A supporting marine information system for maritime spatial planning: The European Atlas of the Seas

Vittorio Barale

European Commission, Joint Research Centre, Directorate for Sustainable Resources, TP 270, Via E. Fermi 2749, I-21027 Ispra, VA, Italy

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ABSTRACT

The European Atlas of the Seas is a web-based coastal and marine information system, originally aimed at the general public, but capable also of supporting non-specialist professionals in addressing environmental matters, human activities and management policies related to the sea. It is based on a combination of data (and meta-data), which present a snapshot of both natural and socio-economic elements of coastal and marine regions in the European Union and its Outermost Regions. The first idea of a European Atlas of the Seas was set forward in 2007 with the launch of the Integrated Maritime Policy for the European Union. Early work on the Atlas was conducted by the Directorate General for Maritime Affairs of the European Commission, while further development of system architecture, data collection, map services and descriptive text was assigned in 2013 to the Joint Research Centre, with the aim to offer new services and features, as well as the interaction with other available information tools. The present European Atlas of the Seas consists of background data layers designed to be displayed as map backdrop, as well as a number of thematic data layers, classified under 8 main categories: geography, nature, tourism, security and safety, people and employment, transport and energy, governance and European policies, fisheries and aquaculture. These can be used to compose customized maps, as user-defined *ad hoc* indicators, and to probe them with tools such as product-to-product correlations, or time series visualisation. Non-specialist professional users can use such analysis and interpretation capabilities to couple data into ecological and socio-economic indicators for a wide range of applications. The thematic map collection provided a common baseline that can be used by Member States of the European Union in getting started with the Maritime Spatial Planning Directive requirements. As this is seen as a pre-requisite for Blue Growth, the European Atlas of the Seas will help the sustainable use of marine ecosystem services and resources.

1. Introduction

The Europe-wide map collection of the European Atlas of the Seas – a web-based Marine Information System (MIS) developed and currently maintained by the European Commission (EC) – provides a common baseline that can help Member States (MS) of the European Union (EU) develop a regionally coordinated Maritime Spatial Planning (MSP) process, the implementation of which is widely seen as a pre-requisite for Blue Growth. With the 2014 entry into force of the MSP Directive (Anonymous, 2014), the EU MS are stepping up efforts to plan the sustainable exploitation of their seas. The information baseline offered by the Atlas, by providing maps of current or designated uses of marine space, by facilitating sharing of best practices, and by monitoring progress and disseminating results of MSP processes, is poised to support MS in their endeavour. At the same time, the Atlas allows regulatory entities to consider advancements in protecting the sea, to assess where space has been reserved for specific uses, and to evaluate

whether Blue Growth objectives have been achieved. To all these stakeholders, the Atlas, based on data originating primarily, if not exclusively, from the EC and its Agencies, offers basic instruments to derive indicators on a range of maritime issues, as well as map services and data analysis tools, such as product-to-product correlations, or time series visualisation. Moreover, the Atlas is designed to facilitate access to new data products, services and features, as well as for interaction with other information tools currently available on the web.

The development of such a support MIS was first advocated in 2007 by the Blue Paper that launched the EU Integrated Maritime Policy (IMP),[1] aiming at a coherent approach to maritime issues and to an increased harmonisation of different policy areas, while focusing on multi-sector economic development, *i.e.* Blue Growth, and on the co-operation of different sectors and actors, *e.g.* on Marine Knowledge (European Commission, 2007). Substantial progress has been made in harmonizing and assembling Europe's marine and maritime data for scientists and engineers through the Marine Knowledge 2020 initiative,

according to which scientific and technical knowledge needs to be made more understandable, accessible and useable, to benefit for a broader audience (European Commission, 2012). In its original conception, the Atlas' collection of maps and related fact sheets was to extend this notion, and present a snapshot of the key environmental and socio-economic elements of coastal and marine environment, in the EU MS and their Outermost Regions, also to the public at large. However, what was originally foreseen as a mere public-oriented communication and education tool, today has evolved into a significant experiment of knowledge brokerage in the maritime sector, mediating between the research domain and a varied group of practitioners, interested in having simplified access to highly specialized information. The overall approach is to convert complex scientific data about coasts, seas and oceans into graphical form, so that non-specialists may use (and overlay, combine, or fuse) the available products, without having to transfer or process large amounts of data, tasks that might require *ad hoc* technical skills often unavailable (Barale et al. 2015).

The EC Directorate General (DG) for Maritime Affairs and Fisheries (MARE) started initial work on the European Atlas of the Seas already in 2008, while the actual system architecture and the original infrastructure, data collection, map services and descriptive texts were drafted in 2009. A first prototype of the Atlas was published on the web in 2010, after a public consultation and a user survey. The 2011 Version 1, covering 50% more contents than the prototype (i.e. around 70 thematic maps) was followed at the end of 2012 by Version 2, with better performance and interoperability, and in early 2013 by an enhanced Version 2.1, hosted by the European Environment Agency (EEA). Through an agreement with DG MARE, the Joint Research Centre (JRC) of the EC was assigned the task to develop first an expanded Version 3, in the period 2013–2014, and then a technically advanced Version 4, addressing new requirements of an enlarged targeted audience, in the period 2015–2016, with the aim to foster the development of new features and services, as well as the interaction with other information access tools either available or planned. Following this approach, Version 4 of the Atlas was upgraded to improve availability of both environmental and socio-economic data, and to provide a suite of ready-made instruments for the evaluation of coastal and marine issues. Unlike earlier releases, the newest Version not only provides a reference point for the public in general, but also is also capable of helping non-specialist professionals (including policy makers and stakeholders at large) involved with environmental issues, human activities or policies related to Europe's coasts and seas.

In the following, the basic technical details about the Atlas Version 4 infrastructure will be provided, together with a description of the current Atlas contents' composition. The improved Information Technology (IT) solutions adopted by this latest Version (accessible from a variety of devices, including tablets and smartphones) allow to explore various maritime themes with each data layer, or to combine together more layers for a comparative look at the same themes. The goal is to provide users with analysis and interpretation capabilities, and to couple data into ecological and socio-economic indicators. The emerging picture of the Atlas is that of a widely applicable project, the real value of which lies in the unprecedented collaborative effort between many partners, in various jurisdictions, to put together an interactive cartographic system that meets most users' needs to share information about marine resources in the EU. The various partnerships and associations constituting the main strength of the Atlas will be highlighted, and the unique opportunities for data access and analysis, offered by this cooperative endeavor between EU MS and Institutions, will be described in some detail.

2. European Atlas of the Seas architecture

The European Atlas of the Seas architecture[2] is based on the

Environmental Systems Research Institute (ESRI™) stack, including the ArcGIS™ Application Programming Interface (API) for JavaScript[R] and ArcGIS™ Server. The new portal developed for the Atlas' Version 4 uses a seamless combination of some Languages and Frameworks designed and provided for the Web. These are: HTML5 and CSS3 for the graphical structure; JavaScript Language for the core and all functions; JQuery Framework for Graphical effects and functions improvements; and Dojo Toolkit framework for the interaction with the Document Object Model (DOM) for mobile applications. Version 4 has all the IT features that were present in previous versions, but with the development of the new API provided by ESRI™ these functions were improved to give a better navigation experience to the users, across maps and layers information.

For the server side infrastructure, around 120 map services[3] – standard protocols for serving geo-referenced map images over the Internet, which are generated by a map server using data from a GIS database (Scharl and Tochtermann, 2007) – are currently displayable in the Atlas. Most map services are published using an ArcGIS™ Server instance devoted specifically to this purpose. Such map services can be re-used by external applications, by means of the ESRI™ Representational State Transfer (REST) API, the Keyhole Markup Language (KML) format (Wilson, 2008) or the Open Geospatial Consortium (OGC) Web Map Service (De la Beaujardiere, 2006). Additionally, some map services published by external partners (i.e. Eurostat, EEA and ESRI™ map services) are systematically re-used. The Atlas is therefore a *de facto* aggregator of external map services, reinforcing in this way its distributed nature.

For the client side infrastructure, the cartographic interface of Version 4 is based on the ArcGIS™ JavaScript[R] viewer. It provides basic functionalities such as panning and zooming, map layer selection, legend display and object selection. A time slider is used to scroll through temporal data across time. With respect to previous versions, the new interface includes, among other features: map generation tools, to allow users to better specify and export a map; two user profiles, "thematic" (general public) and "do-it-yourself" (other users); improved interactivity, using innovative mapping techniques (Gaffuri, 2012); temporal visualisation, for animated maps and graphics with a time dimension. In order to improve the communication between the users and the developers of the Atlas, a user's feedback collection tool is available to send feedback messages. An information news-feed on the Atlas evolution is also available for the regular users.

3. European Atlas of the Seas structure

The European Atlas of the Seas offers global coverage for a number of marine and maritime parameters, but is specifically focused on the European marginal and enclosed seas (i.e., Mediterranean Sea, Black Sea, Baltic Sea, North Sea, Celtic Seas, Bay of Biscay, and Atlantic Iberian Coast), as well as the EU Outermost Regions (i.e., waters surrounding the Azores, Madeira and Canary Islands; plus French Guiana, Martinique, Guadeloupe, and Saint Martin in the Atlantic Ocean; as well as Mayotte and La Réunion in the Indian Ocean). When appropriate, it presents also details of treaties geographically located outside the EU, *e.g.* as in the case of the international Sustainable Fisheries Partnership Agreements (SFPA). The general appearance of the viewer welcoming users to the Atlas, showing a map of the EU marine regions, according to the boundaries adopted by EU MS, is illustrated in Fig. 1.

The information content of the Atlas is composed by a series of geographical layers, mirroring the main theme of the IMP of the EU, subdivided in "background layers", "thematic maps" and "do-it-yourself maps". All texts related to these data layers and maps are available in three languages, namely English, French and German. The main sources of data for the Atlas are the EC Institutions (see Table 1, item 1) and other EU

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[2] For full details, see: http://support.esri.com/en/.

[3] Complete map services list at: http://maratlas.discomap.eea.europa.eu/arcgis/rest/services/Maratlas.
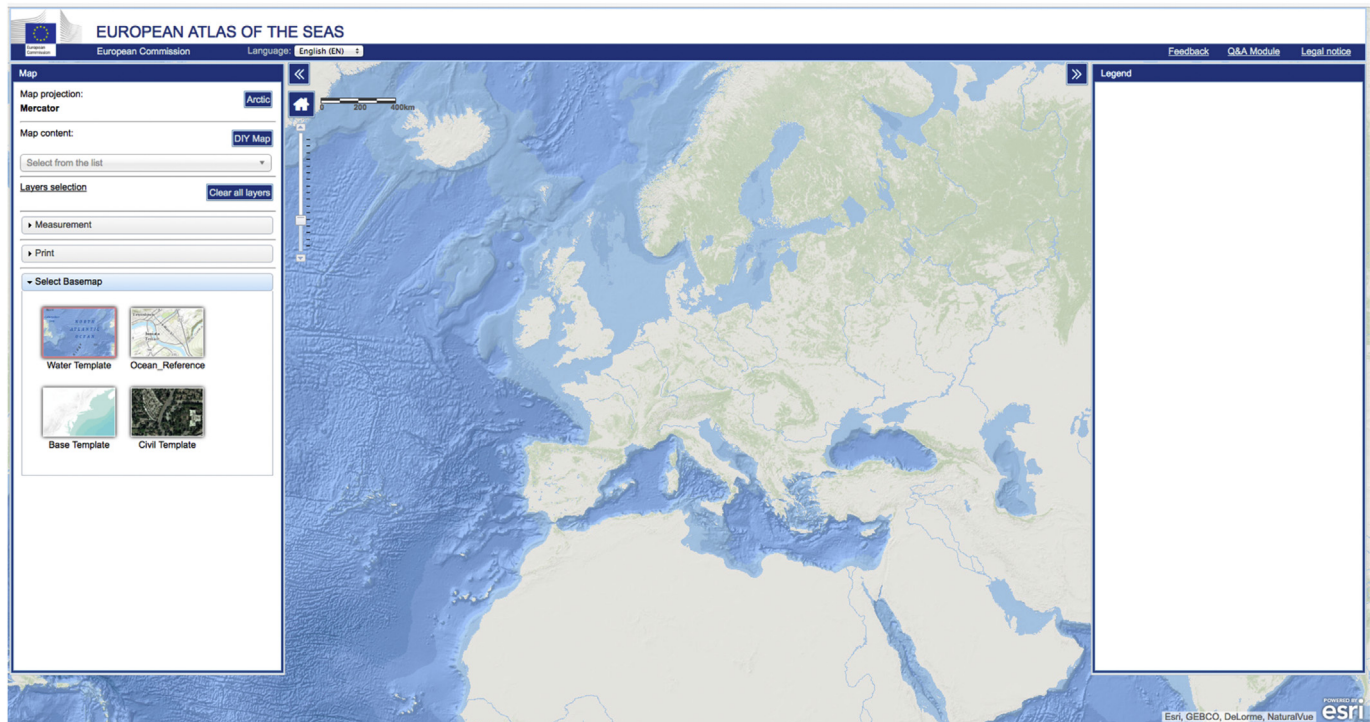
Fig. 1. European Atlas of the Seas viewer. Only a simple background map is shown, with the basic geographical features of the European continent (orography, hydrography) and the surrounding marine basins (bathymetry). In the upper left corner of the map, a spatial resolution slider and scale. To the far left, a window for the selection of the data layers to be displayed; to the far right, a second window ready to display legends and text related to the data layers selected. On the top bar, the user can find clickable switches for language (English, French, German), feedback, a questions & answers module, and legal notices.

Table 1
European Atlas of the Seas data providers.

1	EC Institutions (DG)	Energy (ENER), Environment (ENV), Joint Research Centre (JRC), Maritime Affairs (MARE), Mobility & Transport (MOVE), Eurostat (ESTAT) Geographic Information System of the Commission (GISCO)
2	Other EU bodies	European Environment Agency (EEA), European Maritime Safety Agency (EMSA), European Fisheries Control Agency (EFCA), European Market Observatory for Fisheries and Aquaculture (EUMOFA)
3	EC-funded programmes, projects and networks	Coordination of Information on the Environment' (CORINE) Programme; European Fisheries Areas Network (FARNET), bringing together Fisheries Local Action Groups (FLAGs) and implementing Community-Led Local Development (CLLD) under the European Maritime and Fisheries Fund (EMFF)
4	National governmental agencies or commercial companies from EU and EFTA Countries	VLIZ Marineregions.org, IGN, Swisstopo, AeroGRID
5	National governmental agencies or commercial companies from non-EU Countries	various United States (US) Agencies, *i.e.* US Department of Agriculture (USDA), US Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), National Geospatial Intelligence Agency (NGIA); US associations, like National Geographic and GeoNames; US companies such as ESRI, DigitalGlobe, DeLorme, i-cubed, NAVTEQ/HERE
6	International associations and institution	Association of the European Cadastre, Land Registry and National Mapping Authorities (EuroGeographics); European Maritime Heritage (EMH); General Bathymetric Chart of the Oceans (GEBCO); International Aquarium Forum (IAF); International Council for the Exploration of the Sea (ICES); International Hydrographic Organization (IHO); International Tanker Owners Pollution Federation (ITOPF); International Union for Conservation of Nature (IUCN)
7	UN bodies	United Nations Educational, Scientific and Cultural Organization (UNESCO); Food and Agriculture Organization (FAO) of the United Nations, and International Maritime Organization (IMO)
8	Additional "background maps" originators	Environmental Protection Agency (EPA); National Oceanic and Atmospheric Administration (NOAA); National Park Service (NPS); United States Department of Agriculture (USDA); United States Geological Survey (USGS); Department of Natural Resources Canada (NRCAN); Agriculture and Agri-Food Canada; Food and Agriculture Organization (FAO) of the United Nations; General Bathymetric Chart of the Oceans GEBCO_08 Grid; National Geographic; AeroGRID, CNES/Airbus DS, DeLorme, DigitalGlobe, Earthstar Geographics, GeoBase, GeoEye, Geonames.org, HERE, IGN, OpenStreetMap; ESRI™, GIS User Community

bodies (Table 1, item 2). Several EC-funded programmes, projects and networks, initiated directly under the auspices of either the EC Services and Agencies above (Table 1, item 3), or other national governmental agencies and commercial companies from the EU and European Free Trade Association (EFTA) Countries (Table 1, item 4) or non-EU Countries (Table 1, item 5), also play a major part in populating the Atlas database. In addition, input is provided by a number of international associations and institution (Table 1, item 6), as well as various United Nations (UN) bodies (Table 1, item 7). In the Atlas, the information source is always reported in full

detail, together with the metadata that accompany each map.

Four "background maps", provided by ESRI™ as ArcGIS™ map services (map originators are listed in Table 1, item 8), are included in the Atlas to deliver basic information, and to be displayed as a neutral background for other maps. The Base Template data layer[4] offers

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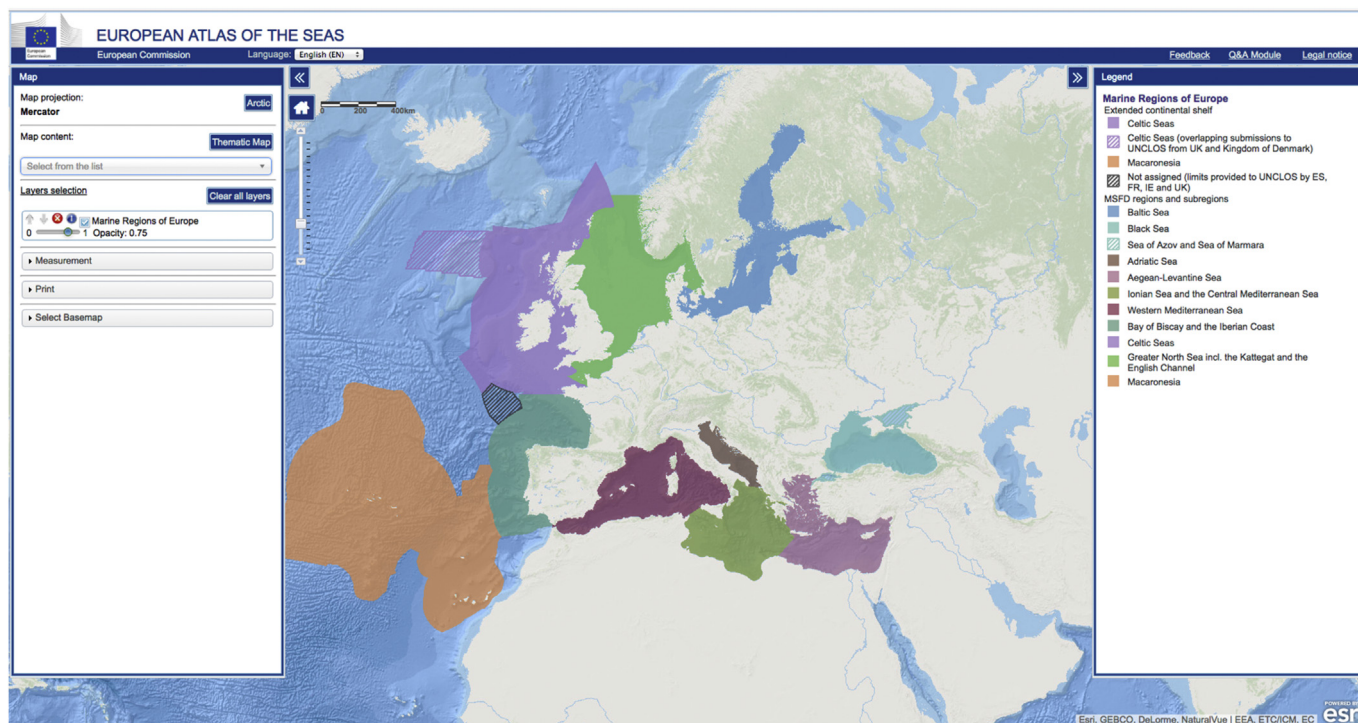[4] For details see: http://server.arcgisonline.com/arcgis/rest/services/WorldTerrainBase/MapServer.

Fig. 2. European Atlas of the Seas ready-made "thematic map", showing a map of the European Union marine regions, according to the boundaries adopted by Member States (adoption of the Marine Strategy Framework Directive Committee of November 10th, 2016). The map results from coordination across the EU legislation, taking into account various Directives. Further, the boundaries of the regions have been aligned, where feasible, with those of the Regional Sea Conventions active in the European Seas.

worldwide coverage of shaded relief imagery, bathymetry, and coastal water features, down to a scale of ~1:1,000,000. The Water Template data layer[5] shows marine bathymetry and inland waters, at variable regional scales, overlaid on land cover and shaded relief imagery. The Ocean Reference data layer[6] comprises administrative boundaries, cities, water features, physiographic features, parks, landmarks, highways, roads, railways, and airports, overlaid on land cover and shaded relief imagery, covering the world down to a scale of ~1:72,000 (or 1:4,000, 1:2000 and 1:1000 for selected areas). The Civil Template data layer[7] presents both high-resolution (1 m or better) satellite and aerial images, for selected parts of the world, and low-resolution satellite images elsewhere.

The Atlas, in view of its education and communication mission toward the general public, provides a series of ready-made "thematic maps" (see *e.g.* Fig. 2). These pre-conceived maps present a broad view of the most popular themes that emerged from the viewing statistics of the Atlas' earlier versions, *i.e.* natural setting, sea bottom, sea level rise, security, transport, tourism, energy, wind, fisheries and fish consumption. The aim of this group of maps is to cater to the needs of unskilled users, who simply want to learn more about a number of standard popular topics, mapped together in a concise way.

Further to background layers and thematic maps, a large number of basic elements are included in the Atlas, relating to natural and socio-economic elements of the European oceans, marginal seas and coastal regions, for the production of "do-it-yourself maps" (see *e.g.* Fig. 3). The name of this unit of the Atlas recalls the potential of all its data layers to be combined and displayed together, thereby allowing professional users to explore information contents and relations, and to create their

own indicator maps. This particular feature is where the Atlas is proving to be really innovative, and capable of delivering an unprecedented approach in fields previously reserved to specialists only.

The Atlas' graphical features allow users not only to set up specific composite maps of interest, but also to save, download and reproduce the results of their data exploration in successive reports. The data layers available for this purpose – stored as time series, when appropriate or feasible, and updated on a regular basis – are classified under 11 main categories (mirroring the main IMP themes) listed in Table 2. The total volume of all these layers – which include raster and vector marine data, as well as coastal data organized according to the Classification of Territorial Units for Statistics[8] hierarchical system – reaches several GB of data. All maps follow consistent cartographic rules and can be exported for external use. A progressive degree of simplification is adopted for small-scale visualisations, while more detailed data are used for large-scale visualisations.

The Atlas database described above presents a broad outline of natural and socio-economic features in the European marine and coastal regions, and is updated regularly with the latest releases from each provider. Automatic update procedures have been developed to ensure a quick upload from the different data sources. For most thematic layers, historical data remain accessible after the updates, so that time series may be constructed, to visualize the evolution of an indicator over a given period. The database may be enlarged at will, with the addition of ancillary layers covering new themes, in particular when relevant to the "blue economy" (*i.e.* foreseen in the EC Blue Growth Strategy[9]), like maritime transport, mineral or living resources, climate change and new biotechnologies.

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[5] For details see: http://server.arcgisonline.com/arcgis/rest/services/Ocean/WorldOceanBase/MapServer.

[6] For details see: http://server.arcgisonline.com/ArcGIS/rest/services/WorldTopoMap/MapServer.

[7] For details see: http://server.arcgisonline.com/ArcGIS/rest/services/WorldImagery/MapServer.

[8] The Classification of Territorial Units for Statistics (often referred to with the acronym NUTS, from the French: *Nomenclature des unités territoriales statistiques*) is a geocode standard used to reference EU Countries subdivisions for statistical purposes. It was introduced by Eurostat in 1988, on the basis of all Countries' local administrative units. See: http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction.

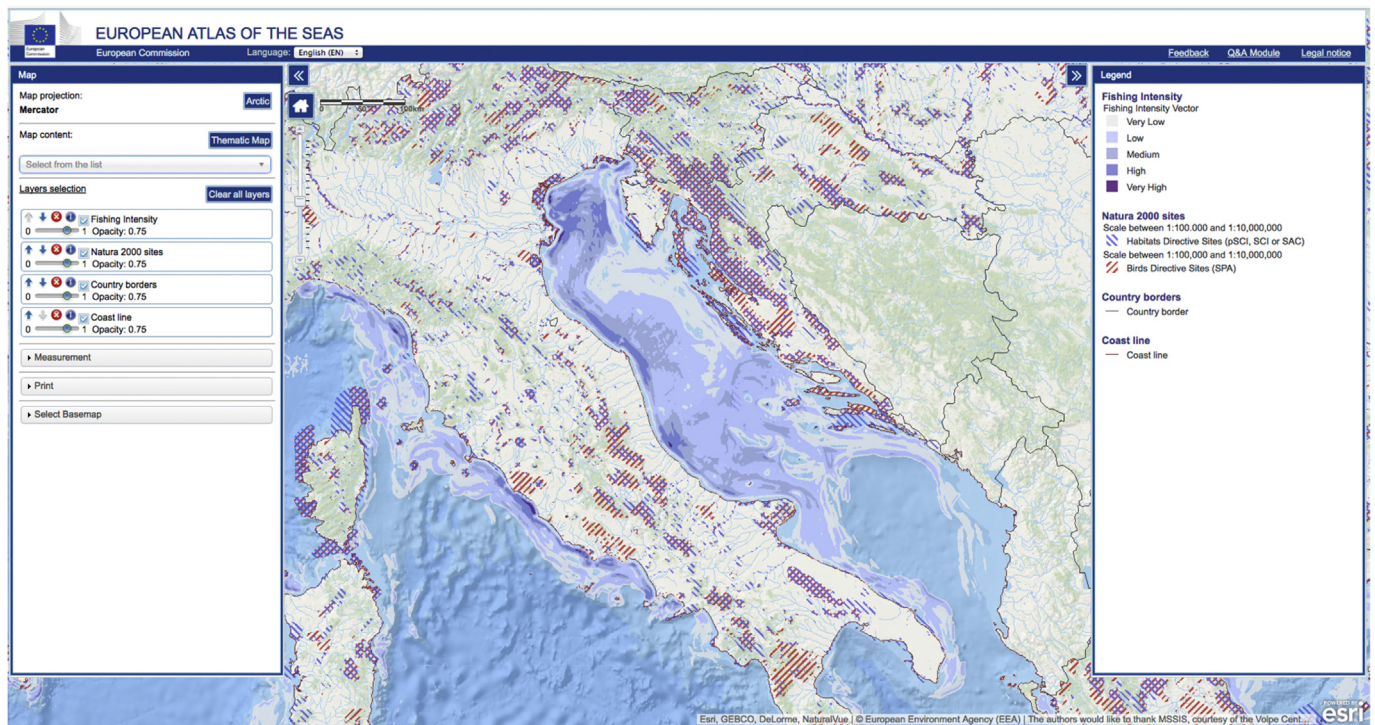[9] See: http://ec.europa.eu/maritimeaffairs/policy/blue_growth/index_en.htm.

Fig. 3. European Atlas of the Seas "do-it-yourself map", illustrating the kind of data integration possible in a site-specific data composite. The map addresses the current status, main opportunities and potential conflicts of a specific maritime sector, *i.e.* the fisheries sector, in the Adriatic Sea. Interactions with nature conservation measures are represented by fishing intensity data (the main classification appearing in the marine area), location of Natura 2000 sites, as well as country borders and coastlines, overlaid on a physical map of hydrographic and bathymetric features.

Table 2
European Atlas of the Seas data layer categories.

	category	details
1	Marine Knowledge	provides basic information on European Union (EU) countries, basins, bathymetry (depth & relief names), coastlines (land cover and infrastructures), hydrography, drainage basins, European Marine Observation and Data network (EMODnet) partners and links to other regional atlases
2	Nature & Environment	includes oceanographic parameters, sea level change, coastal erosion, land cover, Large Maritime Ecosystems (LME), international conventions, protected areas and Natura 2000 sites
3	Socio-Economics	provides demographic and economic statistics for coastal regions, i.e. Gross Domestic Product (GDP), maritime impact, population density, population changes, active population and other age groups, urban-rural typology, employment and unemployment by sector
4	Fisheries	provides layers on fish stocks, fishing fleets (number of vessels, engine power, tonnage), fishing ports, fishing zones (as defined by the International Council for the Exploration of the Sea, ICES, and the Food and Agriculture Organization, FAO), quotas (by countries, fishing zones and species) and catches (by countries and by fishing zones); production, processing facilities, consumption and trade (volume and value); employment, Fisheries Local Action Groups (FLAGs), regional fisheries management (highly-migratory and non-highly-migratory species), producers organizations, advisory councils under the same heading, the "aquaculture" category covers total production and production by species
5	Transport	offers layers on ports, ferry routes, motorways of the sea, shipping (i.e. transported passengers and goods, by port and route)
6	Energy	covers average wind speed and direction, wave height and direction, tidal amplitude, marine energy production facilities, offshore wind farms (existing and planned)
7	Sea Bed Mining	shows undersea relief (names), seabed sediments and deep-sea mineral resources
8	Coastal Tourism	deals (primarily) with coastal environment (*e.g.* coastal geology, as well as state of bathing waters) and coastal infrastructures (*e.g.* accommodation offered, as number of beds per km^2), but covers also United Nations Educational, Scientific and Cultural Organization (UNESCO) world heritage sites, maritime museums and aquariums
9	Maritime Spatial Planning	provides layers on maritime spatial plans and project test sites, and with available coastal and marine atlases
10	Integrated Maritime Surveillance	maps surveillance projects and plans
11	International Ocean Governance	deals with political aspects of maritime affairs: Member States (MS) waters within the European Union, Conference of Peripheral Maritime Regions, Regional Advisory Councils, European Maritime Day

4. European Atlas of the Seas application examples

The tools available in the Atlas for map exploration and combination can be used to extract *ad hoc* indications on various themes from each data layer, or to combine together more layers for a comparative look at the same themes. As seen earlier, the basic idea behind these characteristics of the Atlas is that of providing non-specialist, but professional users with analysis and interpretation capabilities, to couple data into ecological and/or socio-economic indicators. Rather than

aiming to be a mere geographic data catalogue, the Atlas is conceived as an easy access point to marine and maritime datasets (providing coordinates of the websites from which original data can be downloaded, if required), organized into a Geographic Information System (GIS), and as a generator of high-quality, complete, thematic representations, for professionals, European policy-makers and of course citizens at large.

Examples of research innovations set for policy support are those linked to MSP, or to the Common Fisheries Policy (CFP). In the first

case, the Atlas' EU-wide thematic map collection delivers a common baseline that can help MS approaching the MSP Directive requirements. As this is widely seen as a pre-requisite for Blue Growth, future research extending current projects results and facilitating MSP applications will help combine protection and sustainable use of the European Seas' ecosystem resources. The Atlas expands the same support also to near-coastal issues and issues related to land-sea interactions (*e.g.* by providing data layers on coastal land use, bathing waters, coastal geology and erosion, river basins, coastal winds, waves and tides, ports, coastal infrastructures and various economic activities, and by incorporating the entire OURCOAST database[10]).

In the second case – which provides an example of a specific economic sector to be considered in the MSP process – the Atlas' maps offer a new, integrated, cartographic approach to fisheries research results, previously available only in lengthy reports, to improve data display and analysis and to monitor progress of policy implementation. Fig. 3 constitutes a sample of the novel possibilities offered by the Atlas, in a very critical maritime sector such as that of fisheries management. Together with marine parameters, a score of terrestrial parameters are also mapped (both being indispensable in the MSP process), illustrating the Atlas' capabilities for data synthesis and integration. In the same way, users are offered the opportunity to visualize, interrogate and compare on a single platform a very diverse spectrum of information related to fisheries – *e.g.* to associate the state of fish stocks in Europe with the total amount of catches and/or landings, or to visualize the European Maritime and Fisheries Fund (EMFF) operational programs of each MS, and link the different MS priorities and allocations.

As a policy support tool, the Atlas informs decision-making at all EU, national and regional levels. It aims to contribute to the Group on Earth Observations (GEO) Blue Planet Initiative,[11] on the global scale, and to the implementation of the Transatlantic Ocean Research Alliance,[12] on the regional scale. In order to extend inter-regional co-operation and finance macro-regional or sea-basin strategies, the EC services involved and a score of other stakeholders need harmonized information. This in order to provide a consistent view of knowledge related to Europe's seas and coasts, and to allow comparative analysis, tracking of advances, as well as accessibility of information on the geographic distribution and economic potential of maritime industries and/or EU-funded projects (*e.g.* on topics like marine biotechnology, seabed mining, ocean energy, coastal tourism, aquaculture). To this end, the Atlas facilitates a shared understanding of various aspects (natural, environmental, societal) of the European seas and their coastlines, which becomes accessible from computers, tablets and mobile devices, understandable to a broad audience (decision makers, stakeholders, general public), and continuously updated with data from a number of different sources.

The Atlas applications allow to re-use publicly available datasets from EU institutions and bodies and from selected data providers. Data assemblage and dissemination does not involve any duplication of efforts with other initiatives such as those of the European Marine Observation and Data network (EMODnet), the International Council for the Exploration of the Sea (ICES) or the Regional Sea Conventions (RSC), which remain the responsible entities for marine data collection. Dataset creation and management are left with the source organizations. Analysis and processing of data and information are performed, prior to their inclusion in the Atlas, only when required to provide operational solutions to a wide range of user requirements, and to render marine and maritime knowledge easily accessible to all potential users. This makes use of new software tools, or adaptations of existing software, and is backed by documentation of processes and workflows

for data ingestion and updates. Much work has been devoted to the development of a suitable public web application[13] for accessing the Atlas content, with links to other MIS. Similarly, the development of a parallel, restricted web application, available for the time being only within the EC, but expandable to other regulatory subjects as well, allows retrieving Atlas content and specific data layers that demand discretional access. A collaborative platform (WIKI) is also available to the Atlas' management team for data documentation and management of user feedback. Atlas-related activities include training and capacity building, as well as the production of promotional material for user assistance.

5. Concluding remarks

The European Atlas of the Seas remains essentially a publicly accessible web-based source of spatial data. As such, it conveys easy-to-access and easy-to-understand information at the fingertips of stakeholders in the EU Institutions, environmental administrations and bodies, professionals in various maritime sectors (including fisheries, transport, energy) and other types of organizations (*e.g.* private companies, non-governmental organizations, academia), and the wider public. In particular, the Atlas supports policymaking on marine environment, maritime issues and economic sectors, both within and outside the EC, by providing digital, thematic, composite maps of European seas and coasts. The availability of this wealth of information is expected to have a distinct positive effect on EU rules and strategies related to all marine and maritime matters, in particular when the Atlas beneficiaries are policy-makers, and to support the initial steps of MSP in the EU MS.

The European Atlas of the Seas is poised to become an even more advanced visualisation and mapping tool, in the framework of the current effort to simplify and streamline the plethora of MIS available online. The many initiatives in this field, either dealing with a holistic view of the sea or with specific maritime sectors, are a symptom of an unanswered requirement by a wide user community. Most of the current initiatives would benefit from a unifying element, such as the Atlas is becoming, to ensure substantial savings in organizing and delivering data, and giving a second life to past scientific projects. Ultimately, the Atlas aims to help policy-makers and other stakeholders at large cope with the incumbent data, information and knowledge overload, providing expertise in the use of modern, analytical tools.

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[10] OURCOAST: the European portal for Integrated Coastal Zone Management, available at: http://climate-adapt.eea.europa.eu/metadata/portals/ourcoast-the-european-portal-for-integrated-coastal-zone-management.

[11] For details see: http://geoblueplanet.com/.

[12] See: http://ec.europa.eu/research/iscp/index.cfm?pg=transatlantic-alliance.

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[13] The European Atlas of the Seas can be accessed by the general public via the Directorate General (DG) for Maritime Affairs and Fisheries (MARE) website, at the address: https://ec.europa.eu/maritimeaffairs/atlas_en.

Vanhove, also at DG MARE, who foresaw the final release of the Atlas Version 4.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ocecoaman.2018.03.026.

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Annex 1

Acronyms

API: Application Programming Interface
CFP: Common Fisheries Policy
CLLD: Community-Led Local Development
CORINE: Coordination of Information on the Environment
DG: Directorate General
DOM: Document Object Model
EC: European Commission
EEA: European Environment Agency
EFCA: European Fisheries Control Agency

EFTA: European Free Trade Association
EMFF: European Maritime and Fisheries Fund
EMH: European Maritime Heritage
EMODnet: European Marine Observation and Data network
EMSA: European Maritime Safety Agency
ENER: Energy
ENV: Environment
EPA: Environmental Protection Agency
ESRI™: Environmental Systems Research Institute
ESTAT: Eurostat
EU: European Union
EUMOFA: European Market Observatory for Fisheries and Aquaculture
FAO: Food and Agriculture Organization
FARNET: Fisheries Areas Network
FLAGs: Fisheries Local Action Groups
GDP: Gross Domestic Product
GEBCO: General Bathymetric Chart of the Oceans
GEO: Group on Earth Observations
GIS: Geographic Information System
GISCO: Geographic Information System of the Commission
IAF: International Aquarium Forum
ICES: International Council for the Exploration of the Sea
IHO: International Hydrographic Organization
IMO: International Maritime Organization
IMP: Integrated Maritime Policy
IT: Information Technology
ITOPF: International Tanker Owners Pollution Federation
IUCN: International Union for Conservation of Nature
JRC: Joint Research Centre
KML: Keyhole Markup Language
LME: Large Maritime Ecosystems
MARE: Maritime Affairs and Fisheries
MIS: Marine Information System
MOVE: Mobility & Transport
MS: Member States
MSP: Maritime Spatial Planning
NGIA: National Geospatial Intelligence Agency
NOAA: National Oceanic and Atmospheric Administration
NPS: National Park Service
NRCAN: Department of Natural Resources Canada
NUTS: Nomenclature des unités territoriales statistiques
OGC: Open Geospatial Consortium
REST: Representational State Transfer
RSC: Regional Sea Conventions
SFPA: Sustainable Fisheries Partnership Agreements
UN: United Nations
UNESCO: United Nations Educational, Scientific and Cultural Organization
US: United States
USDA: United States Department of Agriculture
USGS: United States Geological Survey