INSPIRE: An Innovative Approach to the Development of Spatial Data Infrastructures in Europe

Max Craglia and Alessandro Annoni
Joint Research Centre of the European Commission
Institute for Environment and Sustainability
Spatial Data Infrastructures Unit
TP 262, Via Fermi 1
20120 Ispra (VA)- Italy
Massimo.Craglia@jrc.it, Allessandro.Annoni@jrc.it

Abstract

The analysis of the development of spatial data infrastructures across the world indicates a shift from a first generation that was product-oriented and focused on the development or completion of spatial data bases, towards a second generation that is more process-oriented and emphasizes partnerships and stakeholder involvement. Nevertheless most spatial data infrastructures to date are led by public sector organizations with a limited involvement by the private sector or society at large. Moreover the involvement of user groups is often sporadic and poorly organized. With this in mind, the paper discusses the approach taken in developing INSPIRE, a spatial data infrastructure for Europe, which is innovative in two respects: firstly because from the outset it seeks to build the infrastructure based on existing developments at the national and sub- national levels, and secondly, because it tries to engage in a more structured way the user communities and geographic information stakeholders by organizing them through spatial data interest communities. This approach poses a number of challenges at both technical and organizational levels but also offers a number of important opportunities in terms of sustainability and future use of the infrastructure.

Introduction

The analysis of the development of spatial data infrastructures (SDIs) across the world indicates a shift from a first generation that was product-oriented and focused on the development or completion of spatial data bases, towards a second generation that is more process-oriented and emphasizes partnerships and stakeholder involvement. In respect to the coordination activities, which are crucial to the development and management of an SDI, the first generation was largely led by the national mapping agencies while the second generation has seen an increasing role been played by different organizational models which are often independent of the mapping agencies and seek to be more representative of the stakeholder communities.

Adopting this analytical framework to the analyses of developments in Europe confirms the shift from a product-centered to a process-centered approach. Nevertheless most spatial data infrastructures to date are led by public sector organizations with a limited involvement by the private sector or society at large. Moreover the involvement of user groups is often sporadic and poorly organized.

With this in mind, the development of a spatial data infrastructure for Europe, INSPIRE, led by the European Commission is innovative in two respects: firstly because from the outset it seeks to build the infrastructure based on existing developments at the national and sub- national levels, and secondly, because it tries to engage in a more structured way the user communities and geographic information stakeholders by organizing them through spatial data interest communities. This approach poses a number of challenges at both technical and organizational levels but also offers a number of important opportunities in terms of sustainability and future use of the infrastructure.

The paper is organized as follows: the next section reviews the literature on spatial data infrastructures discussing the nature of these initiatives and the shift from first to second generation SDIs. Using this framework it then evaluates the findings of a recent survey of SDIs in 32 European countries highlighting current trends, opportunities and challenges. The section that follows introduces INSPIRE and the process that is taking place for the development of this initiative, focusing specifically on the characteristics of the Spatial Data Interests Communities that are contributing to its development. The last section discusses the opportunities and challenges that this approach entails.

The changing nature of SDIs

The development of SDIs has been increasingly documented by a number of studies, including Masser (1999, 2005), Williamson et al (2003), Craglia et al (2003), Vandenbroucke (2005), Crompvoets and Bregt (2003).

Whilst there are many definitions of SDIs, a useful framework is the one put forward by Rajabifard et al. (2003) (see Figure 1), which places particular emphasis on the dynamic relationship between data, people, and a package that includes technology policy and standards. The authors argue that the relationship between these categories is dynamic because changes of communities and society (people) and their needs require access to different sets of data mediated by the ever changing technology. The interactions among these components in turn put new demands on rights, restrictions and responsibilities enshrined in policy. This dynamic nature of SDIs poses a number of challenges for their development and maintenance as there is a constant need for interpreting and responding to political and technological changes and new user needs, which may have been unforeseen at the initial stage of the SDI. Whilst there are well-documented challenges in the design, implementation and maintenance of information systems that are confined within the bounds of an organization and respond to clearly-defined applications and user groups (see for example, Jirotka and Goguen, 1994; Dittrich et al. 2002), additional challenges exist in the context of SDIs because their Internet-based nature makes it more difficult to identify user communities and hence respond to their needs. This is also why the coordination aspects of an SDI are so critical. Without effective coordination, it is possible to have different components in place: reference data, metadata, clearinghouses, but no cohesive whole.

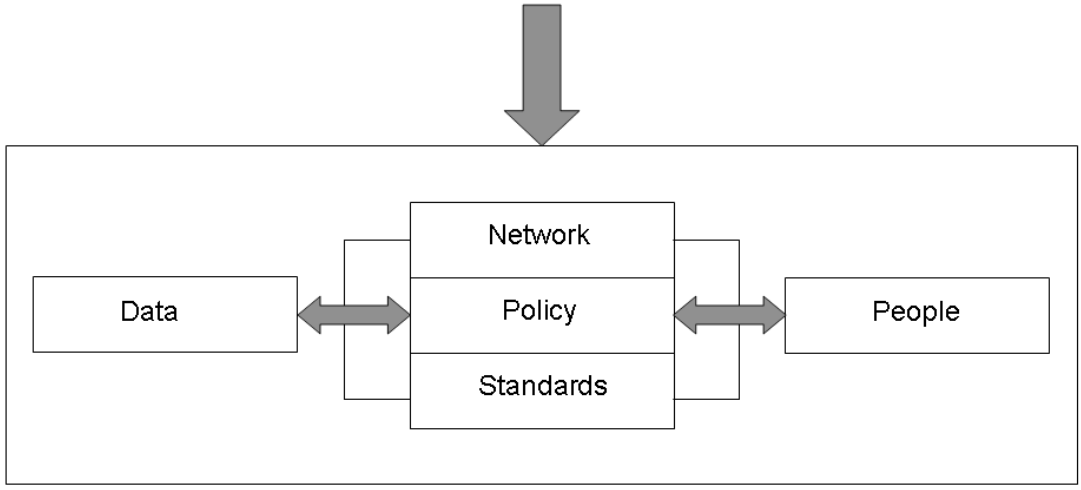

Figure 1: Nature and Relations Between SDI Components (source Rajabifard et al. 2003a, pg. 27.)

The crucial importance of coordination was already recognized from an early review on international experiences in 2002-03 (Craglia et al., 2003) where it was argued that:

> *Coordination is one of the most important aspects in the development of an SDI,… [and includes]*
> *• leadership,*
> *• mediating inter-agency conflicts,*
> *• sustaining political support,*
> *• selling the benefits to multiple audiences,*
> *• providing technical guidance and enforcement of common standards,*
> *• raising awareness and disseminating the results.*
>
> *In addition coordination can also play a very useful role in identifying gaps or inconsistencies in the legal and organisational framework, and suggesting remedial action to the government. This is particularly important as the legal framework within which SDIs operate is strongly affected by many other policy areas, such as Public Sector Information legislation, Freedom of Information, international conventions (e.g. Aarhus), competition law, and so on. Moreover all these areas of policy may have some variation not only at national but also across sub-national levels (pg 240)*

Therefore, the more dynamic the social, political, and technological environment in which the SDI is embedded, and the more distributed the framework upon which it is built, the greater the need for coordination.

A complementary perspective through which to analyze the importance of coordination comes from the review of the diffusion process of SDIs and their evolving nature to respond to social and technological change. Masser (2005) frames his review of SDIs through the classical diffusion model originally put forward by Rogers, who defines diffusion as "the process by which an innovation is communicated through channels overtime among the members of the social system"

(Rogers 1995). This model takes the form of a bell-shaped curve with innovators and early adopters at the beginning of the process followed by an early majority, late majority and laggards at the tail end. In this respect Masser argues that the eleven SDIs he reviewed in 1998 represent the group of innovators and early adopters. Amongst these, were Canada and the United States in the Americas, Qatar, Indonesia, Japan, Australia, and Korea, in Asia, and a small group of European countries like Netherlands, Portugal, and the United Kingdom. In spite of their differences in size wealth, scope, and organization, this group was defined as representing the first generation of SDI which was characterized as having a specifically national focus, an emphasis on the development of spatial data bases, and often (but not always) leadership provided by the national mapping agencies.

The transition towards the second generation of SDIs, or the early majority in the Rogers model, is placed by Rajabifard et al. (2003) around the year 2000 with the development and consolidation of an SDI community (the social system in Roger's definition) including the establishment of a series of conferences at the international and global level, the publication of shared experiences in the SDI cookbook and in general terms the strengthening of those channels of communications that in the model of Roger's are enabling the diffusion process. This second generation of SDIs is characterized by an increasing recognition of the other stakeholders of geographic information within society. Hence the emphasis moves from the development of products towards a process that emphasize partnerships, agreements and a broader set of applications. This in turn tends to move the leadership of the SDI from data producers towards new organizational models which are generally independent and designed to be representative of these different stakeholders. It could be argued that the sharing of experiences as well as the consolidation of technologies and standards such as ISO, and OGC have also enabled newcomers to pay more attention to the institutional and organizational arrangements than having to worry about technology. Table 1 summarizes the key features of the two generations of SDIs.

In the European context a comprehensive study of SDIs in 32 countries has been undertaken by the University of Leuven in 2003, 2004, and 2005 in a project funded by the European Commission. In his overview of the 2005 results, Vandenbroucke identified the following key features:

1. An increasing contribution of the regional and local levels for building the National SDI and activities related to it,

2. A greater involvement of stakeholders other than the main data producers,

3. An increasing adoption of international standards and specifications (ISO, OGC), and availability of web-based services and portals.

Nevertheless, Vandenbroucke also notes that "the large majority of countries do not yet have an integrated approach in which the tasks for building and maintaining the NSDI are well defined and divided amongst the different stakeholders" (page 12), and that: "One of the conclusions that can be drawn … is that clear mandates for building (parts) of the components of the NSDI are often lacking or that some mandates are rather fuzzy in relation to the NSDI" (page 1).

Similarities and Differences	1st Generation	2nd Generation
Nature	Explicitly National	Explicitly National within the hierarchical context and therefore more flexible for cross jurisdictional collaboration
Development Motivation	Integration of Existing Data	Establishing the Linkage between People and Data
Expected Outcomes	Linkage into a Seamless database	Knowledge Infrastructures, Interoperable Data and resources
Development Participants	Mainly Data providers	Cross-Sectoral (provider, integrators, users)
Funding/Resources	Mainly no specific or separate budget	Mostly include in National Mapping program, or having separate budget
Driving/coordinating Agency	Mainly National Mapping Organisations	More independent organisational committees/ Partnership groups
Awareness	Low awareness at the beginning, gradually learning more	More aware, knowing more about SDI and its requirements
Capacity Building	Very low	Communities are more prepared to engage in on-going activities
No of SDI Initiatives	Very limited	Many more
SDI Development Model	Predominantly Product-based	Increasingly Process-based, or hybrid Product-Process approach depending on the jurisdiction
Relationship with the other SDI levels and International Initiatives	Low	Much more
Measuring the Value of SDIs	Productivity, savings..	Holistic socio-cultural value as well as measuring the expense of not having an NSDI

Table 1: Key features of the two generations of SDIs (source Rajabifard et al. 2003b, pg. 106)

Vandenbroucke classifies the countries surveyed into two groups: in the first group, a national data provider (National mapping and/or Cadastral Agency) is the officially mandated or de facto leading organization for the establishment of the NSDI, with a further subdivision depending whether users are involved or not; in the second group, NSDI initiatives are led by a council of ministries or administrative departments, by a (non governmental) GI-association, or other type of partnership of mainly data users. This group is further subdivided according to the presence or absence of a legal or otherwise formal mandate for the SDI-coordination (ibid, page 15).

This classification mirrors to a large degree the two generations identified by Masser (2005) and Rajabifard et al. (2003). Hence, we can re-classify the 32 European countries in Vandenbroucke's study into three categories of similar size relating to the first generation (data-producer led, users not involved), second generation (user led)

and transition between the two in which users are involved but do not lead the process.

Whilst the generational view of SDI and the diffusion process is helpful to understand the evolution of the infrastructures and the new challenges that this poses, Rogers himself recognized the pro- innovation bias of his model, in other words the tendency to assume a linear transition between one stage and the next. This is clearly not the case in respect to infrastructures embedded in social and political processes such as SDIs. For example the Portuguese infrastructure launched on the Internet in 1995 has suffered for almost five years very limited progress due to budgetary constraints and a reorganization of the coordinating structures (Juliao, 2005). Similarly the United Kingdom which featured as one of the first generation SDI in the review by Masser (1999) has suffered setbacks and is now fragmenting with independent strategies for Scotland, Wales and Northern Ireland, while England struggles to define and implement its own strategy due to the lack of overall political leadership in this field (Masser, 2005). Even in the United States, which were seen by many as the leading example particularly for the high level political commitment enshrined in President Clinton's Executive Order, progress has not been without difficulty. Engaging state and local jurisdictions as well as the private sector to develop a truly national SDI has been particularly problematic as recognized in a number of reports (Urban Logic, 2000; National Research Council, 2001). For example a study undertaken by Harvey and Tullock (2003), at the local level shows that almost half of the local organizations contacted did not know about the NSDI and it did not rely on the use of any standard for their geospatial activities, leading the authors to conclude that a data centric view of the infrastructure is unlikely to succeed and that much more emphasis is needed on establishing and supporting social networks.

The conclusions of this review of the literature indicate that the changing nature of SDIs requires an increasing involvement of stakeholders and user communities not just in the public sector but also in the private sector and society at large. More effort is therefore needed in building and maintaining social networks, understanding needs and evaluating social impacts, and delivering results which demonstrably add value to both operational and strategic activities of heterogeneous user groups with often conflicting objectives. This in turn puts even more emphasis on the coordination aspects of the SDI and a social-orientation of the infrastructure than was hitherto the case. Addressing these challenges in the multicultural and multilingual context of Europe is particularly difficult and requires a fresh approach as discussed in the following sections.

INSPIRE

INSPIRE is a proposed European Directive establishing the legal framework for setting up and operating an Infrastructure for Spatial Information in Europe based on infrastructures for spatial information established and operated by the Member States. The purpose of such infrastructure is in the first instance to support the formulation, implementation, monitoring, and evaluation of Community environmental policies. The component elements of those infrastructures include:

- metadata,
- key spatial data themes and spatial data services;
- network services and technologies;

- agreements on sharing and access;
- co-ordination and monitoring mechanisms,
- process and procedures.

The background purpose and general organization of the INSPIRE proposal have already been described by Annoni and Craglia (2005) at GSDI-8, but it may be worth recalling that this initiative intends to overcome key barriers still affecting Europe in spite of the progress in SDI developments discussed earlier. These barriers include:

- inconsistencies in spatial data collection: spatial data are often missing or incomplete or vice versa the same data are collected twice by different organisations,
- lacking documentation: description of available spatial data is often incomplete,
- spatial data sets not compatible: spatial data sets can often not be combined with other spatial data sets,
- incompatible geographic information initiatives: the infrastructures to find, access and use spatial data often function in isolation only,
- barriers to data sharing: cultural, institutional, financial and legal barriers prevent or delay the sharing of existing spatial data.

From the outset of this initiative it was recognized that to overcome some of the barriers highlighted above it would be necessary to develop a legislative framework requiring Member States to coordinate their activities and agree on a minimum set of common standards and processes. This in turn requires the wide support of the Member States to the objectives of INSPIRE. Therefore, a very collaborative process was put in place to formulate the INSPIRE proposal. This process in particular involved the establishment of an Expert Group with official representatives of all the Member States, and Working Groups with expertise in the fields of environmental policy and geographic information to formulate proposals and forge consensus. From this process, it was agreed that the key principles of INSPIRE should be:

- that spatial data should be collected once and maintained at the level where this can be done most effectively,
- that it must be possible to combine seamlessly spatial data from different sources across the EU and share it between many users and applications,
- that it must be possible for spatial data collected at one level of government to be shared between all the different levels of government,
- that spatial data needed for good governance should be available at conditions that are not restricting its extensive use,
- that it should be easy to discover which spatial data is available, to evaluate its fitness for purpose and to know which conditions apply for its use.

Following three years of intensive consultation among the Member States and their experts, a public consultation, and the assessment of the likely impacts of INSPIRE (see http://inspire.jrc.it), the European Commission adopted the INSPIRE proposal for a Directive in July 2004 (CEC, 2004). This proposal is currently going through the co-decision procedure of the European Union which requires the joint approval of the European Parliament, which is directly elected by European citizens, and the Council, which represents the Member States.

The European Parliament expressed its favourable opinion on the Commission's proposal in June, 2005 and introduced a number of amendments that clarify the proposed legislation. The Council adopted a common position in January, 2006 introducing a number of limitations to the data sharing arrangements put forward by the Commission. The text analysis of the original proposal and of the one adopted by the Council undertaken by Corbin (2006) (see Table 2) clearly shows the change in emphasis between the two and demonstrates once more that SDIs are strongly embedded into a political process which touches upon the different ways in which public sector organizations in general, and data producing ones in particular, are funded in the member states.

10 words or phrases used by the Commission that are not used in the Council draft	**10 words and phrases not used by the Commission but used by the Council**
accessibility	apply charges
commercial activities	click-licences
common licensing	corresponding fees
competition	cost-benefit
Decision 1692/96/EC25 *	excessive costs
distortion	limit sharing
focuses	payment
harmonised specifications	precondition
requisite	reciprocal
rights of use	viability

* (European Transport Networks)

Table 2: Comparison between Council and Commission INSPIRE text (source Corbin, 2006)

The second reading of the Commission's proposal by Parliament has taken place in March, 2006 and it is hoped that a solution balancing the positions of Parliament, Council and the Commission can be found by the end of the year. Whilst this process takes place, the Joint Research Centre of the European Commission and EUROSTAT are coordinating the drafting of the implementing rules envisaged by the directive[1].

Such implementing rules are needed for each of the key components of the infrastructure, namely: metadata, data specifications and harmonization, network services, data and service sharing, and monitoring and reporting. Given the political context of the proposal, their drafting requires not only a high level of technical competence but above all the participation and engagements of all the key stakeholders in geographic information in Europe. To organise this process two mechanisms have been put in place: the first, is to engage the organizations at European national and sub-national level that already have a formal legal mandate for the co-ordination, production, or use of geographic and environmental information. The second, is to facilitate the self-organization of stakeholders, including both data providers and users of spatial data, in Spatial Data Interest Communities (SDICs) by region, societal sector, and thematic issue. SDICs should naturally form strategic

[1] a Directive is a piece of legislation that defines the general principles and objectives to be met while leaving Member States to define their own way to reach these objectives through national legislation. Implementing rules include instead those technical details which are mandated by the Commission to all Member States to ensure the coherent implementation of the Directive.

partnerships: public-public, public-private, and private-private, to align the demand for spatial data and services with the necessary investments.

The central role that the SDICs play in the development of implementing rules includes:

- to identify and describe user requirements (to be understood as in line with environmental policy needs, as opposed to "maximum" requirements beyond the scope INSPIRE and beyond realistically available resources),
- to provide expertise to INSPIRE Drafting Teams,
- to participate in the review process of the draft Implementing Rules,
- to develop, operate and evaluate implementation pilot,
- to develop initiatives for guidance, awareness raising, and training in relation to the INSPIRE implementation.

In addition, the Legally Mandated Organizations (LMOs) 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 11th 2005 for the registration of interest by SDICs and LMOs who were also asked to put forward experts and reference material to support the preparation of the Implementing Rules. The deadline for the registration of experts was the 29th April 2005. By that date, the following had registered on the INSPIRE website:

- Spatial Data Interest Communities: 133
- Legally Mandate Organisations: 82
- Proposed Experts: 180
- Referenced Materials: 90
- Identified Projects: 91

The analysis of the LMOs (Figure 2) shows that the majority are national in character and dominated by producers of reference data. SDICs on the other hand, characterize themselves primarily as a research organizations and GIS coordinating bodies. It is important to notice that each SDIC bundles together many organizations representing different viewpoints and interests.

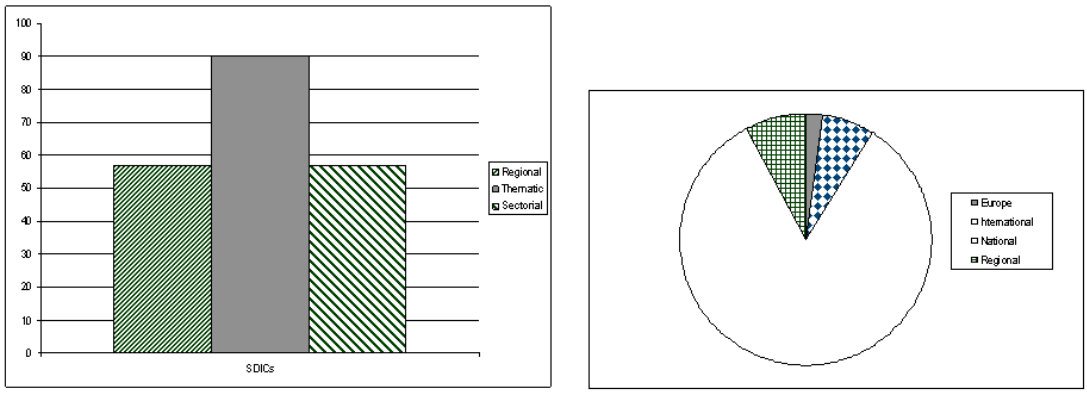

Figure 2: Key features of registered SDICs and LMOs

An example of SDIC organised by region is the GDI NRW that is a non-profit initiative of the state of North-Rhine Westphalia. In the GDI NRW, representatives of economy, administration and science work together in a Public-Private Partnership as geoinformation providers, enablers, brokers and user. The GDI NRW has more than 100 members, including various state authorities in North-Rhine Westphalia (land surveying office, geological survey, ministry of the environment etc.), about 20 local authorities, several research institutions and multiple business companies.

There are also interesting examples of SDICs organised by thematic issue such as the European Soil Bureau Network (ESBN), the European environment information and observation network (EIONET), the European Meteorological Infrastructure (EMI), and several others.

The ESBN, created in 1996 is a network of national soil science institutions. Its main tasks are to collect, harmonise, organise and distribute soil information for Europe, for which there is increasing demand to address a number of environmental problems and issues, including: leaching of agrochemicals, deposition of heavy metals, disposal of waste, degradation of soil structure, risk of erosion, immobilisation of radionuclides, supply of water at catchments level, assessing the suitability and sustainability for traditional and alternative crops, and estimation of soil stability.

The EIONET was established in 1990 and aims to provide timely and quality-assured data, information and expertise for assessing the state of the environment in Europe and the pressures acting upon it. The EIONET is a partnership network of the European Environment Agency (EEA), a number of European Topic Centres and a network of around 900 experts from 37 countries in over 300 national environment agencies and other bodies dealing with environmental information.

The European Meteorological Infrastructure (EMI) is an operational infrastructure established by the European National Meteorological Services to deliver information services to decision makers, customers and users throughout Europe. EMI is part of the World Meteorological Organization telecommunication system for the European Region.

These few examples show not only the thematic breadth of the SDICs contributing to the definition of INSPIRE, but also the extent to which the development of this spatial infrastructure needs to build on other infrastructures already existing in the different communities of interest, making sure that it can interoperate effectively with their architectures, technologies, standards and protocols, and organizational frameworks.

Whereas the communities described above already exist, the INSPIRE open call also forced several organisations to create new groups of interest or to join existing ones. As a consequence, many user groups that were often not considered by data producers in strategic decisions are now invited to be part of the SDICs and start to have greater influence in the processes defining data priorities and needs.

The number of SDIC and LMOs has continued to increase since April, 2005 as the awareness of the INSPIRE process increases, and as of March 2006 includes 160

SDICs and 98 LMOs, while the number of registered projects and reference material has almost doubled passing the 300 mark.

Of significant interest is the high number of experts (180) proposed by the SDICs and the LMOs. Considering that the experts proposed are not paid by the European Commission, but are supported instead by the organizations and communities that have nominated them, these figures indicate the degree of success of the call, and the extent of support offered toward the implementation of INSPIRE.

From the large pool of experts available, some 70 individuals where selected on the basis of their experience and with a view to balance the perspectives of data producers, users, and solution providers from the private sector. On the basis of this selection, and the advice of the representatives of the Member States, five Drafting Teams were established, one for each of the implementing rules: metadata, data specifications, network services, data and service sharing, and monitoring and reporting. They started operations in October, 2005 and already demonstrate how European-wide legislation can be developed with stakeholder contributions.

Three aspects are particularity important in 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 the thematic communities that are addressed by INSPIRE. This is no small undertaking as the proposed Directive covers more than 30 different data themes, including reference data and environmental data themes which are the responsibility of multiple agencies at national regional and local level across 25 countries. As a matter of comparison it is worth reminding that the US NSDI defined only seven framework themes: geodetic control, orthoimagery, elevation, transportation, hydrography, governmental units, and cadastral information, for each of which it is possible to identify a Federal agency taking the lead in data collection and management. This is not the case in Europe where there are no European-level institutions in charge of data collection.

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 which satisfy user requirements without imposing 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 the ownership of their work. They make the recommendations and submit them to 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 European Commission takes ownership of the draft implementing rule, and submits it to public consultation for further review.

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

Analysis and Conclusion

The review of the literature on spatial data infrastructures has indicated a shift from product-oriented SDIs, towards process-based initiatives that emphasise partnerships, social networks, and multi-sectoral collaboration.

INSPIRE extends this process by engaging hundreds of stakeholder organizations across Europe already from the drafting stages of the legislative framework. Involving all the interested parties from the very beginning and giving them at leading role in shaping the infrastructure is in line with best practice and the literature on participatory approaches (e.g. Arnstein, 1969; Thomas, 1996), which emphasize the importance of moving from mere tokenism, towards real empowerment. Moreover the establishment of a social network of key stakeholders in different regions and thematic areas provides an opportunity for the long-term sustainability and use of the infrastructure. At the same time it is necessary to recognize the complex challenges that such an approach entails. Like many pieces of European legislation INSPIRE is a long process spanning some fifteen years from inception to full implementation. Sustaining the momentum, mediating the different interests, coordinating the activities, managing the expectations, and delivering meaningful value to all the stakeholders is a very complex undertaking particularly when embedded in the constantly changing political and technological environment.

In addition to its internal organizational challenges (SDICS and LMOs), the development of INSPIRE must also manage its organizational and technical relationships with the SDIs developed within Member States at national and sub-national levels, important other European initiatives such as e-government, other thematic information networks and infrastructures such as those of the International Hydrographic Organization, and the World Meteorological Organization, and other global initiatives such as GSDI, and GEOSS, a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) (http://earthobservations.org/). This requires a particular effort in respect to coordination with all these initiatives, identification of synergies, and of the minimum degree of harmonization (of data, and practices) and interoperability of services needed to achieve the INSPIRE objectives of supporting the European policy.

Last but not least, the drafting of the INSPIRE implementing rules needs to balance the dynamic process of change in technologies, practices and requirements across these different geographic and thematic layers with the need to encode agreements into legal text backed up where necessary by standards at the European (CEN) or the international level (ISO), and industrial specifications and implementations. The tension between the need to accommodate change, and hence retain flexibility, and the need to "freeze" practices and agreements into standards and legislation to ensure the stability necessary for implementation characterizes all SDIs and in fact all information infrastructures (Hanseth and Lyytinen, 2005) but the complexity of the participatory process set in place by INSPIRE, and the multiplicity of actors, languages, and cultures present makes this aspect of the infrastructure design and maintenance particularly important to address.

In conclusion, we have emphasized the importance of building a modern spatial data infrastructure through a combination of bottom-up participatory approaches across multiple stakeholder communities, and careful coordination backed up by a legal

framework. Creating a broad social network with empowered stakeholders, and building on existing infrastructures, professional practices and agreements, are central features of the INSPIRE approach for a sustainable spatial data infrastructure. This approach nevertheless entails multiple challenges of which we are aware and which we are striving to address together with our partners.

References

Annoni A. and Craglia M. 2005. Towards a Directive establishing an infrastructure for spatial information in Europe (INSPIRE) in *Proceedings of GSDI-8 From Pharaohs to Geoinformatics - The Role of SDI's in an Information Society*, Cairo, April 16-25th, http://gsdidocs.org/gsdiconf/GSDI-8/papers/ts_47/ts47_01_annoni_graglia.pdf

Arnstein S. R. 1969. A ladder of citizen participation. *Journal of American Institute of Planners*, 35 (4), pp. 216-224.

Commission of the European Communities. 2004. Proposal for a Directive of the European Parliament and of the Council establishing an infrastructure for spatial information in the Community (INSPIRE), COM(2004)516 final. Brussels, Commission of the European Communities.

Corbin C. 2006. INSPIRE Word-Phrase Analysis v. 1. Document posted to the european-gi-policy@jrc.it list on 2nd March 2006.

Craglia M. et al. (Eds.) 2003. *GI in the Wider Europe*. http://www.ec-gis.org/ginie/doc/ginie_book.pdf

Crompvoets J. and A. Bregt. 2003. World status of national spatial data clearinghouses. *URISA Journal* 15:43-50.

Dittrich, Y., C. Floyd, and R. Klischewski, (Eds.). 2002. *Social thinking, software practice*. London, MIT.

ESA, 2005. Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan. ISBN 92-9092-495-0. http://earthobservations.org/

Harvey F. and D. Tulloch 2003. Building the NSDI at the base: establishing best sharing and coordination practices among local governments. http://www.tc.umn.edu/~fharvey/research/BestPrac7-03.pdf

Hanseth O. and Lyytinen K. 2005 Theorizing about the design of Information Infrastructures: design kernel theories and principles. Paper presented at the 1st Workshop on Cross learning Research Workshop on Cross-Learning between Spatial Data Infrastructures (SDI) and Information Infrastructures (II), ITC, Enschede, 30-31 March 2005.

Jirotka, M and J. A. Goguen, (Eds.) 1994. *Requirements engineering: social and technical issues.* London, Academic Press.

Juliao R. P. 2005. Rebuilding n SDI: the Portuguese Experience: presented at *11th EC-GIS Workshop*, Alghero, 2th June- 1st July, http://www.ec-gis.org/Workshops/11ec-gis/presentations/14juliao.pdf

Masser I. 2005. *GIS Worlds: creating spatial data infrastructures*. Redlands: ESRI Press.

Masser I. 1999. All shapes and sizes: the first generation of national spatial data infrastructures. *International Journal of Geographical Information Science* 13:67-84.

National Research Council 2001. National Spatial Data Infrastructure Programs: Rethinking The Focus. Washington D.C.: National Academy Press.

Rajabifard A, M.E F. Feeney and I. Williamson. 2003a. Spatial Data Infrastructures: Concept, Nature, and SDI Hierarchy. In Williamson I., A. Rajabifard A. and M.E F. Feeney (Eds.) pp. 17-40.

Rajabifard A, M.E F. Feeney, I. Williamson and I.Masser. 2003b. National SDI Initiatives. In Williamson I., A. Rajabifard A. and M.E F. Feeney (Eds.) pp. 95-109.

Rogers E. 1995. *Diffusion of Innovations* 4th edition. New York: Free Press.

Thomas, H. 1996. Public Participation in Planning. In Tewdwr-Jones, M. (Ed.) *British Planning Policy in Transition: planning in the 1990s*. London, UCL Press, pp. 168-188.

Urban logic. 2000. *Financing the NSDI: national spatial data infrastructure*. www.fgdc.gov.

Vandenbroucke D. 2005. *Spatial Data Infrastructures in Europe: State of Play, Spring 2005*. K.U. Leuven. http://www.ec-gis.org/inspire/reports/stateofplay2005/rpact05v42.pdf

Williamson I., A. Rajabifard A. and M.E F. Feeney (Eds.). 2003. *Developing spatial data infrastructures: from concept to reality*. Boca Raton, FL.: CRC Press.