# *SPATIAL DATA INFRASTRUCUTRES (SDIs) IN GREECE; AN ASSESSMENT OF GEOPORTALS FOR CARRYING OUT HYDROLOGICAL PROJECTS*

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## ABSTRACT

*The role of Spatial Data Infrastructures (SDIs) plays a very important part in improving electronic governance in Greece. Following the INSPIRE Directive, the European Parliament and Council for the creation of infrastructure for geospatial data in the European community began making slow but steady progress in 2007 in Greece towards creating geoportals that will meet the needs of those interested in acquiring geospatial information and data.*
*In the current paper, a reference to geoportals providing the necessary geodata is provided concerning the completion of hydrological projects in Greece. A brief description of the framework conditions in Europe on this subject and an assessment of Greek geoportals are presented following scrutiny and the use of available geospatial data. Additionally, some suggestions are given for future improvements aimed at further development. In short, the current work reveals the need for collaboration between the existing geoportal providers in the creation of a common bank consisting of geospatial data and geo-information, where all the necessary geo-spatial data can be uploaded, verified and made available to potential users.*

**Keywords:** Spatial Data Infrastructures (SDI), Geographic Information (GI), Geoportal, Geodata, Hydrology, Greece
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## 1. INTRODUCTION

The past two centuries have been identified as centuries of information dispersal. These eras of information are directly related to the era of computers and the development they have facilitated over the years. In the current digital age, the changes/consequences of this development have been obvious. Everything that happens in our environment and that affects us directly or indirectly is based on the manipulation of information. For the purpose of this paper, we will focus only on geographic information.

In recent years, geographic information (GI) has become increasingly important as a framework for describing patterns on the surface of the Earth and vast databases have been created to provide an inventory of natural and cultural resources. At the same time, geographic analysis and modelling tools and techniques have been refined to help explain and predict contemporary and future patterns and processes. GI systems (GIS) are the very heart of this movement, because they provide the digital tools necessary for implementing the concepts of geographic thinking (Maguire and Longley [1]).

Since the late 1970s, many national surveying and mapping agencies and organizations have begun to recognize and feel motivated to initiate strategies for providing greater access to standardized GI (Williamson et al. [2]). Spatial Data Infrastructures (SDIs) are technical, organizational and legal frameworks for geo-information resources (McLaughlin and Groot [3]). The term 'spatial data infrastructure' (SDI) was coined in 1993 by the US National Research Council (Mapping Sciences Committee [4]) to describe, amongst other things, the provision of standardized GI access. The definitions of Spatial Data Infrastructure (SDIs) have included, directly or indirectly, the necessity to provide search, visualization and data download services (GSDI - Technical Working Group and contributors [5]). Overall, the main advantages of an SDI for the participating organizations and society are, according to Bernard et al. ([6]): cost effective data production, avoidance of duplications, efficient data exchange and use over administrative and enterprise borders, and improvement of decision-making based on available high value data.

A key component of an SDI that facilitates access to GI and GI services is a geoportal. The word “portal” stems from the Latin word *porta* and indicates an entrance point (Annoni et al. [7]). The word “porta” also appears in the Greek vocabulary as meaning “gate”. In general, a geoportal acts as a gateway to digital GI content and services made available within the concept of an SDI.

During the past few years, many definitions have been created to express the meaning of geoportal (Tait [8], Fisher [9]). More specifically, a geoportal may be defined as an Internet or intranet entry point with the tools for retrieving metadata, searching for GI, visualizing GI, downloading GI, disseminating GI and in some cases the ordering of GI services (i.e., facilitating GI commerce). The building blocks of an SDI are geodata, its technical network, metadata, web services and standards (BKG [10]). Specific web services provide geodata and corresponding metadata to the Internet (Schäffer et al. [11]).

The present paper points out and analyses the scope and the increasing significance of the term ‘Spatial Data Infrastructures’ (SDIs). In order to do so, the geoportals as hosts of data on the web are used as tools. Further focus is given to data that are required for the completion of a hydrological project. Therefore, the main geoportals that are currently available in Greece are under examination, while the scheme across the European Union is described in terms of the INSPIRE Directive. Finally, there is a first-ever attempt to evaluate geoportals in Greece and recommended future proposals for improvements driven by hydrological purposes, namely the provision of geospatial data necessary for the completion of hydrologic projects.

## 2. GEODATA FOR HYDROLOGICAL PURPOSES

Geospatial data are data that in some direct or indirect way relate to the site in question. For example, forest maps, general urban plans and a country's road network are geospatial data. A list of the addresses of public services or statistics on employment in the country is also geospatial data (www.geodata.gov.gr).

In the very first stages of every scientific project, the researcher needs to be aware of the type of data that have to be acquired and analyzed, in order to carry out the research project. In the case of a hydrological project, Mani and Thiruvengadachari ([12]) underlined that the project requires a minimum set of thematic data on land use, soil, topography and drainage, in order to become operational. Moreover, ground water analysis will additionally require spatial data on geology (lithology/rock type and structure) and data regarding geomorphology. General supporting data cover the full hydrographical network, the full categorization of the watershed boundaries, irrigation and other points of interest such as discharge, climatological and other stations.

Additionally, land use/cover (including surface water), usually CORINE 2000 (CLC [13]), has been used in many Greek hydrologic projects (Maris et al. [14], Paparrizos et al. [15]). The hydrolithic map of Greece from the Institute of Geology and Mineral Exploration (IGME) (IGME [16]) is another useful tool. Satellite data or maps provided by the Geographic Service of the Greek Army, and drainage patterns, settlements, contours and spot heights, which can be extracted from satellite data or maps of the Greek Army Geographical Service, are very useful, but their sponsorship as well as any processing is subjected to restrictions and legal provisions. Figure 1 summarizes all the necessary data needed to complete a hydrological project.

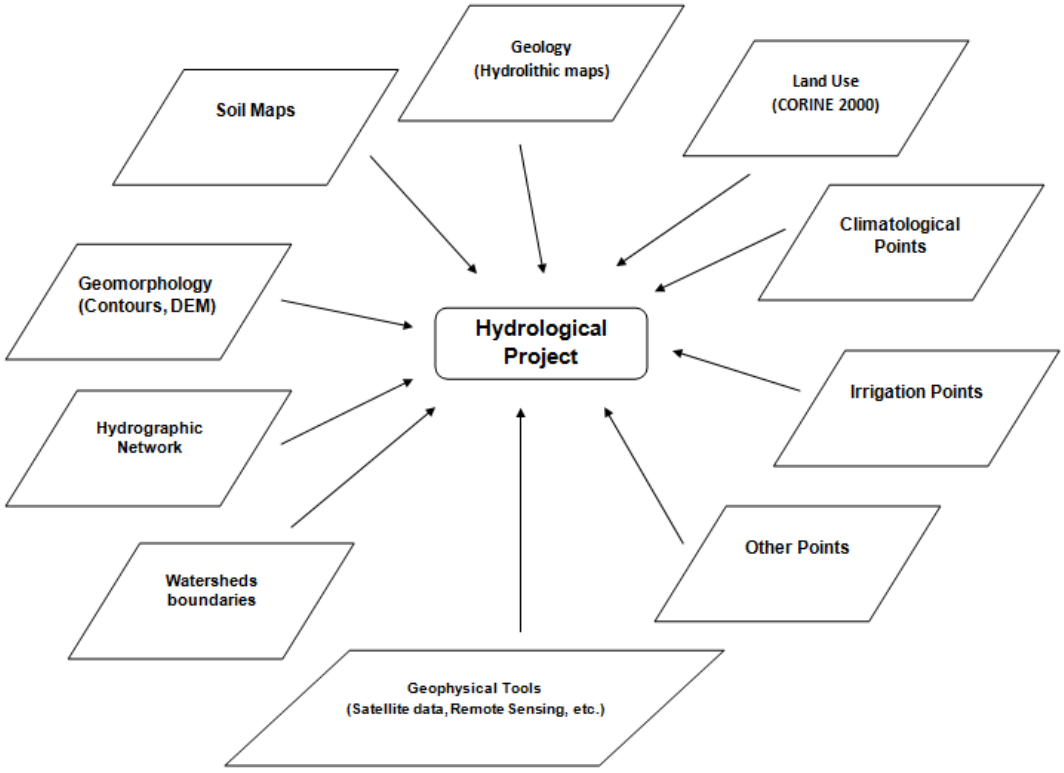


**Fig.1: Data layers for completing a hydrological project**

## 3. GEOPORTAL FRAMEWORK IN EUROPE

The definition of geoportal, along with its applications, was stated above. These applications are achieved through an assembly of architecture groups (users' applications, catalogues, web services, networks and GI) that provides a community-wide access point to distributed GI and GI services. A geoportal often serves a specific community, offering

personalized views as required by that community (Alameh [17]). However, geoportals at a national level should be interoperable and use standardized software interfaces for connecting with the many spatially related services offered by the different providers. Furthermore, a National Geoportal should connect the differently themed geoportals within a nation, thereby providing a single entry point to all GI related datasets and services across the nation. A National Geoportal is a key feature of a National Spatial Data Infrastructure (Giff et al. [18]).
In the 1980s and early 1990s, many countries, including European countries, the United Kingdom (Chorley [19]) and the Netherlands (Netherlands Commission of Geodesy [20]) undertook extensive reviews and studies to demonstrate the cost effectiveness of their national survey activities and particularly to demonstrate how this could be improved using information technology (Groot [21]).

Already in the 1990s, the European Union intended to regulate the sharing of spatial data between public bodies. While GI2000 was never realized, the underlying ideas were taken up again in the INSPIRE initiative, which led to the 2007 Directive establishing an Infrastructure for Spatial Information in the European Community (INSPIRE Directive), which was adopted on 14 March 2007 (European Parliament and Council [22]). A main perspective of this directive was that "it is possible for spatial data collected at one level of public authority to be shared between other public authorities" (Janseen and Kuczerawy [23]).

Nowadays, the current geoportal activities in Europe are in part inspired by the INSPIRE Directive. The INSPIRE Directive was enacted to promote and govern the sharing and reuse of public sector GI across Europe through the implementation of a European Community Infrastructure for Spatial Information (INSPIRE). A key component of any SDI is a geoportal; the Directive addresses the implementation of a European Geoportal in Recital 20 and Article 15. These two sections seek to establish a European Geoportal that will act as an entry point to all the geoportals of the member states of EU. Although the Directive does not require member states to have a National Geoportal, it is recommended that the INSPIRE Geoportal links to the geoportals of the member states through each National Geoportal. The Directive does however, requires the establishment of a network of several types of services as described by NSDT ([24]) and mentioned in the paper's introduction [Article 11 (1) Directive 2007/2/EC].

To this end, the majority of European countries are undergoing numerous geoportal activities at different levels of society to facilitate the sharing and reuse of GI and to ultimately comply with the INSPIRE Directive (Directive 2007/2/EC) (Giff et al. [18]). Among others, Norway (Strande [25]), Germany (GDI-DE [26]), Portugal and Spain (Juliao [27]) and Denmark (Jarmbaek et al. [28]) are in a process of establishing and developing SDIs.

## 4. GEOPORTAL ACTIVITIES IN GREECE

One of the countries that took serious note of the INSPIRE Directive was Greece. Greece created the Geoportal which provides geospatial data via the site www.Geodata.gov.gr. Beginning operations on August 14 2010, Geodata.gov.gr was designed, developed and is maintained by the Institute for the Management of Information Systems of the "Athena" Research and Innovation Center in Information, Communication and Knowledge Technologies, with the aim of providing a focal point for the aggregation, search, provision and portrayal of open public geospatial information. In the first months of its operation, the geoportal established Greece as one of the eight countries worldwide that offered free geospatial data.

Geodata.gov.gr is one of the Greek Government's open government initiatives in the framework of the Open Government Partnership. Furthermore, its operation is included in the Road Map to support the enforcement of Law 3979/2011 for e-Government, as a best practice example for the application of Information & Communication Technologies (ICT) in public administration and as an open data repository for the provision of geospatial information. Finally, geodata.gov.gr provides technical support to the National Spatial Data Infrastructure, in accordance with the National Strategy for ICT and e-Government.

Geodata.gov.gr offers three basic services for geospatial data: search, transformation and imaging. In searching, the data is accompanied by complete metadata, i.e., information describing the data. Users can find data by using a key word, choosing the public body they are interested in, sorting the data by date, or by combining the above approaches. During the transformation, the data is simultaneously offered in different formats and reference systems that can be used by all, without requiring extra knowledge or commercial software. Indeed, even if someone has never used GIS software before, they can download and view the data through Google Earth. As reference imaging, geospatial data by definition is useful when shown on maps. This information should be accessible and beneficial to all citizens without requiring any special knowledge. For this reason, all data in geodata.gov.gr are offered in the form of interactive maps. The user can simultaneously display different sets of data, browse the site, seek out areas that interest them and even integrate maps into other applications (www.geodata.gov.gr). The menu of the geoportal is offered only in Greek.

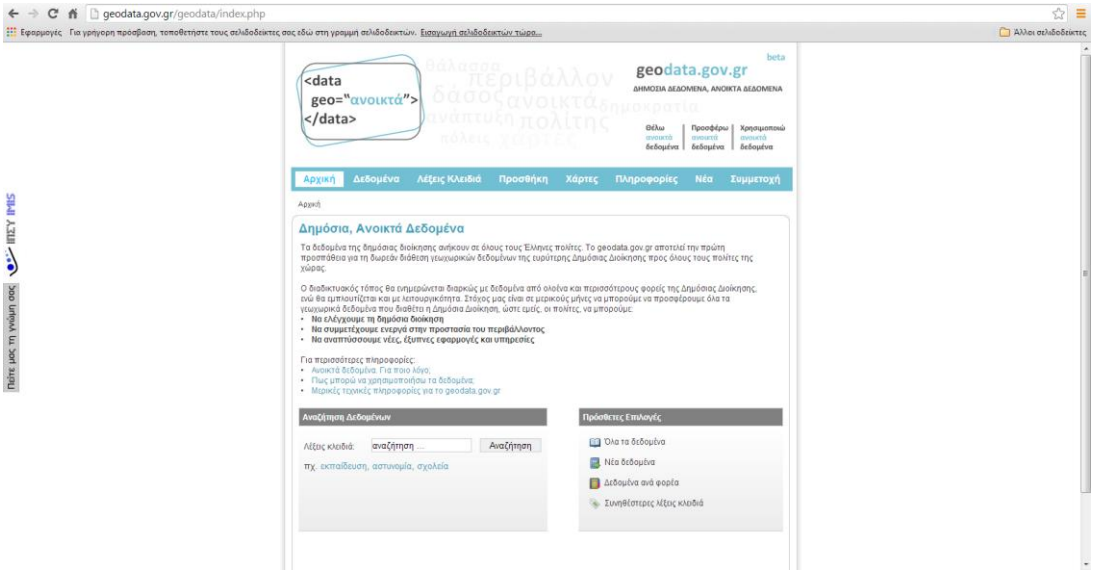


**Fig. 2: Interface of geoportal www.geodata.gov.gr**

Another geoportal, which is the official point of information and communication for the National Geospatial Information Infrastructure (NGII), is the Hellenic Mapping and Cartography Organization, located online at www.inspire.okxe.gr. Its operation is intended as a one-stop source for both producers of geo-information and users, with the aim of serving as a tool for the effective implementation of the INSPIRE Directive and maximum use of available and produced geo-information. Through the National List geospatial resources Geoportal, the user can search for geospatial data and services from public authorities and their terms and conditions of distribution and use. The Geoportal provides free tools for recording geospatial user data, as well as metadata creation tools. The search service (Discovery Service) allows for searching sets of geospatial data and services through metadata. Based on an open standard CSW 2.0.2 ISO profile, it has been developed according to the specifications issued under Directive 2007/2/EC. The service imaging (View Service)

allows visualization of geospatial data in image form at predetermined reference systems. It is based on the OGC WMS 1.3.0 model and is compatible with the INSPIRE Directive (www.inspire.okxe.gr). The menu of the geoportal is offered in Greek only.

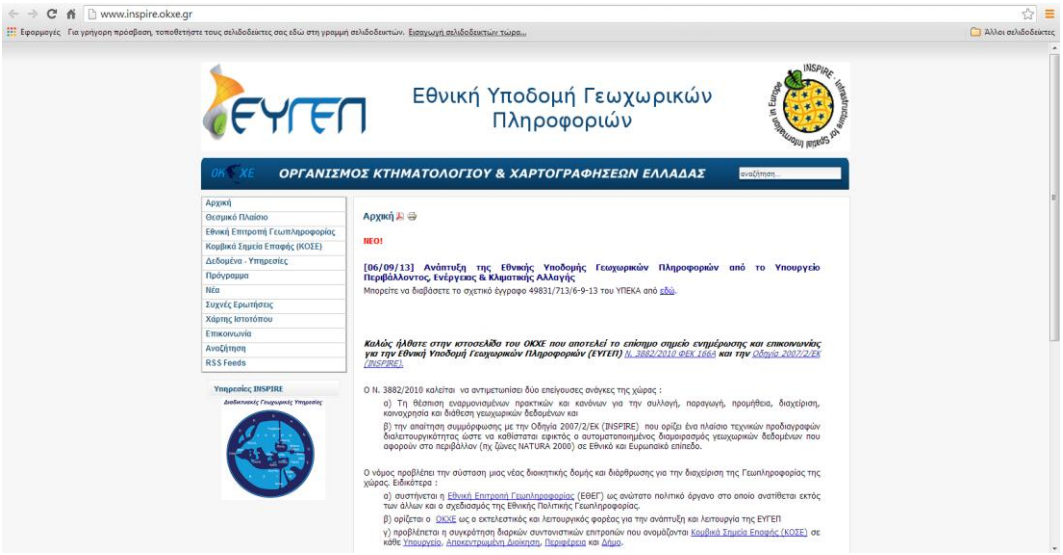


**Fig. 3: Interface of geoportal www.inspire.okxe.gr**

Finally, www.hydroscope.gr is a National Databank for Hydrological and Meteorological Information, designed by the National Technical University. It is a geoportal that provides access to hydrological, meteorological and geographical data in Greece, derived from bodies such as the Ministry of Environment, Energy and Climate Change, the National Meteorological Service, the Ministry of Rural Development and the National Observatory of Athens. Essentially, hydroscope is the result of the extended efforts by a crowd of scientists at the Department of Water Resources and Environment of the National Technical University of Athens (NTUA), in collaboration with various private and public institutions. It has been implemented in three phases through research projects funded by the General Secretariat for Research and Technology of the Ministry of Development, Ministry of Environment, Energy and Climate Change and the European Union, and is one of the most ambitious portals in Greece.

Through the hydroscope index, which is available as a free code (open source), it is available to the user as a convenient and simple way to search and download geographic data. Regarding geographical data, the map of satellite images is retrieved from LandSat image processing. These images are offered free by the Center for Earth Resources Observation and Science (CEROS), the Geological Survey of the United States (USGS), the platform ESDI (Earth Science Data Interface) and the service Global Land Cover Facility (GLCF). When processing, the images were taken from the stages of the merging of the panchromatic spectral channels; this was done to improve the ability to separate the final image and radiometric correction, that there are similar shades throughout the area covered. Geoportal finally provides Web Map Services (WMS), as defined by the Open Geospatial Consortium (www.hydroscope.gr). The menu of this geoportal is available in Greek only.

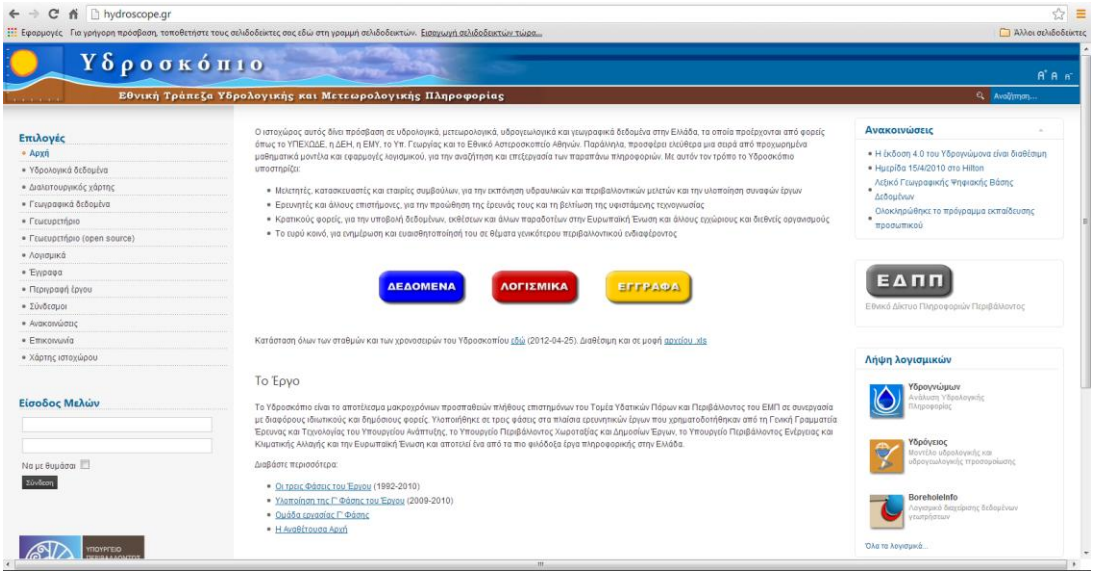


**Fig. 4: Interface of geoportal [www.hydroscope.gr](http://www.hydroscope.gr)**

## 5. DISCUSSION– EVALUATION OF GEOPORTAL ACTIVITIES IN GREECE

In summary, in Greece, there are currently three operating geoportals, providing geospatial data and all related data directly or indirectly to the public sector. The public sector produces daily data through a range of activities and at all levels of operation. The free availability of this information is a necessary condition for transparency and accountability in the functioning of public administration; citizens can in this way at any time use easy and affordable means to control the decisions of public administration. Open data is also a powerful development tool.

The great advantage of the Greek geoportals is the availability of free and instant geodata. This open geospatial data can be characterized as extremely important. The geospatial data is probably the largest and most critical data category for the Greek public sector.

The production and updating of this data is normally extremely costly. Nonetheless, it is qualitatively important as utilized in practically any activity within the public and private sectors as it relates to Greece. A great example is the protection and enhancement of the environment and the completion of environmental studies, e.g., hydrological projects, which has been the focus of this paper. Having made extensive use of data from the three geoportals, we can comment about all of them that they lack detailed geospatial data, which is the main drawback of the portals. Therefore, results for completing a hydrological project cannot be taken into account based the geospatial data that currently exist in the specific geoportals. These geoportals, which all have almost the same geo-information, contain only Greek water districts, the central catchment river network of the main rivers and not the complete hydrographical network, Greek coastline files available for downloading and the CORINE Land Cover of Greece, as defined in 2000. In hydroscope geoportal, the Hellenic Mapping and Cartography Organization index is enabled for the user, while in Geodata.gov.gr the user only has the option of searching essential geospatial data by keywords.

All three geoportals also provide the possibility of online layers at higher bit data and unlike Geodata.gov.gr, most of the geospatial data is freely available for download. In hydroscope, most of the geospatial data are not available for free downloading and can only

be done using Web GIS. Practically, this means that it may be a guide but is unable to provide geospatial data for direct use or processing.

Finally, regarding the policy mood in Geodata.gov.gr, all data are loaded and available for download along with their metadata. In hydroscope, there some data can be downloaded directly with its metadata, while others provide only metadata. The Geoportal of the Hellenic Mapping and Cartography Organization has available geospatial data, supplied after the user meets with the agency and send them an email asking for it.

An applied example can be mentioned here regarding the Sperchios river basin in Central Greece. The purpose of the study by Paparrizos and Chatziminiadis ([29]) was to estimate the erosion prevailing to the above mentioned area. In order to perform the current hydrological project, several parameters needed to be estimated or obtained. Topographic, land use and soil maps were available from-European geoportals. Nevertheless, there was a lack of satisfactory vector and raster data (watershed boundaries, hydrographical network, elevation, etc.). This lack of available data, which the researchers need to create ~~on~~ their own, extended the research for quite a while.

A summary of the main points of the framework is shown in Table 1 below, while Figure 5 shows the geospatial chain, which is the process followed in order to get the data to the user.

**Table. 1 Summary of the main framework of Greek geoportals**

| Geoportal | Services | | |
|---|---|---|---|
| | Catalogue | Viewing | Downloading |
| Geodata.gov.gr | Key-Words searching | Yes | Yes |
| hydroskope.gr | Yes | Yes | Limited downloading |
| inspire.okxe.gr | Yes | Yes | After request |

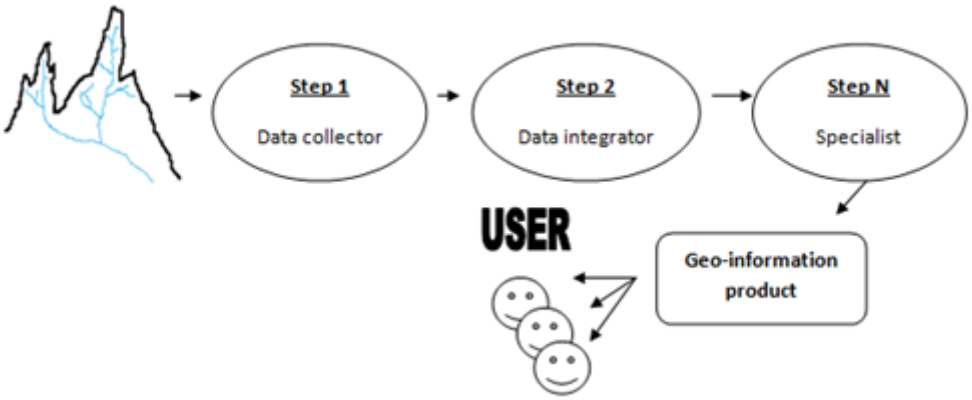


**Fig. 5: The Geo-Information value chain**

## 6. CONCLUSIONS – FUTURE PROPOSALS AND IMPROVEMENTS

After evaluating geoportals and highlighting this issue in the current paper, we submit some proposals designed to improve the Spatial Data Infrastructures (SDI) that exists in Greece.

Firstly, in order to be able to submit our future proposals, we need to consider that SDI development has a strong organizational component and is public sector oriented. The geospatial web is not organized, but it is pushed by technology.

In terms of growth and the improvement of infrastructure, collaboration between geoportals needs to be effected, as regards the environment and especially the integration of hydrological studies in order to create a complete and unified database. In other words, a bank of geospatial data and geo-information must be created, followed by a complete geo-index where all the geospatial data can be collected. This data will be either products from manufacturers from particular specialists in this area, produced by university research through undergraduate, graduate and doctoral dissertations, or independent bodies and research centres, non-government organizations, etc. There must be a particular committee sourced from the public sector. In this regard, we suggest people with important previous experience in the sector, i.e., from the sector of the National Geospatial Information Infrastructure. Individuals who will staff this committee will consist of specialists in the subject, scientists who will be able to collect the entire volume of geospatial data and geo-information present in geoportals, as well as all the additional geodata in existence. They will evaluate in detail the correctness and validity of this entire amount of geodata before making it publicly available.
The state should strengthen the financing of a single geoportal so that it consists of individual geoportals already available, and link it with the European portal www.inspire.geoportal.eu. This should be viewed as an investment, which will not only bring many gains to the public sector and help to develop the economy, but also potentially win international recognition and establish relationships between Member States of the European Union on the issue of Spatial Data Infrastructures, while promoting open government under the Open Government Partnership (www.ogp.opengov.gr) in Greece.

During the short time since the adoption of the INSPIRE Directive by the European Parliament and Council in 2007, which involved the countries of the European Union and was designed to define the framework for and install infrastructure for geospatial data in the EU for environmental and other activities and uses, some very important steps have been taken in Greece towards creating a strong infrastructure for geospatial data. This is exemplified by the high number of visitor rates to the geoportals, as many people are interested in using its services to freely access geospatial data.

For this reason, although the function of geoportals is still at an early stage, Greece should be directly involved in its further development, thereby generating immediate savings for the public sector by reusing geodata and consolidating Greece as one of the leading countries worldwide in the area of Spatial Data Infrastructures.

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