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DEVELOPMENT OF AN INTERACTIVE GIS FOR THE MEDITERRANEAN

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DEVELOPMENT OF AN INTERACTIVE GIS FOR THE MEDITERRANEAN

FOREWORD

The Dynamic Atlas on the Mediterranean Marine and Coastal Protected Areas (MedGIS project) is the result of a common will by MAP, RAC/SPA & UNEP´s Regional Seas Programme to develop an interactive GIS for the Mediterranean Region. The project has been undertaken to set up a Mediterranean Geographical Information System and a web map service for all the riparian countries.

This tool, advocated to be used by all the MAP components, has become a tangible result thanks to the kind contribution of UNEP Regional Seas Programme at Nairobi. The map service is already available in Internet and it provides, through queries, tables with the information existing in the Database linked to the maps displayed.

This project contributes to address the recommendation to the Secretariat by the Contracting Parties "to make the RAC/SPA databases available on the Internet and circulate GIS data and, in collaboration with the CBD Secretariat, make efforts to establish a Mediterranean clearing-house mechanism on marine and coastal biodiversity that will network with the national clearing-house mechanisms and others set up within the framework of the CBD". It provides a tool to managers for integrating every useful information regarding biodiversity, human factors and their geographical location in the Mediterranean; Its further development may allow undertaking prediction analysis on trends concerning biodiversity topics. The project acts as a demonstration one able to be extrapolated to other Regional Seas Programmes.

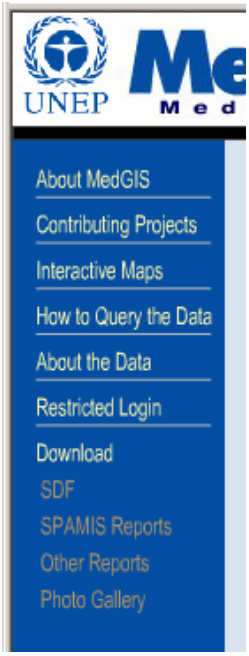
It must be stressed the fact that this tool is intended to facilitate information to all the MAP components, including RACs, MAP Programmes and the Contracting Parties. It is a most needed synchronous tool for a proper management and optimisation of data availability and interlinking, collected by them through diverse projects and other activities;

MedGIS may aid among others on: centralisation of information on the Mediterranean environment in relation to spatial parameters; updated compilation of existing information on protected areas, sites of conservation interest, biodiversity, and human factors in the Mediterranean.

It is intended to make it interoperable and in compliance with other international programmes and initiatives, such as the UNEP- World Conservation Monitoring Centre (WCMC), the European Network on Biodiversity Information (ENBI), the Global Biodiversity Information Facility (GBIF), the European Register of Marine Species (ERMS) and the European Directory of Marine Environment Datasets (EDMED).

The collaboration of RACs and the Barcelona Convention Parties may strongly enhance the usefulness of a further development of MedGIS for the Mediterranean Region.

A. THE DYNAMIC ATLAS CONTENT

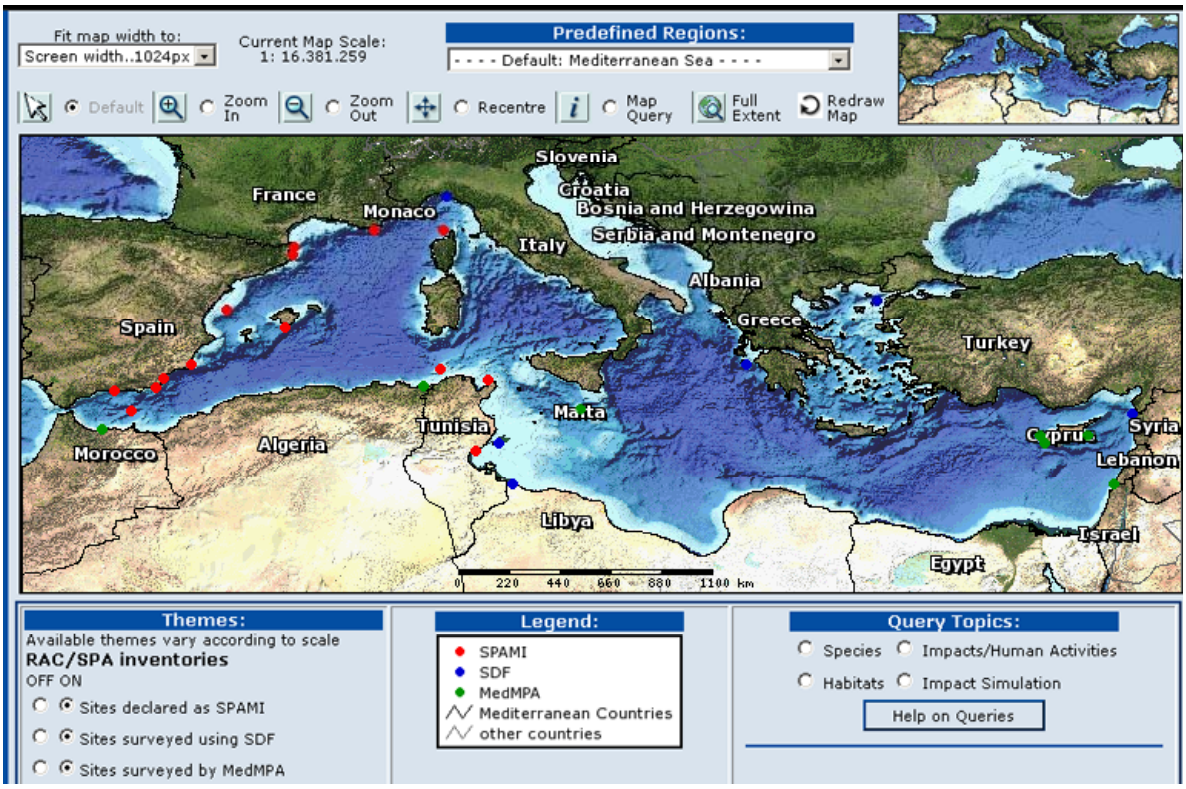


Information the user may find at the web site:

→ General information on MedGIS
→ Contributing projects, organisations, centres, universities and companies
→ The **Interactive Mapping** Tool (described here in detail)
→ Tips on how to query the data
→ Information on the data included, the type and origin of the data, etc.
→ Access for authorised personnel to sensitive data
→ Download area: Documents, such as blank Standard Data-Entry Forms, reports on SPAMIs and a photo gallery

B. THE INTERACTIVE MAP TOOL

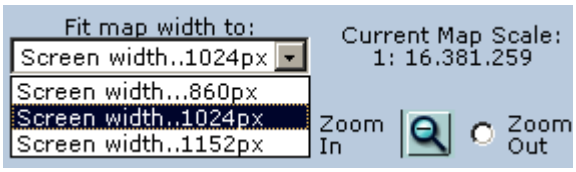
Recently logged-in, the user will see a general map of the Mediterranean Region. A seabed model is intended to facilitate the orientation. Points indicate the locations of SPAMIS and sites surveyed within the MAP framework.



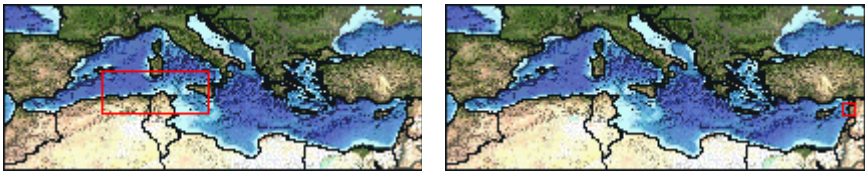
general view of the web map service application

There are several map tools situated right the map which permit to **amplify, re-centre, return to the full map extent or query** the map. To amplify the map and get to the detail, click on the radio button right to the magnifying glass icon and then just click on a region on the map to zoom in.

Map size adjustment and **scale indication**: In order to match a variety of screens, we added the possibility to change the size of the map. By default the map will adapt to the most common screen size (1024 pixels = 17 inches), but the user may choose a different size from a selection list located above the map.



The **reference map** is a tool which is linked to the main map and thus reflects the exact location and extent of the map currently displayed. While the user zooms in and explores the area in detail, this reference map provides the necessary orientation.



Reference maps

Scale dependent feature drawing and feature labelling assure on one hand that the map composition does not get too overloaded and the map features are always displayed at an adequate scale. That means that while zooming in or out, some map features appear or disappear or get replaced by others: For example, the seabed model, which has been designed for a coarse scale map is not suitable for a closer look. It gets thus replaced by much finer scale bathymetric lines around the coastal areas.

Point features are adequate at great scales (> 1: 5.000.000) where map space matters, while polygon features provide more information but can only be properly appreciated at smaller scales (< 1: 5.000.000). Map themes which are available both as point and polygon layer (e.i. WDPA International Sites), replace each other automatically according to the current scale, maintaining the current status (on/off). Satellite imagery is indicated first by a bounding box polygon to indicate the exact location. This bounding box is replaced by the satellite image as soon as the map scale becomes adequate.

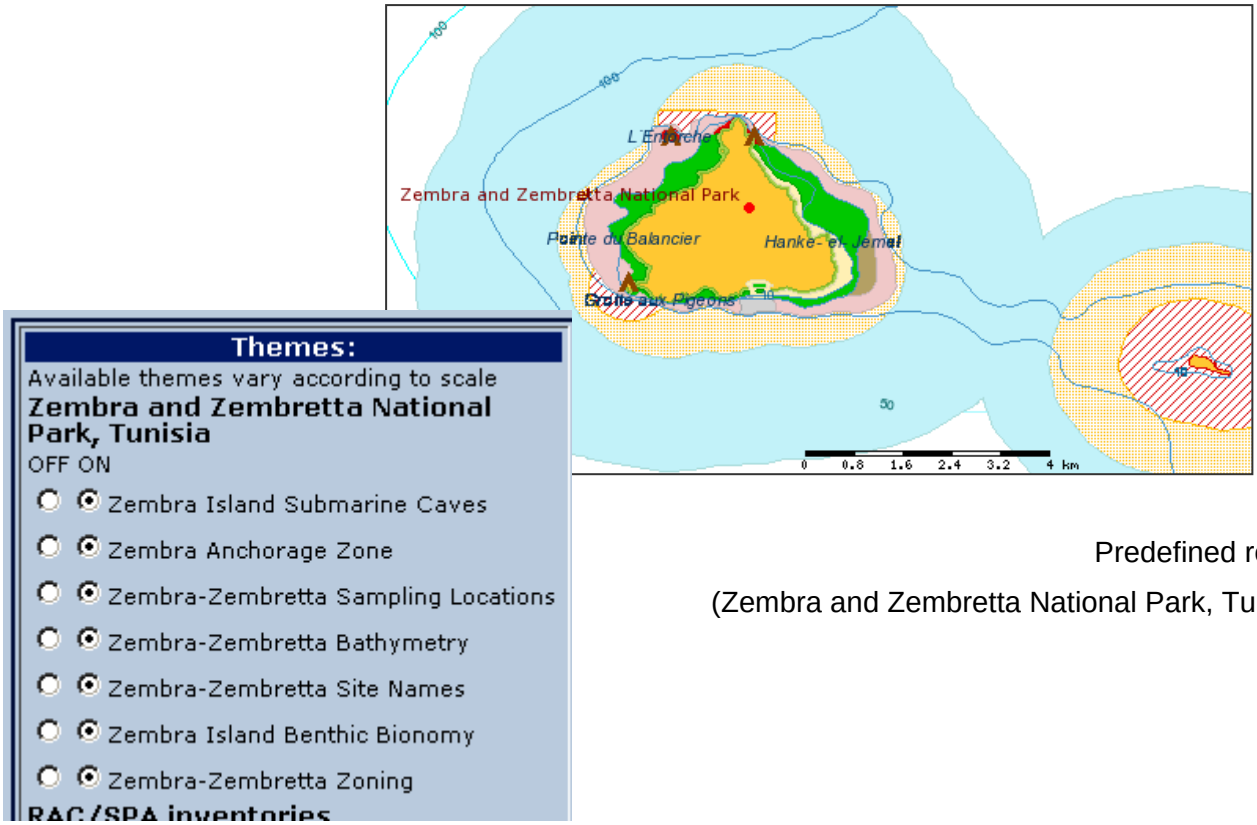
Predefined regions – selection list: There is currently a total of 27 sites which have been considered for this subsets of data. 14 sites already declared as SPAMI, 9 additional sites surveyed within MedMPA projects and 6 of the sites where the RAC/SPA Standard Data-Entry Form (SDF) has been applied. Two sites were surveyed using more than one protocol. At present, the 16 more complete ones have been integrated into MedGIS. For 7 of these sites detailed cartography was available and 6 are already included in this prototype (El Kala National Park/Algeria; Akamas, Cape

Greco and Moulia/Cyprus; Rosh Haniqra Akhziv Marine Reserve/Israel; Zembra & Zembretta National Park/Tunisia). For three sites satellite imagery was available (Zakynthos Marine National Park/Greece; Oum Toyour & Ras El Bassit/ Syria; D'Al Hoceima National Park/Morocco), although finally only the SPOT image covering Zakynthos is visible to the general public. The Landsat images of Oum Toyour appears under 'restricted data' until agreeing a free view with the concerned parties (although satellite images are becoming more and more available even without the necessity of purchase) and the scene covering D'Al Hoceima was not available in it's georeferenced version.

In general, a great variety of data is represented: some sites include bathymetric lines, sampling locations, important areas or features such as rocky areas, caves or anchorage zones. Almost all of them show a detailed zoning of the Protected Area. Also included are the 7 Spanish SPAMI sites, although their 'local' datasets only consists of polygons indicating their extension.

Predefined regions selection list

The user may go directly to these predefined regions by choosing a site in the selection list located above the map. When any of these predefined regions is selected, the cartography which belongs to this site becomes automatically available in the list of layers to be toggled on and off. The data layers are identified by a common group name and thus appear as group when the respective region has been chosen; otherwise they disappear.



Predefined region
(Zembra and Zembretta National Park, Tunisia)

Initially we considered to keep all regional data in separate folders and make this data (map data as well as database attributes) accessible only to the respective regions. We quickly discarded this option for several reasons: First, the overall objective is to make information available to all. Second, for researches and decision makers, it is not only important to consult cartography and attribute data within their own – usually well known – region, but also to have information on what's going on in the neighbourhood and other protected areas. For the moment, all areas with detailed cartography are available to any user, although some point locations indicating sensitive areas (such as monk seal caves and osprey nest sites) are only visible to authorized users. Only one region is available at a time. As soon as one of themhas been selected, all the other ones become invisible.

In order to use MedGIS as a tool for research and decision making, regional map layers may have to be available according to other criteria (for example: show all local maps which coincide with the currently visible area and scale range). This would permit to actually see all regional map layers of various SPA at once. One might wish to know where the nearest patches of a determined habitat type are, let's say, seagrass meadows, or whether if there are other locations with seal caves in the area and how far away they are.

The grouping may also be conducted differently: Layers of all regions showing habitat types might be unified in one layer and thus displayed and queried as a whole. This, of course, requires a previous

agreement on habitat types definition and a general naming standardisation. That is why retrieving data in standard formats is so important to optimise synergies.

List of Map Themes: Map themes appear in a list and may be toggled on or off one by one according to the user preferences. The map layers are grouped according to their character:

Regional cartography (if selected)
Restricted Data (if authorized login)
RAC/SPA inventories
Remote Databases (not yet available)

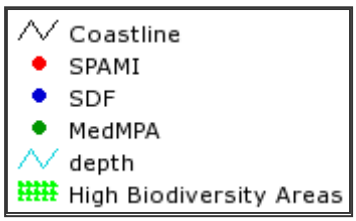
Protected Areas (Mediterranean)

Human Activities/Potential Impacts

Reference Layers

Background and Satellite Imagery (Mediterranean)

The themes that are listed here vary according to their availability at the current map scale.



The **legend** is generated automatically and displays the themes and classes currently visible.

It is very important to provide some core information on the cartography and therefore a **table of data origin** was included at the bottom of the web page. This table is automatically generated, reading the **metadata** of each map layer which is currently displayed: name, feature type and the responsible contributor, including a link to his web site if available.

Table of data origin

Origin of the data layers currently displayed:

layer title	type	contact organisation	abstract
SAPBio Areas Of High Biodiversity Levels		UNEP - RAC/SPA link	Areas with high bathymetric diversity, suspect to hold high biodiv Project: SAPBio, see also: link
Mediterranean Countries Names		NIMA link	annotation layer
Bathymetry (SAPBio)		UNEP - RAC/SPA link	Survey project: SAPBio link
Sites surveyed by MedMPA		UNEP - RAC/SPA link	Survey project: MedMPA link
Sites surveyed using SDF		UNEP - RAC/SPA link	Survey project: SDF link
Sites declared as SPAMI		UNEP - RAC/SPA link	Survey project: SPAMI link
Coastline (SAPBio)		UNEP - RAC/SPA link	Survey project: SAPBio link

A similar table of metadata is available via the Menu-About the Data.

All available data should be registered in the future within a central database with detailed information (see database chapter below). Apart from basic parameters such as type, description and the providing party (the institution or organisation that the user would ask permission if the user wanted a legal copy of the data) credit could also be given to the subcontracted company or university, details on department, address, contact person, methods used, purpose of the study, type of survey, date and geographic area, data format, lineage, geographic projection, scale of data capture etc. This would certainly strengthen the user's confidence in the data as well as provide public recognition to the responsible scientific and technical staff involved in the data gathering.

C. MAP-QUERIES

Map queries at point locations: This type of query implies interaction with the map area. The user moves the curser over the map and clicks on a determined point in order to get information about this feature.

First, the **query map tool**  located right above the map must be activated. The user may then click on any feature in the map, for example on one of the points that represent *Specially Protected Areas of Mediterranean Importance* (SPAMI).

The query returns – in form of a table at the bottom of the web page – all attribute information hold in the spatial data file (a *shapefile*). In this case: name of the locality, marine, wetland and terrestrial

area, year of declaration etc. Different data layers show different attribute data. All data layers, except satellite images and the seabed model can be queried using the query map tool.

For the present version, this type of query can only be conducted at point locations. We may add a drag-rectangle tool in the future. (For alternatives on 'query-by-rectangle'-queries see query on ports below).

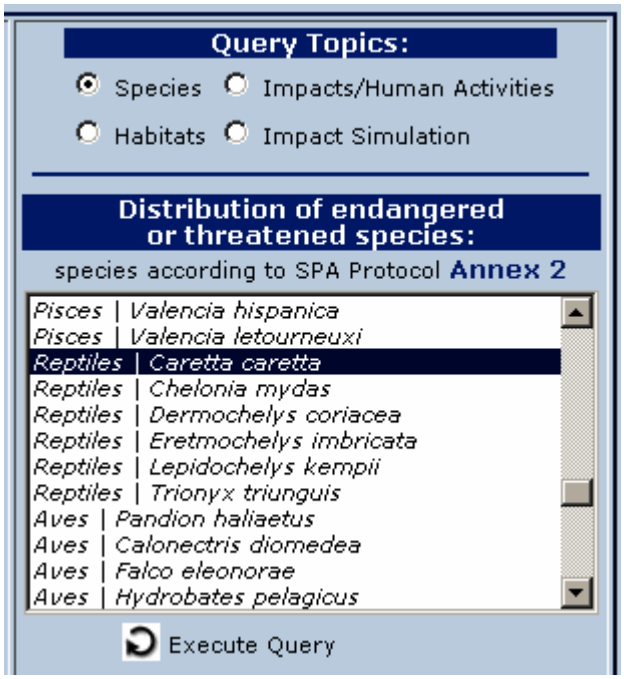
D. QUERY TOPICS: Species, habitats and impacts

The following queries access a relational database where the survey data is stored. All queries show tabular output. Some of them draw additionally symbols on the map according to the corresponding coordinates returned by the database.

Just right to legend the user may choose between one of several query topics: species, habitats and impacts. The functionality of these options varies and depends on whether the user is currently looking at a predefined region or at the whole Mediterranean Sea:

Distribution Mapping

If the whole Mediterranean Sea is displayed, we assume that the user wishes to map the distribution of a particular species, habitat or impact type.



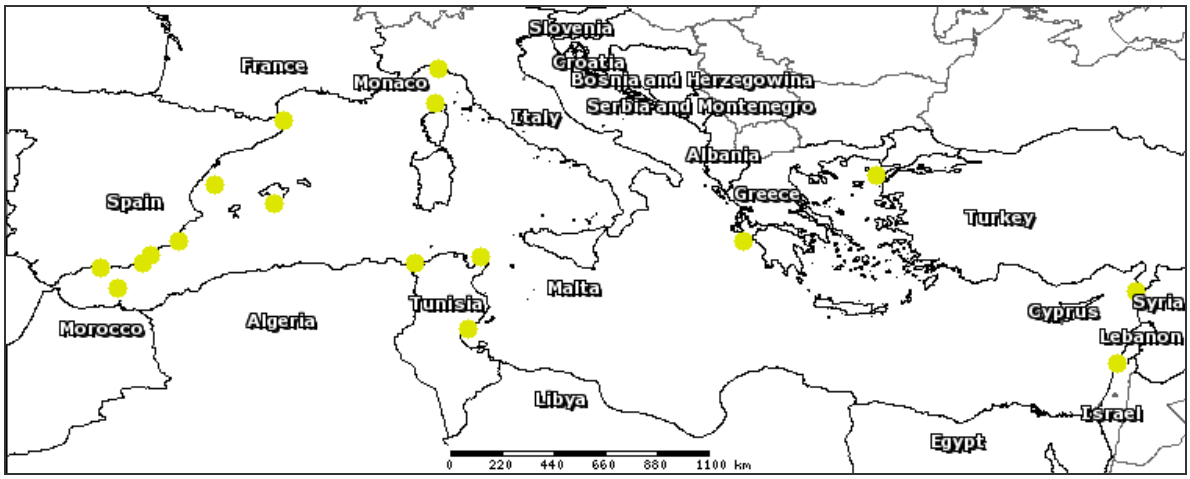
By choosing one of these options, a selection list will show up and the user may select one by clicking on its name (the selection will be highlighted in blue).

Let's try, for example, *Caretta caretta* - the Loggerhead Sea Turtle.

Image: GMIX-Designs (OBIS)

In order to see the complete list of species included in the SPA Protocol the user may click on the hyperlink **Annex2**.

If the user then executes the query by clicking on the Execute Query button, she/he gets two types of output: On one hand, all survey sites at which this species is present will be marked with a symbol:



Presence of *Caretta caretta*

Additionally, the user gets an output table at the bottom of the page, which shows more detailed information: If the species is either resident, rare, common or threatened, the year the survey was conducted etc.

The coordinates represent the *centroid* of the survey locations and the *Maximum Error Distance* gives the user an idea about how far away the real location (which is not given here) may have been at the furthest.

Distribution of habitat and impact types works just the same, except that there are different levels (from rather general to very specific) at which the user may make the selection: For example, the user may choose *'Fishing, hunting and collecting'* and get in return anything that falls into this category. Or she/he may as well be only interested in *'professional fishing'* and particularly in *'Trawling'*. In the latter case the query will only return this particular type of fishing. Please note, that not all of the sites have been surveyed using the same standards, so we had to choose the most adequate subset for this query. In other words: There are only few sites (perhaps none presently) that may return the type the user chooses.

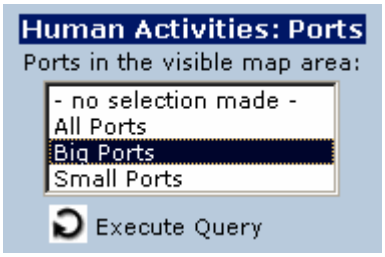
QUERY RESULTS:
Trawling found at:

Code	Impact Category	Impact Description	Name	Country	Intensity	% exposed	Influence	Location	Survey Year	Survey Project
212	Fishing, hunting and collecting	Professional fishing: Trawling	Promontorio di Portofino	Italy	High influence		Negative	Outside	2002	SDF
212	Fishing, hunting and collecting	Professional fishing: Trawling	Gökçeada - TÜDAV Marine Park	Turkey	High influence	100	Negative	Inside	2004	SDF
212	Fishing, hunting and collecting	Professional fishing: Trawling	Gökçeada - TÜDAV Marine Park	Turkey	High influence		Negative	Outside	2004	SDF

.

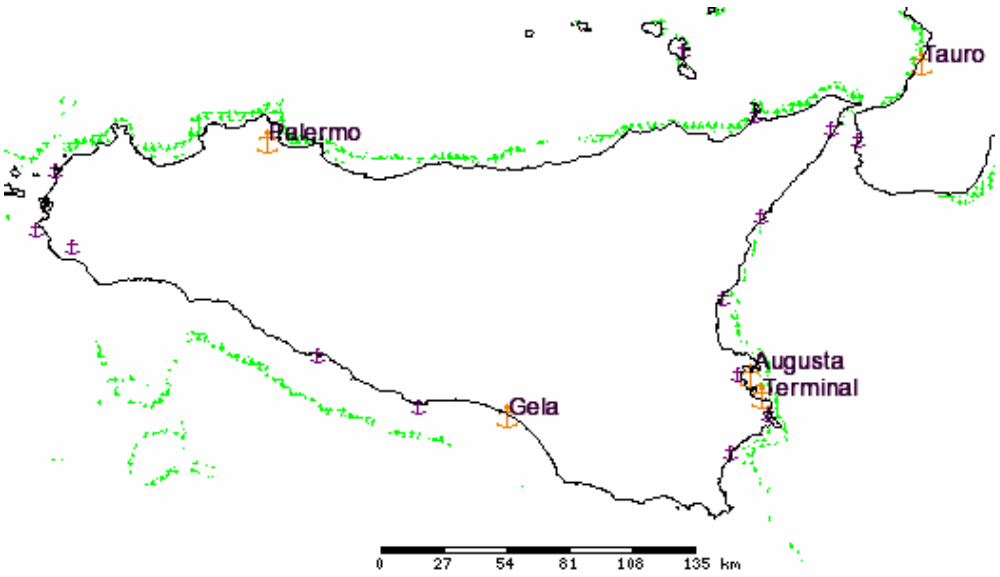
If the user has chosen a habitat type, she/he gets information on the area covered by this habitat and it's importance, while regarding impacts the user learns about how much is exposed to it, the intensity and whether its inside or outside the park.

Combined Spatial and Attribute Queries

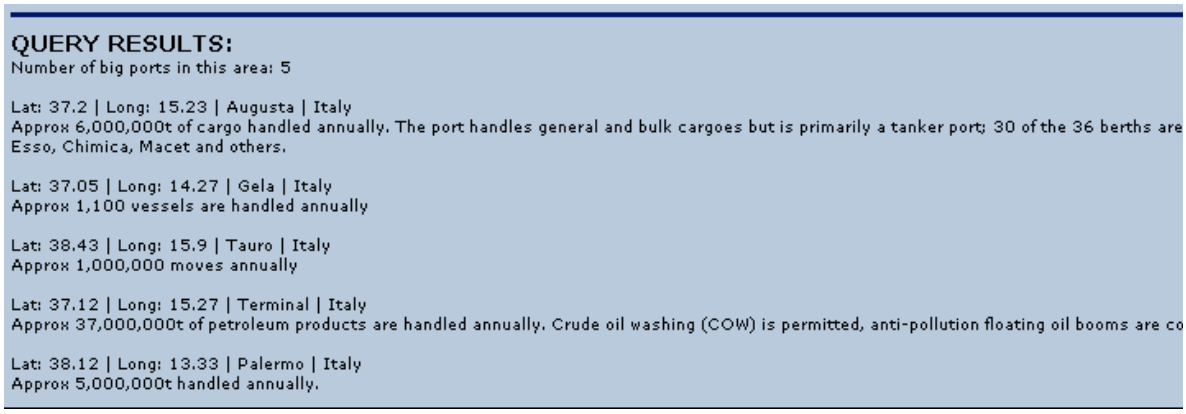


Under *Impacts/Human Activities* the user will also find a query on *ports*. This query type does not use the relational database, but executes an attribute query on the spatial data layer. While the same information is also returned by using the map query tool clicking on a particular port, this query permits to retrieve information selecting either big ports, small ports or any ports.

Additionally, only features in the visible extent of the map are returned, so that the user can limit the output to the area of her/his interest (this is actually a query by rectangle).



All ports that meet the condition selected (big, small or any) are highlighted on the map.



QUERY RESULTS:
Number of big ports in this area: 5

Lat: 37.2 | Long: 15.23 | Augusta | Italy
Approx 6,000,000t of cargo handled annually. The port handles general and bulk cargoes but is primarily a tanker port; 30 of the 36 berths are
Esso, Chimica, Macet and others.

Lat: 37.05 | Long: 14.27 | Gela | Italy
Approx 1,100 vessels are handled annually

Lat: 38.43 | Long: 15.9 | Tauro | Italy
Approx 1,000,000 moves annually

Lat: 37.12 | Long: 15.27 | Terminal | Italy
Approx 37,000,000t of petroleum products are handled annually. Crude oil washing (COW) is permitted, anti-pollution floating oil booms are co

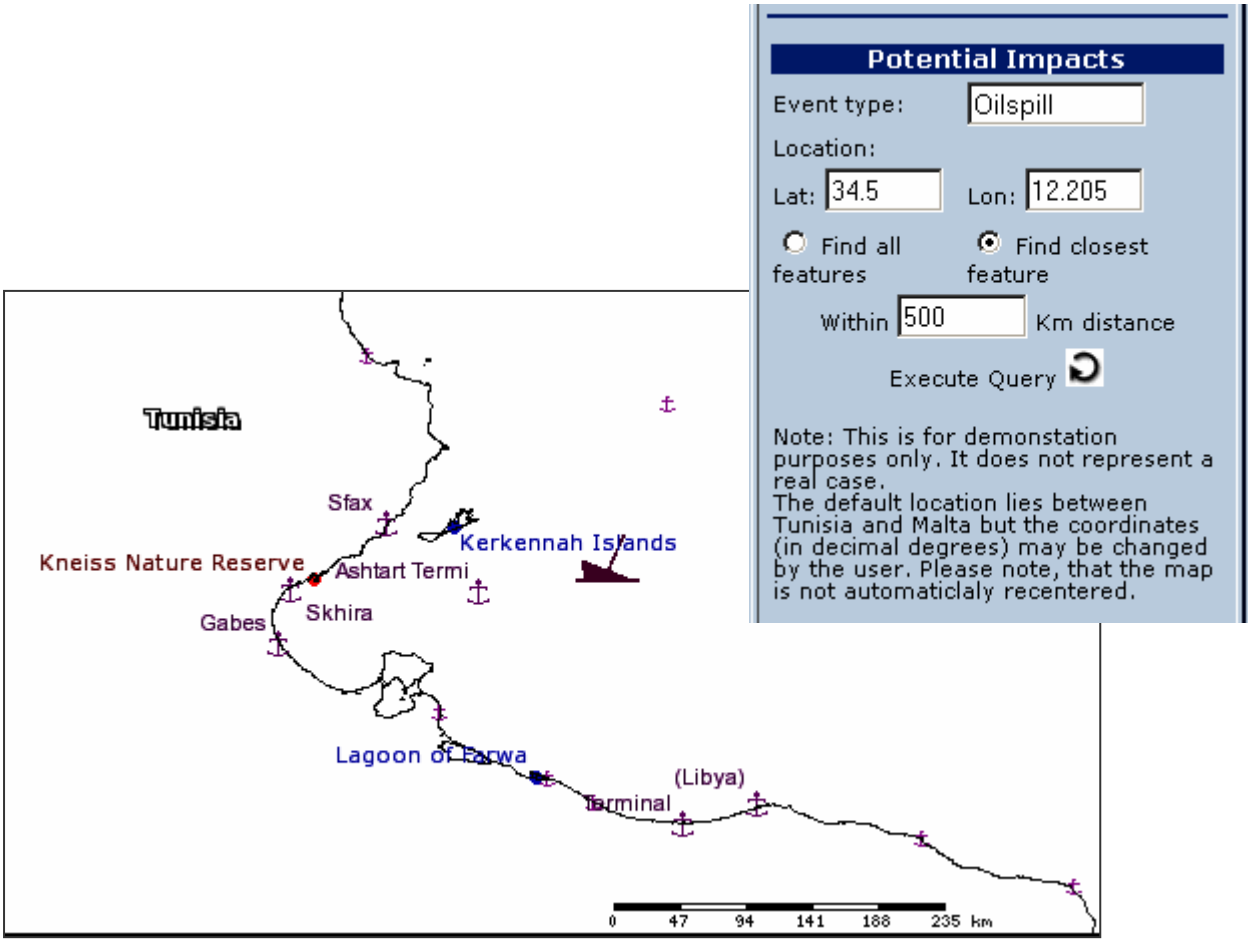
Lat: 38.12 | Long: 13.33 | Palermo | Italy
Approx 5,000,000t handled annually.

Ports results table

Within-Distance Query

A special case is the last option: an oil spill simulation. The objective was just to demonstrate how one can find and identify any features (all or just the closest feature of each theme) which are located within a determined distance to a particular point location. The oil spill is a hypothetical case and we didn't consider neither wind nor current speed and directions.

The user may create his own “contingency” simulation by indicating other coordinates and distances, in order to see what would be affected and how far away it is.



DISTANCE QUERY RESULTS: Lat: 34.5 Lon: 12.205

Within 500 Km distance:

MediterraneanCountries

Clostest feature found at 84 Km distance.

ALPHA_2	COUNTRY	ALPHA_3	FIPS10_4
TN	Tunisia	TUN	TS

WDPA_RegionalSites_point

Clostest feature found at 176 Km distance.

LON	LAT	AREANAME	ISO3	COUNTRY	POLY	CONV_CODE	SITE_CODE	AREA_HA	CONV_FULL	CRITERIA	EST_DATE
10.30000	34.36667	Iles de Kneiss	TUN	Tunisia	N	24	131910	5850	Barcelona Convention		00000000

WDPA_NationalOtherAreas_point

Clostest feature found at 96 Km distance.

LON	LAT	AREANAME	DESIGNATE	STATUS	ISO3	COUNTRY	IUCNCAT	POLY	SITE_CODE	EST_DATE	AREA_HA	NOTES
11.20000	34.73333	Kerkennah isles	Nature Reserve	Proposed	TUN	Tunisia	Unset	N	15196	19540101	2500	

WDPA_National_IUCN_ProtectedAreas_point

Clostest feature found at 233 Km distance.

This is (the top of) the list of affected features (protected areas were switched on):

In the future we hope to link MedGIS to the REMPEC oil spill-database, so that the simulation will be finally replaced by real locations. Anyway, this type of query may be very interesting for decision makers, since it shows all potentially affected features within a determined area even before the event occurs.

Checklists at predefined regions

If the user is looking at one of the predefined regions, we assume that she/he wishes to get a checklist of all endangered or threatened species or a list of habitat types or human activities and impacts on the area. So, instead of sending the selected name(s) to the database the user just executes the query and retrieves the required list directly.

The returned species checklist shows any species present at the predefined regions currently displayed and which is included in either Annex 2 (threatened and endangered) or Annex 3 (under regulated exploitation).

The remaining data fields of the table vary according to the survey protocol used: While some of them register information on relative abundance, global and local status of the species, others register instead its presence as resident or migrating species, as well as evaluate the population, conservation and the role of the site.

The checklists on impacts and habitat types are similar. The cases integrated in MedGIS have also been using different protocols and lists. But here the type lists didn't match, so we decided to query

only those which applied the 'Standard Data-Entry Form' (see link to the document). This Standard Data-Entry Form distinguishes between ‘marine’, ‘coastal’ and ‘other’ habitats, while earlier inventories registered only marine and coastal habitats according to the Habitats Directive (Annex I) of the European Commission which has less classes, especially among the marine habitats.

QUERY RESULTS:
Zakynthos Marine National Park, Greece

Code	Habitat Type	Representativity	Conservation Status	Vulnerability	Coverg.[%] within the site
II.3.1.1	Facies of banks of dead leaves of P. oceanica and other	Non-significant presence	The habitat is very discontinuous and the assemblage is sparse and residual	Medium	1
III.2.2.2	Association with Halophila stipulacea	Significant	The habitat is very discontinuous and the assemblage is sparse and residual	Low	1
III.5.1	Posidonia oceanica meadows (= Association with Posidonia oceanica)	Excellent	The habitat is continuous and the assemblage compact	Low	35
III.6.1.2	Association with Cystoseira amentacea (var. amentacea, var. stricta, var. spicata)	Good	The habitat is continuous and the assemblage compact	Low	5
III.6.1.20	Association with Sargassum vulgare	Excellent	The habitat is continuous and the assemblage compact	Low	10

Habitat checklist for Zakynthos Marine National Park

E. ON THE MEDGIS DATABASE

To develop this application we have almost exclusively applied open source software. MedGIS is running on an ordinary desktop PC, connected to Internet, and the only commercial component is the operating system (Windows2000 NT). Server software (Apache) and database system (MySQL) are open source software, as well as the scripting languages we use (PHP, MapScripts, JavaScript). The web mapping system itself has been built using MapServer[1] 4.4 which is a CGI program, created by the University of Minnesota. The user just needs any **web browser** supporting HTML 4.0, such as Internet Explorer or Netscape Navigator. No additional software has to be installed. The user interacts locally with his/her web browser and submits requests to the Application Server (this is where MapServer is installed and the MedGIS data allocated). The Application Server processes these requests (the user’s selections or clicks on the map) and dynamically generates HTML pages which are returned to the user. In a similar way one would interact with an online bank account, most of the MedGIS data is available without using a password.

Quality and quantity of the data are crucial for any GIS and its suitability as research and decision making tool. The same is true for web mapping applications. Obviously, the MedGIS prototype can neither be considered complete nor fully functional as a tool yet, but we hope to provide a first insight. We describe here the information already included in the prototype version, with special emphasis on

[1] MapServer home page: http://mapserver.gis.umn.edu/

data directly derived from projects related to the Mediterranean Action Plan. We also add some reflections on data which are likely to form part of it in the future.

There is still a long way from turning data into information and information into conclusions. Anyway, the future development of MedGIS will very much depend on the contributions, the collaboration and the feedback from different members of the MAP community. As the improvement in data availability and usage will also create new management and research opportunities, it is likely that the requirements and objectives of the users will change and the 'Dynamic Atlas' linked to this GIS Database will always be dynamic in the true sense of the word.

Data nature

The data can be looked at from different points of view. Technically, we distinguish between spatial data and attribute data. Most of the thematic map layers represented in MedGIS consist of spatial data files in vector format – such as the Protected Areas (point) locations, the bathymetric lines (lines) and the No-Take-Zone[2] (area). These spatial data files contain the coordinate pairs that describe the features in space. They may also be related to attribute data in an associated table. Raster images (GeoTIF), such as the seabed model or the satellite images are composed of cells or pixels. Each pixel contains a digital value but there are no associated attribute tables as for vector data files. Regarding the seabed model and the satellite images (colour compositions) in MedGIS, these pixel values are not particularly meaningful and the images are mainly used as backdrop images to provide the user with some kind of ground reference. Nevertheless, there are raster images or 'coverages' which contain digital values that do have a meaning: sea surface temperature maps, landuse/landcover maps, digital elevation models and prediction maps, contain digital values that represent temperature, altitude, vegetation class, probability etc. This type of spatial data is not (yet) represented in MedGIS, but very likely to be there in the future, since coverages are the adequate format for representing continuous, gradually changing parameters and many biological and ecological phenomena have this characteristic.

In those cases where a great amount of attribute data for a vector layer is available, the attribute data are best stored and read from a relational database. We chose MySQL[3] – an open source software and a Relational Database Management System based on Standard Query Language (SQL). All information derived from survey projects and impact assessments is stored in this database while the

[2] No-Take zone below 1000m Depth according to the General Fisheries Commission for the Mediterranean
[3] MySQL http://www.mysql.com/

spatial data file which represents the sites only contains some basic attributes on the site itself (name, area, declaration year etc.).

MedGIS includes several query methods which, according to the nature of the query, access either the relatively small attribute tables belonging to vector files or the rather complex relational tables that form the database[4].

We could as well distinguish between data which are stable in time and data subject to changes (time depending data). Most of what we consider 'reference data', such as bathymetric depth, land elevation and administrative boundaries are stable over decades. Information regarding the extension of a site declared as protected area, its name and year of declaration, the country it belongs to as well as the land and marine area composition could be regarded as data (relatively) stable in time. But when it comes to biophysical parameters and natural resources the opposite is true: Water temperature, species abundance and even species presence are subject to change in time (in question of hours, days or years). Surveys and observations are data sampling events – snapshots of the current situation - which are repeated at more or less regular time intervals in order to reflect these changes. Again, data subject to change is best stored in relational databases.

Data categories

MedGIS contains data of a great thematic variety. Disregarding the reference data, we deal with data of three different categories: Natural resources, (anthropogenic) impacts & risks, and biophysical and geophysical data.

Natural resources

From one side, there are data on species level, data on presence and abundance of species, gathered during surveys and observations. In MedGIS, the registered species are limited to some 130 species belonging to the Specially Protected Area (SPA) Protocol[5] Annex 2 and Annex 3 for being especially vulnerable, endangered or of economic interest.

[4] MySQL may also be converted into a spatial database and replace the vector files with database tables. This will be considered in the future.
[5] SPA Protocol http://www.rac-spa.org/annex2.htm and http://www.rac-spa.org/annex3.htm

Data on species level were gathered either during surveys and observations carried out with RAC/SPA support or by the responsible bodies of several protected areas. At some sites additional species to the annexes were also registered (nevertheless, any other species registered are dormant in the database and may as well be made accessible in the future).

Data include additional information on the species related to a determined location, such as if a species is rare or common at that location, migrating or breeding and the importance of the site for a particular species. The parameters registered in Standard Data-Entry Forms (SDF)[6] and surveys conducted in Specially Protected Areas of Mediterranean Interest (SPAMI) were different and are not always directly comparable among each other. Anyway, the queries output both groups of data fields. MedMPA[7] project sites did not have standard forms at all, but we were able to reconstruct such a species checklists by analysing the text.

Considering that it is very likely that the inventories will be repeated in several sites and that the list of species will be amplified, special attention should be paid registering Zero and Null values in order to avoid misinterpretations. Zero (=absence confirmed) is not the same as Null (=not looked for). If new species are added to the Protocol between survey campaigns (for example, invasive species, ecological indicator species or important food-chain species) which have not be counted during previous campaigns but do appear later, could be interpreted as 'new arrivals' while it is actually not known whether they were present in the past or not. Registering Zero values for absence during the surveys and Null values (database default) permits us to distinguish both cases.

There is also data on landscape composition and habitats, generally based on detailed habitat classifications (a total of 92 classes in 4 specification levels), often accompanied by area estimations (percentages at local and national levels), and sometimes accompanied by maps and spatial data files describing the location and extension of these habitats.

Additionally, data on natural resources are derived from quite diverse ecological units, such as wetlands, coastal and marine environments. This involves different expert groups, different gathering methods and different ways to store, analyse and display the information.

[6] Standard Data-Entry Form http://161.111.161.171/MedGIS/documents/SDF_ENG.pdf
[7] MedMPA: Regional Project of the Development of Marine and Coastal Protected Areas in the Mediterranean Region http://www.medmpa.net/

The Standard Data-Entry Forms (number of sites included: 6) distinguish between 'marine', 'coastal' and 'other' habitats[8]. The list is based on the Classification of Benthic Marine Habitat Types for the Mediterranean Region[9]. The category which was completed at most sites was 'marine habitat', while 'coastal habitat' and 'other habitat' were often left out. Some SPAMI inventories registered marine and coastal habitats according to the Habitats Directive (Annex I) of the European Commission which distinguishes fewer classes, especially among the marine habitats, while other SPAMI inventories already applied MAP categories, which coincide with those used in SDF. The available MedMPA project inventories available for MedGIS pilot project did not contain listings on habitats at all, although they included habitat descriptions. There are currently efforts made to 'translate' the Habitats Directive classes into the new classification system.

Anthropogenic impacts and risks

The survey data on impacts and risks focus on human presence and activities (agriculture, fishery, leisure, industry, pollution) but also include natural hazards, such as erosion, forest fires, inundations, volcanism and earthquakes. The registers generally include the type, often accompanied by an estimation of its magnitude and origin (inside or outside the Protected Area), and a percentage of area affected.

The Standard Data Entry Forms offer a total of 177 classes using 3 levels of specification. Both, habitat and impact surveys allow queries from rather generalised to much specialised classifications. I.e. the category 'Fishing, hunting and collecting' includes 8 subcategories, of which 3 are further subdivided. Queries selecting a high level class include all lower subdivisions. Despite of having only 6 sites available for proper habitat and impact queries we included this option for demonstration purposes. Efforts are made to homogenise inventories by using standardized lists and classes and by facilitating thesaurus to pick the adequate keywords in order to fill in the forms correctly.

Those impacts which are of human origin (as well as some of the impacts of natural origin) directly depend on political and socio-economical pressures, related to environmental awareness on one hand and industrial development of the region or country on the other hand. One may also add to this category, all restrictions due to protection and local or national management plans, ports, marine

[8] http://161.111.161.171/MedGIS/documents/other/Guide-marine_Habitat-FSD.pdf and http://161.111.161.171/MedGIS/documents/other/Ref_list_coastal_habitat_eng.pdf

[9] as elaborated by the Meeting of Experts on Marine Habitat Types in the Mediterranean Region (Hyères, France, 18-20 November 1998) and subsequently reviewed by the Fourth Meeting of National Focal Points for Specially Protected Areas (Tunis, 12-14 April 1999)

traffic, fish exploitation, oil platforms etc. This information could possibly be provided by other UNEP-MAP Activity Centres.

Biophysical and geophysical data

This a third category which should be considered important due to its influence on all other phenomena: Biophysical and geophysical data include: air and water temperature, wind and current direction and speed, salinity, chlorophyll content and composition, land and water pollution, biomass, depth and elevation, soil type etc. Except for bathymetric depth, the MedGIS prototype does not yet include data of this category. Hence, given the increasing importance of Internet as information source and the opportunities emerging networks provide, there are good chances to retrieve these thematic maps and to display and query them simultaneously with MedGIS data. Especially promising are remote sensing services which provide satellite images and their derivates (landcover maps, vegetation indices, surface temperature, pollution, climate parameters etc.).

Data spatial precision

We may also look at the data from a spatial (geographic feature) point of view: So far, most of the data included in MedGIS are data at point locations (even those which aren't really points, such as Specially Protected Areas). Species presence, habitat type or land elevation, are usually taken at geographic localities, identified by geographic coordinates or place names. (Note that as for human activities and impacts, this 'point' may be a lot more fuzzy). In the case of the MedGIS survey data, this spatial reference is not directly given. Instead, each parameter has been registered to the Protected Area itself and is thus defined by the centroid (or central point) or the site. This has several advantages and disadvantages: the low spatial precision of the data (several kilometres) allows us to freely reveal the presence of all species, regardless of their vulnerability. On the other hand, the low spatial precision makes it difficult to relate the presence of a species to other parameters (such as water depth or temperature) which in turn is necessary for habitat suitability analysis and generating distribution (prediction) maps. Such low precision is also not good enough for management and emergency plans.

Wherever the spatial extension (polygon) of a site was available, we calculated the Maximum Error Distance, estimated as maximum distance from centroid to border following the MaNIS

Georeferencing Guidelines[10]. This has been done for 7 of the Spanish SPAMI. The Maximum Error Distance is an indicator for coordinate precision and is usually requested by networking search engines (such as GBIF[11] and OBIS[12]), although it is not mandatory.

Apart from delimitating the extensions of the remaining survey sites, the next task would be to recover and include the original spatial references of the inventories wherever possible. According to the characteristics of the 'subject' and the methods applied, the localisations will vary a lot in spatial precision: For example, whale sightings made at hundreds of meters distance from a boat are less precise than localisations by radiotracking of a tagged whale, which again is less precise than taking the coordinates of a stranded whale using a differential GPS. Amount of data, certainty of taxon determination, counts of individuals and positional precision depend on various factors such as the characteristics of the species itself, its population density, the survey effort and methods applied, among others. It is not adequate to represent all these localisations by points without providing the user with additional information on how this data was obtained. As for maps on species distribution or densities, it is common to display the counted or estimated number of individuals (or species or any other biodiversity indices) in form of regular spatial units, such as grids or map graticules. The spatial precision of the observation determines the minimum size of the mesh to which the data may be assigned. There are also cases in which it may not be desired to display data at its original (high) precision. For example, still unpublished data as well as sensitive data may be deliberately represented at a lower positional precision. This is often a better alternative than not showing sensitive or unpublished data at all.

Special attention deserve primary data and synthesised information. While primary data, derived by counting, measuring or observing phenomena, are the basis for research on the subject itself, synthesized information is based on the research results, derived from statistical analysis, prediction models, data interpolation and extrapolation. This synthesised information is then often itself input for new analysis on other subjects in the same or related research fields. In MedGIS, the map layer 'Areas suspect to hold high biodiversity levels' is such an example (see: The Mediterranean Marine Gap Analysis Paper [13]). Naturally, the whole Mediterranean Sea cannot be surveyed in order to identify all biodiversity hot spots. Instead a gap analysis[14] has been conducted aiming at the identification of those areas, which according to certain criteria (spatial heterogeneity of the shelf-

[10] MaNIS Georeferencing Guidelines by John Wieczorek, Univ. of California, Berkeley http://elib.cs.berkeley.edu/manis/GeorefGuide.html
[11] GBIF: Global Biodiversity Information Facility http://www.gbif.org
[12] OBIS: Ocean Biodiversity Information System http://www.iobis.org/Welcome.htm
[13] http://161.111.161.171/MedGIS/documents/other/GapAnalysis_Paper.pdf
[14] http://www.gap.uidaho.edu/about/what_is_gap_analysis.htm

slope system), have an elevated probability to hold high biodiversity levels. Such synthesised information allows policy makers to better take nature conservation into account for decision making. Zoning categories and delimitation of areas of high conservation values is another example for synthesised information. However, these data can only be visualised but not yet queried in the MedGIS prototype. We disregarded as well sampling locations and related raw data for queries in the current version, since this may be only of interest to few users. As a tool for decision makers and management plans, this type of information is probably the most important. Certain priority should be given to this type of information in order to provide conclusions and knowledge rather than not interpreted raw data.

What all these data have in common is a spatial relation and an effect on the natural resources in the Mediterranean Region. It is also noteworthy that most non-European countries are already represented in the prototype. But, while MedGIS at the present stage contains mainly data gathered inside Specially Protected Areas, it is quite obvious that these sites cannot be regarded as environmentally isolated from the rest of the Mediterranean Region.

Many of the potential users are involved in research and/or planning and are interested in explaining the past and the presence or predicting the future, modelling different scenarios in order to develop plans which allow achieving a sustainable use of the Mediterranean region and its rich natural resources. They are simultaneously potential users and contributors to such an Information System. Thus, it would be convenient to determine which are the necessities of the wider MAP frame community, what information is already available or could be made available and which the gaps to be filled are, both on biological issues and related fields.

Metadata and their importance

Metadata are data about the data. They allow a user to find adequate data for his/her purpose and to find out who did the survey, who processed the satellite image, which methods have been used, year, scale…etc. Incomplete or missing metadata are a great problem. Tracing back the core metadata years after a project has been closed is a very hard work. Additionally, without metadata, proper credit can not be given to the data contributors.

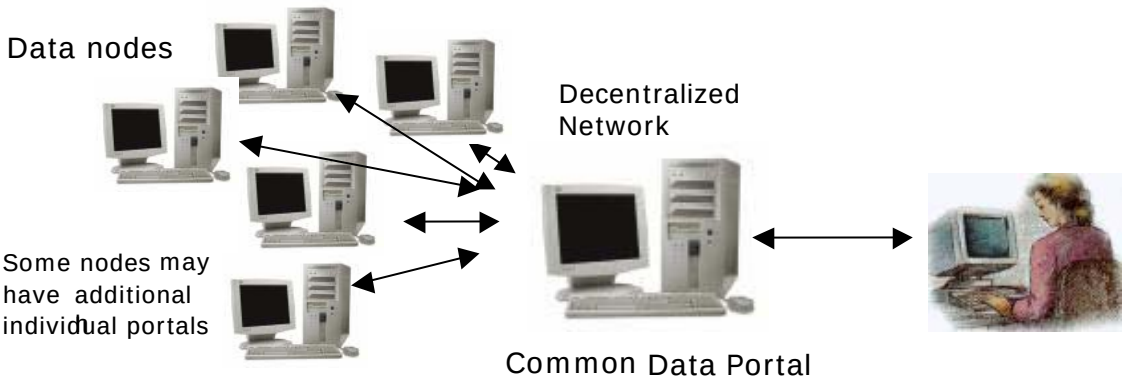
Possible further developments

Now that the prototype is up and running, it has to be defined what else MedGIS needs in order to become a suitable tool for decision making, protected area management, conservation research and emergency response. What data should be available and which functionalities do users need for to query the spatial database and their attributes? Which data should be restricted to internal use and not be available to the public? Who shall control the restricted access (give out passwords)? How can data authorship be adequately cited?

RAC/SPA also seeks collaboration from Parties, other Centres and initiatives, in order to get different expert groups with their survey and research results closer together. An improvement in data availability and usage will also create new management and research opportunities.

It may appear somewhat risky to combine sets of very diverse data themes. An adequate integration requires certainly a very high degree of coordination between the different centres and working groups and homogenisation of data gathering and exchange. Great efforts are already underway to coordinate and achieve synergy. But, this enormous information diversity might call for a subdivision of MedGIS. The MedGIS user interface may become soon overloaded and too complex for fast and effective use, especially when the addressed users are also quite diverse. One might argue that it is more reasonable to focus on data quality and quantity rather than data variety.

Most international networks, specialise on few data themes, have one common data access portal and many data nodes which are connected to this portal, providing standardised data. The main advantages of a distributed network are: the control and responsibility remain at the providing data nodes and data maintenance and updates are easier. At the same time, the user does not need to visit several sites in order to obtain the desired information, since all data are simultaneously available through the common portal.

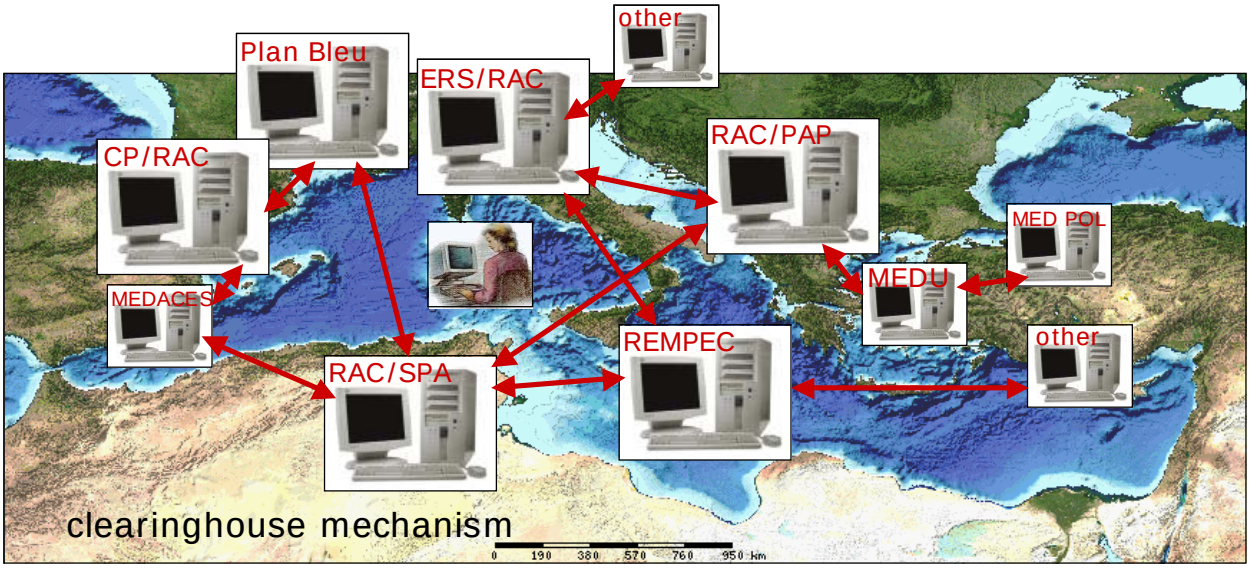


On the other hand, a service which combines all factors relevant for protection and conservation of habitats and biodiversity is indeed very important. For researches and decision makers, it does not

suffice to know which species are present at a determined site. They also need to know what affects them in one way or the other. More precisely, we need to be able to combine the knowledge of experts of different disciplines. The possibility to integrate teams of various disciplines into one network, able to act and react in real-time, is a great challenge and may well be worth such a coordination effort. But still, the problem of to loosing the overview about such a huge variety of data themes remains.

A practical approach would be to evolve into a network formed by several MAP Regional Activity Centres on which data are shared but yet have various portals instead of one that tries to suit them all. According to their expertise, each of these portals would serve different data sets, and some of the data are obtained from other centres. Each portal would thus simultaneously be server (own data) and client (external data).

This network type would preserve all of the advantages of the distributed system with one common portal, except that the user has to choose –according to his/her interests- which portal to visit, since the available information will not be identical. Additionally, it permits that each centre presents to a maximum their own data and expertises, hence counting on contributions form other centres of the UNEP-MAP frame. The services not necessarily have to be designed and financed exclusively for and by UNEP-MAP, nor are the members obliged to evolve in concordance. They may simultaneously satisfy other national, European or global projects and initiatives as long as all implement international (OGC[15]) standards.



[15] Open Geospatial Consortium http://www.opengeospatial.org/

To get an idea of how such a network would look like, we may imagine the following case: REMPEC holds an important data base on oil spills and other toxic accidents in the Mediterranean Sea. This database contains detailed information on ship accidents, including the chemical compounds, the cause of the accident, measurements taken, the flag of the ship, who came to aid etc. The experts at REMPEC require as well some information on sensitive areas: They need immediate access to maps which represent SPAs and find out about the shore line structure and the littoral habitats potentially affected by any accident in order to make adequate decisions and interventions. The required data may actually be included and queryable in MedGIS and may be retrieved via Internet. Thus, instead of trying to fit everything into one portal interface and then let the user struggle his way through a complex set of options and selection lists, REMPEC would maintain its own portal and additionally integrate just the necessary external data on protected areas. Other nodes on the network may wish as well to draw the locations of oil spill accidents on top of their thematic maps. But they are probably mainly interested in those accidents which have happened recently. Or, they might need rather generic risk assessment maps or models predicting the probability of occurrence or the movement of pollutants, rather than to know the exact cause of the accident or the flag of the ship.

Any centre with expertise on a particular field (for example: oil spill monitoring or satellite image processing and vegetation mapping, coastline changes, socio-economic indices and human activities …) may provide other nodes with high quality and reliable, homogenised information, avoiding thus loss in time and resources as well as data duplication. The benefit of data sharing would be an amplified one, since part of the data could be provided via Internet, automatically and always actualised. Ideally, each node would contribute with synthesised information (rather than huge amounts of primary data) to a better understanding of the marine and coastal environment.

There are also many working groups – often specialised on a particular species or taxonomic group (cetaceans, sea turtles, seaweed etc.) which could significantly contribute to and benefit from a network. Those groups belong to local or international NGOs, university departments, Framework-projects of the European Commission etc., gathering data on dolphin sightings, algae blooms, bird census and similar. Some may not be prepared yet to set up their own service but yet wish that their data were hosted by another centre which passively maintains their database server, while the responsible authors still keep control over their data. Being contributor gives these centres also international recognition. Each Centre would maintain full control and responsibility on their data and thus data quality and actualisation would be considerably improved. Besides, data and metadata losses during data transfer can be reduced or avoided. As a side effect, it will assure a better data

registration, dissemination, data storage and update since responsibilities are assigned thematically to one or few centres.

Perhaps the main advantage of such a network is to bring the different expert groups with their survey and research results closer together. An improvement in data availability and usage creates new management and research opportunities. In other words - the whole is more than the sum of the parts! The achievements of all of them would increase suitability and visibility – both within the MAP frame and to other user communities and the public.

Many may be unaccustomed to share and exchange data, knowledge, resources and technology, standards and guidelines, etc. especially via Internet. But design of the data portal, software and operating system do not matter when it comes to sewing the different nodes together. Open-source software makes it easy for developing countries and low budged NGO's to catch up and step out with their results. Hence it requires that the members get together regularly in order to present the data they could possibly serve to the network and to specify their needs on external information.

MedGIS also seeks to become interoperable and meet the standards of initiatives such as GBIF, OBIS and NatureGIS[16] and other networks related to the Clearing House Mechanism of the CBD[17]. GBIF, which focuses on data on species level, offers coordination, financial and technical support, so that already existing data can be adapted and made available to a broad user community. UNEP has been a member of GBIF as associated organisation since 2001.

Another important association is OBIS, which in turn is also member of GBIF. OBIS is focussing on marine environment conservation, an area which coincides with great parts of MedGIS. OBIS' FishBase[18] is perhaps the most important database on fish and certainly the biggest of it's kind that is already online. MedGIS could benefit as well as contribute to these global networks without loosing its own character.

These and other initiatives and international projects are already developing metadata standards and software to facilitate metadata recording. GBIF deals mainly with data on species level and would not

[16] European thematic network for Protected Areas/Nature Preservation and Geographical Information http://www.gisig.it/nature-gis/
[17] Convention on Biological Diversity. Convention text: http://www.biodiv.org/convention/articles.asp
[18] Global Information System on Fishes http://www.fishbase.org/home.htm

be suitable for data on habitats or impacts or human activities. OBIS may be more adequate for most data derived in marine environments. Since these initiatives have all the same objective – make their data available on Internet – great effort is undertaken to achieve interoperability and their standards are based on the same ISO norms. They then may or may not add additional optional parameters to improve suitability within their network. The OBIS schema for metadata is a relatively simple data model to represent taxon occurrence records and is very similar to the GBIF DarwinCore[19] model (in fact, both are compatible and can be browsed by the same communication protocol. It is perhaps a good starting point for a future development in the UNEP-MAP framework. Another interesting metadata profile, especially for protected areas, is the NatureGIS metadata profile[20] .

The participation of the Parties in the development of MedGIS at national level would strongly augment the usefulness of this CHM tool.

[19] DarwinCore v.2: http://tsadev.speciesanalyst.net/documentation/ow.asp?DarwinCoreV2
[20] NatureGIS metadata: http://www.naturegis.net/metadata/naturegisprofile.htm

Appendix I

Technical evaluation of MedGIS by the Consortium of Universities TEIDE

TECHNICAL EVALUATION OF MEDGIS MAP SERVER APPLICATION

This document certifies that researchers at the Information Systems department (www.geoinfo.uji.es) at University Jaume I, in representation of the TeIDE consortium of universities, dedicated since the year 2000 to research in Spatial Data Infrastructures (SDI),

have analyzed the MedGIS website, specifically the Interactive Maps server, hosted at http://161.111.161.171/MedGIS/

with regard to its adherence to the international standards which guide current best practice in SDI development. TeIDE researchers are also OpenGeospatial Consortium members and registered consultants, having assisted recently in OGC projects for the EU Satellite Centre (Madrid) and European Space Agency (ESRIN, Frascati).

The standards of issue here include the adoption of Open GIS specifications, developed by OpenGeospatial Consortium (www.opengeospatial.org) and also international standards defined by ISO Technical Committee 211 (www.isotc211.org). The key standard used here is the Web Map Server (WMS) interface specification, created by OGC and recently approved as international standard by ISO.

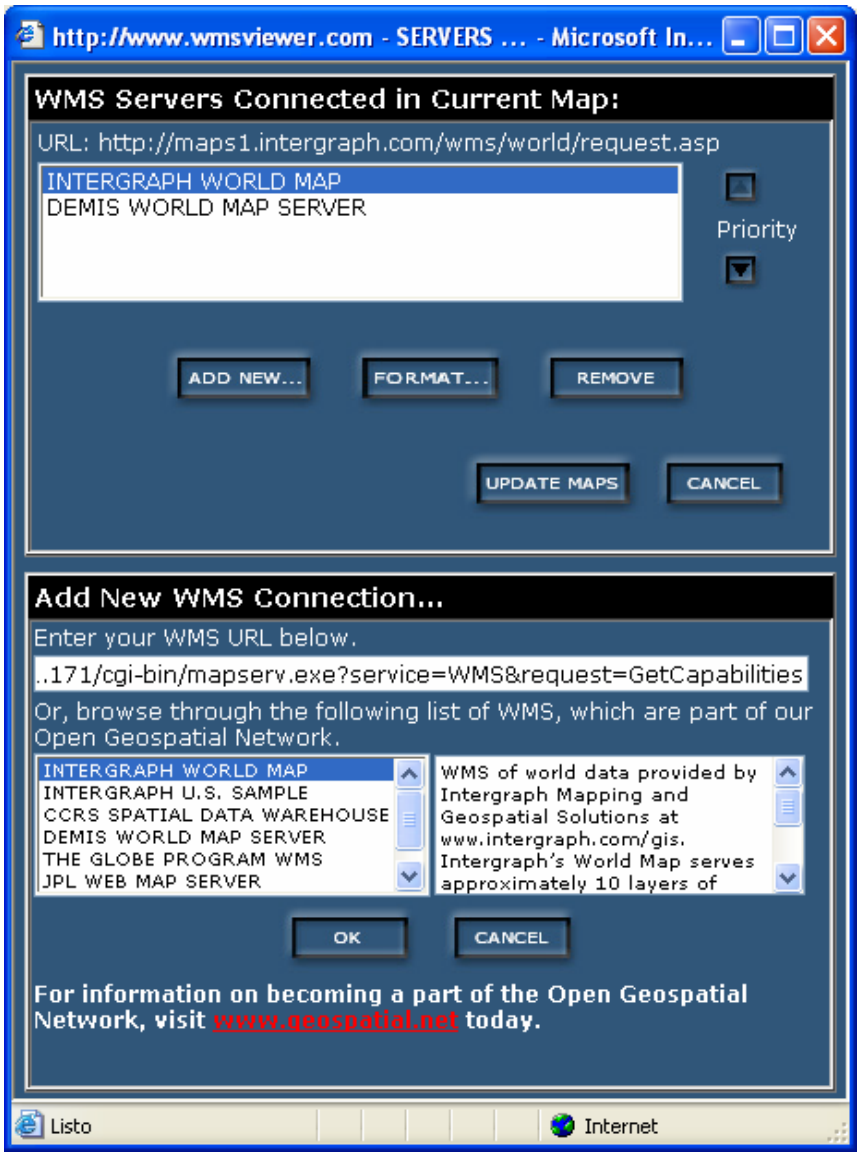
Although many map server applications have appeared on the web over the past 5 years, only a small portion of these have taken the extra step to facilitate access to the data layers to the outside world. That is, the majority of map servers hide the access parameters so that users are forced to enter transparently through the single door offered by the map server client application. This serves to raise the visitor counter at the web map website, however it does very little to enable data interoperability and to contribute to the wider data sharing community. Therefore, while many of these implementations are technically conformant with key standards, they do not adhere to the spirit of open Spatial Data Infrastructures. MedGIS is different in that it offers both access methods: via the MedGIS portal but also direct access from other clients, as we show in the images below.

Facilitating Connection to MedGIS

One of the key features of the MedGIS map server application which allows us to award it high marks for interoperability, is that the service includes explicit instructions on how to connect from outside, that is, using another client software. These instructions, found at http://161.111.161.171/MedGIS/MedGISserverInfo.html allow us, for example, to copy and paste the following internal server address:

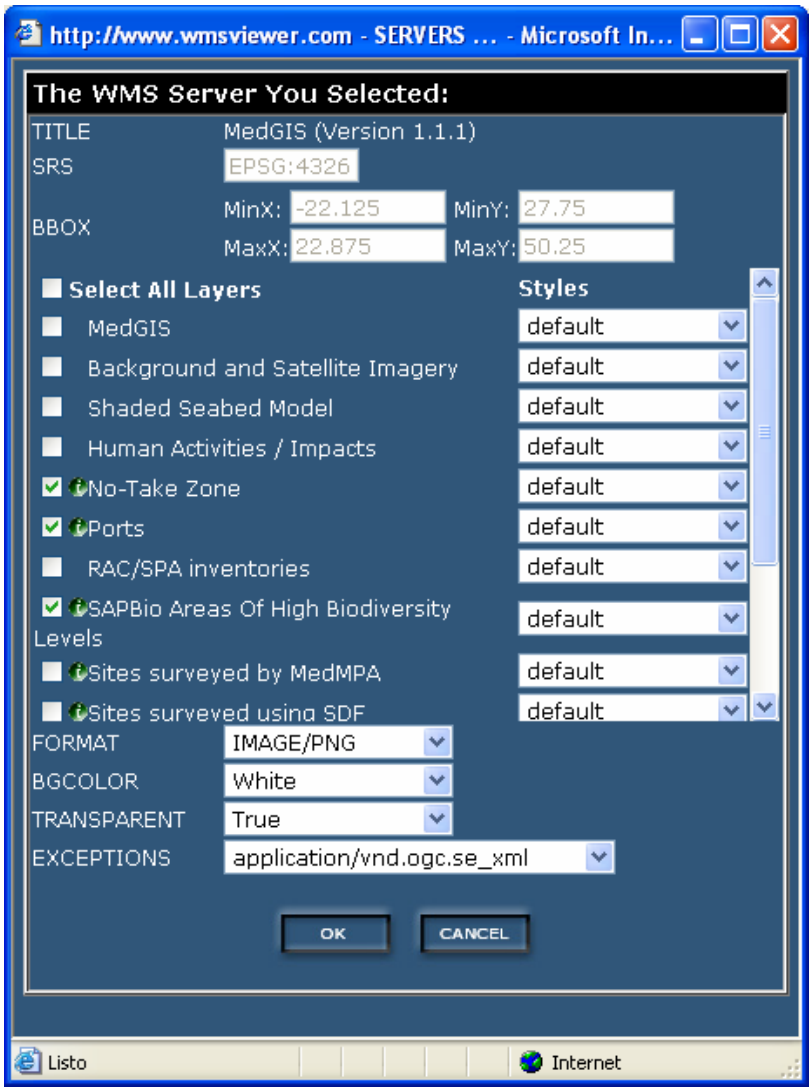
http://161.111.161.171/cgi-bin/mapserv.exe?service=WMS&request=GetCapabilities

into another Web Map viewer application (in this case we have selected the WMS Viewer created by Intergraph Corporation and released as open source). See in the figure below that we have pasted the URL into the box “Add your WMS URL below”.

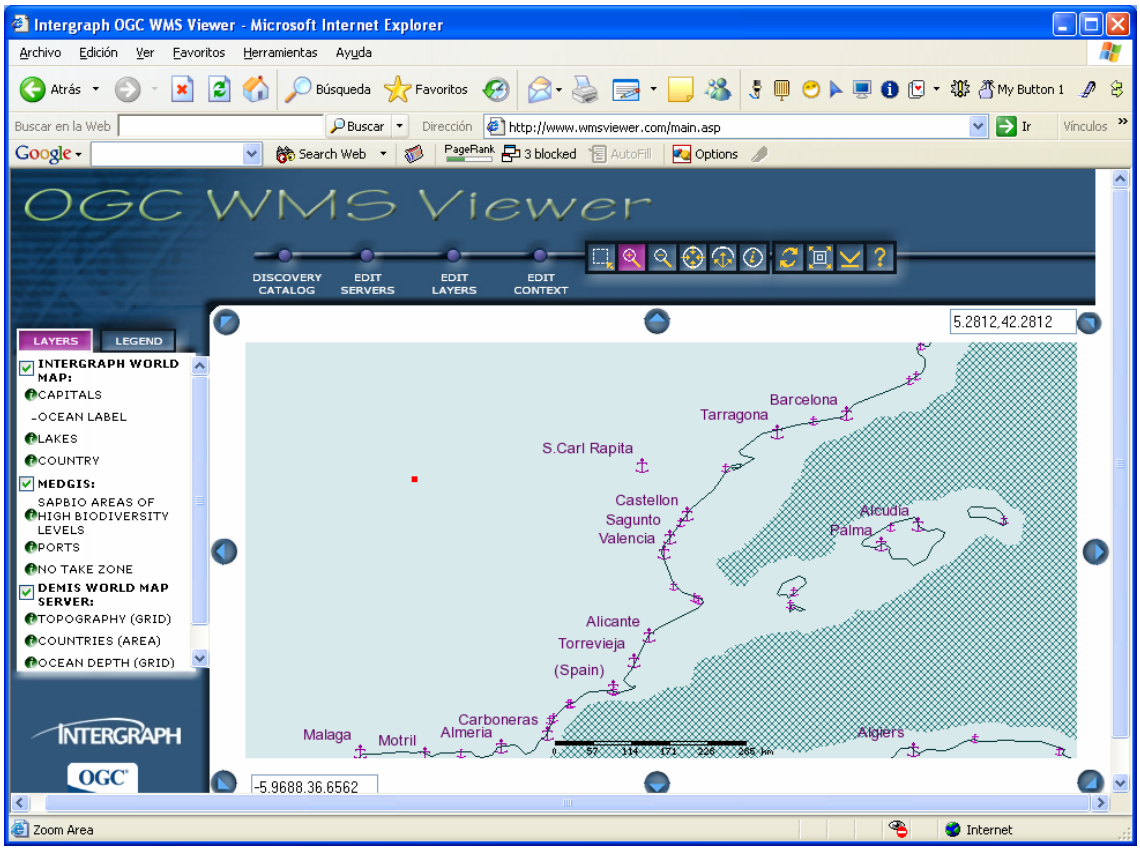


Doing so allows the client application to submit an initial, internal query to the MedGIS server, asking for it’s capabilities: data layers available, coordinate systems supported, etc.

The following image shows MedGIS server’s response, allowing us to select the data layers we would like to integrate into the world map view we already have available from other sources. In this case we have selected three data layers or themes.



Here in the last image we see how the MedGIS layers appear on top of the coastlines and capitals (red dots) provided by the Intergraph server. It is interesting to note also that the MedGIS layers may be consulted (indicated by the green icons) and, thus, will return database registers regarding each port, no-take zone, etc. when these are selected with the mouse.



Future work

The MedGIS map server can and should be extended to add further access to data files, including cartographic data in Geography Markup Language (GML-XML) format. Also to be added are metadata records describing each data set, which will help users to locate these valuable data utilizing various semantic web and catalog search services. ISO TC211 also has defined the geospatial metadata format 19115. Further documentation on how to create and add new data layers would be helpful.

Conclusion

The MedGIS map server application is a fine start, in the direction to providing valuable environmental not only to internal users but also to outside experts wishing to access MedGIS map layers within their own viewing software. The designers/programmers of the MedGIS map server application have created a simple, functional, rapid application which will serve as a nice base upon which a more functional, full-featured web-based information system can be built.

Dr. Michael Gould

20 May 2005, Castellón de la Plana, Spain