ	5	GML Poly		10/08/1990	
Vanuatu Exclusive Economic Zone	PRU.01.2.13.VLIZ	6	GML Poly		31/12/1981	
Solomon Islands Exclusive Economic Zone	PRU.01.2.13.VLIZ	7	GML Poly		11/12/1990	
Micronesian Exclusive Economic Zone	PRU.01.2.13.VLIZ	8	GML Poly			
Nauruan Exclusive Economic Zone	PRU.01.2.13.VLIZ	9	GML Poly		08/12/1997	
Marshall Islands Exclusive Economic Zone	PRU.01.2.13.VLIZ	10	GML Poly			
Wake Island Exclusive Economic Zone	PRU.01.2.13.VLIZ	11	GML Poly			
Northern Mariana Islands and Guam Exclusive Economic Zone	PRU.01.2.13.VLIZ	12	GML Poly			
Taiwanese Exclusive Economic Zone	PRU.01.2.13.VLIZ	13	GML Poly			
Philippines Exclusive Economic Zone	PRU.01.2.13.VLIZ	14	GML Poly			

The values of the Indicator "salinity" are collected in the new file:

RU_ID_Namespace	RU_ID_LocalCode	GenericID	Name	Period	BeginLS	EndLS	PoliceObjective	Value
PRU.01.2.13.VLIZ	1	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	5
PRU.01.2.13.VLIZ	2	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	5
PRU.01.2.13.VLIZ	3	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	5
PRU.01.2.13.VLIZ	4	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	5
PRU.01.2.13.VLIZ	5	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	5
PRU.01.2.13.VLIZ	6	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	5
PRU.01.2.13.VLIZ	7	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	7
PRU.01.2.13.VLIZ	8	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	7
PRU.01.2.13.VLIZ	9	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	7
PRU.01.2.13.VLIZ	10	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	4
PRU.01.2.13.VLIZ	11	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	6
PRU.01.2.13.VLIZ	12	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	6
PRU.01.2.13.VLIZ	13	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	6
PRU.01.2.13.VLIZ	14	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	4
PRU.01.2.13.VLIZ	15	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	4
PRU.01.2.13.VLIZ	16	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	4
PRU.01.2.13.VLIZ	17	PI.25.1	Salinity	2000-2012	01/12/2012		Sea PH Control	4

Now it is possible to make a join of both files: Reporting Units and Salinity Indicator, since they share a common Identifier column (ReportingUnit ID NS + RU ID LocalCode)
Other Indicators can be also joined to the same Reporting Units

5 Building capacity among PEGASO partners

Capacity building within PEGASO is strictly related to the main objective of the project, namely: "Bridging science and decision making, enabling possibilities of thinking together, sharing the different knowledge from the different Mediterranean and Black Sea experiences and cultures, to build a set of common knowledge on ICZM as geared by the ICZM Protocol" (PEGASO DOW).

5.1. Training sessions for building a common SDI

To build a common and fully operational SDI, a training programme on how to develop and implement a geonode was organized. This consists in two different training activities. On one hand, an on-line course imparted through a **moodle platform** in which partners received training about SDI development and implementation, geonodes construction and data sharing following INSPIRE principles. On the other hand an attendance training course was organized with the local support of Flanders Marine Institute VLIZ, in Oostende (Belgium) where participants complemented the online training covering topics related to SDIs functions, geonodes development, interoperability issues and creation of web services. During this second training, trainees had the opportunity to put in practice the concepts and methods learnt during the on-line course, resolving specific doubts as well as sharing experiences within the Consortium.

The moodle e-learning platform was set up *ad hoc* for the PEGASO Consortium in order to develop an on-line course entitled "*PEGASO Spatial Data Infrastructure: training for geonode development*".
The course itself was divided in two phases: the first phase started on the 16th of April 2012 and for three months consisted on the overview of the main aspects to develop a local geonode (including practical exercises and theory). The second phase of the on-line course, from the 17th of September to the 8th of October 2012, consisted of an on-line workshop on how to build indicators through the SDI. In particular, the indicator "Aging of population" was chosen from the PEGASO indicators list (WP4) for this purpose. This practical exercise aimed to capacitate partners on how to build an indicator through the SDI, with special focus on key aspects such as the importance of data availability, issues related to the scale, resolution and quality of the results and the representation aspects (harmonization of the data, colour ramp, range of values).

The hands-on Training entitled "*Introduction and implementation of Spatial Data Infrastructures (SDI's)*", was organized in Oostende from the 22nd to the 25th of October 2012 and it was an excellent complement to the e-learning course. The target group was coastal professionals with GIS background, mainly from partner Institutions of PEGASO project that were interested in SDI issues and that wanted to develop a local geonode. The issues of the training dealt with the role of the geonodes and the needs in terms of resources (computer, software and human resources), difficulties and constraints, benefits, and the importance, components and functionalities of an SDI. For that purpose, further collaboration through the participation and synergies with partners involved in other similar projects (or those that have already developed an SDI or a geoportal) was considered a key issue for the success of the event.; in this sense the training course was carried out in collaboration with the International Oceanographic Data and Information Exchange Project Office (IODE), involving experts from the International Coastal Atlas Network (ICAN) and other relevant projects as enviroGRIDS (Anthony Lehmann and Karin Allenbach).

5.2. Training materials and methods

The training methodology consisted on a set of presentations (videos, power points, readings) and practical.

The moodle e-learning platform (Moodle is an abbreviation for Modular Object-Oriented Dynamic Learning Environment) is an open source e-learning platform, also known as a Course Management System, Learning Management System, or Virtual Learning Environment (VLE). Moodle has a set of features that are considered typical in an e-learning platform, besides some original innovations (like its filtering system) and is very similar to a learning management system. For the SDI e-learning training some of the Moodle typical features were activated and used in order to support trainees understanding the concepts(Online quiz and Wiki, Files upload and download, Grading) and further to enhance communication among participants (Discussion forum, Moodle instant messages, Online calendar and Online news and announcement).

The on-line material used during the training was composed by a set of documents regarding SDI aspects such as "First steps on building an SDI", "SDI in action", "GeoNetwork software to develop a geonode", among others. Apart from the theory aspects covered along the different modules, on the e-learning site a variety of tests and exercises were designed. These exercises were proved to allow the trainees commitment and the understanding of technical aspects. At the end of the course an amount of 72 questions including multiple choice, true/false and matching test were developed organized in 27 Dynamic exercises.

PEGASO Hands-on Training: "Introduction and implementation of Spatial Data Infrastructures (SDI's)". For the Oostende face-to-face training key documents were prepared: the "Harmonization Guidelines" needed for the construction of the indicators and its implementation on the SDI and the "Guidelines for building the PEGASO SDI". In addition a Polimedia Video was recorded explaining the functioning of the PEGASO viewer (available on the Polimedia Service at Universitat Autonoma de Barcelona: http://polimedia.uab.cat/#v_371)

The content of the training was related to the SDI's services and functionalities in the context of PEGASO:

Session	Day 1 (Introduction)	Day 2 (Configuring partner`s environment)	Day 3 (Using data from different SDI's for your own GIS application Group facilitation)	Day 4 (Creating a metadata and creating a geoportal)
09:00 h - 11:00 h	What is a SDI (components, benefits and challenges)	Introduction to GeoNetwork Catalogue and CSW: Installing an adapted version (to PEGASO) of the GeoNetwork software	Using data from different SDI's for your own GIS application	Metadata and the creation of Metadata records. Introduction to metadata Using the Geonetwork form & the INSPIRE web Form, Creating Services Metadata
11:00 h - 12:00 h	The PEGASO SDI: the why, how, what and demonstration	Introduction to GeoServer, WMS and WFS Installing Geoserver and activating WMS, WFS and other services (until 13:00)	Guidelines for publication and data harmonization PEGASO's data harmonization: definition of styles, symbols and scales.	
13:30 h - 14:30 h	SDI`s basic Services and functionalities: Discovery, View, Download, Processing	Practical exercises Spatial indicators for ICZM in the Mediterranean using Geoserver & Geonetwork : Publishing data to a WMS, Styling portrayals, transforming data, downloading data using WFS (from 14:00)	Practical exercise Data harmonization of selected spatial indicators for ICZM in the Mediterranean. Exercises on participatory tools and methods. Reflection of group interaction processes	Creation a Geoportal Internet: Resources for creating Web pages, Installing the Pegaso Geoportal (until 15:00)
14:30 h - 17:00 h	Use case of SDI`s focusing on the functionalities, basic technologies and standards used (ISO standards, OGC Standards, INSPIRE…) The EnviroGrids SDI The ICAN SDI the International Coastal Atlas Network			Practical exercise: exercise, creating a Web page for hosting a local SDI

Table 6. SDI practical course program

Following the master class, the workshop focussed on practical exercises on how to set up an SDI, using open source software, and working out a specific case related to ICZM.

A pre- and post-tests (in the frame of WP6 related to capacity building) were used to evaluate the knowledge gained from participants in both training courses and to evaluate whether the training was successful. The tests included different type of questions: open-ended questions, close-ended questions and Multiple Choice Questions (I.D. 6.1.10 Post evaluation training).

5.3. Results and outcomes

During the **SDI e-learning training** a total of 19 trainees were enrolled, belonging to 12 different Institutions (UNIVE, UNIGE, IUCN, DDNI, UMA5, UPO, MHI, HCMR, BSC PS, VLIZ, PLAN BLEU, NARSS) and 5 of them were involved in the CASES (North Adriatic Sea, Danube Delta, Al Hoceima Coast, Sevastopol Bay, Guria Coastal Region); in this sense the training allowed the participants, especially those involved in CASES, to understand concepts related to SDI functioning and implementation, to acquire the needed knowledge on how to implement a local geonode, aspects related to the recommended interoperable services, to represent thematic information and to create maps according to the coordinate reference system agreed in PEGASO, and further to share doubts and expectations about the specific implementation of the infrastructure in their CASES. The SDI e-learning training results were quite positive, trainees showed an active attitude in general but there was a significant decline in activity in the lasts weeks before its end. However, the analysis the final survey (evaluation test) showed that student's opinion about the course was positive.

During the **hands-on training** session in Oostende a total of 30 participants attended.
Participants were asked to fill in a pre and a post-evaluation questionnaire of the training related to aspects such as the need of SDI training course, the objective and structure of a SDI, the technical characteristics of SDI, the Datum used, the Interoperability of the data, the application open source used in the PEGASO SDI (GeoServer and GeoNetwork), the knowledge of the INSPIRE directive, the construction of metadata and the harmonization process. The SDI training was appreciated by the participants who demonstrated their willingness to implement a SDI or to use the information received to improve the existing ones. Furthermore, the majority of participants considered the content provided appropriate, interesting, feasible to reproduce at their own Institutions, and expressed a good opinion about the trainers, the methods used by the trainers and the overall structure of the course.

Annex I. Relevant metadata records (extracted from ISO19139).

Producing a good metadata record is very important to correctly document the layer and making it valuable for partners and potential 3rd party users. A metadata record should be detailed enough to let a previously uninformed user to be able to understand the contents of the layer and decide whether it can be useful for him.

The ISO 19139 standard proposes a huge set of metadata fields. In order simplify the process of metadata filling, a subset of fields is proposed and explained here:

Title: Should be precise and descriptive. Example: "PEGASO Land Cover Map 2000"
Abstract: A descriptive summary of the contents of the dataset. This summary should be understandable even for people not previously knowing the dataset
Creation, publication or revision date: This field is especially relevant if several revisions of the layer are expected to be produced, as it helps identifying which revision is documented on this metadata record.
Edition: This field can be used to specify the version of the dataset, in case a versioning system is in use (example: "v16", meaning version 16 of Corine Land Cover 2000 dataset).
Point of contact section: This section should make clear who should be contacted in order to get more information about the dataset. At least an email, a person name and/or an organization name should be filled.
Descriptive keywords: A list of keywords, separated by commas. At least one (or more) of the INSPIRE GEMET themes should be included as keyword (see Annex IV for available INSPIRE GEMET themes). One keyword from "PEGASO FP-7 project partners" thesaurus should be including indicating the partner publishing the dataset (see Annex V for a list of partner acronyms). It is also recommended to include one or more keywords from "ICZM protocol objectives" thesaurus (see Annex V), specially when publishing indicators. Additionally, other relevant keywords can be included. Example: "Land Cover, Land Use, PEGASO, MODIS", keyword type: "Theme").
Resource constraints (legal constraints, security constraints): Make use of "Use limitation", "Access constraints", "Use constraints" and "Other constraints" fields to clearly describe the usage and distribution terms for the dataset. These fields are really relevant, as they state whether the user can legally make a specific use of this dataset in the context of the project. Examples: "Free to use, modify and redistribute for any purpose", "Free to use, modify and redistribute for academic and non-commercial uses", "Requires a License from ESA", "It can be freely used, but it can not be redistributed without written permission from XX", "It can be freely used for any purpose as far as the source is credited using the following statement: '© 2013 PEGASO Projects, YOU ARE THE BEST'", etc.
Equivalent scale (vector data): The level of detail expressed as a scale factor, i.e. 10000 for a 1:10000 map.
Extent:

- **Temporal extent (reference date)**: the date or period of time covered by the contents of the dataset (example: "2000-1-1 to 2001-12-31" for Corine Land Cover year 2000).

- **Geographic extent**: Geographic area that is covered by the dataset, usually specified as the coordinates of a rectangle containing this area. Examples:

    - NASA Bluemarble satellite photo has a world-wide coverage, thus its extent is (-90, 90, -180, 180) (south latitude, north latitude, west longitude, east longitude).
    - Corine Land Cover 2000 covers the area of the following countries: Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia the former Yugoslavian Republic of, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom which translates to (27ºS, 72ºN , -25ºW, 45ºE).

Distribution information: In this section, the subsections "Transfer Options" and "Online resource" should be used to link the metadata to the dataset on the WMS, WFS, WCS and download services. See "Annex II. Expected codification for "Distribution Information" section on ISO19139 metadata records." for details on how to encode this links on the metadata.

Spatial representation , reso lution (for raster data): Ground sample distance, i.e. the centre-to-centre distance between adjacent spatial samples on the earth's surface. Example: 250 metres, 100 metres.
Reference system: The coordinate reference system (CRS) of the dataset (examples: WGS1984, ETRS89 LAEA). The preferred way to specify the CRS is by means of the EPSG [4] code, as it is an unambiguous, standardized way to specify all the parameters of the coordinate reference system in use. Examples: EPSG:4326 for WGS1984; ESPG:3035 for ETRS89 LAEA.
Data quality info, report and lineage: These fields should be used to describe the expected accuracy, uncertainty or computed error for the dataset. The lineage section should be used to describe the data sources (e.g. other layers, satellite sensors, etc) used to create the layer and the methodology or GIS steps performed on these data sources to produce the dataset.

We encourage you to fill other fields besides the ones explained here, if you feel they are useful for describing your layer.

[4] The EPSG Geodetic Parameter Dataset is a structured dataset of Coordinate Reference Systems and Coordinate Transformations, accessible through a data registry (http://www.epsg-registry.org/). It is maintained by Geodesy Subcommittee of OGP (International Association of Oil & Gas producers), formerly European Petroleum Survey Group.

Annex II. Expected codification for "Distribution Information" section on ISO19139 metadata records.

Download links

The download links should be documented on the CI_OnlineResource section of the metadata record.

- The URL of the downloadable resource should be placed of the 'linkage/url' subsections.
- The 'protocol' should start with the string "WWW:LINK-" and the 'function' section should contain 'download' on the codeListValue attribute.
- Alternatively, the 'protocol' should start with the string "WWW:DOWNLOAD-". In this case the 'function' section is optional.

Sample XML metadata fragment to document download links

```
<gmd:distributionInfo>
  <gmd:MD_Distribution>
    <gmd:transferOptions>
      <gmd:MD_DigitalTransferOptions>
        <gmd:onLine>
          <gmd:CI_OnlineResource>
            <gmd:linkage>

<gmd:URL>http://pegasosdi.uab.es/data/public/eea/clcv15/clc90/g100_90.zip</gmd:URL>
            </gmd:linkage>
            <gmd:protocol>
              <gco:CharacterString>WWW:LINK-1.0-http--link</gco:CharacterString>
            </gmd:protocol>
            <gmd:name>
              <gco:CharacterString>Raster 100m (GeoTiff)</gco:CharacterString>
            </gmd:name>
            <gmd:description gco:nilReason="missing">
              <gco:CharacterString/>
            </gmd:description>
            <gmd:function>
              <gmd:CI_OnLineFunctionCode
codeList="http://www.isotc211.org/2005/resources/codeList.xml#CI_OnLineFunctionCode"
codeListValue="download"/>
            </gmd:function>
          </gmd:CI_OnlineResource>
        </gmd:onLine>
      </gmd:MD_DigitalTransferOptions>
    </gmd:transferOptions>
  </gmd:MD_Distribution>
</gmd:distributionInfo>
```

WMS layer links

The links to the layer on WMS service should be documented on the CI_OnlineResource section of the metadata record.

- The URL of the WMS server should be placed of the 'linkage/url' subsections.
- The 'protocol' should be 'OGC:WMS'

- The ‘name’ section should contain the name of the layer in the WMS service.

Sample XML metadata fragment to document WMS links

```
<gmd:distributionInfo>
  <gmd:MD_Distribution>
    <gmd:transferOptions>
      <gmd:MD_DigitalTransferOptions>
        <gmd:onLine>
          <gmd:CI_OnlineResource>
            <gmd:linkage>
              <gmd:URL>http://pegasosdi.uab.es/ogc/wms</gmd:URL>
            </gmd:linkage>
            <gmd:protocol>
              <gco:CharacterString>OGC:WMS</gco:CharacterString>
            </gmd:protocol>
            <gmd:name>
              <gco:CharacterString>CLC1990v15_100m</gco:CharacterString>
            </gmd:name>
            <gmd:description gco:nilReason="missing">
              <gco:CharacterString/>
            </gmd:description>
          </gmd:CI_OnlineResource>
        </gmd:onLine>
      </gmd:MD_DigitalTransferOptions>
    </gmd:transferOptions>
  </gmd:MD_Distribution>
</gmd:distributionInfo>
```

WCS layer links

The links to the layer on WCS service should be documented on the CI_OnlineResource section of the metadata record.

- The URL of the WCS server should be placed of the ‘linkage/url’ subsections.
- The ‘protocol’ should be ‘OGC:WCS’
- The ‘name’ section should contain the name of the layer in the WCS service.
- The ‘description’ section should include the following text: ‘WCS Server: http://your-wcs-server-address (requires a WCS client to connect)’

Sample XML metadata fragment to document WCS links

```
<gmd:distributionInfo>
  <gmd:MD_Distribution>
    <gmd:transferOptions>
      <gmd:MD_DigitalTransferOptions>
        <gmd:onLine>
          <gmd:CI_OnlineResource>
            <gmd:linkage>
              <gmd:URL>http://pegasosdi.uab.es/ogc/wcs</gmd:URL>
            </gmd:linkage>
            <gmd:protocol>
              <gco:CharacterString>OGC:WCS</gco:CharacterString>
            </gmd:protocol>
```

```
            <gmd:name>
              <gco:CharacterString>CLC1990v15_100m</gco:CharacterString>
            </gmd:name>
            <gmd:description>
              <gco:CharacterString>WCS   Server:   http://pegasosdi.uab.es/ogc/wcs
(requires a WCS client to connect)</gco:CharacterString>
            </gmd:description>
          </gmd:CI_OnlineResource>
        </gmd:onLine>
      </gmd:MD_DigitalTransferOptions>
    </gmd:transferOptions>
  </gmd:MD_Distribution>
</gmd:distributionInfo>
```

WFS layer links

The links to the layer on WFS service should be documented on the CI_OnlineResource section of the metadata record.

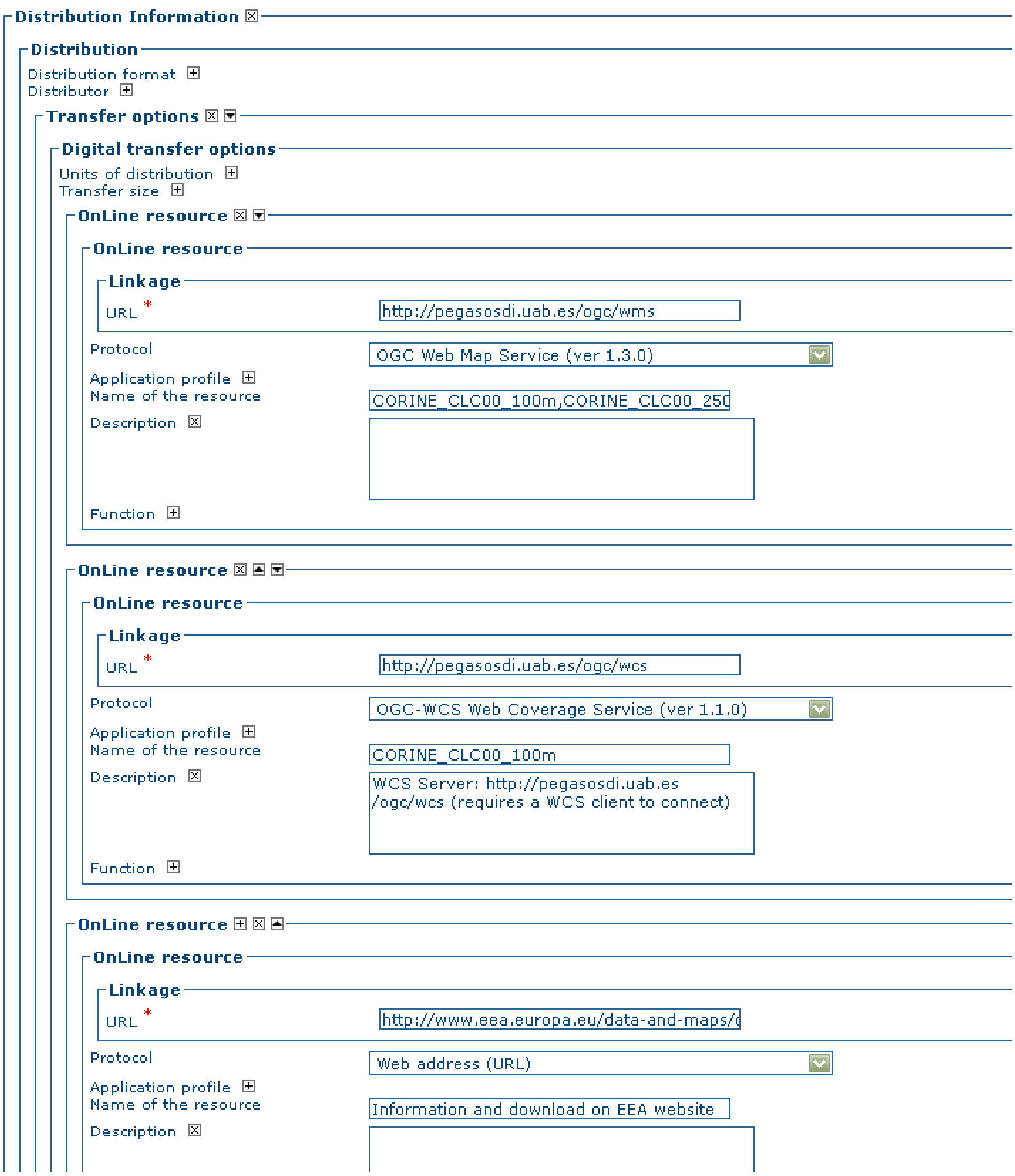
- The URL of the WFS server should be placed of the 'linkage/url' subsections.
- The 'protocol' should be 'OGC:WFS'
- The 'name' section should contain the name of the layer in the WFS service.
- The 'description' section should include the following text: 'WFS Server: http://your-wfs-server-address (requires a WFS client to connect)'

Sample XML metadata fragment to document WMS links

```
<gmd:distributionInfo>
  <gmd:MD_Distribution>
    <gmd:transferOptions>
      <gmd:MD_DigitalTransferOptions>
        <gmd:onLine>
          <gmd:CI_OnlineResource>
            <gmd:linkage>
              <gmd:URL>http://pegasosdi.uab.es/ogc/wfs</gmd:URL>
            </gmd:linkage>
            <gmd:protocol>
              <gco:CharacterString>OGC:WFS</gco:CharacterString>
            </gmd:protocol>
            <gmd:name>
              <gco:CharacterString>CLC1990v15_100m</gco:CharacterString>
            </gmd:name>
            <gmd:description>
              <gco:CharacterString>WFS   Server:   http://pegasosdi.uab.es/ogc/wfs
(requires a WFS client to connect)</gco:CharacterString>
            </gmd:description>
          </gmd:CI_OnlineResource>
        </gmd:onLine>
      </gmd:MD_DigitalTransferOptions>
    </gmd:transferOptions>
  </gmd:MD_Distribution>
</gmd:distributionInfo>
```

Creating this codification in GeoNetwork

GeoNetwork catalogue software provides a web interface to create metadata records following ISO19139 standard. The codification describing in the previous sections can be achieved by filling the appropriate fields on GeoNetwork interface, as show in the following snapshot:



Annex III. Metadata record linkage from WMS, WCS and WFS layer metadata.

For each layer published on WMS, WCS or WFS (WxS) services, it is possible to create a link to the layer metadata on PEGASO catalogue. It is strongly recommended to set up this link, which provides extended information for each layer. The link is configured differently depending on the map server (MapServer, GeoServer, etc) used to publish the layers. In any case, the following subsections illustrate the expected encoding of the link on a correctly configured mapserver.

Linkage from WMS service

The 'getCapabilities' request should include a MetadataURL section for each available layer, pointing to the metadata record of the layer on the metadata Catalogue.

Sample XML fragment for a WMS 1.3.0 getCapabilities response

```
<MetadataURL type="TC211">
  <Format>text/html</Format>
  <OnlineResource                                              xlink:type="simple"
xlink:href="http://pegasosdi.uab.es/catalog/srv/en/metadata.show?uuid=5d621310-
df0d-4e2f-aa4a-6f4f3e389ca1"/>
</MetadataURL>
```

Linkage from WCS service

The 'describeCoverage' request should include a Metadata section for each available layer, pointing to the metadata record of the layer on the metadata Catalogue.

Sample XML fragment for a WCS 1.1 describeCoverage response

```
<CoverageSummary>
  <ows:Metadata
xlink:href="http://pegasosdi.uab.es/catalog/srv/en/metadata.show?uuid=5d621310-
df0d-4e2f-aa4a-6f4f3e389ca1"/>
  [ . . .]
</CoverageSummary>
```

Sample XML fragment for a WCS 1.0 describeCoverage response

```
<CoverageOffering>
  <metadataLink              metadataType="TC211"              xlink:type="simple"
xlink:href="http://pegasosdi.uab.es/catalog/srv/en/metadata.show?uuid=5d621310-
df0d-4e2f-aa4a-6f4f3e389ca1"/>
 [ . . .]
</CoverageOffering>
```

Linkage from WFS service

The 'getCapabilities' request should include a MetadataURL section for each available layer, pointing to the metadata record of the layer on the metadata Catalogue.

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Sample XML fragment for a WFS 1.1 getCapabilities response

```
<FeatureType>
  [ . . . ]
  <MetadataURL format="text/html" type="TC211">
    http://pegasosdi.uab.es/catalog/srv/en/metadata.show?uuid={EE82258F-97AC-4B36-
BB70-12348632AF1F}
  </MetadataURL>
  [ . . . ]
</FeatureType>
```

Sample XML fragment for a WFS 2.0 getCapabilities response

```
<FeatureType xmlns:bo="http://www.BlueOx.org/BlueOx">
  [ . . . ]
  <MetadataURL
xlink:href="http://pegasosdi.uab.es/catalog/srv/en/metadata.show?uuid={EE82258F-
97AC-4B36-BB70-12348632AF1F}"/>
  [ . . . ]
</FeatureType>
```

Annex IV. Inspire GEMET themes

List of Inspire Spatial Data Themes (34 themes) and their definition:

Addresses: Location of properties based on address identifiers, usually by road name, house number, postal code.

Administrative units: Units of administration, dividing areas where Member States have and/or exercise jurisdictional rights, for local, regional and national governance, separated by administrative boundaries.

Agricultural and aquacultu re facilities: Farming equipment and production facilities (including irrigation systems, greenhouses and stables).

Area management/restriction/regulation zones and reporting units: Areas managed, regulated or used for reporting at international, European, national, regional and local levels. Includes dumping sites, restricted areas around drinking water sources, nitrate-vulnerable zones, regulated fairways at sea or large inland waters, areas for the dumping of waste, noise restriction zones, prospecting and mining permit areas, river basin districts, relevant reporting units and coastal zone management areas.

Atmospheric conditions: Physical conditions in the atmosphere. Includes spatial data based on measurements, on models or on a combination thereof and includes measurement locations.

Bio-geographical regions: Areas of relatively homogeneous ecological conditions with common characteristics.

Buildings: Geographical location of buildings.

Cadastral parcels: Areas defined by cadastral registers or equivalent.

Coordinate reference systems: Systems for uniquely referencing spatial information in space as a set of coordinates (x, y, z) and/or latitude and longitude and height, based on a geodetic horizontal and vertical datum.

Elevation: Digital elevation models for land, ice and ocean surface. Includes terrestrial elevation, bathymetry and shoreline.

Energy resources: Energy resources including hydrocarbons, hydropower, bio-energy, solar, wind, etc., where relevant including depth/height information on the extent of the resource.

Environmental monitoring facilities: Location and operation of environmental monitoring facilities includes observation and measurement of emissions, of the state of environmental media and of other ecosystem parameters (biodiversity, ecological conditions of vegetation, etc.) by or on behalf of public authorities.

Geographical grid systems: Harmonized multi-resolution grid with a common point of origin and standardised location and size of grid cells.

Geographical names: Names of areas, regions, localities, cities, suburbs, towns or settlements, or any geographical or topographical feature of public or historical interest.

Geology: Geology characterised according to composition and structure. Includes bedrock, aquifers and geomorphology.

Habitats and biotopes: Geographical areas characterised by specific ecological conditions, processes, structure, and (life support) functions that physically support the organisms that live there. Includes terrestrial and aquatic areas distinguished by geographical, abiotic and biotic features, whether entirely natural or semi-natural.

Human health and safety: Geographical distribution of dominance of pathologies (allergies, cancers, respiratory diseases, etc.), information indicating the effect on health (biomarkers, decline of fertility, epidemics) or well-being of humans (fatigue, stress, etc.) linked directly (air pollution, chemicals, depletion of the ozone layer, noise, etc.) or indirectly (food, genetically modified organisms, etc.) to the quality of the environment.

Hydrography: Hydrographic elements, including marine areas and all other water bodies and items related to them, including river basins and sub-basins. Where appropriate, according to the definitions set out in Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (2) and in the form of networks.

Land cover: Physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies.

Land use: Territory characterised according to its current and future planned functional dimension or socio-economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational).

Meteorological geographical features: Weather conditions and their measurements; precipitation, temperature, evapotranspiration, wind speed and direction.

Mineral resources: Mineral resources including metal ores, industrial minerals, etc., where relevant including depth/height information on the extent of the resource.
Natural risk zones: Vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions.
Oceanographic geographical features: Physical conditions of oceans (currents, salinity, wave heights, etc.).
Orthoimagery: Geo-referenced image data of the Earth's surface, from either satellite or airborne sensors.
Population distribution — demography: Geographical distribution of people, including population characteristics and activity levels, aggregated by grid, region, administrative unit or other analytical unit.
Production and industrial facilities: Industrial production sites, including installations covered by Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (1) and water abstraction facilities, mining, storage sites.
Protected sites: Area designated or managed within a framework of international, Community and Member States' legislation to achieve specific conservation objectives.
Sea regions: Physical conditions of seas and saline water bodies divided into regions and sub-regions with common characteristics.
Soil: Soils and subsoil characterised according to depth, texture, structure and content of particles and organic material, stoniness, erosion, where appropriate mean slope and anticipated water storage capacity.
Species distribution: Geographical distribution of occurrence of animal and plant species aggregated by grid, region, administrative unit or other analytical unit.
Statistical units: Units for dissemination or use of statistical information.
Transport networks: Road, rail, air and water transport networks and related infrastructure. Includes links between different networks. Also includes the trans-European transport network as defined in Decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community Guidelines for the development of the trans-European transport network (1) and future revisions of that Decision.
Utility and governmental services: Includes utility facilities such as sewage, waste management, energy supply and water supply, administrative and social governmental services such as public administrations, civil protection sites, schools and hospitals.

Source: GEMET - INSPIRE themes, version 1.0, 2008-06-01 (http://www.eionet.europa.eu/gemet/inspire_themes?langcode=en)

Annex V. PEGASO keyword thesauri.

Based on specific information described in the indicator factsheets regarding policy objectives, we have decided to define an easy controlled vocabulary (thesaurus) to be employed when you create the metadata (keywords, within *Identification* section) for your PEGASO datasets either in your catalogue or in the central SDI catalogue.

Thesaurus name: "ICZM protocol objectives".

ICZM Articles	*Sections*		*Keywords*
Article 5		Description of ICZM OBJECTIVES	
	Article 5.a		
		facilitate, through the rational planning of activities, the sustainable development of coastal zones by ensuring that the environment and landscapes are taken into account in harmony with economic, social and cultural development	ICZM Objective A
	Article 5.b		
		preserve coastal zones for the benefit of current and future generations	ICZM Objective B
	Article 5.c		
		ensure the sustainable use of natural resources, particularly with regard to water use	ICZM Objective C
	Article 5.d		
		ensure preservation of the integrity of coastal ecosystems, landscapes and geomorphology	ICZM Objective D
	Article 5.e		
		prevent and/or reduce the effects of natural hazards and in particular of climate change, which can be induced by natural or human activities	ICZM Objective E
	Article 5.f		
		Achieve coherence between public and private initiatives and between all decisions by the public authorities, at the national, regional and local levels, which affect the use of the coastal zone	ICZM Objective F

Thesaurus name: "PEGASO FP-7 project partners".

Keywords	*PEGASO partner*
UAB	The University Autonomous of Barcelona
UNOTT	The University of Nottingham
UNIVE	Universita Ca'Foscari Di Venezia
VLIZ	Vlaams Instituut Voor De Zee
HCMR	Hellenic Centre for Marine Research
UOB	University of Balamand

NARSS	National Authority for Remote Sensing and Space Sciences
IBSS	Institute of Biology of the Southern Seas
MHI	Marine Hydrophysical Institute-Ukrainian National Academy of Sciences

One of the main benefits of this approach is:

- to perform customized (filtered) search queries on metadata discovery from the catalogue
- to perform a keyword-based filter to load a dataset from the WMS viewer

When using these thesauri for metadata creation, **the thesaurus name should be included in the metadata** together with one or more keywords belonging to this thesaurus. This enables thesaurus based keyword filtering.

Annex VI: Summary of the Training Materials (UPO)

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UNIVERSIDAD PABLO DE OLAVIDE SEVILLA

Course: PEGASO Spatial Data Infrastructure: training for geonode development

E-LEARNING:	Web supplemented via Moodle E-Learning Platform
TEACHING STAFF RESPONSIBLE FOR COURSE	Pablo Fernandez-Moniz; Emllia Guisado; Gonzalo Malvarez;
ACADEMIC SUBJECT:	Geographic Information Technologies

RATIONALE: PEGASO's Description of Work document introduces the relevance and responsibility for the implementation of a Spatial Data Infrastructure. This task (3.2), consists in the development and implementation of participants' geonodes for PEGASO's SDI. In order to build a geonode in each organization, this short course aims at the development of capacities at a basic level for partners involved in the project to achieve the complete implementation of their geonodes. The provision of the E-learning based course is a first step in the capacity building plan in WP3 which will be completed in the hands on practical course in Oostende in October 2012.

Course CONTENT AND STRUCTURE

Module 1: First steps on the SDI

In this module a general introduction to the SDI, the methodology of the training course and the schedule is provided. An overview of the importance and role of SDI in PEGASO project will be analysed, focusing later on the use of the Inspire Directive in the European context. Further, the PEGASO data Harmonization guidelines will be discussed, and finally we will learn how to use OGC standards and Metadata specification.

1.1 Start up of the SDI training. From 16th April to 30th April.

Week 1: SDI training start up.Welcome to SDI training.

Week 2: SDI Importance: Why using SDI?. Importance of sharing our data and the contextualization with the Inspire directive. Contextualization of the SDI in PEGASO project and usefulness.

1.2 Introduction to SDI and Geographic data. From 30th April to 14th May

Week 2: Data harmonization and structure in PEGASO.OGC and services: What is OGC and its standards. Services available.

Week 3: How to connect to SDI servers. Installation of a desktop GIS and loading different services (WMS, WFC and WCS). How to use a light client. Metadata in Geographic information. Standards for geospatial metadata: the baseline ISO 19115; ISO 19139 for implementation of data metadata and the ISO 19119 for services metadata.

Course: PEGASO Spatial Data Infrastructure: training for geonode development

Module 2: SDI in action. From 14th May to 29th June

This module will be based on GeoServer functionality. To start, some issues about internet communication will be discussed to achieve knowledge about these tools. Further, a revision of the state of the art and availability of Map Servers software will be made, and finally we will learn how they work. The module will end with the provision of the capacity on how to set up the environment configuration and the variety of services on GeoServer: WMS, WFS and WCS.

2.1 GeoServer installation.

Week 4 and 5: How does GeoServer work? GeoServer installation in our localhost

2.2 Setting up a WMS service.

Week 6 and 7: Setting up a WMS service.

2.3 Setting up a WFS service.

Week 7 and 8: Setting up a WFS service.

2.4 Setting up a WCS service.

Week 9 and 10: Setting up a WCS service.

Module 3: Integrating our SDI with all partners. GeoNetwork. From 2nd July to 15th July

Through this module we will demonstrate how to explore data on GeoNetwork (the software used by the PEGASO SDI), to continue with the knowledge of how to fill metadata (create the metadata information needed for the SDI). Finally, a full training in how to connect and share our SDI will be provided.

Week 11 and 12: Integrating our data on GeoNetwork. Methodology to share our data with other partners. Metadata in GeoNetwork.

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UAB Universitat Autònoma de Barcelona

Flanders Marine Institute

IODE

PEGASO Hands-on Training: Introduction and implementation of Spatial Data Infrastructures (SDI's)

WP3: Training on the SDI, 22 – 25 October 2012
UNESCO/IOC Project Office for IODE
Wandelaarkaai 7/61,
B-8400 Oostende, Belgium

Agenda

MONDAY, 22 October 2012 – Introduction

09:00 – 09:20	Registration
09:20 – 09:30	**Welcome** *Claudia Delgado (IOC Project Office for IODE)*
09:30 – 10:30	**General introduction to SDI's** **What is a SDI= Components, benefits and challenges** *Prof Dr. Gonzalo Malvárez (UPO)*
10:30 – 11:00	Coffee break
11:00 – 12:30	**The PEGASO SDI: the why, how, what and a demonstration** *Juan Pedro Pérez-Alcántara (UPO)*
12:30 – 13:30	Lunch
13:30 – 14:15	**SDI's basic Services and functionalities: Discovery, View, Download, Processing** *Juan Pedro Pérez-Alcántara (UPO)*
14:30 – 15:15	**Case study of SDI's focusing on the functionalities, basic technologies and standards used (ISO standards, OGC Standards, INSPIRE...)** **The EnviroGrids SDI** *Prof. Dr. Anthony Lehman (UniGe)*
15:15 – 15:45	Coffee break
15:45 – 16:30	**Case study of SDI's focusing on the functionalities, basic technologies and standards used (ISO standards, OGC Standards, INSPIRE...)** **The ICAN SDI, the International Coastal Atlas Network** *Dr. Yassine Lassoued (ICAN)*
16:30-18:00	Welcome reception and free evening

TUESDAY, 23 October 2012 – Configuring partner's environment

09:00 – 10:30	**Introduction to GeoNetwork Catalogue and CSW** **Installing an adapted version (to PEGASO) of the GeoNetwork software** *Yassine Lassoued (ICAN)*
10:30 – 11:00	Coffee break
11:00 – 12:30	**Introduction to GeoServer, WMS and WFS** **Installing GeoServer and activating WMS, WFS and other services** *César Martínez (UAB) & Jorge López Pérez (UAB)*
12:30 – 13:30	Lunch
13:30 – 15:00	**Practical exercise** **Data harmonization of selected spatial indicators for ICZM in the Mediterranean** *César Martínez (UAB)*
15:00 – 15:30	Coffee break
15:30 – 17:00	**Discussion on** **Data harmonization of selected spatial indicators for ICZM in the Mediterranean** *Chaired by Prof Dr. Gonzalo Malvárez (UPO)*
19:00	Dinner at seaside of Oostende

WEDNESDAY, 24 October 2012 – Using and sharing data

09:00 – 10:30	**Using data from different SDI's for your own GIS application** *Nathalie De Hauwere (VLIZ)*
10:30 – 11:00	Coffee break
11:00 – 12:30	**Guidelines for publication and data harmonization PEGASO's data harmonization: definition of styles, symbols and scales** *César Martínez (UAB)*
12:30 – 13:30	Lunch
13:30 – 15:00	**Practical exercises** **Spatial indicators for ICZM in the Mediterranean using GeoServer & GeoNetwork : Publishing data to a WMS, Styling portrayals, transforming data, downloading data using WFS** *César Martínez (UAB)*
15:00 – 15:30	Coffee break
15:30 – 17:00	**Practical exercises** **Spatial indicators for ICZM in the Mediterranean using GeoServer & GeoNetwork : Publishing data to a WMS, Styling portrayals, transforming data, downloading data using WFS** *César Martínez (UAB)*

18:00	'Amuse-gueule' sightseeing in Oostende

Thursday, 25 October 2012 – Creating metadata & creating a geoportal

09:00 – 09:30	**Metadata and the creation of Metadata records** **Introduction to metadata** *Simon Claus (VLIZ)*
09:30 – 10:30	**Metadata and the creation of Metadata records** **Using the INSPIRE web Form** *Nathalie De Hauwere (VLIZ)*
10:30 – 11:00	Coffee break
11:00 – 12:30	**Metadata and the creation of Metadata records** **Using the GeoNetwork form** **Creating Services Metadata** *Nathalie De Hauwere (VLIZ)*
12:30 – 13:30	Lunch
13:30 – 15:00	**Creating a Geoportal** **Internet resources for creating Web pages** **Installing the Pegaso Geoportal** *César Martínez (UAB) & Jorge López Pérez (UAB)*
15:00 – 15:30	Coffee break
15:30 – 17:00	**Practical exercise:** **Exercise, creating a Web page for hosting a local SDI** *César Martínez (UAB) & Jorge López Pérez (UAB)*
17:00	End of the training course

Annex VII. List of PEGASO indicators and codes.

CODE	FACTSHEET NAME	SUBCODE	DERIVED INDICATOR
01	Added value per sector		
02	Area of built-up space	*01*	*Percentage of change in built-up space by 0-10 km buffer in year X compared to year Y*
		02	*Percentage of built-up space by 0-10 km buffer at year X by NUTS3*
		03	*Percentage of change in built-up space by 0-1 km buffer in year X compared to year Y*
		04	*Percentage of change in built-up space by 0-10 km buffer in year X compared to year Y*
03	Bathing water quality		
04	Commercial fish stocks		
05	Coastal and marine litter		
06	Economic Production		
07	Employment		
08	Erosion and instability		
09	Natural capital	*01*	*Number of habitat types by conservation status category*
		02	*Number of species by conservation status category*
		03	*Percentage of habitat types within each category of conservation status (proportional of total number of habitat types)*
		04	*Percentage of species within each category of conservation status (proportional of total number of habitat types)*
10	Hypoxia		
11	Number of enterprises		
12	Population size and density	*01*	*Number of inhabitants per km^2 (population density) in municipality units in year X*
		02	*Number of inhabitants per km^2 as a proportion of total population of NUTS3 region*
		03	*Percentage of change in number of inhabitants in year X compared to year Y (difference in 10 year periods)*
13	Risk assessment		
14	Sea level rise		
15	Water efficiency index		

Table 1: List of indicators and codes

An indicator can be composed of one or more values per reporting unit. For instance, indicator PI.12.01 "**Number of inhabitants per km2 (population density) in municipality units in year X**" will have a single value (number of inhabitants) per municipality, while indicator PI.09.01 "**Number of habitat types by conservation status category**" will have at least four values per protected area: number of habitat types having a favorable status, number of habitat types having a unfavorable - inadequate status, number of habitat types having an unfavorable - bad status and finally number of habitat types having an unknown status. Therefore, in order to harmonize the production of the indicators, these values should be codified using a predefined scheme, as illustrated on Table 2:

INDICATO	VALUE CODE	FIELD NAME	VALUE DESCRIPTION

R			
PI.02.01	VL1	VALUE	*Percentage of change in built-up space by 0-10 km buffer in year X compared to year Y*
PI.02.02	VL1	VALUE	*Percentage of built-up space by 0-10 km buffer at year X by NUTS3*
PI.02.03	VL1	VALUE	*Percentage of change in built-up space by 0-1 km buffer in year X compared to year Y*
PI.02.04	VL1	VALUE	*Percentage of change in built-up space by 0-10 km buffer in year X compared to year Y*
PI.09.01	VL1	VL_HAB_CS1	*Number of habitat types having a favourable conservation status*
PI.09.01	VL2	VL_HAB_CS2	*Number of habitat types having an unfavourable - inadequate conservation status*
PI.09.01	VL3	VL_HAB_CS3	*Number of habitat types having an unfavourable – bad conservation status*
PI.09.01	VL4	VL_HAB_CS4	*Number of habitat types having an unknown conservation status*
PI.09.02	VL1	VL_SPE_CS1	*Number of species having a favourable conservation status*
PI.09.02	VL2	VL_SPE_CS2	*Number of species having an unfavourable - inadequate conservation status*
PI.09.02	VL3	VL_SPE_CS3	*Number of species having an unfavourable – bad conservation status*
PI.09.02	VL4	VL_SPE_CS4	*Number of species having an unknown conservation status*
PI.09.03	VL1	VL_HAB_CS1	*Percentage of habitat types having a favourable conservation status*
PI.09.03	VL2	VL_HAB_CS2	*Percentage of habitat types having an unfavourable - inadequate conservation status*
PI.09.03	VL3	VL_HAB_CS3	*Percentage of habitat types having an unfavourable – bad conservation status*
PI.09.03	VL4	VL_HAB_CS4	*Percentage of habitat types having an unknown conservation status*
PI.09.04	VL1	VL_SPE_CS1	*Percentage of species having a favourable conservation status*
PI.09.04	VL2	VL_SPE_CS2	*Percentage of species having an unfavourable - inadequate conservation status*
PI.09.04	VL3	VL_SPE_CS3	*Percentage of species having an unfavourable – bad conservation status*
PI.09.04	VL4	VL_SPE_CS4	*Percentage of species having an unknown conservation status*
PI.12.01	VL1	VALUE	*Number of inhabitants per km^2 (population density) in municipality units in year X*
PI.12.02	VL1	VALUE	*Number of inhabitants per km^2 as a proportion of total population of NUTS3 region*
PI.12.03	VL1	VALUE	*Percentage of change in number of inhabitants in year X compared to year Y (difference in 10 year periods)*

Table 2: Field codes, names and descriptions per indicator value

Source documents and references

I.D.3.2.1. Guidelines for building PEGASO SDI

I.D. 3.2.1.B Harmonization guidelines

Geonodes interconnection

Results from Internal reports about geonodes status

Training material for Oostende and e-learning course

Results from pre and post doc test

Coleman, D.J. and McLaughlin, J. 1998, Defining global geospatial data infrastructure (GGDI): components, stakeholders and interfaces, Geomatica, Canadian Institute of Geomatics, 52(2): 129-144.

GSDI, 2004. Spatial Data Infrastructure Cookbook v. 2.0. Global Spatial Data Infrastructure Association, viewed on 16 December 2004, http://www.gsdi.org/gsdicookbookindex.asp.

Masser I. (2005) The Future of Spatial Data Infrastructures, ISPRS Workshop on Service and Application of Spatial Data Infrastructure, Oct.14-16, Hangzhou, China, 9p.
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Phillips A., Williamson I., Ezigbalike C. (1999) Spatial Data Infrastructure Concepts, The Australian Surveyor, Vol.44 No1, p20-28
http://www.sli.unimelb.edu.au/research/publications/IPW/SDIDefinitionsAusSurv.html,

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Rajabifard A. and Williamson I.P. (2001) Spatial Data Infrastructures: Concept, SDI Hierarchy and Future directions, in Proceedings, of GEOMATICS□80 Conference, Tehran, Iran., 10p.
http://repository.unimelb.edu.au/10187/1247

Ryttersgaard J. (2001) Spatial Data Infrastructure, Developing Trends and Challenges, International Conference on Spatial Information for Sustainable Development Proceedings, Nairobi, 8p.
http://www.fig.net/pub/proceedings/nairobi/ryttersgaard-TS1-1.pdf

UNGIWG (2007) UNSDI Compendium - A UNSDI Vision, Implementation Strategy and Reference Architecture, 150p.
http://www.ungiwg.org/docs/unsdi/UNSDI_Compendium_13_02_2007.pdf

UNECA (2005) SDI Africa: An Implementation Guide, 120p.
http://geoinfo.uneca.org/sdiafrica/default1.htm

Draft documents from INSPIRE:
INSPIRE Data Specification on *Area management/restriction/regulation zones and reporting units*. D2.8.III.11_v2.0 / 2011-06-20
INSPIRE Data Specification on *Statistical units*. D2.8.III.1_v 2.0 / 2011-06-20
INSPIRE Data Specification on *Population Distribution – Demography*. D2.8.III.10_v 2.0.1 / 2011-07-13
INSPIRE Data Specification on *Sea Regions*. D2.8.III.16_v2.0 / 2011-06-20
INSPIRE Data Specification on *Habitats and Biotopes*. D2.8.III.18_v2.0 / 2011-06-15
INSPIRE Data Specification on *Bio-Geographical Regions*. D2.8.III.17_v2.0 / 2011-06-15
INSPIRE Specification on *Geographical Grid Systems.* IS-GGS – v3.0

Other Documents:
http://epp.eurostat.ec.europa.eu/portal/page/portal/gisco_Geographical_information_maps/geodata/reference
Deliverable D.3.1. "*Report on the inventory of Participants and main relevant EU Projects data and SDI, with a Quality assessment and identification for needed actions on harmonization tasks*". Available on the intranet Link to the document

Villa, P., Reitz, T., Gomarasca, M.: The HUMBOLDT project for data harmonization in the framework of GMES and ESDI: Introduction and early achievements. International Society for Photogrammetry and Remote Sensing - Proceedings of Commission IV. S. 1741 - 1746. , Beijing, China (2008).