

Supporting island research and development through the ‘Archipelago’ information system

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ABSTRACT: Information systems play a crucial role in supporting decision-making for managing and administrating territories at different levels of authority. Unfortunately, most such information systems are not dedicated to or customized for the special needs imposed by islands. In this work we describe the design, implementation, and operation of the ‘Archipelago’ digital repository, an integrated information system for supporting island research and development. The main objectives of the system are the storage, documentation, and dissemination of any kind of data regarding islands, as well as the provision of cartographic facilities for searching, visualization, and comparison. The basic principle of the system is the ability to geographically designate any stored material. The system is compatible with the standards for digital information documentation and interoperability, and it is based on free and open-source software tools.

Keywords: digital repository, geographic services, islands, metadata, spatial data infrastructure, web cartography

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1. Introduction

Both research work and decision-making processes should be based on relevant, accurate, updated, and (preferably) complete information. For islands in particular, the availability of useful, timely information has been identified as a key issue in decision-making towards achieving sustainable development (UNDESA & OAS, 2003). Nowadays, a plethora of digital content, statistical data, and geospatial datasets are available online. For the facilitation of appropriate information discovery, a number of methods and practices have been established and continuously evolve, such as metadata standards, thematic portals, geoportals, institutional repositories, and ontologies. Unfortunately, most of the above technological achievements are not dedicated to or customized for the special needs imposed by islands.

Islands are very diverse but they share the concept of insularity (Royle, 2001; Gillis, 2004; Baldacchino, 2004; Armstrong & Read, 2006). The insularity discussion highlights a number of 'negative' characteristics of islands, or characteristics that are considered as negative by many people. There is a tendency to associate islands with rural, peripheral, and isolated landscapes and communities. It is we—humans—who imbue a place with the quality of *islandness* (Grydehøj, 2014). The essence of islandness evokes the stereotype of islands as places essentially disconnected, cut-off, and apart. Unlike the stereotype, however, island communities tend overwhelmingly to be integrated into complex networks of exchange for goods, people, and ideas (Grydehøj et al., 2015). Islandness is not easily defined. It takes as many different forms as there are islands. Its meaning differs from place to place, as well as over time. Islandness has taken on a whole new meaning today, since distinctions between islands and continents, once taken for granted, have become muted or dubious. In our time, when people are connected more electronically than territorially, the entire world is becoming archipelagic, with islands appearing everywhere, inland as well as offshore (Gillis & Lowenthal, 2007). If islandness is a particular state or condition of being, there is a corresponding action in *islanding* (Baldacchino & Clark, 2013; Clark, 2004). Baldacchino and Clark (2013) propose 'island' as a verb, 'islanding' as an action. We need this verb to mediate and attenuate dizzying oscillations between paradise and prison, openness and closure, roots and routes, materiality and metaphor.

According to Pleijel (2014, p. 9):

An island [...] can be large or small. It can lie in a river, in a lake, beside a coast, in an archipelago or lie far out in the middle of the ocean. Volcanic or coralline, mountainous or flat [...] an island can be connected to the mainland by ferry, bridge, tunnel, plane or cable car. Islands can be cramped or they can be spacious. Devoid of habitation, sparsely populated or overpopulated; they can be populated year-round or only part of the year. It can be a municipality, a town, a region or a state.

'Dry' and linked islands should not be excluded from island considerations, in order to avoid artificially isolating and peripheralising island society from mainland society (Grydehøj et al., 2015). Islands, oceans, and ships should not always be reductively conceptualized in isolation, because they are often bound together into complex, multifaceted, and shifting relations and assemblages (Pugh, 2016). Islands as metaphors or reality (Hall, 2012; Hay, 2006; Sharpley, 2012), islands as a central place in Western cultures' mythical geographies (Gillis & Lowenthal, 2007), islands as locus or focus (Ronström, 2012), islands as productive of individual and social identity and as places in process (Fletcher, 2011), impose a set of requirements for information and information management that

should be met, in order to support research and development tasks in a convenient and efficient manner.

One such requirement is the designation of spatial location and geographic context. Island borders, exclusive economic zones, distance from the continental part of the state or other continental states, distance from other islands, or distance from world market places, play a significant role in explaining insular standards of living (King, 1993; McCall, 1994; McElroy & Lucas, 2014). Researchers and stakeholders should be able to have a geographic perspective of all information relevant to islands, not only for datasets processed by geographic information systems. Moreover, using today's web-based mapping systems, it is difficult to visually compare one island to another distant island or to continental areas, as the desired mapping area exceeds the limits of the display window. Another issue is that small islands are degenerated graphically to a set of points in small cartographic scale maps, preventing the presentation of any thematic information.

Another requirement is the preservation of island identity in the information system. In order to study the status of an island or to make decisions, data for variables and indicators should be available at the granularity level of an island (ESPON, 2013). This is not always feasible, since many statistical authorities (e.g., the Greek one) produce reports for administrative entities that may include island clusters, or combine islands and mainland areas.

Islandness also expresses a non-measurable but distinctive 'experiential identity'. Islands are spaces which are shaped by, but also which shape, the experiences of the people: insiders and outsiders, natives, visitors or retirees, academics and amateurs, scholars and poets (Connell, 2003; Gillis, 2004; Hay, 2006; Baldacchino, 2007; Gillis & Lowenthal, 2007). So, information systems for islands should handle intangible issues, mostly related with local culture, such as historical documents, oral histories, videos, music, and local dialects.

As a final point, islanders tend to be more participatory in dealing with local problems and voluntarily collecting and sharing information (Benedicto, 2014; UNDESA & OAS, 2003). In addition, we are well on the way toward moving from an epoch of comfortable oppositions and binary thinking that position insiders against outsiders, openness versus closure, roots versus routes, global versus local (Baldacchino, 2012). Thus, a web-based information system enabling open access to and submission of digital material is more appropriate to support islands' research and development tasks.

In the framework of the Integrated Programme for Islands Research, which was co-funded by the European Union and the Greek State, the University of the Aegean faced the challenge of establishing a web-based digital repository, able to support research and development tasks in the field of islands. In this work we describe the design, implementation, and operation of that system, named *Archipelago*. Its main objectives are the storage, documentation, and dissemination of any kind of digital content regarding islands, as well as the provision of cartographic facilities for searching, visualization, and comparison.

This article is organized as follows: Section 2 presents the system requirements and design of *Archipelago*, while Section 3 presents its implementation and operation up until today. Section 4 concludes the paper and presents future work.

2. System requirements and design

Based on the above discussion of island characteristics, as well as on current trends for web-based repositories operation and interoperability, the following basic requirements had to be satisfied by our system:

- Users should be able to store and retrieve all content types (documents, audio and video files, pictures and photographs, geographical datasets and images, etc.).
- All stages of the depositing process should be supported. Everyone would be able to make a submission, provided that a registration process is completed first.
- Metadata standards for both digital content and geospatial datasets should be integrated.
- Geographic designation should be available for all content types.
- Manipulation of statistical datasets (variables and indicators) should be possible at least at the island granularity level.
- Keyword as well as spatial search utilities should be provided.
- Multiple views for the same or different cartographic layer(s) should be available for concurrent display.
- Moreover, the system should be developed within a reasonable time frame in order to be useful for the other actions in the project, and with reasonable effort. So, we decided not to implement something entirely from scratch, but rather to investigate the customization of a suitable open-source platform. Unfortunately, the conclusion of the research was that there was no available platform that totally satisfies the aforementioned requirements. However, there are two categories of platforms which, when appropriately combined and customized, may result in the desired system: repository systems and spatial data infrastructure frameworks.

The first category, web-based repository systems (Roy, 2015; Simons & Richardson, 2013; Ware, 2004), are able to store any kind of digital item, to keep metadata in accordance with recognized standards, to offer strong searching and browsing utilities, and to support the whole content depositing process.

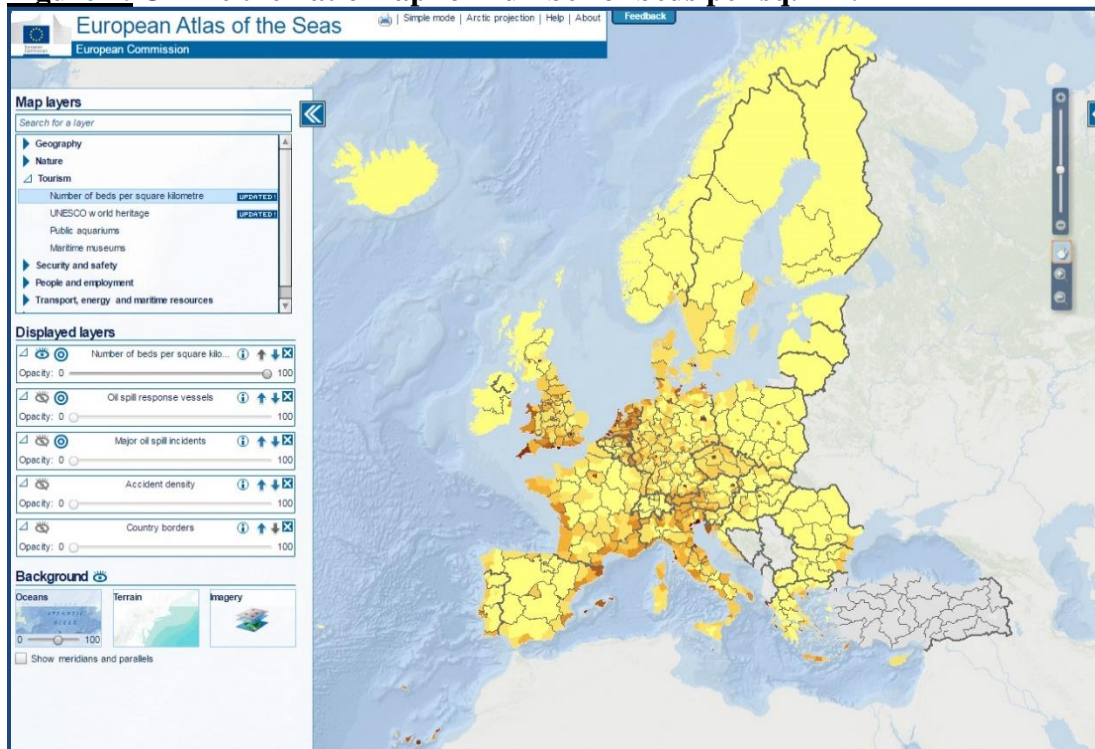
More specifically, repository systems provide the means for the permanent storage and management of digital content of any type, e.g., documents, pictures and photographs, audio files, video files, and animation files. What goes into a repository is currently less of an issue of technological or software ability, but more a policy decision made by each institution or administrator. Authorized users are able to upload the related files, accept the repository policy, and fill in a number of metadata records describing various aspects of the content, such as title, creator, description, subject, type, language, etc. These metadata records are usually compatible with the 15 elements of the Simple Dublin Core standard (www.dublincore.org). After the deposit, the repository personnel check the submission for validity and conformance, and either accept and register it, or reject it and inform the user for resubmission. End users of the repository are able to browse through its contents, to search for items using criteria against their metadata, and to view or download selected items. Although these operations cover many of the specified requirements, repository systems offer little support for the recording of the geo-spatial location referenced by an item. In addition, they support neither geo-spatial metadata standards, nor geo-spatial searching and viewing utilities.

The second category, web-based catalogs supporting spatial data infrastructures (SDIs) (Groot & McLaughlin, 2000; Williamson et al., 2003) can keep metadata records (in accordance with geo-spatial metadata standards) for geo-spatial datasets and services. They also provide spatial searching and viewing operations. More specifically, SDI supporting systems manage metadata records for geo-spatial datasets (stored in databases or files) and services (provided by map servers) in accordance with specialized metadata standards, such as ISO1911 and INSPIRE (Nogueras-Iso et al., 2005; INSPIRE, 2008). End users may search the metadata catalog using keyword-based criteria and spatial-based selections of geographic areas with inclusion, exclusion, or intersection

qualifiers. Afterwards, selected items may be loaded onto map viewers as layers offering a number of cartographic operations, such as zoom, pan, overlay, and identification. Although geo-spatial catalogs fulfill the spatial-specific requirements, they cause significant metadata-maintenance effort for non-geo-spatial content, and they do not conveniently support the deposit process. Besides those limitations already mentioned above, we encountered two other limitations: the displaying abilities of map viewers and the granularity levels of datasets provided by statistical authorities (especially in Greece).

Contemporary map viewers (either embedded into an SDI framework or not) usually provide a single viewing window for presenting cartographic layers, without providing the ability for including inset maps. This makes the depiction of thematic information for small areas (like most islands) and their comparison either with continental areas, or with distant islands, difficult, or even impossible. For example, in Figure 1, it is difficult to distinguish the colour of Malta or Isle of Wight. Even if users zoom in at the territory of Malta, they will be unable to compare it with remote islands (e.g., Bornholm) because the latter will be excluded from the display.

Figure 1: Online thematic map for number of beds per sq. km.



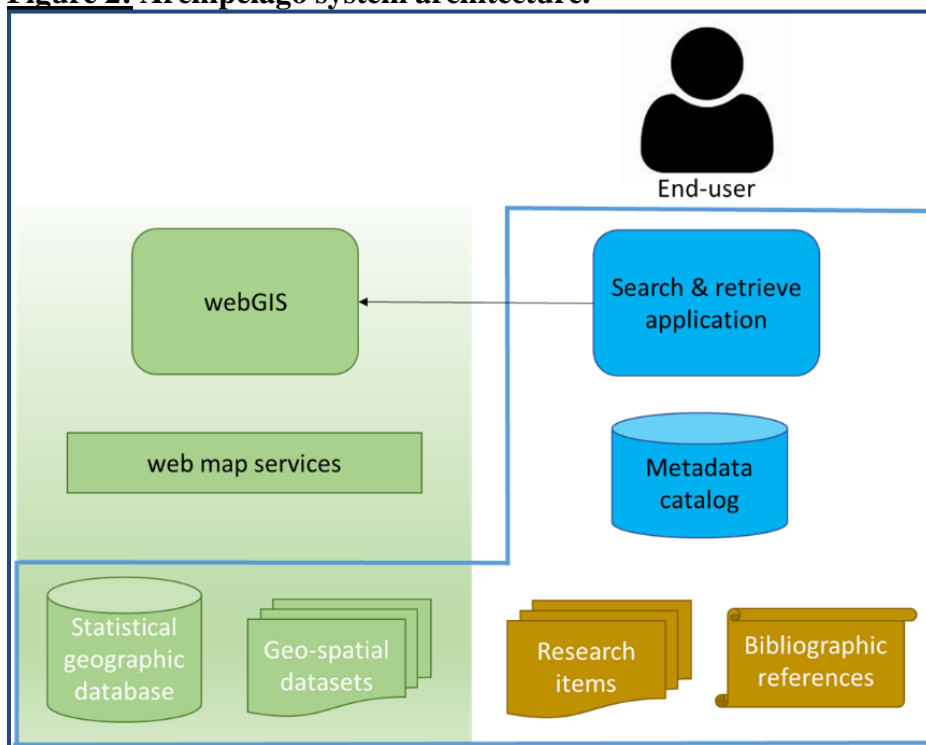
Source: http://ec.europa.eu/maritimeaffairs/atlas/index_en.htm

The final limitation we faced was the granularity level of available datasets. Statistical authorities provide data for certain classification levels, from NUTS0 to NUTS3, or LAU1 and LAU2. These levels mainly correspond to administrative entities, not to geographical ones, so they do not conform with the territories of islands. In Greece, there are no available data for the 34 inhabited islands that are not single administrative units. Some data, like population, may be computed at the island level, by aggregation of values of the lowest (settlement) level.

What emerged from our research was the need to establish a subject-based (or thematic) repository (Armbruster & Romary, 2010), able to provide a comprehensive collection of freely

accessible material relevant to islands. In addition, we decided to expand such a system, so that it will become geo-spatially enabled, and augment it with geospatial metadata storage and search capabilities, a cartographic viewer customized for small area comparison, and a spatial database system able to store data at the granularity level of an island. This innovative approach results in the development of the Archipelago system, the architecture of which is presented in Figure 2.

Figure 2: Archipelago system architecture.



At the core of the Archipelago system is data regarding islands. Data is distinguished in two general categories. The first category refers to research items such as papers, books, reports, and audiovisual items. When the body (file or files) of the research item is not available for any reason (e.g., is under a copyright license), the system handles it as a bibliographic reference. The second category refers to geo-spatial datasets, such as shapefiles, raster files, and geo-located statistical datasets managed by a geographic database. The reason for the distinction of data in these two categories is because spatial datasets have different requirements in terms of metadata standards and visualization methods.

Maintaining a single metadata catalog provides the advantage of searching and accessing all data through a common environment. This metadata catalog comprises the middle part of the Archipelago system and is consistent with international metadata standards in order to support interoperability. Research material is documented in accordance with the Dublin Core Schema, which is the best-known standard for describing web resources and digital content. In contrast, spatial datasets are documented in accordance with the INSPIRE Metadata Standard, which is the official metadata standard for describing spatial datasets in the EU. Both standards have been extended in order to support the preservation of information that concerns the geographic area to which items refer.

End users interact with the Archipelago system through the web-based search and retrieve application. The application interacts with the metadata catalog and returns the items that match

the search criteria (keywords, metadata values, or user-defined spatial extents). Users can specify if they want to search only for research material, spatial datasets, or both. The results are returned in a list and the user can decide on further actions, such as view an item's full description, download any associated files, or view its cartographic representation in the webGIS application.

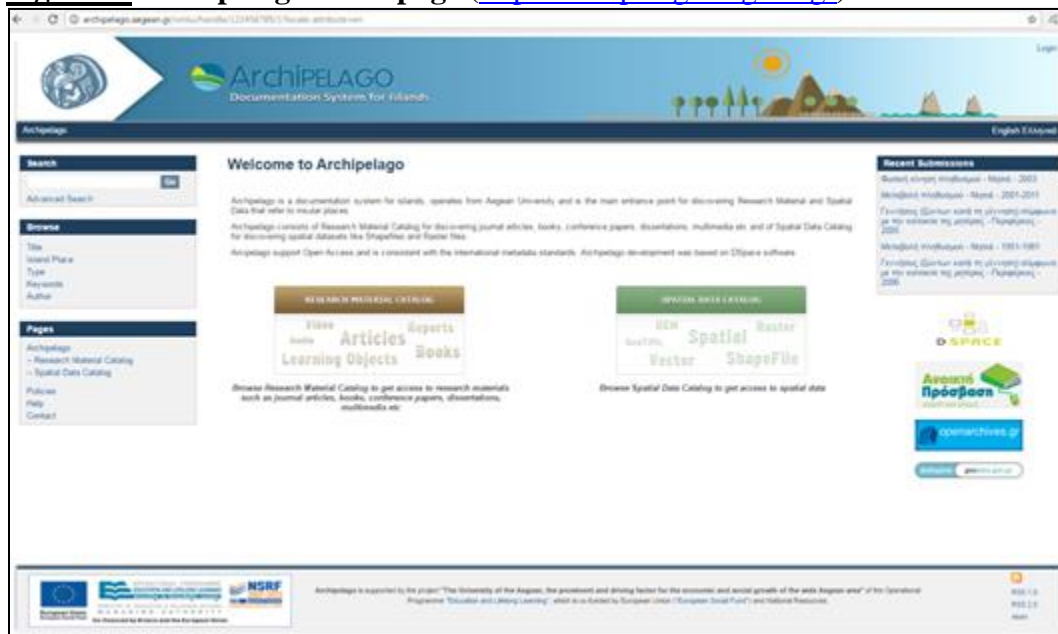
The webGIS application consists of a base map where the spatial datasets can be visualized after their transformation to web map services. The innovative feature of the application is its ability to display spatial datasets on multiple concurrent views in order to support the visual comparison of remote areas.

3. System implementation and operation

In this section, we present Archipelago's main functionality along with the necessary customizations developed in order to tackle the islandness peculiarities that were discussed in the previous sections. We also provide information that we collected during its operation period.

Archipelago is available at <http://archipelago.aegean.gr>. It was built exclusively using open source software and in accordance with open data international standards. In particular, the open source repository system dSpace (www.dspace.org) was customized in order to satisfy the system requirements and design decisions that were specified for our purposes.

Figure 3: Archipelago home page (<http://archipelago.aegean.gr>).

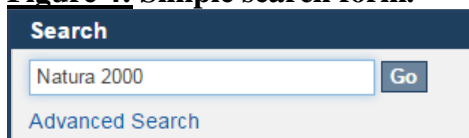


Archipelago consists of two collections: (a) Research Material Catalog (for research items) and (b) Spatial Data Catalog (for geo-spatial items), as depicted in Figure 3. The main difference between the two collections is the metadata standard used for item documentation. Research material is documented in accordance with the Dublin Core Metadata standard, while the documentation of spatial datasets is based on the INSPIRE Metadata Standard. As the INSPIRE Metadata standard is not supported natively in dSpace, we had to customize it for that purpose. To support geographic designation of research material, we extended the Dublin Core Metadata Standard with the optional 'Geographic Bounding Box' metadata field (mandatory in the INSPIRE Metadata Standard), which represents a rectangle, in the form of geographic coordinates, denoting the spatial extent

to which an item refers. In this way, all research material may be accompanied by its geographic reference. In addition, we extended both standards by adding a new mandatory field named 'Island Place'. This field denotes the geographic area to which the item refers and can be an island complex (e.g., the Caribbean Sea), an island (e.g., Cuba), or an island sub-region (e.g., Guantanamo). Appendix 1 describes the metadata fields used for the two collections.

End users can access both collections simultaneously or each collection separately. They can discover items by entering one or more keywords in the search form (Figure 4).

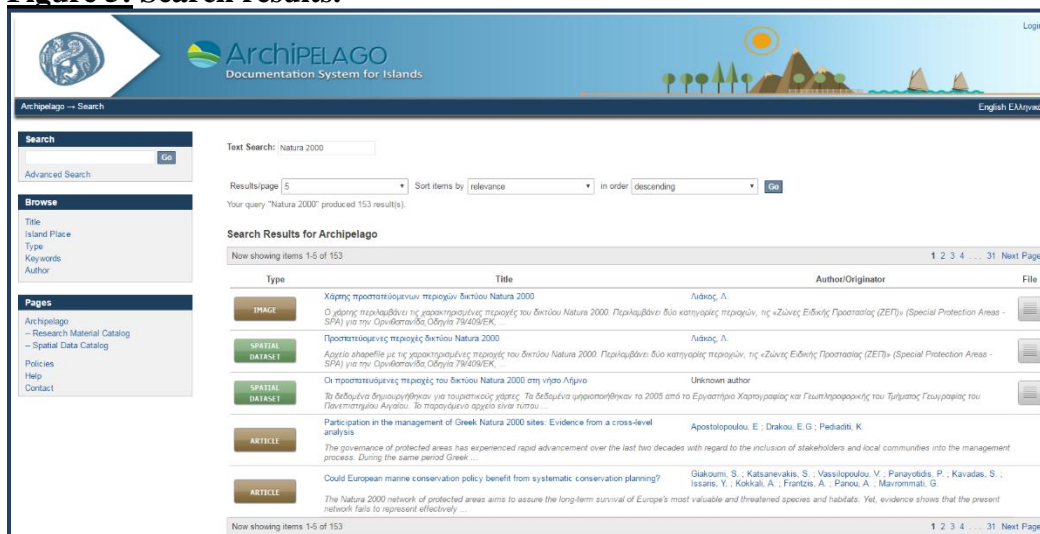
Figure 4: Simple search form.



The image shows a simple search form with a dark blue header containing the word 'Search'. Below the header is a light blue search bar with the text 'Natura 2000' and a 'Go' button to its right. Below the search bar is a link for 'Advanced Search'.

For example, by entering the keyword "Natura 2000", all items that are related to that keyword are retrieved and displayed. For each item, its type, title, and author are displayed, along with an indication of whether the body of the item is available for download (Figure 5). The colour of the type label determines the collection to which the item belongs (brown for research material and green for geo-spatial datasets). The user can access the full description of the selected item by clicking on its title.

Figure 5: Search results.



The image is a screenshot of the search results page. At the top, there is a navigation bar with the 'Archipelago' logo and the text 'Documentation System for Islands'. Below the navigation bar, there is a search bar with the text 'Natura 2000' and a 'Go' button. To the left of the search bar, there is a sidebar with a 'Search' section and a 'Browse' section. The main content area shows the search results for 'Natura 2000'. The results are displayed in a table with columns for 'Type', 'Title', 'Author/Originator', and 'File'. The table contains four rows of results, each with a colored icon indicating the type of item (brown for research material and green for geo-spatial datasets). The first row is an 'IMAGE' type, the second is a 'SPATIAL DATASET' type, the third is a 'SPATIAL DATASET' type, and the fourth is an 'ARTICLE' type. The table also shows the number of results (153) and a 'Next Page' link.

Figure 6 displays the full description of a research item, based on the Dublin Core metadata standard, without the 'Geographic Bounding Box' metadata field. Figure 7 displays another full description of a research item, where the 'Geographic Bounding Box' metadata field is included. Figure 8 displays the full description of a spatial dataset, based on the INSPIRE metadata standard, where the 'Geographic Bounding Box' metadata field is mandatory.

Figure 6: Description for research material (without ‘Geographic Bounding Box’).

Title	Thresholds of terrestrial nutrient loading for the development of eutrophication episodes in a coastal embayment in the Aegean Sea
Creator	Tsiritsis, G. Spatharis, S. Sampatakaki, A. Spyropoulou, A.
Thematic Database	Περιβάλλον - Environment
Keywords	Terrestrial loading Nutrient thresholds Eutrophication Vollenweider factors Watershed model Aegean sea
Description	Thresholds of terrestrial nutrient loading (inorganic N and P) for the development of eutrophication episodes were estimated in an enclosed embayment, the gulf of Kalloni, in the Aegean, Eastern Mediterranean. Terrestrial loading was quantified by a watershed runoff model taking into account land use, geomorphology, sewerage, industrial and animal farming by-products. The eutrophication episodes were assessed by an existing scale for the Aegean coastal waters based on chl a, whereas the necessary nutrient concentrations (N and P) for the development of such episodes were defined using a probabilistic procedure. Finally, for the linking between nutrient loading arriving at the gulf and the resulting nutrient enrichment of the marine ecosystem, three loading factors were applied, developed by Vollenweider for lake and marine ecosystems. The first assumes no exchange between the embayment and the open sea, whereas the two others take into account water renewal time. Only the threshold for inorganic nitrogen estimated by the first factor was exceeded in the study area during February after a strong rainfall event coinciding with a eutrophication episode observed in the interior of the gulf, implying that the waters of the gulf are rather confined and the receiving body operates as a lake. The degree of confinement was further examined by studying the temperature, salinity, and density distributions inside the gulf and across the channel connecting the gulf to the open sea. It was found that the incoming freshwater from the watershed during winter results to the formation of a dilute surface layer of low salinity and density, clearly isolated from the open sea. The nutrients from the river inputs are diluted into this isolated water mass and the eutrophication threshold for nitrogen is exceeded. Although phosphorus loading was also high during winter, the corresponding limits were never exceeded. The proposed methodology sets a quantitative relationship between terrestrial nutrient loading and the development of eutrophication episodes in coastal embayments, assuming that information on the physical setting of the system is available. These cause-and-effect relationships can be invaluable tools for managers and decision makers in the framework of Integrated Coastal Zone Management.
Language	Αγγλικά
Type	Άρθρο σε περιοδικό - Journal Article
Identifier	uri:http://archipelago.aegean.gr/xmlui/handle/123456789/4731
Related Links	http://siba-ese.unisalento.it/index.php/twb/article/view/1825229Xv2n3p25/337
Island place	Lesvos

Figure 7: Description for research material (with ‘Geographic Bounding Box’).



Title	Thresholds of terrestrial nutrient loading for the development of eutrophication episodes in a coastal embayment in the Aegean Sea
Creator	Tsiritsis, G. Spatharis, S. Sampatakaki, A. Spyropoulou, A.
Thematic Database	Περιβάλλον - Environment
Keywords	Terrestrial loading Nutrient thresholds Eutrophication Vollenweider factors Watershed model Aegean sea
Description	Thresholds of terrestrial nutrient loading (inorganic N and P) for the development of eutrophication episodes were estimated in an enclosed embayment, the gulf of Kalloni, in the Aegean, Eastern Mediterranean. Terrestrial loading was quantified by a watershed runoff model taking into account land use, geomorphology, sewerage, industrial and animal farming by-products. The eutrophication episodes were assessed by an existing scale for the Aegean coastal waters based on chl a, whereas the necessary nutrient concentrations (N and P) for the development of such episodes were defined using a probabilistic procedure. Finally, for the linking between nutrient loading arriving at the gulf and the resulting nutrient enrichment of the marine ecosystem, three loading factors were applied, developed by Vollenweider for lake and marine ecosystems. The first assumes no exchange between the embayment and the open sea, whereas the two others take into account water renewal time. Only the threshold for inorganic nitrogen estimated by the first factor was exceeded in the study area during February after a strong rainfall event coinciding with a eutrophication episode observed in the interior of the gulf, implying that the waters of the gulf are rather confined and the receiving body operates as a lake. The degree of confinement was further examined by studying the temperature, salinity, and density distributions inside the gulf and across the channel connecting the gulf to the open sea. It was found that the incoming freshwater from the watershed during winter results to the formation of a dilute surface layer of low salinity and density, clearly isolated from the open sea. The nutrients from the river inputs are diluted into this isolated water mass and the eutrophication threshold for nitrogen is exceeded. Although phosphorus loading was also high during winter, the corresponding limits were never exceeded. The proposed methodology sets a quantitative relationship between terrestrial nutrient loading and the development of eutrophication episodes in coastal embayments, assuming that information on the physical setting of the system is available. These cause-and-effect relationships can be invaluable tools for managers and decision makers in the framework of Integrated Coastal Zone Management.
Language	Αγγλικά
Type	Άρθρο σε περιοδικό - Journal Article
Identifier	uri:http://archipelago.aegean.gr/xmlui/handle/123456789/4731
Related Links	http://siba-ese.unisalento.it/index.php/twb/article/view/1825229Xv2n3p25/337
Island place	Lesvos
Geographic Bounding Box	25.78103149414,26.736842041015,38.868072554467,39.494293257592 

Figure 8: Description for spatial dataset.

Title	Προστασόμενες περιοχές δικτύου Natura 2000
Description	Αρχείο shapefile με τις χαρακτηρισμένες περιοχές του δικτύου Natura 2000. Περιλαμβάνει δύο κατηγορίες περιοχών, τις «Ζώνες Ειδικής Προστασίας (ΖΕΠ)» (Special Protection Areas - SPA) για την Ορνιθολογία (Οδηγία 79/409/ΕΚ, και τους «Τόπους Κοινωνικής Σημασίας (ΤΚΣ)» (Sites of Community Importance - SCI) (Οδηγία 92/43/ΕΟΚ.
Type	Σύνολο χωρικών δεδομένων - Spatial Dataset
Language	Greek
INSPIRE Topic Category	Περιβάλλον - Environment
Keywords	Natura 2000 Ζώνες Ειδικής Προστασίας Special Protection Areas - SPA Τόποι Κοινωνικής Σημασίας Sites of Community Importance - SCI
Island place	Αιγαίο Πέλαγος
Geographic Bounding Box	22.8903,29.6463,34.7987,40.7344 
Lineage	Υπουργείο Περιβάλλοντος, Ενέργειας και Κλιματικής Αλλαγής
Coordinates Reference System	ΕΓΖΑ 87 (EPSG:2100)
Format	shapefile
Limitations on public access	No limitation
Responsible Party	Λίδιος, Λ.
Responsible Party eMail	leonidas_lakios@yahoo.gr
Metadata Point of Contact	Λίδιος Λεωνίδας
Metadata Point of Contact Email	leonidas_lakios@yahoo.gr
Metadata Date	2014-02-01
Metadata Language	Greek
Related Links	http://www.minenv.gr/1/12/12/1/2103/g12103000/g1210300000.html http://www.minenv.gr/1/12/12/1/2103/g1210300.html

Additionally, end users can perform an advanced search by combining text criteria, such as title or author (Figure 9). A novelty of the Archipelago system is the development of a spatial search form (Figure 10), which allows end users to designate a spatial extent in order to discover items that are spatially related with it (intersect or within). The spatial search functionality is performed against the 'Geographic Bounding Box' metadata field. Although this kind of search is embedded in SDI systems (which are mainly used for storing and disseminating spatial datasets), as far as we know, it is the first time that spatial search functionality has been developed for a repository system.

Figure 9: Advanced search form.

Conjunction	Search type	Search for
<input type="text" value="OR"/>	<input type="text" value="Title"/>	<input type="text"/>
<input type="text" value="AND"/>	<input type="text" value="Author"/>	<input type="text"/>
	<input type="text" value="All Fields"/>	<input type="text"/>

Figure 10: Spatial search form.



Hold the Shift Button and use the mouse to draw search area

Spatial Operation

An alternative means of item discovery in Archipelago is by using the browsing form (Figure 11). The main difference between this and the search forms is that the browsing form returns all Archipelago items in ordered lists. For example, browsing by Island Place returns a list of all island regions that are available in Archipelago (Figure 12). The end user can select an island region and a new list with all items related to that region is returned.

Figure 11: Browse form (1).

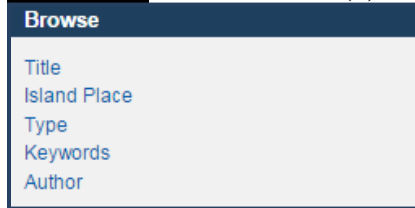
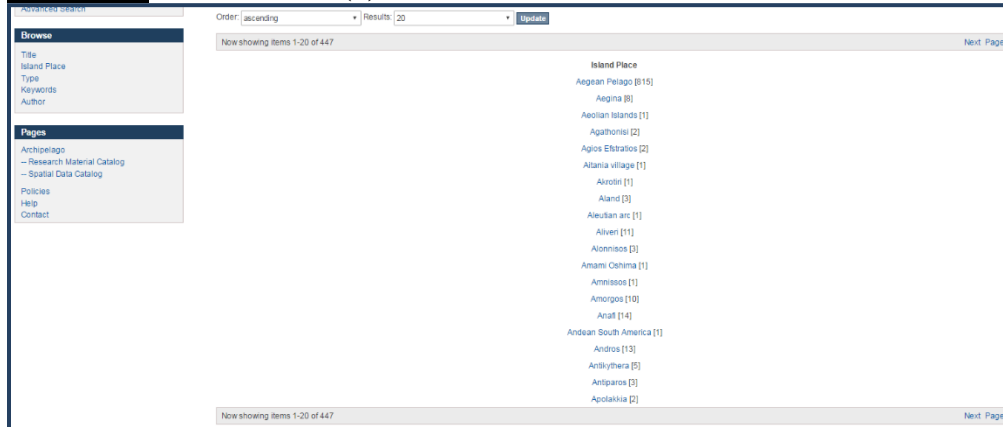
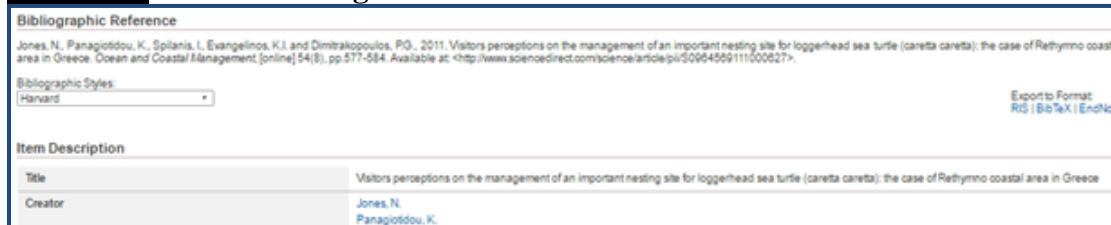


Figure 12: Browse form (2).



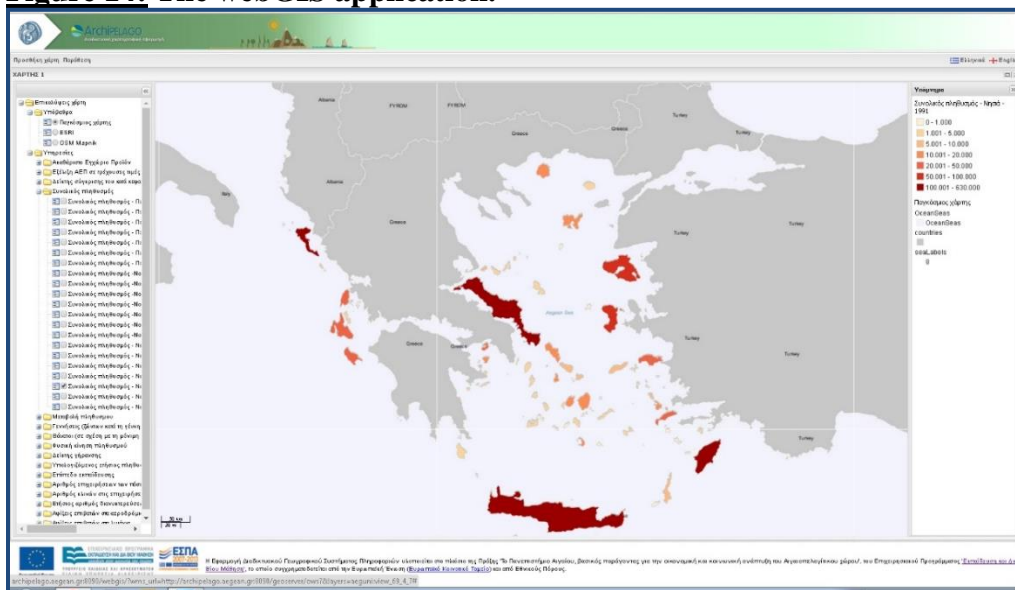
The citation description for all research material may be dynamically provided in any of several bibliographic styles, such as Harvard, Chicago, APA, MLA, Vancouver and IEEE (Figure 13). Moreover, the citation could be exported in RIS, BibTeX or EndNote format.

Figure 13: Citation manager for research materials.



Cartographic representation for spatial datasets may be created by the definition of web map services. To display such a service, end users may activate the webGIS application by clicking on the 'Open/View in WebGIS' link from the full description form. The application opens in a new tab with the selected dataset activated (Figure 14).

Figure 14: The webGIS application.



The webGIS application displays the spatial datasets as cartographic layers. The end user can select to activate one or more spatial datasets (web map services), in order to view them in the map area of the application. The associated legend for the activated layers is shown at the right of the screen. By right-clicking on a layer from the list, users can select to see its metadata page.

The main innovation of the application is the support of multiple views. In this way, end users can better distinguish the islands or compare islands that are distant from each other. This is clear in Figure 15, where there are two different instances of the webGIS application. On the left side, two views of the same spatial dataset are displayed, each having its own extent and scale; the legend is the same. On the right side, six views of the same spatial dataset are displayed. For presentation reasons, the legend is visible at only one view; end users may activate it on demand. It is possible to display different spatial dataset for different views (Figure 16), and there is no upper limit for view creation.

Figure 15: Multiple views for the same spatial dataset (Total Population, 1991).

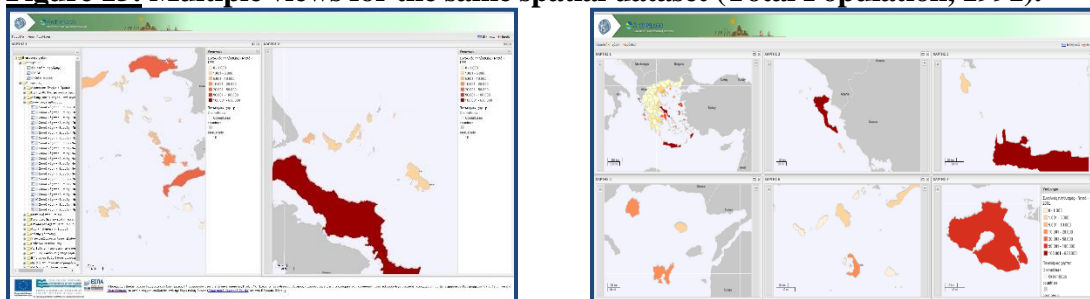
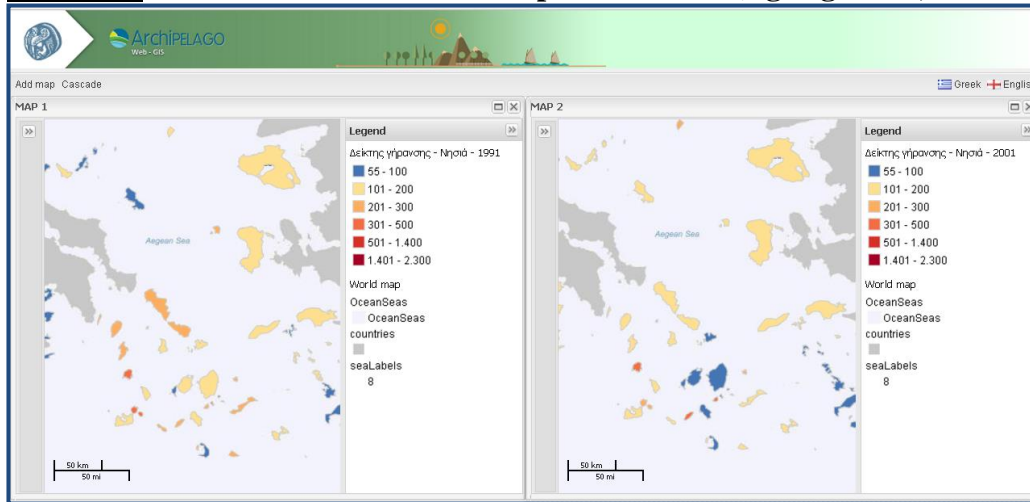


Figure 16: Different views for different spatial datasets (Ageing Index, Left: 1991, Right: 2001).



The deposit process (submission of content) in Archipelago is a pretty straightforward procedure, which is performed entirely from the web interface. Firstly, users sign in to the system. If they gain submission privileges, they can follow the ‘submit a new item’ link from the user menu. In the new page, submitters should specify the collection to which the item refers, fill in the metadata fields and upload any associated files (Figure 17). After submission, content administrators (called reviewers), are notified about the new submission. Reviewers check if the submission is eligible for acceptance by examining factors such as missing or misplaced metadata, relationship of item with island regions, and copyright issues. If all above criteria are satisfied, reviewers accept the submission and the item is permanently stored in Archipelago. If not, the submission is either totally rejected or it is returned to submitters for resubmission along with comments for correction.

Figure 17: Submission process.



All geo-located statistical datasets are stored in a geographic database, managed by the open source PostgreSQL/PostGIS database management system (www.postgresql.org). It is possible to store any variable or indicator, at any geographical granularity level (i.e., County, Region, Prefecture, Municipality, Settlement, or Island), and for any period of time. In order to populate the database, a separate utility was built that checks the input files for errors or redundancies, and stores the data in the database, so that the end user does not need to be a database expert.

Archipelago started its operation in September 2014. As stated in the introduction, its objective is to support and advance research work on islands worldwide; to be a one-stop point for digital content, datasets, and bibliographic references in the area of island studies.

During its two-year period of operation, we have collected and documented about 6,600 items that are related to islands (Figure 18). Most of the items are included in the Research Material Catalog (approximately 6,000) and the body is available for about 1,000 of them. There also are about 600 available spatial and statistical datasets. Concerning the language of the contents, about 80% are in Greek, 15% in English, and the rest are in other languages, such as French and German.

Figure 18: Archipelago content by type.

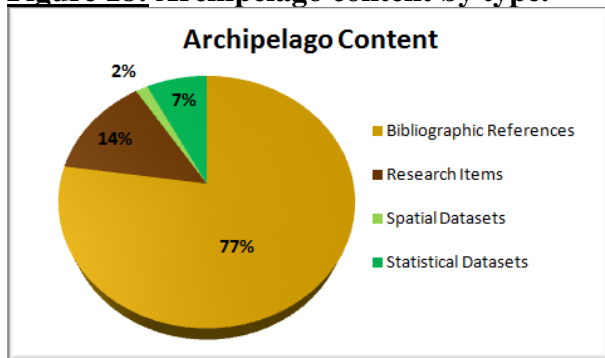
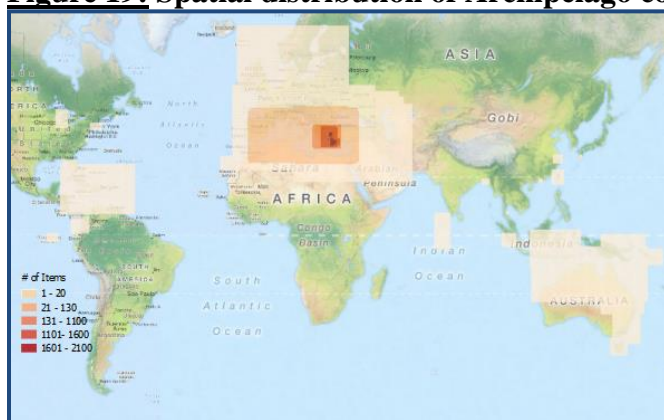


Figure 19 depicts the spatial distribution of the areas to which Archipelago content refers. Most items are spatially related to Greece and in particular to Aegean islands. There are a considerable number of items that refer to the Mediterranean Sea, while there are also items that refer to other regions such as the Caribbean Sea and Australia.

Figure 19: Spatial distribution of Archipelago content.



The statistical datasets pertain to 39 different variables (a total of 540 datasets) for Greek islands. Since there were no available data from the Hellenic Statistical Authority for islands that are not single administration entities, they had to be calculated from smaller geographic entities, mostly from municipalities and settlements. These statistical datasets were used for the preparation of the *Atlas of Islands* (Spilanis & Kizos, 2015), which is the first attempt at an integrated report on the current state of the Greek islands. It contains economic, social, and demographic variables, as well as quality variables of the natural and human environment on the islands. It analyzes the factors that explain the above variables, assess the impacts and future prospects, and any assessments, proposals, or recommendations for measures and policies to be implemented.

4. Conclusions and future work

The Archipelago repository was developed to satisfy the specific needs in data management, documentation, and visualization for islands. The innovative features incorporated into the system include (a) the unified management of metadata for research items and for geospatial data, (b) the addition of metadata fields for denoting the spatial extent and for recording the island place to

which an item refers, (c) the incorporation of spatial search utilities for discovering items, (d) the ability for concurrent display for the same or different cartographic layer(s) on multiple views, which enables the comparison of different geographic areas, and (e) the ability to manage variables at the granularity level of an island.

At this moment, the content of the Archipelago system mostly refers to the Greek islands. Our goal is to gradually designate Archipelago as a one-stop point for information that supports research on islands worldwide. By considering the particular cases of ‘island cities’ and ‘urban archipelagos’ (proposed by Grydehøj, 2014; Grydehøj, 2015), it may be possible to further the understanding of other spatial aspects of islandness (Fernandes & Pinho, 2015). The use of the system and its content is also envisioned to assist islands around the world that use it so as to reduce the digital and geographical division.

In this direction, several actions have been planned at an organizational as well as at a technical level. Among them, there are publicity actions in order to attract end users and data providers, actions to gain funds that will ensure the administrative and operational stability of the system, and additional technological improvements that will enhance the system’s friendliness and efficiency.

Part of the future work plans is the geolocation of the Island Place metadata field, meaning the assignment of each island geographic area available in Archipelago with geographic coordinates. This will significantly enhance the search capabilities of the Archipelago system, as it will link island regions geographically and therefore semantically. For example, by searching for Mallorca, Archipelago will be able to propose additional items that are related somehow to Mallorca, such as items that refer to the Balearic Sea or the Balearic Islands.

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Appendix 1

Table 1: Research material metadata fields (based on Dublin Core).

Fields	Description	Compulsory
Title	The name given to the resource, usually by the Creator or Publisher	√
Description	An unchanged content description of the resource containing abstracts in written texts as objects or content descriptions in the case of visual resources.	√
Keywords	The subject will be expressed as keywords or phrases that describe the subject or the content of the resource	√
Language	The language of the intellectual content of the resource.	√
Source	Information about a second resource from which the present resource is derived.	No
Relation	An identifier of a second resource and its relationship with this item. This element allows the declaration links between related resources.	No
Geographic Bounding Box *	The geographical scope of the resource expressed in contour coordinates (North, East, South, West) in WGS 84.	No
Thematic category *	The thematic category that the resource belongs to.	√
Island Space *	The geographical area (island cluster, sea, etc.) to which the content item is in text format. Examples: Lesvos, Dodecanese Islands, North Aegean, Mediterranean.	√
Creator	An entity primarily responsible for making the resource.	√
Publisher	The responsible entity made the resource available in its present form.	No
Contributor	An entity responsible for making contributions to the resource.	No
Rights	Information about rights held in and over the resource.	No
Creation date	A date of the establishment and availability of the resource.	No
Temporal extent	The temporal extent to which the content of the resource refers to. Can be expressed in date format, pair of dates, or text.	No
Type	The type of resource, such as articles, books, study, job report, technical report, report, dictionary, data file, etc.	√
Format	The format of the data which is stored on the resource e.g., .doc, .xls, .pdf, .png, .avi, etc.	No
Identifier	A phrase or number used to uniquely identify the resource. Examples of internet resources: URL, URN, for books: International Standard Book Numbers (ISBN).	No
Related Links *	The address of a website (URL), which provided additional information about this resource.	No

Fields	Description	Compulsory
Notes *	Free text element field for completion of any comments / notes on resources not covered by the other fields.	No

* New fields that added to support Archipelago

Table 2: Spatial Dataset Metadata Fields (based on INSPIRE)

Field	Description	Compulsory
Title	This a characteristic and often unique name by which that resource is known.	√
Abstract	A brief summary of the content of all or any series of geospatial data in order to more accurately understand the content of the resource.	√
Type	The type of geospatial data described. The type can be either “series spatial data (series)” when the resource is part of a group of similar items (e.g., aerial photograph of an area that belongs to a set of aerial photographs), or “spatial data (dataset)” when resource for a self-contained set of geographical data (e.g., shapefile).	√
Language	The language or languages used within the data. For example, the language of the contents of the table fields of a shapefile.	√
Topic category	One or more subject areas defined in the INSPIRE Directive and to which the data refers.	√
Keywords	Keywords for the description of geospatial data.	√
Island Space *	The geographical area (island group of islands, sea, etc.) to which the content of the data refers, in text format. For example, if the data concerning the island of Lesvos, chose “Lesvos” and not “Islands Lesvos” or “Northern Aegean Islands”.	√
Geographic Bounding Box	The geographical scope of the resource expressed in contour coordinates (North, East, South, West) in WGS 84.	√
Temporal Extent	The temporal extent to which the content of the resource refers to. Can be expressed in date format, pair of dates or text.	No
Creation Date	The creation date of geospatial data.	No
Lineage	A statement on process history and / or overall quality of the spatial data. The format of the file (i.e. .xls, .dxf, .dbf, .shp, etc.) should be noted as well as any backgrounds used for the production of a resource from digitization.	√
Coordinates Reference System *	Insert the reference system of the position of geographical data description. This may be a geodetic or projective reference system in two or three dimensions.	No

Field	Description	Compulsory
Equivalent Scale	The scale denominator mainly vector and wherever they apply, e.g., where aerial scale. Example of scale 1:50000 listed as 50000.	No
Distance	Complete in number, size of the unit (pixel) on the ground mosaic data format (raster) which did not come from scanning. Example for size pixel 60 cm we indicate 60. If raster data obtained from scanning (e.g., scanned topographical charts) complements the analysis carried out in the scanning dpi (dots per pixel).	No
Unit of Measure	If distance exists then fill here mandatory for mosaic data format (raster) which is not derived from scanning, the unit of distance that determines the size of the unit the previous field. Example for size pixel 60 cm choose "cm". If raster data obtained from scanning (e.g., scanned topographical charts) then select here the price dpi.	No
Conditions applying to access and use	This field lists the conditions for accessing and using of geospatial data and the corresponding charges (if any). If no conditions apply to the access and use of the resource, "no conditions apply". If conditions are unknown, "unknown conditions". Also, if there is a link where the conditions for access and use of the resource described in detail, it must be in this field.	√
Limitations on public access	Article 13 of Directive 2007/2/EC.	√
Responsible party	A description (name) of the organization responsible for the creation, management, maintenance and distribution of geospatial data.	√
Responsible party email	The e-mail address of the competent party designated in the above field.	√
Metadata Point of Contact	Description of the organization responsible for the creation and maintenance of metadata.	√
Metadata Point of Contact email	The e-mail address of the competent party designated in the above field.	√
Metadata Date	The date that determines when the metadata created or updated.	√
Metadata Language	The language of the metadata	√
Related Links *	The address of a website (URL), which provides additional information for this resource.	No
Notes *	Free text field for comments / notes about the data not covered by the other fields.	No

* New fields added to support Archipelago.