The Development of a Trans-national Academic SDI: Experiences, Realisations and Perspectives

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Abstract

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1 INTRODUCTION

Universities and Research Institutions are often in charge of research projects regarding territories of limited extent. Because of their restricted spatial scope, these projects investigate their study area thoroughly, examining many different aspects, thus obtaining precious results having a high economic and technical value. These results are mainly in digital form: geo-referenced documents (such as shapefiles, maps and satellite images), or textual, graphic and multimedia documents with a well identified geographic reference (e.g., reports, theses, books, presentations, photographs, etc.). Unfortunately, these investigations and their products are seldom known outside a small academic community, in spite of their importance for a wide users' arena (researchers of other Universities, governmental or local authority's organizations, private institutions, interested citizens).

The aim of the *IDE-Univers* project, partially funded by the European Union, was to create a geo-information space on the Internet, aiming at integrating knowledge about small territories, produced by research institutions in the Mediterranean. It capitalized on contemporary technological advances in the field of SDI (e.g., geographic metadata standards, catalogue software, geographic services), in order to support the discovery and exchange of spatial information derived from research activities. Five partner institutions from three Mediterranean countries collaborated for 18 months to produce a trans-national distributed SDI, involving 50 data providers. The aim of this paper is to discuss

the outcomes of the project in various dimensions (technological, operational, and strategic) and its present status, three years after its completion.

In the technological dimension, there were a number of significant contributions. Software tools were developed or customized to local languages and context, in order to facilitate all phases during the development of the SDI, from metadata editing to distributed catalogues interconnection.

In the operational dimension, there was a successful know-how transfer from the project leader to the rest of the partners and to the data provides, who had no previous experience on the procedures needed for the establishment and maintenance of an SDI. Also, a novel evaluation methodology was introduced, for all parts of the SDI architecture (catalogues, web map services, geo-portals), focusing both on quantitative tests (capacity, availability, performance, etc.) and qualitative assessment (difficulties and solutions, cost/effective estimation, etc.).

In the strategic dimension, the long term objective of the project to create a Mediterranean-wide academic SDI is partially fulfilled. Although 8196 metadata records and 3181 on-line layers had been incorporated in the SDI using project funding, the increment during the last three years is very limited. Additionally, no new data providers have participated after the completion of the project. However, all participating institutions are now well-aware of the importance of geospatial technology and many of them have started new initiatives, based on the very fruitful experience they gained during the project.

The rest of the paper is organized as follows. <sections>

2 THE IDE-UNIVERS PROJECT

The IDE-Univers project (Infrastructure de données spatiales entre universités et centres de recherce dans la Méditerranée Occidentale – http://www.ideunivers.eu) was partially funded by the Community Initiative Programme INTERREG IIIB MEDOCC of the European Commission, under Measure 3.4 (Communication and information technologies for land development). It lasted from September, 2006 till March, 2008.

The overall objective of the project was to establish a trans-national thematic SDI in order to facilitate access and exchange of geo-referenced information produced by Universities and Research Institutions in the Mediterranean basin. Further objectives were: (a) to promote SDI concepts and techniques to academic/research institutions, reinforcing collaboration and culture sharing; (b) to include in the SDI not only geospatial data, but also heterogeneous documents/media with a specific geographic reference, (c) to evaluate the

feasibility of SDIs in the academic/research sector in terms of efforts and costs; and (d) to learn lessons for future applications.

The project was coordinated by Secretaria de Telecomunicaions i Societat de la Informació - Generalitat de Catalunya (STSI), with the support of Instituto de Cartografía de Catalunya (ICC) in Spain. Besides STSI/ICC, Technical Partners (TP) of the project were: Istituto per il Rilevamento Elettromagnetico dell' Ambiente (IREA) of the National Research Council in Italy, the University of the Aegean (UA) in Greece, and the Instituto de Cartografía de Andalucía - Junta de Andalucia (ICA), also in Spain. Region Emilia-Romagna (ER) in Italy was a User Partner (UP), representing the public administrations interest in the project's results, in order to improve urban and environmental management.

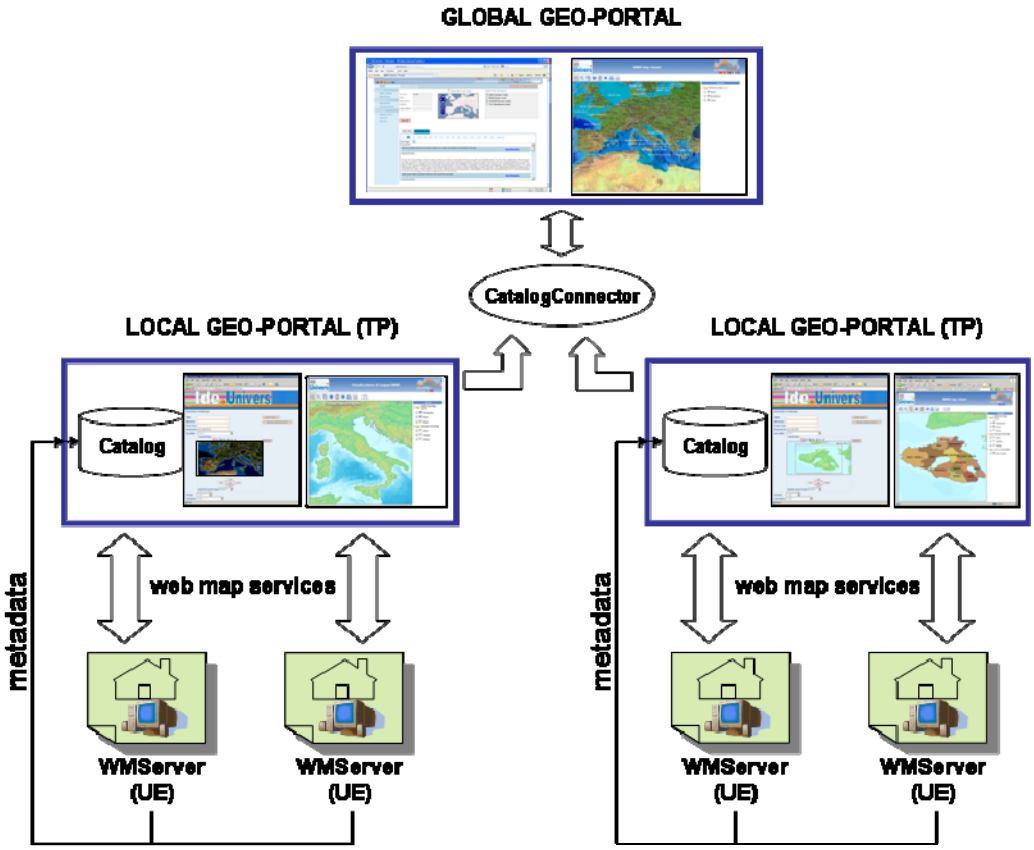
Each TP was responsible to consult, tutor and monitor a number of User Entities (UE), i.e. University Departments or Laboratories, Research Institutions or Public Entities that own geospatial data or documents/media that could be geo-referenced (cumulatively called *geo-resources*). The task of each UE was initially to produce an inventory of its geo-resources, followed by the production of the corresponding metadata records, layers and web map services. In total, 50 geo-resources providers participated in the project.

3 TECHNICAL DESCRIPTION

The architecture of the IDE-Univers SDI is depicted in figure 1. Following INSPIRE principles, each UE has complete control on the owned geo-resources. The produced metadata were gathered to the (local) catalogue of the responsible TP, while the web map services are provided by a web map server operating at each UE. Each TP operates a local geo-portal including the local catalogue, the searching facilities and the map viewer. All local catalogues are interconnected through the CatalogConnector application, developed on purpose of the project. In this way, a global geo-portal is established offering unified searching and viewing facilities.

Four local geo-portals were established: the Catalan, the Italian, the Andalusian and the Greek ones, each one covering a specific geographic region (Catalonia, Italy, Andalusia and Greece, respectively). End-users may interact in their own language (or English) either to a local geo-portal to access geo-resources about a certain region, or to the global geo-portal to access geo-resources about all project's regions.

Figure 1: The architecture on the IDE-Univers SDI



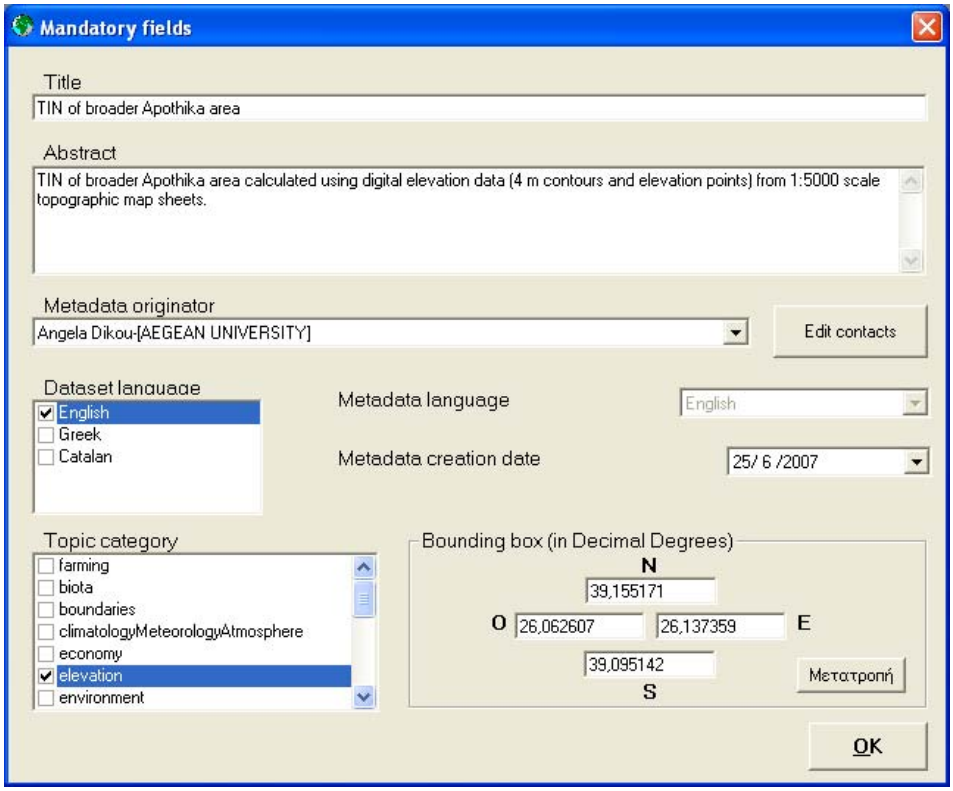
In the following paragraphs the various components of the architecture are presented in detail.

3.1 Software tools

3.1.1 Geo-resources discovery

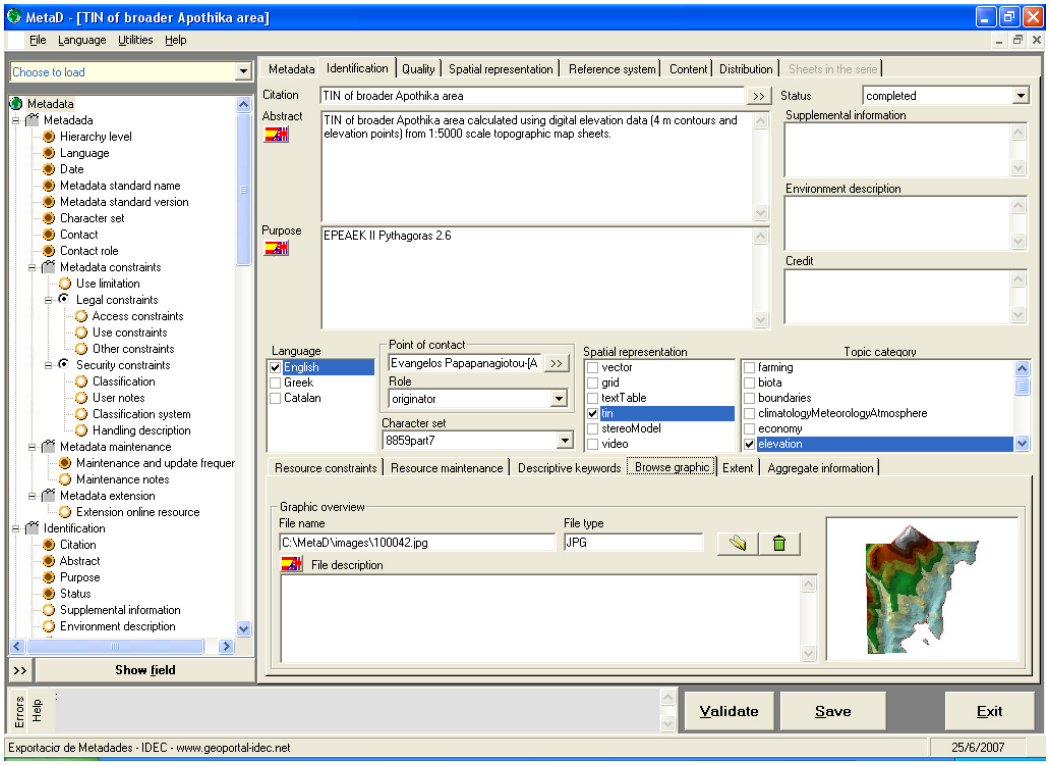
For the production of the metadata records, all UE used the *MetaD* software application, provided by the ICC. MetaD is ISO19115–compatible and enables the management of metadata in a structured way that facilitates, besides the creation, the maintenance and the exportation of metadata in a simple and user-friendly way. Certain customizations had been made by the Italian and Greek TP in order to translate the user interface in their languages, to change the spatial reference system and create/modify the thesauri to be adapted to the local requirements. Each metadata record was duplicated in order to be available both in English and the native language of the TPs (Catalan, Spanish, Italian, and Greek). Figures 2 and 3 depict two representative forms of the software.

Figure 2: The mandatory metadata fields



The first form (fig. 2) assembles the metadata that is mandatory for every geo-resource, such as the title, a short description, the bounding box, or the topic category. The second one (fig. 3) is the main form of the application, organizing all metadata fields in tabs. List boxes, check boxes or combo boxes are used in order to assist the user filling the metadata information. At the left side of the form, a tree view designates the filled and not filled fields, either mandatory or not. In order to facilitate maintenance and versioning, all metadata are stored in a relational database managed by MetaD. Specific operations are available for validation of the metadata, as well as their extraction in XML format for inclusion in the SDI catalogues.

Figure 3: The main MetaD form

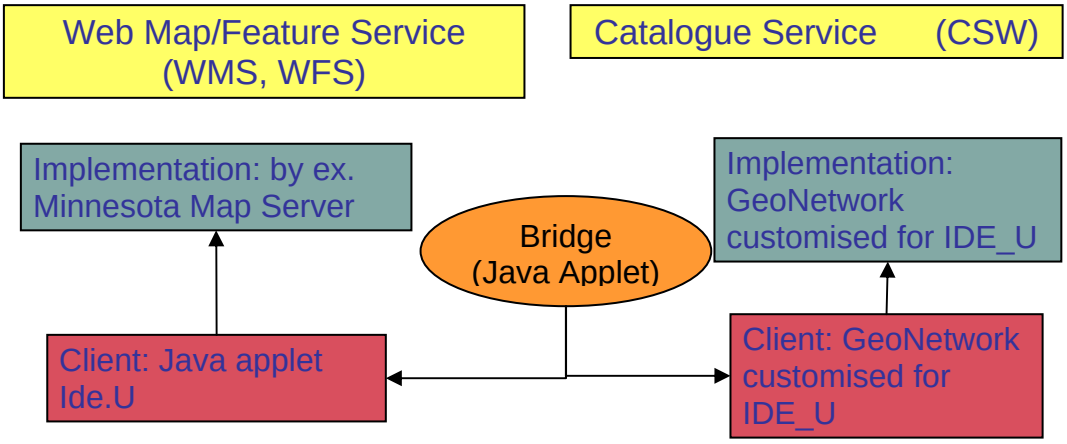


The metadata of each UE (in XML format) were forwarded (off-line) to the local catalogue of the responsible TP. The Italian and Greek TPs were operating the Geonetwork-opensource (http://geonetwork-opensource.org), while the Catalan and Andalusian ones were operating the INdicio (http://www.galdosinc.com) catalogue applications. The catalogue applications provide searching facilities against various criteria (including free text, keywords, time, and spatial bounding box) (fig. 4a for searching) and enable the access to the services defined for the selected geo-resources (figure 4b).

Figure 4b: Search results

For every matching record, the user is able to read a short descriptive summary and access the available services, presented in the form of clickable buttons: Metadata, Link and WMS Map Server. The first service returns the whole set of metadata assigned to the selected geo-resource. The second service begins a preview and/or downloading process (for non-spatial geo-resources). The third service activates a WMS-client web application (IDE-Univers map viewer), which constitutes the third step of the searching and viewing process (for spatial geo-resources). This last feature is made available by a bridge application developed by ICC whose architecture is shown in figure 5.

Figure 5: Bridge between discovery and visualisation



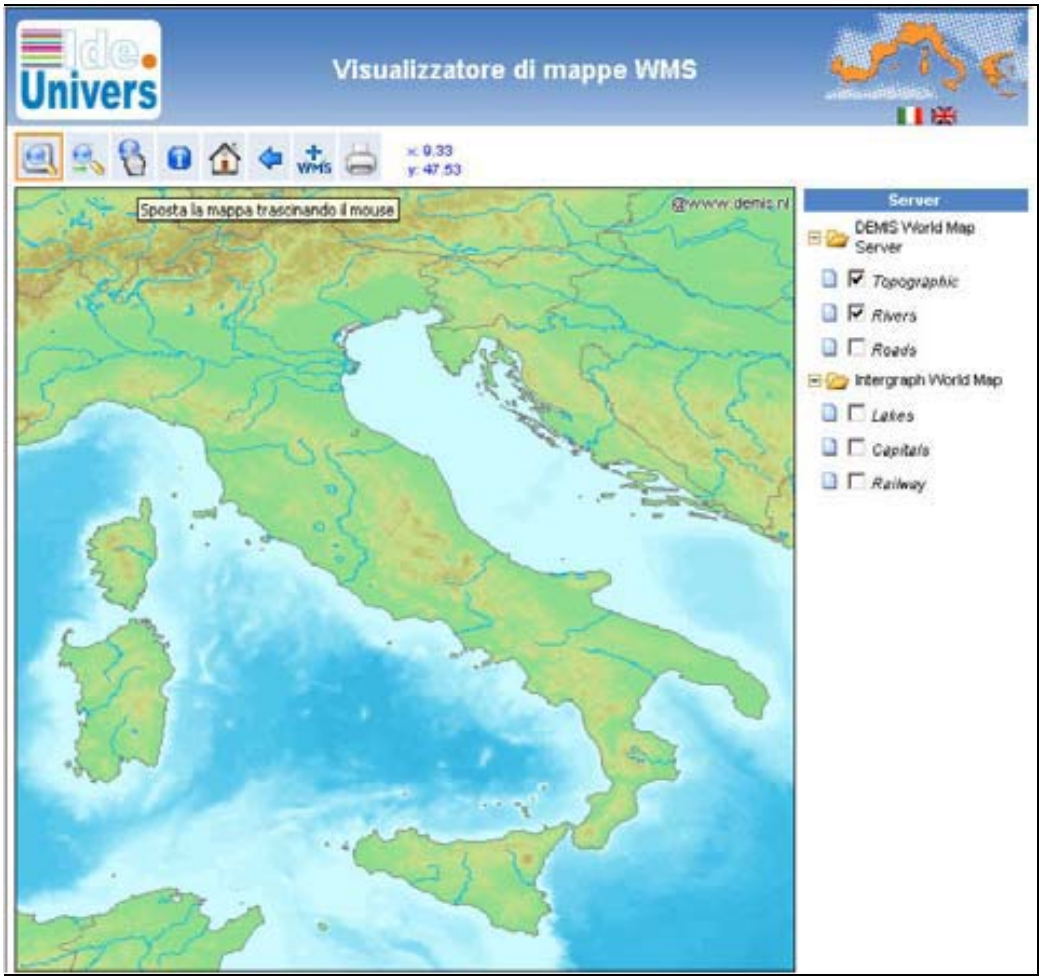
Metadata for services

3.1.2 Geo-resource access and visualisation

Each UE hosted a Web Map Server (supporting at least the OGC Web Map Service Interface) for the accessing and downloading of geo-resources. The University of Minnesota (UMN) MapServer (open source software) and the ESRI ArcIMS or ArcServer (proprietary software) were the main choices made.

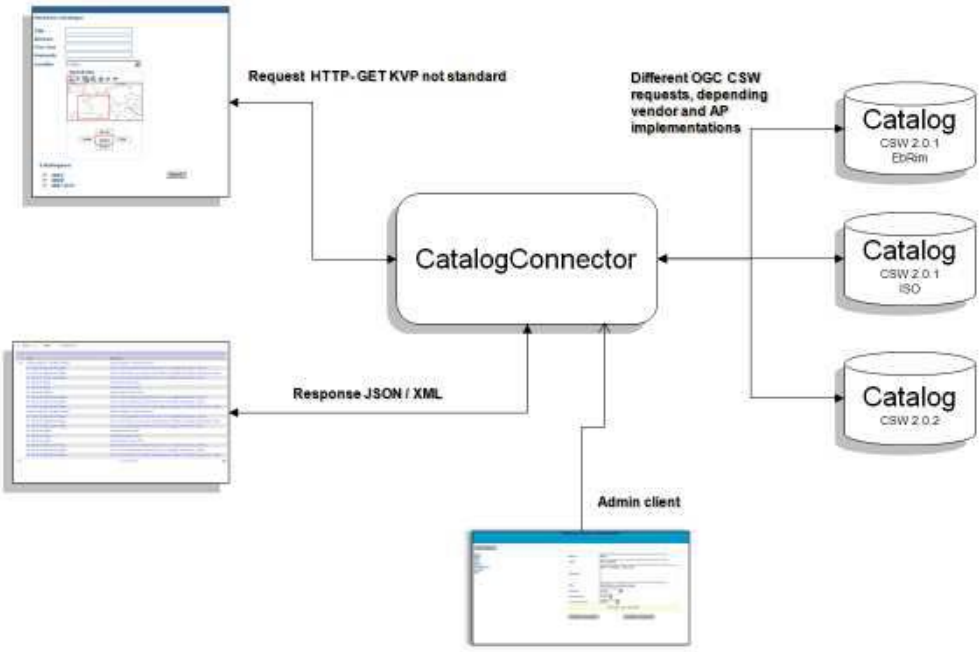
In order to allow map presentation and the provision of basic cartographic operations, all TPs furnished in their geo-portals a web map viewer application (WMS-client), provided by ICC (fig. 6). The application was customized to support the Italian and Greek languages (besides Catalan, Spanish and English). The map viewer offers to the end-user a number of map processing operations, like pan, zoom-in, zoom-out, etc. Moreover, it offers the possibility to add any WMS server (given its URL is known, or predefined) and explore its available layers. A further, very useful feature of the viewer is the possibility to follow a link to the metadata describing each visualized layer. This feature is supported by the bridge application depicted in figure 5.

Figure 6: The map viewer (Italian customization)



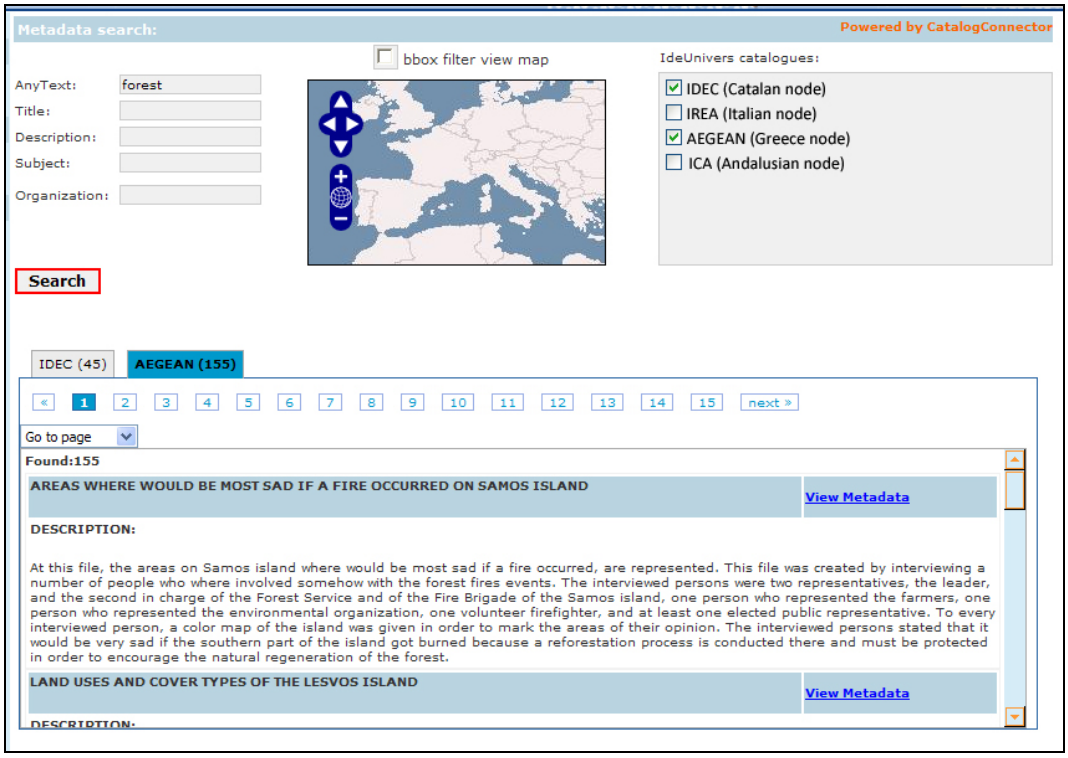
All local geo-portals are interconnected to a global one, providing services at a higher level. This constitutes an open architecture, enabling more component SDIs to participate in the infrastructure. The interconnection is supported by the CatalogConnector (CC) open source software. Instead of establishing a new global catalogue and populate it using harvesting procedures, the CC undertakes the task to forward end-users' requests to all local catalogues and aggregate the results.

Figure 7: CatalogConnector architecture



From a technical point of view, CC is a CSW-client application, developed in Java that sends simultaneous CSW requests to several metadata catalogues (using ebRim or ISO 19115/19119 profile), processes the responses and shows them in a single web page using XML or JSON format (fig. 7). The CC administrator is able to pre-define the target catalogues using a user-friendly interface (admin client), recording for each one the following information: name, title, description, URL, product, CSW version and XML-enconding (for requests). No middleware software is needed to be installed at the local catalogue's site, as in other approaches (for example, Gi-cat - http://essi-lab.eu/cgi-bin/twiki/view/GIcat). At this moment, CC is able to make requests to catalogues based in products as CatalogCube, con terra, Deegree, ESRI GPT, eXcat, GeoMedia, GeoNetwork, Indicio and InGrid. The procedure to add a new product is quite easy, without code modification. What is needed is a number of XML files defining the rules for mapping the syntax of the requests and for parsing the responses.

Figure 8: Searching using CatalogConnector

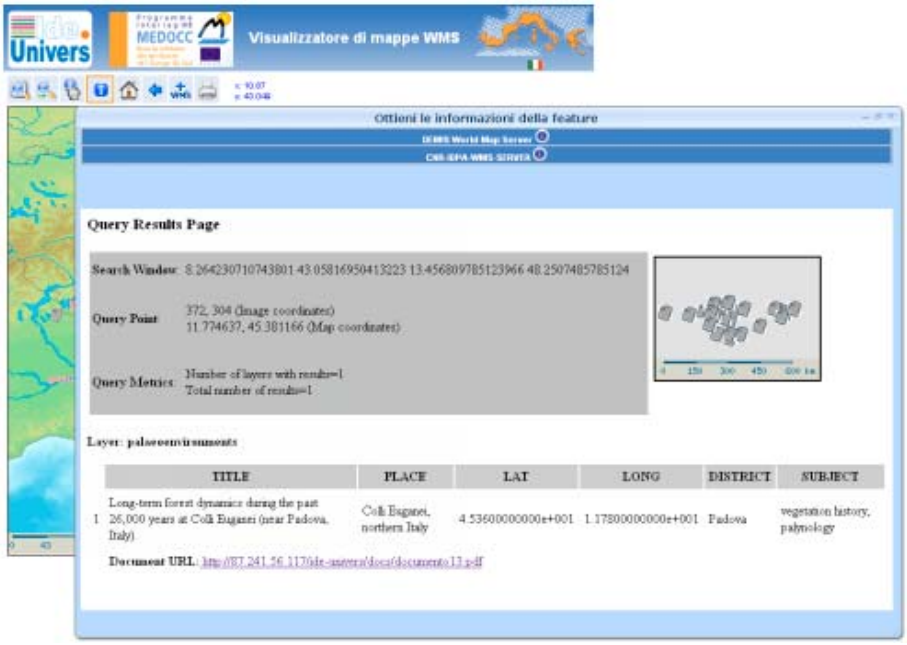


3.2 Data and services

One of the objectives of the project was to incorporate in the SDI not only geospatial data (such as shapefiles, satellite images, thematic maps etc.), but also documents and media of any type (either digital or not) that are strongly related to a specific geographic area (such as row data, graphics, presentations, reports, theses, papers, photographs, etc.), which are usually produced during researches on a territory. The latter non-spatial documents/media were handled as follows (Bucci and Carrara, 2008): a structure of vector entities (e.g., points) was defined for a given document/media type and thematic category (e.g., papers on a given subject and associated to some geographic areas). Each entity was characterised by spatial coordinates and a set of descriptive attributes, altogether stored as a shapefile. A number of such structures were defined, corresponding to the different document/media types and thematic categories. Shapefiles allowed to easily publishing the structures as layers in visualisation services (WMS) (figure 9), while simple geographic query mechanisms of WMS allowed visualising descriptive attributes of an entity by a graphic selection on a map (figure 10). The advantages of the proposed solution were its feasibility and simplicity.

Figure 9: Shapefile for geographic footprints of textual documents

Figure 10: Descriptive attributes of the shapefile shown in fig. 9



A total number of 8196 such geo-resources had been included in the SDI during the project, covering various fields of interest, while the focus was on three main domains: environment, land management and socio-economics. The non-geospatial data were about 60% of the total. Table 1 summarises the web map servers, metadata records, layers and WMS per local geo-portal.

Table 1: Data and services of the SDI

Local geo-portal / Items	Catalan	Italian	Andalusian	Greek	Total
Web map servers	11	7	11	12	**41**
Metadata records	5213	1150	475	1358	**8196**
Layers (maps)	1423	668	335	755	**3181**
Services (WMS)	104	10	37	128	**279**

4 EVALUATION

During the last month of the project, an evaluation procedure had been performed, in order to analyse both the technical and financial aspects of the established SDI. Following IDE-Univers architecture, the evaluation procedure was divided into a number of different tests, each one executed by the different responsible administrators. In particular:

- Testing 1: Tests to evaluate catalogue applications; to be performed by their administrators.
- Testing 2: Evaluation tests for the web map servers; to be performed by their administrators.
- Testing 3: Evaluation actions on the web map client (viewers) capabilities; to be performed by web map client administrators.
- Testing 4: A series of tests that check link consistency between geo-portals' web-pages, and links between catalogue results and their corresponding maps (showed by the web map client); to be performed by catalogue and web map client administrators.

Each responsible administrator was guided by a handbook created in the project on purpose of this activity (Bucci, F., 2008). The testing criteria suggested and used were mainly based on the INSPIRE implementing rules (for testing performance, availability and capacity) (INSPIRE, 2007), with the addition of some ‘ad hoc’ tests (for catalogue’s retrieval quality and web map viewer’s visualisation and capabilities quality). Besides the aforementioned quantitative tests, the evaluation procedure had incorporated a number of qualitative

questions (for each administrator separately) in order to push forward problems encountered, lessons learned and solutions followed, and to estimate a cost/benefit assessment.

4.2 Methodology

Four different questionnaires, containing both quantitative and qualitative questions, were prepared and forwarded to the administrators of the different components of the SDI (see Appendix A). Most quantitative questions should be answered after the execution of performance and capacity tests using the Apache JMeter open source software (http://jakarta.apache.org/jmeter). Performance tests addressed the requirement 7.4.3.1 in (INSPIRE, 2007): "*The time for sending initial response to service request in normal situation shall be 3 seconds*". In (INSPIRE, 2007), availability tests should address the requirement 7.4.3.2: "*The probability of the discovery service to be up shall be 99% of time, no more than 15 minutes downtime per day during working hours*". The project evaluation requested to satisfy a lighter requirement, i.e. each administrator was in charge of providing a declaration stating the period (all days in the week, some days, etc.) during which the service was maintained up, and which procedures have been carried out to avoid/fix downtimes during working days.

The qualitative questions tried to record the gained experience from UEs and TPs, covering three different aspects: (a) difficulties (troubles, reasons, and solutions), (b) conveniences (easy steps, reasons) and (c) resources (needed skills, time, and cost). In the following paragraphs the four evaluation sub-procedures are briefly presented.

4.1.1 Evaluating Catalogues

For the performance test, a metadata test-bed composed of 250 records was uploaded to each catalogue. A predefined JMeter Test Plan object was executed afterwards, to assert that the duration of a request for these 250 records was less than 3000 milliseconds.

For the availability test, each catalogue administrator provided a declaration for the availability of the service and the procedures carried out to avoid downtimes, followed by a logfile analysis for a certain period of time.

For the capacity test, the previous performance test was executed simultaneously by 100 users (threads). JMeter recorded the percentage of failed requests.

For a retrieval quality test, four search scenarios (issuing different criteria) were performed: (a) no criteria at all, in order the whole catalogue contents to be retrieved, (b) category search, in order only the contents of the specified category

to be retrieved, (c) spatial search, in order only the contents referred to a specific bounding box to be retrieved, and (d) negative spatial search, in order only the contents outside of a specific bounding box to be retrieved. Catalogue administrators reported the recall and precision measurements for the above searches.

3.1.2 Evaluating Web Map Services

For the performance test, a test-bed WMS (shapefile producing a 1024x768 pixels PNG image) was incorporated as a layer in the web map service to be evaluated. A predefined JMeter Test Plan object was executed afterwards, to assert that the duration of a request to this WMS, was less than 3000 milliseconds. Another test, requesting a non-existing WMS, was also performed.

For the availability test, each web map server administrator provided a declaration about the availability of the service and the procedures carried out to avoid downtimes, followed by a logfile analysis for a certain period of time.

For the capacity test, the previous performance test was executed simultaneously by 100 users (threads). JMeter recorded the percentage of failed requests.

For a WMS visualisation test, the layers of each WMS were checked both for their visibility (if they appear at all) and their correct appearance (in the “right” position on the map). This test was performed with three different web map viewers: (a) the IDE-Univers WMS-client (see section 3.1.2), (b) a light web map client software (uDig - http://udig.refractions.net, or gvSIG - http://www.gvsig.org), and (c) the JRC Viewer (http://www.inspire-geoportal.eu).

3.1.3 Evaluating WMS Viewers

For a performance test, each customised IDE-Univers WMS-client was checked to determine both a qualitative time rating for loading a WMS layer from the local geo-portal and a qualitative time rating for loading a WMS layer from a remote WMS (accessed through “add WMS”).

For a capability test, each customised IDE-Univers WMS-client was checked against a number of operations, such as zoom-in, zoom-out, pan, center map, transparency and addition of a remote WMS.

3.1.4 Evaluating Geo-portals

For the capacity test, a predefined JMeter Test Plan object, requesting each geo-portal’s main-page, was executed simultaneously by 100 users (threads). JMeter recorded the percentage of failed requests.

For the availability test, each geo-portal administrator provided a declaration for the availability of the service and the procedures carried out to avoid downtimes, followed by a logfile analysis for a certain period of time.

The evaluation includes also some link connectivity tests between the different components of the SDI, in particular between metadata in the Catalogue and corresponding WMS layers or data available for download. These tests are: (a) test of the link between a layer of a local WMS shown in the Viewer to its metadata; (b) test of the link between a layer of a remote WMS shown in the Viewer to its metadata; (c) test of the link between metadata of a layer and its visualisation; (d) test of the link between the metadata of a resource available for download, by ex. a scientific article, and its proper visualisation; (e) testing of geo-portals anchors connectivity using W3C Link Checker (http://validator.w3.org/checklink).

4.2 Results

The evaluation procedure was fully performed by the administrators of the three TPs (Catalan, Italian and Greek), while the Andalusian one brought to completion only part of it, due to time and personnel limitations. The results could be deemed as satisfactory and encouraging, given that with the exception of the ICC, the rest of the partners did not have any experience on SDIs. In the following paragraphs we briefly discuss the evaluation results.

4.2.1 Catalogues evaluation

The performance and capacity tests were successfully accomplished by all component catalogue services. All catalogue administrators certified that discovery services were available all days of the week (24/7), while failures were recovered only during working hours. The retrieval quality test was successfully performed by three (out of four) catalogue administrators.

4.2.2 Web Map Services evaluation

This evaluation sub-procedure was performed by the web map servers' administrators of three (out of four) component SDIs. The performance test was successfully accomplished by the 90.3% of the WMS. The 77.4% of the WMS reported less than 20% of failed requests during the capacity test, while the rest reported up to 50% failed requests. Only one WMS reported a rather high error rate (97%). All administrators certified that map services were available all days of the week (24/7), while failures were recovered only during working hours. The visualization test was 100% accomplished only using the IDE-Univers WMS-

client. For the uDig/ gvSIG software and the JRC Viewer, the successful results were 65.5% and 55.2%, respectively.

3.1.1 WMS Viewers evaluation

Both performance and capability tests were successfully accomplished by all IDE-Univers WMS-clients' administrators, since all reported that the time rating for loading a WMS layer from the local geo-portal or remote server was "good", and all the supported operations were properly carried out.

3.1.2 Geo-portals evaluation

This evaluation sub-procedure was performed by all geo-portals' administrators. Only one reported an error rate of 2% during capacity test, while the rest reported no failed requests. All administrators certified that geo-portals were available all days of the week (24/7), while failures were recovered only during working hours. The link connectivity test was successfully accomplished by all geo-portals.

3.1.3 Qualitative evaluation

We focus the presentation of the results of the qualitative evaluation only to the questions regarding the development of the WMSs (layers publication), since this task appeared to be the most critical to the establishment of each component SDI. Most web map servers' administrators reported that the most difficult task was the correct configuration of the mapfiles, especially the definition of the EPSG codes referred to the coordinate systems and the definition of the symbology for raster datasets. They proposed the development of a mapfile editor/debugger, accompanied by tutorials and know-how transfer procedures from experienced people. In contrast, the installation of the UMN MapServer and the production of new layers were included in the most convenient tasks. For the development of a WMS of 100 layers, the time estimated varied between 2 and 5 weeks, while the cost varied between 1000 and 2500 euros. Only one UE reported duration of 4 months, along with a cost of 7500 euros.

4. EXPERIENCES

All collaborators in the project, both TPs and UEs, were rather excited for their participation and shown significant enthusiasm during the accomplishment of their tasks; for everyone there were new challenges to be achieved, mainly in the technological domain.

The ICC was the instructor for the rest of the TPs, having considerable experience from the successful establishment and operation of the SDI of Catalonia (IDEC) (Jordi's report). The principal technological issue to be solved

by ICC was the interconnection of the local catalogues, which was managed by the development of the CatalogConnector. In addition, ICC was assigned the reliable and timely training/managing of both its associated UEs and the rest of TPs (in order to train their corresponding UEs afterwards). Each one of the rest TP should be trained to perform certain procedures (like metadata editing and WMS development), to use all software tools related to the project (see section 3), customize them (this applied for the Italian and Greek languages), and train/manage their own UEs. The aforementioned knowledge transfer and administration were made possible through meetings, seminars, handbooks, synchronous and asynchronous communication, and help-desk services; a real feat involving over 50 institutions and laboratories, over two hundreds of people and 5 different languages.

The experience gained during the 18 months of the project, came to a number of lessons and proposals that we assert they are still valid today:

One of the first things realized was the need to regard the creation, documentation, publishing and sharing of geo-resources as an *overall process*. All the participating actors should have the whole final picture in their minds. In this way, metadata will be easily filled, layers' names and URLs will be early known, map symbols and colours will be appropriately selected, agreed terms of use will enable the appropriate services (for example WMS vs. WFS). This was relatively easy to be obtained, since people working in academic environments are willing to learn and apply teleological methods

The other critical point was the lack of efficient and convenient software tools to support the individual steps during SDI development. On the one hand, UEs had reported that proper tools are needed for the development and debugging of mapfiles (used in the UMN Mapserver), in parallel with WMS-clients able to visualize cartographic configurations correctly (especially for raster datasets). In addition, UEs complained that metadata editing was the most suspending factor in SDI creation and maintenance. So, they proposed the development of tools for the semi-automatic generation of metadata from spatial data and services. On the other hand, TPs needed tools for metadata validation checks and for management of bulk metadata records.

A third outcome was the importance of incorporating non-spatial data and even non-digital documents/media in an academic SDI. Results reported in these heterogeneous forms are very common when considering academic investigations on specific territories, and they could not be ignored. In this way, end-users have a complete view of all research products, although some of them may not be available on-line; metadata entries contain all required information for a direct communication to the appropriate person or organization.

Evaluation procedure is useful despite the resources required to achieve it.

A final conclusion was the adequacy of open source software (with minor customizations) to support the creation of functional and robust SDIs. Both Geonetwork open source and UMN MapServer demonstrated not only their ability to achieve their purpose, but also their convenience and ease of use by non-familiar, while geospatial aware, users.

5. IDE-UNIVERS TODAY

IDE-Univers may be characterized as successful, since the main and all individual objectives placed have been completely fulfilled. Additionally, all quantitative indicators (such as number of metadata records, number of UE, number of web map servers, etc.) have been achieved by the more. However, the dynamics of the project was not sufficient for its further development.

The visiting statistics of the main webpage of the project are not encouraging (table 2). <Analysis>

Table 2: <title>

Year	View pages	Visits	Visitants
2008	1893	1260	677
2009	1911	1237	860
2010	1712	1086	597
2011*	556	341	239

* Until 30th April

The status of the SDI today, three years after project's completion, is reflected in Table 3.

Table 3: Data and services of the SDI today

Local geo-portal / Items	Catalan	Italian	Greek	Total
Web map servers	11	7	12	**30**
Metadata records	5388	1150	1358	**7896**
Layers (maps)	1540	668	755	**2963**
Services (WMS)	115	10	128	**253**

The Catalan local SDI has slightly grown up. The metadata records increased almost 3.4%, while the number of WMS increased almost 10.6%. In addition, all services are available in a stable basis. This reflects the high awareness of Catalan stakeholders in the field of SDI, which is the result of the long efforts of the ICC. It is a strategic practice of IDEC (Infraestructura de Dades Espacials de Catalunya) to provide all the necessary resources to support local, regional and thematic SDIs relating to Catalonia (e.g., Guimet, 2006); and has been awarded many times for that (e.g., eSDI-net+, 2009). The IDE-Univers project was another useful example to promote to other communities the benefits of sharing spatial data and services. In addition, one of the collaborating UE, exploiting the experience gained, was able to participate to a similar project in a foreign American country.

The Italian and the Greek geo-portals along with their connected web map services are still running, not without problems. The availability of discovery, access and visualisation services can not be guaranteed, since failures are not recovered immediately. In addition, no new UE has joined these local SDIs, or new metadata records and WMSs have been added. However, there is a strong interest in SDI development issues of both the responsible TPs and a number of the UEs, which could not be advanced anymore by the IDE-Univers framework. New initiatives have been launched, based on experience gained during the project.

In Italy, some of the collaborating UEs have developed new OGC services irrespective of IDE-Univers, while they avoided creating autonomous metadata catalogues, since metadata editing was deemed the most time and resource consuming activity. Also, one UE was become interested to new issues, such as automatic extraction of geographic content from textual document, searching tools enabling both textual and geo-based queries, harvesting in Web 2 and Volunteer Geographic Information (VGI), and disambiguation methods for geo-information (same coordinates with different terms). The TP has launched an ongoing effort to create a new infrastructure for the Italian National Research Council (CNR), but to no avail so far, due to a poor interest of policy makers towards geo-resources produced by research activities.

In Greece, the TP succeeded recently to get funding by the government to create a new SDI, generalising and extending the existing one in the framework of IDE-Univers. Also, a number of UE are developing new web mapping applications for specific thematic categories (like forest fires and marine habitats).

The main negative point is the withdrawal of the Andalusian geo-portal from the SDI. This happened because of the weakness of the responsible TP to support it

(the personnel dealt with the project change jobs), as well as the little interest of the university community to keep the web map services running.

6. REALISATIONS AND PERSPECTIVES

SDIs are not expensive investments. IDE-Univers was a light project of 18 months with a limited budget (about 775,000 euros). Each UE received few thousand euros to participate. However, with the adequate support from TPs, the outcome was impressive, although without real progress. Trying to explain this situation, we conclude that the drawback was not (only) the termination of funding after the completion of the project. We argue that the main shortcomings were: (a) the lack of an administrative unit to support the infrastructure, (b) the limited publicity of the project results, (c) the lack of quality criteria in the selection and description of the disseminated geo-resources, (d) the lack of convenient tools to support data providers in their daily operations related to SDI, (e) the single metadata catalogue per TP, and (f) the very refined granularity of some UEs (i.e. specific labs, instead of Departments).

Most efforts during the development of the SDI were focused on the technical aspects of it. In this way, other important aspects, like policies, publicity and data quality, were downgraded, especially from the less experienced TPs.

With the exception of STSI/ICC, all other TPs did not establish a permanent administrative unit to support the operation and further development of the SDI. These tasks were assumed by the (limited) people that had participated in the project. In Italy and Greece, these people are still working within the TP organizations, so they try to keep the SDI operational and to open new opportunities for it. However, in Andalusia the people have changed jobs, so the TP has withdrawal from the consortium. The Catalonian local SDI and the global geo-portal are supported by IDEC.

The publicity of IDE-Univers results was inadequate. Although a number of papers about the project have been presented in GIS or SDI-related conferences and included in proceeding volumes, and numerous brochures have been distributed, the visits to the global geo-portal are still limited. What is missed is the targeted promotion to the potential interested stakeholders: either end-users (like public authorities, private organizations and other universities), or data providers (other universities and research institutions).

No procedures have been established for quality control during geo-resources inventory and description (metadata editing). The UEs were in practice free to select the geo-resources to be incorporated to the SDI and to provide the according metadata records to the catalogue. Although this is not necessarily reprehensible, it requires a high degree of maturity and responsibility. In some

cases, the UEs in their efforts to achieve the established goals (both temporal and quantitative) have chosen geo-resources without significant added value, or have poorly filled out the metadata fields. These have resulted to low performance during searching, either in terms of precision and recall measures, or in terms of the utility value of the results, that both discouraged end-users.

<lack of convenient tools>

<single metadata catalogue per TP>

<very refined granularity of some Ues>

The key point for achieving funding is policy makers to be convinced for the potential advantages of SDIs. In particular, academic SDIs could be the driving force of the economy at local, national or European level, supporting decisions for investments, business plans and public works, while at the same time may play a dominant role in environmental protection and sustainable development.

The European initiative for open access to research results creates new challenges regarding academic SDIs. By now, Spain is the first country in the EU passed a state law on Open Access Mandate (May, 2011). Under this perspective, every University and Research Institution is envisaged to establish an autonomous SDI for geo-resources produced from co-funded research activities. Furthermore, the interconnection of these SDIs and the development of ontologies (one per scientific field), will support distributed semantic discovery services at a European level.

7. CONCLUSIONS

After 3 years of the end of the project we can affirm that IDE-Univers was a successful story of:

- SDI generation in a bottom-up process
- Development oriented to distributed communities
- Effective deployment supported by previous experiences

However, for its continuity and further development, it is necessary to be obtained:

- Administrative support
- Quality assurance for data and services
- Promotion and marketing strategy

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APPENDIX A: EVALUATION QUESTIONNAIRES

LICENSING