ArcNews

Building INSPIRE: The Spatial Data Infrastructure for Europe

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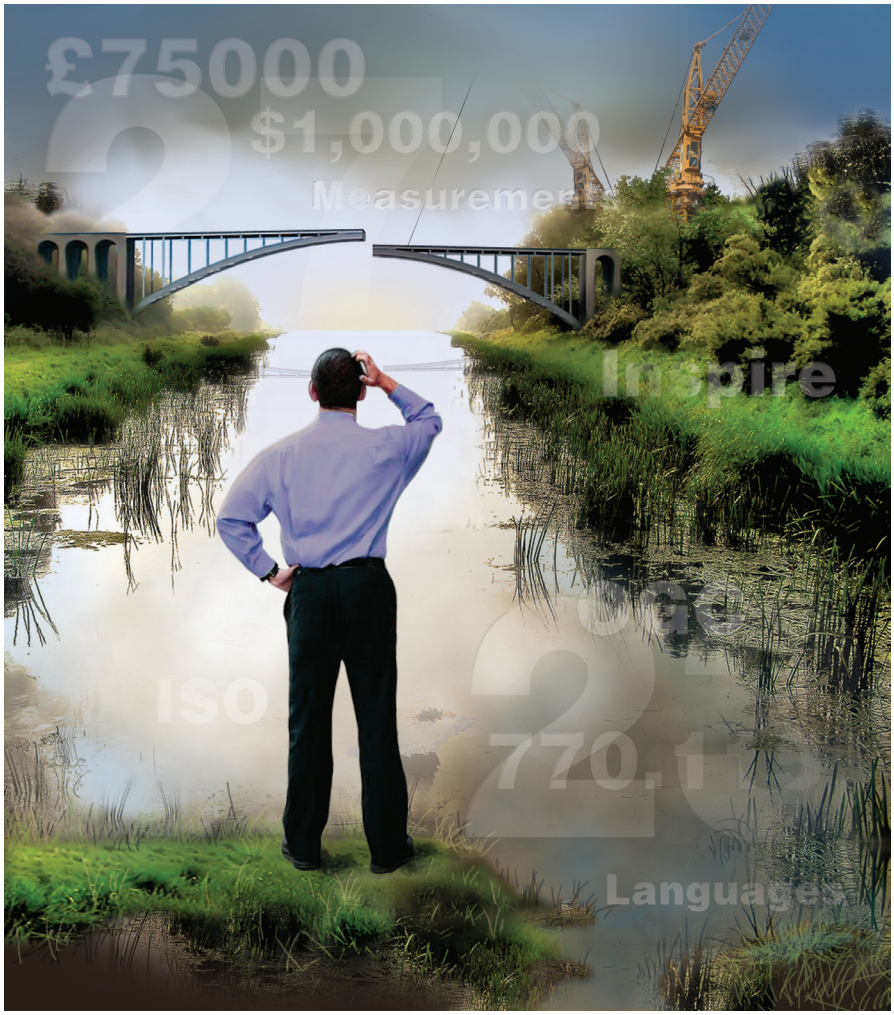

This article is about the European spatial data infrastructure (SDI), which is called, formally, Infrastructure for Spatial Information in Europe, or INSPIRE. Many readers of *ArcNews* will be familiar with the concept of an SDI, as efforts in the United States to develop a National SDI (NSDI) have been under way since the mid-1990s (*see also the article "Governance of the NSDI" by Will Craig in the Fall 2009 issue of* ArcNews), and many other countries in the world are very active in developing their own. For the readers who are not so familiar with the concept of an SDI, it is easier to think of it as an extension of a desktop GIS. Whilst in a "normal" GIS most of the data we geospatial professionals use for analysis is our own or collected by the agency we work for, an SDI is an Internet-based platform that will make it easier for us to search and find data that may be relevant for our work and that may be collected, stored, or published by other organizations and often other countries. The key components of an SDI are, therefore, catalogues of available resources, documented in a structured way through metadata; agreed-upon access policies and standards; and a set of services to access and download the data to our GIS. In many countries, some key datasets have been identified that are perceived to be of general usefulness to many (the so-called "framework" data in the United States). Priority has therefore been given to documenting them and making them available. Once we have found and downloaded the data we need, we analyze it in our GIS, and finally, we contribute (often but not often enough) to the international pool of knowledge by publishing the results of our analysis so that others can use them.

This, of course, is a rather simplistic perspective. SDIs are children of the Internet, without which they would not exist. They are also the response to an increased recognition that the environmental and social phenomena we are called to understand and govern are very complex, and that no single organization has the know-how and the data to do the job alone. Hence, we need to share knowledge and data across multiple organizations in both public and private sectors, and SDIs support this effort.

INSPIRE

The INSPIRE Directive is a legal act (Directive 2007/2/EC) of the Council of the European Union and the European Parliament setting up an Infrastructure for Spatial Information in Europe based on infrastructures for spatial information established and operated by the 27 Member States of the European Union (EU). For the readers not familiar with the institutional setup of the European Union, it is worth

pointing out that the EU is not a federal state but a union of 27 sovereign Member States that agree through a series of international treaties (the latest being the Lisbon Treaty of 2009) to the policy areas in which they wish to share responsibilities and resources (e.g., agricultural, environmental, and regional policies) and those that remain instead the exclusive domain of the national governments (e.g., defense and immigration).

Annex I
Coordinate reference systems
Geographical grid systems
Geographical names
Administrative units
Addresses
Cadastral parcels
Transport networks
Hydrography
Protected sites
Annex II
Elevation
Land cover
Orthoimagery
Geology
Annex III
Statistical units
Buildings
Soil
Land use
Human health and safety
Utility and governmental services
Environmental monitoring facilities
Production and industrial facilities
Agricultural and aquaculture facilities
Population distribution and demography
Area management/restriction/regulation zones and reporting units
Natural risk zones
Atmospheric conditions
Meteorological geographical features
Oceanographic geographical features
Sea regions
Bio-geographical regions
Habitats and biotopes
Species distribution
Energy resources
Mineral resources

Table 1: Key data themes addressed by INSPIRE.

The key decision-making bodies are, therefore, the national governments—represented in the Council with a number of votes proportional to the size of the country—and the European Parliament that is elected by universal suffrage every five years. The European Commission is the civil service body of the EU and has the power of proposing legislation (to the Council and European Parliament) and monitoring its implementation once approved. Not being a federal state also means that there is no equivalent to the U.S. federal agencies in respect to the collection of topographic or demographic data like the United States Geological Survey and the Bureau of the Census. All data comes via the responsible organizations in the Member States. As a result, setting up an EU-wide SDI can only be done in a decentralized way, building on the SDIs and related activities established and maintained by the Member States.

The purpose of INSPIRE is to support environmental policy and overcome major barriers still affecting the availability and accessibility of relevant data. These barriers include

- Inconsistencies in spatial data collection, where spatial data is often missing or incomplete or, alternatively, the same data is collected twice by different organizations
- Lack or incomplete documentation of available spatial data
- Lack of compatibility among spatial datasets that cannot, therefore, be combined with others
- Incompatible SDI initiatives within a Member State that often function only in isolation
- Cultural, institutional, financial, and legal barriers preventing or delaying the sharing of existing spatial data

The key elements of the INSPIRE Directive to overcome these barriers include

- Metadata to describe existing information resources so data can be more easily found and accessed
- Harmonization of key spatial data themes needed to support environmental policies in the European Union
- Agreements on network services and technologies to allow discovery, viewing, and downloading of information resources and access to related services
- Policy agreements on sharing and access, including licensing and charging
- Coordination and monitoring mechanisms

INSPIRE addresses 34 key spatial data themes organized in three groups (or Annexes to the Directive) reflecting different levels of harmonization expected and a staged phasing *(see table 1)*.

The legal framework of INSPIRE has two main levels. At the first, there is the INSPIRE Directive itself, which sets the objectives to be achieved and asks the Member States to pass their own national legislation establishing their SDIs. This mechanism of European plus national legislation allows each country to define its own way to achieve the objectives agreed upon, taking into account its own institutional characteristics and history of development. As an example, Germany does not have a single SDI but a coordinated framework with 17 SDIs, one for each of its states (Länder) and one at the federal level (which also means that 17 different legal acts had to be passed to implement INSPIRE). Similarly, Belgium will have probably three SDIs, one for each of its regions (Wallonia and Flanders) and one for Brussels. The INSPIRE Directive also requires the establishment of an EU geoportal operated by the European Commission to which the infrastructures of the Member States have to connect.

The drawback of having 27 different "flavours" of INSPIRE is that making the system work is undoubtedly more difficult. For this reason, the Directive envisages a second level of legislation, more stringent because it has to be implemented as is and does not require follow-up national legislation. In European terminology, this is called a *regulation*. Therefore, INSPIRE envisages technical implementing rules in the form of regulations for metadata, harmonization of spatial data and services, network services, data and service sharing policies, and monitoring and reporting indicators to evaluate the extent of the Directive's implementation and to assess its impact. Each of these regulations needs the approval of the Member States and the European Parliament. As of January 2010, the regulations for metadata, network services (discovery and view), and monitoring and reporting have already been approved. Those for data- and service-sharing policy, network services (transformation and download), and the first set of specifications for the harmonization of data have been approved by the representatives of the Member States and are now under the scrutiny of the European Parliament.

INSPIRE has some characteristics that make it particularly challenging. The most obvious is that it is an infrastructure built by 27 different countries using more than 23 languages. The requirements for multilingual services and interoperability among very different information systems and professional and cultural practices are, therefore, very demanding. This means, for

example, that existing standards have to be tested in real distributed and multilingual settings. In the best scenario, all works well, but for a European-wide implementation, there is a need to translate the standards and related guidelines into the relevant languages (International Organization for Standardization [ISO]; Open Geospatial Consortium, Inc. [OGC]; and other relevant standards are typically in English only). In other instances, testing has demonstrated that the standards are not mature enough, or leave too much room for different interpretations, and thus require further definition or individual bridges to make different systems interoperate. This can be seen with tests on distributed queries in catalogues all using the same specifications (OGC Catalog Service for the Web 2.0). The tests identified a number of shortcomings that required the development of an adaptor for each catalogue, which in a European-wide system with thousands of catalogues would obviously not scale.

These shortcomings have been put forward to the OGC for consideration (for further details, see **inspire.jrc.ec.europa.eu/reports/DistributedCatalogueServices_Report.pdf**). In harder cases still, there are no standards available, and, therefore, they have to be created. This applies, for example, to "invoke" services that are needed for service chaining and to the specifications required for the interoperability of spatial datasets and services, which is a central feature of INSPIRE. To understand the context, it is worth reminding readers that each country in Europe has its own heritage and traditions, which include different ways and methods for collecting environmental and geographic data and different traditions on how to analyze and visualize the data, including different coordinate reference systems (sometimes more than one in each country), projections, and vertical reference systems. These different traditions mean that it is not enough for an SDI in Europe to help users find and access data. It is also necessary to understand the meaning of what we are accessing to make appropriate use of it.

This means, in turn, that we need to develop not only translation tools to help overcome the language barriers but also agree on reference frameworks, classification systems and ontologies, data models, and schemas for each of the data themes shown in table 1 against which the national data can be transformed or mapped. This is necessary because we cannot ask the Member States and their national and local organizations to reengineer all their databases. Thus, the approach adopted is to develop agreed-upon European models and systems of transformation (on the fly or batch) so that the level of interoperability necessary for key European applications can be achieved. The approach sounds simple, but putting it into practice is very complex, as it has already required three years of work to develop an agreed-upon methodology (the Generic Conceptual Model) and tools; mobilize hundreds of experts in different domains; and deliver and test the first round of specifications for the Annex I data themes, with Annexes II and III to follow in the coming years. A visit to the INSPIRE Web site (**inspire.jrc.ec.europa.eu/index.cfm**) in the data specifications sections demonstrates the huge amount of work involved.

The Organizational Model

The organizational model put in place to develop INSPIRE is one of its more interesting features, drawing significant attention from outside Europe. In essence, it is a huge exercise in public participation, the like of which is most unusual in policy making, at least in Europe. From the outset, it was recognized that for INSPIRE to be successful and overcome the barriers to data access and use identified earlier, it was necessary for the legislators, implementers, and practitioners in the Member States to come together and agree on a shared understanding of the problem and possible solutions. Therefore, an expert group with official representatives from all the Member States was established at the beginning of the process in 2001, together with working groups of experts in the fields of environmental policy and geographic information to formulate options and forge consensus.

The INSPIRE proposal was subject to an extended impact assessment (**inspire.jrc.ec.europa.eu/reports/fds_report.pdf** and **inspire.jrc.ec.europa.eu/reports/inspire_extended_impact_assessment.pdf**) to identify potential costs and benefits before opening for public consultation. The revised proposal was then debated by the Council and European Parliament over a three-year period before final adoption in 2007. This process in itself is a good example in democracy, but the more interesting aspect is the way in which interested stakeholders are continuing to participate in all the ongoing activities required to develop the INSPIRE implementing rules (i.e., the follow-up legal acts and detailed technical guidance documents).

To organize this process, two mechanisms have been put in place: the first is to engage the organizations at European national and subnational levels that already have a formal legal mandate for the coordination, production, or use of geographic and environmental information (called Legally Mandated Organizations, or LMOs). The second mechanism aims to facilitate the self-organization of stakeholders, including spatial data providers and users from both the public and private sectors, in Spatial Data Interest Communities (SDICs) by region, societal sector, and thematic issue. The central roles that SDICs play in the development of implementing rules include the following:

- Identify and describe user requirements (to be understood as acting in line with environmental policy needs, as opposed to "maximum" requirements beyond the scope of INSPIRE and beyond realistically available resources).
- Provide expertise to INSPIRE drafting teams.
- Participate in the review process of the draft implementing rules.
- Develop, operate, and evaluate the implementation pilots.
- Develop initiatives for guidance, awareness raising, and training in relation to the INSPIRE implementation.

LMOs have similar functions but also play a central role in reviewing and testing the draft implementing rules and in assessing their potential impacts in respect to both costs and benefits.

An open call was launched on March 11, 2005, for the registration of interest by SDICs and LMOs that were also asked to put forward experts and reference material to support the preparation of the implementing rules. The response was immediately very good, with more than 200 SDICs and LMOs registering within a month, putting forward some 180 experts (funded by them) from which we have set up drafting teams to help in developing the first batch of technical documents. At the present time, a second call for experts is open on the INSPIRE Web site to support the development of Annex II and III specifications, and an Internet forum (**inspire-forum.jrc.ec.europa.eu**) has also been set up for Member States to share experiences and tools to help implement INSPIRE. Table 2 shows the extent of the community directly involved in shaping the policy and the technical documents.

Three aspects are particularly important in

The Inspire Community in 2009
361 Spatial Data Interest Communities (SDICs)
198 Legally Mandated Organizations (LMOs)
300 experts (drafting teams and working groups)
238 experts for Annex II/III latest call
3,087 user organizations registered on the INSPIRE Web site

Table 2: The INSPIRE community in 2009.

understanding the work and the challenges of the drafting teams: first, each expert represents a community of interest and, therefore, has the responsibility to bring to the table the expertise, expectations, and concerns of this community; secondly, each drafting team has to reach out to all thematic communities that are addressed by INSPIRE. As a matter of comparison, it is worth recalling that the U.S. NSDI defined only seven framework themes: geodetic control, orthoimagery, elevation, transportation, hydrography, governmental units, and cadastral information, most of which have a federal agency that is taking the lead in data collection and management. The implication for the drafting teams is that they have a much more difficult task in collecting and summarizing reference material, seeking common denominators and reference models, and developing recommendations that satisfy user requirements without imposing an undue burden on those organizations that have day-to-day responsibility for data collection and management across Europe. Seeking compromise between different requirements and perspectives is crucial to the work of each drafting team.

Last, but not least, it is important to note that the drafting teams have ownership of their work. They make the recommendations and submit them for review to all the registered SDICs and LMOs and the representatives of the Member States. It is only after they have taken on board all the comments received that the Commission takes ownership of the draft implementing rules and submits them for internal consultation. After revision and checking, the draft implementing rules go through the final round of the democratic process before becoming a new legal act. This involves qualified majority voting by the representatives of the Member States and the scrutiny of the European Parliament.

The complexity of this participatory approach is certainly innovative not only in relation to the developments of SDIs but also more generally to the formulation of public policy at the European level. The outcome produces both consensus-based policy and the development and maintenance of a network of stakeholders that make it possible to implement more effectively this distributed European SDI.

The Challenges

Although a great deal of work has clearly taken place with the support of many stakeholders, there are still several organizational and technical challenges (and opportunities) that need to be addressed.

Organizational: The most immediate challenge is to maintain the momentum and the high level of commitment of all stakeholders and the experts contributing to the development of the implementing rules. This is not trivial and requires a notable amount of resources (time, money, expertise, commitment) to ensure that stakeholders feel ownership of the process, which then becomes a prerequisite for more effective implementation. Just to give an example of the scale of the task, the development of the data specifications for Annex I themes involved addressing more than 7,500 comments received from hundreds of stakeholders and organizing some 350 meetings (both physical and virtual) over a two-year period. If you consider that there were 8 themes in Annex I and another 26 to do, in addition to the revisions and maintenance of all guidance documents already created, then you have a sense of this facet of the organizational challenge. The INSPIRE forum is one way to address this challenge, but managing expectations, ensuring real participation, and delivering the benefits are key aspects we constantly need to focus on.

Another facet, which is even more important, is the organizational challenge in the Member States to implement INSPIRE. The INSPIRE Directive asks Member States to establish and maintain their SDIs, nominate an organization as a contact point with the Commission, and set up appropriate coordinating mechanisms, all of which have given rise to a flurry of activity across Europe. In many countries, SDIs already exist and work well at national and subnational levels. So the effort is more focused on agreeing on a division of responsibility than in setting up new structures. In other countries, INSPIRE offers an opportunity for the organizations that have been leading SDI developments for years to get their just recognition and acquire new status and legitimacy.

Of course, the difficult financial climate of this period makes it potentially more challenging to invest in new infrastructures and ways of working. Hence, the challenges in most countries are to leverage resources available from different sources (European, national, international) and/or ensure strong synergy between the investment required by INSPIRE and those committed in related projects, for example, in the framework of e-government. In this sense, the work needed is critical not only to align sources of funding but also to ensure that initiatives, standards, systems, and deployments are well coordinated and that they do not duplicate, or contradict, each other. Readers of this article who are familiar with large public-sector organizations will know how challenging this may prove to be.

Underpinning this organizational challenge are the key issues of awareness, education, and training. Although we have involved thousands of people in the development of INSPIRE,

and most national-level organizations in the Member States are aware of this initiative, there is still much to do. Even in the organizations involved in INSPIRE, sometimes only a few people are actively participating, and the level of awareness of INSPIRE and its future impacts may be lost to other parts of the same organization.

Moreover, many public-sector administrations at the subnational level still have limited or no knowledge of INSPIRE. This is partly due to (1) insufficient dissemination efforts in the Member States; (2) local and regional authorities only becoming more directly involved when the data themes they are responsible for, which are mainly in Annexes II and III, are addressed by INSPIRE; and (3) the complexity of the technical documentation being produced at the present time, which very few people can understand or use. This brings us to the education and training issues. Even if we take a very simplified view of an SDI and assume that all it involves is creating metadata and setting up OGC-compliant services for discovery, view, and access, then where are the technicians versed in the relevant standards and technologies who will be able to implement these services across hundreds of datasets in the thousands of organizations across Europe? Who is training them? Where are the technical colleges and universities forming such competent technical staff? Where is the training material consistently being designed and translated across Europe so that everybody implements exactly the same specifications? And, where are the courses to train professional users (city planners, environmental engineers, social scientists, etc.) on the added value of the SDI to their work? The answer, of course, is that we still have to build up this capacity.

There have been notable efforts in respect to the professional users such as the Center for Spatially Integrated Social Science in the United States (**www.csiss.org**) and several EU-funded projects in Europe (e.g., **www.vesta-gis.eu**), but the demand far outstrips the supply, and often, the funding to support these projects is limited to a few years, typically three or four. An interesting effort to overcome this short-term funding problem is represented by the Vespucci Initiative for the Advancement of Geographic Information (GI) Science (**www.vespucci.org**), a not-for-profit, self-funded initiative bringing together leading GI scientists and practitioners in intensive weeklong courses to foster interaction and exchange of experience along the "training the trainers" formula. After eight years of operation, some 500 participants have lived the Vespucci experience, and thousands more will have benefited from the indirect effects of being trained by the Vespucci alumni.

*The INSPIRE geoportal (**www.inspire-geoportal.eu**).*

Technical: The main challenge here is to develop and maintain an infrastructure that works and that delivers added value. As indicated earlier, the suite of international standards and specifications available is sometimes not mature enough to deliver or is subject to different interpretations, change, and inconsistencies. To give one small example, at the core of SDIs is metadata. The international standards for metadata for datasets and services are ISO 19115 and ISO 19119, respectively. The application schema for both is ISO 19139, but these schemas can be found at two different locations: the ISO repository for official standards and the Open Geospatial Consortium Schema Repository. Unfortunately, the schemas available at these two sites differ because of the different versions of Geography Markup Language (GML) they use.

This is now being addressed, but it is just one example of the many problems one has to face in practice. The devil is always in the details, and in the case of INSPIRE, we took the view that it was not feasible to include all the very detailed specifications down to rules for encoding into a legal act, as any change in standards, technologies, or good practice would then require lengthy procedures to amend the legislation. As a result, the INSPIRE implementing rules are short and only say what functionalities are required, leaving the detailed implementation to nonbinding guidelines documents. This has its drawbacks, as we cannot guarantee that everyone will use the guidelines and that interoperability will be achieved immediately. On the other hand, experience has shown that we are still making small adjustments to the guidelines for metadata two years after their approval. Had they been set in tablets of stone (i.e., legally binding), there is no way that we could be able to make any change fast enough.

So, in practice, we adopted a more pragmatic approach, setting up an Initial Operating Capability Task Force with representatives from the agencies in charge in every country to implement INSPIRE. With them we can discuss in detail how they are implementing their services, what seems to work, and what does not; make the necessary changes and adjustments; and disseminate good practice, as well as share tools (and reduce costs). INSPIRE is a process, not just an artifact!

A second challenge is to facilitate the transition from a spatial data infrastructure perspective, that is, the "extended GIS metaphor" used in the introduction, which only addresses relatively few technical experts, toward a spatial information infrastructure, a service providing information products and analyses that are of wider use to nonexperts. This requires turning many of the functionalities and analytic processes encoded in GIS software and usable by few trained geospatial professionals into geoprocessing services that can operate in established workflows over the datasets available on the Web and provide answers to questions posed by the many who are not experts.

The research issues here are many and include eliciting and formalizing processes and models from experts; turning them into geoprocesses, which can be understood and used across disciplines (including explanation of the theoretical underpinning of models so that they can be used appropriately); and selecting the

appropriate service to go with the appropriate data to contribute to addressing a question in ways that are methodologically robust. Some of these challenges were addressed, for example, by the ORCHESTRA project (www.eu-orchestra.org/overview.shtml), but in that instance, all the geoservices had to be chained manually, which would not scale up in a global setting with thousands of datasets and services available. So we need automatic or semiautomatic means of making the right choices and links.

To add spice to these challenges, there are also always new ideas and technologies to understand and harness. So as we were settling in to implement service-oriented architectures (SOA) for SDIs with the corollary of ISO metadata, OGC discovery services, etc. (i.e., following the paradigm of the library that separates the resources from their metadata), along came Linked Data (linkeddata.org) with Resource Description Framework (RDF) to provide semantically rich descriptions of resources and their linkages. Of course, Linked Data and SOA are not necessarily at odds. However, this is a good example of the way one needs to build the infrastructure for today with a view to where we should be going tomorrow.

Toward the Next-Generation Digital Earth

To help sharpen our vision of the future, the Vespucci Initiative brought together in 2008 a number of environmental and geographic information scientists from academia, government, and the private sector to consider the changes that have taken place since the 1998 Digital Earth speech by U.S. Vice President Al Gore (www.isde5.org/al_gore_speech.htm). The meeting was an opportunity to consider the major technological developments that have made it possible to bring the experience of Digital Earth to hundreds of millions of people in their homes and desktops. It also reviewed the many public-sector-led initiatives aimed at organizing geographic information (SDIs and INSPIRE, the Global Earth Observation System of Systems initiative [earthobservations.org], the International Society for Digital Earth [www.digitalearth-isde.org], etc.) and the major private-sector developments aimed at organizing world information geographically. These have made it possible for citizens to contribute and share geographic information easily and interact with each other in what is labeled as Web 2.0.

Overall, the emerging view was that there is a need to bring together these seemingly parallel worlds: top-down official information and bottom-up citizen-provided information. On this basis, we articulated a revised vision of Digital Earth to help guide our effort. This vision recognizes the need to integrate scientific and public- and private-sector data to help us understand the complex interactions between natural, man-made, and social environments over time and across space—a framework to help us realize what has changed or is likely to happen, when, and why. To support this vision, we also identified key research topics on which to focus our energies, including improved methods for the spatiotemporal modeling of heterogeneous and dynamic data (citizen provided, sensors, official), the visualization of abstract concepts in space (e.g., risk, vulnerability, perceived quality of life), and ways to assess and model reliability and trust in information coming from many different sources (for more details, see ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/119/99).

You could argue that with all the work we still have to do to develop and implement INSPIRE in Europe, we can ill afford to look for new organizational and technical challenges and research topics. Yet we should never lose sight of why we are building these infrastructures and investing significant public resources to do so. They are not ends in themselves but a means to improve our understanding and stewardship of the environment and develop our knowledge-based society. Without a clear view of where we want to go and what is needed to get there, we will not be able to guide the process effectively and address the grand challenges of today and tomorrow. The *Next-Generation Digital Earth* paper provides an initial contribution in shaping the longer-term view, and we welcome your feedback and contributions on inspire-forum.jrc.ec.europa.eu/pg/groups/98/next-generation-digital-earth.

About the Author

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More Information

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Economic Growth Strategy Transformed Through a Spatial Data Infrastructure

Croatia Simplifies Landownership Process with a National Geoportal

The Republic of Croatia, roughly the size of West Virginia, is home to more than 4.4 million people. Ranked as the 18th most popular tourist destination in the world, sightseers visit its beautiful national parks, the high peaks of the Dinaric Alps, and more than 1,000 islands in the temperate Adriatic Sea.

A successor state of the former Yugoslavia, the country declared its independence in 1991, which the European Union (EU) and the United Nations recognized in 1992. Building itself up from virtually nothing, the country is now governed by a forward-thinking parliamentary republic, which is adopting new laws to promote economic growth and help its candidacy for EU membership.

Making countrywide geographic data available throughout the nation with a spatial data infrastructure (SDI) is one way the country continues to grow. An online geoportal created with GIS technology makes this possible. The geoportal makes it easier for citizens, government, and private-sector users to find and access vast quantities of geographic information and related services. The geoportal is the first phase of a Croatian national SDI and has already shown its value by reducing the time it takes to register land within the country by 90 percent.

Enabling Property Rights in Croatia

Ten years ago, a simple land title transaction took an average of 400 days to carry out. Most information was stored and managed in paper-based files, making it difficult to share. Agencies, such as the State Geodetic Administration (SGA) in charge of the country's official maps and cadastre, and the Ministry of Justice, responsible for land registers issued at municipal courts, could not easily

exchange data.

In 2000, the Croatian Parliament adopted a State Survey and Real Property Cadastre Program to transform the existing registers into digital format. This involved topographic surveys as well as resurveying 5 percent of the existing cadastre focusing on areas of special interest, such as towns, coastlines, islands, nonregulated state agricultural land, and infrastructure corridors.

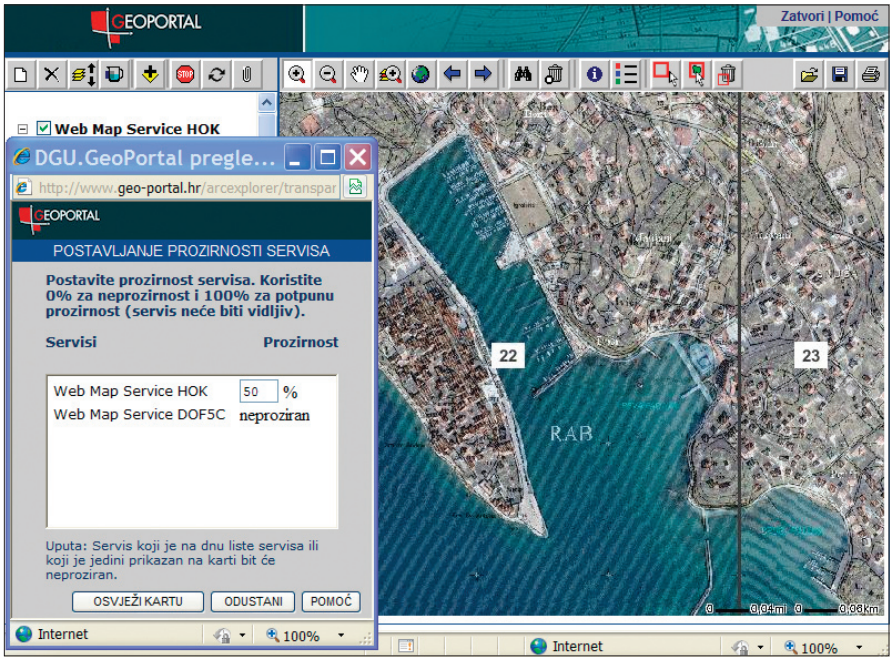
The datasets were cofinanced by federal institutions and interested local governing bodies. For example, orthophoto production was completed through 30 different agreements between local and state governments. Over a 10-year period, 21 counties produced topographic data and resurveyed each cadastre. By the end of 2010, 56,000 cadastral maps will be digitized and verified.

Once created, the data is gathered and housed in the Real Property Registration and Cadastre Joint Information System (JIS). The JIS unites the cadastral data managed by SGA and legal information from the Ministry of Justice. Having consistent and shareable data across the country via the ArcGIS Server Geoportal extension is improving the processes of implementing land reform because documents can be issued from both cadastre and land registers. The average time for processing changes to land titles has dropped from a 400-day average to less than 37 days.

A view over the old city walls of Dubrovnik, Croatia, and its old harbor.

Online Data Access Through Geoportal

As the first step toward an SDI, the cadastral data managed by SGA is now available for browsing, searching, and purchasing via an online data catalog found at **www.geo-portal.hr/Portal**. To develop the geoportal, the state selected ESRI's distributor in Croatia, GISDATA d.o.o., and con terra GmbH, the professional services arm of ESRI Deutschland GmbH, ESRI's distributor in Germany and Switzerland. The companies established an action plan to develop a national SDI. They chose ArcGIS Server and the ArcGIS Server Geoportal extension to provide the platform for the state's ministries to quickly access geospatial resources regardless of location or type.



*As the first step toward an SDI, the cadastral data managed by SGA is now available for browsing, searching, and purchasing via an online data catalog found at **www.geo-portal.hr/Portal**.*

Based on the EU's Infrastructure for Spatial Information in Europe (INSPIRE) directives for sharing geographic information across Europe, Croatia's national SDI will provide a more open, transparent, and efficient use of spatial information, as seen through the improved land registration.

SGA registers data with the geoportal by using metadata, which follows the ISO standards required by INSPIRE. Only the metadata is uploaded to the geoportal, while SGA's sensitive data remains securely housed within its own servers. Through the ArcGIS Server Geoportal extension, registered data includes digital orthophotos, 1:5,000-scale basemap information, raster cadastral maps, administrative units through the Central

What Is an SDI?

SDI stands for *spatial data infrastructure*. What does that mean? Think of the roads and dams and underground pipes necessary for the well-being of a community or nation. These fundamental engineering projects are, of course, *infrastructure*. An SDI is similar except that it consists of essential data rather than concrete or steel. A broader view recognizes that it is a framework of technologies, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve the use of geospatial data across multiple public and private organizations.

Registry of Spatial Units, and land survey information from the Registry of Geodetic Points.

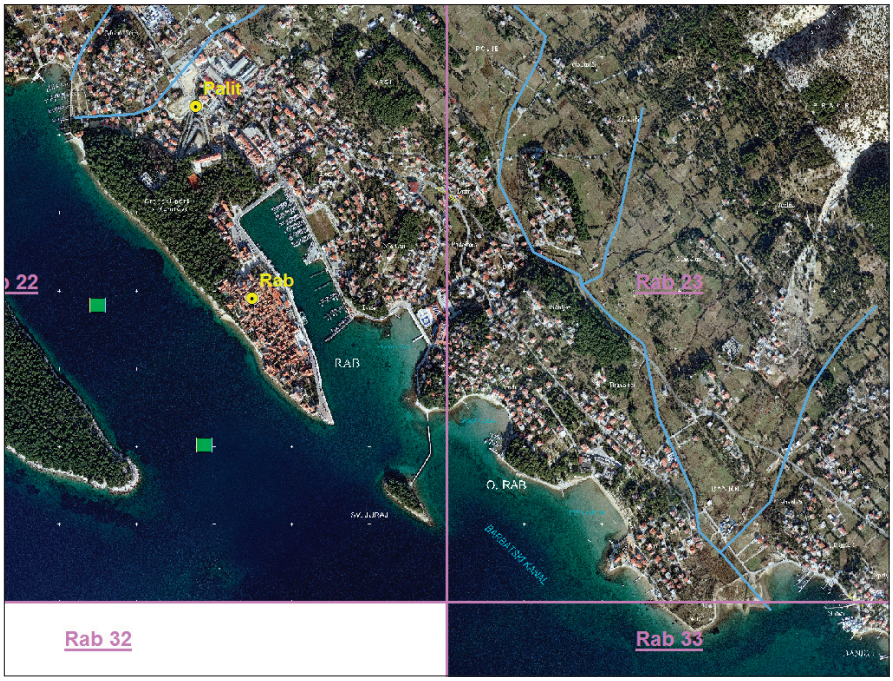
The First Step to a National SDI

By the end of the year, more agencies within Croatia will register their data with the geoportal, using the SGA data as a guide for resolution and standards. The Ministry of Defense; the Ministry of Culture; and the Ministry of Agriculture, Fisheries, and Rural Development will all provide spatial data.

By creating a comprehensive SDI, Croatia expects to continue to see improvements in the reduction of time when producing and accessing data. Geospatial data and service producers in the government will be easily connected to the consumers who need the data. Data integrity will be maintained, and the users can more easily share the authoritative version of data.

Dr. Zeljko Bacic, director general of SGA, says, "Simple access to geospatial data is the key prerequisite for an efficient and economically prosperous society. A geoportal in operation means that other governmental organizations can use SGA data but also make their data accessible. This is the first step to the establishment of a Croatian national geoportal as part of a national SDI. I am convinced we shall do this soon, as we have a clear direction from the Croatian government and sufficient knowledge and capacity to do this."

The SGA geoportal has revealed opportunities in local and regional government for GIS users in nature protection, urban planning, agriculture, public safety, and more. "The SGA geoportal is the first of its kind in southeastern Europe," says Andrej Loncaric, director of GISDATA in Croatia and the southeastern region. "Croatian GIS users now have access to vast quantities of geospatial data that will make their everyday work much easier."



SGA provides the platform for organizations to quickly access geospatial resources regardless of location or type.

More Information

For more information, contact Zeljko Bacic, director general, State Geodetic Administration, Republic of Croatia (e-mail: zeljko.bacic@dgu.hr).

European Union's Environmental Map Services Move to Cloud

EEA executive director Jacqueline McGlade.

The European Union's (EU) European Environment Agency (EEA) is working closely with Esri to improve the agency's cloud environment map services. EEA and Esri have signed a memorandum of understanding that allows EEA to expand deployment of ArcGIS 10 and better fulfill its project goals. European countries will be able to share environmental data more easily, and agencies, scientists, and policy makers will have quick access to data for viewing and analysis in GIS.

EEA helps EU and its member countries make informed decisions about improving the environment, integrating environmental consideration into economic policies, and moving toward sustainability. It also coordinates the European Environment Information and Observation Network (Eionet). Esri's complete integrated software system ArcGIS 10 plays a prominent role in helping EEA achieve its goal of delivering geographic visualization and analysis capabilities to environmental data consumers.

"We were very pleased to sign a new agreement with Esri for use of its ArcGIS 10 software," says EEA executive director Jacqueline McGlade. "This relationship will enable the 450 institutions participating in Eionet to access the software and will allow us to develop technologies, such as mobile GIS, within our community."

EEA collaborates with its member countries in the European Commission's Shared Environmental Information System (SEIS) initiative. The initiative aims to improve data availability and quality, streamline data handling, modernize reporting, and foster the development of information services and Web-based applications. Many countries have started to apply the principles of SEIS, which are based on distributed information management. Several European initiatives are providing the building blocks for SEIS, including

- *Infrastructure for Spatial Information in Europe (INSPIRE)*—A European Union directive to create a spatial data infrastructure that enables sharing geospatial data among European public-sector organizations and with the public
- *Global Monitoring for Environment and Security (GMES)*—A collaboration between the European Commission and the European Space Agency for the establishment of a European capacity for earth observation from space and in situ that supports sustainable development and global governance

• *Water Information System for Europe (WISE)*—EEA and European Commission's Internet tool that informs citizens about water quality and EU water policy
• *Ozone Web*—EEA portal for near real-time ozone information
• *Eye on Earth*—EEA's two-way communication platform, which brings together scientific information with feedback and observations of millions of ordinary people via social networking sites
• *Biodiversity Information System for Europe (BISE)*—A Web portal for data and information on biodiversity in the European Union

These services are transitioning to cloud computing, wherein technological capabilities are commonly maintained off premises and delivered on demand as services via the Internet. An advocate of cloud computing, McGlade notes, "Our community has a great appetite for all kinds of applications, and we can move these in and out of the cloud as needed. Every time we add a new service that has a transaction element, we see the access numbers go up and up. We have to accommodate the fact that the more information we put out there, the more people want to look at it. We anticipate that people want to do their own start-ups and their own applications out of the reference data that we are creating."

Cloud GIS offers data storage, end-user Web applications, and focused computing services. It costs less, is always available, has faster application delivery, is flexible, and has improved business continuity. Most importantly, it enables collaboration and community computing for easier and faster information sharing.

Through EEA, the quality of bathing water can be assessed across Europe for quick understanding of information and trends in each country and across time.

"Costs of this type of service are falling and tumbling," continues McGlade. "As far as cost, EEA is looking at a significant reduction of costs by moving to the cloud technology." Together with the development of Web mapping services offered by EEA, a much larger user community is served with high-quality, up-to-date environmental data.

The memorandum of understanding supports the design and development of a means for sharing and accessing essential geographic environmental data provided by the agency's 32 member countries and 6 cooperating countries in approximately 450 organizations. During the next year, EEA and Esri will work together to develop

• Cloud architecture that serves EEA initiatives and European Union directives
• Data sharing that is in line with the principles of INSPIRE and SEIS
• Standardized templates and layer definitions that are based on the Esri Community Basemaps initiative
• A collaborative plan that supports the Eye on Earth initiative

"We want our users to be able to access multiple layers, do their own mashups, and create their own applications," explains McGlade. "GIS technology is moving rapidly ahead. In our latest discussions with Esri, we talked about crowdsourcing and mashing possibilities and getting data into the working environment so that people in the field can use GIS for analysis. Esri's providing the way to make this happen."

More Information

For more information, contact Guenther Pichler, Esri (e-mail: gpichler@esri.com).

The EEA gives access to the CORINE land cover, a European land cover map produced by photo-interpretation of Landsat ETM+ images as well as LUCAS (land use/cover area frame survey) to estimate areas that do not coincide with the administrative regions.

Migration to ArcGIS Server Improves EEA Map Services

The European Environment Agency (EEA) is one of the first European Union agencies to offer Web mapping services. EEA sees this service as an information product and a way to promote its message of sustainable environments. Its Shared Environmental Information System (SEIS) supports an initiative that helps environment data providers share methodologies, ideas, standards, and technologies. SEIS is a means for exchanging data from local to global levels. ArcGIS is used as an important component to build SEIS.

EEA's GIS team has been devising a social networking system to improve base data and reduce the complexity that surrounds data sharing, but this effort is not without challenges. Data gathering and sharing differ among nations. Community members have varying platforms and a variety of data centers. EEA's solution is to create templates that make it easier to collect data from thematic areas, such as air, water, biodiversity, lands, and climate change. EEA is using ArcGIS Server to accommodate different data types.

Another challenge for the Web map service provider has been to match capacity to demand. Initially, EEA's map service platform was built using ArcIMS to deploy 100 percent of the Internet mapping software's functionality. EEA's GIS team is migrating map services to ArcGIS Server. This move has improved the system's stability.

"ArcGIS Server is very stable," notes EEA's project officer of geospatial developments, Jan Bliki. "It allows us to isolate our services in a well-defined way. A poorly behaving map service won't bring down the rest of the infrastructure."

The GIS shop consists of three in-house people and some GIS consultants. EEA has 100 map applications running more than 65 map services. In the past, this was very difficult to manage, and the team often worried that the servers would go down when demand was high. After the migration to ArcGIS Server, the service had no single crashes or major problems. Bliki explains, "One day, we had a huge peak of demand. In just four hours, 35,000 visitors hit one map service. That is about two million map requests. The system worked through it without any problem. We could have easily withstood 50,000 visitors and been fine."

ArcGIS Online is an important piece of EEA's infrastructure. Esri is working with EEA to discuss and define environmental layers to enter into the community basemap. EEA receives huge amounts of data on a weekly basis. Esri technology will make it possible for European citizens to access that data. Community members can feed their data into a data template and post it on ArcGIS Online.

"We find that ArcGIS Online is a new way to promote map services and give developers mashup capabilities they never had before," Bliki says. "It is a place where our members and anybody else can share data and compare environmental messages with each other. Map services as a product for the public rather than for developers is a new way of thinking but will totally change the reusability of our information."

Because ArcGIS Server is based on open geospatial and IT standards, EEA can serve data to anybody. "Most of the other GIS products don't provide that," notes Bliki. "We serve a full packet for open source, Google, Bing Maps, and Esri ArcGIS products. Once we set up the service, it is very easy to serve it to everybody." EEA SEIS users can consume data on Web browsers, mobile devices, and desktop systems.

"We have already moved most of our services from ArcIMS to ArcGIS Server," continues Bliki. "The applications were a bit harder to move over because we had to establish the best approach. Now that we have it set up, we can make map services available on the Internet in a few days rather than what used to be weeks."

The GIS team considers the whole design process to be faster and much more dynamic when they use ArcGIS Server," says Bliki. "Previously I had to ask a developer to help with high-level tasks. Now I can divide these tasks easier between cartographers, database managers, and developers and create very stable and reliable service products."

Many people use EEA's integrated spatial information system to access relevant themes and products. They can easily search and view data and download functions that help them with analysis and policy making. "EEA's Web site (**discomap.eea.europa.eu**) makes it possible for people to reuse our map services together with their own data," concludes Bliki. "We believe that the new approach of ArcGIS Online and map services seen as a product to everyone is going to change the international approach of serving environmental data."

More Information

For more information, contact Guenther Pichler, Esri (e-mail: gpichler@esri.com).

ArcGIS for INSPIRE: A Collaborative Geospatial Information-Sharing Solution for the European Union

The Infrastructure for Spatial Information in Europe (INSPIRE) is chartered by a European Union (EU) directive and is intended to give EU member states the ability to share geographic information through an Internet-accessible infrastructure. INSPIRE will act as a foundation for producing, sharing, and consuming geospatial information, improving decision making and operations with respect to issues affecting Europe as a whole.

For European countries and organizations that need to implement this infrastructure, Esri has created ArcGIS for INSPIRE, a solution that supports the evolution from existing geospatial solutions to a fully operational, INSPIRE-compliant spatial data infrastructure (SDI). ArcGIS for INSPIRE provides a comprehensive, integrated technology base that ensures successful participation in the EU geospatial information-sharing community and takes out the complexity of implementing an SDI.

With ArcGIS for INSPIRE, Esri is providing a complete solution for an SDI in Europe. The solution is extensible and supports the needs of both INSPIRE data and service providers, as well as consumers, allowing them to

- Manage, publish, and discover INSPIRE-compliant data and metadata, as well as transform existing data to conform to INSPIRE initiatives.
- Provide INSPIRE-compliant view and download services.
- Consume geospatial data and services that comply with INSPIRE directives.

ArcGIS for INSPIRE is an extension to the ArcGIS system. The solution includes the ArcGIS Server Geoportal extension, which allows organizations to manage and publish metadata for their geospatial resources. The Geoportal extension not only supports standards-based clearinghouse and metadata/service directory applications but is now also open source. This continues the software's evolution to support users who need integration with various content management systems, map viewers, and other software.

Users can license ArcGIS for INSPIRE to supplement their existing ArcGIS implementation or begin creation of their own SDIs by implementing an ArcGIS system, being assured that their software is both INSPIRE compliant and compatible with open source solutions they may already use. ArcGIS for INSPIRE has been developed based on experience gained during the implementation of the SDI in a number of European countries, including Portugal, Lithuania, and Croatia.

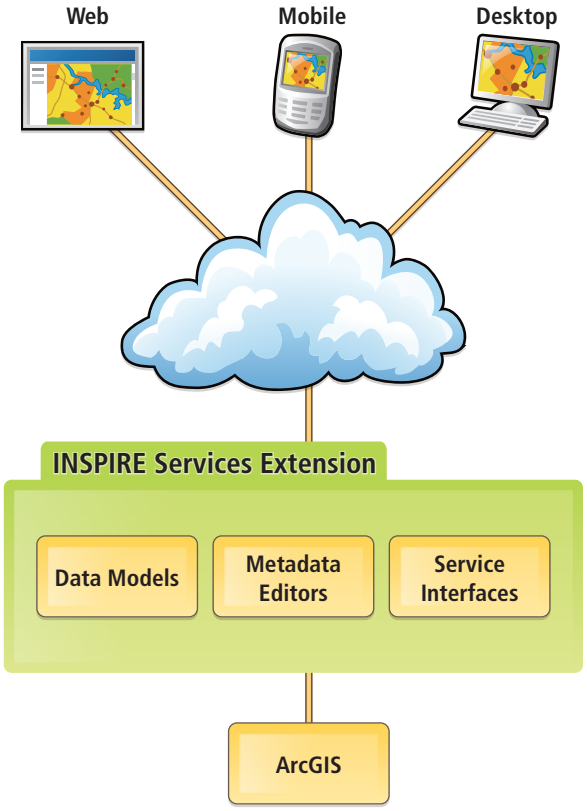
Portugal—Early Adopter of SDI and INSPIRE

Portugal is an example of a country that adopted an SDI early on and is now offering INSPIRE-compliant data and services throughout the country. Established 18 years ago through Decree-Law, Sistema Nacional de Informação Geográfica (SNIG), Portugal's national geographic information system, was the first national SDI in Europe and is maintained by the Instituto Geográfico Português (IGP). SNIG has helped shift GIS implementation in the country to more collaborative production and dissemination of geographic information using the Internet, user groups, and mobile technologies.

SNIG is the tool used to discover, understand, and explore the geographic wealth in Portugal. This is accomplished through a geocommunity that serves as a meeting point for users to exchange knowledge through a forum, entrances created for specific thematic data networks, and provision of education about SNIG. Through this geocommunity, users collaborate and exchange ideas and knowledge about geographic information. The *Official Administrative Boundaries Map,* a fire risk assessment map, and a set of maps produced for the *Atlas of Portugal* are a few examples of the Web services used by the geocommunity.

SNIG is one of the first SDIs to have a fully operational portal and is built on ArcGIS Server and the ArcGIS Server Geoportal extension.

SDI in Portugal today means that GIS is more than simple land representation through cartography; it is important to collect, organize, store, retrieve, and explore spatial data to create action. "We understand that more important than having data repositories, we must have dynamic information flowing through the channels," says Professor Doctor Rui Pedro Juliao, the deputy director-general for IGP.



The need to collaborate and share data across national boundaries has driven the European Union to implement the Infrastructure for Spatial Information in Europe (INSPIRE) initiative. ArcGIS for INSPIRE is designed to simplify that collaboration.

Lithuania Connects Data Providers into a United National SDI

The Lithuanian Geographic Information Infrastructure (LGII) was created to connect major national spatial information providers to a spatial information infrastructure. LGII is an open, shared National Spatial Data Infrastructure (NSDI) for accessing and distributing geographic information products and services online. The solution connects major public-sector information sources through a single Internet portal (www.geoportal.lt) that was launched in 2009.

HNIT-BALTIC, UAB, Esri's Lithuanian distributor, worked with German firm con terra GmbH to create a system to effectively manage, integrate, and manipulate the multitude of diverse data layers and create a user-friendly, front-end Web portal to view and distribute the data. The system—based on ArcGIS Server, including the ArcGIS Server Geoportal extension; IBM's WebSphere; and FME, a spatial

extraction, transformation, and loading (ETL) solution from Safe Software Inc.—provides the ability to translate, transform, integrate, and distribute spatial data so users can continue to work in their native GIS formats.

Data providers include 10 Lithuanian government institutions and enterprises that are connected by a centralized national metadata system and the federal geographic data system, which are based on a uniform reference data model and standards. Both systems conform to INSPIRE initiatives.

Users can access the LGII portal anytime to discover data offerings and acquire whatever specific dataset they may need for their business tasks. Once in the system, the user simply selects the desired area from a map view, chooses the data layers required, and specifies the particular GIS output parameters by selecting from 18 different data formats and 10 coordinate systems.

"People in Lithuania have newfound knowledge now, and that knowledge is power," says Mindaugas Pazemys, deputy director, GIS-Centras. "Rather than being consumed by trying to find data, public and private users can now focus on how to capitalize on that data and develop revenue-generating applications or services. That's working smarter and ultimately leads to economic growth."

In Croatia, Simplifying Access Leads to Growth

The Republic of Croatia has simplified access to countrywide geographic data through an online geoportal, a type of Web site that makes it easier for citizens, government, and private-sector users to find and access vast quantities of geographic information and related services. The geoportal has already proved its value as an essential component of the country's Organized Land Project, which streamlines and regulates the real property registration of land in the republic. By making data more accessible, the average time for processing changes to land titles has dropped from a 400-day average to 37 days.

The geoportal is hosted by the State Geodetic Authority (SGA) of Croatia and can be found at **www.geo-portal.hr/Portal**. Dr. Zeljko Bacic, head of SGA, states, "Simple access to geospatial data is the key prerequisite for an efficient and economically prosperous society. The geoportal in active operation means that other governmental organizations can [not only] use SGA data but also make their data accessible. This is the first step to establishing a Croatian national geoportal as part of a national SDI."

Modeled after the INSPIRE directive, SGA is able to support the discovery and purchase of national data through the geoportal while also providing strict access control and data quality policies. Data available through the geoportal includes digital orthophotos, basemaps, administrative units, and land survey information.

The geoportal was developed by Esri distributor GISDATA d.o.o. and con terra GmbH using Esri's ArcGIS Server Geoportal extension. The Geoportal extension provides the platform for organizations to quickly access geospatial resources regardless of location or type.

"The implementation of this portal is enabling a change in behavior from a restrictive data policy to a more open, transparent, and efficient use of spatial information," says Andrej Loncaric, director of GISDATA in Croatia and the southeastern region of Europe.

More Information

For more information on ArcGIS for INSPIRE, visit **www.esri.com/sdi-in-europe.html**.

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