MarSP
Macaronesian Maritime Spatial Planning

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DATA SPECIFICATION FOR MARITIME SPATIAL PLANNING INSPIRE DATA MODEL

MarSP Deliverable:D.5.1

December 2019

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Coordinated by
Governo dos Açores
FRCT

Funded by
This project was co-funded by the European Maritime and Fisheries Fund Under the Grant Agreement EASME/EMFF/2016/1.2.1.6/03/SI2.761306

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Região Autónoma da Madeira
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Universidad de Las Palmas de Gran Canaria
ECOAQUA

WP name	MSP data interoperability and MSP Platforms
Task name	Database interoperability
Deliverable Name	Data specification for Maritime Spatial Planning INSPIRE data model
Due Date of deliverable	June 2018
Actual submission Date	December 2019
Citation	Abramic A, Garcia A, Tello Antón O, Agudo LM, Bruque Carmona G, Zanella A, Norton C, Haroun R. 2019. Data specification for Maritime Spatial Planning INSPIRE data model. Deliverable - D.5.1., under the WP5 of *MarSP: Macaronesian Maritime Spatial Planning* project (GA nº EASME/EMFF/2016/1.2.1.6/03SI2.763106).

Document Information	
Document Name	Data specification for Maritime Spatial Planning INSPIRE data model
Document ID	C-3PO - D.5.1
Version	1.0
Version Date	19/12/2019
Author(s)	Andrej Abramic, Alejandro Garcia , Olvido Tello Anton, Luis Miguel Agudo, Gerardo Bruque Carmona, Andrea Zanella, Conor Norton, R. Haroun
Dissemination Level:	Public

Summary

Macaronesian Maritime Spatial Planning (MarSP) project was a perfect opportunity to finalize conceptual MSP INSPIRE data model development and, what is more important, to test developed data model and apply it on the real use cases, developed in the Macaronesia MSP process. During the 2nd MarSP technical workshop – capacity building, held in March 2019, the developed MSP data model was discussed and tested during the "hands on" session, together with GIS and MSP experts.
Finally, the developed data model data specification & guidance document, templates and example (Draft of MSP Madeira) are delivered to facilitate application of the delivered solution.

This document is expected to be modified and adapted so that it can be used by GIS users of any level of expertise.

Executive Summary

The Maritime Spatial Planning (MSP) INSPIRE data model concept has been developing from 2014, applying *Infrastructure for spatial information in Europe Directive 2007/2/EC* (INSPIRE) data management concepts for marine planning, through the Marine Pilot project (EC Joint Research Centre 2014-2016) and continuing with the PLASMAR project (INTERREG–V 2017-2020). The results and findings delivered have been published in the paper "**Maritime spatial planning supported by infrastructure for spatial information in Europe (INSPIRE)**" (Abramic et al., 2018). This study analyses how and if the use of INSPIRE data model can support and benefit data management processes, and provide overall support to Maritime Spatial Planning process and implementation of the requirement of the Directive 2014/89/EU. In particular, this research discusses whether the INSPIRE standard for spatial planning (the so-called data model) includes all of the components required for the implementation of the MSP process, or if there is a need for an extension, and/or additional data modelling.

Currently, **there are difficulties in harmonising products, visions, maps and frameworks of maritime spatial plans delivered by countries sharing the same marine (sub)region**. This is mainly due to the fact that maritime plans do not use a common symbology and data structure to describe maritime activities. A solution for this issue is to apply on a marine spatial plans data basis, with INSPIRE standards on data sets, layers and portrayals.

The Macaronesian Maritime Spatial Planning (MarSP) project was a perfect opportunity to finalise conceptual data model development and, what is more important, to test developed data model applying it on the real use cases, developed in the Macaronesia MSP process.

Initially, the INSPIRE data model for terrestrial planning (*Planned Land Use*) was tested to see if it could be applied to MSP. Tests pointed out that the terrestrial data model is robust, and can map MSP's, but it tends to lose detail and specific information on marine uses. To be used for MSP, the *Planned Land Use* data model needs to be adapted for planning of the maritime activities in the marine space.

The INSPIRE *Planned Land Use* data model was extended to cover the requirements of MSP, adding new specific attributes, enabling new specific code lists - including specific and detail classification on marine uses.

Finally, three MSP INSPIRE data model templates are delivered:

1. The INSPIRE complex data model - XML Schema Definition for *gml* INSPIRE compliant file (Expert level);
2. The INSPIRE flat data model – GeoPackage template – (GIS user); and
3. *The INSPIRE- like* flat data model – shp file template – (rookie GIS user).

The MSP data model was discussed and tested by GIS and MSP experts during 2nd MarSP technical workshop, held in March 2019. During this two-day workshop participants had a chance to test the data model during the "hands on" session, applying it to a real world case, and discussing and proposing modifications for the final MSP data model product. **The draft of the MSP Madeira, published as a first INSPIRE compliant Maritime Spatial Plan was used for this 'hands on' component**.

The data model and related products are available at theCanaries MSP platform, in the tool section:

http://www.geoportal.ulpgc.es/marsp/

Data Specification on Land Use D2.8.III.4_v3.0. was used as a base of the development of this data specification.

Content

Maritime Spatial Planning and need for the data model

Data needed for the MSP process are diverse by definition, including different domains, geographical areas, spatial and temporal scales, quality and completeness of description, availability, and re-use potential. Further, data availability varies within the EU regions due to differences in applied data management around data infrastructures, documentation (specifications) and metadata catalogues. Issues and needs related to harmonised data and metadata, available within standardised data flows (Barbanti et al., 2015) have been highlighted by most international pilot projects. MSP processes require information in the cross border context. The cross border data management issue is not a new topic in Europe and it is expected by many to be overcome with the development of the Infrastructure for Spatial Information in European Community (INSPIRE), European binding data initiative (Directive, 2007/2/EC). Using standards for data modelling and network services, INSPIRE aims to overcome data heterogeneity issues, to enable cross-border data and information integration and to foster the development of common European data flows. In a nutshell, INSPIRE aims to improve access, re-use, harmonisation and sharing of high quality spatial data (including coastal, marine, and maritime data) held by the public sector, in support to the implementation of EU environmental policies, as well as of policies or activities that may have an impact on the environment.

Directive 2014/89/EU requires Member States to establish maritime spatial plans, covering the spatial and temporal distribution of relevant existing and future activities, before 2021. Plans in digital format are not regulated within the MSP Directive, but it clearly falls under the umbrella of INSPIRE and the related Commission Regulation No. 1089/2010 on the interoperability of spatial data sets. This regulation provides specific requirements in relation to the digital plans, shared data interoperability and spatial planning data model.

Currently, there are difficulties in harmonising the vision and frameworks of maritime spatial plans of countries sharing the same marine region or sub-region, beyond national EEZ areas, even in the most advanced European examples (Figure 1).

This is mainly as developed plans do not use harmonised data models, standard rules for layers and styles for portrayal of the spatial object types delivered in the spatial plan. The issues identified and reported during the implementation of the various joint European maritime planning initiatives and pilot projects, could potentially be resolved by applying INSPIRE standards on data sets, layers and portrayal of marine spatial plans. This will assist in harmonising and integrating the spatial plans for marine (sub)basins of different member states, particularly around consistency and quality of data sets and it will reduce the overlapping and unnecessary efforts in this area.

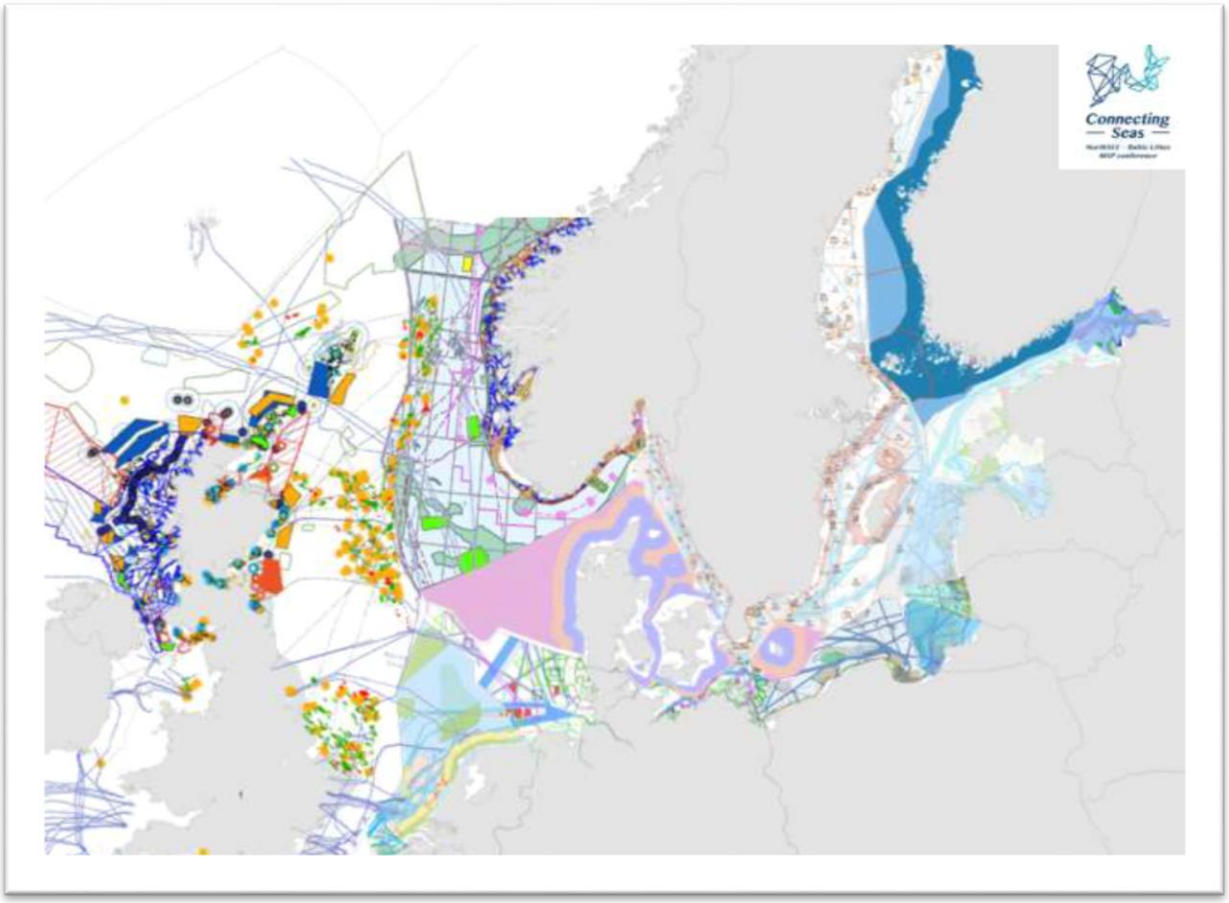


*Figure 1 - Atlantic, North Sea and Baltic MSP initiatives presented using heterogeneous portrayals, colours, geometry, data models (*Presented by Kai Trümpler*, Connecting Seas Conference*. 13-14 February 2019. Hamburg, Germany *).*

In the development of the INSPIRE *Planned Land Use data model*, as specified in the Technical Guidelines document on "*INSPIRE Data Specification on Land Use*" the uses and planning of the sea were considered, but not elaborated in detail. Based on the INSPIRE *Planned Land Use data model,* the MSP data model concept has been in development since 2014, applying INSPIRE data management concepts for marine planning and data, through the **Marine Pilot project (EC Joint Research Centre 2014-2016)** and continuing with the **PLASMAR** project **(INTERREG–V 2017-2020)**. The **MarSP project** was a perfect opportunity to finalise data model development, to test results on a real world case study developed for Macaronesia.

INSPIRE themes, data models, application schemas for MSP

The INSPIRE website hosts the *Interactive Data Specification*, web application that was used to identify INSPIRE themes, data models and the related application schema that will be able to map the maritime spatial plan. Performing the search with the *Interactive Data Specifications* application, we obtained clear results regarding the application schema that should be used for MSP mapping (see Table 1). The **spatial planning data model is included in the INSPIRE data theme *Land use***. Even though the Planned Land Use data model was originally developed for terrestrial planning, as specified in the Technical Guidelines document on "INSPIRE Data Specification on Land Use", the uses and planning of the sea were considered correspondingly during the development process (EC/JRC, 2013).

Table 1 - Results of analysis with Interactive Data Specifications application

Search term	N results	N of results in relation to MSP	N of Objects	Application Schemas	Themes
Maritime spatial planning	did not match any label, definition or description of selected INSPIRE object categories	0			
Marine spatial planning	did not match any label, definition or description of selected INSPIRE object categories	0			
Marine	24	24		Water Transport Network, Sea Regions, Area Management Restriction and Regulation Zones, Geology, Mineral Resources, Bio-geographical Regions, Administrative and Social Governmental Services, Habitats and Biotopes, Soil, Species Distribution, Common Transport Elements	Sea Regions, Protected Sites, Agricultural and Aquaculture Facilities, Hydrography, Habitats and Biotopes, Meteorological geographical features
Maritime	5	5	5	Maritime Units, Production and industrial facilities, Water transport network	
spatial planning	4	4	3	Planned Land Use, Protected Sites Simple	Land Use
planning	4	4	3	Planned Land Use, Protected Sites Simple	Land Use
marine spatial plan	did not match any label, definition or description of selected INSPIRE object categories	0			
Maritime spatial plan	did not match any label, definition or description of selected INSPIRE object categories	0			
spatial plan	5	5	4	Planned Land Use, Protected Sites Simple	Land Use

Land use theme & Planed Land Use conceptual data model

In the INSPIRE, *Land Use* is defined as: *Territory characterized according to its current and future planned functional dimension or socio-economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational)*. It is the description of land in terms or its socio-economic and ecological purpose. The inland water bodies as well as coastal waters are considered within the connected piece of land and planning of the use of sea and the use of seabed has been taken into consideration.

Land Use is itself split up into two different types:

1. The *Existing Land Use*, which objectively depicts the use and functions of a territory as it has been and effectively still is in real life.
2. The *Planned Land Use*, which corresponds to spatial plans, defined by spatial planning authorities, depicting the possible utilisation of the land in the future. Planned land use is regulated by spatial planning documents elaborated at various levels of administration. The INSPIRE *Planned Land Use* provides the exact spatial dimension of all the elements that a spatial plan is composed of. The application *PlannedLandUse* schema is available at the INSPIRE repository[1], for applying to the related data model.

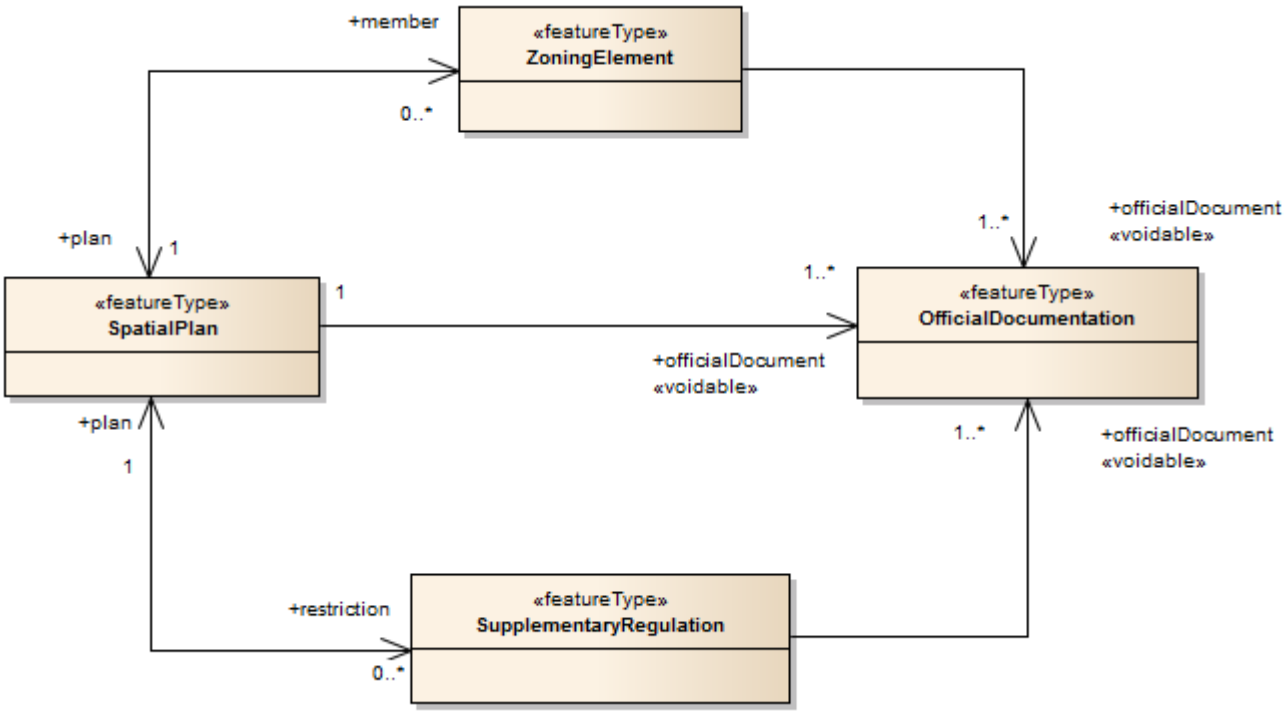


Figure 2 - Planned Land Use overview. Figure extracted from https://inspire.ec.europa.eu

[1] https://inspire.ec.europa.eu/schemas/

Planned Land Use conceptual data model consists of four features types (see Figure 2):

1. **The Spatial Plan** – the parent spatial object that comprises a set of features, that indicates a strategic direction for the development of a given geographic area, states the policies, priorities, programmes and land allocations that will implement the strategic direction and influences the distribution of people and activities in spaces of various scales.

2. **Zoning Element(s)** – the spatial feature(s) included in the Spatial Plan, which support of zoning concept of planning, and presents regulated allocations for uses and activities. The Zoning Element includes a compulsory attribute for describing and classifying zoning activity; **Hierarchical INSPIRE Land Use Classification System (HILUCS)**[2], with a multi-level classification system of 98 use categories.

HILUCS has three hierarchic levels, starting with six values at the primary level, continuing with the secondary and third levels: **1_Primary Production** (e.g. 1_1_ Agriculture; 1_1_2_Farming Infrastructure); **2_Secondary Production** (e.g. 2_4_Energy Production; 2_4_1_Nuclear Based Energy Production); **3_Tertiary Production** (e.g. commercial or community services); **4_Transport Networks Logistics and Utilities** (e.g. Railway Transport); **5_Residential Use**; **6_Other Use** (e.g. Abandoned areas).

3. **Supplementary regulation** – a discretionary/non-mandatory spatial feature, an object that provides supplementary information and/or limitation of the use of land. This is necessary for spatial planning purposes and/or for formalising external rules defined in a legal text (e.g. limitation related to the local regulations on flood management, protected areas or any other international, European or national legal instrument that can affect planning).

4. **Official documentation** – a mandatory non-spatial feature (or features) – a set of documents, which includes applicable legislation, regulations and descriptive elements of the spatial plan, but additionally may be referred to the Zoning Elements and/or Supplementary regulation features.

[2] http://inspire.ec.europa.eu/codelist/HILUCSValue

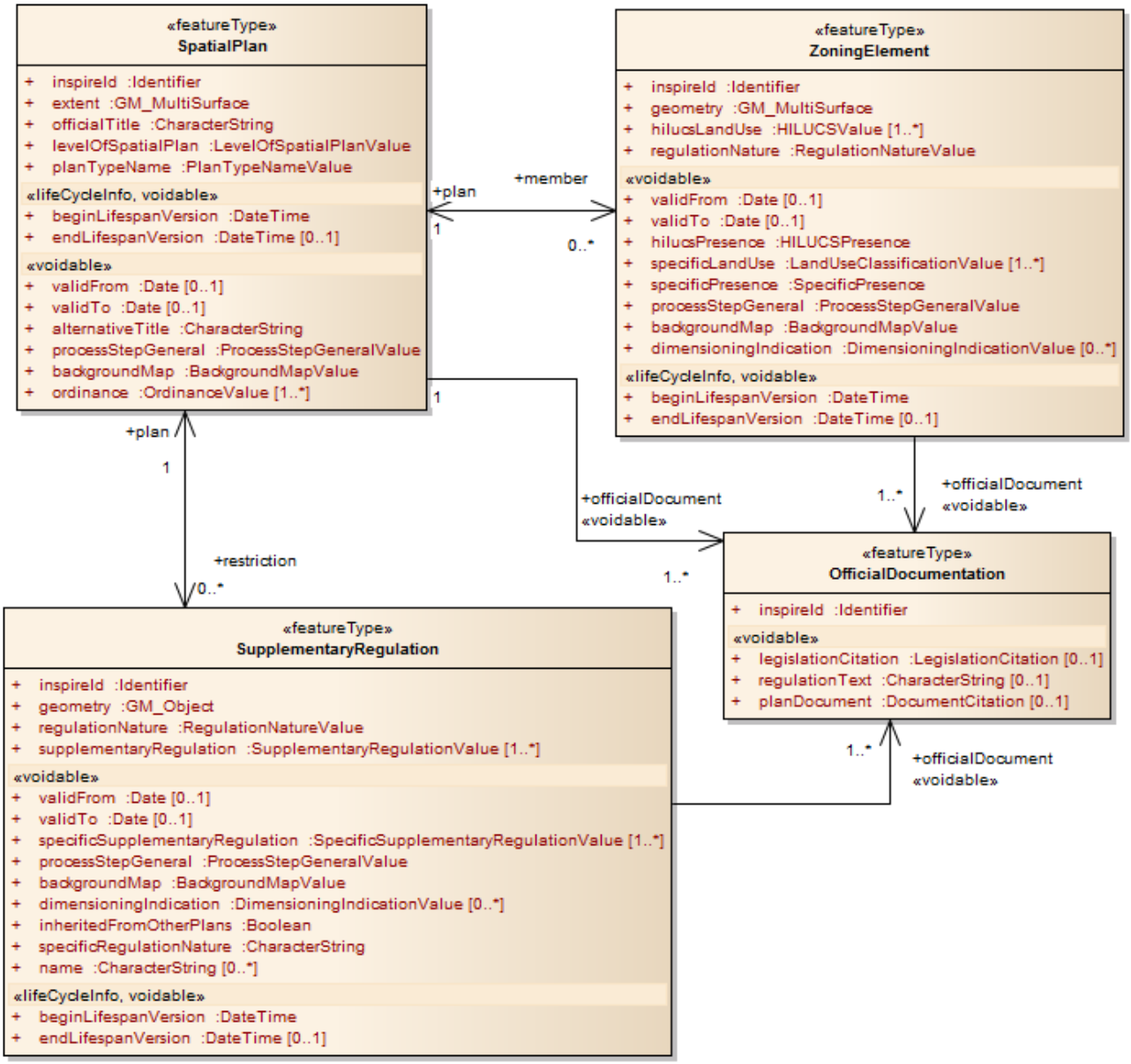


Figure 3 –Planned Land Use concptual model. Figure extracted from https://inspire.ec.europa.eu

Planned Land Use applied to MSP

The *Planned Land Use* data model was examined and tested with published spatial planes available at the UNESCO/IOC Marine Spatial Planning Initiative webpage [3](for example, the Draft of the Spatial Plan for the German Exclusive Economic Zone – North Sea, the Master Plan for the sustainable use of the Belgian Part of the North Sea and the Trilateral Wadden Sea Plan). Mapping of maritime spatial plans provided positive results and did not point out any incompatibilities with planned marine uses (Abramic et al 2018). The *Planned Land Use* data model is robust enough to encode actual maritime spatial plans, still, zoning classification - ***Hierarchical INSPIRE Land Use Classification System*** **(HILUCS)** - provides general, **non-specific information, which not closely enough specify all possible maritime uses** (see Table 2). The HILUCS classification, provided as a closed INSPIRE code list (not extendible) is too broad, but allows comparison of the different data sets developed and provided from different sources and/or data providers (Abramic et al 2018).

Table 2 - Examples of MSP common spatial objects mapped into HILUCS (Abramic et al., 2018).

Spatial object	HILUCS
Reservation Area Shipping	4_1_4_WaterTransport
Priority Area Shipping	4_1_4_WaterTransport
Traffic Separation Scheme	4_1_4_WaterTransport
Offshore wind energy	2_4_4_RenewableEnergyProduction
Offshore wave energy	2_4_4_RenewableEnergyProduction
Offshore tidal energy	2_4_4_RenewableEnergyProduction
High Voltage Cable (in use)	4_3_1_ElectricityGasAndThermalPowerDistributionServices
Reservation Area for Pipelines	4_3_1_ElectricityGasAndThermalPowerDistributionServices
Priority Area for Pipelines	4_3_1_ElectricityGasAndThermalPowerDistributionServices
Natural Gas pipeline	4_3_1_ElectricityGasAndThermalPowerDistributionServices

In order to deliver more specific information on marine/maritime uses, the feature “Zoning Element”, illustrated in Figure 4, includes an additional non-mandatory attribute – specificLandUse. This attribute includes any value defined by the spatial data provider (e.g. shallow sea offshore wave energy VS HILUCS 2_4_4_RenewableEnergyProduction) and it is able to remove any ambiguity on marine use.

Further, land planning is mainly focused on the two dimensional allocation of the human uses, primarily on the Earth surface. This type of the approach could provide additional issues, as in the MSP uses of marine space are distributed not only on marine surface, but also within water column, on the seabed and in the marine subsoil. This potential issue can be resolved with the extension of the *Planned Land Use* data model. The extension should include information on vertical distribution of the human uses within the marine area, indicating if uses apply on the marine surface or/and water column or/and seabed or/and subsoil.

[3] http://msp.ioc-unesco.org

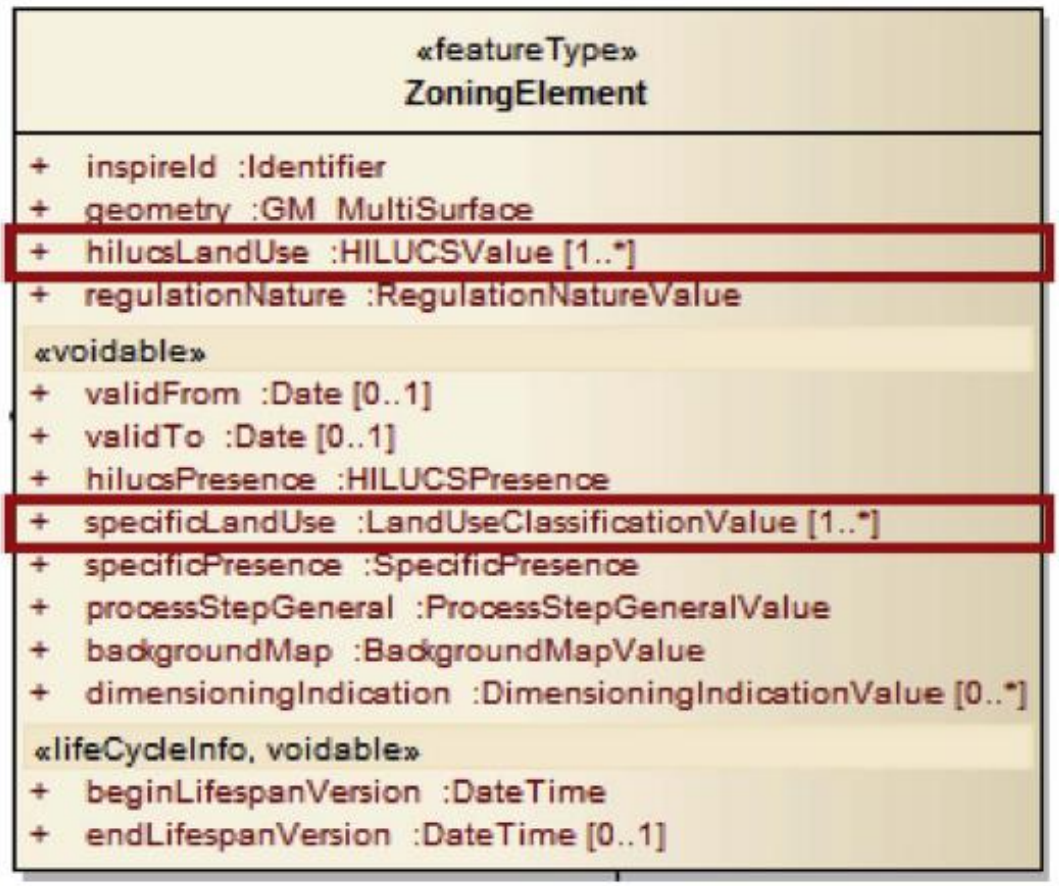


Figure 4 - Zoning Element feature, with obligatory (hilucsLandUse: HILUCSValue) and nonobligatory (specificLandUse: LandUseClassificationValue) attributes. Fig. 4 is extracted from the Abramic et al., 2018, and INSPIRE UML data model repository publicly available in HTML format at http://inspire.ec.europa.eu/.

MSP data model, conceptual modelling

Marine use classification – extended HILUCS

In development of the INSPIRE Planned Land Use data model, as specified in the Technical Guidelines document on "INSPIRE Data Specification on Land Use" the uses and planning of the sea were considered, but not elaborated in detail. Mapping and testing the Planned Land Use data model with elaborated maritime spatial plans, we conclude that the model is robust enough to map maritime activities, with the additional need to adapt in the area of marine use:

- **To develop classification system that can properly map, specify maritime activities/marine use, and if possible be compatible/comparable with HILUCS**;
- **To include information on vertical distribution of maritime activities**; marine surface or/and water column or/and seabed or/and subsoil.

To provide more detailed classification on maritime activities, it is possible to use non-compulsory attribute – *specificLandUse* (Figure 4), including values from available vocabularies, and libraries that are well documented within the ***SeaDataNet*** **European initiative**[4]:

1. **M12 JNCC** categories of human activity in the marine environment, 11 classes;
2. **M13 JNCC** standard list of human activities in the marine environment, 39 classes; and
3. **HA2 EMODnet** human activity categories, 56 classes.

Within the Planned Land Use data model is still not compulsory to provide classification beyond HILUCS. For maritime spatial planning this is essential, if we want to avoid ambiguity on the marine uses, as the model adapted around MSP requirements should include one more compulsory attribute that provide specific information on maritime uses. The Zoning Element spatial feature, was extended with one **new compulsory attribute that includes specification on marine uses *hilucsMSP*:** (Figure 5), and the feature is renamed in the **MSP Zoning Element**.

[4] http://seadatanet.maris2.nl/v_bodc_vocab_v2/welcome.asp

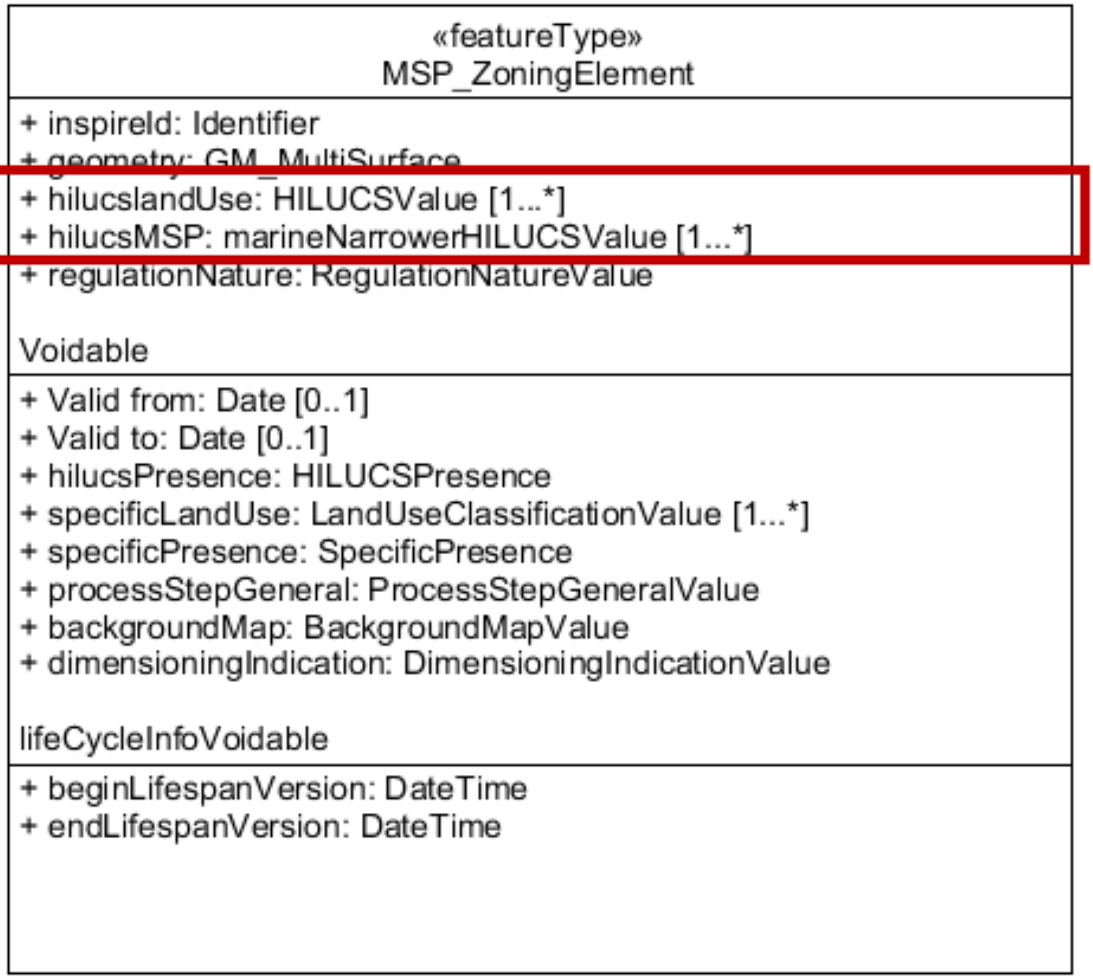


Figure 5 - MSP_Zoning Element, Zoning Element extended with hilucsMSP attribute

HILUCS is an INSPIRE closed code list, that is regulated by COMMISSION REGULATION (EU) No 1089/2010[5], and managed in INSPIRE code list register as not extendible code list. Using the HILUCS three level structure for specifying the marine use, it is necessary to extend to the 4th,or even 5th level to specify marine uses. **The motivation to extend *not extendible code list* is to apply the same classification structure for land and sea uses**, that consequently can increase interoperability within: the land use data sets; the marine use data sets; the spatial information on land planning; and, finally, for MSP.

To adapt HILUCS for MSP, **it HILUCS Extended register[6] is developed** (Figure 7) This includes all "basic" HILUCS values, with the additional, extended 3rd, 4th and 5th level values, **that specify marine use**, including types of marine renewable energy production, maritime services, types of underwater cultural heritage, etc.

[5] https://eur-lex.europa.eu/eli/reg/2010/1089/2013-12-30
[6] http://www.geoportal.ulpgc.es/registro/plannedLandUse/HilucsExt/

«codeList» LandUseClassificationValue
narrower extesion of HILUCS - MarineNarrowerHILUCS
tags asDictionary: True extesibilty: Narrower vocabulary: http://www.geoportal.ulpgc.es/registro/plannedLandUse/HilucsExt/

Figure 6 - Narrower extension of HILUCS with marine uses

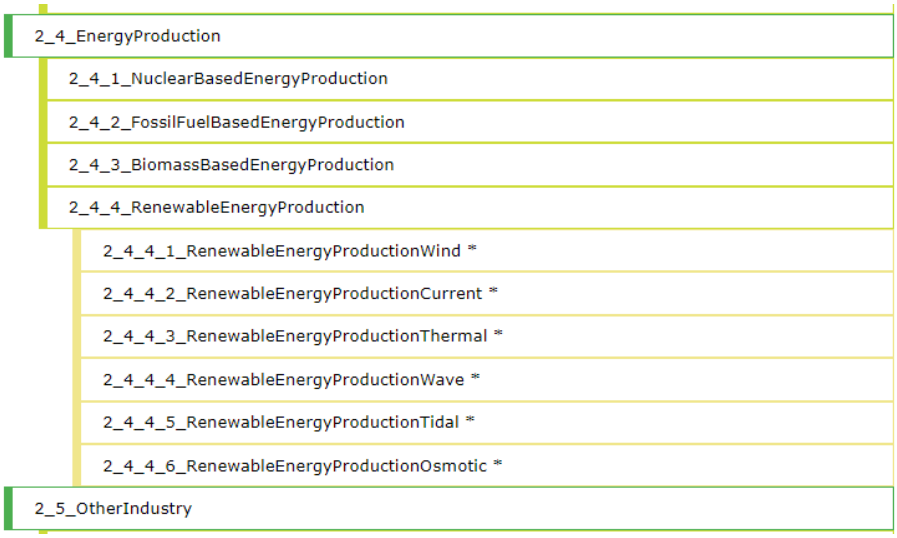


Figure 7 - HILUCS Extended register - extended values on level 4, maritime Renewable energy production types (2_4_4_x)

Multi-use and co-use, frequent used in MSP, is covered by the basic model, including land/marine use cardinality [1..*] (Figure 5), with the option that the zoning element is classified by one or more HILUCS values. The same property is included within the *hilucsMSP* attribute, which can include more than one extended HILUCS values (e.g. marine area for investigations on renewable wind energy, would include two values:
3_2_2_ProfessionalTechnicalAndScientificServices; and
2_4_4_1_RenewableEnergyProductionWind.

.

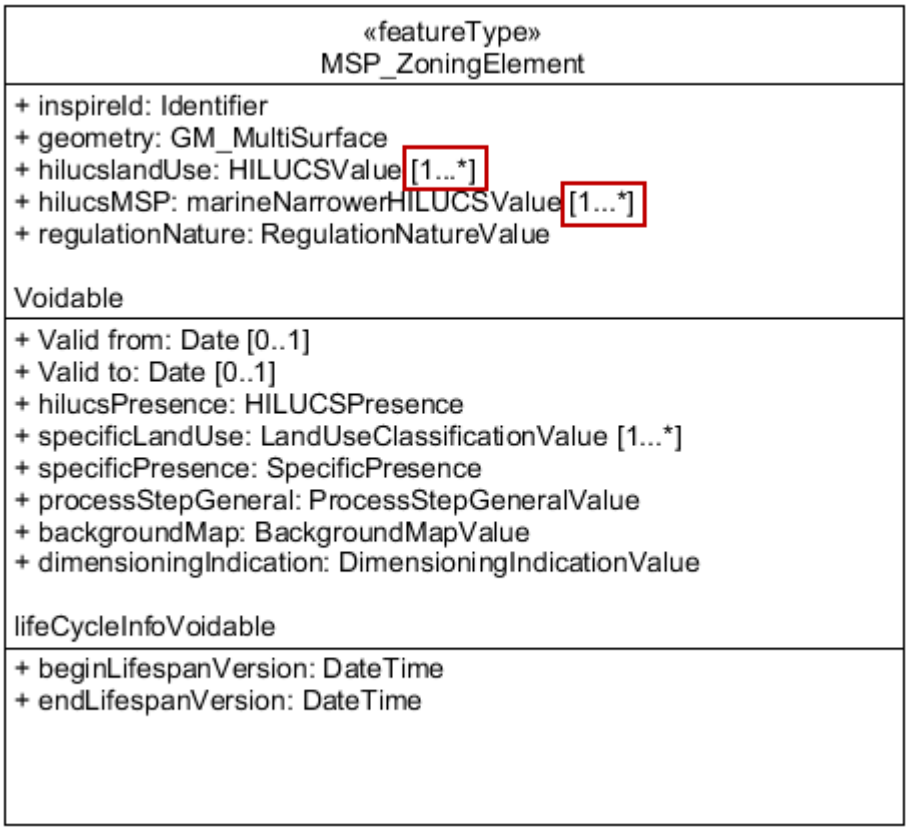


Figure 8 - Cardinality of the land/marine use

Marine use vertical distribution

Strategic, terrestrial spatial planning is mostly a two-dimensional exercise, and a discipline that describes human activities on the earth's surface. Considering the vertical nature of some marine uses, and the maritime activities previously tested (see Table 2; Abramic et al., 2018) it was clearly not adequate to present land use using two dimensions. This is because human activities and marine uses in a two-dimensional presentation often appear to be overlapping, even when there is no interaction between these (e.g. maritime transport and submarine cables, Figure 9).

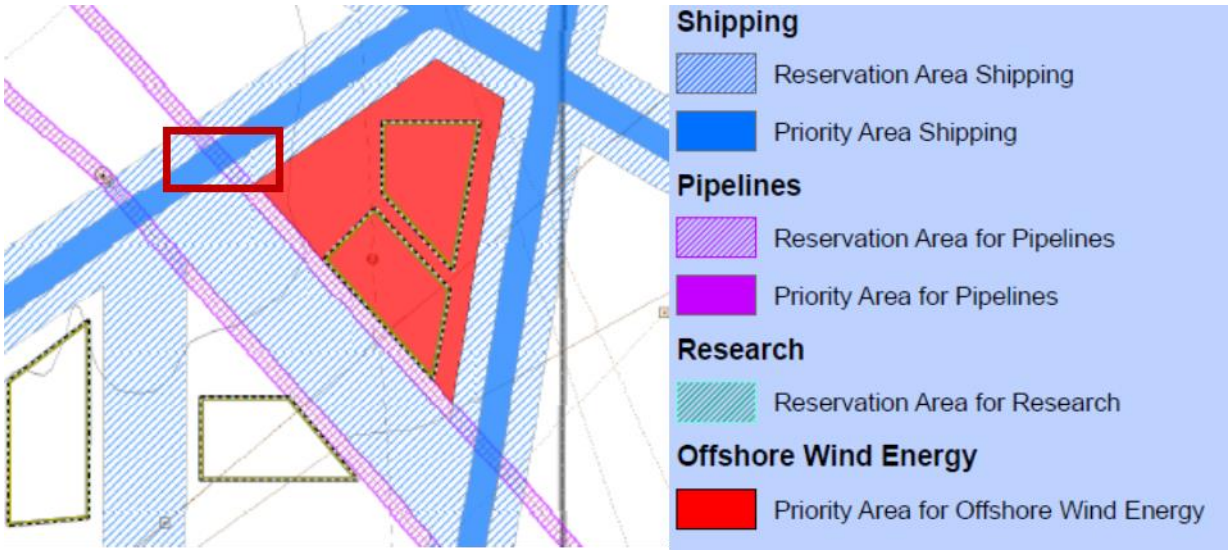


Figure 9 - detail of German EEZ; maritime transport and pipelines

Particular uses are distributed only on the sea surface, other ae only present on the seabed. Others or can extend downwards from the water surface, through the water column to the subsoil (e.g. offshore wind turbine). For this reason the data model needs to be adopted to cover the distribution of the uses, including "dimensions" within the sea surface, water column, above and below to the seabed.

Finally, to adapt the data model for the MSP, **we extended MSP_Zoning Element with one more compulsory attribute *Vertical Distribution*** that provide information where activity is taking part: surface and/or water column and/or seabed and/or subsoil.

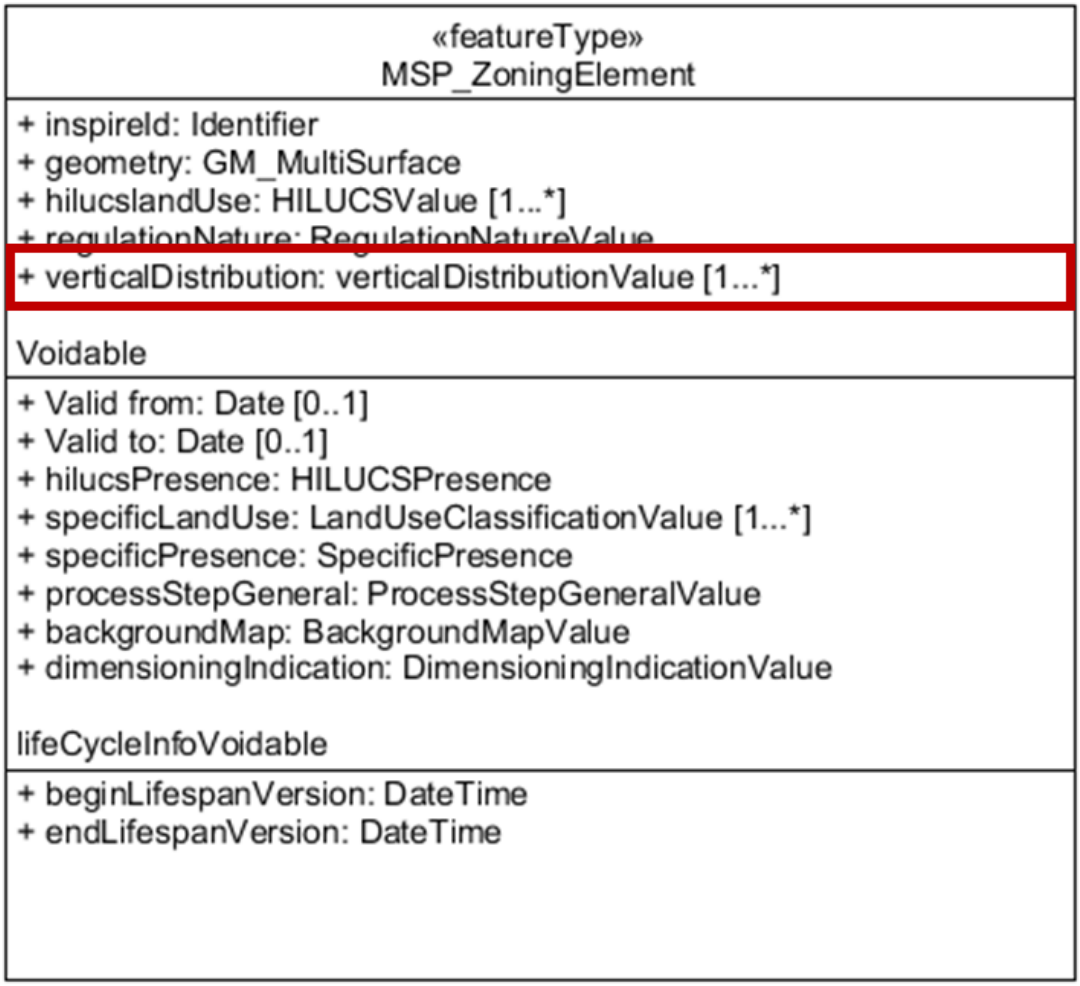


Figure 10 - MSP_ZoningElement extension Vertical Distribution

Within the ECOAQUA registry we provide a **code list *verticalDistributionValue*** that includes four basic values (Figure 11), and all possible combinations (Figure 12).

Vertical distribution has a cardinality 1 to many [1…*], as related to the hilucsMSP attribute. If we include more than one HILUCS value, describing multiuse, we should include the corresponding vertical distribution values.

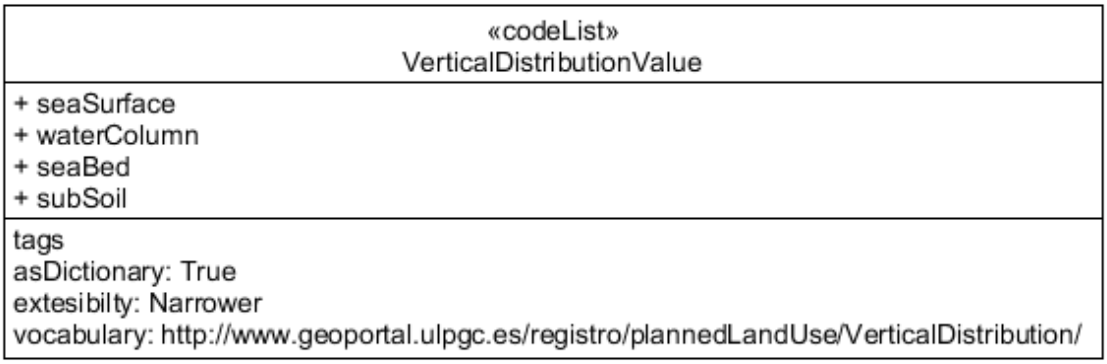


Figure 11 - Vertical distribution code list, only basic values

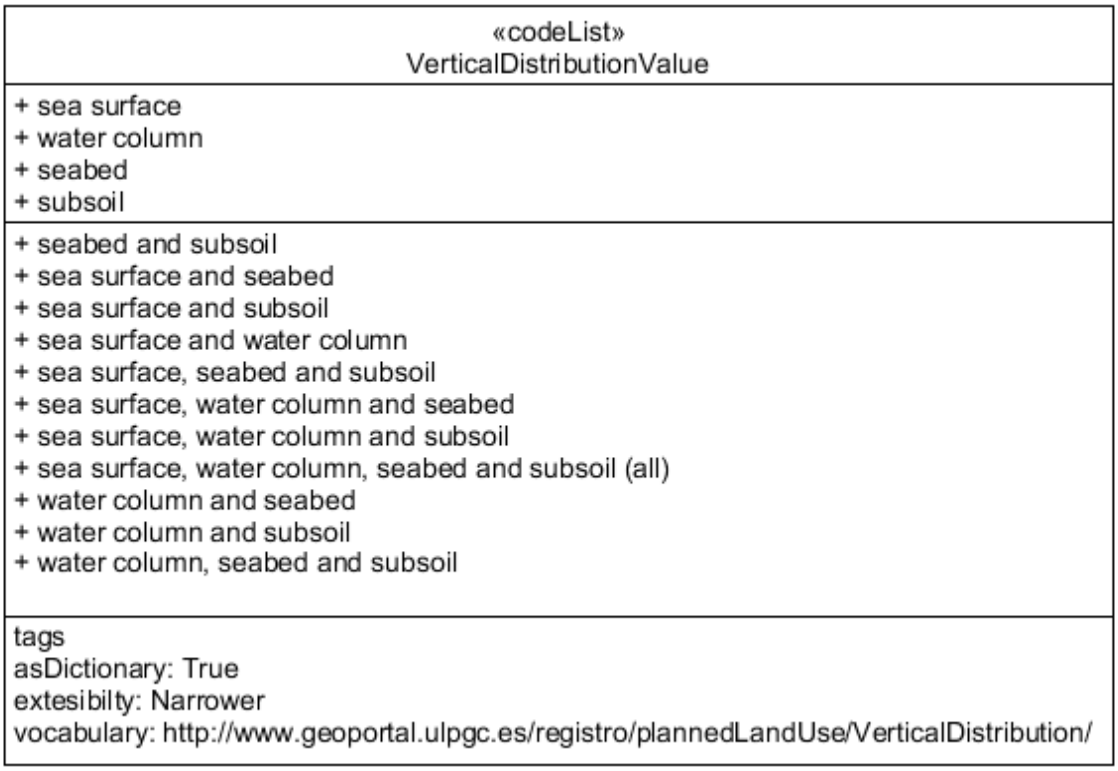
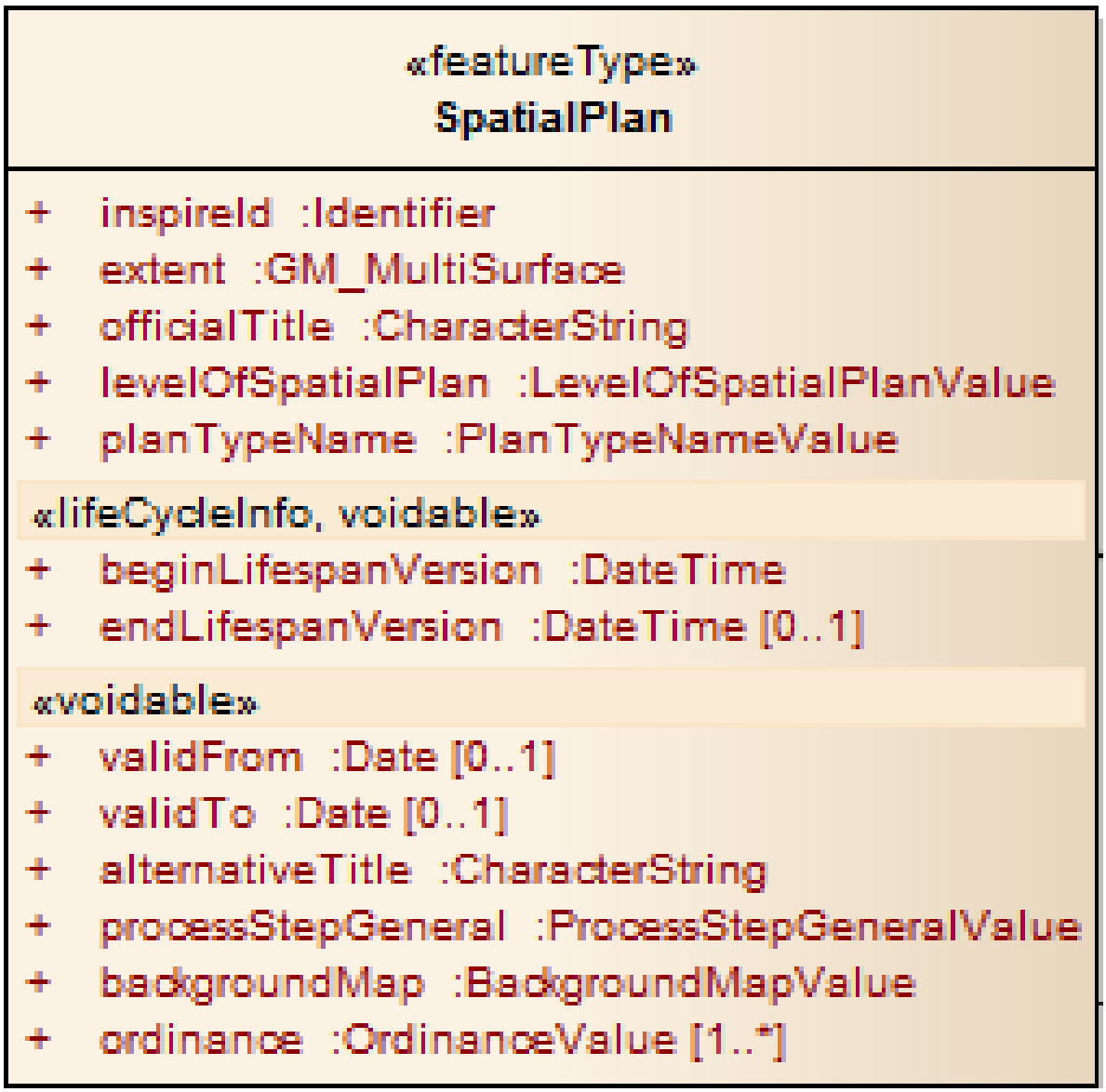


Figure 12 – Final Vertical distribution code list

Data specification – Feature catalogue

Feature type: MSP Spatial Plan



Compulsory Attributes:

INSPIRE ID, is a complex attribute type that is divided into three attributes**:**

- **LocalID** (characterString) A local identifier, assigned by the data provider. The local identifier is unique within the namespace where no other spatial object carries the same unique identifier.
- **Namespace** (URL) - Namespace uniquely identifies the data source of the spatial object, it should be a Uniform Resource Locator (URL)- web address.
- **VersionID** (characterString) – A version of ID, not compulsory.

extent (GM_MultiSurface) -It could be geometrical union of all the instances of the spatial objects ZoningElement and SupplementaryRegulation. Within the MSP it is marine administrative unit as Territorial waters or Exclusive Economic Zone.

officialTitle (CharacterString)- The official title of the spatial plan.

levelOfSpatialPlan (codeListValue) – The level of the administrative units covered by the plan. Please use the URL value from INSPIRE not extensible list:

http://inspire.ec.europa.eu/codelist/LevelOfSpatialPlanValue

planTypeName (codeListValue) – The name of the type of plan that the Member State has given to the plan. It can be used any URL, code list, value defined by data provider.

Voidable Attributes (non-compulsory attributes):

processStepGeneral (codeListValue) – A general indication of the step in the planning process that the plan is undergoing. Please use the URL value from the INSPIRE not extensible list:

http://inspire.ec.europa.eu/codelist/ProcessStepGeneralValue

backgroundMap (URL) – The identification of the background map that has been used for constructing this Plan – use only as a reference on the internet service or directly to the map.

ordinance (URL) - This attribute is a multiple because, independently from the current legal status of the plan, there can be references to more than one ordinance in relation to the different steps that the planning process has already undergone (e.g. ordinance for the preparation of a new plan, ordinance for adoption, ordinance for approval, etc.)

validFrom (DateTime) – The first date at which this spatial plan is valid in reality.

validTo (DateTime) - The time from which the spatial plan no longer exists in the real world.

alternativeTitle (CharacterString) – The alternative (unofficial) title of the spatial plan.

beginLifespanVersion (DateTime) **–** The date and time at which this version of the spatial object was inserted or changed in the spatial data set

endLifespanVersion (DateTime) **–** The date and time at which this version of the spatial object was superseded or retired in the spatial data set

Association attributes:

officialDocument (URL) – The association role (Link) to the *OfficialDocumentation* feature that corresponds to this spatial plan.

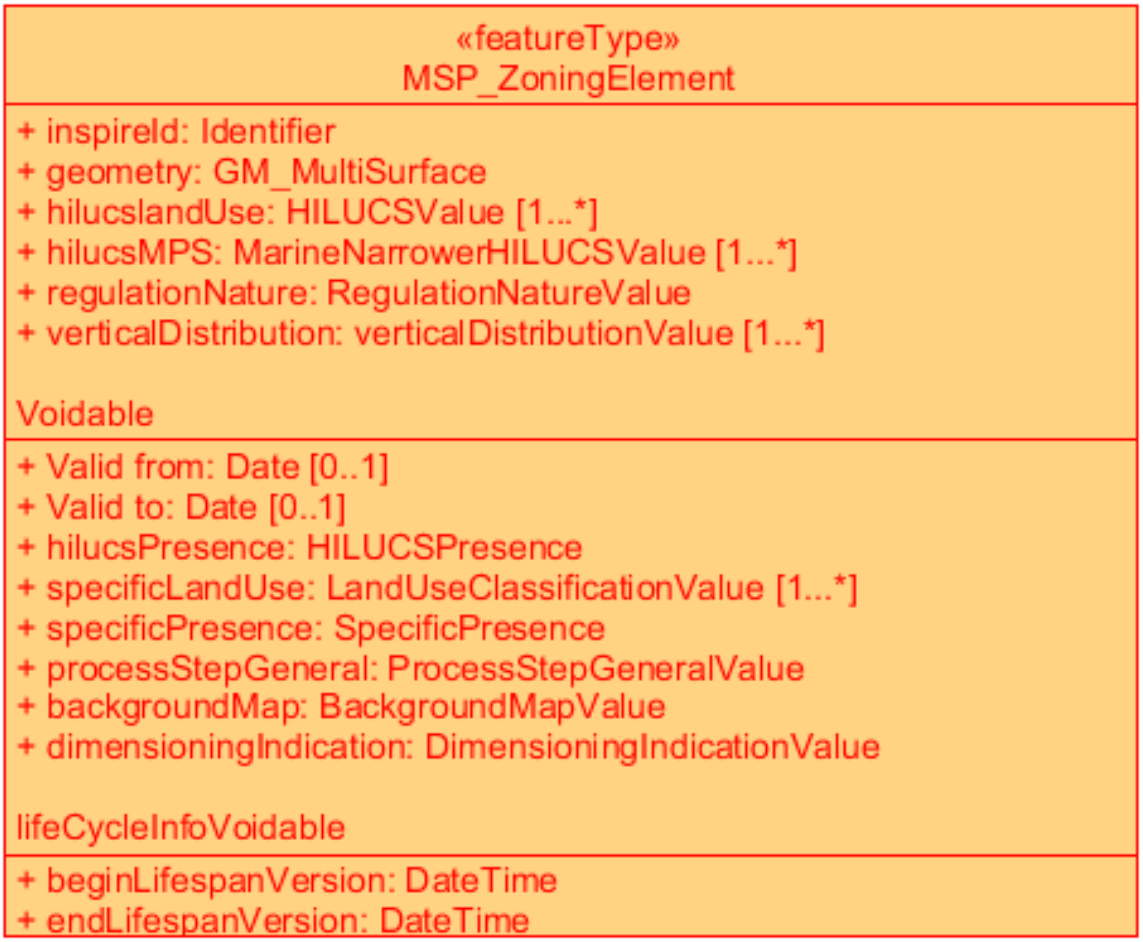
Geographic coordinate system attributes:

srsname (URL) – The name of the coordinate reference system used in the feature. It is proposed to use URL's provided by the Open Geospatial Consortium as coordinate system identifiers based on EPSG Geodetic Parameter Registry (http://www.epsg-registry.org). Table 3 includes values for the default coordinate reference system.

Table 3 -List of URL's reference system values

Coordinate reference system	Short name	http URI identifier
3D Cartesian in ETRS89	ETRS89-XYZ	*http://www.opengis.net/def/crs/EPSG/0/4936*
3D geodetic in ETRS89 on GRS80	ETRS89-GRS80h	*http://www.opengis.net/def/crs/EPSG/0/4937*
2D geodetic in ETRS89 on GRS80	ETRS89-GRS80	*http://www.opengis.net/def/crs/EPSG/0/4258*
2D LAEA projection in ETRS89 on GRS80	ETRS89-LAEA	*http://www.opengis.net/def/crs/EPSG/0/3035*
2D LCC projection in ETRS89 on GRS80	ETRS89-LCC	*http://www.opengis.net/def/crs/EPSG/0/3034*
2D TM projection in ETRS89 on GRS80, zone 26N (30°W to 24°W)	ETRS89-TM26N	*http://www.opengis.net/def/crs/EPSG/0/3038*
2D TM projection in ETRS89 on GRS80, zone 27N (24°W to 18°W)	ETRS89-TM27N	*http://www.opengis.net/def/crs/EPSG/0/3039*
2D TM projection in ETRS89 on GRS80, zone 28N (18°W to 12°W)	ETRS89-TM28N	*http://www.opengis.net/def/crs/EPSG/0/3040*
2D TM projection in ETRS89 on GRS80, zone 29N (12°W to 6°W)	ETRS89-TM29N	*http://www.opengis.net/def/crs/EPSG/0/3041*
2D TM projection in ETRS89 on GRS80, zone 30N (6°W to 0°)	ETRS89-TM30N	*http://www.opengis.net/def/crs/EPSG/0/3042*
2D TM projection in ETRS89 on GRS80, zone 31N (0° to 6°E)	ETRS89-TM31N	*http://www.opengis.net/def/crs/EPSG/0/3043*
2D TM projection in ETRS89 on GRS80, zone 32N (6°E to 12°E)	ETRS89-TM32N	*http://www.opengis.net/def/crs/EPSG/0/3044*
2D TM projection in ETRS89 on GRS80, zone 33N (12°E to 18°E)	ETRS89-TM33N	*http://www.opengis.net/def/crs/EPSG/0/3045*
2D TM projection in ETRS89 on GRS80, zone 34N (18°E to 24°E)	ETRS89-TM34N	*http://www.opengis.net/def/crs/EPSG/0/3046*
2D TM projection in ETRS89 on GRS80, zone 35N (24°E to 30°E)	ETRS89-TM35N	*http://www.opengis.net/def/crs/EPSG/0/3047*
2D TM projection in ETRS89 on GRS80, zone 36N (30°E to 36°E)	ETRS89-TM36N	*http://www.opengis.net/def/crs/EPSG/0/3048*
2D TM projection in ETRS89 on GRS80, zone 37N (36°E to 42°E)	ETRS89-TM37N	*http://www.opengis.net/def/crs/EPSG/0/3049*
2D TM projection in ETRS89 on GRS80, zone 38N (42°E to 48°E)	ETRS89-TM38N	*http://www.opengis.net/def/crs/EPSG/0/3050*
2D TM projection in ETRS89 on GRS80, zone 39N (48°E to 54°E)	ETRS89-TM39N	*http://www.opengis.net/def/crs/EPSG/0/3051*
Height in EVRS	EVRS	*http://www.opengis.net/def/crs/EPSG/0/5730*
3D compound: 2D geodetic in ETRS89 on GRS80, and EVRS height	ETRS89-GRS80-EVRS	*http://www.opengis.net/def/crs/EPSG/0/7409*

Feature type: MSP Zoning Element



Compulsory Attributes:

INSPIRE ID, is a complex attribute type that is divided into three attributes**:**

- **LocalID** (characterString) - A local identifier, assigned by the data provider. The local identifier is unique within the namespace that is no other spatial object carries the same unique identifier.
- **Namespace** (URL) – A namespace uniquely identifying the data source of the spatial object, it should be Uniform Resource Locator (URL)- web address.
- **VersionID** (characterString) – A version of ID, non-compulsory.

Geometry (GM_MultiSurface) – The geometry of this zoning element.

hilucsLandUse (codeListValue) - HILUCSValue, classification of land use values included in the INSPIRE register as a non-extendible INSPIRE code list: http://inspire.ec.europa.eu/codelist/HILUCSValue

hilucsMSP (codeListValue) – A specific MSP data model attribute - extended HILUCS code list, to cover and specify marine uses needed for the MSP. Please use narrower extended HILUC values, specified for use of the marine space. Available at HILUCS Extended register developed by ECOAUQA Institute: http://www.geoportal.ulpgc.es/registro/plannedLandUse/HilucsExt/

regulationNature (codeListValue) - The legal nature of the land/marine use indication, not extendable INSPIRE code list available at:
http://inspire.ec.europa.eu/codelist/RegulationNatureValue
verticalDirstribution (codeListValue) **–** A specific MSP data model attribute, describes where activities take place in vertical axis of marine space, including sea surface, water column, seabed and subsoil . This code list is part of the data model for Marine Spatial Planning developed by Ecoaqua Institute and available at the register: http://www.geoportal.ulpgc.es/registro/plannedLandUse/VerticalDistribution/

Voidable Attributes (not compulsory attributes):

ProcessStepGeneralValue (codeListValue) – A general indication of the step of the planning process that the zoning element is undergoing. Include values from INSPIRE register http://inspire.ec.europa.eu/codelist/ProcessStepGeneralValue/adoption

hilucsPresence (number) – The actual presence of a land use HILUCS category within the object. Use only where there is more than one hilucsMSP value – muliti-use, providing presence in the same order as uses.

specificLandUse (codeListValue or characterString) – A Land Use Category according to the nomenclature specific to this data set, the data provider should choose classification of land/marine use. The vocabularies are available from SeaDataNet at: http://seadatanet.maris2.nl/v_bodc_vocab_v2/welcome.asp

specificPresence (value) – The presence of one or several land use classification values in an area according to the code list (e.g. SeaDataNet) provided by the data provider, indicated either as the percentage covered for each value or as the values listed in their order of importance.

backgroundMap (URL) - Identification of the background map that has been used for constructing this zoning element – use only a reference on the internet service or directly to the map, use only if a very different form reference map, included in the plan.

beginLifespanVersion (DateTime) **–** The date and time at which this version of the spatial object was inserted or changed in the spatial data set.

endLifespanVersion (DateTime) **–** The date and time at which this version of the spatial object was superseded or retired in the spatial data set.

validFrom (DateTime) – The first date at which this spatial plan is valid in reality.

validTo (DateTime) - The time from which the spatial plan no longer exists in the real world.

DimensioningIndicationValue (value) **-** Specifications about the dimensioning of maritime developments that can provided as dimension indication character values, dimension indication measure values, dimension indication real values or dimension indication integer values.

Association attributes

spatialPlanID (URL)- A link to the spatial plan that includes zoning element. Links are composed of the union of **namespace** and **LocalID** as described in SpatialPlan feature attributes.

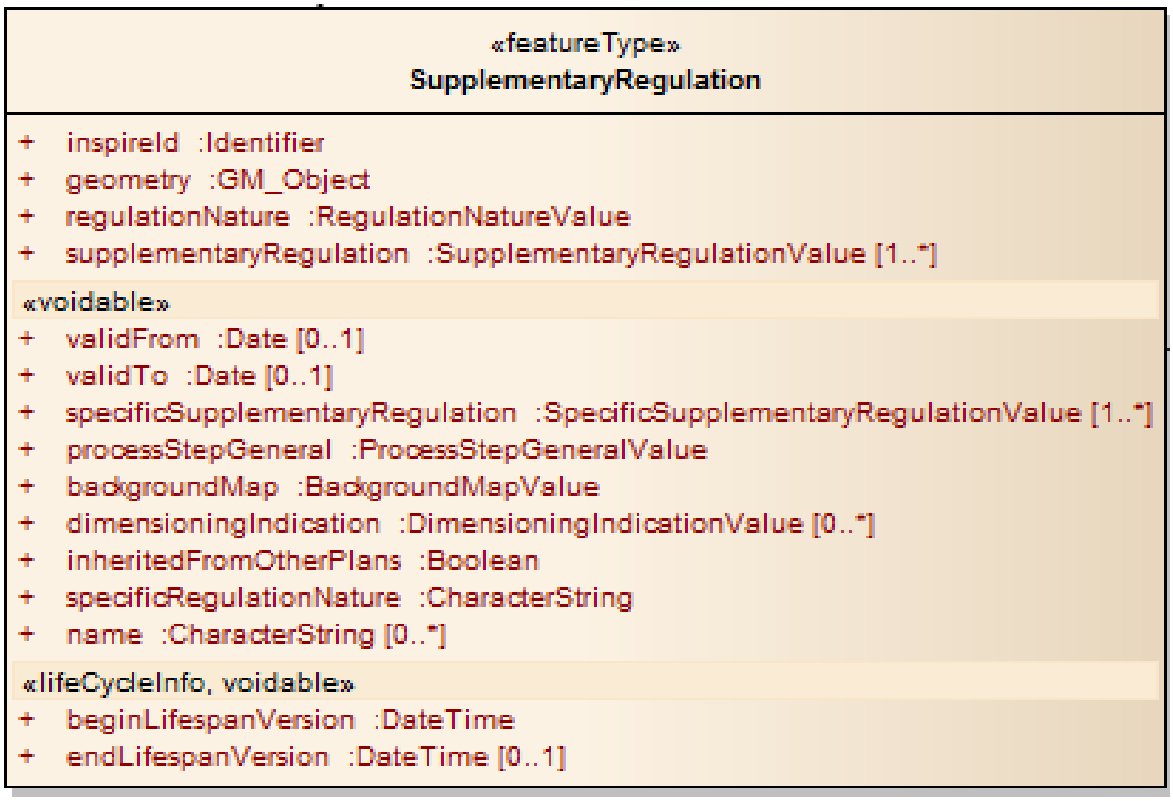
Association voidable attributes

officialDocument (URL) – The association role (Link) to the *OfficialDocumentation* feature that correspond to this zoning element(s)

Geographic coordinate system attributes:

srsname (URL) – The name of coordinate reference system used in feature. It is proposed to use URIs provided by the Open Geospatial Consortium as coordinate system identifiers based on the EPSG Geodetic Parameter Registry (http://www.epsg-registry.org). Table 3 shows values for the default coordinate reference system.

Feature type: Supplementary Regulation



Compulsory Attributes

INSPIRE ID is a complex attribute type that is divided into three attributes**:**

- **LocalID** (characterString) - A local identifier, assigned by the data provider. The local identifier is unique within the namespace that is no other spatial object carries the same unique identifier.
- **Namespace** (URL) – A namespace uniquely identifying the data source of the spatial object, it should be Uniform Resource Locator (URL)- web address.
- **VersionID** (characterString) – A version of ID, not compulsory.

Geometry (GM_MultiSurface) - Geometry of this zoning element.

regulationNature – The legal nature of the land use regulation. Indicates whether the land use regulation is legally binding or not. Use INSPIRE code list for values: http://inspire.ec.europa.eu/codelist/RegulationNatureValue/definedInLegislation

supplementaryRegulation - Code of the supplementary regulation. Can be used as a hierarchical supplementary regulation code, available on INSPIRE registry, or any other value, using the registry of EU (EuroLex) or national legislation. In this case, the proposed INSPIRE code list has been extended in order to registry specific values for MSP data model.

INSPIRE registry:

http://inspire.ec.europa.eu/codelist/SupplementaryRegulationValue/

ECOAQUA MSP data model extension:

http://www.geoportal.ulpgc.es/registro/plannedLandUse/SupplementaryRegulation/

EU legislation EuroLex registry:

https://eur-lex.europa.eu/homepage.html

Voidable Attributes (not compulsory attributes):

ProcessStepGeneralValue (codeListValue)- A general indication of the step of the planning process that the zoning element is undergoing. Include values from INSPIRE register http://inspire.ec.europa.eu/codelist/ProcessStepGeneralValue/adoption

specificSupplementaryRegulation (codeListValue or characterString) - A reference to a category of supplementary regulation provided in a specific nomenclature of supplementary regulations provided by the data provider – no need to include this attribute as a code list as

specificRegulationNature (CharacterString) – The legal nature use regulation from a national perspective.

backgroundMap (URL) – The identification of the background map that has been used for constructing this zoning element.

inheritedFromOtherPlans (Boolean)- An indication of whether the supplementary regulation is inherited from another spatial plan.

beginLifespanVersion (DateTime) **–** The date and time at which this version of the spatial object was inserted or changed in the spatial data set

endLifespanVersion (DateTime) **–** The date and time at which this version of the spatial object was superseded or retired in the spatial data set.

validFrom (DateTime) – The first date at which this spatial plan is valid in reality.

validTo (DateTime) - The time from which the spatial plan no longer exists in the real world.

DimensioningIndicationValue (value) **-** Specifications about the dimensioning of maritime developments, that can provided as dimension indication character values, dimension indication measure values, dimension indication real values or dimension indication integer values.

Association attributes

spatialPlanID (URL)- A link to the spatial plan that includes supplementary regulation element(s). Links are composed of the union of **namespace** and **LocalID** described in SpatialPlan feature attributes.

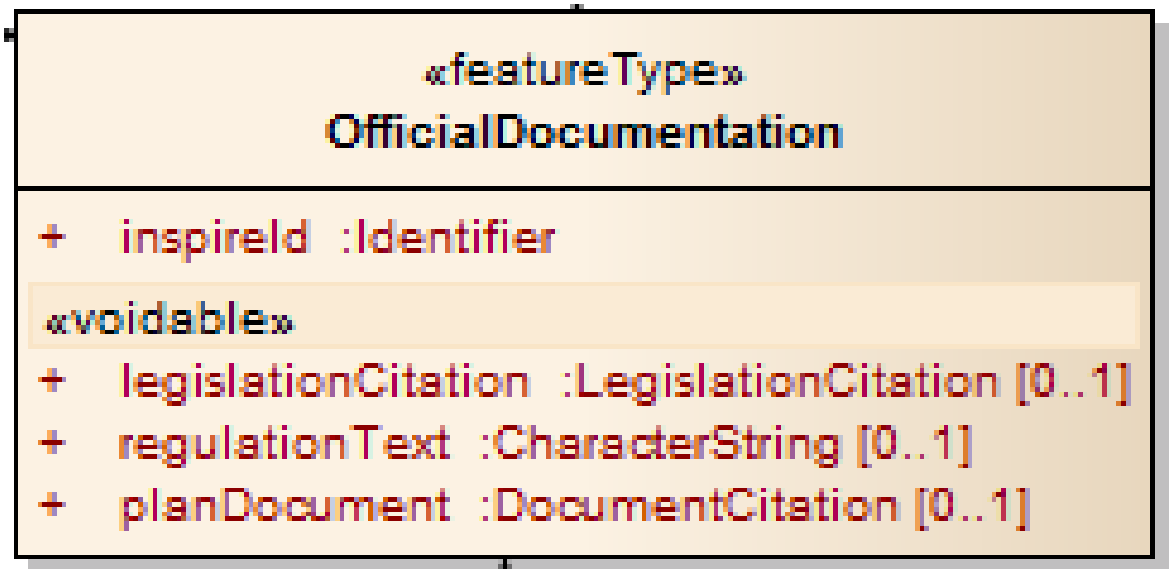
Association voidable attributes

officialDocument (URL) – The association role (Link) to the *OfficialDocumentation* feature that corresponds to this Supplementary Regulation element(s).

Geographic coordinate system attributes:

srsname (URL) – The name of the coordinate reference system used in the feature. It is proposed to use URIs provided by the Open Geospatial Consortium as coordinate system identifiers based on EPSG Geodetic Parameter Registry (http://www.epsg-registry.org). Table 3 shows values for the default coordinate reference system.

Feature type: Official Documentation



Compulsory Attributes

INSPIRE ID is a complex attribute type that is divided in three attributes**:**

- **LocalID** (characterString) - A local identifier, assigned by the data provider. The local identifier is unique within the namespace that is no other spatial object carries the same unique identifier.
- **Namespace** (URL) – A namespace uniquely identifying the data source of the spatial object, it should be a Uniform Resource Locator (URL)- web address.
- **VersionID** (characterString) – A version of ID, not compulsory.

Voidable Attributes (not compulsory attributes):

legislationCitation (URL)- A reference to the document that contains the text of the regulation.

regulationText (CharacterString) - Text of the regulation.

planDocument (CharacterString) – A citation of scanned plans and structural drawings, which may be geo-referenced or not.

Templates

To facilitate use of the MSP INSPIRE data model, are developed three type of templates:

1. MSP_INSPIRE_Data_Model.xsd - Geography Markup Language (GML) application schemas
2. MSP_INSPIRE_Data_Model.gpkg – GeoPackage template
3. MSP_INSPIRE_Data_Model.zip – zip file includes ESRI Shapeflies, that follows INSPIRE conceptual model (structure), but due limitation of format attribute names not exceed 10 characters:
    a. MSP_Spatial_Plan;
    b. MSP_Zonning_Elements;
    c. Suplemnetary Regulation;
    d. Official Documentation (not spatial object, only dbf):

Templates can be downloaded at the Tools section of the *MSP platform Canaries* that can be accessed: http://www.geoportal.ulpgc.es/marsp/

Figure 13 - MSP platform Canaries, available templates and data specification of MSP INSPIRE data model

SLD Portrayal

As explained above, MSP processes require information in a cross border context. Currently, there are difficulties in harmonising the vision and frameworks of maritime spatial plans of countries sharing the same marine region or sub-region, even in the most advanced European examples (Figure 1). This is in part due to the fact that plans do not use harmonised data models, standard rules for layers and styles for portrayal of the spatial object types delivered in the spatial plan. These issues could be resolved by applying INSPIRE standards on data sets, layers and portrayal of marine spatial plans.

In this sense**,** the **MarSP project** was a perfect opportunity not only to finalise data model development for MSP, but also to develop the common styles for portrayal of the spatial object in the spatial plan, and applying the results on real world use cases developed for Macaronesia.

Accordingly, with the aim to define a standard symbolisation for all spatial objects that could be mapped in a Maritime Spatial Planning process, from Spanish Institute of Oceanography (IEO) has developed a Styled Layer Descriptor (SLD) based on a set of symbols also created by IEO. These symbols correspond to all spatial objects previously considered in the extended HILUCS developed by ECOAQUA.

The SLD is a profile of the Web Map Service (WMS) Encoding Standard, and both are OpenGIS® standards**.** A SLD defines an encoding to allow the users to define a symbolisation and colouring of geographic feature and coverage data. To ensure that users and software are able to control the visual portrayal of data, it is necessary to use a styling language that the client and server can both understand. The OpenGIS® Symbology Encoding Standard (SE) [http://www.opengeospatial.org/standards/symbol] provides this language and SLD profile allows the application of the symbology to WMS layers, and defines an operation for standardised access to legend symbols (http://www.opengeospatial.org/standards/wms).

At the outset, the standards that already existed in symbology for marine cartography were searched.

Next, the symbols of the International Hydrographic Organization (IHO) were studied and several sketches were designed. The above was not useable as it was based on specific figures or icons on images, it provided poor visibility in cases of overlapping layers, and because the viewer was not proficient in map updates or spatial scale changes.

Following this, numerous map display services (Web Map Service - WMS) of Marine Spatial Planning (MSP) were examined to analyze if there were available homogeneous or analogous representations for the same spatial use. No similarities were found between the different symbologies of the different WMS.

Consequently, it was decided to project and outline a general portrayal structure for the MSP data model. This design has been devised based on the structured Hierarchical INSPIRE Land Use Classification System (HILUCS) and its six main land use categories:

1. Primary Production
2. Secondary Production

3. Tertiary Production
4. Transport, Networks, Logistics And Utilities
5. Residential Use
6. Other Uses

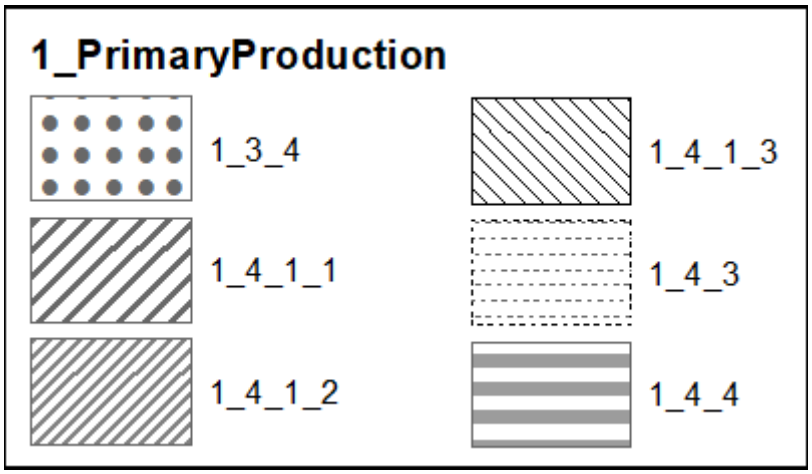
The elements of HILUCS list should be applicable to both existing land use and planned land use.

The majority of elements are areas, even if they include linear elements. Therefore, it was decided that they would be polygon representations with an outer perimeter line, of equal width value for all, a hollow interior, but with a plot of lines or points.

A general colour or tone for each of the six main classes was assigned. With this in mind, all symbols within these categories should have a similar tone.

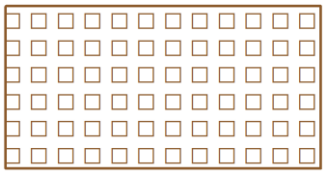
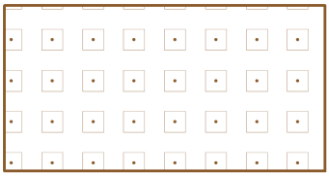
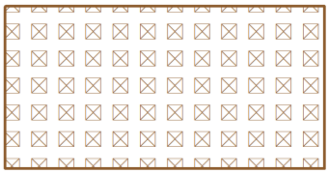
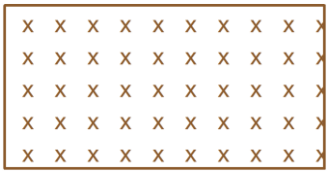
Category	Colour
1_Primary Production	
2_Secondary Production	
3_Tertiary Production	
4_Transport, Networks, Logistics And Utilities	
5_Residential Use	
6_Other Uses	

Different pattern or geometrical frame styles were assigned to the next level within the hierarchical structure.

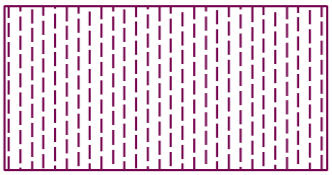
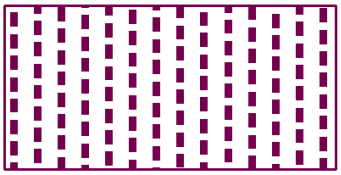
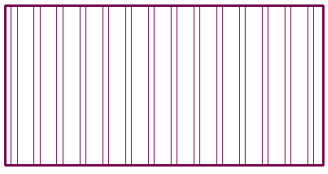
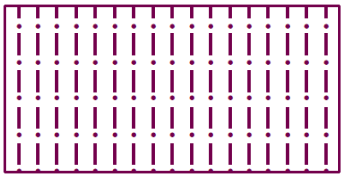


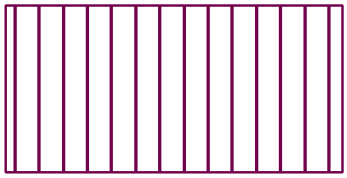
The higher the level of detail of the element of the HILUCS list, the greater the complexity of the symbol or pattern used, within a clearly structured hierarchy. Here are some examples:

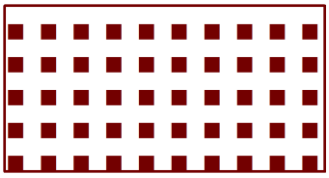
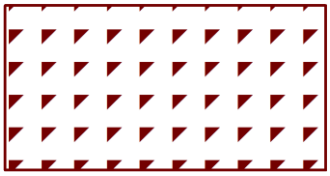
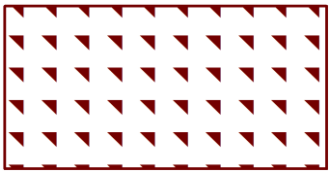
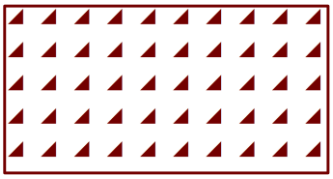
Category	Sketch or Pattern

3_4_6_MaritimeServices	
3_4_6_1_NauticalSports	
3_4_6_2_Beaches	
3_4_6_3_CoastalTourism	

At each, following level of detail, different geometrical frames were established within the style of the upper level. This involves a play between values of angle, offset, separation, layers, etc. See examples below:

Category	Sketch or Pattern
4_3_3_1_SolidWasteTreatment	
4_3_3_2_WaterWasteTreatment	
4_3_3_3_MarineLitterLocation	
4_3_3_4_MarineOilDischarge	

4_3_3_5_MarineOffshoreDischarge	

Category	Sketch or Pattern
3_4_7_UnderwaterCulturalHeritage	
3_4_7_1_Natural	
3_4_7_2_Wreck	
3_4_7_3_Archeological	

Owing to the characteristics of some elements, it was necessary to create a line chart symbology.

This structure is sequenced in successive categories and levels of detail, and different frames were assigned to each element of the HILUCS list for this MSP model.

The symbology could be created with different desktop softwares; the most commonly used are QGis and ArcGis. The software allows export to XML format.

Once the symbology has been developed with the available software (QGis, ArcGis for instance) it is necessary to export the XML format to the standard SLD format. QGIs provide an export tool for this option. SLD format is an open standard, therefore, any modification could be carried out through a text editor. [https://docs.geoserver.org/latest/en/user/styling/sld/cookbook/index.html].

Finally, to apply the style to a map service created a Web Server (for example Geoserver or ArcGis Server) must be used. SLD file with the “style manager” must be imported and will then be available for use.

Geospatial Web Servers such as Geoserver have the SLD standard as the primary language to define styles. [https://docs.geoserver.org/latest/en/user/styling/sld/reference/index.html].

In the case of Madeira, the symbology to the layers that will be publishing through Web Map Service are applied. In this case, the dataset MSP_ZonningElement must have the field "hilucsMSP.1.href" because this data will be symbolized through it, via a rule of filter defined by the standard SLD.

```
<ogc:Filter>
    <ogc:PropertyIsEqualTo>
        <ogc:PropertyName> hilucsMSP.1.href</ogc:PropertyName>
        <ogc:Literal>"code value"</ogc:Literal>
    </ogc:PropertyIsEqualTo>
</ogc:Filter>
```

In the Figure 14, we show an example of application of SLD developed for MSP data model by IEO, which has been applied to a map service in the Madeira archipelago MSP data model. SLD can be download at Canaries MSP platform, section MSP Tools (see chapter Templates), MSP INSPIRE model resources.

SLD can be downloaded at the Tools section of the *MSP platform Canaries* that can be accessed (see chapter Templates and Figure 13) : http://www.geoportal.ulpgc.es/marsp/

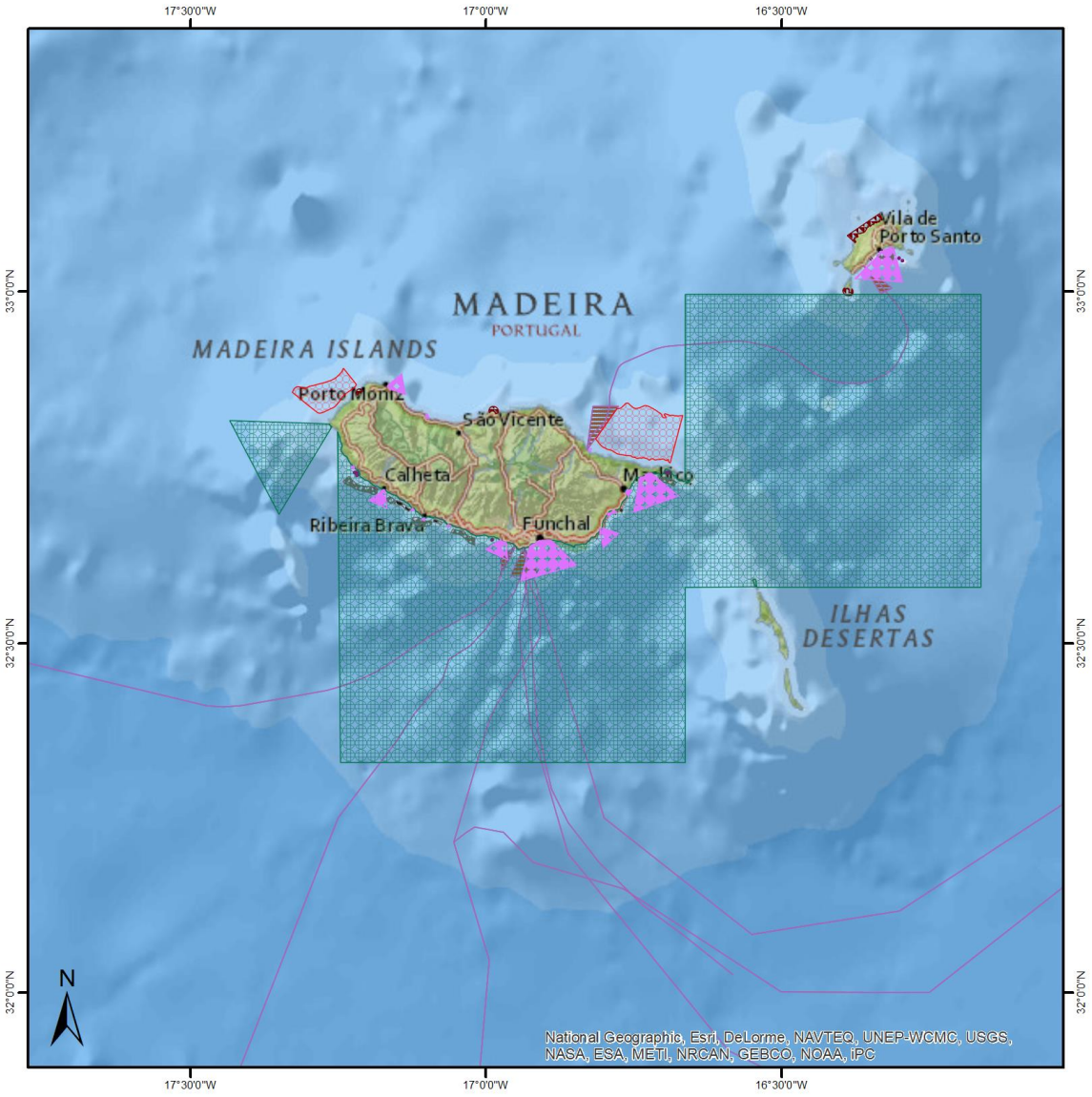


Figure 14 - SLD applied on the Madeira MSP draft

Mapping INSPIRE attributes in *.shp attributes

Shapefile (.shp) files, geospatial vector, despite a number of limitations as developed in early '90s, is the most used GIS data format globally. One of the limitations is a maximum number (10) of the attribute name characters. This limitation makes shapefile incompatible with INSPIRE rules, as most of attributes within the INSPIRE conceptual model have more than 10 characters.

In the shapefile INSPIRElike data model presented here, we include mapping of the shapefile attribute name with INSPIRE compliant names that are included in the model.

Spatial Plan attributes	
Shapflie attribute name	**INSPIRE conceptual model**
LocalID	**LocalID**
namespace	**Namespace**
versionID	**VersionID**
	extent (Geometry)
officTitle	**officialTitle**
LevelSpPla	**levelOfSpatialPlan**
PlanTyNam	**planTypeName**
proStepGen	**processStepGeneral**
bcgMap	**backgroundMap**
ordinance	**ordinance**
validFrom	**validFrom**
validTo	**validTo**
altTitle	**alternativeTitle**
begLifeV	**beginLifespanVersion**
endLifeV	**endLifespanVersion**
officDocum	**officialDocument**
srsName	**srsname**

MSP Zoning Elements	
Shapflie attribute name	**INSPIRE conceptual model**
LocalID	**LocalID**
nameSpace	**Namespace**
versionID	**VersionID**
	Geometry
HilucsV1	**hilucsLandUse**
HilucsMSP1	**hilucsMSP**
regulNatur	**regulationNature**
vertDistr	**verticalDirstribution**
proStepGen	**ProcessStepGeneralValue**
hilucsPres	**hilucsPresence**
SpecifLU1	**specificLandUse**
specPresen	**specificPresence**
bcgMap	**backgroundMap**
begLifeV	**beginLifespanVersion**
endLifeV	**endLifespanVersion**
validFrom	**validFrom**
validTo	**validTo**
DimIndVal	**DimensioningIndicationValue**
spatPlanID	**spatialPlanID**
officDocum	**officialDocument**
srsName	**srsname**

Supplementary Regulation	
Shapflie attribute name	**INSPIRE conceptual model**
LocalID	**LocalID**
nameSpace	**Namespace**
versionID	**VersionID**
	Geometry
regulNatur	**regulationNature**
suppRegula	**supplementaryRegulation**
proStepGen	**ProcessStepGeneralValue**
spcSupReg	**specificSupplementaryRegulation**
spcRegNat	**specificRegulationNature**
bcgMap	**backgroundMap**
inherited	**inheritedFromOtherPlans**
begLifeV	**beginLifespanVersion**
endLifeV	**endLifespanVersion**
validFrom	**validFrom**
validTo	**validTo**
DimIndVal	**DimensioningIndicationValue**
spatPlanID	**spatialPlanID**
officDocum	**officialDocument**
srsName	**srsname**

7 steps to make Maritime Spatial Plan INSPIRE compliant

Step 1
Downlaod MSP data model templates www.geoportal.ulpgc...

Step 2: Choose the template:
MSPdataModel_ESRI_shp MSPdataModel_GeoPackage MSPdataModel_XSD 4 GML

Step 3: Mapping the MSP into data model
Mapping the MSP Spatial Plan
Mapping the MSP framework into MSP Spatial Plan layer, including at least all compulsory attributes defined for Feature type MSP Spatial Plan, including: Id; name; title; extension and territorial hierarchy of plan . Extension is a polygon that presents Exclusive Economic Zone or overall area included in the planning process.
MSP Spatial Plan will include attribute with association link with Official documentation (e.g. as URL).

Step 4: Mapping the MSP into data model
Mapping the MSP-Zoning Elements
Mapping planned activities in the MSP-Zoning Elements layer. Each maritime activity included in the plan will be separated feature with own geometry and at least compulsory attributes, including: Id; classification of zoning activities with HILUCS & extended HILUCS; regulation nature; and vertical distribution value.
Each Zoning Element will include association link with MSP spatial plan and optionally with Official documentation.

Step 5: Mapping the MSP into data model
Mapping the Supplementary Regulation
Mapping Supplementary regulation elements with Supplementary regulation layer. Each regulation included in the planned area will be separated feature with own geometry and at least compulsory attributes,including: Id; regulation classification; and nature of the regulation.
Each Supplementary regulation feature will include association link with MSP spatial plan and optionally with Official documentation.

Step 6: Mapping the MSP into data model
Mapping the Official Documentation
Mapping Official documentation. This feature can be included only in Spatial Plan as URL, or as a separated table with all Id and related attributes.

Step 7 - INSPIRE compliancy
If you used GeoPackage template, your mapped data set is already INSPIRE compliant
If you used ESRI_shp template, you data set is an INSPIRE like – not fully compliant with INSPIRE data model. To obtain compliancy it is necessary to upload ESRI_shp file as source data set into Humboldt Alignment Editor (HALE); upload XSD file as a target template; and execute transformation file () into INSPIRE compliant gml file.

Annex – Madeira use-case, example

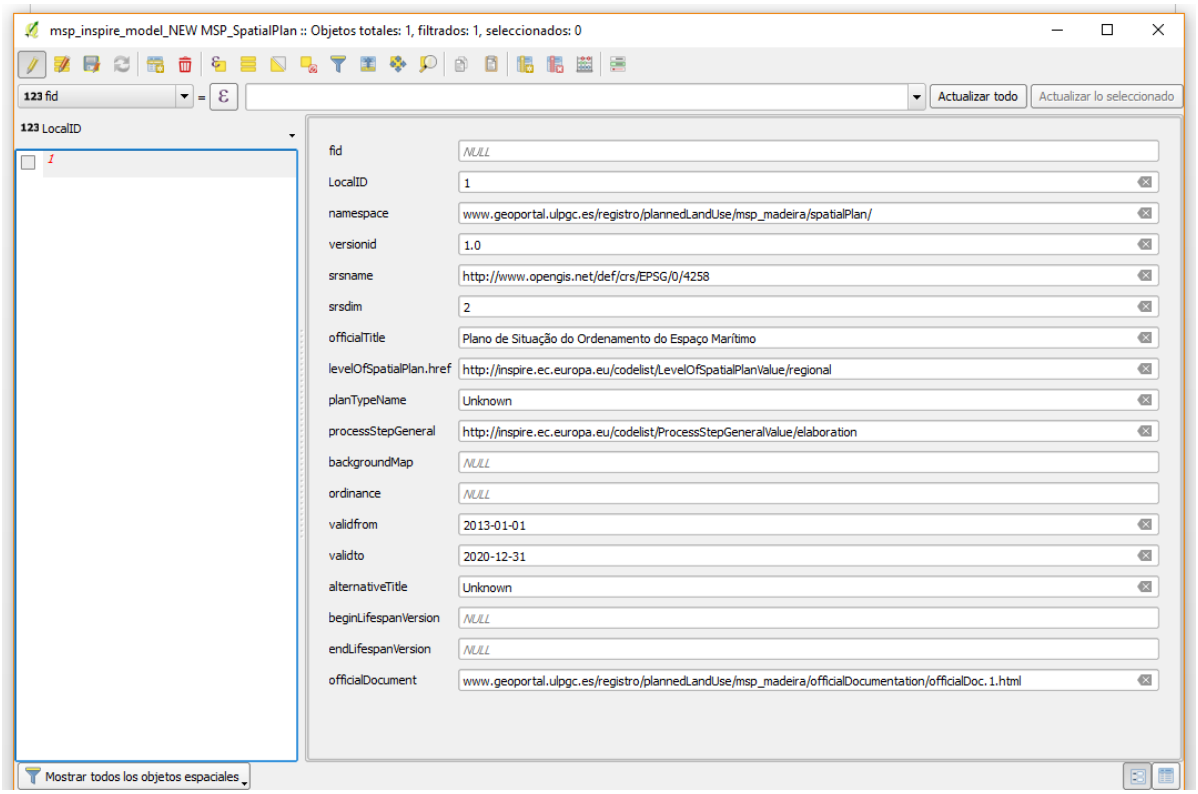


Figure 15 - Attributes example (Madeira MSP draft) MSP Spatial Plan feature

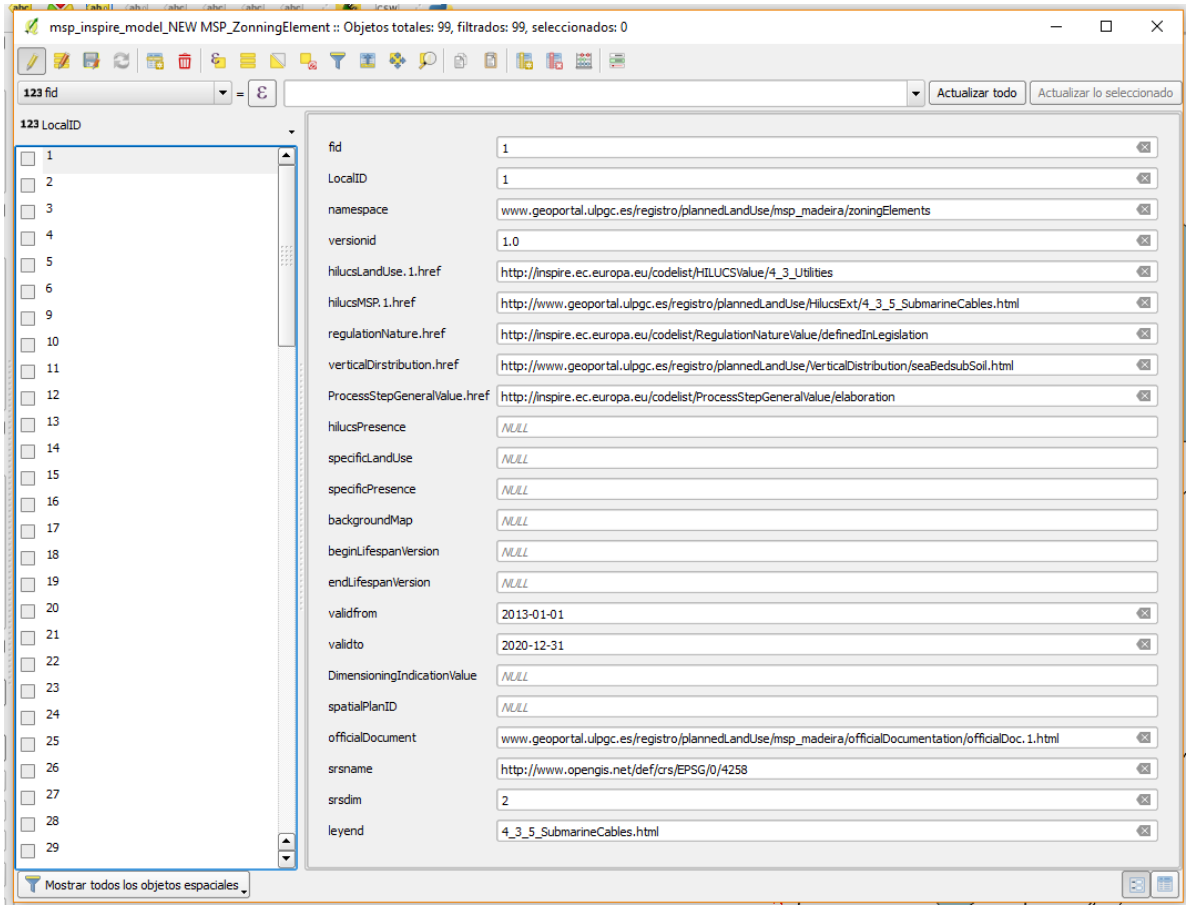


Figure 16 - Attributes example (Madeira MSP draft) MSP Zoning Element feature

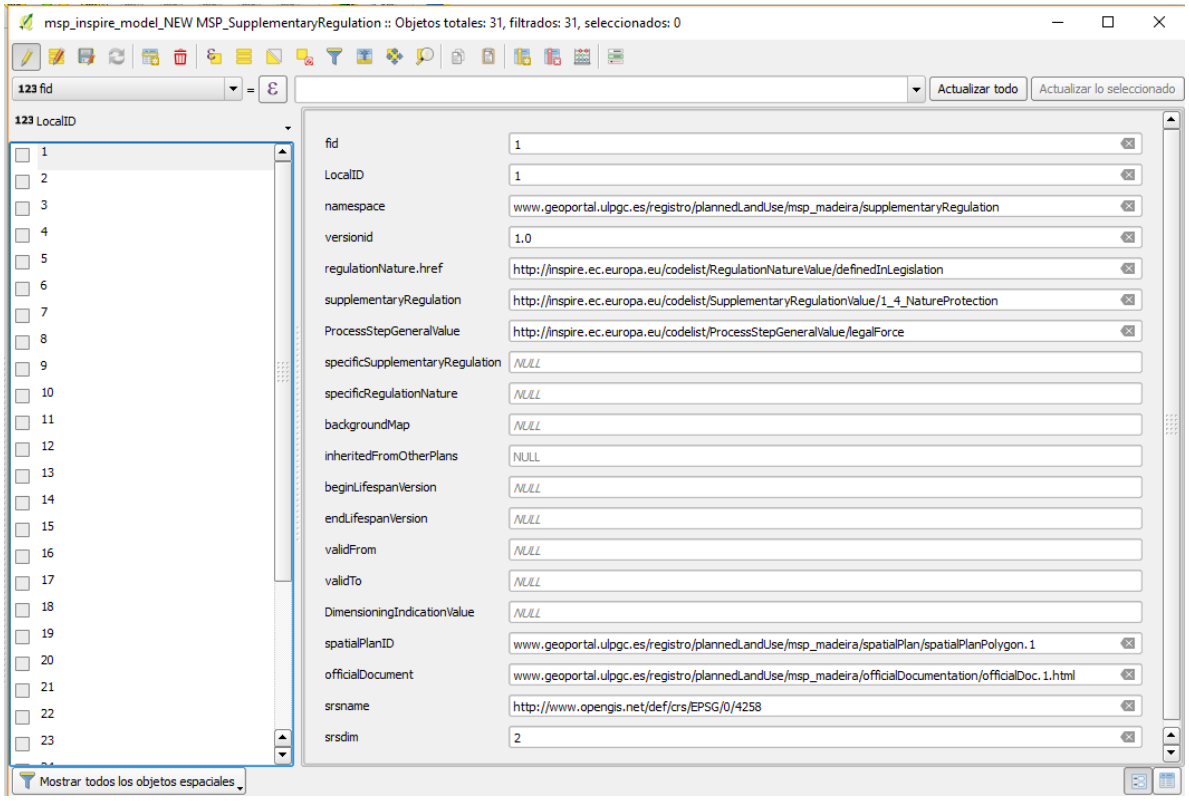


Figure 17 - Attributes example (Madeira MSP draft) Supplementary regulation feature:

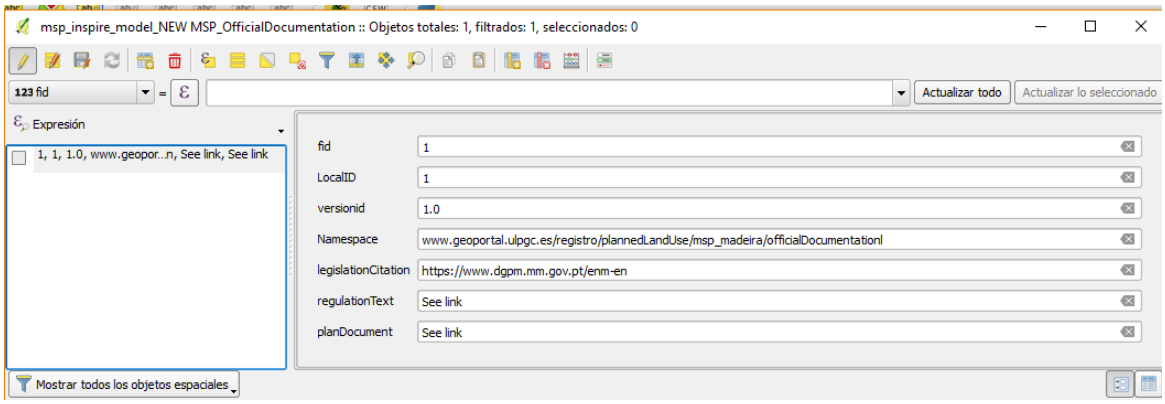


Figure 18 - Official documentation feature