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A fine scale spatial infrastructure for implementing networks of **Marine Protected Areas: The AMAre Geoportal**

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The AMAre Project

AMAre (Actions for Marine Protected Areas) is an ongoing Interreg MED Programme project with the aim to develop shared methodologies and geospatial tools for multiple stressors assessment, coordinated environmental monitoring, multi-criteria analyses and stakeholders' engagements. The final aim is to scale up strategies and recommendations at transnational level adopting an ecosystembased approach considering the goals of the Marine Strategy Framework Directive (MSFD) across MPAs. In this framework we collected and examined available spatial data for the 5 Marine Protected Areas (MPAs) involved in the project. Starting from these data and from MPA needs, we built a common data model based on the INSPIRE Data Specification and we developed a geodatabase. The geodatabase has been populated for the 5 MPAs and published on the AMAre Geoportal that organizes and integrates the principal themes available for MPAs.

1. MPAs world and needs

2. The data model

The AMAre data model is based on the INSPIRE Data Specification we simplified in order to better



multidisciplinary, ranging from habitat distribution (Fig. 1a) to human activities (Fig. **1b**), monitoring (Fig. 1c, 1e, 1f) and management (Fig. 1d). The data and the architecture of geodatabase the were MPAs validated the by through dedicated managers meetings and by GIS experts making the AMAre products reliable management tor purposes long term in а perspective and answering to fine scale specific needs.

data

are

Fig. 1. Examples of data coming from 4294465 the AMAre Marine Protected Areas

3. The geodatabase

We imported the UML model in a ArcGIS File geodatabase (Fig. 3) and we populated 5 distinct geodatabases, one for each MPA with the aim to provide a tool supporting management for private use (Fig. 4). At the same time we organized all the geodatabases in a Oracle database and we published them through an unique web application.

🖃 🖶 Administration	🗉 🖶 CoastalPressure	🗆 🖶 HabitatsAndBiotopes	🖻 둼 Oceanography	ReflectivityGridCoverage	Images
😁 Boundary	AnthropicActivityAndStructure	🖾 Habitat	🔁 CHL_s_has_CHL_sat_m	RiskAnalysis	
😳 LegalVertex	🔁 AnthropicActivityAndStructureHasIndicators	🔁 HabitatHasHabitatSpeciesType	🔁 CHL_s_has_CHL_sat_s	W Salinity	ManagementB
MPA Sector Advances of the sector advances of	😁 CoastalDevelopment	🔁 HabitatHasHabitatStatus	🔁 CHL_s_has_CHL_sat_y	Part SeaSurfaceCurrent	ManagementP
🖶 MPAhasDesignationType	🔁 CoastalDevelopmentHasIndicators	🔁 HabitatHasHabitatTypeCoverType	Chlorophyll_s	SeaSurfaceTemperature	Measurements

fit the project needs and to obtain a unique integrated structure. We modeled the logical schema with Enterprise Architect software, a standards-based modeling environment who defines mappings between UML 2 and ArcGIS concepts, and prototypes an automated import and export capability for ArcGIS geodatabase schemas represented in UML. The model consists of 17 feature datasets, 76 feature classes, 59 relationship classes, 39 tables and 13 raster catalogs organized by 10 thematic groups:



七 MPAhasDocuments	🛨 HumanFrequentation	👑 HabitatSuitabilityModel
🔁 MPAhasIndicators	🗄 HumanFrequentationHasIndicators	🗆 둼 Hydrogeology
日本 MPAhasManagementBody	ElevationGridCoverage	HydrogeologicalArealObject
日本 MPAhasManagementPlan	ElevationVectorElements	😁 HydrogeologicalLinearObject
OtherProtectedSite	😁 BreakLine	🔃 HydrogeologicalPunctualObject
🔁 OtherProtectedSiteHasActivitiesManagement	🛨 ContourLine	🖃 둼 Hydrography
🔁 OtherProtectedSiteHasDesignationType	SpotElevation	HydroArealObject
🔁 OtherProtectedSiteHasDocuments	FishingActivities	😁 HydroLinearObject
🔁 OtherProtectedSiteHasIndicators	🖾 Acquaculture	HydroPunctualObject
🔁 OtherProtectedSiteHasManagementBody	🕂 AcquacultureHasIndicators	🖃 🖶 MarinePollution
🔁 OtherProtectedSiteHasManagementPlan	🖾 Fishery	😳 MarineLitter
🖾 Zoning	FisheryHasIndicators	🔁 MarineLitterHasIndicators
🔁 ZoningHasActivitiesManagement	FishingEffort	NonpointSourcePollution
🗄 🖶 ArtificialInfrastructures	🛨 FishingRoute	🔁 NonpointSourcePollutionHasIndicators
ArealInfrastructure	FishingRouteHasIndicators	PointSourcePollution
😁 LinearInfrastructure	🗆 🖶 Geology	🔁 PointSourcePollutionHasIndicators
PunctualInfrastructure	· ArcheologicalFeature	🗆 둼 Monitoring
🗄 🖶 Biodiversity	CoastalStatus	😁 LinearSample
😳 NestingSite	🛨 CoastType	🖶 LinearSampleHasImages
HestingSiteHasIndicators	GeologicalRisk	🖶 LinearSampleHasMeasurements
🖶 NestingSiteHasSpecieNameType	GeologicArealStructure	ご PunctualSample
SpawningAndNurseryArea	😑 GeologicLinearStructure	PunctualSampleHasImages
占 SpawningAndNurseryAreaHasIndicators	GeologicPunctualStructure	PunctualSampleHasMeasurements
🖶 SpawningAreaHasSpeciesNameType	🖾 GeologicUnit	🔛 Station
🔛 SpeciesAbsenceUnit	GeomorphoArealFeature	🔁 StationHasExperimentalDesign
🔁 SpeciesAbsenceUnitHasSpeciesNameType	😁 GeomorphoLinearFeature	🖾 SurveyArea
🔛 SpeciesDistributionUnit	😳 GeomorphoPunctualFeature	🗄 SurveyAreaHasExperimentalDesign
🔁 SpeciesDistributionUnitHasDistributionInfoType	SeabedSubstrate	Transect
뭅 SpeciesDistributionUnitHasIndicators	😁 Shoreline	👷 🔁 TransectHasExperimentalDesign
🔁 SpeciesDistributionUnitHasSpeciesNameType	🗆 둼 Geophysics	1 Nutrients
🖾 SpilloverArea	😁 GeophProfile	
🔁 SpilloverAreaHasSpeciesNameType	😳 GeophStation	
ຼ 🗄 SpilloverHasIndicators	🖾 GeophSwath	
🐨 Chlorophyll	🔁 GeophSwathHasElevationGridCoverage	

🖶 GeophSwathHasReflectivityGridCoverage

NUT_m_has_NUT_mod_y Socioeconomics NUT_m_has_NUTmod_m NUT_m_has_NUTmod_s LandUse Nutrients_m OX_m_has_OX_mod_m Locality OX_m_has_OX_mod_s MaritimeUse OX_m_has_OX_mod_y Oxygen_m Municipality SeaSurfaceCurrent_m Figure 3 - SystemModifications SeaSurfaceSalinity_m SeaSurfaceTemperature_n SeaSurfaceTemperature_s SSC_m_has_SSC_mod_m SSC_m_has_SSC_mod_s - Erosion SSC_m_has_SSC_mod_y SSS_m_has_SSS_mod_m SSS_m_has_SSS_mod_s SSS_m_has_SSS_mod_y Threats SST_m_has_SST_mod_m Transparency SST_m_has_SST_mod_s ActivitiesManagement SST_m_has_SST_mod_y CHL_sat_m SST_s_has_SST_sat_m CHL_sat_s SST_s_has_SST_sat_s CHL_sat_y SST_s_has_SST_sat_y DesignationType TRA_s_has_TRA_sat_m DistributionInfoType TRA_s_has_TRA_sat_s Documents TRA_s_has_TRA_sat_y ExperimentalDesign Trasparency_s HabitatSpeciesType 🖉 Oxigen HabitatStatus 📴 OxigenBottom HabitatTypeCoverType



4. The geoportal

The AMAre Geoportal is a web application (HTML5 technology) published by the software ArcGIS Server 10 and the Moka CMS (Content Management System). The Moka CMS GIS system is the core of the GIS infrastructure, it is a tool for creating GIS application using cartographic object organized in a catalogue. The AMAre Geoportal allows an interactive visualization of the spatial data organized in a common spatial infrastructure (Fig. 5). The portal combines intelligent web maps with graphs, charts, tables and text to unlock, make accessible and reusable the data in a coordinated manner. The user can navigate through the layers, download features and tables, customize its view and print maps.



Fig. 3. View of the AMAre Geodatabase in ArcCatalog.



Fig. 4. Map of the distribution of habitats and human activities in the Freus d'Eivissa i Formentera MPA. This map is an example of how GIS tools can support the MPA management.



AMAre Website

Torre Guaceto MP Metadata Organization: CNR-ISMAR Organization Role: pointOfContact Sporades MP Identification Information North-East MPA Title: Porto Cesareo MPA - Habita Dataset Publication Date: 2018-10-30 Abstract: Habitat extent and distribution in the Marine Protected Area of Porto Cesard Hierarchy Level: Dataset Data Type: Vecto Data Theme Theme Topics: Biology and Ecolog Spatial Doma Data Quality Information Scope (quality information applies to): Dataset Data History: The map was produced by the Marine Protected Area of Porto Cesareo under the direction Paolo D'Ambrosio and published as digital map in the framework of the AMAre projec Contact Information Organization: CONSORZIO Contact Position: Directo Distribution Informatio Format Name: Shape Format Version: x Distribution Link: http://gismarblack.bo.ismar.cnr.it:8080/mokaApp/apps/AMAV1H5/index. Distribution Link Function: Information

5. Metadata

Metadata Reference Informatio

The AMAre Geoportal is a critical tool to improve the management of the MPAs with a coordinated approach, essential to introduce principles of maritime spatial planning. The main difference between the geoportals dealing with large scale datasets and the one we present is that this was specifically conceived for MPAs fine scale and tailored on their needs. The geodatabase is a common tool to facilitate the decision support system. It encourages the communication with stakeholders and improve the management within each MPA and the comparisons across MPAs on the distribution and the effects of human activities, biodiversity status and relevant management issues.

Each layer of the geoportal has his metadata form (Fig. 6). The metadata are managed by the ESRI Geoportal server, a free, open source product that enables discovery and use of geospatial resources including datasets, rasters, and web services. Geoportal inventories all the metadata of the registered geospatial resources in a geoportal catalog service, which is an Open Geospatial Consortium (OGC) compliant CS-W 2.0.2 service. The metadata contain also the links to OGC services, making maps and data available in an open, internationally recognized format.