SDI, Communities and Social Media

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Czech Centre for Science and Society

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Preface: SDI, Communities & Social Media

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Spatial Data Infrastructure (SDI), communities and social media are three different terms. What do they have in common? At first all these terms are very modern and trendy now. They are very often used not only in technical publications but these words and collocations are also used by the public. It is possible to say that primarily social media could be described as buzzword (fashion word and vogue word).

The excessive and inexpert use of these terms is the reason why we try to define all of them in the preface of the book.

- The Merriam-Webster Dictionary defines social media as the forms of electronic communication (as Web sites for social networking and microblogging) through which users create online communities to share information, ideas, personal messages, and other content (as videos). To meet other definitions it is possible to visit the web page 30 Social Media Definitions by Heidi Cohen.
- The same source as in previous case offers many definitions of the word ‘community‘. For purposes of this book the definition ‘a body of persons of common and especially professional interests scattered through a larger society‘ is the most suitable.
- The definition of SDI was taken over from the INSPIRE Glossary that represents the essential of terminological set of the European INSPIRE directive which constitutes one of the main topic of this book. Spatial Data Infrastructure (of infrastructure for spatial information) means metadata, spatial data sets and spatial data services; network services and technologies; agreements on sharing, access and use; and coordination and monitoring mechanisms, processes and procedures, established, operated or made available in accordance with this Directive.

The focus on groups (not on individuals) is the second common character. Neither social media nor Spatial Data Infrastructure cannot exist without a connection and cooperation of communities. The various communities are authors (creators) as well as users of information and knowledge related to SDI or social media. The following list shows some consequences among all three terms:

- Social media are able to provide information that are needed by communities as well as by SDI.
- And vice versa social media can publish information offered by SDI and communities.
- SDI and communities are connected via spatial data and services processed and distribute spatial data sets. Communities provide (share) spatial data as well as services and on the other hand they are able to re-use existing data and services offered by particular SDIs.
- SDI can also absorb and process the data and information from communities and social media and develop and provide the new data, information and knowledge.

This book ‘SDI, Communities & Social Media‘ introduce another consequences and common aspects among the above-mentioned terms. The experts on various scientific disciplines (e.g. geoinformatics, geomatics, information technologies) described their activities and experience connected with SDI, communities and social media.

The book contains eleven chapters (except preface). They are focused on many various topics like spatial data, neogeography, transport systems or geographic information systems. As well the results of large international projects such as Plan4all, Habitats or NaturNet Plus are presented.

Last of all we wish you pleasant reading and a lot of new and interesting information and pieces of knowledge.

Toward an informal Spatial Data Infrastructure: Voluntary Geographic Information, Neogeography, and the role of citizen sensors

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Introduction

Location-based services, social media, and the growing opportunities for overcoming information fragmentation through the inter-connectivity provided by WWW 2.0 and Application Programming Interfaces (APIs) promises to revolutionize more traditional Spatial Data Infrastructures (SDI). Conceived as a framework of authenticated spatial data with embedded metadata and established standards, SDIs have been the backbone of the GIS community for some time with nodes managed by government agencies and key database stakeholders. The rise of Neogeography, premised as it is on the WWW 2.0, social media, location-intelligent mobile devices, open source map data, and mapping software, poses significant challenges to this traditional order. Breath-taking technological advances, open source internet applications and web data services, along with published open-source APIs provide major opportunities for communities to participate, contribute, and draw upon spatial data and processing services traditionally confined to an expert community. Furthermore, in closing the gap between data providers and data consumers, this emerging community of citizen sensors is capable of providing vast quantities of real-time, geo-tagged media that can enhance and infill much of the geography that created the 'no data-no geography' conundrum faced by the GIS community. However, in so doing, citizen sensors and Volunteered Geographic Information (VGI) challenge the traditional vision of SDI in the core areas of standards, metadata, data management, authenticity, and verification which are the hallmarks of established SDI. This paper unwraps some of these critical threads in a fast evolving field of spatial crowd-sourcing and evaluates the potential contribution and challenges that arise from this emerging fusion of spatially empowered grass-roots communities and volunteers with existing SDI frameworks.

An evolving SDI framework: standards, protocols, and portals

As GIS has evolved into a recognized and established mainstream technology there has been increasing focus by industry, government, and academe on data standards, interoperability, and what has become Spatial Data Infrastructures (SDI). Because of the constraining effect of proprietary data formats so prevalent in early commercial GIS software, and the difficulty experienced in sharing and reusing spatial data, an early focus of the GIS community was on data interoperability and spatial data standards. The need for greater flexibility, access, and openness drove the GIS community toward standards. Initially, issues of interoperability focused heavily on spatial data sharing and metadata. Subsequently, the emphasis has shifted toward establishing standards for system and services protocols. As Cowen comments, 'Whether we are talking about light bulbs or video tape, a user must be able to acquire a product with the assurance that it is going to work properly' (Cowen, 2008). Until 1992 the transfer of proprietary data between systems in the US was facilitated through the USGS development of the Spatial Data Transfer Standard (SDTS). The SDTS remains mandatory for federal agencies to this day (Cowen, 2008). The utility and value of spatial data to the geospatial community, and especially to government and industry, was multiplied many-fold in the 1990s through the US Federal Geographic Data Committee (FGDC) implementation of data interoperability standards and its facilitation of data sharing portals. As the demand for GIS has grown and e-government initiatives and economic pressure to recover investments have grown, the heavy emphasis on data interoperability has given way to bridging islands of GIS resources and to the sharing of GIS services across multiple platforms, servers, institutions, and countries (Kuhn, 2005).

Metadata, the all-important 'data about the data', provides the critical component in data interoperability by providing details of the data source, its attributes and content, its scale and accuracy, its original purpose, where users can access it, and its bounding coordinates (Guptill, 1999; Salge, 1999). Metadata captures in an XML document the common characteristics of 'who', 'what', 'why', 'when', and 'how' of a dataset. These attributes provide not only a catalog of data resources but are the basis upon which data search and retrieval procedures are performed as part of a 'distributed discovery mechanism for national digital geospatial data' (http://www.fgdc.gov/metadata). Some would suggest that promulgating metadata standards was the single most important component of the FGDC program (Cowen, 2008). Several metadata tools have been created to support metadata capture and many software vendors now incorporate metadata creation and editing functions within their own internal data management systems. Interoperability has evolved considerably over the years such that GIS users now think less in terms of sharing spatial data files but rather the sharing of geospatial services for the support of data, systems, and users. The Open Geospatial Consortium (OGC), formed in 1994 from governmental, commercial, and research organizations, and comprising over 300 member organizations, provides a forum in the US around which consensus on open standards for spatial data, Application Programming Interfaces (APIs), web services, and geo-processing, have been achieved (Cowen, 2008). The Web Mapping Testbed, for example, from OGC distributes multiple data sets across many map servers indifferent to the vendor software used (Kuhn, 2005).

These standard protocols now include Web Feature Services (WFS), Web Map Services (WMS), Geographic Markup Language (GML), Web Service Common (OWS) and Representational State Transfer (REST) (http://www.opengeospatial.org). Many of these standards have also attained ISO status under ISO/TC 211 Geographic Information/Geomatics (http://www.isotc211.org/).

As Kuhn (2005) suggests, in its current evolutionary form, is a misnomer for the market for geographic information is now focused less on spatial data, or even data exchange, but rather the provision of geospatial services through which spatial data content integration occurs. Indeed, Kuhn suggests that the term Geospatial Information Infrastructures is now a more appropriate description of the role of SDIs. A geospatial services vision of SDI includes not only spatial data but the technology, the user community, the stakeholders, and the framework elements of standards, metadata, interoperability, policies, coordination, sharing, system architectures and interfaces necessary to serve spatial data based on distributed networks (Kuhn, 2005; Rhind, 1999). Peng (2003) suggests that the GIS community is moving away from server/client architectures to peer-to-peer architectures. In distributed GIServices, nodes become both servers and clients according to the specific need. In Peng's (2003, 10) conceptualization, "GIServices will broaden the usage of geographic information into a wide range of on-line geospatial applications and services, including digital libraries, digital governments, digital earth, on-line mapping, data clearinghouses, real-time spatial decision support tools, dynamic hydrological modeling, distance learning modules, and so on". In essence, top-down driven data streams become subsumed within a cloud of data generated by officials and the public alike. The ability to interact and contribute to distributed GIServices is limited not by authority but by accessibility to the service. As discussed later, the accessibility and power provided by social media and Application Programming Interfaces (API) falls nicely into Peng's distributed services and SDIs will be expected to reflect these services and access points.

Kuhn (2005) describes SDI as 'a coordinated series of agreements on technology standards, institutional arrangements, and policies that enable the discovery and use of geospatial information by users and for purposes other than those it was created for'. Traditionally SDIs have been configured at the national level and are designed to support the spatial data needs of countries. In the US, this leadership role has fallen to the interagency Federal Geographic Data Committee which coordinates the development of the National Spatial Data Infrastructure (NSDI) established in 1994 to service the geographic information needs of the nation (Figure 1). Within the European Union (EU) this role is performed by the INSPIRE geoportal (http://www.inspire-geoportal.eu/) established in May 2007. The leadership role of government in the creation of national and international SDI is a result of the extensive coordination and costs involved, and the need to involve multiple stakeholders beyond government and private enterprise. In the US, the FGDC worked to establish spatial data standards and framework, establish partnerships for data acquisition, and to broadly disseminate the nation's digital geographic information resources (http://www.fgdc.gov/). Through these initiatives, the NSDI has provided structure and consistency to a distributed network of producers and users of spatial data that includes the Geospatial One-Stop data portal and the loosely structured distributed configuration of FGDC Clearinghouses based on the Z39.50 protocol (ibid.). These distributed clearinghouse nodes enable metadata searches and provide access to registered geographic information within the US and some international data content (http://www.fgdc.gov/dataandservices). The FGDC endorses and supports the promulgation of standards and, where no consensus on standards exists, the FGDC facilitates and establishes those standards (http://www.fgdc.gov/standards).

The NSDI Framework initiative, provides a data backbone to the national SDI through a collaborative partnering with other stakeholders in the creation and maintenance of seven core data themes, 'data you can trust', that pervade most GIS applications in the US. The seven framework themes include geodetic control, cadastral layers, orthoimagery, elevation, hydrography, administrative units, and transportation and represent 'the best available data for an area, certified, standardized, and described according to a common standard' (Federal Geographic Data Committee, 1997). Contemporaneously, the FGDC also developed communities of thematic interest, the taxonomy of geospatial data as Cowen (2008) refers to it, that assisted with the formation of standards and exchange protocols.

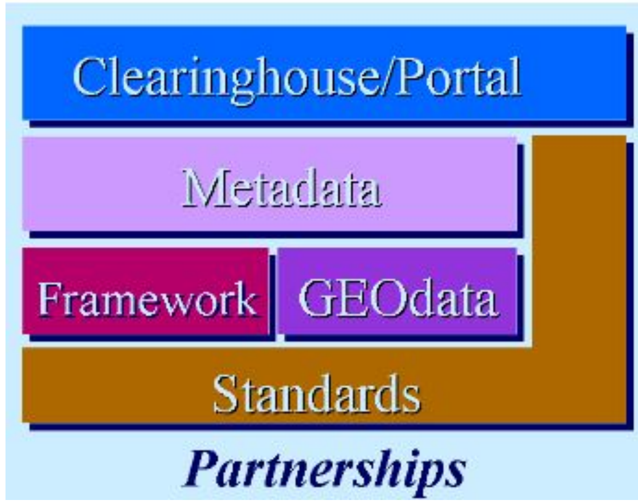

Figure 1: Components of the NSDI (Taken from http://www.fgdc.gov/components).

Together, the clearinghouse nodes and spatial data portals and the eGov sponsored Geodata One Stop (GOS) provide gateways to valuable spatial data generated at all levels of government and commercial enterprise (http://www.data.gov). GOS, for example, provides access to clearinghouses, map services, downloadable spatial data, map files, and geographic services that perform geoprocessing tasks such as place name searches, address matching, and routing. The USGS has been a major player in the US SDI through data sharing initiatives such as the National Map (http://nationalmap.gov/) and National Atlas (http://nationalatlas.gov/) and more sector based data and information sharing such as the hazard focus of the Geospatial Information Response Team (GIRT) (http://ngtoc.usgs.gov/girt/).

The European Union's (EU) Inspire and Eurogi programs similarly make relevant, quality spatial data and services from governmental, commercial and non-governmental organizations available to member countries (Craglia and Masser, 2003). The 2007 Inspire Directive created an SDI for the EU that contained 34 spatial data themes and provided access to the respective spatial data sets and services of member SDIs. Inspire represents a trans-boundary supra-SDI in that it enables the SDIs of member states to be shared based on binding Common Implementing Rules for metadata, data specification, network services, data and service sharing, and for monitoring and reporting (http://inspire.jrc.ec.europa.eu/). Metadata lies at the heart of this system and enables the discovery and access to many distributed datasets available within the EU communities. Inspire has several common principles characteristic of SDI in that its goal is to enable spatial data to be collected once and for it to be maintained and kept by the primary stakeholders where it is most effective and from where it can be shared and distributed to other parties seamlessly and transparently across countries, users, and applications.

National and Global SDIs (GSDI) are now common and embedded in the spatial infrastructure of many countries even though human nature intervenes in many of these efforts to thwart, frustrate, and delay these coordinating activities (Moeller and Reichardt, 2010; Rhind, 1997, 1999; Tulloch, 2008). Global SDIs reflect the emergent worldwide sharing of geographic data and services by international corporations, NGOs, and supra-governmental organizations. The United Nations SDI vision, for example, is for member countries to access a Global SDI as a 'comprehensive decentralized geospatial information framework that facilitates decision-making at various levels by enabling access, retrieval and dissemination of geospatial data and information in a rapid and secure way' (http://www.ungiwg.org/unsdi.htm). As Moeller and Reichardt (2010) suggest, the focus on national security and terrorism, climate change, anthropogenic influences on global ecological systems, disaster response, and trans boundary social and environmental issues have given additional emphasis to the need for a coordinated global sharing of spatial data resources. The authors go on to suggest, 'The future promises a continued evolution of the role and nature of ….. SDIs… and the promise of the realization of a global infrastructure with a set of policies, standards, practices, technologies, and relationships to facilitate the flow of geospatial data and information across government organizations and between all sectors and levels' (Moeller and Reichardt, 2010, 734).

Such optimism, however, is challenged by revolutionary changes in the generation of spatial data by citizens and groups using mobile and location intelligent devices coupled with a spatially enabled web. These ground-breaking changes promise considerable potential but threaten to turn the already evolving role of traditional SDIs 'on their head'.

Volunteered Geographic Information, Participatory GIS, and citizen sensors

Within the field of GIS, the nature and source of geospatial data is changing rapidly from established authenticated datasets to non-traditional sources. The spatial data model of the 1980s and 1990s was of a pyramid style where the foundation was made up of governmental sources (Figure 2). In the US the early digital foundation comprised the topographic maps of the United States Geological Services (USGS) and the demographic and census geography of the Census Bureau. The next level in the pyramid comprised data from private enterprise, state government and regional agencies. At the peak of the pyramid was the spatial data garnered from local communities, local government and agencies, small groups, and individuals. Driving this framework were issues of resources, expertise, and the availability of a technologically capable bureaucracy seeking to meet administrative mandates and operational requirements. Tulloch describes these forces as the 'institutionalization of GIS' (Tulloch, 2008). The hierarchical pyramid structure is redolent of the SDI frameworks discussed above. In more recent years this pyramid structure is becoming increasingly inverted, and the larger data contribution is now in the hands of local agencies, communities, and individuals. This inversion reflects both the diffusion of GIS technology and expertise away from the historically dominating role of major government agencies and private corporations and the evolution and widespread availability of cost effective geospatial data capture technologies in the form of Global Positioning Systems (GPS), Location-Based Services (LPS), and digital sensor data from aerial photographs and satellite imagery.

In the 1990s a series of debates revolved around the response of the GIS community to a socio-theoretic critique of GIS and its impact on society (Pickles, 1995). This GIS and Society discourse (subsequently known as Critical GIS) raised many issues concerning the nature and impact of GIS on society and the differential access to the technology, expertise, and spatial data that formed the three major legs of GIS (Weiner and Harris, 2007). Differential access and the top-down expert nature of GIS, it was suggested, led to structural knowledge distortion and the marginalization of communities unable to participate in the spatial revolution brought about by GIS. One response to these concerns was to incorporate 'bottom-up' local and community knowledge into GIS to create what was essentially a Participatory GIS (PGIS). PGIS has gained considerable traction since then despite the difficulties of capturing local knowledge in all its qualitative and multiple media forms that can range from mental maps, to sketch-maps, to oral histories, to photographs and video imagery. The blending of these qualitative forms within a quantitative and positivist technology such as GIS has contributed to more recent initiatives in Qualitative GIS (Cope and Elwood, 2010). Facilitating PGIS has been the rise of Neogeography, Application Programming Interfaces (APIs), Web 2.0, and the mapping capabilities of the Geospatial Web (Rouse et al, 2007). In addition, the ability for many people to now create geotagged information from mobile location intelligent devices represents a paradigm shift in how we view, store, access and use geospatial data in the 21st century. Together, these technologies provide for not just a PGIS but a Participatory World Wide Web.

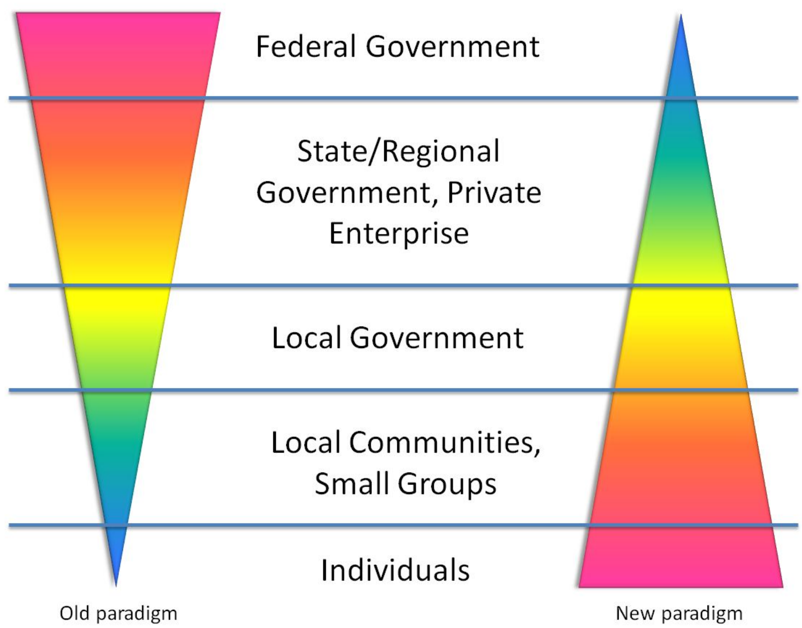

Figure 2: The changing sources of spatial data.

The evolving role of citizens as creators of geotagged data and as major contributors to spatial data repositories on a scale never before envisioned, represents a watershed in spatial data generation, spatial data processing, and SDIs. Volunteered Geographic Information (VGI) has entered the lexicon of GIS and SDI in dramatic fashion and has forced many in GIS to rethink how to handle this new source of spatial data (Goodchild, 2007a). Using cheap handheld GPS-enabled devices the layperson can now tag most data with a digital coordinate. Digital collection devices such as 'smart' cell phones, digital cameras, and digital audio recorders ease the difficulty of collecting, transferring, and uploading spatial data for these increasingly feature embedded GPS and wireless connectivity. Even the least technology savvy person can now upload geotagged images to a photo sharing site. Users can tag pieces of information with latitude and longitude coordinates even without access to a GPS by using such online resources as address matching and sophisticated geocoders. Furthermore, these devices increasingly include critical metadata. Basic information such as collection time/date, collection device, and keyword tags can be added automatically. All of these technological breakthroughs have happened simultaneously accompanied by a dramatic improvement in size and price-performance ratio. Storage costs are no longer an obstacle to data collection for the average person and advances in cloud computing and storage have accelerated this trend. The cumulative impact of these User Generated Content (UGC) technologies is that more data is spatially tagged and stored than at any other time in history.

Other technological breakthroughs have helped the evolution of VGI. The vision and technical advances behind Web 2.0 and Neogeography have given rise to a wealth of tools that has placed the technology infrastructure in the hands of anyone owning a computer or a handheld device. The combination of VGI with these new generation imagery-rich geobrowsers and virtual globes, integrated through now widely available APIs, has markedly changed the structured world of traditional GIS and SDI. VGI has already played important roles contributing to fighting wild fires in California, in mapping and monitoring the Gulf oil spills, responding to the Haiti Earthquake, in responding to natural disasters such as hurricanes, in riot containment or 'kettling' in London, and in the so called 'Arab Spring' in Middle Eastern countries. Neogeography and VGI represent a paradigm shift in spatial data generation and online geobrowsers that collectively close the gap between data producers and data consumers. However, the unofficial nature of VGI does not easily conform to the standards, protocols, or verifiability of traditional 'authenticated' spatial data. In this respect VGI challenges the very core of SDI because, as Goodchild (2007a) suggests, VGI 'asserts' geographic information content without citation, reference or any other supporting authority. Metadata is rarely generated or accompanies VGI though some geotagging devices will automatically generate some metadata content. Furthermore, many geobrowsers such as Google Earth do not provide metadata about the spatial coverages they display (Goodchild, 2007a). This mismatch between authenticated spatial data and unauthenticated VGI poses major challenges to traditional visions of SDI.

Neogeography, the geospatial web and social media

Neogeography represents the confluence of geographic knowledge production and populist communication and interaction technology. Vast arrays of technologies have contributed directly and indirectly to the rise of Neogeography. These technologies span platforms, human machine interfaces, and technical expertise. Together, these methodologies bring serious challenges to SDIs and traditional forms of data acquisition, analysis, and publication. Not only are VGI, crowdsourcing, and Neogeography protean and universal but the vision itself is to provide a subversive alternative to GIS and to traditional SDI. The term Neogeography was first introduced by Di-Ann Eisnor of Platial.com, who early-on envisioned that the technological developments occurring in Web 2.0 could support a range of socially networked mapping platforms that would facilitate, create, share, and publish maps and information about places.

Neogeography, is but one of several terms used to describe a new wave of geographic information generation and web mapping that loosely comprises a combination of Map Mashups, Web 2.0, the Geospatial web, geospatial technologies, VGI, Web Mapping, Map Application Programming Interfaces (Map APIs), crowd sourcing, and citizen sensors, not to mention a host of other lesser technologies that all contribute to the same movement. What initially appears to be a mishmash of concepts, data, and technologies, in reality contribute to a radical departure from traditional notions of spatial data processing, mapping, and GIS. Web mapping systems prior to 2004 provided limited opportunity for users to interact with online preloaded maps. These early maps were restricted in size due to bandwidth issues and had page layouts that tended to crowd out the actual map displayed (Haklay et al., 2008). The maps tended to be steeped with the metaphors of GIS which required a degree of user familiarity with the terms and norms of this expert field. Largely as a result of technical necessity, these early web mapping systems were stove-piped through specific vendor's products. Neogeography represents an important watershed to the GIS collective and to the broader web community (Haklay et al., 2008). As the WWW experienced explosive growth in the past decade, the availability of social media platforms with the capacity to ingest and handle vast quantities of spatially embedded data and media have had a major impact. Flickr for example permits users to upload georeferenced photographs from around the globe. OpenStreetMap is an open source initiative to create map data for areas lacking sources or to portray information excluded from existing spatial datasets. To that list of online repositories can be added YouTube, Facebook, Wikis's, Blogs and many others.

Turner (2006) took an adversarial perspective in proposing that the set of techniques and tools in Neogeography reflected a response of the spatial community and general public to what he perceived as the hegemony of GIS. The traditional concerns of the GIS scientist, such as projections and advanced spatial analysis, Turner suggests, are not the concern of Neogeographers. The central characteristics of Neogeography, he proposes, are threefold. First, "Neogeography is about people using and creating their own maps, on their own terms and by combining elements of an existing toolset" (Turner, 2006, 3). The creators and publishers of this data seek to create maps for themselves, the primary consumers of this data, using the building blocks of Web 2.0 technologies. Turner's second characteristic of Neogeography is the desire of users to share locational information with friends and visitors that helps shape context, and understanding 'through the knowledge of place' (Turner, 2006, 3). The emphasis on sharing between 'equals', reinforces the vision and implementation of Neogeography as a grassroots, plebian, and popular movement. The focus on the layperson is in stark contrast and the antithesis to the expert, professional, specialized, almost aristocratic, nature of GIS as it has evolved to date. Finally, in contrast to the claimed lackluster nature of GIS, Turner suggests 'Neogeography is fun' because of its accessibility to the amateur and the use of mashups that give personal meaning and context to space, and place (Turner, 2006, 3).

Neogeography is not without sophisticated technologies that are generally encapsulated from the general user (Hakley, 2010). Central to the creation of Mashups that heavily underpin Neogeography, are the Web 2.0 technologies that allow for more expressive and interactive Internet applications. Buttressed by the expansion of broadband and wireless access, intensive foundation applications such as Cascading Style Sheets and Javascript combined in the AJAX model (Asynchronous Javascript and XML), plugin technology such as Macromedia/Adobe's Flash, and Microsoft's ASP and .NET, enabled developers to create content rich applications that could mimic the interactivity of traditional desktop applications. This transformation of the Web from static screens of text and graphics to the transport mechanism it is today, the ether through which interactivity happens, has contributed to the manifestation of the 'social web' and User Generated Content (UGC). Central to this transformation has been the change in focus from products based upon a function, such as a piece of software, to the provision of services associated with the data. Thus blogging platforms such as Wordpress or Typepad provided services allowing users to write, produce, and publish their own content. YouTube, launched in 2005, enabled users to upload user created videos to a central hub for general viewing. Social media sites such as MySpace (2003) and Facebook (2004) provided open spaces enabling users to easily publish information concerning their interests and hobbies. The photo sharing site Flickr launched in 2005 and the microblogging site Twitter came shortly after in 2006 and each required a few years to reach critical social mass sufficient to generate UGC useful to data integrators. This explosion of user created data prompted the development of platforms and tools that enable users to upload, edit, and share pieces of information and to link these pools of information to a greater whole.

Importantly, amateur developers were given access to this wealth of user created information via Application Programming Interfaces (APIs), and Mashups. The term Mashup originates in the music industry where two pieces of music are synched and mixed together to create a combined piece. In similar fashion, Mashups under Neogeography combine two or more streams of seemingly disconnected data into a single product. In Web 2.0, the first major implementation of a Mashup was the well-known Google Maps. Google Maps launched in 2005 provided the general public with access to a mapping platform in which users could embed push-pins representing points of interest and containing information and links. Early attempts to reverse engineer Google's method of creating pushpin locations led Google to quickly publish an API that allowed users to access their mapping technology. Developers quickly added these capabilities to their own products and heralded an explosion in Mashups and the birth of the Neogeography movement.

One early drawback to Mashup implementations was the reliance on the developer to access to their own source of information. Data holders quickly realized they were incapable of providing every method desired to access their information and the power of produced data could best be realized through universal access to the information, albeit with limited utilization. Increasingly, data holders published APIs to their data holdings for use by Mashup developers. Simultaneously, the need for Mashup developers to possess advanced technical skills was reduced as database holders provided easy to use, non-technical methods for users to share information – the beginnings of the social media explosion of the past five years.

Today the breadth and depth of information shared between social media data users is staggering. As of 2010, Flickr held over five billion photos and YouTube over 13 billion videos. Facebook has over 800 million active users who interact with over 900 million objects. Twitter currently generates an average of 140 million 'tweets' per day. Users have gravitated to these sites in record numbers to produce and share billions of bits of information – much of it spatial in nature. The APIs for each of these sites allows developers to mine that information in a variety of forms from topical to temporal, and critically the spatial. How to utilize the value of VGI and how integrate it within SDIs represents a major challenge to the established geospatial community.

Challenges and Opportunities

The fusion of VGI, social media, Neogeography, and Web 2.0 technologies represents a paradigm shift in how spatial data is generated, shared, and distributed. It is also a major challenge as to how the framers of SDIs respond to these revolutionary changes. Goodchild (2007a, 2) identifies the basic elements of that challenge: 'The widespread engagement of large numbers of private citizens, often with little in the way of formal qualifications, in the creation of geographic information, a function that for centuries has been reserved to official agencies. They are largely untrained and their actions are almost always voluntary, and the results may or may not be accurate.' The distinction between 'expert' created data and the non-expert layperson volunteered spatial data is critical. The ability for the layperson to now create large quantities of spatial data and to store, retrieve, share, and utilize that data has been remarkable for the breath-taking for the breadth and rate of uptake of these capabilities. The combination of a motivated amateur, easily created UGC, and accessible Web 2.0 tools has led to an explosion in Neogeography and contributed in no small measure to the makings of a grassroots Digital Earth.

The mix of traditional SDI and VGI sit uncomfortably together. Both stem from very different philosophical and methodological approaches to data collection and distribution. Data accessed through SDI is organized into definable and digestible units to facilitate the transfer of information between subsystems. SDI data is housed in central locations with archival backup, and is transferred through legacy data methods such as direct website download, the venerable file transfer protocol (FTP), or even the so called 'sneaker net' of trading physical media. VGI, however, is the polar opposite in that data is seen as a stream of information, not as a defined collection. Neogeography systems are interrogated on an ad-hoc basis, and VGI content is located in a cloud-like structure where users have little knowledge of, or even care about, the exact location of the information. VGI users are adept at identifying who produces the data but not who houses the data. APIs are the universal method for interrogating and distributing VGI and linking Neogeography and the requirement for data 'download' is rare. APIs will need to evolve to provide virtual interfaces for the non-programming user of VGI and it is likely that SDIs and data stores will need to be retro-fashioned into API interrogation systems to ease the integration of past and future data sets.

The confluence of VGI and Neogeography allows for the creation of a relatively new type of knowledge environment – that of social spatial knowledge. Social knowledge generation leverages the power of crowd sourcing to generate millions of data points which can be combined, reconfigured, and redistributed at will. Social knowledge generation presents a vastly different model than traditional GIScience approaches. This social knowledge environment, in which the whole is greater than the sum of its many parts, has unlimited potential to provide a multitude of pathways to reassemble the data and to generate new forms of knowledge.

National-centric or global SDIs will likely remain the bedrock and framework upon which GIS and Neogeography continue to be superimposed. It is possible to speculate that these SDI will evolve to incorporate some elements of VGI. Even though the benefits of Neogeography are not dependent upon an 'authenticated' view of the world, the existence of SDI provides a base against which Neogeography can be contrasted, compared, and validated. Indeed, Grossner and Glennon (1999) suggest that visions for a Digital Earth must contain both comprehensive level I spatial thematic layers that are expertly reviewed along with level III VGI data submitted by the non-expert masses. This combination of authenticated and non-authenticated data contributes to a patchwork of data stitched together to form a multi-authored, multi-source, holistic map.

The value of Neogeography and social knowledge to individual users, researchers, business, communities, government, and the public at large, supported as it is by the open access provided by the WWW, is considerable. Furthermore, Neogeography can leverage these benefits without incurring the considerable hardware, software, database, and humanware investments required by GIS. Many of the system tools can be accessed freely through open source software and the ability of APIs to push the computing demands onto the services providing the API is a major advantage. VGI greatly reduces the cost of data acquisition by exploiting existing data streams and existing SDIs. Furthermore, the near real-time capability of VGI can capture up-to-date information and reflect trending and competing accounts of space and events. Neogeography can also be purposely agnostic in that it is not directly controlled by corporations or government though copyright. Not least, Neogeography can augment and enhance the data and knowledge gaps left by official entities pursuing their own mandates and goals. Several instances of the value of Neogeography can be found in emergency management and response, as well as political protest movements.

However, Neogeography comes with a number of significant challenges to SDIs and mainstream GIS. A trinity of issues concerning verifiability, validity, and privacy confront SDIs and pervade spatial data usage. By its very nature and because VGI is rarely accompanied by the hallmark signatures of 'official' data in terms of authentication and metadata that are so central to the functioning of SDI, VGI is problematic to traditional SDI. SDI derives much of its power and utility from the inherent data standards, verifiability, validity, and privacy controls that are the foundation of the systems. Data in SDIs is owned, maintained, operated, distributed, and updated through known entities with defined roles and responsibilities. The data has invariably been created for a defined purpose and been evaluated for appropriate use within an agency's defined mission. SDI data consumers can be confident in the specified accuracy, verifiability, and validity of a given piece of data not because it is inherently accurate, valid, or verified, but because the metadata documents the degree to which it is inaccurate, invalid, and unverified. This is the key to the existence of metadata for metadata details the limitations under which certain data can be effectively used (Goodchild, 2007b). Metadata provides users with the ability to assess what can reasonably be claimed given any combination of data and analysis.

VGI rarely has any form of metadata recognizable to the GIS expert. Indeed, the basic workflow of Neogeography and VGI makes metadata collection difficult at best for part of the power of such methods lies in their ease of generation and use by citizen sensors. Taking time to provide metadata raises the entry barrier and acts as a deterrent to participation. Although metadata might be of critical value to other consumers of VGI, the benefits to the data creator are not immediate but deferred and most likely secondary to the needs of that volunteer. It is like family members inheriting photographs from former family generations who, because they were cognizant of the names, times, and places of the photographs, never recorded such information or metadata to help inform future generations. Furthermore, while Neogeography is spoken about in a collective sense, the underlying use is invariably individualistic and the technologies and processes inherent in Neogeography differ from system to system. Neogeography systems are invariably private enterprises motivated by the search for profit. A variety of license agreements exist and although most are offered gratis to users, restrictions on data use can be imposed at will by the vendors. Although the information is volunteered by users, nearly every system features clauses that give the vendor ultimate exclusive rights to the information. Open source systems have sought to replicate some systems and retain access to data for public consumption, alteration, and replication but no such claim is true for the data itself. Importantly, there is no expectation or promise to keep information streams available and accessible in perpetuity.

A number of possible trajectories might be identified as valuable approaches to what seems to be an intractable SDI data problem. Given the mismatch between SDIs and VGI, it is interesting to speculate on methods for integrating the two into a unified SDI. Some VGI devices and Neoeography methods have metadata tags that would contribute as least part-way to SDI data standards. Thus Flickr will retain photography metadata concerning the date the image was captured, its location if geotagged, the focal length and much else. The ability for many devices to automatically capture and tag bits of information with technical metadata is increasingly becoming the norm. Some systems even feature mechanisms to translate their proprietary information into file formats that are more easily read by a variety of software, such as XML. The increasing power of computers also allows for information tagging after the fact. By situating a piece of data within a greater context, either through user input or through comparisons to a greater whole, forms of metadata can be 'reverse engineered' for information. For example, the practice of superimposing an old photo on top of a current photo of the same place can provide information concerning the older photo. Technologies that can search photos for common elements, such as faces, can provide a potential list of elements for a photo after the fact. Neogeography can combine streams of information to create elements of metadata. While one technology such as Twitter may have minimal metadata, combining a Tweet with a photo of the same event posted on Flickr may yield metadata for both. Thus a variety of metadata methods presents opportunities for advancing VGI within SDI.

At the same time that metadata might be created to accompany VGI, it is likely that expectations in metadata standards, which traditionally can be exhaustive and sometimes intimidatingly so, will also change. In many respects use of the Dublin Core metadata criteria indicates already the willingness of spatial data users to reduce the completeness of metadata. While it is preferable to collect as much metadata as possible, the advent of Neogeography provides opportunity for negotiating the completeness of these standards to accommodate data with less than complete metadata. The lack of metadata documentation does not negate the utility of VGI though SDI may have to accommodate less stringent metadata standards with concomitant reduction in the ability to search for and utilize VGI.

In similar manner, consumers must likewise be open to the implications of lessened verifiability, validity, and accuracy of VGI spatial data. While it should not be assumed that VGI is unverifiable, inaccurate and therefore unusable, the required validity and accuracy of spatial data is directly related to its intended use. VGI may not be appropriate for all uses, yet it can be extremely valuable for some. It is data user who must ultimately judge the appropriateness of VGI for any given use though it is problematic that this evaluation will need to be frequent if not continuous. The harsh reality is that VGI data consumers will have to adjust procedures and expectations to allow for a greater degree of uncertainty within their work.

Conclusion

Neogeography and VGI have evolved rapidly over the last half decade. They have been intertwined within greater technological and Web 2.0 evolutions. The explosion of VGI has given Neogeography important pillars on which to build and contributed to new forms of social knowledge creation. Each of these changes has brought about enormous potential benefits to a host of communities, many of whom have been under represented in traditional GIScience. Neogeography builds a personal understanding of space and place by combining spatial and non-spatial information sources through accessible and extendable common technologies primarily for the benefit of the spatial non-expert. Yet Neogeography brings with it many challenges to the geospatial community which need to be addressed. Local knowledge is simply too vast and too valuable to be ignored by SDIs. Progressively more data is being produced at the local level for local purposes and it falls upon national SDIs to stitch these bits of data together. Neogeography heightens these trends. If, as Craglia suggests, SDI is a framework of data, technology, policies, standards, and human resources necessary to facilitate the sharing and using of spatial information, then as the many forms of VGI and Neogeography evolve so too will SDI have to change to accommodate and utilize the strengths of such data while preserving the integrity of traditional authenticated spatial data. As Goodchild (2007a, 10) observes, passive technological sensors certainly have their place, but a network of over 6 billion human sensors creates a powerful intelligent synthesizer and interpreter of local information that SDIs cannot afford to ignore.

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Using of social networking tools in the SDI-EDU project for spreading of awareness about how to build Spatial Data Infrastructure

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Introduction

The European INSPIRE Directive adopted in March 2006 defines the standards for future European Spatial Data Infrastructure. With implementation of INSPIRE initiative there will be strong need for capacity building and transfer of experience among architects, spatial planners, European Regions and municipalities, etc. The main concept of building of Spatial Data Infrastructure (SDI) is to move spatial data into web environment and to use web services for building network of distributed geoportals. The SDI-EDU project (full name "SDI-EDU for regional and urban planning") aims to transfer experience from European research projects dealing with building of SDI and spatial planning towards the end users. The focus is also on social networks as one of the main dissemination and communication tool. The main aim of this activity is to communicate (to give information and to retrieve some feedback) the SDI-EDU development through the SDI-EDU educational geoportal. The retrieved feedback should serve as input information for further development.

The SDI-EDU project

The SDI-EDU project belongs to the framework of the Leonardo da Vinci Lifelong Learning Programme. In particular it is a multilateral project – transfer of innovations. The SDI-EDU project started on October 1st, 2009 and its duration is 24 months. The keywords for the presented project are 'SDI' as Spatial Data Infrastructure and 'EDU' as an Education.

Within the framework of the SDI-EDU project we intend to achieve a high level of cooperation between 10 partners involved in this project (Figure 3). The SDI-EDU project aims to transfer former and actual experience from EU research projects dealing with building of SDI and spatial planning like HUMBOLDT, NATURNET REDIME or PLAN4ALL towards planners in European regions and municipalities.

Due to the INSPIRE Directive and its implementation each Member State has to transpose the INSPIRE Directive into its national legislation and to develop the interoperable services allowing the management and sharing of spatial data. There will be also requirements on spatial planning to accept the implementation rules of INSPIRE Directive. For two years, SDI-EDU supports training of responsible people to set up and use some of these services according to the specific problems of the EU regions on local and regional level. Thus the project will let the regions participate actively in the implementation of the INSPIRE Directive.

The European regions, provinces and municipalities will use the results of SDI-EDU to promote their cultural and socio-economic heritage and to find the Spatial Data Infrastructure useful to the regular management of their territories. The extent of the SDI-EDU project consortium proves the utility and it will certainly lead to a larger dissemination of its results in all Member States. The SDI-EDU geoportal will become the bridge joining all European portals with the ambition to exchange the knowledge between all the regional identities. To attain the SDI-EDU objectives all participating regions will acquire an equal level of understanding, skills and use of spatial data infrastructures. They will be able to implement particular and specific applications for the area of their interest with respecting the INSPIRE Directive which is currently in the implementation phase.

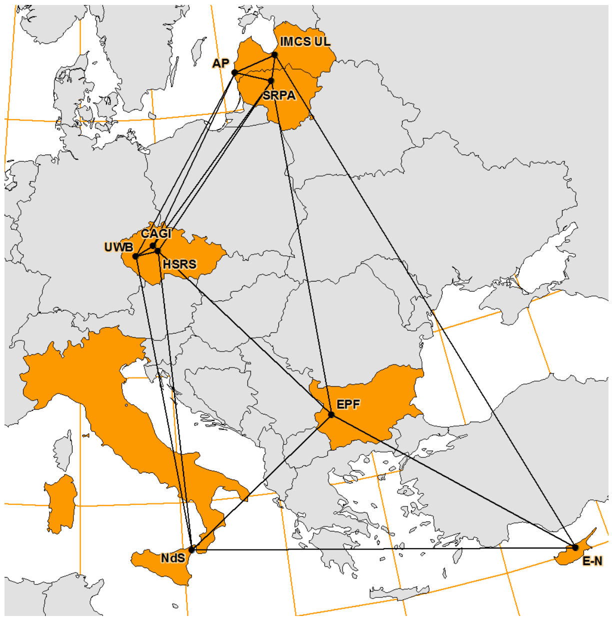

Figure 3: The network of partners in SDI-EDU

The topics for education are as follows:

- Political consequences of INSPIRE on both local and regional level (in relation to spatial planning)
- INSPIRE requirements on local and regional level from the technological point of view
- The examples of solutions for SDI building (commercial x open source)
- INSPIRE, Metadata & spatial planning
- INSPIRE, Spatial data & spatial planning
- INSPIRE Networking architecture
- Intellectual property rights & Spatial data infrastructures
- Monitoring obligation
- Practical examples (how to)

The above mentioned topics will be available for educational purposes on the SDI-EDU project's educational geoportal in the user friendly form.

Role of communities in building of Spatial Data Infrastructure

There are generally three ways how to build SDI (Figure 4, Charvat 2010). The first possible way of building of SDI is SDI build by public administration – in Europe public based SDI is mainly supported by INSPIRE initiative. There are defined rules for data and life cycle. This means that this data are acquired every day, week, month, year … and it is known when this data was made, who is author etc. Data are often managed together with metadata.

Next way are commercial public portals like Google, Yahoo, Microsoft and other portals in this group. It is used every day by ordinary users who are looking for some information. This data can't be often used for building of local or regional SDI due the license issue but there are also missing information as a property or time of making of data.

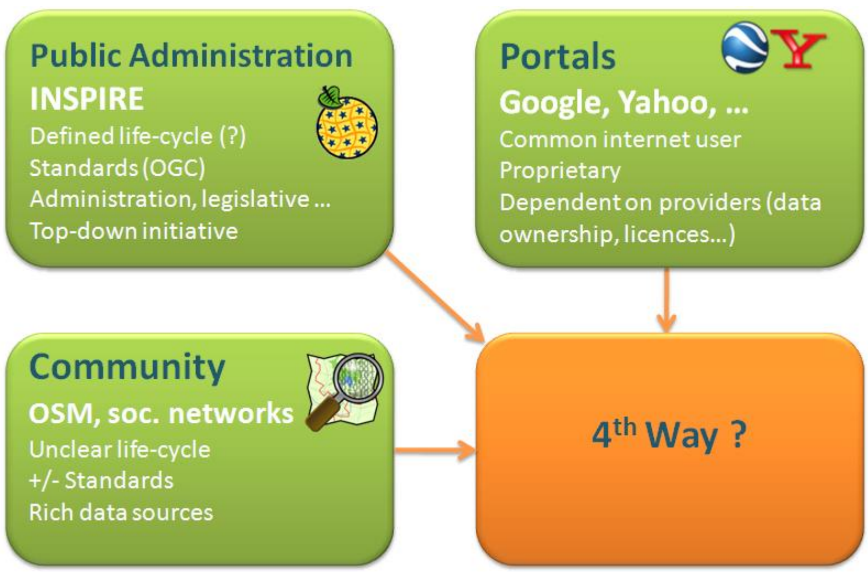

Figure 4: Possible ways of SDI building

The third alternatives are voluntary or online communities. As the example of OpenStreetMap shows, nowadays citizens have an interest in sharing their findings within a community. Therefore, the architecture should foresee collaboration possibilities for people who are not employed by environmental agencies. Data are eventually reported by the general public needs to be checked and validated before it may be published. What is sometime problem are specific data models and formats. This made their usage sometime difficult for non specialist.

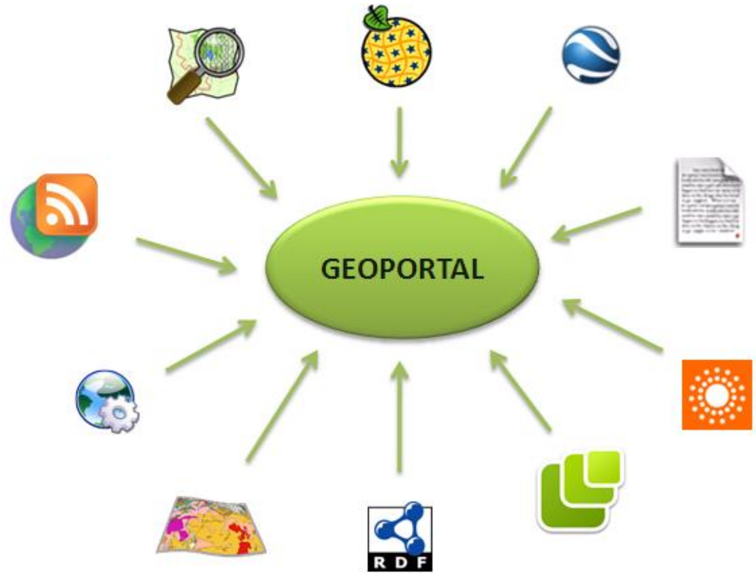

Figure 5: Many possible sources of information accessible via one access point

This is why we try to promote our 4th way of SDI building. The basic idea is to use advantages of standardisation efforts like INSPIRE or OGC and combine this effort with both, commercial initiatives and also and mainly with support for voluntary initiative. The goal is to bring all these possibilities nearest to people, in form, which is easy accessible (Figure 5) and understandable. Our idea is that future solution has to support integration of spatial and non spatial information.

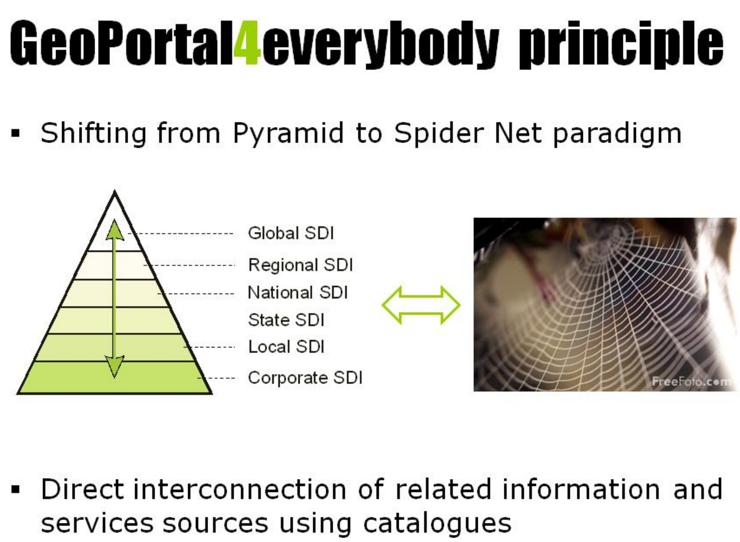

Figure 6: Scheme of the Spider Net paradigm

What we would like also promote is to shift from the pyramid paradigm, which is often mentioned in the relation to building of Global SDI to paradigm of Spider Net (Figure 6). With our concept also used in the SDI-EDU project we prefer system of distributed data sources, where every provider could decide about accessibility of his data against concept of cloud computing, where one organisation is managing all information. The idea is not against outsourcing of data or services or using of external services, but to have control about data from the side of data holders. For implementation of this concept, we suggest ideas of Geoportal4everybody.

GeoPortal4Everybody is a concept, which is based on the next principles:

- Independent components
- Composition according to user requirements
- Based on SOA
- Possibility to integrate with other resources
- Maximum openness
- Open Source
- Open Standards
- Extension to non-GIS community
- Open Search
- Administration of other (non-spatial) data sources

SDI-EDU educational geoportal

The SDI-EDU portal is designed and implemented as a virtual database based on social networks principles of the Geoportal4everybody and principle of web services using URM (Dzerve et al. 2010). It integrates different technologies like GIS, e-learning, multimedia, and virtual reality. Important part is integration of social networking tools. These services are not implemented on SDI-EDU portal directly but are implemented as virtual services on different places in Europe. The access is guaranteed through a single access point at http://portal.sdi-edu.zcu.cz (Figure 7).

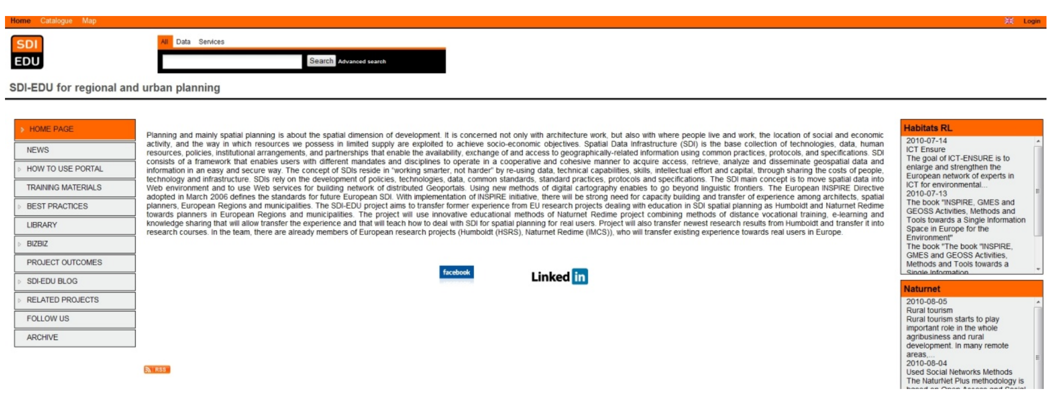

Figure 7: The main page of the SDI-EDU educational geoportal

The tools implemented in the training platform for education are as follows:

- SimpleCMS tools
- Uniform Resource Management including:
  - MICKA,
  - HSlayers,
  - PyWPS,
  - Geohosting including:
    - DataMan,
    - MapMan,
    - Metadata extractor,
- BizBiz.

As external applications could be used by different desktop GIS tools, main support in education will be for Janitor and Topol, but these tools are not direct part of solution, they are more related to educational content. The portal is implemented with initial menu and content, all could be later updated by project team. Selected part will be also possible modified by external users.

SimpleCMS Content Management System

System SimpleCMS Content management system (Figure 8) is focused on usability and simplicity for end users on their mind (Dzerve et al. 2010). Main advantage in comparison with other CMS systems is simple approach for solving complex tasks, where on the code side the clarity and security of the implementation is the main target. The using of SimpleCMS Content Management allows exploiting the potential coming from social networks. The SimpleCMS provides access to the following features and/or provides access to the following options:

- **Menu** - User can define any menus and submenus. Any menu or submenu can be external link (link pointing to any place on WWW and not into the CMS itself), where the redirected functionality is implemented and users can return back to the CMS using visible controls. It supports inserting different Web applications into web pages for training purposes. Any menu can be set as Homepage, where of course only one Homepage per SimpleCMS instance is possible. Menu ranking can be reordered in any way to best fit any updates that might be required during usage.

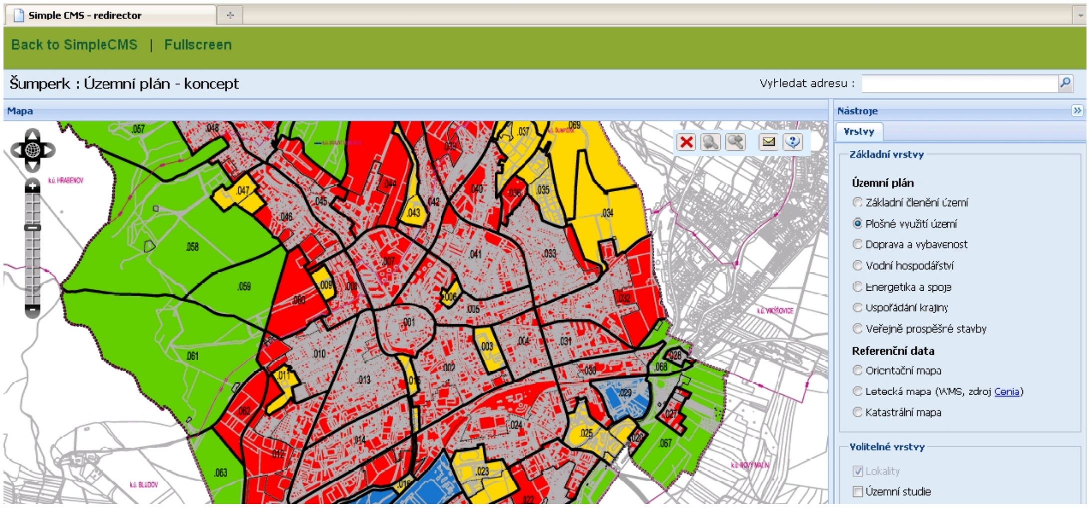

Figure 8: Working with map using SimpleCMS

- **Article** - Content holders are holding the data we want to publish. As regular articles they are composed from the "perex" and the content itself. Using nice WYSIWYG editor provides nice user experience to beginners. Support for full inline html can please any person wanting to do more fine grained look of desired article. Editor allows inserting of multimedia content like videos, photos, etc. There is a special support for inserting of dynamic maps, presentation from SlideShare, YouTube and other social networks for sharing content. Each article can be enhanced by adding various file attachments, which will be described later.

- **Message** - Each menu can be accompanied by the message item, which in reality is simplified article that contains just one view on short text. That does not implement detailed view so it could be described as "perex" only. Since the message(s) is always on top over the articles they can be best used as the menu description. Also here is used the some WISIWIG editor, with full functionality like in articles.

- **RSS** - The CMS supports including any RSS feeds from remote sites. This allows nice and handy way of promotion for our/friendly services that we want our consumer to know about.

- **Translations** - The controls of the CMS can be translated into various languages where the gettext localisation system is used, which provides easy translations to most known languages and possibility to use already created vocabularies from any other open-source project, which makes translating work really simple.

- **Remote articles promotion** - Each menu in the CMS setup has automatically generated RSS feed for grabs to others. Also optional connectivity to Posterous is possible, so your web presentation can be presented on all various social networking sites (for example Facebook).

Uniform Resource Manager

Uniform Resource Management provides a framework in which communities can share information and knowledge through their description, which is easy understandable inside of the community (Dzerve et al. 2010). In order to effectively share information and knowledge, there is a standardized schema, which supports uniform description of information and knowledge including common vocabularies. A schema defines the meaning, characteristics, and relationships of a set of properties, and this may include constraints on potential values and the inheritance of properties from other schemas. The schema specification language is a declarative representation language influenced by ideas from knowledge representation (e.g. semantic nets, frames, predicate logic) as well as database schema specification languages and graphic data models. The context characterizes any information, knowledge and observation. Context strongly influences the way how the information will be used. There exist different definitions of context. The important issues for the context are:

- an identity of an entity,
- a profile of an entity,
- a spatial information,
- a temporal information,
- an environmental information,
- a social relation,
- resources that are nearby,
- an availability of resources.

Many context attributes characterize the environmental information or knowledge. From the context point of view, the information or knowledge could be divided into different parties:

- information or knowledge provider i.e. a party supplying the resource,
- custodian accepts accountability and responsibility for the resources and ensures appropriate care and maintenance of the resource,
- owner of the resource,
- user, who uses the resource,
- distributor who distributes the resource,
- originator who created the resource,
- point of Contact to be contacted for acquiring knowledge about or acquisition of the resource,
- principal investigator responsible for gathering information and conducting research,

- processor who has processed the data in a manner such that the original resource has been modified,
- publisher, i.e. party who published the resource,
- author, i.e. party who authored the resource.

Geoportal is a place which allows users to search, view, examine and share spatial and non-spatial data (Figure 9).

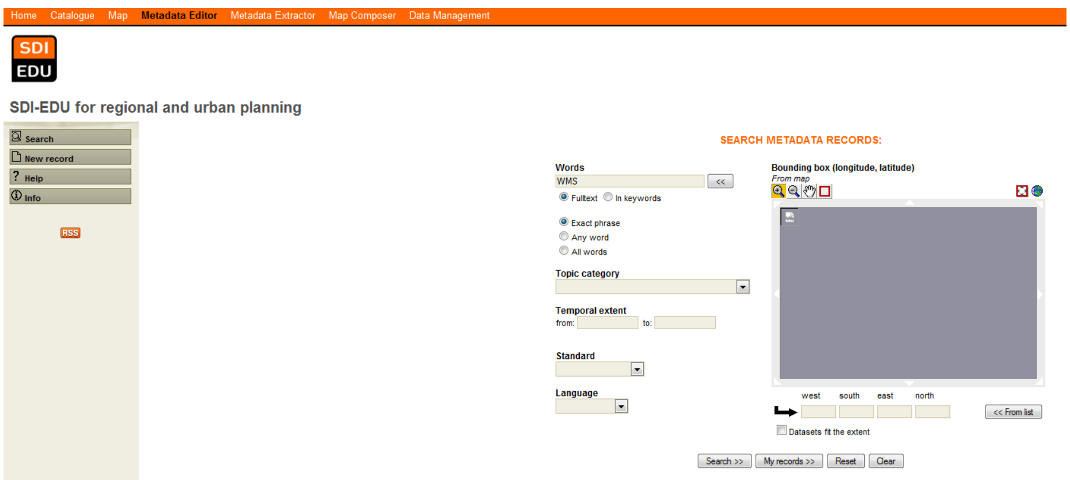

Figure 9: Using of MICKA for searching metadata records

Geoportal is based on interoperability standards (OGC, W3C, OASIS, ISO) which are connected to other resources on web and helps to create distributed structure of information and knowledge based on spatial localisation. Geoportal should not be closed central storage of spatial data without possibility of redistribution of this data. Geoportal should not be a solution that doesn't support searching of data and information and their viewing and using by external sources.

BizBiz educational tool

The last part of the SDI-EDU project's educational geoportal is the BizBiz tool (Dzerve et al. 2010). BizBiz is a learning video tool for SDI-EDU training platform. It is integrated into URM portal. BizBiz (Figure 10) is a web browser based e-conference collaboration and learning tool which allows conference members to watch live video enabled presentations remotely from their computers. It does not require users to install special software apart from modern web browser and java virtual environment and most of the configuration connected with webcam and screencast is done automatically. Additional equipment is headphones, optionally webcam.

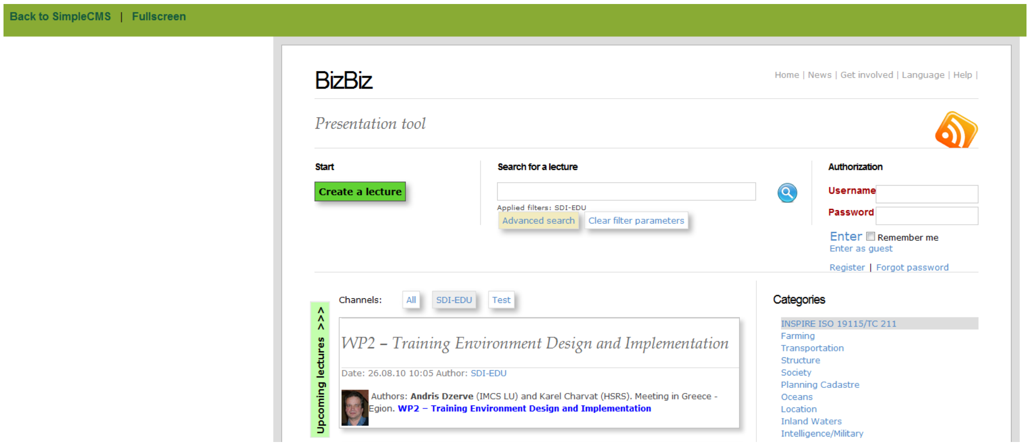

Figure 10: BizBiz main page

BizBiz focuses on providing a learning platform for spatial planning and GIS but can be used also in other applications. BizBiz is free of charge and published under open source (Affero GPL) licence in source forge.

SDI-EDU on social networks

Web 2.0 applications include blogs, wikis, podcasts, RSS feeds, tagging, social network sites (e.g. Facebook – Figure 11, MySpace), search engines and others. The focus of the SDI-EDU project is on social network sites (e.g. Facebook, Twitter) as one of the main dissemination and communication tool. The main aim of this activity is to communicate (to give information and to retrieve some feedback) about the SDI-EDU developments through the SDI-EDU geoportal. This will enable to induce discussion about certain topics.

News will be posted by the project partners and will be automatically distributed to a number of selected communities – social network sites. Feedback from these social network sites will be retrieved using RSS and answered again from the central point.

Figure 11: SDI-EDU on Facebook

This approach will allow involving other communities from one place without having to enter each community. Users of various social network sites can read entries and comment through their respective communities and don't have to register elsewhere. The retrieved feedback should serve as input information for further developments.

Conclusion

The tools of SDI-EDU training platform are approved and ready for practical use in the SDI-EDU educational geoportal. This portal (training platform) includes social networking tools including virtual libraries, educational materials, content sharing tools, connection to social networks and application integrator. Next, this platform consists of Uniform Resource Manager and the BizBiz video lecture tool where multilinguality plays an important role in a case when partners share the same information which has to be presented in their native languages. The SDI-EDU educational geoportal is an entry point for any news (new development, problematic topics, progress in the project, etc.). The principles and using of social networking tools are helping to reach the success of the project.

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User-Generated Spatial Content and the Need for SDI Standards

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Introduction

The geospatial technologies industry and cooperative spatial data infrastructure programs worldwide provide governments, local communities, non-governmental organizations, businesses, the academic community and citizens with increasingly useful tools to solve a wide range of problems.

In the last 3-5 years mobile devices and easy-to-use web services have added a new dimension to this progress. Previously, most mapping and spatial data infrastructure development was performed by or for governments. Today, information services used by all sectors of society are becoming spatially enabled and are contributing to the development of the global spatial data infrastructure. Citizens with hand-held devices incorporating phones, cameras, GPS, maps and location services, and also internet-connected sensors embedded in homes, offices, stores, and vehicles are contributing location and descriptive data.

The volume and importance of user-generated geospatial content has grown rapidly in these last years, and this growth poses important technical, social, and institutional challenges. The democratization of spatial data is helping us to realize spatially enabled societies. In this paper we examine the associated opportunities, as well as the challenges, and offer general approaches to addressing them through OGC standards.

Part 1

"Geoweb" is a relatively new term encompassing or in some cases referring to the same things as democratization of spatial data and services. This includes user-generated spatial content, Volunteered Geospatial Information, neo-geography, neo-SDI, SDI 2.0, geospatial mass-market, geo-lite, crowd-sourced geospatial data, web mapping, map browsers, geoweb start-up companies, open source and open data initiatives, location-enabled social networking services, geogames, and geospatial mash-ups.

SDI managers need to understand and respond to the geoweb because it offers new opportunities to meet SDI objectives, and also because it represents a set of disruptive technologies that are likely to destabilize parts of some SDI programs. In the long run, the geoweb is a positive development.

As OGC's chief technology officer, Dr. Carl Reed, wrote in the OGC News, January 2007: "The Geospatial Web is about the complete integration and use of location at all levels of the internet and the web. This integration will often be invisible to the user. But at the end of the day, the ubiquitous permeation of location into the infrastructure of the internet and the web is being built on standards."

We believe the SDI vision and mission that governments have embraced will ultimately benefit from today's democratization of spatial data and services. All sectors of society are becoming spatially enabled and are contributing to the development of the global spatial data infrastructure. But to exploit the capabilities of new devices, services and social networks, and to make the growing amount of volunteered or automatically collected data accessible and useful, SDI managers and the OGC, too, need to learn and adapt.

Part 2. Web 1.0 was about publishing. Web 2.0 is about participation. Web 3.0 is coming.

SDI 1.0 was mainly about governments at all levels of jurisdiction in a nation coordinating their data collection and management efforts in order to be efficient and to maximize the return on their collective investment. If Web 1.0 was about publishing, SDI 1.0 was about data sharing, which is one kind of publishing. Web services using OGC-compliant standard interfaces and encodings didn't necessarily lead organizations to abandon this publishing paradigm.

SDI 2.0 introduces a different paradigm. It is instructive to read the Wikipedia entry for Web 2.0 with geospatial data in mind. That entry begins with this paragraph:

> The term "Web 2.0" (2004–present) is commonly associated with web applications that facilitate interactive information sharing, interoperability, user-centered design, and collaboration on the World Wide Web. Examples of Web 2.0 include web-based communities, hosted services, web applications, social-networking sites, video-sharing sites, wikis, blogs, mashups, and folksonomies. A Web 2.0 site allows its users to interact with other users or to change website content, in contrast to non-interactive websites where users are limited to the passive viewing of information that is provided to them.

(http://en.wikipedia.org/wiki/Web_2.0)

Wikipedia is itself, of course, a Web 2.0 exemplar, a remarkably valuable source of information created almost entirely by volunteer contributors around the world.

Geospatial information is becoming an integral part of the rapidly expanding and branching Information and Communication Technology (ICT) world, a world in which billions of people, not merely hundreds of thousands, are participating as producers and users of geospatial information (Johnson 2009). Increasingly, many kinds of geospatial data are free or low cost, often because people can collect data almost effortlessly in their daily activities by means of location-aware, internet-connected devices. And the costs of storing, processing, communicating and using the data keep falling. Considering these economic factors, government SDI managers would be neglecting their mission if they failed to consider how SDI 2.0 figures into calculations of return on investment.

At the same time, it would be a serious mistake to believe that what we are calling SDI 2.0 can replace everything we have been calling SDI. Also, it would be a mistake to assume that SDI 1.0 and SDI 2.0 will forever be seen as distinct categories. The larger trend to note is that geospatial data is becoming just another data type, an integral part of the rapidly expanding and branching ICT world. And geotechnologies are becoming just another category of tools on decision makers' desktops. This trend will ultimately obviate the need for distinguishing between SDI 1.0 and SDI 2.0.

While we are still considering the usefulness of SDI 2.0, we should also be cognizant of

Web 3.0, and where and how geospatial fits in the next generation of web development. More than a year ago, Jessi Hempel wrote about Web 3.0 for FORTUNE Magazine. In the conclusion of her article she highlighted the inclusion of geospatial tools and services:

But today's Web 2.0 companies may find themselves transformed or even eclipsed by yet another wave of web innovators. New companies are cropping up to expand the utility of the web, creating location-based services and financial payment systems that can be bolted onto existing sites. Often bootstrapped, they are frequently profitable and may get acquired quickly. Even in today's tough environment, these upstarts are the ones raising money and trying to score a life- or business-altering hit. Welcome to Web 3.0.

Part 3. Revisiting government's role

Much has been written about the differences and apparent divide between this new world of geoweb users and developers and the old world of academic, corporate and government users and developers of geospatial technologies. At conferences and in magazines and blogs, there are lively debates about:

- The value of government data creation and curation versus geospatial data in the context of "Raw data now!" (Berners-Lee 2009), which means, in the extreme case, that government should make all of its data available on an FTP server and let the public and the market decide how it should be packaged, served, used and improved.
- Catalogs and metadata (requiring expertise) versus search engines, tags and user ratings that anyone can use.
- Requirements for transparency and openness versus requirements for privacy, intellectual property protection and security (Francica 2009).
- Costs of maintaining national datasets versus costs of collecting data when and where it's needed, as well as the data quality challenges related to currency and consistency.

The role of government is central in many of these discussions. National SDIs (NSDIs) have their origins in a pre-web world and are challenged by peoples' demands for more community involvement. NSDIs typically first collect data through broad national collection efforts, and then seek users of the content they provide. Increasingly, NSDI organizations are seeking involvement of local users in creating or managing the content, and they are less focused on national coverages. This trend is strengthened by community efforts and participatory (usually ad-supported) websites such as OpenStreetMap that typically depend on the involvement of community-oriented data providers and developers. Both public sector agencies (such as keepers of mass transit schedules) and private sector companies (such as OpenStreetMap) are inclined to offer data in flexible ways, providing options for developers through open Application Programming Interfaces (APIs) and lightweight, open source tools and components.

In traditional SDIs, governments sponsor and lead SDI efforts. In contrast, most new geoweb infrastructure projects such as OpenStreetMap are started by an individual developer or a small team. They create a capability that attracts users and other developers, and as the project grows it may attract capital of various kinds, if a business model can be found. Most traditional SDI efforts are pre-planned and top-down, though planning usually includes getting user requirements and input and a growing number of SDIs are taking a bottom up approach, for example in Australia and Spain. In contrast, most geoweb efforts are begun spontaneously, on an entrepreneur's hunch, and they grow "virally", that is, through word-of-mouth. Their progress unfolds through ad hoc decisions made in response to evolving market needs and business goals. Foremost in the launch team's mind is the question, "How can we get more participation?"

Commercial imagery providers, of course, have been key providers of SDI information for decades, but their business models have changed, too, with most of them now serving more customers with products and services that are tailored to smaller regions and more particular needs.

The question "How can we get more participation?" is the second question to guide government SDI managers as they consider ways to leverage Web 2.0 capabilities in their SDI programs. Their first question is, "What kind of participation do we want?"

Bill Oates, Head of Cartographics for the Welsh Assembly Government, gave a talk at the Where Camp EU 2010 Conference titled, "Do we need or want an SDI?" (Oates 2010). Oates describes the characteristics of a "neoSDI":

- Community sponsored and led
- Core government funding but allows for others to add value
- Community developed
- Forums / community space
- Very Web 2.0

And he asks questions such as:

- What is an SDI for?
- Do we really need one?
- Is it not being provided for by the market?
- What problem does it solve?
- Is what we want out of a neoSDI the same or different?

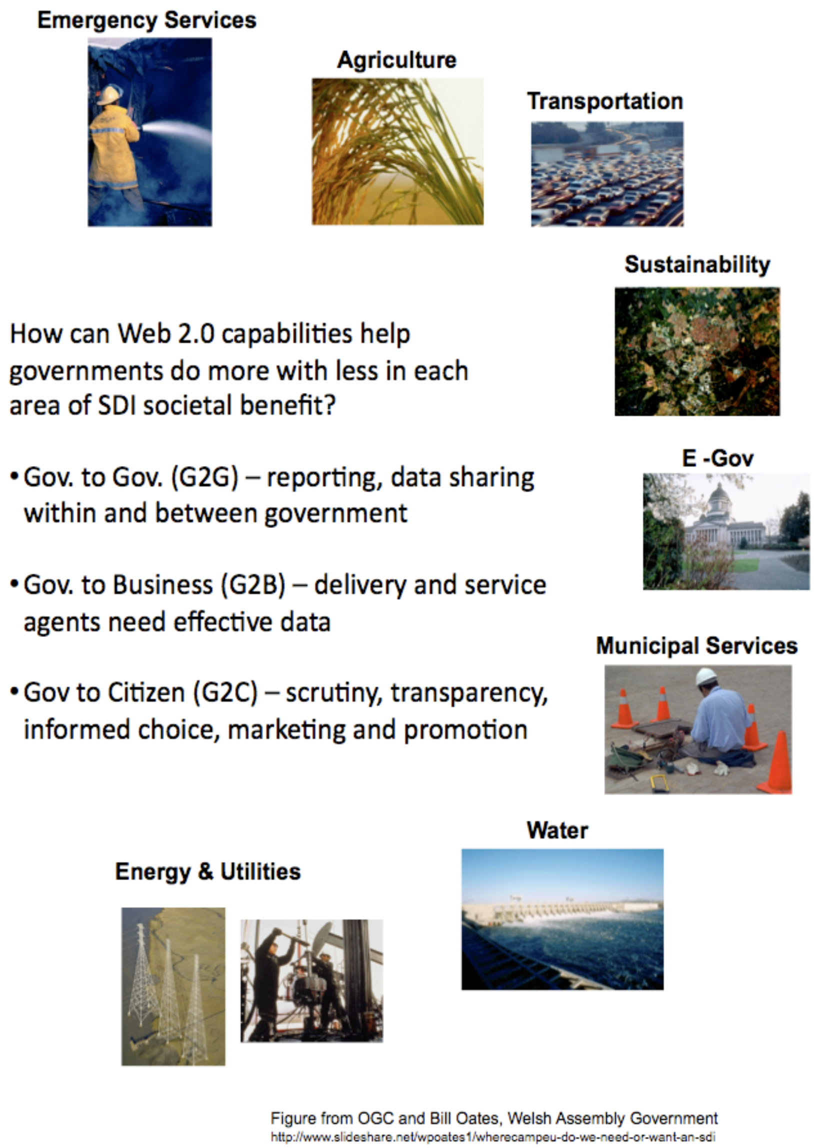

Figure 12: An SDI is a complex web composed of different kinds of interactions undertaken to achieve different kinds of societal benefits. Some G2G, G2B and G2C purposes are well served by Web 2.0 approaches, and others aren't.

Oates' review of the business problems an SDI solves include those in the text in Figure 12. The images in that figure depict SDI application domains in which such business problems arise.

Traditionally, users of geospatial technologies have developed tools and techniques targeted towards formal applications that require precision and accuracy. In some cases, those tools and techniques may remain viable for many years to come. In other cases, ICT advances, geospatial and otherwise, may have inflicted "creative destruction" (a concept popularized by the economist Joseph Schumpeter) on the traditional tools and techniques. Old ways eventually become obsolete, impractical, and marginalized.

The new SDI 2.0 tools and practices enable creative SDI managers to approach some kinds of problems in new ways. Web sites can open governments to their constituents, engage them in governance and provide information 24 hours a day. Many communities find that modern tools and technologies of communication and community building make a real difference in residents' quality of life, and some of these tools and technologies involve geospatial information.

But there are also limits to what can be accomplished today with SDI 2.0 solutions, and some of these limits are likely to be in place for a long time. Crowd-sourced information produces non-uniform coverage, and search engine discovery is unlikely to displace all discovery systems based on registries of metadata. Many uses of geospatial data require data that has been collected professionally using precise instruments and formal methods, and sometimes it is critical that the data has been documented with good metadata. Many applications in the geospatial domain are useful because they have evolved over the years to meet exacting requirements, and it is difficult to imagine today's geoweb providing alternatives to such applications. However, the geoweb might be useful in some ways, adding, for example, new ways to disseminate information or supply ground truthing – ways to validate the content.

Part 4. Place-based policies

An August 11, 2009 Obama Administration "Memorandum for the Heads of Executive Departments and Agencies" from Peter R. Orszag, Office of Management and Budget; Melody Barnes, Domestic Policy Council; Adolfo Carrion, Office of Urban Affairs; and Lawrence Summers, National Economic Council is titled "Developing Effective Place-Based Policies for the FY 2011 Budget" (www.whitehouse.gov/omb/assets/memoranda_fy2009/m09-28.pdf). The memorandum "outlines policy principles meant to advance the Administration’s domestic and fiscal priorities and to increase the impact of government dollars by leveraging place-conscious planning and place-based programming.... Effective place-based policies can influence how rural and metropolitan areas develop, how well they function as places to live, work, operate a business, preserve heritage, and more. Such policies can also streamline otherwise redundant and disconnected programs.... Change comes from the community level and often through partnership; complex problems require flexible, integrated solutions. ... To the extent possible, programs should allow for communities to identify distinct needs and address them in appropriate, strategic ways."

This kind of policy advice, which is also part of the policy environment in other nations (such as the Scottish Government’s “Spaces, Faces and Places” strategy - http://www.scotland.gov.uk/Publications/2005/08/31114510/45128), can provide a rationale for SDI 2.0 initiatives, because it encourages bottom-up, grass-roots involvement of citizens and local officials and organizations. Place based policies recognize that places are unique and interdependent, and that input from people "on the ground" is necessary to overcome many kinds of problems, such as inefficiencies due to jurisdictional fragmentation and data fiefdoms. Place-based policies -- and SDI 2.0 solutions that elicit local knowledge in communities -- are useful in activities such as education, energy and sustainability planning, neighborhood organizing and planning, land use planning ("smart growth"), public health and business development. Objectives that some may see as a poor investment of tax dollars -- empowerment and inclusion of marginalized populations, optimizing access to social services, and establishing land rights or locally popular natural resource management regimes -- are more likely to be met and more likely to provide a national economic return if they have a strong foundation of community involvement. SDI 2.0 can potentially lead to empowerment of large segments of the population who lack skills and authority.

User-generated geographic content, or Volunteered Geographic Information, can require some effort "out in the world" on the part of users, such as OpenStreetMap, or it can require just a few keystrokes such as users employ to create Flickr tags for colloquial place names for photos. Some government municipalities in North America are using Web 2.0 applications to gather information about road pot-holes and graffiti. Such information is useful and it can be provided by people with no knowledge of surveying or Geographical Information Systems (GIS).

There are many other examples:

- TomTom, the Dutch manufacturer of automotive navigation systems (and the company that recently purchased Tele Atlas, a major, global digital map maker) offers an information product called Speed Profiles. Speed Profiles aggregates and enhances real speed data from millions of GPS-enabled devices, using consumer driving patterns to provide true average speeds on individual road segments. Such information might be delivered to drivers -- or perhaps municipal transportation and emergency response employees -- through a municipal web site or web service. Or, if such information is easily available to drivers through commercial services, this could become an SDI capability the municipality no longer needs to spend tax money on.
- WikiMapia is a proprietary online service that combines Google Maps with a wiki system that enables users to add notes to Earth locations.
- Crime mapping is used by law enforcement agencies to map, visualize, and analyze crime incident patterns, and some applications accept citizen input.
- There are SDI 2.0 services for: guiding disabled persons for access and travel, putting map libraries online, bicycle and pedestrian routing, disaster relief, street views for historical photos, bus routes and real-time schedules, orienteering and hiking, and many other functions. These may be offered as ordinary websites, iPhone location applications, and Android tools and applications.

Web 2.0 tools don't always directly involve individual citizens. Landgate (formerly Department of Land Information) in Western Australia is participating in a pilot project to demonstrate the usefulness of linking health and spatial data. This is to advance spatial analysis for improved decision making in the field of health. In collaboration with the Cooperative Research Centre for Spatial Information (CRC-SI), the Department of Health and Curtin University, the project will develop a Spatial Health Intelligence Platform, establish a trusted network of health operators across the country and form the basis of further bodies of work in this space over the next several years.

Most decisions by individuals, businesses, organizations, agencies and elected officials are based partly on geospatial information. Sometimes it is sufficient to have a stable, authoritative source of geospatial information to refer to, but in other cases there is a back and forth or multiparty information flow involved. This requires interoperability between systems and the data or information being shared. Ultimately, governments will find that there are appropriate uses for both "action driven" SDI 2.0 solutions and the more traditional "process driven" solutions that involve experts (Kishor 2009). These SDI 2.0 solutions will be structured to support complex analysis and ultimately produce authoritative geospatial information. Sometimes one approach will be used to validate or support the other. Sometimes interactive web services whose content is partly user-provided will enable agencies to provide services at lower cost.

We can expect that as SDI managers become more adept at making choices about SDI 2.0 solutions, the playing field will also change as ICT technologies, tools and methods continue to evolve. But it's reasonable to believe that experience gained in this early period of Web 2.0 (while Web 2.0 has a distinct identity) will prepare people for the changes to come and allow them to share information quickly and be more responsive.

Part 5. OGC standards and SDI 2.0

For many years now, OGC standards and programs have been applied to address a range of interoperability requirements significant to SDI managers worldwide. Hundreds of products implementing geospatial standards of the OGC, ISO and complementary open standards are available in the marketplace. These geospatial standards underpin community geospatial solutions from local to international levels.

Policies that encourage use of these standards are helping to improve geospatial information sharing and are enabling technologies to be mobilized more quickly at lower cost. OGC's cooperative activities with other Standards Development Organizations (SDOs; Figure 13) increase the value of the standards by ensuring their usefulness across organizations and jurisdictions. The OGC's strong lifecycle standards maintenance program is responsive to community needs and provides continuity and predictability that institutions require. These standards are now increasingly being included in Requests for Proposals and in geospatial software and service procurements.

Figure 13: Geospatial information cuts across many technology and application domains, hence OGC works closely with many other standards development organizations (SDOs)

The OGC's focus has been on offering business value to members and the wider geospatial industry. This has been achieved by creating a robust, comprehensive and self-consistent platform of standards to support organizations that have made major investments in geospatial technology and data. The scope of OGC's work has steadily expanded to address a plethora of application areas. Notably, the Sensor Web Enablement activity has produced the largest set of additional standards, but the list of OGC Domain Working Groups (http://www.opengeospatial.org/projects/groups/wg) indicates the breadth of other activity:

- 3D Information Management
- Architecture
- Catalog
- Coordinate Reference System
- Coverages
- Data Preservation
- Data Quality
- Decision Support
- Defense and Intelligence

- Earth Systems Science
- Geo Rights Management
- Geography Markup Language
- Geometry
- Geosemantics
- Hydrology
- Location Services
- Mass Market Geo
- Metadata
- Meteorology and Oceans
- Oblique Imagery
- Risk and Crisis Management
- Security
- Sensor Web Enablement
- University
- Web Feature Service
- Workflow

The OGC community and OGC membership have expanded every year, and a large number of the world's major geospatial companies and agencies are members. However, there is still plenty of scope to grow the membership as standards become more widely accepted and implemented across the world. Several of the largest ICT platform companies in the world, such as Google, IBM, Microsoft and Oracle are also members who contribute to OGC standards. OGC and its standards are well established and with this momentum behind the organization it is well placed to help the SDI community.

But the geoweb poses a particular challenge to OGC and the OGC membership.. The geoweb has several hundred times more users than the legacy geospatial world and geoweb developers often don't find the encodings and interfaces they need in the OGC baseline of standards. This means that they don't deem it worthwhile to participate in the consensus process involved in defining OGC standards.

A central fact about the geoweb is that web developers do not need to be geospatial technology experts to implement "mash-ups" and other "geo-hacks" that bring geospatial information and services into their applications. This lowering of the barrier to entry into geoprocessing is a natural product of the growing power of the web platform and the evolution of geospatial industry business models.

It shouldn't surprise anyone that developers with ready access to "pluggable" location service components might not appreciate the value of OGC standards. Most such developers have not been through the agony of trying to use geospatial data from multiple non-interoperable sources. And web developers are very often racing against time, trying to preempt competitors and gain "first mover advantage." They don't have time to participate in a consensus standards process. And they are also typically building transactional applications that need to be highly efficient because the number of transactions is large and the acceptable response times are short. The spatial data they need to create, store and process is typically in very small packages, and the smaller the better. So most geoweb developers implement compact, special purpose encodings and interfaces rather than implementing the OGC's consensus standard encodings and interfaces. This is because the OGC standards carry baggage that's necessary to enable interoperability among diverse systems. But for most purposes, the baggage is actually quite lightweight.

Consider, for example, GeoRSS (http://www.georss.org/), a geoweb standard developed outside of the OGC. It is designed to meet the requirement of some RSS applications to include one or more pairs of coordinates in an RSS feed. The GeoRSS website provides this example of the two flavors of GeoRSS:

Simple GeoRSS:

<georss:point>45.256 -71.92</georss:point>
and GML GeoRSS or "Pro" GeoRSS, developed with input from the OGC:
<gml:Point>
<gml:pos>45.256 -71.92</gml:pos>
</gml:Point>

The number of extra bytes necessary to make the encoding compatible with the very large world of OGC Geography Markup Language (GML) Encoding Standard compliant applications is very slight, but sufficient to turn some developers away. (See the OGC White Paper that describes GeoRSS (http://portal.opengeospatial.org/files/?artifact_id=15755) and provides a number of use cases.) It is also the case that some developers don't realize that GML and some other OGC standards can be implemented as stripped down, tailored profiles and application schemas.

If a geoweb project leads to the creation of a successful company, there are many reasons why the company will begin to see their proprietary encodings and interfaces as baggage. The company may want to share their data to enable interoperability with a major social networking website, for example. Or perhaps several social networking websites will agree to share data for some purpose, and they will settle on an OGC standard that gives them access to a vast, distributed collection of spatial data and processing resources. Or perhaps a larger company will want to buy the successful geoweb company, but lack of a standards-based encoding will constitute a sales objection. Or perhaps the successful geoweb company will want to purchase components to expand the company's processing capabilities, and customizing the standards-based components will prove costly.

It is instructive for geoweb developers to consider KML, the encoding schema for Google Maps and Google Earth, since it is 'lighter' than GML. KML was brought into the OGC by Google and is now an OGC standard. In April 2008, KML version 2.2 was officially adopted by the OGC membership as an OGC standard. (http://www.opengeospatial.org/standards/kml.) KML (originally Keyhole Markup Language) is now the OGC standard for annotation and visualization on existing or future web-based online maps (2d) and Earth browsers (3d), from any provider. Through the OGC standards process, KML has become more aligned with international best practices and standards, thereby enabling greater uptake and interoperability of Earth browser implementations. KML 2.2's consistency with the OGC's other standards (http://www.opengeospatial.org/standards) means that developers will face fewer obstacles bringing content from other kinds of geospatial systems into Earth visualization systems. For example, work products created using a Geographic Information System (GIS), tracking system, Earth imaging system, or "sensor web" (Web-based sensor network) will be easily displayed with other data employing widely used browser-based systems. For example, a KML file could contain locations of hiking trails (stored as GPS coordinates or street addresses) overlaid on a highway map or on remotely sensed imagery of a wilderness area. Similarly, data encoded in GML from applications implementing the OGC Web Feature Service (WFS) standard can readily be styled to KML for visual presentation.

The OGC invites other companies to release their interfaces and encodings into the OGC process to become open standards. Harmonization of incoming standards with the OGC baseline, though it may happen, is not a requirement. The OGC is a smart place to bring well-used and open but proprietary standards, simply because the OGC global lifecycle management process is tried, proven and trusted. At all levels in the OGC organization, there is recognition that de facto standards (such as KML) and consensus standards in the marketplace will more effectively serve users needs if the de facto standards are delivered into the OGC process to be managed collaboratively by the OGC membership, which represents the interoperability requirements of the world community of geospatial technology users and developers. OGC standards can derive from open source projects, proprietary commercial products or the development work of the consortium itself. Both open source projects and vendors of proprietary software recognize that in many cases it pays to release an interface or encoding into an open standards process, because doing so can expand markets, reduce development costs, create good will and simplify partnering arrangements.

Geoweb in OGC testbeds

In addition to the geoweb efforts described above, a considerable amount of work relevant to the geoweb has been done in recent OGC Testbeds:

A scenario in the 2008 OWS-6 Testbed (OWS stands for OGC Web Services) involved an actual implementation in Taiwan of SWE standards and chained Web services in a working debris flow detection system. In parts of Taiwan—due to terrain, weather and geology—some upland river valleys are subject to sudden and dangerous flows of earth and boulders, so it's important to provide alerts and warnings. This scenario involved alerts, notifications, grid processing and real-time event architecture.

The Aviation Thread in the current OWS-7 Testbed is investigating and will demonstrate the applicability of the Aeronautical Information Exchange Model (AIXM) and the Weather Information Exchange Model (WXXM) in an OGC Web Services environment. These models and web services are part of applications and tools that support Airline Operations Centers and Flight Dispatch applications in the net-centric System Wide Information Management (SWIM)-related components of the US NextGen and European Union's SESAR programs. Such applications provide information for representing a Common

Operating Picture; supporting flight planning (including General Aviation) and preparation (MET and AIM); calculating weight and balance; estimating fuel requirements; in-flight emergency response; etc.

These applications are more heavy-weight than most geoweb applications and they are subject to rigorous security and reliability constraints. But they have much in common with the geoweb. They are designed to bring in information from diverse public information sources; they are highly interactive, involving a wide range of stakeholders; and their requirements for frequently updated contingent routing plans parallel those of some public road navigation services. They rely heavily on GML schema to enable communications within and across communities of use (AIXM, WeatherXML, CityGML, MarineXML, etc).

Other OGC standards efforts relevant to the geoweb include:

The OGC Open Location Services Interface Standard (OpenLS) specifies interfaces that enable companies in the Location Based Services (LBS) value chain to "hook up" and provide their pieces of applications such as emergency response (E-911, for example), personal navigator, traffic information service, proximity service, location recall, mobile field service, travel directions, restaurant finder, corporate asset locator, concierge, routing, vector map portrayal and interaction, friend finder, and geography voice-graphics. These applications are enabled by interfaces that implement OpenLS services such as a Directory Service, Gateway Service, Geocoder Service, Presentation (Map Portrayal) Service and others. Telecommunications companies have implemented OpenLS, often with modifications, in their "walled garden" application environments, because it concisely meets a number of critical requirements. As these companies' business models evolve in the direction of closer cooperation with their competitors, it is likely that their use of this standard will prove beneficial to them and to their customers. The OGC Web Services, Phase 6 (OWS-6) Testbed activity completed in June 2009. The Decision Support Thread in OWS-6 (see Figure 14) included the development of a prototype Outdoor and Indoor 3D Routing Service designed to provide navigation information that lets users easily find out how to get to their chosen destination in a city environment. CityGML is the accepted standard for describing 3D data sets for city environments, including buildings. But CityGML does not currently include a data model for routing information. By adding the network topology, path routing was performed seamlessly and efficiently between the outdoor and indoor environments.

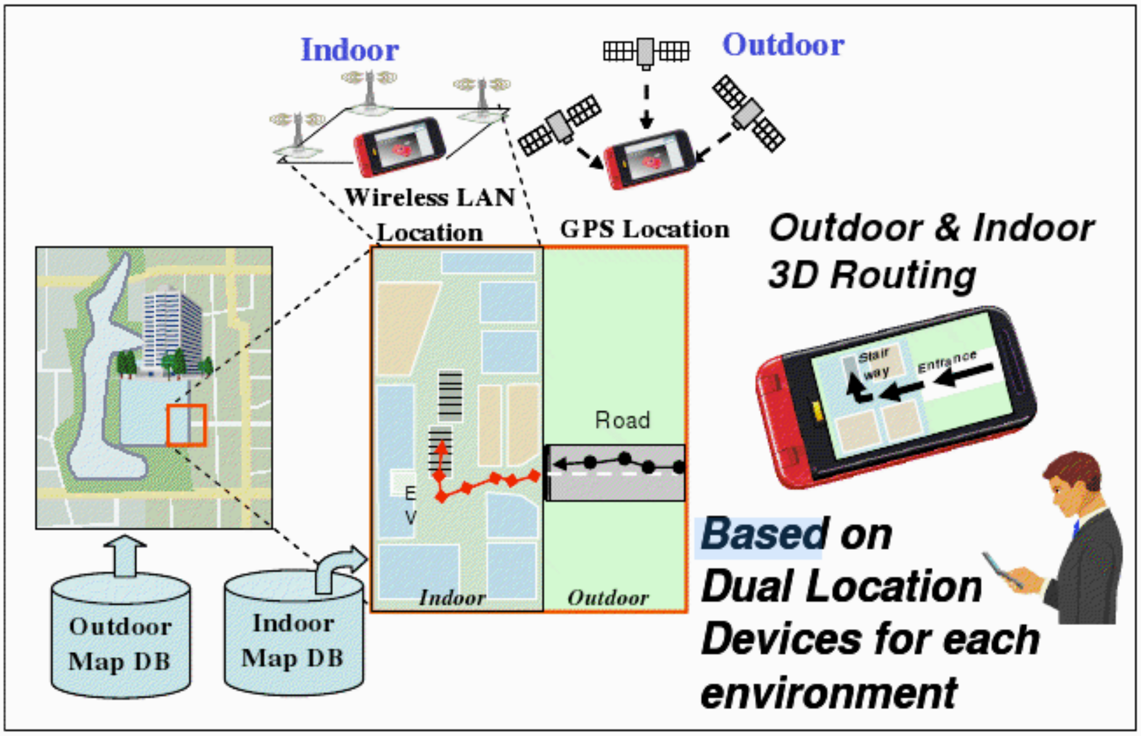

Figure 14: The OGC's OWS-6 Testbed made a significant contribution to the eventual standardization of methods for combining indoor and outdoor routing

The IETF (Internet Engineering Task Force) GeoPriv Working Group's PIDF-LO Geometry Shape Application Schema coordinate location payloads is encoded as a GML application schema. This payload encoding is now being incorporated in numerous other internet standards. There will be efficiencies potentially available to many geoweb and cloud computing applications in using the "raw" internet location encoding. (Location-based services need to securely gather and transfer location information for location services, and at the same time protect the privacy of the individuals involved. GeoPRIV describes an architecture for privacy-preserving location-based services in the Internet.)

The OGC City Geography Markup Language (CityGML) Encoding Standard (http://www.opengeospatial.org/standards/citygml) is in official use in several cities and regions in Europe. It provides Web-based sharing of urban models, design drawings and other data and services. CityGML provides the means for applications to manage multiple levels of detail. It will almost certainly play a role in the evolution of geoweb urban navigation, because it performs well and it is entirely based on open Web service standards.

In February, the OGC and the buildingSmart alliance (bSa) released a report, "Summary of the Architecture, Engineering, Construction, Owner Operator Phase 1 (AECOO-1) Joint Testbed." The report summarizes results of a nine-month effort in the OGC's Interoperability Program to increase interoperability among software systems used by architects, construction companies, cost estimators and building energy analysts. The AECOO-1 Testbed was jointly led by the bSa and the OGC, with participation from architecture firms, general contractors, government agencies, and trade associations including the American Institute of Architects and the Large Firm Roundtable. This collaboration has brought the OGC into a new industry domain, "Building Information Models" (BIM). One of the anticipated results of BIM standards is common use of 3D building models that are rich with information about spaces and building components. Subsets of these very detailed models will be leveraged to create various building representations to support a range of activities such as safety and security, retail service location, energy management and building maintenance. Through these activities, the OGC is on track to play a role in the development of indoor location standards, which will be essential to geoweb applications that access and deliver information about building interiors and contents.

The OGC has played a major role in coordinating the development of the basic technical foundation of a service oriented architecture for the Global Earth Observation System Of Systems (GEOSS) (http://www.earthobservations.org/). The OGC is leading AIP-3, the third year of the GEOSS Architecture Implementation Pilot. AIP-3 will involve multiple participants in developing and demonstrating standards-based multi-vendor solutions related to disaster management of floods caused by tropical storms, hurricanes, cyclones, and tsunamis. An Emergency Route Planning Service will use the OGC OpenLS route service and there will be interactive visualization of digital terrain models and 3D landscape and city models. Applications will access data layers on population, settlement points, urban extents, intercity roads, and related topics, and they will use client interfaces based on the Google Maps API and OpenLayers. Scientific workflow and a sensor event service for river flow alerts will be shown. Similar complex scenarios will be addressed in the areas of water quality and drought, energy, health, biodiversity & climate change, and data harmonization. GEOSS and the AIP-3 are, among other things, advancing geoweb applications for science and for disaster management. This is very much at the "bleeding edge" of geoweb technology, because the requirements and back-end processing services are so complex. But the solutions that result, as well as the extended cooperation among the OGC, IEEE and ISPRS, will lay the groundwork for more capable geoweb applications than are available today.

Sensorpedia (http://www.sensorpedia.com), a program developed by Oak Ridge National Laboratory, networks users based on mutual information interests. It applies design principles common to popular Web 2.0 sites:

- Use of a URL as the common denominator for referencing specific pieces of data
- Access control based on social networking and groups of trusted users
- A flexible tag-based classification scheme in place of a fixed hierarchy of information
- Simple Application Programming Interface (API) supporting the creation of data “mashups” from multiple data sources
- Publish-subscribe mechanism enabling automated notification of data updates

Sensorpedia provides a Google Maps interface through which users can search and explore published sensor data. The Sensorpedia API uses web services designed to accept and publish data using established standards such as the Atom Syndication Format and GeoRSS and it relies on open data portability standards such as OpenSocial, OpenID, and OAuth to ensure interoperability with other web-based software applications. Sensorpedia also interfaces with sensor systems based on the OGC's Sensor Web Enablement (SWE) standards.

Sensorpedia is an important example of how sensors will figure into the Geoweb. Sensors can be fixed or carried on moving objects, and human beings can serve as sensors. Humans serve as sensors in "citizen science" projects such as the Christmas bird count and Project GLOBE. The number of sensors and sensor applications is increasing rapidly. Cell phones transmit geocoded information, credit cards and wifi hotspots tell where we've been, and internet-connected sensors of all kinds are being used in a wide variety of applications. Sensors will play a major role in the geoweb, but the applications will be limited and isolated if they don't provide for the use of OGC SWE standards (Figure 15).

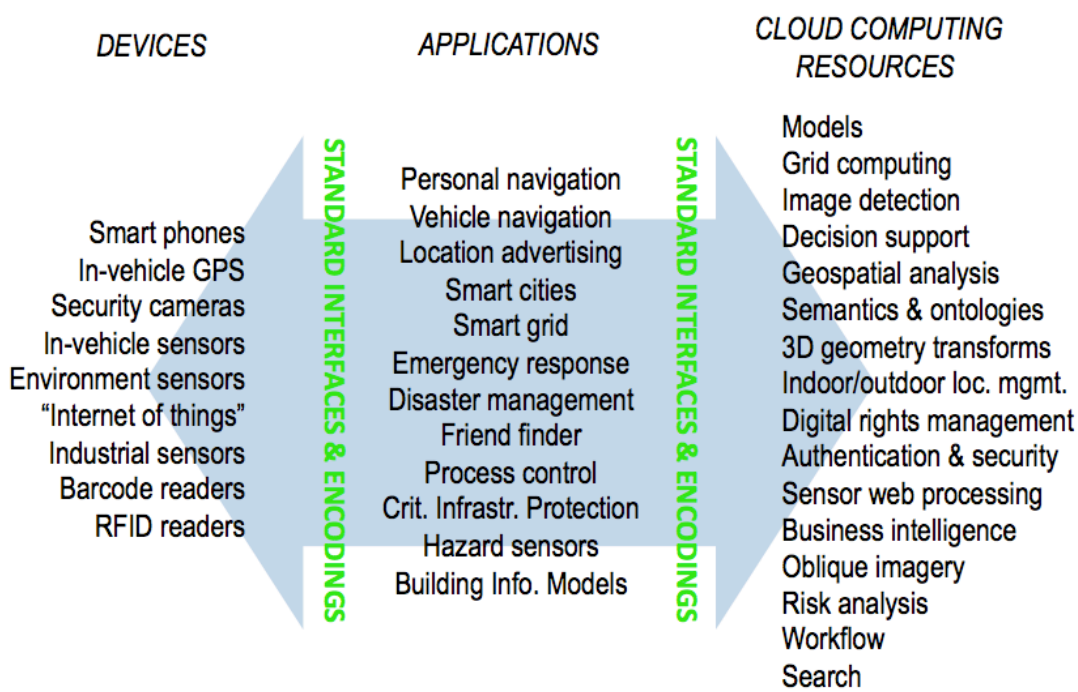

Figure 15: Through standards, applications will communicate in a "loosely coupled," vendor-neutral fashion with both devices and "heavy" processing resources

The geoweb in spatial law and policy

Now, both public sector and private sector users and providers of geospatial data and technologies face a wide range of legal issues associated with growth in consumer and business applications for spatial technology. Such applications include Earth browsers, satellite navigation devices in cars and PDAs, location based services associated with cell phones, business intelligence, social networking and satellite tracking of vehicles and equipment. All of these applications potentially raise issues that involve intellectual property rights, liability, privacy, and national security. In many cases, the existing legal and policy framework is inadequate to provide governments, businesses and consumers clear guidance on these issues.

In response to this growing situation of legal and policy uncertainty, OGC established a Spatial Law and Policy Committee (SLPC). The purpose is to 1) better understand legal and policy implications of geospatial information and technology use, and to 2) influence geospatial information technology standards development requirements in the OGC. It will help OGC to be responsive to the range of policy and legal positions that will exist worldwide. In the past, legal issues associated with spatial data and technology were primarily a concern for lawyers that worked with or for the government.

The SLPC will provide an open forum for OGC members' legal and policy advisors to discuss the unique legal and policy issues associated with spatial data and technology. The Committee will also work with relevant legal groups, and professional organizations, to raise awareness of these issues within the broader legal community. The SLPC will not provide legal advice to the OGC or its Members and will not take a position on any legal or policy matter on behalf of the OGC or its membership. It will rather focus on clarification of the legal and policy environment of the Consortium and work to ensure that Consortium standards reflect related best practices and the societal requirements that shape institutional uptake of interoperable geoprocessing.

A number of law and policy issues are particularly relevant for geoweb applications. (See Kevin Pomfret's Spatial Law and Policy Blog http://spatiallaw.blogspot.com/.)Where users are providing crowd-sourced information (often a collection of assertions), quality, trust, reputation and liability are potential issues. And map browsers that show land parcels run into objections because parcel sharing is a controversial issue, and some countries, notably India and China, impose severe restrictions on display of maps.

Conclusion

Standards from the OGC, ISO and other standards development organizations underpin the interoperability best practices of GSDI, but geospatial interoperability is not yet well established in the still-young geoweb. SDI success stories and geoweb success stories are ample and growing, but the union of SDIs and the geoweb is still an area for discovery and experimentation. In SDIs we are enabling the fusion of real-time sensor feeds with geospatial information for improved situational awareness and decision making, but implementations of the important standards infrastructure for geoweb-style sensor webs are only beginning to become established. In some domains -- ocean observation, Earth observation and urban planning and management, we are uniting (and bridging) communities of interest that wish to improve discovery, access and application of geospatial information. In these domains and others, established and widely implemented OGC Web Service standards will continue to provide the technical footing for institutional interoperability.

The geoweb can be expected to provide certain kinds of new capabilities and deliver spatial services to new user communities. It will become more powerful as geoweb developers and the OGC find new common ground for standards that enable improved geoweb interoperability and improved connection between the geoweb and the industrial strength technologies that have evolved in the legacy geospatial technology markets. The best way for SDI managers to begin is to learn about the geoweb and experiment with small scale implementations, and imagine ways that the geoweb can provide accessory functions in the government-to-government, government-to-business (and business-to-government) and government-to-citizen (and citizen-to-government) communications involved in various SDI application domains.

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Efficient way of usability evaluation of Web-based GIS applications

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Introduction

Accessibility of spatial information to all users, regardless their knowledge and skill in the GIS field and their equipment, belongs to contemporary development trends. Web-based geographic information systems (GIS) are able to ensure this kind of service. Of course, only software of a very high quality should be used for this purpose. Software quality can be evaluated for example by the ISO/IEC 9126 standard. According to the standard, usability belongs to the six basic software quality characteristics. Usability is the only quality characteristics focused on software users and ability of software to efficiently meet user's requirements. Many various qualitative and quantitative experimental methods exist which can be used for usability evaluation. However, a specific way of usability evaluation must be proposed to perfectly comply with evaluated application, its specificity and aims of evaluation. Authors previously run many experimental measurements – usability evaluations of Web-based GIS applications which were focused on citizens, tourists and businessmen, i.e. casual end-users. In the contribution, a suitable way of usability evaluation of Web-based GIS applications for casual end-users is briefly described, based on previous authors' experience and obtained experimental results. The proposal takes into account specificity of this kind of applications. Proposed way of usability evaluation includes both representatives of real users and experts and allows obtaining both qualitative and quantitative results. Issues connected to costs and benefits of usability evaluation are discussed as well.

Web-based GIS applications

Users increasingly require easy and remote access to spatial data and geo-services. Many new technologies geo-enabling the Web, smartphone applications, etc. have arisen and they are quite popular today because they add several interesting functions and they usually allow interactive work of users. Web-based GIS applications belong to them.

Web-based GIS are applications focused on end users who usually do not have any knowledge and skills from this field. Aim of this kind of applications is to provide users an easy and remote access to spatial data and services by means of Web technologies and protocols, like HTTP. Equipment of users (i.e. their hardware, software and Internet connection) can be very different. It means that applications should be able to run on all of platforms and they should be very easy to use.

Web-based GIS applications provide in general the following functions to their users (Tsou (2004)):

- Data storage and maintenance
- Spatial analyses, e.g. queries and route planning
- Visualisation of spatial information and results of analyses.

Some of the functions are used by end users directly, some of them are used by end users only indirectly (namely data storage). For more detailed view, it is important to define precisely target group of users. User classification slightly differs from author to author. At least the following basic types of users should be distinguished (Komarkova, et al., (2007), Peng and Tsou (2003)):

- Casual end-users, like citizens, tourists, business partners, etc. They use Web-based GIS applications casually and irregularly. A very low level of the digital literacy must be still expected. No GIS knowledge and skills can be assumed and assured because users cannot undergo any training. Their equipment is very different, they can use any existing hardware and software (primarily Web browser and operating system). They may not be able to install any software and their Internet connection can be slow. On the other side, only a few basic functions are usually needed by them. They at most need to set their region of interest, display geographic information, change scale, run very simple queries and print outputs or save resulting map as an image. Selection of appropriate data layers and saving URL of resulting maps can represent additional interesting functions.

- Regular end-users, e.g. employees, like civil servants, regular customers, cooperating partners, etc. Regular and everyday utilization of Web-based GIS applications is quite typical for this group of users. They usually use only several functions but some functions may be very specific. All required functions can be identified in advance. Users can be trained in if it is necessary, and they repeatedly use the functions and tools. The next advantage is connected to their hardware and software – it can be identified and they usually use similar or the same equipment (e.g. appointed Web browser or another client software). In the case of necessity the equipment of users can be influenced.

- High-end users, usually GIS specialists who collect, prepare and process data, run spatial analyses, and provide results of their work to the other users. They do not belong to the main target group of users of Web-based GIS.

- Mobile users, i.e. rapidly growing group of people who use mobile devices like navigations and smartphones. Mobile device is the most important specific characteristic of this group. Mobile device causes some limitations for applications, e.g. due to the display size of the device. Users themselves can vary from casual end users to high-end users. The set of demanded functions is usually limited but some special functions may be needed (e.g. disconnected editing of data).

Usual architecture of Web-based GIS is the three-tier client/server architecture. According to the principles of the architecture, the following three main tiers can be recognized (Alter (2002), Peng and Tsou (2003)):

- Data tier – spatial and non-spatial data, their management (may be implemented as a database management system) and granting user permissions

- Application (logic) tier – functionality of an application, i.e. data processing; at minimum map application server and Web server must be available in the case of Web-based GIS

- Presentation tier – user interface (UI); user enters queries by means of it and obtains results so this part must be understandable, learnable and easy to use to be user-friendly.

Usability and its Evaluation

The usability of a user interface becomes extraordinary important in today's information age. The discipline dealing with it, so called usability engineering, is a quite new one in terms of the history, experience and number of trained people. But an importance of the usability evaluation has increased rapidly in last 10 years (Nielsen (1999)). In contrast to the past, users are no longer forced to use particular product that does not fully satisfy their needs or requirements, just because there is no other product available. That is also why the measuring of usability had been previously underestimated.

Usability is software quality characteristics. It is the only ISO 9126 quality characteristics focused on users.

According to the available definitions (e.g. Fenton and Pfleeger (1997), Folmer and Bosch (2004), ISO (1998)) usability can be understood as "an ability of an information system to meet both all explicit (i.e. expressed) user's requirements and his/her implicit needs in a given context of use, so user will not experience any problems with user interface during fulfilling typical tasks and he will be able to fulfil tasks in an appropriate time" (Komárková, et al., (2011)). At present, usability and its evaluation belong to fundamental parts of software engineering (Nielsen (1995)). Usability can reveal qualities of a product as well as a lack of its functionality. Usability can be for example measured by means of several measures given by the standard ISO 9241-11 (ISO (1998)):

- Effectiveness measures: e.g. achieved percentage of successfully fulfilled tasks
- Efficiency measures: e.g. time necessary to complete a task
- Satisfaction measures: e.g. rating scale for satisfaction.

Usability can be evaluated by means of usability evaluation methods. According to the Gray and Salzman (1998), the term "usability evaluation method" is used to refer to any method or technique performing a usability evaluation of UI at any stage of its development life cycle. In Scholtz (2004) the usability evaluation methods are divided into three main groups (e.g. Ivory (2001) states five groups):

- User-centred evaluations (usability testing methods)
- Expert-based evaluations (inspection methods)
- Model-based evaluations.

These methods differ depending on the source used for the evaluation. This source can be users, usability experts, or models. All three types of methods rely on usability engineers or usability professionals to design, conduct, analyze, and report on the evaluations (Ivory (2001), Komarkova, et al., (2007)). Several suitable methods are listed in the Table 1. It is shown at which phases of the system development life cycle (SDLC) they can be used.

Method	Analysis	Design	Testing
Card Sorting	x		
Contextual interviews	x		
Focus groups	x		
Heuristic evaluation		x	x
Individual interviews	x	x	x
Parallel design		x	
On-line survey	x	x	x
Task analysis	x		
User testing	x	x	x
Use cases	x		

Table 1: Evaluation methods

As stated in Nielsen (1995), user testing with real users is the most fundamental usability evaluation method. In some sense, it is irreplaceable since it provides direct information about how end users use evaluated products and what their exact problems are with the concrete interface being tested. During usability testing, participants use the system or a prototype to complete a specified set of tasks while the evaluator or specialized software records the results of the participants' work. The evaluator then uses these results to derive usability measures, such as the number of errors and task completion time (Nielsen (1995), Shneiderman and Plaisant (2004)). Nielsen (1999) states that a usability test, where five participants take part, usually reveals approx. 80 % of the site-level usability problems (e.g. navigation) and 50 % of the page-level problems (e.g., understandability of the navigation structure).

In contrast to a user-centred evaluation, a usability inspection consists of evaluation methods whereby an evaluator examines the usability aspects of a UI design with a respect to its conformance to a set of guidelines (Ivory (2001)). The fundamental goal of all inspection methods is to find usability problems in an existing interface design and then use these problems to make recommendations for improving the usability of an interface (Nielsen (1995)). Guidelines can range from highly specific recommendations to broad principles.

Unlike the other usability evaluation methods, inspection methods fully rely on evaluator's judgment. A large number of detailed usability guidelines have been developed for web interfaces, some of them can be found for instance in (Nielsen (1995), Lynch and Horton (1999)). Commonly used inspection techniques are heuristic evaluation (Nielsen (1995)) and cognitive walkthroughs (Lewis, et al., (1990)). The former is considered easy to learn, while the latter is considered neither as easy to learn nor easy to apply (Nielsen and Mack (1994)).

In heuristic evaluation, one or more evaluators independently evaluate an interface using a list of heuristics. After evaluating the interface, the evaluators aggregate their findings and associate severity ratings with each potential usability problem. The output of this evaluation is typically a list of possible usability problems (Nielsen (1995)). A heuristic evaluation is the most informal inspection method (Nielsen and Mack (1994)), mainly because it relies on a small set of usability criteria. Since the heuristic evaluation is very cheap, fast and easy-to-use (Nielsen and Mack (1994)), it is therefore the most widely used inspection method (Scholtz (2004)). Studies as (Nielsen and Mack (1994)) have also shown that the simpler the technique, the more effective the method is for identifying usability problems. Actually, the most used usability evaluation methods are the user testing and heuristic evaluation. These methods have both advantages and disadvantages that are shown in the Table 2. The heuristic evaluation appears favourable for cheap and quick finding of the most significant usability faults of an existing user interface.

	Heuristic evaluation	User testing
Advantages	- Quick and cheep feedback for designers. - Easy of use. - Lower time demand. - Posibility of application of theoretical and practical experiences.	- Findings are drawn from behaviour of real users, - Some usability problems can not be revealed by other methods. - It is executed in real conditions and it is possible to meassure time necesèry for task completion.
Disadvantages	- Dependency on concrete person that is doing analysis. - Necessity of using quality heuristic criterias.	- Time and financial demands. - Dependency of results on participanta selection. - Necessity of multimedia equipment.

Table 2: Comparison of heuristic evaluation and user testing

Although there are several general recommendations available, usability evaluation procedure must be newly proposed or refined for each evaluation to precisely meet its aims and provide expected and useful results.

Proposed Methodology

After running many experiments and studies (e.g. Komarkova, J., et al., (2007, 2011) and many others), the following methodology how to run usability evaluation was proposed in Komárková, J., et al., (2011b):

1. Initialization – the first decision that usability testing should be done
2. Aims of the usability evaluation study – their precise formulation including decision whether quantitative or qualitative results should be collected
3. Proposal of possible usability evaluation methods
4. Consideration of costs and benefits of usability evaluation
5. Usability evaluation procedure proposal – final choice of suitable usability evaluation methods, precise plan on experiments, list of necessary tools, participants, evaluators, and equipment
6. Evaluation – running the whole evaluation according to previously established plans
7. Data analyses – suitable statistical methods can be used for quantitative results, audio and video records must be passed through, etc.
8. Results and proposals – interpretation of results

Usability engineering activities can result in various expenses reductions during the SDLC and in some cases in benefit increase too. Some of the benefits and expenses reductions are listed in Aaron (2005) but not all of the listed items suit to Web-based GIS. For example an increasing of software purchases does not suit, because Web-based GIS are usually free of charge for casual end users. Some of them even offer public services. Next example is increasing of market share (competitive edge) that cannot be used as well because Web-based GIS does not support any competition, at least in original meaning. Therefore it is necessary to select from existing business case studies and research works adequate components of revenue of usability investment in Web-based GIS and to suggest the own ones if some aspects are not published so far.

Possible expenses reductions:

- Reduction of qualified staff – well designed Web-based GIS can be used by the less qualified staff, e,g, at tourist information centres
- Reduction of user errors, increase of success rate – users find required information and they find it faster so they are satisfied and they do not need to call for help
- Decrease of support costs – organizations have both direct and indirect costs. These can be tracked both in technical support an in the hidden costs of co-workers helping each other. In one study it was estimated that this extra costs were many years ago even between \$6,000 and \$15,000 every year for every computer (Bulkeley (1992)). Usability improvements can reduce this cost

Benefits increase:

- Increase of user satisfaction – users easier and faster accomplish their goals so they are more satisfied
- Increase of an efficiency of decision processes – Web-based GIS can serve as a decision support system in many different cases. It can be used to make plans for holidays on one side and for emergency service on the other side
- Increase of trust in a system (e.g. public administration) – Stanford University's Web Credibility Project showed that "ease of use" was the second highest factor contributing to a customer's overall perception of credible Web site (Bisant Interactive (2002)). Another study clearly showed that user's trust can be significantly increased by providing relevant information when and where users need it (Egger and de Groot (2000)). If users trust in a system they will use it more effectively. For example a lot of people still do not trust in electronic tax returns or data boxes and therefore they visit offices so the service is more costly
- Learning increase – it is impossible to train external casual end users of Web-based GIS applications. Therefore external user interface must be extremely intuitive to let users quickly learn how to use it
- Security increase – usability tends to minimization of user errors that can result in security risk for whole information system.
- More leisure time as a result of productivity increase – users save time they would spend on non user-friendly user interface.

Some additional notes, how to improve efficiency of usability evaluation procedure:

- Nature and purpose of the study must be clearly determined in the very beginning. Quite different methods including number of participants should be chosen in the case of quantitative (e.g. comparison of applications to support choice of the best one) or qualitative (e.g. usability problems identification to improve the application) studies
- Target group of users and typical ways of utilization of the evaluated application should be described in the detail to focus evaluation exactly on the correct issues. There can be significant differences between applications for casual and regular end users
- It must be decided which functions/application features will be tested. The list should be derived from the previous item. In the case of Web-based GIS it should be decided if only specific functions would be tested, or cartographic issues and general Web controls would be included too. Testing needless functions means costs without any return. According to one experiment, the following functions are the most important for causal end users, even in the case they have some GIS knowledge and skills: zooming, panning, spatial and attribute database queries, network analyses, results saving, printing and sharing, data visualization controlling
- Availability of real users or their representatives

- Number of participants and evaluators – some of the participants can take part in the experiment for free but some of them may require some reward. A deep usability user testing of a larger Web site can last several hours
- Testing environment, necessary equipment
- Running cost benefit analysis to calculate costs and identify expected benefits
- Selection of the most suitable usability evaluation methods according to previous items
- Selection of a proper way of data collection and pre-processing – e.g. transforming large number of paper questionnaires into digital data can be costly
- Utilization of obtained results – it must be ensured from the beginning that obtained results will be used to improve the application. Without taking an action all the previous work was just wasting of time and money

Conclusion

As it was stated many times, applications should be user-friendly to support users in their activities and not to make their lives more complicated. Utilization of usability evaluation methods during the whole life cycle is a possible way how to improve a user interface of applications to be more user-friendly. Usable user interface can bring several benefits according to the type of an application and its users. On the other side, improving usability of an application can cause high additional costs of software development. So, it is important to plan usability evaluation procedure in a very detailed level, including cost benefit analysis, to do not waste money. In fact, each usability evaluation procedure must be planned to fit the evaluated application and meet requirements on evaluation. Evaluation of Web-based GIS applications is more difficult because both specific GIS functionality and common Web tools and controls should be evaluated. Several important issues connected to efficiency of Web-based GIS applications evaluation were pointed out.

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Alternative and User Centric Spatial Data Infrastructures in South-East Europe: Building spatial data infrastructures in South-East Europe: Alternatives, bottom up and user oriented approaches

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Introduction: SDIs and Some Characteristics

Spatial Data Infrastructures (SDIs) are formal arrangements with their main goal to provide access to geospatial data in a country, or across a given area or domain. Data is provided from several sources, and Spatial Data Infrastructures are distributed environments. SDIs normally use GIS and may grow out of the use of GIS (Geographic Information System) within a distributed infrastructure. However, whereas GIS comprise technology and data, Spatial Data Infrastructures require policy agreements and a proper organization that they can operate.

The goal of using Spatial Data Infrastructures is to share data between institutions, to realise and to foster services, and to enhance the diffusion of public data to other stakeholders, especially private companies and citizens therefore reducing costs,. SDIs may exist on several levels: on national level, initiated by national governments, making data available for a whole country, or on local or regional level, with arrangements valid only for a certain geographical region or for certain thematic areas. The use of geospatial data and SDIs has increased worldwide in the last two decades. Currently, there are about one hundred spatial data infrastructures at the national level and many other at supra- and sub-national levels [Budhathoki, et al., 2008].

Definitions of spatial data infrastructures emphasise the user of geospatial data, but practically, such infrastructures are initiated and established by data owners, which are often government authorities or administrations such as governmental mapping agencies. These spatial data infrastructures that we may call formal operate with two main assumptions: formal organizations are the producers and suppliers of geospatial information; users are the passive recipients of information. [Budhathoki, et al., 2008] This view is confirmed in [Budhathoki, 2010], where SDIs are called provider centric and providers only assume that their products and services satisfy user needs. Further, the users of spatial data infrastructures are normally not end-users, who are citizens or businesses, but rather specialists working in administrations [Boes, Pavlova, 2008].

Despite a growing interest in SDIs, several researchers notice problems in SDI development and research and state that the use of formal SDIs is not encouraging [Budhathoki, 2010].

The Internet as Enabler of New Spatial Data Infrastructures

Whereas SDIs were originally conceived as formal arrangements with national providers as the initiators, several deviations from this conception have taken place in recent years. There is a move to make geospatial data available on local level [Rix, Fast, 2010], and more and more user centered information services are becoming available [Budhathoki, 2010]. This cannot be dissociated from the development of technology [Boes, 2008], with both hardware and software becoming cheaper. New technology such as GPS, available now in digital cameras and mobile phones, has revolutionized the processes of spatial data creation. The use of maps and cartographic information on the Internet has led to several new disciplines and research areas. For instance, geospatial data has been made available for specific purposes to request user input in so-called Public Participatory GIS [Tulloch, 2007]. Other forms of use, combined with the phenomenon of the Web 2.0, have become even more popular and could be summarized by the term “cybercartography” [Tulloch, 2007]. Some authors suggest the name “Neogeography” [Coleman, et al., 2009] to define “geographical techniques and tools used for personal activities or for utilization by a non-expert group of users”; others have defined the term “Volunteered Geographic Information“ [Goodchild, 2007] for user generated geospatial content. As a consequence, the public at large has become aware of the use of maps and geospatial information.

Examples are abundant today. It was in fact the publication of Google Earth and Google maps in 2005 that created a revolution making maps available to the masses that is to non professionals. Google Earth allows easy editing of maps, to publish points of interests, to draw lines and polygons, to publish annotations, images or movies on a map. Users can create their own maps in using “My Maps”, launched by Google in 2007, in using a simple point and click interface. Google maps offer an API (Application Programming Interface) with JavaScript that is used by many to create mash-ups that is their own mapping application and insert their data into the maps provided by Google. Except Google Maps, other examples that could be quoted are Microsoft Virtual Earth and Bing Maps. Maps and location information is increasingly used in social networks. Geospatial data has become part of a mass market. It is argued that these satisfy a variety of needs within industry, government and social networking communities [Coleman, et al., 2009] that is otherwise not addressed by formal spatial data infrastructures.

A very interesting example is “CommonCensus” (http://www.commoncensus.org), displaying a map of the US. On this site, users are requested to document to which metropolitan area and territory they feel their identity most closely associated with. The result is a nationwide map that assigns every point in the country to a metropolitan area with which citizens are most closely associated [Tulloch, 2007]. This site has collected data from over 40,000 participants. It is interesting to note that this web site has been created by an individual who has no education in geography or statistics, and who did not have any support from government or NGOs.

Another, widely published example is OpenStreetMaps (http://www.openstreetmap.org/), which is a free editable map of the whole world completely created by laymen users. OpenStreetMap allows to view, edit and use geographical data in a collaborative way from anywhere on earth. Figure 16 shows the street map of Skopje in the Republic of Macedonia as created by its users.

Figure 16: The city of Skopje, Republic of Macedonia, in OpenStreetMaps

User generated information has proven to be particularly useful in the case of disasters [Boes, 2009a]. In many disasters, such as the Hurricane Katrina in August 2005, efforts to collect input both from victims and from volunteers ready to help have proven to be superior to formal support activities. Data are transmitted using mobile technology, which is in particular in Africa the main means of communication. Other Internet based applications use spatial information such as "Second Life" where users can create landscapes, cities and living environments which are essentially 3-dimensional spatial systems.

More examples could be quoted. In all these cases, users are providing information connected to a location. They are using web based systems with user friendly interfaces that are reachable from everywhere in the world [Tulloch, 2007]. Users are not those who have a special education or training in geography or cartography but untrained amateurs with little expertise or formal training who also have little time and resources they can afford to spend [Elwood, 2007]. Since these volunteers are not professionals, questions arise concerning the quality of the results produced and quality assurance procedures. There are arguments that the quality procedures are just different which at the end also guarantee qualitative results [Coleman, et al., 2009].

Since users are the primary actors, results are determined directly by their needs and not by providers that base their products or services on certain assumptions of the user demand. Users are forced to think of new solutions that correspond directly to their needs and therefore, they create new innovation. In many cases, open software solutions are used and use of innovation and also standards becomes interrelated [Budhathoki, 2010].

Some further examples might give more insight into these issues. Brazil is a transitional economy with a large geographical area, which needs GIS and SDIs for decision making in regional planning as necessary for the population and the economy [Câmara, et al., n.d.]. The role of the national mapping agency in Brazil is however rather limited and the necessary maps are provided by research and the private sector. They see spatial information as fundamental part of the information infrastructure and act as early adopters of SDI technology for the diffusion of geospatial information. Stakeholders from both research and private sectors, with their understanding of Information Technology, built on the use of GIS and started to develop an SDI using new and alternative approaches. The software was built in Brazil and released as open source software. Use of open source software is considered important as a means against vendor lock-in. A decisive factor was a strong collaboration between the key actors from research and private sectors. Communication between providers and users was established in several scientific and user conferences. International collaboration was initiated on a personal basis and provided experiences useful for SDI development. In fact, real problems were driving SDI development and adoption.

SDI development in Cuba emerged as a combination of both top down and bottom up approaches. Following the establishment of its national SDI, UNDP funds supported pilot projects using spatial data leading to the existence of several local SDIs that were based on the principles of the national SDI. Use of spatial data is considered integrative part of a larger programme for Information Society development. User needs originating from areas such as fleet management are driving the setting up of local SDIs. Also here, open source was important and education and capacity building played an important role. Evaluation and monitoring of progress has been a constant task [Fernándeza et al., 2009].

In the United States, shifts in local government practices have created new stakeholder groups with special demands on spatial data and on SDIs [Elwood, 2007]. A participatory GIS project has been created in Chicago for community development, which involved NGOs, local non profit organizations and voluntary organizations in spatial planning and use of geospatial technologies. They create their own spatial data from their local knowledge and need to integrate these data with official data sources. Many challenges are observed to access such formal data sources. One of these is data quality and currency of the official data, which do not correspond to the real situation in the local environment. Although these grassroot groups are not professionally trained people with respect to geospatial information, they provide evidence of the significance of their local knowledge and the disparities between them and the official data providers. Scenarios are put forward to solve conflicts between them. The local grassroot groups could for example provide their local and current data to the official data providers. A symbiosis could be created for the benefit of both and the local groups could be supported by the authorities that these authorities accept the data of the local groups along with their official data. Users are close to local needs and are able to provide solutions to problems that need the use of geospatial data. They can therefore provide an important input to official data providers who are in fact far away from the real problems outside of their domain and local, domain specific knowledge turns out to be very important for high quality geospatial data. However, one problem observed was unwillingness to share data since data constitute a powerful source of influence.

These examples demonstrate that new and innovative approaches are created by the users of geospatial data. Important elements are collaboration between actors, transparency and openness. Required is easy to use software adapted to user needs, which is in many cases fulfilled by open source software that users can tailor to their needs. Despite the concerns that not formally trained users would not be able to provide high quality data, they can in fact offer a solution to many currency problems if actors on both sides are willing to collaborate.

Research today recognizes as well that the role of the user of geospatial information and of SDIs changes and some authors propose to “reconceptualize” the user of a spatial data infrastructure in order to create a middle ground between spatial data infrastructure and volunteered geographic information, which has important implications for future SDI research. [Budhathoki, et al., 2008]

At this point, we could attempt a definition of what we call an “Alternative Spatial Data Infrastructure”. As a traditional SDI, the alternative SDI combines different sources of geospatial data and makes these data available using certain procedures for access to data. Major actors are the users who start from their needs to build the SDI in a bottom up way, without observing formal procedures. They provide content to some or even to a large extent, combine it with other sources of data and who then also use these data. In many cases, they are laymen users of geospatial information. These SDIs are driven by special needs, operate in a certain area and often contain data useful for certain purposes only. They are dynamic and their content is permanently updated.

Goodchild [2007] speaks of Volunteered Geographic Information (VGI) and calls the users “sensors” who work together to build up such an SDI. He states that “Given a server with appropriate tools, the various pieces can be fitted together, removing any obvious inconsistencies, and distributed over the Web. The accuracy of each piece and the frequency, with which it is updated, can be determined by local need.”

SDIs IN SOUTH-EAST EUROPE

The region of South-East Europe consists mostly of small countries, with the two European Union member states Bulgaria and Romania; Croatia, the Republic of Macedonia and Turkey as candidate countries to the European Union and all the others aspiring membership to the European Union as well. The region suffered from various conflicts even in the recent past and the countries are all considered as transition economies.

Data availability and accessibility is a problem in the countries of South-East Europe, and at most, components of a Spatial Data Infrastructure are implemented. Although these countries lack behind in the development of SDIs, they demonstrate strong interest in the area and it is recognized that spatial data are important for the economic and social development. This is the result of a recent study [Boes, Dimopoulos, 2009; Boes, 2009b] documented after a workshop in February 2009 in Thessaloniki which brought together representatives of nearly all countries in South-East Europe. This activity led to an overview of the status in South-East Europe and was part of the European project eSDI-net+ (http://www.esdinetplus.eu/). This project ended in August 2010 and has created a network of actors in the area of SDIs in Europe, with the South-East European countries part of it.

The study showed that there are several applications that need spatial data and which drive the development of SDIs. These are on one side more traditional applications such as cadastre and land registration, land management and agriculture. On the other side, environmental applications use spatial data as well and it is in this area that most innovative approaches can be observed. Environmental needs create collaboration between several actors including citizens, and require access to data from different sources.

It is just in the environmental sector that many institutions and NGOs come up with solutions for the protection of the environment and activate citizens to contribute. This is related to a growing civic society movement and their needs for geospatial data. Various examples can be provided. Protected areas need spatial data and institutions such as nature park directorates in Bulgaria have to answer questions of citizens, for example what an owner of a parcel that belongs to a protected area is allowed to do on his parcel. Such local authorities realise that they need GIS and spatial data from several sources for their services. This creates collaboration between providers and users and they exchange data and information related to a location in their area.

An interesting example is provided by the Bulgarian NGO BlueLink (http://www.bluelink.net/) that was created in April 1998 as an information network by eight non-governmental organisations (NGOs) from five major Bulgarian cities. In May 1999, the number of registered users of BlueLink's services exceeded 100. More than 15 topic oriented e-mail lists were operated then. In 2008, BlueLink started an important and interesting project which they called "Spasigorata", which means "Protect the Forest" (http://www.spasigorata.net/). Its home page is shown in Figure 17. Users, citizens or tourists, can publish their observations about illegal logging of forests on the site in using an interactive map from Google Maps and GPS coordinates to localise sites of registered violation. Users can send signals as text and in graphical format, via email, web interface or SMS. "Spasigorata" supports activities for monitoring and control by state institutions. BlueLink attracts a wide range of experts, NGOs and civil society organizations for the development and actual use of the online system which supports common efforts for the preservation and development of the Bulgarian forests.

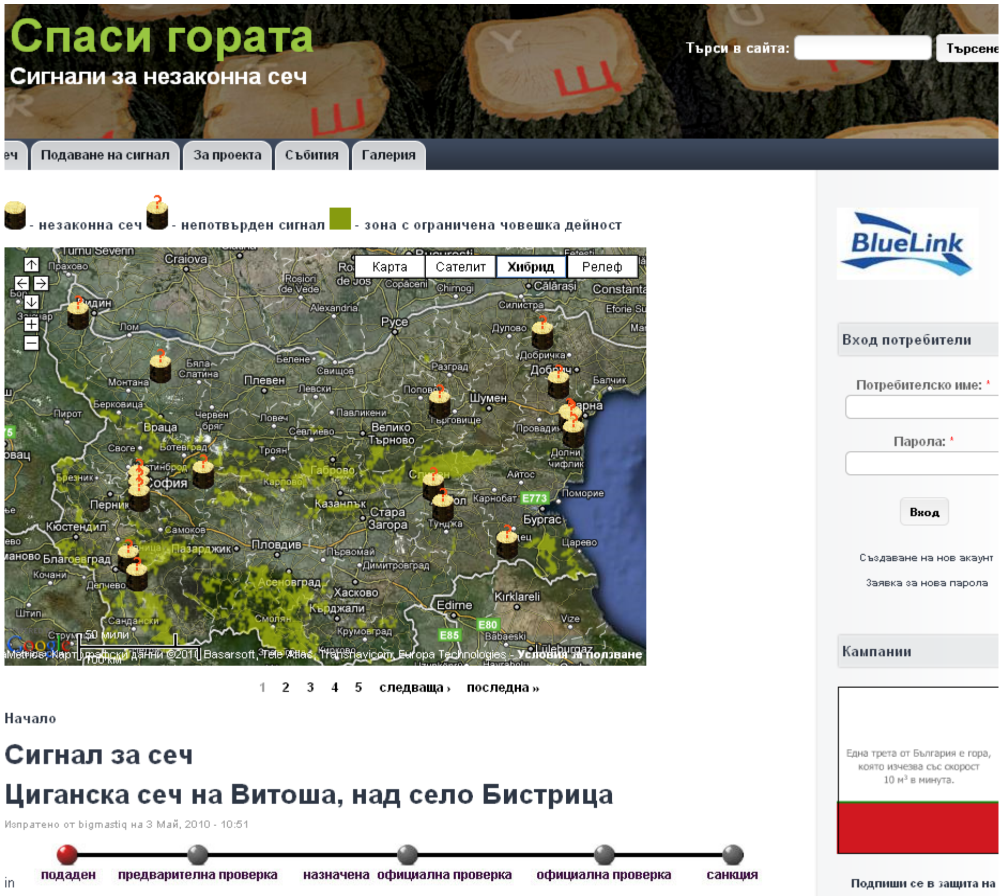

Figure 17: Web site of "Spasigorata.net" with points marked by users where illegal logging is observed

In the Ohrid Lake watershed area, an environmental GIS Database for its management and conservation was set up that gives access to different types of data such as a digital topographic map of the watershed area, the land use map of the watershed area and many others. Data exchange between public institutions in Slovenia is made possible by the site "prostor.gov.si" that also gives access to spatial metadata and to surveying data. The portal http://prostor.gov.si allows users to view the Land Cadastre, the Building Cadastre and the Register of Spatial Units data. Access is given to registered users, primarily those working in public administration on national and local levels, commercial users (real estate agents, lawyers, insurance agencies, banks, etc.) and land survey service providers [Lipej, Modrijan, 2010].

The Slovenian farm registry (http://rkg.gov.si/GERK/) contains data regarding specific fields of operation in a farm, including the spatial location of fields and their type of usage. All information related to the agriculture in Slovenia is included and a service is provided for accessing and modifying these data in order to make it possible for all agriculture-related organizations to use the same data and infrastructure. The data is used in all processes related to agriculture, which could be animal identification and registration, disease outbreaks, forestry service, land use, IACS or some payment schemes. Farmers can submit applications, carry out on-the-spot controls or controls with remote sensing.

Geocenter (http://www.e-geocenter.com) constitutes a spatial and real-estate information centre for supporting small and middle sized business. It provides support in all spatial and real estate activities to citizens, economic operators, public services in the larger area of Maribor. In this region, municipalities work together to provide information and analytical support. The Slovenian Geopedia (http://www.geopedia.si) is a web-based free atlas, which can be edited and extended by the general public. It contains various kinds of geographical and geo-referenced data that come from many different sources and offers a user-friendly web interface, where it is easy to find items of interest and to display them on interactive maps. Users can define and publish new layers with custom styling and textual descriptions, aggregate related layers into custom maps and associate them with other sources of information. In other words, Geopedia is a true collaborative on-line GIS with at the same time an important source of user-generated geographical content.

These examples show that both in highly developed countries and in transition countries such as those of South-East Europe various portals for spatial information exist and that users become more and more involved in the use and distribution of geospatial data. Also here, it is often users and applications in certain areas that drive the use of geospatial data, although this does not necessarily lead to the implementation of a Spatial Data Infrastructure. Mobile technology has made the use of maps for orientation and navigation ubiquitous and today's smart phones such as the iPhone, the Android or Nokia phones all provide access to maps.

How to Go Ahead – the Alternative Approaches

Various examples were narrated where users of geospatial data took the initiative to create their own applications and their own access to data which goes further than traditional, formal approaches. Geospatial data are on its way to become a commodity as these examples demonstrate. Much experience exists in industrialized countries; the examples from transition countries in Latin America and South-East Europe demonstrate that also there, users become increasingly aware of geospatial data and maps and adapt their use to their needs. The more geospatial data becomes available, the more it is used and combined with other data that is related to a location on the earth.

NGOs representing citizen movements are often those user organizations that are most active and with innovative ideas to realize and incorporate their needs. They operate often on a voluntary basis and can use their knowledge of their needs and their local environment to produce new or innovative solutions. An important factor is collaboration, openness to others and transparency, enabling learning from each other in order to build the necessary capacity for using geospatial data. Thus, users also turn into data providers but in a different way than official data owners occupied with providing access to their data.

The availability of technology and the Internet [Boes, 2008] facilitates the use and distribution of geospatial data, using easy geo-browsing, mash-ups, GPS, broadband communications and mobile technology. Technology has become much cheaper and in easy reach of users allowing them also to realize their requirements with geospatial data. This is often provided by open source software, in combination with low cost and the possibility to adapt it to special requirements. Technology makes it possibly to easily mash-up or combine data and applications and its use becomes ubiquitous.

It is also observed that these applications cross the borders of geospatial data and technology and are combined with other data and other applications. Games and virtual worlds constitute good examples in this respect. Geospatial data become data as any other data. Users combine any kind of data which leads to Spatial Data Infrastructures starting from the users, according to the definition given beforehand, in a bottom up way, which differs from traditional spatial data infrastructures. INSPIRE for example follows a top down process in building spatial data infrastructures following guidelines defined beforehand.

These findings are confirmed from other sources as well. The European project Nature-SDI+ (http://www.nature-sdi.eu/) builds up knowledge and capacity in staff from European protected areas. In order to understand user needs in this area, a European wide survey had been carried out [Hennig et al., 2010] that led to the conclusion that geoportals should focus on the demands of both users and data providers in this area, which are monitoring, reporting, research work, planning and management. A strong demand is documented for additional data to be brought together with existing geospatial data and geoportals should be open for data provision from everybody and all user groups. Users do not want to go to different web sites to find data but want to locate their data via a single point of access. These findings are not only valid for users in protected areas, and could easily be applied in other areas. We can argue that this goes beyond the definition of traditional geoportals such as defined by INSPIRE.

It is necessary to point to such examples and make them available for wider use in order to create better awareness of what is done and incite more users to create their own applications. The knowledge of existing applications would encourage other users to follow up and create new applications and their own spatial data infrastructures. A platform for distributing this information could be the project eSDI-net+, which is after its end taken over by EUROGI, the European Umbrella Organization for Geographic Information [Rix, Fast, 2010].

This might create the impression that innumerous stand-alone applications and spatial data infrastructures would be created that do not fit together. It is argued however that users, driven by the realization of their needs, are aware that data need to fit together and often, open source software systems are used that excel in the implementation of open standards. Thus, the author sees rather a convergence towards the use of opens standards and interoperability. Figure 18 is an attempt to sketch the individual components that would work together to build an SDI in the sense of this paper.

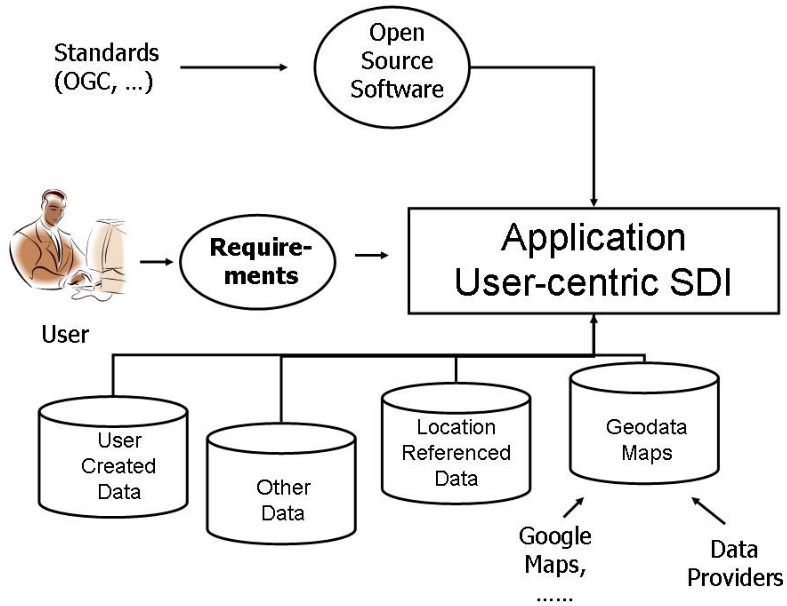

Figure 18: Elements of an alternative spatial data infrastructure

The Open Geospatial Consortium (OGC) recognizes these developments towards alternative approaches. They have recently created their "Global Advisory Council" as a world-wide and informal community of standards protagonists to promote awareness and use of standards by everyone. This council is acting as a body to collect input and feedback from users and implementers of standards in all regions of the world to improve the standardization process. Having said this, the OGC's Global Advisory Council has special importance to the developments related in this paper.

Not only bodies such as the OGC, but also stakeholders of the geospatial community should better become aware of the increasing use and distribution of spatial data. Data owners such as mapping agencies should make their data available on reasonable terms and agree on working with users which would also be for their benefit. This is already happening in some cases, for example, the Ordnance Survey of the United Kingdom makes some of their data freely available. However, the use of data from private providers such as Google prevails. Users should take advantage of the geospatial data offered on the Internet and not hesitate to combine this with their data.

It is believed that these alternative and the traditional approaches converge in the long term towards a truly distributed Spatial Data Infrastructure. This results in a new form of democratization, where an increasing number of citizens use such tools to express themselves.

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The role of SDIs as enablers of next generation intelligent transport systems

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Introduction

This paper presents the results of i-Tour "intelligent Transport system for Optimized URban trips", an on-going project that is being funded by the European Commission, to promote use of intelligent mobility systems and multi-modal interfaces for transport of passengers within urban environments.

The project is developing a user-friendly travel information system, built on top of standard SDI technology. The system has been designed to best perform within complex multi-modal networks within urban environment. Furthermore the project proposes a number of novel approaches to data collection including crowdsourcing techniques, borrowed by the social networking communities. In fact i-Tour predicates an approach whereby citizens can benefit from a wide range of Location Based Services, or LBS, through mobile client software designed to run on Android-powered smartphones or tablets.

Most interestingly, from a purely societal standpoint, i-Tour has been conceived to promote and award sustainable travel choices based on use of both public transport and other forms of sustainable mobility (e.g. cycling).

i-Tour provides intelligent multi-modal routing services to users, by selecting the best trip according to the travellers' preferences. The system can respond adequately to real-time events through proper re-scheduling, based on real-time information, including weather conditions, traffic information and public transport load, which are made available through the SDI via a number of web services. This allows i-Tour clients to be able to suggest optimal transport planning, avoiding for instance trips on overcrowded trains or suggesting to walk during good weather conditions.

The project predicates a vision is in line within the priorities set by the EU within the ICT Strategic Research Agenda for Mobility, which advocates the use of info-mobility service, including pre-trip, on-trip and post-trip information. More specifically, i-Tour is developing a service-based open infrastructure, as SDI, to ensure proper distribution of all different datasets made available to the system. The SDI is designed as an open source toolbox allowing each public transport operator to be responsible for the creation, maintenance and update of a specific set of sophisticated web services, extending beyond standard OpenGIS® (OGC) standard services.

According to the SDI paradigm each actor of the federation, in this case each public transport provider, becomes responsible for the deployment and maintenance of a specific geographical service, whilst being consumer of other providers' services.

However the contribution of i-Tour should be not only assessed on a technological basis but also in terms of societal implications on the wide community. In fact, for the first time, i-

Tour brings to the domain of transportation the typical approaches found in social media, in particularly leveraging on crowdsourcing approaches. This approach, which follows the paradigm of “users as sensors”, ensures that updated information is constantly made available through the SDI through contributions by the users.

Last, but not least, the project is delivering a number of strategies to promote awareness in terms of environmental footprint of private transportation, through a number of so-called serious games, which motivate users to opt for public transportation in place of private travel solutions.

Outlook

The general public is now well aware that the increasing number of vehicles throughout Europe has a significant impact in terms of economical and social costs, leading to widespread congestion (causing costs up to 1% of EU total GDP) and pollution. Private transportation is also cause of significant social costs as road accidents are mass scale killers. According to WHO (World Health Organisation) 885,000 people p.a. globally lose their lives in traffic accidents involving private vehicles. As noted by the Commission for Global Road Safety: "every month a silent tsunami wave of road traffic crashes sweeps away 100,000 lives". In Europe alone traffic accidents are accountable 45,000 deaths and 1,3 million people injured per year (Simba II 2011), with a total cost for the European Union of approximately 200 billion euros per year.

Traffic is also responsible for large scale health issues, as it is widely acknowledged that air pollution caused by road transport affects in EU up to 20,000 of people per year (Krzyzanowski et al. 2005), with further social and economical costs.

All these factors are the major causes for growing concern over the environmental impact of transportation. According to recent figures from European Environmental Agency (McGlade 2008) passengers and freight transport alone are accountable for 22% of carbon emission in the EU-27. This is the main drive of initiatives such as the ’50 by 50’ Global Fuel Economy Initiative (GFEI), by UN Environment Programme (UNEP), International Energy Agency (IEA), International Transport Forum (ITF) and FIA Foundation. GFEI predicates reduction by 50% of EU greenhouse gas emissions from cars with a reduction of 6 billion barrels of oil and 2 billion tons of CO_2 per year.

However, as highlighted by Commission’s Directorate-General for Energy and Transport there is “no one magic formula” to solve all the aforementioned issues and an integrated technological approach is required. This requires, on the one hand, advances in vehicle energy efficiency and safety and, on the other hand, it must promote an evolution in terms of transportation policies, traffic management, sustainable mobility initiatives, and more flexible and personalised mobility schemes.

To this extent the growing social awareness on sustainability is having significant effects in terms of public attitude towards transportation. In the last few years awareness of the general public on environmental impact of man-made activities has significantly increased. To this extent, personal mobility makes no exception. In particular in western Europe there has been a growing concern about reducing the environmental footprint of personal mobility.

Using mixed private-public transit is an excellent way to reduce costs and environmental footprint as demonstrated by a recent study by the American Public Transportation Authority. The study suggests that using mixed transit can be one of the most effective ways to reduce carbon footprint: a solo commuter switching to public transportation can reduce in a single day their CO2 emissions by 10 Kg (or more than 2,200 Kg per year).

However while people are increasingly sensitive to the importance of a clean and safe transportation there is a lack of effective solutions so hampering any potential society benefit. Within the ICT domain a number of portals are now emerging, either promoting sustainable transportation through scheduling over public transport routes, such as Google Transit (Google 2011) or measuing environmental footprint of public and private transport such as EcoPassenger (2011) EcoTransit (2011).

To be effective, intelligent mobility systems need to provide relevant and updated information to the user in order to optimise their journey through a pre-trip planning or even on-trip planning. A good traffic management system today needs to be able to support integrated multi-modal and inter-modal approaches, including distributed mobility management.

Intelligent mobility systems should convey information related to road safety including exact congestion mapping, delivery of local warning service, dangerous weather conditions, special events (rallies, road works, etc), bad pavement conditions and traffic conditions. New generation info-mobility systems should also deliver personalized services, according to the profile of end users, trying to balance between the trade-off of amount of detailed information and real-time response.

The project i-Tour responds to the aforementioned scenario through the development of technologies to support and promote safer and environmental-friendly mobility concepts through personalised IT solutions designed to improve security, avoid congestion and optimize journeys.

More specifically the architecture of i-Tour has been engineered to answer to the needs of a typical public transport provider willing to provide access to a wide range of geospatial resources of interest, ranging from information on transport network to live sensor data assessing the number of people on a given bus.

The requirements, from the infrastructural point of view, were to maximise interoperability and ease of integration through the development of an extended Spatial Data Infrastructure tailored to the wide community of transport operators. In fact high interoperability was considered essential to facilitate its uptake among various transport operator with very limited need for adaptation of their existing data and service architecture.

From a mere technological perspective the i-Tour SDI can be considered as a complex system of hardware and software components geographically distributed yet interconnected through a Service Oriented Architecture (SOA). Data providers (e.g. transport providers, service providers, public administrations) can deploy web services which can be used to provide specific functionalities to client software, to access data repositories as well as to transform data within a fully interoperable environment. Such an interlinked approach allows the definition of cross-dependencies and competency regions within and among different SDIs. In fact each data provider becomes responsible for the management and publication of their own data and services while it can seamlessly benefit from having interoperable access to data and services managed by other operator.

The project illustrated in this chapter has required the involvement of various transport operators, including motorway, railway, bus, ferry and metro operators. Their involvement has been essential for the definition of the initial requirements, for the provision of the datasets required by the infrastructure and for the validation of the results within a real-life scenario.

i-Tour answers to these issues by proposing an open source software infrastructure, which is to be made available as toolbox to administrations and public transport providers to provide interoperable provision of real-data and services on a variety of multimodal transport systems. i-Tour is also developing a software client from which desktop and mobile users can consume and produce information on the transport system conditions in a user-friendly manner

Related works

The scenario set by the project, which tries to maximise use of public transportation, essentially requires that the system should be considered as an extended pedestrian-centric routing system. In fact, when dealing with multi-modal trips, the system must be able to provide directions to a mostly walking user boarding or connecting to a public transport means. Typical scenarios include a user walking home, cycling to a station to catch a train, or walking within a station to get on a connecting metro line. All the various transportation conditions must be properly supported in addition to standard car-centric guiding, as available from standard navigation software.

Although standard car-based routing is provided by i-Tour as part of the extended multi-modal concept, however, due to its novel implications, within this chapter we will only focus on routing situations wherever the user will not be driving private vehicles.

Little attention has been paid by commercial applications to this scenario. Virtually all the commercial solutions provide only routing based on private vehicles. The greatest majority of applications available for smartphones or other portable devices essentially cater for car navigation and routing. In fact very little attention has been paid to true pedestrian routing. Most of the systems that offer pedestrian routing do so essentially as adaptation of car navigation, simply by loosening constraints set by driving on roads (one way streets etc.). Furthermore they do not provide any support for routing through public transport networks. In other words, although most portable car navigation systems can be set to "pedestrian mode", their interface does not change; neither does it accounts for any specific requirement the new context may arise. Selection of destination is typically based on addresses or Points of Interest (PoI), while travel preferences only include options such as fastest, shortest route, toll or toll-free roads etc. The route is typically drawn on the map or clearly indicated by arrow (if in 3D). Whenever en-route traffic updates are received the system automatically offers to calculate a new route to account for updated status.

Other more advanced navigation systems, based for instance on Augmented Reality (AR) interfaces, such as Wikitude Drive (Wikitude 2011), essentially rely on the very same interaction pattern, the only difference being the content in the background which evolves from a standard 3D scene, to a live images captured by the camera of the smartphone. However, within this domain, the use of augmented reality, albeit technically mature, can be considered at its infancy both in terms of user interaction and feedback. In fact little improvement has been made to provide additional or different information than those available within 3D navigation systems, to best exploit the contextual information available through an augmented reality scene.

Furthermore the mere re-proposition, within a portable Augmented Reality (AR) system, of concepts typical of 3D interfaces for navigation systems, partly vanishes the most beneficial aspect of AR, which is the constant contact with the surrounding context. In fact, in most AR applications the directions or other graphical components (e.g. arrow indicating the path) typically cover a significant portion of the screen, often being placed in the middle of the road, typically corresponding to the geometry used by the underlying representation of the road network. Instead, indications in Augmented Reality should account for the geometry of the real scene surrounding the user, optimizing location of visual aids in order to reduce potentially dangerous obstructing of important visual clues.

If we steer away from car-based navigation systems, the few dedicated cycling navigation systems available from the market are either adaptations of car navigation systems, such as TomTom (2011) Rider series, or an evolution of bike trip computers, such as Garmin (2011) Edge series. Their adaptation to specific requirements of bikers merely resides in an extended road network (to account for bike lanes and paths suitable for riding) or in the use of a larger buttons (to allow for easier interaction when cycling or wearing gloves).

Instead little attention has been paid to providing different types of routing, for instance based on landmarks met along the street, on real-time information (e.g. regarding availability of bikes at designated bike-sharing facilities) or, least of all, based on integration with other transportation means.

With specific regard to multimodal routing interfaces, only a handful of solutions are available from the web. The most famous example is Transit (Google 2011), which is practically an extension of the standard web-based routing system available through standard Google services. Fewer examples are found if we look for systems designed for portable devices (e.g. smartphones). In this case very little solutions are available from both the market and from the research community.

A notable exception is CityAdvisor (2011) an application for smartphones that provides routing over the public transport network. The directions provided are essentially the ordered list of unimodal journeys required to reach destination, without providing any navigation on how to reach them nor on how to transit among different journey segments. Furthermore no advanced recommendation is available based on specific user preferences neither a mechanism based on updates is set in place.

With specific regard to true multimodal travels, very little development has been done to create specific routing (Rehrl et al 2007). Research has shown that normally users heavily rely on signs while they rely on landmark for way finding at stations and nodes where the user required re-orientation (Fontaine & Michel Denis 1999). Augmenting routing information with 3D functions is important when complex 3D routing is required. In fact research has demonstrated that providing 3D axonometric representation (Fontaine 2001) helps people create mental representation of the station, helping their navigation. According to several studies (Fontaine & Michel Denis 1999) it is particularly important to provide directions through signs as navigational aids, integrating maps and guidance instructions.

Particular attention has been paid to cognitive aspects of the traveller. According to previous research (Gaisbauer & Frank 2008) it is important to account for the so-called image schemata, a concept introduced in the late eighties, to define the conceptualization of the surrounding physical environment. Perceptive order is not just a rational and numerical problem, it is not a picture of the outer world, instead it is the result of a selective mental process of organisation that involves the whole structure of the object.

Traditionally, perception has not been considered as the "reality" of the spaces surrounding us (Weizsäcker 1947) but the "process by which a mental image, or percept, of an object or phenomenon is acquired. This is a process of segregation and unification by which environmental stimuli are organised into specific forms" (Weber 1995). Nowadays perception is regarded as not completely determined by stimuli, instead, it essentially subjective and strongly influenced by the observer himself.

A first essential aspect to be considered is therefore how to create an interaction model that can help the traveller build a perceptually better mental image of the surrounding environment. A number of techniques have been proposed to improve guidance and routing beyond traditional mapping and navigation applications. A notable example is the so-called TapGlance (Robbins et al 2008), which reinforces contextual awareness between map and information of relevance (e.g. a list of Points of Interest), through the use of animated transitions between screens based on use of so-called "faceted searches".

Research has also shown that standard turn-by-turn directions, originally thought for driving directions, are not best suited to pedestrian navigation. The use of landmarks to augment recommendations and navigation, which has been subject of extensive research, can be instead very beneficial to pedestrian routing. Landmark-based routing relies on directions given according to key points (landmark) along the route and it provides a simpler navigation mechanism with constant contact with the surrounding scene (May et al 2003). One of the most relevant examples is described in (Hile et al 2008) and (Hile et al 2009). In this case, routing is ensured through use of geotagged images. The system renders on top of them directions (coloured arrow) identified around the path. The identification of landmarks is automatically made through segmentation of so-called "loxels" (location cells), which are used to segment the path and the surrounding area. Relevant landmarks are identified and then used to formulate the appropriate routing directions. Additionally the work in (May et al 2003) suggests performing calculation of camera pose through computer vision techniques in order to define precisely 3D orientation and location in the real space of each image. Information on camera pose is then used to project, in overlay, the directions to be followed by the user as arrows in overlay.

The formulation of instructions has also been subject of several studies. (Stark et al 2007) have compared the effectiveness of four different ways of formulating routing concepts including: i) auditory instructions on top of visual routing instructions, ii) visual routing only, iii) map positioning and provision of directions and iv) textual description based on street names. The study has proved that instructions based on street names were more effective than mere right or left turn instructions. Users have proved to become more acquainted with the surrounding area becoming familiar with street names. This factor, in turn, has positively contributed to help them build a mental city map therefore make better routing decisions.

Additional aids to navigation of pedestrians have been proposed. The relatively small screen available through smartphones requires development of sophisticated techniques to visualise information on events that occur outside the current map view. NRU (Lastiminute.com 2011) uses the so-called radar view, a dynamically adjusted view, alighted with the real direction of the users, that allows appreciating points of interest in the nearby. Other techniques include Halo (Baudisch & Rosenholtz 2003), specifically developed to avoid continuous zoom in/out to compensate for events or information appearing in off screen portions of the map. The technique is based on the adoption of circles located around events off-screen, whose radius is set to intersect the portion of map currently visible. The ring increases in size with the distance from the screen, providing also information on the distance of the object.

Typical use case

The following use case, which has been identified for its relevance in terms of use of multi-modal transport systems, can be used to better show the objective of i-Tour.

It should be noted that the scenario below has been edited from specific feedback by the various transport operators involved in the project. During the analysis, particular attention has been paid to the implications of use of Location Based Services, trying to underline the value added processes that can be delivered, within a mobile context, through a personal mobility system.

The use case starts with the user about going to work. Before leaving her house she connects to i-Tour from her home PC. The system asks if she would like to leave the car at home and get to the office by public transport as there is not any scheduled appointment on her agenda that requires driving. The system then proposes several alternatives based on public transport using bus, metro, train, and carpooling. Among the various alternatives, ranked according to the user's personal travelling preferences and behaviours, she initially selects the option that requires travelling by bus. However, after checking the timetable and the route, she refuses this solution. She then selects, among the various options, a journey plan based on a 30 minutes trip by train to the central station, with a further journey leg by metro, followed by either a 5 minutes public city bike ride or by a 20 minutes walk to the office. After confirming the latter option she turns off the PC, then she switches on the smartphone and starts the i-Tour app, ready to leave home. As the system detects, through the GPS and the accelerometers/gyroscopes, that the user is walking, it starts providing sound-based feedback to guide the user to the station.

After boarding the train i-Tour informs her that one of her friends is travelling on the very same train, asking if she wants to place a call to her. Shortly after, the user checks the availability of a city bike at the central station where i-Tour reports that three bikes are still available.

After some minutes the device alerts her, by vibrating and beeping, that there is no more bike available at the train station and it proposes two alternatives. The first requires taking a bus 50 meters away from the station with a 10 minutes connection. The second requires walking 500 meters to reach another city bike parking. She selects the second option and, once outside the train station, she switches to augmented reality mode, to be able to see information on the surrounding environment on top of images of the surrounding space captured by the camera fitted on the smartphone, until she is guided to the city bike parking and, eventually, to her office.

Before the lunch break the user logs onto the i-Tour portal and, from her PC, starts the desktop client and asks the system the following query: “get me to the closest shop that accepts my credit card where I can buy some food”. The system processes the request and it suggests a shop that is located 10 min away by walk. This option is proposed since it is reported sunny; hence there is no reason to plan a trip by public transport. The system informs that the shop will close in 45 minutes. The user accepts, she leaves the office carrying her smartphone that meanwhile automatically starts providing directions on how to get to the desired location.

When the user gets to the shop she finds out that this has recently changed their opening time so she updates the system with the new information. The information and her trust level, is sent via the Internet to the i-Tour central repository to be processed and made accessible to the wider community. The mobility system informs then of an alternative food shop in the nearby and it provides the necessary routing.

At the end of the day i-Tour informs that the choice of using public transport for daily trips has resulted in an reduction of CO_2 and PM (Particulate Matter) emission (values are illustrated) and that she will need to save additional X kg CO_2 or Y grams of PM emissions to be eligible of a 10% monthly discount on public transport fares.

The SDI for personal mobility

The complexity of the previous scenario clearly highlights the several limitations imposed by use of standard SDIs. For this reason it has been necessary for i-Tour to extend the traditional concept of SDI by developing a software infrastructure based on a very articulated Service Oriented Architecture capable to ensure interoperable provision of real-time and static data regarding a variety of multimodal transport systems. Such a complex infrastructure is designed to provide multi-modal routing services via user-friendly ubiquitous clients. The latter can be either e web-based 3D Geobrowser or a 3D App, to be run by smartphones within a Location Based Service scenario.

Definition of the “knowledge model”

From the methodological point of view the study started with the definition of user scenarios end-users’ requirements through specific questionnaires designed for both final users (laypeople) and for technical staff. The latter has been necessary to identify operational procedures in place for the various daily activities.

The use cases identified and the requirements collected were the basis to create a common “knowledge model”. It should be noted that we explicitly refer to “knowledge model”, and not “data model”, to highlight the very abstract nature of this activity, which has brought to the specifications of the various classes shared by the different software components and sub-systems, which operate as “bridge” or communication channels. At this stage in fact a set of class interfaces (i.e. class names and function structures) were defined to represent, in a conceptually abstract manner, the various information required by the different i-Tour software components to deliver all the functionalities needed to satisfy the use cases. The classes of the “knowledge model”, which were formally modelled as UML class diagrams, have been logically structured in hierarchical fashion based on the following top level classes: geometry, event, location, rate, activity, user, transport, environment.

These top-level classes, further specialised by extensive subclassing, have allowed modelling of all the different aspects handled by i-Tour ranging from type of fare, to user groups, from type of transport mode and vehicle, to type of location etc.

Definition of the "data model"

Starting from the knowledge model the data model was then derived as persistent state of the former, thus implicitly ensuring consistent mapping between the two.

The data modelling activities was performed starting from the assessment of the data/technology available through the various stakeholders involved in the project. To do so a questionnaire was distributed to transport operator with the aim to identify resources available. The questionnaire was designed to collect:

1. Information in terms of functional description of transport management systems in place for both urban and extra urban trips.
2. Technical description of ICT infrastructures necessary for management of transportation networks.
3. Information on data available both in terms of static data, for instance road networks or traffic model, and real-time data, for instance regarding traffic flows, traffic forecasts etc.
4. Other relevant data which may be available through external resources, for instance through third party web-services, providing for instance information on traffic, weather conditions etc.

The operators were also asked to provide a functional description of the transport infrastructure, for each transport mode, including rail (train, underground, etc.), road, waterways (ferries, etc.) or other transport means (funicular, cable car, etc.). Operators were asked to detail to the greatest possible extent situations where mode change could occur (e.g. at stations), providing –wherever possible- descriptions of parking areas to be used when switching from/to private to/from public transport.

The results of these activities were, on the one hand, the creation of an O-D (Origin-Destination) matrix for the different transport networks, with additional information on sources of updates, frequency of updates and, on the other hand, the definition of a functional and technical architecture diagram of the IT and ITS (Intelligent Transport System) infrastructures in use by the transport operators.

The most significant results of this first preparatory activities, was the design of the overall i-Tour architecture. This follows a three tiers (layer) outline typical of most SDIs with a communication paradigm based on a Service Oriented Architecture (SOA) where each component (deployed as service) interacts with the others through a set of messages written in a standard format (e.g. based on XML, mostly OGC standards).

The data level

Similarly to standard SDIs, i-Tour has required installation, configuration and deployment of a typical data level based on a spatial database, in this case based on open source solution PostgreSQL with PostGIS extension. However in i-Tour the data level has been enriched with further more articulated functionalities as illustrated in Figure 19.

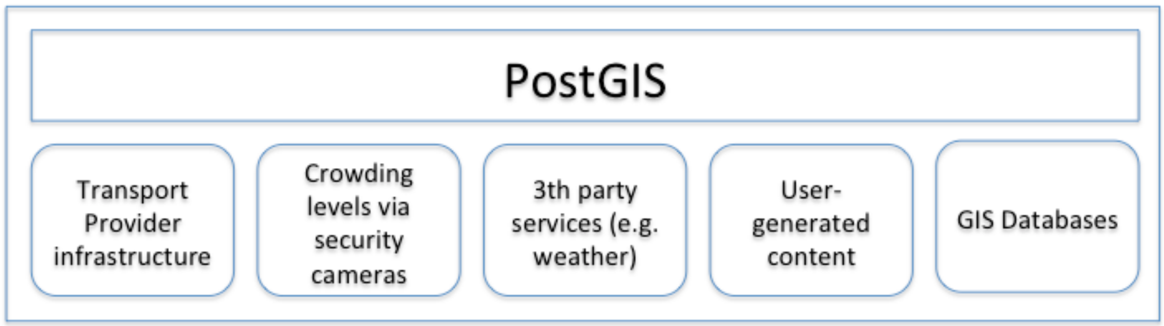

Figure 19: The internal overview of the data layer

At this level, real-time data coming from each transport operator is transformed in real-time to the i-Tour data model and sent to the central database. As illustrated in Figure 20 this is done through two gateways. One operates as interface with the IT and ITS infrastructure of the transport provider. This components, which operate at data level, ensure real-time transformation to the i-Tour data model. This way data coming from proprietary ITS are converted on the fly and sent to the central i-Tour database for use by the multi-modal routing system. This includes, for instance, information on delays, traffic conditions, bus crowding level, position of public transport vehicles, messages containing information on accidents or maintenance.

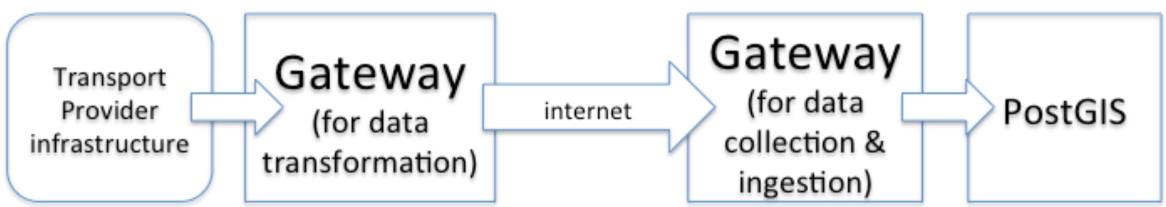

Figure 20: The ingestion process from the proprietary infrastructure of the transport provider to the data level of i-Tour

Further low-level software components, depicted in Figure 1, provide real-time data transformation of further ancillary information of interest for i-Tour such as information generated by users (as described in following sections) or weather information. Data coming from specialised public APIs, such as Google or Yahoo! Weather services, are converted in real-time and forwarded to the i-Tour database, where they are stored according to the data model illustrated in the previous sections.

Most relevantly, as illustrated in Figure 1, the data level features very advanced components capable to collect, in real time, information on crowding levels at designated platforms based on video processing techniques. The system developed uses existing analogue cameras already used for video surveillance at one of the pilot stations managed by Circumvesuviana, in Italy. It should be noted that the use of existing video surveillance cameras ensures future easy scalability to other stations.

The video scene analysis component uses, as input, the video from the video cameras to detect the number of people present within the platform as well as the presence of the train. The information is then transferred to an application server that performs the tracking and sends a message to another server responsible to process events and to update the i-Tour database. The system has been calibrated through pre-recorded video from real surveillance cameras at the designated station, and it will soon be installed and become operational, providing live information on crowding conditions at stations' platforms. Additionally the system is capable to detect the presence of the train at station, on top of information on people waiting for it, to be generate real-time information on train arrivals.

All the aforementioned information, being stored within the i-Tour database, become available to the routing service, illustrated in the following sections, which uses them to calculate the best travel solution on the basis of current system conditions and user preferences.

The middleware

If compared to standard SDIs, i-Tour, from the logical point of view, features a middleware layer (Figure 21) organised into two logical sub-levels. The lower level is necessary to ensure functions such as authentication, or access to data (e.g. to raster, vector and alphanumeric data) from the client software components through OWS (OGC® Web-service). In particular this level comprises low-level services deployed through proprietary and FOSS enterprise platforms capable to ensure compliancy with W3C or OGC standards, with specific reference to OWS such as Web Map Service (WMS), or Web Feature Service (WFS).

However i-Tour goes beyond this by proposing a further layer logically located at higher level, hosting more complex processing functionalities, as service, required to provide the following services: 1) Natural Language Interaction (NLP) service; 2) recommender service; 3) route planner service; 4) activity scheduler service; 5) emission estimation service; 6) preference representation and learning service.

Each component of the layer is conceived as an autonomous functional entity (as a service), exchanging results and data with the others through RMI, XML or SOAP messages. In this way it is possible to build a Spatial Data Infrastructure (SDI), with the main advantage of having the opportunity to deal with a modular logical layer where each component can be easily changed or extended to adapt to the different datasets and requirements without interrupting the provided service.

Figure 21: A logical overview of the middleware, which is split in two layers

The NLP service operates as man-in-the-middle between the user and the system to ensure a friendlier user experience through support of natural language. This way the user can formulate articulated travel queries without being forced to use menus, lists or checkboxes, as in traditional WebGIS applications. The client in fact supports typing of queries through free text. Alternatively the user can speak a command using their mobile phone. The voice command is then sent to Google Voice service that returns, as text, the interpreted message. The free text is sent by the client together with additional contextual data, most notably the location to the user, to the natural language processing service. Communication is based on standard XML-based web service interface.

The routing service is being conceived by considering the greater level of freedom typical of pedestrians, who are not bound by lanes, as they can walk over sidewalks etc. The routing system is based on concurrent use of several transport networks, all connected within a so-called supernetwork. This ensures accurate modelling of the environment at higher detail if compared with traditional navigation systems accounting, for instance, for issues such as connections between different train platforms etc.

Providing an extensive description of the routing algorithm is beyond the scope of this chapter. An in-depth description can be found within previous works by the authors of the routing algorithm (Zhang et al. 2011), who are partners of i-Tour. Nevertheless within this context, it is worth illustrating, at high level, the features of the system as indeed they allow significant advancements when compared to routing features traditionally proposed by standard SDIs. In particular the route planner service has been engineered to generate, for a given trip, a number of route-choice alternatives across several transport networks, both public and private. Based on data of the user, the presented alternatives are ranked in a suggested preference order. The model is capable to handle routing queries across private as well as public transport networks, accounting for information such as real-time transport network status (e.g. traffic, crowding levels), user preferences etc.

The approach followed in i-Tour is based on a high-level abstract modelling of the overall multimodal transport network whereby transfer links are used to represent a modality transfer (e.g. from bus to train etc.). This technique has been based on the so-called supernetwork approach. Within such a high-level network there are both physical nodes and event nodes. The former have attributes such as distance, time, speed, quality etc. The latter incorporate timetables of services and represent arrival and departing at a given stop or station. The multimodal network is classified into private (e.g. foot, car, bike) and public modes (e.g.

bus, train etc.).

The modelling has been based on a generalised cost function that can account not only for time required to get from a node to another, but also for cost, quality of service (e.g. crowding levels or other ratings provided by the users), as well as other conditions. It should be noted that in the context of this task i-Tour has developed various approaches to consider and model all these parameters in an automatic way, based on conjoint analysis through stated choice experiments or through implicit observations of travel choices based on real or simulated cases.

Most notably it should be noted that the approach developed is totally agnostic with regard to static vs. real-time data. In fact, in i-Tour, real-time (dynamic) information is retrieved by the various web services and then stored in the database. Since the algorithm developed simply uses the latest current "snapshot" stored within the database, this intrinsically ensures that each routing request is performed on top of the most recent information available.

The route planner relies on a further high-level service, closely bound to the former, which deals with activity scheduling. This service is responsible for identification of schedule conflicts or opportunities for a user and for presenting alternative solutions for adapting the current schedule in a suggested preference order.

A further service, which is invoked whenever appropriate by the route planner, is used to estimate emissions, both in terms of carbon dioxide (CO2) and particulate matter (PM), caused by each trip. The algorithm implemented by the service is based on the latest existing COPERT European standard (version 4), which provides a database of parameters related to vehicle emissions, which are constantly updated to account for new vehicles. The emission estimation service is invoked by the route planner both to identify travel choices with lesser environmental footprint -in terms of emission-, as well as to provide information on emission necessary to travel by private transport.

It should be noted that this information is then used by the client, which will be introduced in the last part of this chapter, to promote incentive strategies based on the amount of C02 and PM saved by travelling onx public transport or other sustainable forms (e.g. walking or cycling) in place of private cars.

Finally the routing system relies on a further service that ensures preference representation and learning functionalities. The service is invoked to estimate specific travel preferences based on actual travel choices of the user, which are fed back to the system.

Extension of OpenLS

It is important to highlight that the communication between the multi-modal routing service and the client will be ensured through an OpenLS communication interface. OpenGIS® Open Location Services Interface Standard (OpenLS) is a standard protocol, developed by the Open Geospatial Consortium, that enables development of interoperable Location Based Services (LBS).

However the current OpenLS routing specifications have been essentially designed for uni-modal journeys, that is based on a single transportation mode, essentially motorised vehicles or user walking. As no support is provided for more complex multi-modal routing the use of OpenLS routing features in the context of public transport is rather limited. i-Tour has thus proposed and developed an extension of the current standards in order to account for the requirement of multi-modal travels.

The extension developed also propose introduction of more articulated user profiling for the travellers to be able to define their travel preferences beyond standard fastest and shortest routes, to be able to deal with preferences regarding the accessibility of a route, the degree of physical fatigue required to travel along a given route, as well as the degree of environmental-friendliness –in terms of CO_2 or Particulate Matter (PM)- of a given travel solution.

The application level

At the highest level of the logical stack of i-Tour we find the clients. In particular two clients have been developed: one, to be used within a desktop environment (Figure 22) and a second, most relevantly, developed as App for android-powered smartphones or tablets (Figure 23). It should be noted that both clients are engineered to deliver a ubiquitous experience. In fact one of the most relevant requirement set at the beginning of the project was to develop a system that would allow users to seamlessly migrate from a desktop PC to a smartphone. The user should literally be able to turn off the PC, turn on the smartphone and retrieve the last current state within the App.

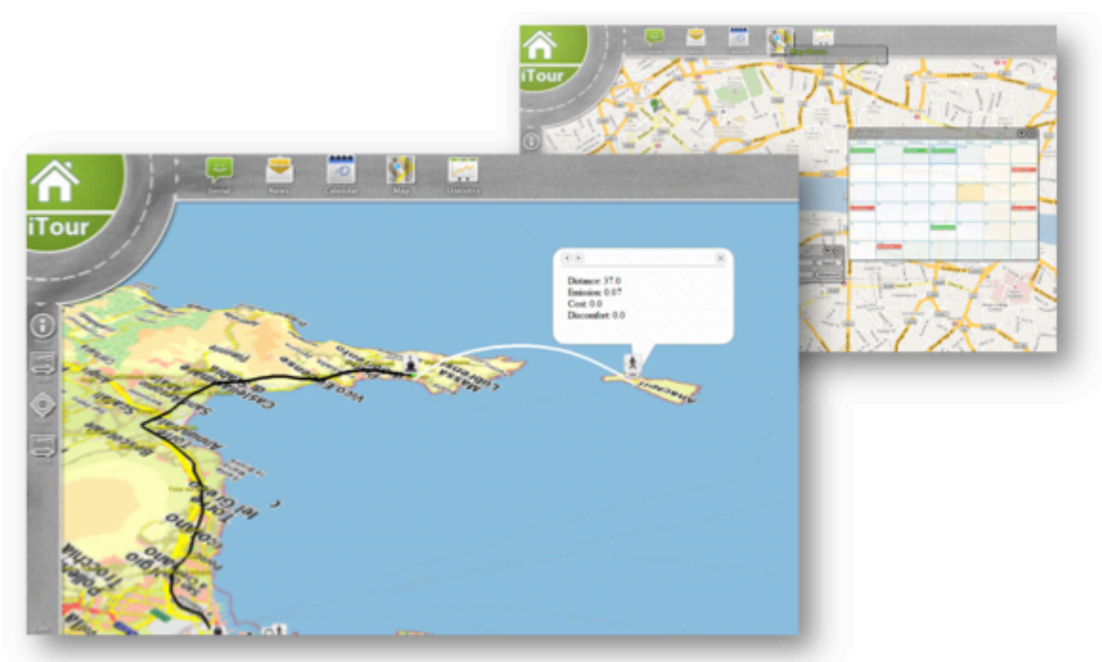

Figure 22: A screenshot of the web-client

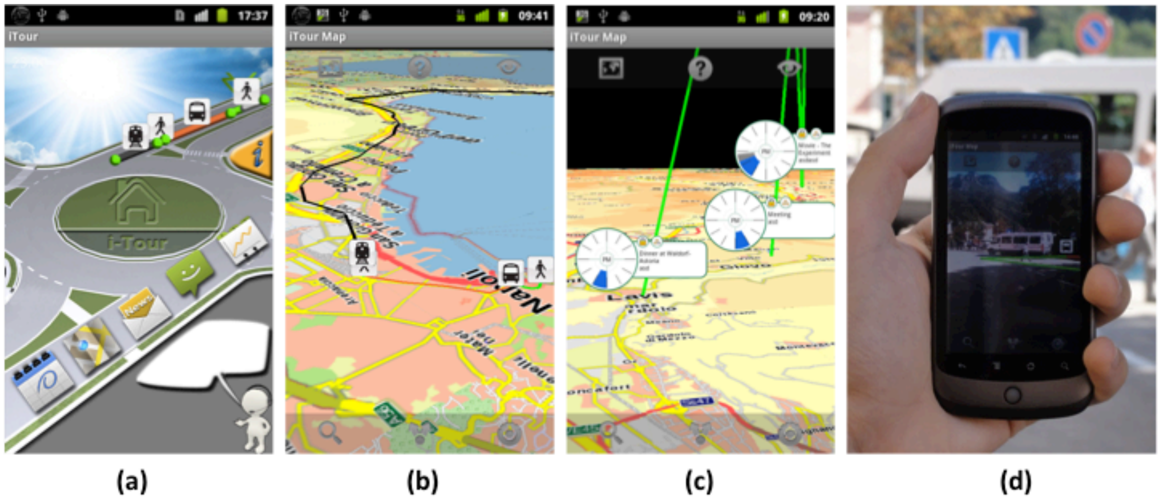

Figure 23: Few images of the i-Tour mobile client: a) the main interface providing access to all functionalities; b) an image of the 3D view during routing (maps and routes are available as OWS); c) a 3D view of the scheduler showing connections between places where an appointment is scheduled; d) an image of the augmented reality mode whereby geographical information is overlaid on top of images of the surrounding scene as captured by the mobile phone camera

This has been greatly facilitated by the adoption of a service-oriented architecture. In fact in i-Tour all the relevant information, that as a whole create the user's current "state", are managed at central level, with the client only managing local data. This centralised approach ensures that whenever the user moves from one device to another the current state is always maintained. Furthermore the graphical layout of both desktop and mobile clients have been designed to ensure a consistent experience both in graphical terms as well as in terms of provided functionalities. However, given the great relevance paid to the nomadic nature of a personal mobility assistant, the reminder of this section will specifically focus on the mobile application.

As illustrated in Figure 23-a the main interface of the system allows the user to appreciate the most relevant information regarding his/her travel solution. The upper part of the screen is devoted to information on current trip, represented by a set of segments each with an associated icon showing the various transport mode, and to real time data such as weather. At any time the user can access further information on the remainder of the trip, for instance regarding connection times, expected time of arrival etc.

At any time the user can also select the map mode and appreciate the route in 2D or 3D (see Figure 23-b) with the underground mapping information being sent as standard OGC WMS and WFS services. Furthermore the client can operate in augmented reality mode as shown in Figure 23-d. In this case the images captured by the camera of the smartphone are used as background for virtual content, regarding the trip or the surrounding environment, which are rendered on top of the images of the scene, properly aligned to ensure visual consistency.

Whenever the user formulates a routing request, this is sent to the aforementioned service that returns the various options available to the client, which in turn shows them to the user in the form of a graph, as illustrated in Figure 24. The centre of the graph represents the current position of the user while various-leaves of the graph all represent the (same) final destination of the user. The graph shows the various travel options divided by journey's legs. The distance of the various nodes from the centre can represent either the time needed to get to destination, the distance, the cost or the environmental footprint. This way it becomes very easy for the user to identify, among the various options available to get from A to B, the most suitable to the user's needs. The graph is also designed to quickly inform the user about the transport means for each leg of the journey, about the quality of service as rated by the various users, the possible congestion level.

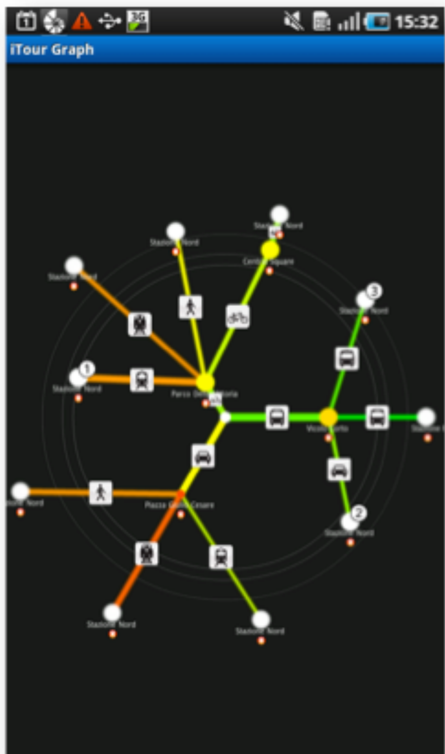

Figure 24: The graph-based interface used to select the best travel option

Furthermore the system can be used to provide feedback about the surrounding environment, following a true crowdsourcing approach. A thorough description of the recommender system is outside the scope of this chapter and can be read from (Mashhadi & Capra 2011). Through the mobile client the user can rate (Figure 25) both points of interests (e.g. restaurants, shops etc.) as well as transport network facilities including, for instance, a given bus or train. This information, properly validated by the system according to their level of trust, is then used to ensure the best recommendation to the user. The user can also update information such as opening times. The user can also provide information on events en-route such as strike, traffic, markets, roadblocks, etc.

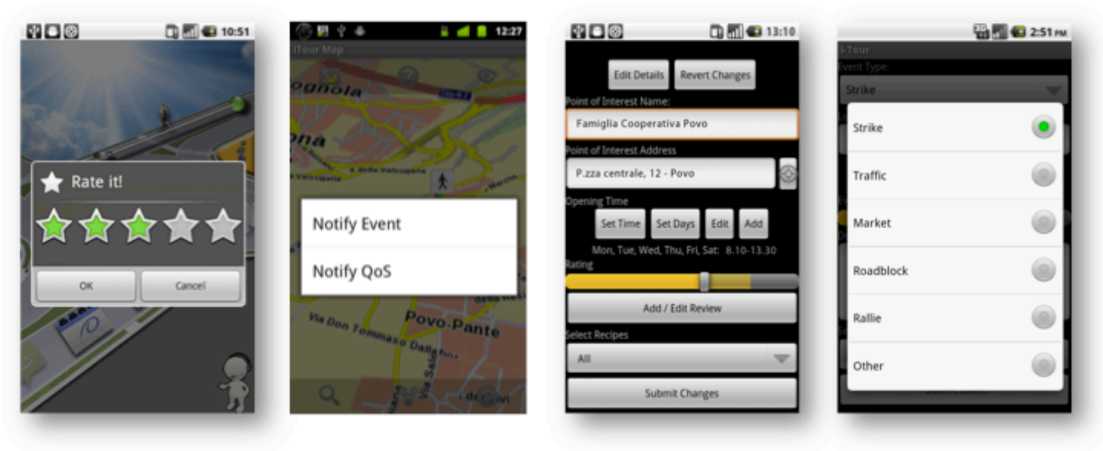

Figure 25: The rating interface

One of the most relevant features of the client, from a societal perspective, is the promotion of sustainable travel choices. The cornerstone of this is a "credit" mechanism, based on the amount of CO2 and PM saved by the user travelling on public transport or other sustainable means (e.g. walking or cycling), which is used to create a positive feedback loop mechanism based on low environmental footprint. The information on the CO2 and PM is retrieved through the aforementioned service responsible for calculation of emissions. The credit accrued by the user can be then exchange for awards of various types such as free tickets or other awards.

Following the same approach the client allows various forms of so-called serious games, also referred to as DEG or Digital Educational Games. Leaving aside for a moment the issue of the didactical relevance of DEG, most authors acknowledge that Digital Educational Games are extremely effective at building motivation among players (Prensky 2007). Within this context in i-Tour the motivational factor is extremely important since the personal mobility system becomes a motivating factor to promote use of public transport.

This has been done by integrating a commercial game engine with the client application. A strictly formalised communication protocol between the travel assistant component and the game engine ensures that any third party software producer can extend features of the system by developing new games, provided they comply with the specifications of the system. The tight integration ensures that points acquired through games promoting green transportation can be exchanged for real credits to be used by the traveller. Viceversa the user can use credits accrued through travelling within the public transport networks to acquire extra features within the gaming environment.

Last but not least the serious game attitude has been extended with the geographical dimension. Following approaches already fostered by popular social networks such as FourSquare, travellers, or in this case players, can rent a virtual representation of a real place within the public network infrastructure. A player could, for instance, rent "virtually" from the transport provider a certain area within a station in exchange for "real" credits accrued through their travels. The cost of the lease will depend on the location of the area, extent and duration of the lease and by a factor price to be defined by the transport operator. Once a traveller, or player, becomes the owner of the virtual space, he/she can use it to showcase special awards, already achieved through gaming, to the communities of other peer players passing by that very location in the real world. For instance player A could decide to rent for two weeks an area of 100 meters radius at a given station to showcase particular awards gained by playing at a given game. Player B when passing by that station, would be prompted that player A is selling, at a given price, special awards that would allow him/her to achieve better results. If accepted, the credit paid by player B to purchase the special feature is transferred to the account of player A. All these mechanisms have been designed to leverage on sustainable travel behaviour potentially creating, at the same time, new business models based on location based services.

Conclusions

This chapter has illustrated the results of the i-Tour project. This has extended the traditional concept of SDI with more advanced functionalities required to provide a routing mechanism customised to the user's preferences which uses the various public networks available.

Furthermore, from the societal point of view, the system moves a step further through the development of a mechanism to promote sustainable travel behaviours at urban level. This is done through a rewarding mechanism promoting low-impact travel choices based on public transport.

These results have been achieved through the extension of the traditional concept of SDI, by providing more advanced functionalities, as services, necessary to ensure recommendations, routing over multimodal networks, natural language interaction and emission models. The services typical of traditional SDIs, such as WMS, WFS have been extensively used as well as more advanced OWS including OpenLS. Most notably the latter has been extended to ensure support of multimodal routing and recommendation functionalities, originally not foreseen by the existing standard, and which are key to i-Tour.

The first deployments of the system, made in cooperation with several transport providers in Italy, namely in the areas of Naples and Trento, show positive results in a real operational environment.

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Charging for environmental data: when, when not, who and who not

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Summary

Should users pay for access to environmental data produced by governments and institutes? This question has fed a long lasting and heated debate that is often coloured by contributions fully in favour or fully opposed to free access. We observe a risk of stagnation in this debate in which proponents of either funding model do not leave their stance, leaving policy makers more confused than informed on what funding model to choose. Based on an extensive review and acknowledging that there is no one-size-fits all funding model we have developed a simple framework for choosing between funding models. In most cases free-access is to preferred, but there are clear exceptions in which charging is viable and recommendable.

Introduction

The digital revolution is increasing the ease with which people can access, copy and re-use digital data (Litman 2000). As a result there is a growing demand for making information better accessible (Groot and McLaughlin 2000, Williamson et al. 2003, Nebert 2004, Masser 2005, Goodchild et al. 2007). Apart from technical issues and lack of standardisation, access is impeded or restricted through legislation (Kabel 2000). Legislation comes at two levels. At the first level it is decided whether data should be openly accessible or not. This broader debate on democratic rights, privacy and national security is beyond the scope of this chapter (e.g. see Halchin 2002, Seifert and Relyea 2004, Davis 2005, Tombs 2005 and Otjacques et al. 2007, Burdon 2009). Given that the outcome of political debate is open access the second level requires the decision whether to charge or not. In order to be effective data charging policies need to be backed up by copyright legislation.

We define Public Sector Information (PSI) as information needed, collected, stored and managed, to support one or more legally mandated tasks. PSI datasets are funded from tax money. Some PSI datasets are collected only once or at longer intervals (eg soil maps, roads), others are regularly updated (eg weather, land rights). While primarily produced in order to enable government to produce specific public goods, PSI often turn out to be of value for unintended users inside government, in the private sector, in non-governmental organisations and for citizens. This is often the case for environmental datasets.

The big question is: should one pay for the access to these datasets? This question has been subject of a longstanding debate (Onsrud 1992a, 1992b, 1998, Onsrud and Rushton 1995, Johnson and Onsrud 1995, Lopez 1998, Rhind 1992, 1999, 2000, Weiss 2002, Klinkenberg 2003, Longhorn and Blakemore 2004, Joffe 2005 and Van Loenen 2006, van Oort and Bregt 2010). This debate, which occurs mostly outside the scientific journals, is scattered and complex, with compelling arguments in favour and against data charging. The debate is largely about two issues. Firstly about to what extent funding should come indirectly from taxes and to what extent it should come directly from non-governmental users (companies, citizens, ngo's, researchers). Secondly the debate is about the pros and cons of government agencies charging each other.

We now have almost 20 years of research on the issue but no conclusive answer to the question we started with. Meanwhile, we have seen three major developments:

1. A growing bottom-up and free compilation of data, often but not necessarily grounded on reference maps provided in Google Earth. A common term in this field is VGI, voluntary geographic information (Goodchild 2008)
2. The distribution costs have gone down dramatically thanks to the advance of the internet and world wide web and maps produced in or converted to digital formats
3. Many governments or institutes have moved towards free-access policies but equally many are still charging for access (Joffe 2005, Blakemore and Craglia 2006). As a result, one may find that inferior quality free data are used because users cannot afford superior quality but priced governmental data

Research on funding models tends to suggest that overall free-access is the superior funding model, although there are also convincing papers pointing in a different direction (Onsrud 1992b, Longhorn and Blakemore 2004). Quite possibly both camps ("to charge or not to charge") are right in their own respect, i.e. there is no one-size-fits-all funding model. Once we acknowledge this our next step should be to clearly and systematically identify individual cases and for each case the ideal funding model. A systematic overview of such cases is currently lacking and will be presented in the next section.

A framework for choosing between funding models

Many arguments in favour and against free-access have been put forward in the literature. Validity of arguments and their underlying assumptions have been discussed, sometimes more and sometimes with less rigour. Below we summarise the key issues. In brackets references for further reading are added. The bulleted list is in no particular order

Factual comparison of pro's and con's of different funding models is very difficult, due to methodological problems. PSI are used to produce public goods (crime fighting, road maintenance, protection of property rights, etc). Thus the costs may be easy to quantify but the benefits may be quite impossible to quantify. Asking the question "how much would is cost to complete this task with/without PSI" also does not work because people find it very difficult to answer such questions. Comparisons between countries with and without pricing will be confounded by other differences between countries. Asking informants is also a tricky business because often the best informed people also have a stake in the debate (the have-nots want free-access, the data chargers stress the value of data charging). [Onsrud 1998, OXERA 1999, Lopez 1998, Pira 2000, Weiss 2002, van Loenen 2006, Rhind 1999]

PSI production is expensive, therefore PSI tends to be produced by a limited number of producers. Competition as an economic principle that drives prices down and drives producers to take into account users' needs does not work in this setting, because there is a monopoly from the supply side. The exception is when PSI is still in the development phase. The go-no go decision still needs to be made and depends on whether there is sufficient demand for this new PSI from users within government (the prime PSI users). [King 1995, Rhind 1992]

Charging users on first sight generates extra funding. On second sight though it reduces the number of users, thereby the chances of a commercial value-adders and it can lead to less informed decision-making. The revenues generated through charging are more easily quantified than the indirect revenues that come from enhanced access. [Pira 2000, Weiss 2002, Klinkenberg 2003, Batty 2006]

Is charging feasible at all, considering the ease of which digital data are copied and distributed and considering what happened to the music industry? And do the costs of charging weigh-up against the benefits? The answer to these questions depend on the transaction costs. Selling a license to one big user in one single transaction minimises the transaction costs per user. Charging individual users is gives far higher transaction costs. Likewise, prosecuting one big copyright violator (e.g. a large company) is financially viable, identifying and prosecuting individuals for copyright violation is not. [Onsrud 1992b , King 1995, Sanders 2006, Litman 2000, Longhorn and Blakemore (2004), Anderson 2006]

For commercial users, developing value-added product based on PSI is a risky business. It is not evident from the start that customers will embrace a new product. The fact that PSI are not principally produced as input for these novel products implies that they are not necessarily suitable as input. They may require additional processing costs and they may turn out not to be useful after all. Charging in this stage of product development may scare of start-up companies and reduce the chance that from many trials eventually some successful products emerge.

Once commercial users have developed a successful new PSI-based product charging can be viable: if the price is not too high they still make profits. Moreover they are building a product based on tax-funded PSI so it seems fair to let some of the money flow back to the treasurer. And finally it is well feasible at this stage to implement a copyright policy (see above).

For non-commercial users (citizen's, NGO's, researchers) the price that can be charged is generally so low that the transaction costs will unlikely outweigh the benefits. Moreover one could argue that since the PSI is funded with their tax money, why should they be double charged?

From the above summary we distil two key variables along which validity of arguments in favour of data charging varies:

1. User types: government, commercial (companies) and non-profit (citizens, NGO's, researchers);
2. Product phases: development & production.

Our framework (Table 3) identifies for all combinations of user types and product phases the ideal funding model.

User type	Production phase	Recommendation
Government	Development (of a new PSI dataset). Production specfications not yet fixed, they are determined in negotiation with potential PSI users (goverement agencies)	Potential users (govt. Agencies) have at this stage still the power to decide not to buy the dataset if it is too expensive or not what they need for their public tasks. They pay for the new PSI dataset.Other user types (private, individual, NGO) have no access at this stage.
	Production: PSI widely used within government. PSI is produced using fixed set of stable product specifications. Many government tasks cannot be executed without this PSI.	Free access (including updates) for govememt users. Other user types (private, individual, NGO) may have access, see below.
	Development: changes in legally mandated tasks translate into new product specifications	Data charging for post-processing
Commercial	Development (experimental stage). The private company is developing a commercial value added product that incorporates PSI.	Free access to PSI (only PSI in production mode, see above)
	Production: a commercially successful product has been developed and the company is making a profit out of it	Government charges the private company for access to the PSI.
Citizens, NGO's, researchers	Production: PSI datasets that are widely used within government	Free access
	Production: a commercially successful value-added product that incorporates PSI	The user pays the private company

Table 3: Recommended funding models dependent on user type and production phase

Conclusion & discussion

Most publications cited in the introduction of this chapter have focussed on answering the big question "to charge or not to charge". This resulted in a mixed picture, some concluding that in many cases data charging has its merits, most others concluding that overall free access is to be preferred. The novelty of this chapter is that we clearly and systematically identify different cases and for each case the ideal funding model. In some cases charging is preferred, in others free access is preferred. The rationale for this framework was grounded in a review of the literature.

In the last decade we have seen to two major developments related to the topic of this chapter. Firstly the 9/11 terrorist attacks which have prompted policies to make data less accessible for reasons of national security. We argued such decision making occurs at a level before the data charging decision. It does become an issue when unreasonable national security arguments are used to ban access to environmental data. While the political debate on national security and implications for data access is of great importance, it was not the topic of this chapter. The second major development has been the emergence of free of charge datasets (e.g. open street map, google earth, online route navigation systems) and lowering of costs of sharing data over the internet. In the internet economy (Anderson 2006) the common business model is free access for most users and a select group of users paying for advanced services (e.g. google earth pro, road datasets incorporated in navigation hardware installed in vehicles). Many free datasets show similarities with existing PSI. One could argue that their mere existence is evidence of the failure of governments and institutes to make their own PSI better available to the public. The presence of such free of charge non-PSI datasets adds a new dimension to the debate on data charging. Citizens, NGO's, private companies and government agencies increasingly demand for PSI to be made freely available. Again, we risk of ending up with the tragedy of the commons so eloquently described by Onsrud (1998). Onsrud feared that if one government agency would charge the other, then to recover the costs this second government agency would also need to charge others for access to its' own PSI. In the end everyone would be charging every one. Some would not be able to pay the price, thus reducing the number of users. Prices would need to go up even further to recover the costs, which would in turn lead to even less people using the PSI. Now, we see the same threat coming from a different direction: restrictive pricing policies for PSI may drive users to free of charge online data, eroding the user base of PSI and in the end public support for tax funded PSI. The counter measure is in most cases simple: free access. The framework that we have presented is in line with evolving insights in the internet economy (Litman 2000, Anderson 2006). Our framework recommends free access for the majority of users and for a few users, where feasible and justifiable, we recommend data charging.

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User centric design for SDI architecture

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Habitats Project (www.inspiredhabitats.eu/)

Introduction

HABITATS project (Social Validation of INSPIRE Annex III Data Structures in EU Habitats) focuses on the adoption of INSPIRE standards through a participatory process to design and validate Data, Metadata and Services Specifications with real citizens and business.

To address this, the HABITATS consortium of 10 partners, including content providers, users and service providers builds a trans-European social network to generate usage scenarios and requirements and assess the impact of project outcomes, to directly feed into interactive data/metadata modelling of the four INSPIRE Annex III data themes 16-19. Widespread user validation is grounded in 7 pilot services covering these data themes across Europe and led by content-providing partners.

The validation pilots are formed by multi-stakeholder partnerships where users actively participate in the co-design of the network services, develop on-demand for integration into the pilot service mash-up platforms. Validation pilot partnerships develop and test organisational/institutional arrangements for service sustainability and business models that underpin the project's exploitation strategy. Specific and realistic quantified indicators measure the envisaged improvements in availability, access and use.

The HABITATS network of services allows users to identify, access, use/reuse, in an interoperable and seamless way, aggregated geographical information covering much of Europe and coming from a wide range of sources, from local to European level, resulting in:

a) Data/metadata models for INSPIRE

b) Network Service architecture, applet set & invoking service toolkit;

c) Seven validated pilot services for concrete usage scenarios;

d) Service/business models and exploitation plans for long-term viability;

e) HABITATS user community social network to accompany the standards adoption process & spread the project's impact throughout Europe.

Important part of the project is to define an architecture (platform neutral) for HABITATS and the basic set of networking services which will be an extension of existing INSPIRE services, for the management, discovery, sharing and processing of spatial planning data by public and commercial sector, NGOs, citizens, private sector, education and science, and all those who play an important role in biodiversity and see regional protection and also exploitation.

The objective of this task is to define such architecture for SDI, which will allow effective management of sensitive areas, research in these areas, and also promotion of these regions. HABITATS defined the tools and interfaces by which the different parties will be able to manage, discovery, share and reuse spatial data.

Architecture design was realised on the base of a Reference Model of Open Distributed Processing (RM-ODP) (ISO/IEC 10746-1). This model is the architecture reference model used also within ISO/TC 211 "Geographic Information – Reference model" [ISO 19101:2002], and on Open Geospatial Consortium Reference Model (ORM). The use of RM-ODP gave us two opportunities:

To define the basic design of the solution as platform neutral and to support different local implementation. This is important, because the objective of the document D4.2 is not to describe one unique technology solution, but to give general models, which could be used by different organisation across Europe. These models are then demonstrated on selected pilot cases that are part of the project, in order to demonstrate the feasibility of such solution.

To build on positive experiences of previous European research projects, as this methodology is used by most European (mainly research) projects and some recommendations already exist. A previous analysis demonstrates that the basic principles for INSPIRE, GEOSS and GMES projects are very similar and that some basic building blocks could easily be re-used in different applications. Our objective is to extend these models to make them more oriented towards actual user needs.

An important part of the methodology was to divide design of generic architecture and pilot dependent architecture. On the basis of user requirements, generic use cases will be defined and generic services will be designed for these generic use cases, which will be reusable for different pilot solutions. On the basis of these generic services pilot applications will be defined, which will be composed from generic services. Generic services will be available for developers so they can implement specific user applications using these generic services. Important is that these applications can reuse existing components.

Pilots

The pilots fall into the three forward-looking categories described above as follows:

1. Management of natural resources
    1. Wild Salmon Monitoring (IE)
    2. La Palma Protected Marine Area (ES)
2. Eco-tourism
    1. Hiking Trip Planner (IT)
    2. Natural Reserve (ES)
3. Economic activities
    1. Sheep and Goat Herd Management (IT)
    2. Economical activity at marine coastal benthic habitats (LV)
4. National policy
    1. Czech National Forest Programme (CZ)

Each of these validation pilots relies on trans-regional and trans-European data sharing between pilot settings within INSPIRE networks presented in the project, and with collaborating members of the HABITATS User Communities.

Wild Salmon Monitoring

Ireland has the best practice in Salmon Conservation and Management – so the processes and data-structures used in Ireland have pan-European significance for INSPIRE, and so are very relevant for the HABITATS project, and should also help to promote Irish fishing across Europe.

Inland Fisheries Ireland (IFI) have taken over responsibility for coordinating the monitoring and conservation of wild salmon in Ireland. MAC is working with the IFI National Salmon Monitoring Programme, Salmon Scientific Standing Committee, and other involved agencies such as the Irish Marine Institute (MI) to develop a Salmon Conservation Limits portal, to pilot the use of the HABITATS INSPIRE metadata profile, and bottom-up social validation process to improve presentation, accessibility and use of the data that is being collected, and get better buy-in by all stakeholders (particularly scientists, anglers, and angling related businesses) to be aware of, understand and engage in the salmon conservation procedures, regulations and catch limitations that are set each year. This provides better intelligence to researchers, fishermen and decision makers on salmon conservation, so that they can better manage the wild-salmon resource in a sustainable manner and help prevent the extinction of wild salmon in rivers on the North Atlantic coast of Europe. Once operational in Ireland the process will be scaled up in collaboration with the FP7 SALSEA-Merge project which is investigating the migration and distribution of salmon in the North-East Atlantic, working with the North Atlantic Salmon Conservation Organisation (NASCO).

To explore use of the HABITATS approach, the initial Irish Salmon CL pilot is focusing on one specific area and community (such as a catchment or sub-catchment), where users can link to the various data for that area, including a range of static data (such as catch regulations, WFD fish data, water quality etc) as well as more dynamic data partially generated by users themselves there (e.g. by online listing of their catches etc). Part (or a tributary) of the river Nore in the South-East of Ireland could be a good pilot site, as discussions with the community of active local groups and stakeholders there are proving to be quite positive. However the final pilot location is to be made by the IFI in the coming weeks.

La Palma Protected Marine Area

Protected Marine Areas (PMA) are areas where it is intended to maintain a high environmental quality in order to protect and even regenerate the flora and fauna in the area. For the development of this pilot, the La Palma's Protected Marine Reserve (Canary Islands) in the Atlantic Sea has been chosen. The island of La Palma is suffering from a peculiar environmental sea degradation due to the coast plantations (basically banana plantations).

The objective of this pilot is to develop a system based on ICT to automatically control the environment. The system will get data based on indicators from the coast area of the PMA, then process them, analysed them and make them available so the authorities can take the best decisions. Data can be obtained through the use of sensors or, like in the case of the flora and fauna data, with human intervention. When using sensors and in order to make it simple for our purpose, the coast area of this PMA has been divided into two sub-areas that will be defined as open sea (not more than 600 m from the coast) and border sea. With the same criteria, indicators that we will take into account will be: biological parameters or physical-chemical parameters and only the three among the most relevant ones will be taken for each one of the sub-areas.

Natural Reserve

This pilot is going to be developed for a small area in Madrid (Spain), El Campo del Moro, but the strength of the pilot is that if a standardization of the data and metadata modelling for this kind of environmental tourism is defined, some other standards will appear for the specific hardware that is needed for its representation, and the idea of environmental tourism could equally be developed in the whole Europe. The objective within a Nature Restricted Areas (NRA), as the European Nature 2000 Network defines it, is the survival of species in danger of extinction, contributing at the same time to soften the impact of human activities. They are the instrument to nature conservation in the European Union. For the development of this pilot obviously it is not possible to choose a NRA, but for the purposes of this pilot an interesting place has been chosen in Madrid. The objective of this pilot is to develop a system that, using real nature information and adding metadata to real images (texts, images, sounds, etc.), allows improving environmental tourism with a real nature observation. Introducing interpretation information and augmented reality we will particularly protect fragile areas. Environmental information can be used in a wide range of areas apart from environmental education or nature interpretation, it can also be used for historical or cultural heritage, evaluation of new edification impact, etc.

Hiking Trip Planner

The Madonie Park in Sicily attracts thousands of visitors every year, including hikers who explore the mostly mountainous 35,000 hectares; there are 6 mountains over 1,500m and several others well over 1,000m. The highest, Pizzo Carbonara is 1,979m, second in Sicily only to the mighty Etna (3,323m).

Hikers are attracted, in addition to the landscape, particularly by the park's flora and wildlife. Indeed, there are over 2,600 different species of plants, many of which are endemic to the area.

The Park Authority is currently developing a multimedia repertory of many of the park's main features – including both natural elements and places of traditional farming and herding – and, in the context of on-going initiatives, is developing an interactive multimedia map of the area that will allow hikers to plan visits as a function of the natural elements to see. The validation pilot in HABITATS will integrate habitats-related data into this map, to allow to view bio-geographical regions within the park. In addition, use of mobile platforms (where coverage is available) will also be tested. Finally, the currently planned facility allowing for users to upload multimedia content and insert comments and suggestions, will be enhanced to validate the possibility for users to insert content through the SDI.

Sheep and Goat Herding Management

In the Madonie Park, over 1,500m is dominated by the Madonie Forest while lower down the slopes, the locals continue to pursue millennial agricultural activities including sheep and cattle farming and the cultivation of wheat, olives and fruit. This gives rise to specific traditions such as the seasonal "transumanza" when herds are moved from their summer to winter pastures and back, and contributes to the Madonie's gastronomic specialties of meat, sausages, salami, cheese, olives, mushrooms, and fresh seasonal vegetables.

Grazing, as is well known, has a significant environmental impact and therefore needs to be carefully managed in order to guarantee the long-term sustainability of the grazing habitat. For this reason, the Park Authority adopted a grazing plan and releases licences; according to the grazing plan the Park Authority rotates the assignment and utilization of grazing areas in order to not damage areas of environmental interest with an excessive pressure due to the presence of herding activities. All this should be carried out also by adding new layers on the current condition of pastures and other environmental parameters regarding the same areas. Besides the Park Authority is responsible for other actions of monitoring, maintaining the necessary fencing and other infrastructures, etc. This management activity uses the Park's GIS system, but the decision-making processes, in the past has been generally based on experience and implicit knowledge. The validation pilot provided updated environmental data to support better informed decisions, but it is also be a starting point to regulate the production of data according to Inspire recommendations.

Economical activity at marine coastal benthic habitats

IMCS will cooperate with the Latvian Institute of Aquatic Ecology using the monitoring data of coastal benthic communities and related environmental parameters. The needs and requirements of various stakeholders will be researched and afterwards IMCS will pilot the use of advanced interfaces to improve presentation, accessibility and use of the data. It will help in decision making for port construction measures, fisheries policy, wind mill development actions in order to use the benthic habitats in a sustainable way. The benthic habitats in Latvian coastal waters are the areas with the highest biological diversity and partly covered by NATURA 2000 territories. The data on composition, abundance and dynamics of the benthic communities together with the related environmental parameters (physico-chemical measurements) collected by the Institute of Aquatic Ecology, will be made accessible to provide scientifically based information to various stakeholders carrying out different types of economical activity at the coastal areas of Latvian marine waters. The data collection is part of the Latvian National environmental policy, according to EU Water Framework Directive and Habitats Directive. It is vaguely represented online and therefore the HABITATS pilot will explore making it available as an online service.

National Forest Programme

The purpose of this use case to deliver and share the harmonised forest site data to be used as basis for the definition of the suitable forest management practices. The geographic data of the forest site classification describe the permanent ecological conditions, ie. division of forests into segments with similar growth conditions. The outputs of forest site classification serves as a basis for determining the economic measures, and operational and production goals (Forest management plans, forest management scheme). The importance of the outputs of forest typology was further strengthened in the new political-economic-environmental conditions, which has also become the basis for the evaluation functions of forest ecosystems, forest valuation, or the creation of management plans for specially protected areas.

Timber transport technologies have the direct connection (link) with natural conditions of the site. According to the forest road network can be constructed the basic infrastructure for access to forest site and is important for forest management. Based on transport accessing forestry harvesting technologies, silvicultural treatment and forest road network are constructed. Background of Joint rescue service aimed at navigation improvement for rescue service access in the forest complex (e.g. fire) is another significant area of model analysis in terms of Habitats project. The information from the FMI forest road network database serve the integrated rescue system to localize and reach the event of forest fire in short time. The further information derived from the forest site maps (SLT) and digital terrain model (DTM) enhances the driver's orientation and time estimations. As there are similar activities in other the neighbouring countries (Slovakia, Austria), this pilot scenario can be used for the cross-border cooperation within the Habitats project.

Cross pilot use cases

We recognise, that there exist list of use cases, which are valid cross scenarios. This use cases demonstrate mainly needs for data harmonisation. We recognise common use cases focused on tourism. Education, environment protection and researchPilot Actors

Pilot actors include stakeholders participating on management of platform, data owners and producers and contributors to services and user groups of all pilots. Here are list of pilots actors:

Generic actors and users

Generic actors (Table 4) could be organisations, individuals or groups of individuals with a common interest on the functionality of HABITATS solutions. They will play a role in the deployment and utilisation of the HABITATS infrastructure.

Users	Description	Activities
Non registered End User	Users, who can use HABITATS system without registration for searching and accessing information in infrastructure and using public services	– Uses services without registration; o Search for data o Search for information o Personal content composition o Visualise information o Downloaded free information o Use free services.
Registered User	Users, who are registered in infrastructure. They can search and visualise content and who can also publish some type of user driven content	o Search for data o Search for information o Personal content composition o Visualise information o Downloaded free information o Use free services. o Publish metadata

		○ Personalised profile ○ Publish information ○ Share content with others ○ Use advanced services
Expert User	Users registered on the Portal, who connect to data/services according to their rights, and have some limited possibility to publish their own data and results of their analysis	○ Search for data ○ Search for information ○ Personal content composition ○ Visualise information ○ Downloaded free information ○ Use free services. ○ Personalised profile ○ Publish information ○ Publish metadata ○ Share content with others ○ Manage context among servers ○ Define analysis ○ Prepare reporting ○ Use advanced services
Conent Provider	Users registered on the HABITATS platform, who publish and make their own data or services accessible; who access data/services according to their rights.	○ Search for data ○ Search for information ○ Personal content composition ○ Visualise information ○ Downloaded free information ○ Use free services. ○ Personalised profile ○ Publish information ○ Share content with others ○ Manage context among servers ○ Define analysis ○ Prepare reporting ○ provides data on the web; ○ produces metadata; ○ assures quality of data and metadata; ○ defines policies and license agreements.
Administrator	System administrator with full access to the Portal.	Technically manages the System.

Table 4: Generic actors and users.

Actors activities

The following table assigns single recognised user groups to generic users. The same role will not be present in all pilots, but they present a generic division (Table 5).

User group/stakeholder	End user	Registered users	Expert user	Content provider	Administrator
Technological partners					
Research organisation					
Public servant					

Park administration					
Policy makers					
Professionals groups					
Teachers					
Citizens					
Students					
Tourists					

Table 5: Actor activities.

Generic use cases

The defined user cases are initial list, which is based on pilot use cases. This generic use cases will be further elaborated in final version of this deliverable.
List of use cases (Table 6):

Generic use case	Generic tasks	Scenario relevance	Description	Actors involved
User administration and security:	User groups definition	All scenarios	To define user groups and their access rights to single services of system	Administrator
	Stakeholder registration	All scenarios	Every user can register himself in the system. The system generates a password for him.	Registered User, Expert User, Content Provider, Administrator
	User approvement	All scenarios	Administrator has to approve, so users can have access to system	Administrator
	Setting user roles	All scenarios	Administrator can define for eache user, to which groups he belongs	Administrator
	Digital Rights Settings (DRM)	All scenarios	It is necessary that it can be defined, which groups of users have access to concrete data, metadata and services	Content Provider, Administrator
	User priority definition	All scenarios	Every user can select priorities from a prepared list. This helps to customise the system for them	Registered User, Expert User, Content Provider, Administrator
	User deregistration	All scenarios	Every user can decide about deleting his registration in the system. In such cases all information about them has to be deleted from the system. In some cases, the administrator could decide to deregistered a user.	Registered User, Expert User, Content Provider, Administrator
	User login	All scenarios	A user can log or unlog himself to switch required functionality	Registered User, Expert User,

				Content Provider, Administrator
Search and discovery	Search metadata;	All scenarios	To use simple or extended search in connected catalogues	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Browse metadata	All scenarios	Every user can see metadata detail from searched data	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Join a new catalogue	All scenarios	Every user can temporally selected a new catalogue for search	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Search for objects	All scenarios	Every user can provide search for existing objects	Non registered users, Registered User, Expert User, Content Provider, Administrator
Data and metadata management	Uploaded data	All scenarios	Data could be uploaded on a server in predefined formats	Registered User, Expert User, Content Provider, Administrator
	Delete data	All scenarios	System has to support delegating data	Expert User, Content Provider, Administrator
	Change data format	All scenarios	System has to support changes of data format	Content Provider, Administrator
	Change data model	All scenarios	System has to support changes of data model	Content Provider, Administrator
	Metadata uploading and editing	All scenarios	System has registered, edited and deleted metadata for data	Registered User, Expert User, Content Provider, Administrator
	Service registration	All scenarios	System has registered, edited and deleted metadata for services	Registered User, Expert User, Content Provider, Administrator
	Catalogue registration	All scenarios	System has registered, edited and deleted new catalogues for harvesting and switch parameters for harvesting	Expert User, Content Provider, Administrator
	Coordinate transformatio n	All scenarios	System has to support changes among different coordinate system	Expert User, Content Provider, Administrator
	Downloaded data	All scenarios	Data can be downloaded by users according to their rights	Non registered users, Registered

				User, Expert User, Content Provider, Administrator
	Sensor data collection	La Palma Protected Marine Area (ES)	Data are automatically collected from sensors	Content Provider, Administrator
	On line terrain collection	All scenarios	Data are online stored in a system using mobile equipment with positioning systems	Registered User, Expert User, Content Provider, Administrator
	Off line terrain collection	All scenarios	Data are stored on mobile system and then uploaded on server	Registered User, Expert User, Content Provider, Administrator
	Off line terrain collection with laboratory analysis	Wild Salmon Monitoring (IE) La Palma Protected Marine Area (ES) Economical activity at marine coastal benthic habitats (LV)	Position of measurement is stored on mobile equipment and then uploaded on server. After data analysis in laboratory, results of measurement are connected to position	Expert User, Content Provider, Administrator
	Web based Data vectorisation	All scenarios	The client allows to visualise objects and stored attributes	Registered User, Expert User, Content Provider, Administrator
Visualisation	Compose data and service	All scenarios	User can compose its own data composition from services. The composition description could be stored on local computer	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Publish composition of data and services	All scenarios	User can compose its own data composition from services. The composition description could be stored on local computer and on server	Registered User, Expert User, Content Provider, Administrator
	Visualisation of composition	All scenarios	The selected composition could be visualised	Non registered users, Registered User, Expert User, Content Provider, Administrator
	2D View data	All scenarios	Client for Web based visualisation	Non registered

				users, Registered User, Expert User, Content Provider, Administrator
	Selection of objects	All scenarios	Client for Web based visualisation	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Thick client for 2D visualisation	All scenarios	Desktop solution has to allow visualisation of web based data	Non registered users, Registered User, Expert User, Content Provider, Administrator
	3D Visualisation	All scenarios	Client for Web based visualisation	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Thick client for 2D visualisation	All scenarios	Desktop solution has to allow 3D visualisation of web based data	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Terrain visualisation	All scenarios	Mobile equipment has to allow online access to web based data and visualise this data	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Off line Terrain visualisation	All scenarios	Mobile client has to allow download of data from server and then visualise this data	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Augment reality	La Palma Protected Marine Area (ES)	System has to support on line augment reality visualisation	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Off line Augment reality	La Palma Protected Marine Area (ES)	Mobile client has to allow download of data from server and then support augment reality visualisation	Non registered users, Registered User, Expert User, Content Provider, Administrator
Analysis	Web based Tracking analysis		System has to support basic tracking functionality	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Off line	Wild Salmon	Mobile clients has to support	Non registered

	tracking analysis	Monitoring (IE) Hiking Trip Planner (IT)	navigation functions	users, Registered User, Expert User, Content Provider, Administrator
	Image processing	La Palma Protected Marine Area (ES) Wild Salmon Monitoring (IE)	System has to support analysis of satellite images	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Sensors data analysis	La Palma Protected Marine Area (ES)	System has to support on line and on demand sensors data analysis	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Other type of analysis	All scenarios	There is need for such analyses like buffering, overlapping, attribute analysis etc.	Non registered users, Registered User, Expert User, Content Provider, Administrator
	Modelling and scenarios building	All scenarios	System has to support a complex analysis like for example analysis of chemical distribution in water	Non registered users, Registered User, Expert User, Content Provider, Administrator
Registry management	To manage information in thesaurus		Thesaurus like Gemet has to be supported	Content Provider, Administrator
	Manage gazetteers	All scenarios	System has to support gazetteers for searching geographical terms	Content Provider, Administrator
	Manage other registries	All scenarios	Need for support registries like list of organisations, etc.	Content Provider, Administrator
Monitoring and control service	Monitor registration process	All scenarios	It is necessary to monitor, who is registered, logged in etc.	Content Provider, Administrator
	Monitor requests for access with DRM	All scenarios	For data it is necessary to monitor, who accesses data	Content Provider, Administrator
	Monitor requests services	All scenarios	For services it is necessary to monitor, who uses concrete services	Content Provider, Administrator

Table 6: Generic use cases.

Data types used in habitats architecture and how the data are accessed

Data in HABITATS (Table 7) architecture are divided according to their origin and their usability. Basic types of data can be found in next table.

Data type	Description	Examples of data	How data are used	How are data accessible
Reference data	Reference data are data, which are coming from other systems, and which are not changed inside of HABITATS	Topographic maps, Pan European data sets, administrative borders, cadastre, orthophotos,	Data are primarily used for visualisation, in some tasks they could be used also as background data for analysis (could define areas of analysis, buffers, etc.)	Data could be stored locally, or their could be accessible using Web Services (Web Mapping Services for visualisation, Web Feature Services or Web Coverage services for data analysis)
Satellite imagery	Data coming from Earth observation, which are used for analysis and visualisation	SPOT IMAGE, Quick Bird, MODIS (Aqua and Terra)	Data are primary used for data analysis, partly for visualisation	Primary data will be accessible trough external catalogues using Web coverage services
In-situ observation	Data measured by sensors and stored in databases	Meteorological data, quality water measurement	Data are used for analysis (including temporal) and partly for visualisation. Usually visualisation is necessary using graphs etc.	Data from sensors are usually stored in database and then are accessible through services like Sensor Observation Services, or Web Processing Services
Terrain measurement	Data collected in the field using specific measurement equipment	GPS measurement, geometrical measurement, photography with positioning etc.	Data are validated and then used for updating of existing data, next analysis or visualisation	Data are accessible from equipment in proprietary formats or using Web services
User edited data	Specific data layers, where groups of people could on line edit data and attributes	Point of interests, user collected data about objects, user observation	Data are validated and then used for updating of existing data, next analysis or visualisation	Data are stored in database using system middleware, accessible could be using web services
User derived data	Results of analysis of previous types of data	Image classification, extrapolation from sensors	Data are used for reporting and visualisation	Data are stored on server (often temporally) and are accessible using Web services

Table 7: Habitats data.

Each of the previous data types has its own life cycle. This cycle also depends on whether the data are stored locally or are externally accessible using Web services. For the design of the HABITATS architecture mainly the data managed locally are important. The basic operations are:

- Data upload, which could include
    - Data upload
    - Data format transformation
    - Data model transformation
    - Metadata import or description
- Data publishing
    - Publishing Web services (WMS, WFS, WCS)
    - Publishing metadata for services
- Using data for analysis
    - Services related to published data are used as part of processing services
- Visualisation
    - Data are visualised using WMS
- Data querying
    - Attribute queering
    - Graphical querying
- Data analysis
    - Buffering,
    - Overlapping,
    - Tracking
- Data updating
    - Data upload
    - Data format transformation
    - Data model transformation
    - Existing data replacement
    - Updating metadata
- Data deleting
    - Deleting data
    - Deleting related services
    - Deleting related metadata for data and services

Basic component

The next step was functional decomposition of the system into basic objects which interact at interfaces. It describes the functionality provided by the system and its functional decomposition. This viewpoint focuses on the components of the system, not considering distribution aspects, which are managed within the Engineering and Technology viewpoints. The proposed architecture extends principles of Service Oriented Architecture, based on publish-find-bind paradigm. The primary components identified for HABITATS are described below.

Wild Salmon Monitoring

The Irish Pilot Salmon CL portal integrates inputs from many sources, as listed in section 4.9.2. The portal is being implemented at www.habitats.ie using GeoNetwork1 for the metadata definition and maintenance, and GeoServer2 to expose the various data. Using the HABATATS metadata (defined in D3.2.1) this data is being made Discoverable and Viewable as Catalogues on the Irish Spatial Data Exchange (ISDE) and HABITATS RL Portal to demonstrate and validate its "INSPIRE Compliance".

The Salmon CL portal will also contain various Salmon Angling services and applications that are constructed from the various data sources in response to users' requests and suggestions, and will be constantly evolved throughout the WP5 Validation Pilots.

Thus the pilot will implement the following services:

- The data management
- The metadata management
- Catalogue service platform
- The HABITATS metadata profile is being applied.
- View, share and download services will be in the geoportal
- Next step expected is to develop smatphones apps

La Palma Protected Marine Area

In this pilot we obtain data from a sensor system and from a sensor connector we store these data in a database. This first database is a SQL DBMS in the form of tables and the relationship among the data is also stored in tables.

From these tables, we get the representative geodata in shapefile format. The platform to publish these data is composed by Geoserver, Geonetwork with PostgreSQL. This platform works with WMS, WFS, WCS and CSW standards and allows View and Discovery services. Also we get Authetication service and from this we could manage groups, roles and users with different levels of permission, it allows a profiling and open the door to Download an Metadata Editor services.

Augmented Reality - Natural Reserve

We have harvested the representative geodata in shapefile format, mainly interesting points. The platform to publish these data is composed by Geoserver, Geonetwork with PostgreSQL. This platform works with WMS, WFS, WCS and CSW standards and allows a Discovery service. Also we get Authetication service and from this we could manage groups, roles and users with different levels of permission, it allows a profiling. It opens the possibilities to Download, Metadata Editor, and View services. The last case could be oriented to different users.

The View service must be process through our Augmented Reality software to be displayed in the AR devices and mobile phones. From these platforms we could work to implement the Web 2.0 for the users.

Hiking Trip Planner and Sheep and Goat Herding Management

The platform used:

- Data management
- WMS,
- WFS,
- CSW services
- WPS
- Download services

Economical Activity at Marine Coastal Benthic Habitats

In pilot are collected all Latvia Institute of Aquatic Ecology maintained data and datasets. Historically data are collected and maintained in ESRI Shapefiles, Microsoft XLS and CSV files. These data has been normalized, created data models and imported in SQL relation database management system with spatial data support. Using in database created data model and stored data in the platform is possible to create and manage as OGC WMS, WFS, WPS, WCS services and manage access and publishing options. Since data are not maintained in INSPIRE equivalent or extended data model will be provided INSPIRE compliant WFS view on data. Meta-data system are stored information about datadatasets and services, meta-data system is able to read WMS, WFS and WCS service meta-data information.

National Forest Programme

FMI currently we can offer:

- Datasets for Habitats reference laboratory
- WMS service
- Validated metadata (available both in English and Czech language)

The conclusions about The Forest site classification data for sustainable management and utilization of forest road network:

- Platform used - UMN Minnesota, Openlayers and Micka
- Validated metadata (available both in English and Czech language)
- WMS, WFS, CSW services
- Download services

System distribution of infrastructure

The HABITATS Networking Architecture has the goal of defining a system able to ensure the interoperability and security of provided data and services. In particular, since an integration with the INSPIRE initiatives is needed, it is based on:

- A methodological approach able to define a system architecture that is scalable and adaptable to the specifications and standards currently being defined;
- The adoption of a Service Oriented Architecture based on WebServices and SOAP technology.
- The reference laboratory will have next roles in project!
- To offer possibility for testing new services
- To offer access to global data for pilots
- To support implementation of cross pilot scenarios
- To making discoverable Habitats services for external platforms

The objective of RL is implement such functions, which will guarantee this functions. Interlinkage of RL with pilots will be based on next schemes.

Pilot implementation are implementing only functionality required by pilot user needs, Reference Laboratory is implementing implement full functionality. The basic scheme is on next picture (Figure 26).

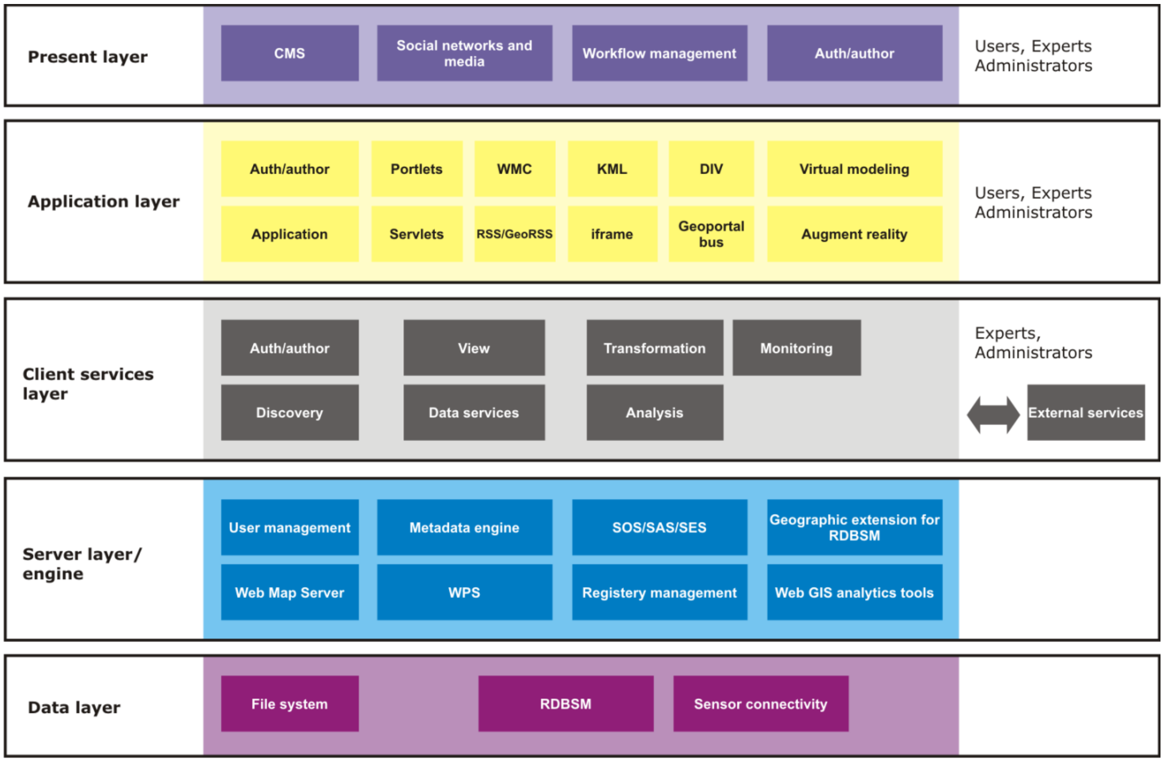

Figure 26: Habitats architecture.

Implementation

Reference laboratory implementation

The Reference Laboratory (Figure 27) architecture provides functionality through modular, re-usable and interoperable application services. Each modular service have to have a clear, standards-based interfaces so that the services underlying technology, which could be replaced if or when the current base-technology is upgraded to a new version - or when a competitors technology platform emerges takes over as technology leader. As a consequence, the architecture is extensible, especially in terms of plug-ins for additional, non-standard or "modified standard" protocols. which have been applied on national or regional level. The modular architecture secures that any third party is free to create his or her own extension points to the core architecture.

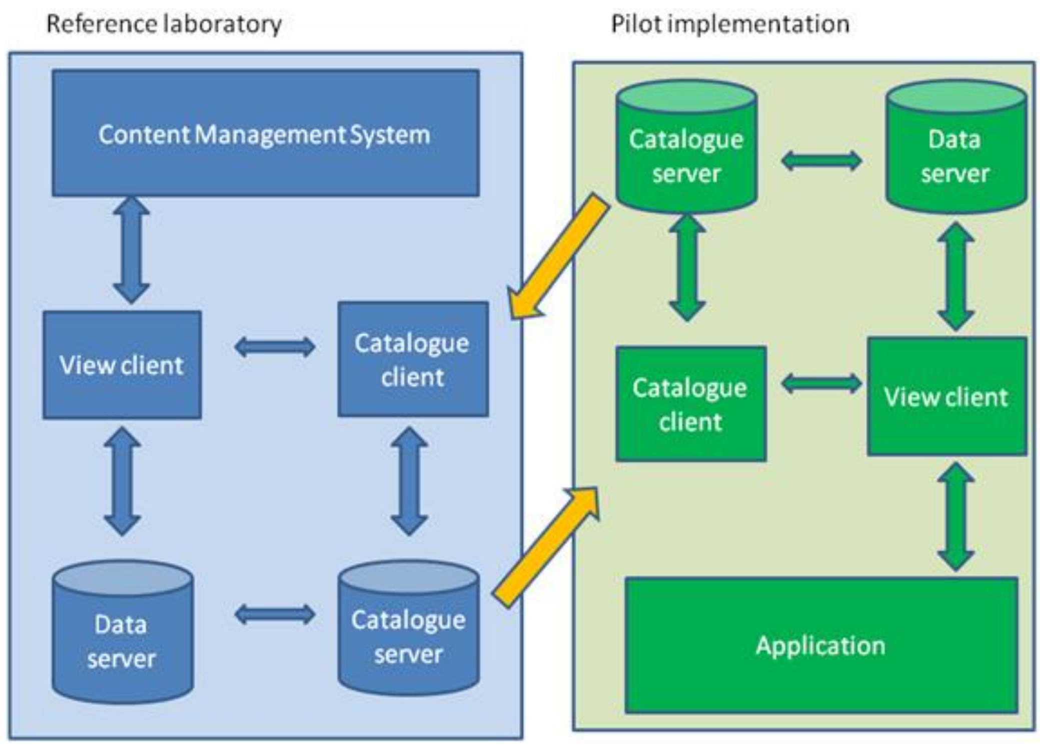

Figure 27: Reference laboratory

Wild Salmon Monitoring

The Irish Pilot Salmon CL follows all of the primary components of the HABITATS SOA architecture based on the publish-find-bind paradigm.

The portal is implemented using GeoNetwork and GeoServer, and includes data and services from many sources including the SSC regulations for 2011 on limits in specific rivers, fishing information and wider regulations, the Irish Spatial Data Exchange, IFI Salmon Monitoring Programme, WFD water quality monitoring, Wild Salmon census data from the Marine Institute and scientific wild salmon conservation data (see section 4.9.2).

The Salmon CL portal will also contain various Salmon Angling Services and Applications that are constructed from the various data sources such as

- Salmon Angling current Information.
- Where are the local Salmon biting.
- When Can I fish.
- Fishing License
- Catch recording (on a map)
- Feedback (as a tourist Angler).
- Etc

These are being developed in response to users' requests and suggestions using Microsoft Silverlight in a Visual Studio IDE, and will be constantly evolved throughout the WP5 Validation Pilots. In addition the Salmon CL Portal data layers will be exposed through GeoServer to be merged into the IFI ArcGIS Interactive Map Viewer.

La Palma Protected Marine Area

The architecture design is according following scheme (Figure 28)

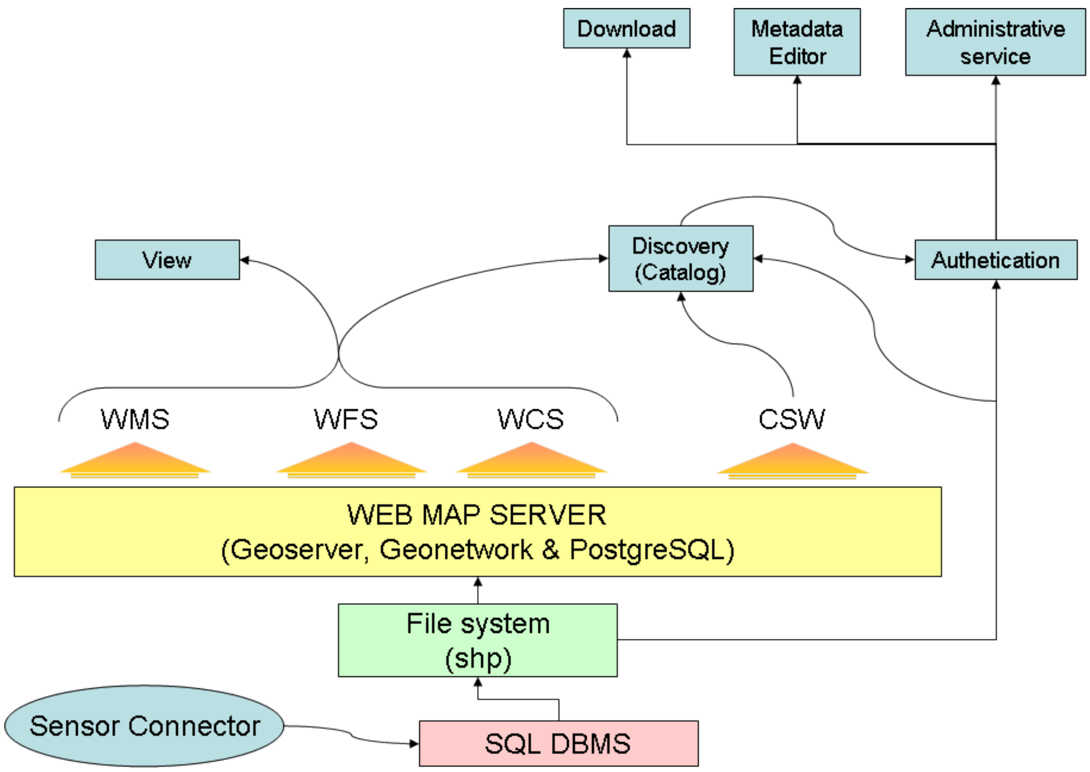

Figure 28: La Palma Pilot Application.

The first implementation based on selected infrastructure will be described in D4.3.1 HABITATS Networking Services and D-5.2.1, D-5.3.1, D-5.4.1 Pilot Platform Integration, Execution & Interim Evaluation Report.

Natural Reserve

The architecture design is according following scheme (Figure 29)

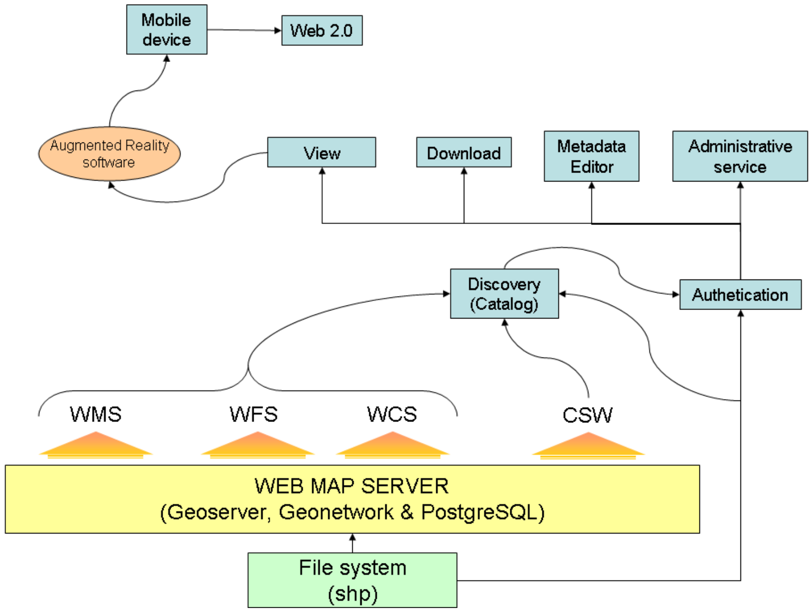

Figure 29: Natural Reserve scheme.

Hiking Trip Planner and Sheep and Goat Herding Management

The architecture design is according following scheme (Figure 30).

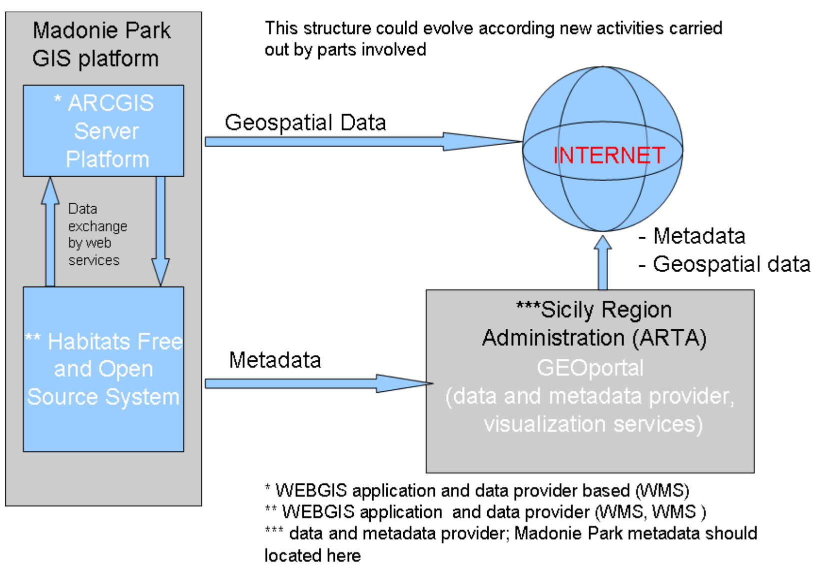

Figure 30: Hikking application scheme.

The first implementation based on selected infrastructure will be described in D4.3.1 HABITATS Networking Services and D-5.2.1, D-5.3.1, D-5.4.1 Pilot Platform Integration, Execution & Interim Evaluation Report.

Economical Activity at Marine Coastal Benthic Habitats

The architecture design is according following scheme (Figure 31).

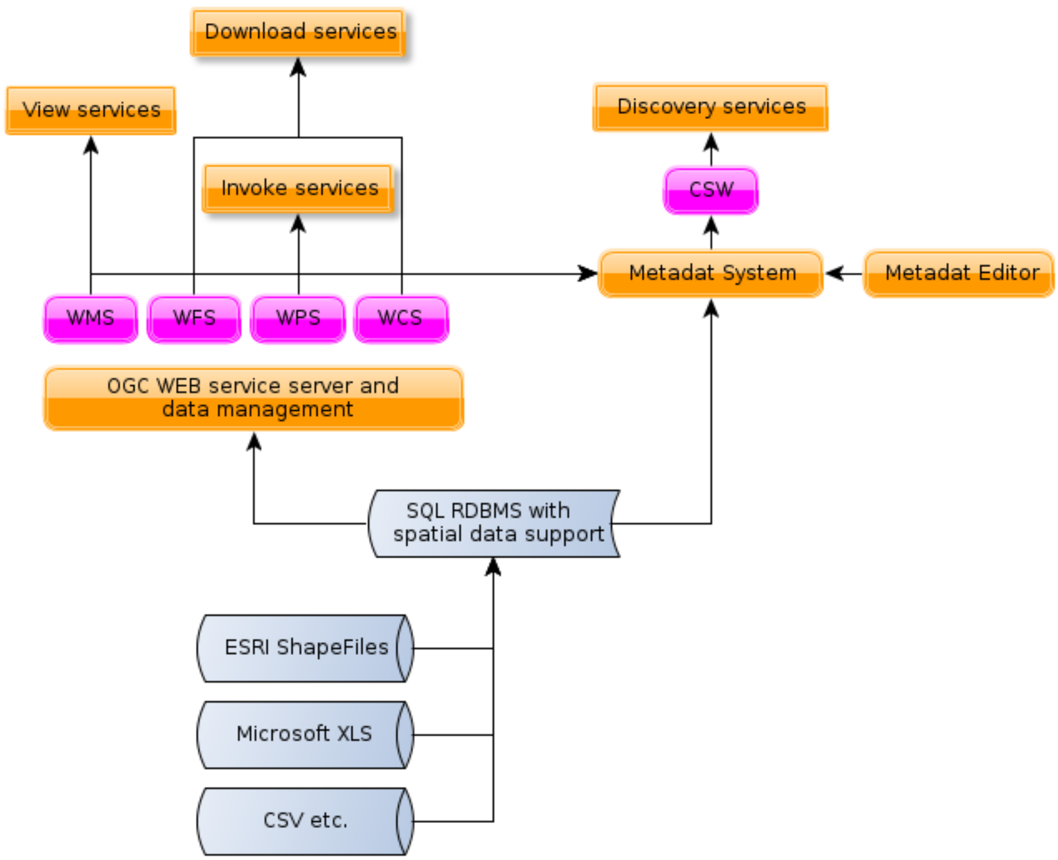

Figure 31: Economic activities scheme.

The first implementation based on selected infrastructure will be described in D4.3.1 HABITATS Networking Services and D-5.2.1, D-5.3.1, D-5.4.1 Pilot Platform Integration, Execution & Interim Evaluation Report.

National Forest Programme

Simple scheme for the first use case - "Forest site classification data for sustainable management and utilization of forest road network" is displayed bellow (Figure 32):

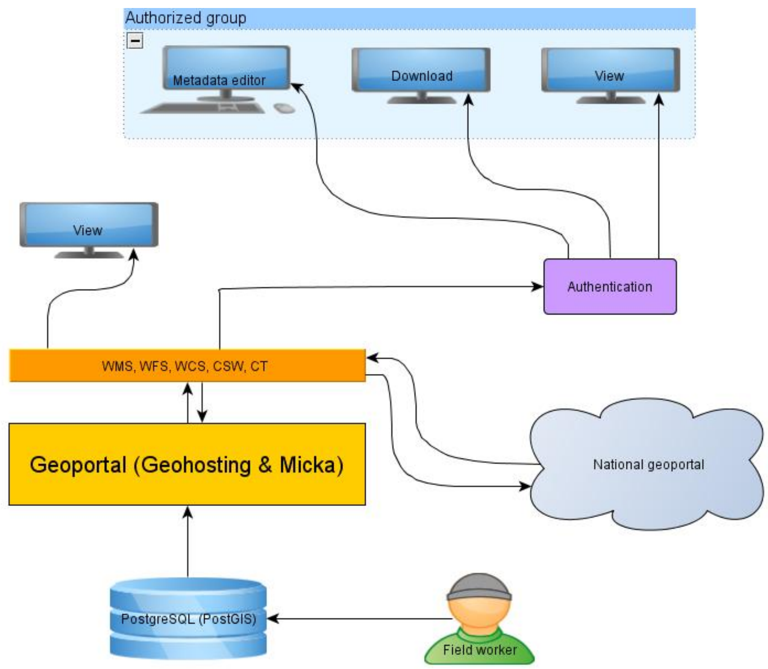

Figure 32: Forest pilot.

FMI has a long experience with MapServer.

The first implementation based on selected infrastructure will be described in D4.3.1 HABITATS Networking Services and D-5.2.1, D-5.3.1, D-5.4.1 Pilot Platform Integration, Execution & Interim Evaluation Report

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NaturNet Educational Portal user validation

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The Nature Net Plus project description

NaturNet Plus was a multilateral project funded by the European Commission's Lifelong Learning Programme. NaturNet Plus transferred knowledge from previous projects and initiatives including the NaturNet Redime project, Plan4all, Humboldt and other. The transfer was made to the regions and enterprises in Latvia, Lithuania, Bulgaria, Romania and Italy. The main focus was on vocational training in sustainable tourism; mainly in sensitive areas as protected territories, national parks and coastal zones. The project established newly generated educational content and introduced it through innovative platform for vocational training and eLearning to a set group of final beneficiaries interested in the field of sustainable tourism, geographic information systems (GIS) technologies, metaschools tools etc.

Overview of the NatureNet Plus validation plan

NaturNet Plus was mainly targeting the following groups for disseminating the project results and for utilization of the educational program presented at the NaturNet portal:

- On local level – politicians and decision makers in the field of environment and tourism, regional and local governments, cities, etc.
- On regional and interregional level - public authorities, private companies, associations, universities, tourist offices, tourist industry.
- On national and European level - expert panels on basic issues of sustainable tourism, professional associations, universities and other relevant research centres.
- Citizens and different tourist social networks (this groups are main users of tourist services) - their opinion is most important for local authorities and tourist services providers, where their needs have to be satisfied by tourist services. The involvement of this target group is also important for education of other groups. The process of involvement presents complexity of different issues and requirements for new techniques supporting the interconnection with existing social tourist networks.
- Specialized VET centres and professional VET networks (this groups could be described as the main providers on VET) – the participation of this target group is very important for the validation process as they could participate as corrective party for the process of training. Also could provide educated trainers and can introduce the project product as part of their internal classes and education activities.

NaturNet Plus validation process was based on a bottom-up approach. An important part of the communication plan and the training and validation methodology was the involvement and feedback of target groups to define their requirements and to validate the project results. This includes project partners of NaturNet Plus as well as external institutions and other private and public users. Involvement of those groups in the validation process shall be reached via inquiry-based assessment, specialized questionnaires, papers, reviews and co-authoring in specialized articles, via internet and mainly via events (seminars, professional education events, vocational trainings etc.). Three main questions were identified concerning validation:

- Who is addressed by the NaturNet Plus products and what are their interests?
- Who has to be involved for further activities to ensure sustainability of the NaturNet Plus results?
- How should the results be prepared and presented to obtain a high acceptance by the NaturNet Plus partners and relevant stakeholders beyond the partnership?

The strategic approach for validation was taken into consideration including several interconnected objectives. It aim should be at improving and testing the project content of the eLearning modules provided by the project and to clarify the project results with the project partners and other stakeholders. It should include also a feedback from all the partners and stakeholders that will serve as a one of the most general validation step. Informing broader public and possible future users of the ongoing project activities and its results should be noticed too.

Answering the above questions four main steps of the validation of the NaturNet Plus project were described:

Step 1

Elaboration and implementation of quality management plan

The quality management plant is important for every validation process as it provides the internal view of the project team for the product and of external experts involved in the project implementation. The main aim of such plan is to provide internal assessment on the products performance and quality. Generally such plans includes specialized tools as reviews, assessments, external audits, peer reviews, surveillance reports etc.

Step 2

Online training of trainers

Thus, the project team is small and specialized in the specific implementation of pre-defined work packages for the training activities have to be educated and involved additional groups of experts – the trainers. The experts should be experienced in VET and eLearning techniques and should be used for the further steps of education of representatives of different target groups of stakeholders.

The training of trainers could be organized at different sub levels as by individual testing and self-education of people selected as experts, through online classes for training the trainers or through seminars and/or workshops where the preselected pool of experts to be organized at international basis and to be familiarized with the tools and application of the NaturNet plus project.

Step 3

Providing specialized training for people interested in the field of the project

Based on the previous involvement and education of trainers from each country a special selection of interested experts and people representing each of above described target groups should be organized. After that could be organized special seminars in each partner countries, series of seminars per country or a series of blended courses (combination of e-based lectures, mobile learning and live seminars and discussions). The aim of this stage is to secure a group of stakeholders to be affected by the project results.

Step 4

Validation report

As a result of the previous three stages one report should be elaborated. As part of the report should be described lessons learned from the validation process, and recommendation for future steps and improvement of the system.

Methodology for validation

Step 1

Elaboration and implementation of quality management plan

1. General assessment of the system performance and the training materials though surveys and testing. Based on a general questioner it should be made by random people or based on special selection by the stakeholder's pool. A short external assessment report should be made.
2. Release of a handbook for developing courses on special tourism qualifications for each country. As an add-on to this handbook a special guidelines for trainers could be issued.
3. Data quality assessment – this assessment should be implemented and provided by the project partners as a feedback to the experts. It should be based on scientific and statistical evaluations.
4. Performance evaluations and surveillances – continuous assessment of the real-time implementation. This should be implemented through development of a specific administration panel in order to secure the daily based communication between the end users of the project applications and the project development team. A short surveillance report at the end on the project should be elaborated.

Step 2

Online training of trainers (ToT)

The online ToT could be organized at two sub-steps:

1. Involving the future trainers in the process of general assessment of the system performance (described in step 1) and including them in the pre-selected testers group.

2. Organizing one general event for ToT where a group of 30 people (for all countries participants in the project) to be involved for online training on the system features. The training aim is to organize a group of professionals, familiar with the NaturNet Plus project and content in order to use it in their future practice. The training could be organized as a one day online event divided on two main sessions:
   a) 1st session – presenting the features of the NaturNet portal and applications. Practical activities and exams;
   b) 2nd session – improving the portal and eLearning contents. Development of new lessons using the NaturNet Plus applications and adapted training modules by means of class-room courses. Presenting the lessons to a broad audience during the training and after with the NaturNet Plus portal could be an asset.

Step 3

Providing specialized trainings as single events for active stakeholders

For the implementation of this step, at least 6 single trainings for stakeholders should be organized in the partner countries. The timing of each event should be one day, where the following objectives should be fulfilled. The main aim of these trainings is to involve people interested in the recent local tourism trends and the NaturNet Plus applications and to train them using the eLearning module improving their skills for their future working activities.

Each event could be organized under the following general agenda:

- 1st session – presenting the features of the NaturNet portal and the NaturNet applications.
- 2nd session – specific discussion according to the needs of the participants. Involvement of specialized trainers.

Step 4

Validation report

The validation report have to describe all the activities performed within this project work package in order to secure good training and validation of the project results. Generally the report should be divided on three main parts, describing the main validation activities carried out and the outcomes of each, the main improvements made during the validation and the recommendations and lessons learned for future developments and improvements of the main NaturNet Plus project outputs and outcomes.

Trainings methodology

The methodology used for training of active stakeholders was basically a workshop divided in two sessions – presenting the NaturNet outputs features – the NaturNet portal and the NaturNet application and a practical work and examination with the participants. In the second session, more discussions were implemented based on pre-set questions. The main recommendations and issues stressed by the stakeholders are presented in the last sections of this report. The event was implemented as one day training. All project applications features were presented based on a pre-published presentation on the NaturNet Portal.

Draft agenda for workshops in pilot areas (2011)

1. NaturNet Plus project – brief introduction (available in all project languages)
2. Scenarios, tools and best practices
    - Sustainable tourism as a tool of development in natural sensitive areas
        - Next collaboration of destination management and SWOT analysis
        - How to use social networks to discuss local strategies
        - Comparison of existing documents from region and some public assessment
        - Who could be involved in regional strategy
        - How use in future Naturnet plus portal and social networks for building of local or regional strategy
        - Assessment of current results
        - How to start work in national languages
    - Collaborative gaming as a tool for promoting of environment and cultural heritage.
        - Current status of GeoGame
        - Process of training for preparation of Games
        - How to translated games to different languages
        - Preparation and announced of competition about best regional games (in English language)
    - Using spatial information and social media for tourist support
        - Using OpenStreetMap as potential reference layer (if other data are not available) for local tourist systems
        - How to combine data with other sources on portal
            - How to register services
            - How to upload data on server
            - How to register local or other catalogues, if the catalogues are available
            - How to publish data on portal (using shape file)
            - How to search for data using catalogues
            - What is Web Map Context
            - How to prepare Web Map Context and how to share WMC with others

        - How is possible to digitalise context using NaturNet portal
        - How we can use data from NaturNet portal in different social media or content management systems
    - NaturNet Plus Geoportal and concept of social media
        - What is current content and how to continue
            - How to translate content
            - How to integrate with social networks
            - Slideshare or other media and how to integrate with portal
            - What content could be usefull to translate
            - IPR
        - Tools description
            - Which tools are available
            - What has to be translated
            - How to provide
    - Future tourist information systems
        - Concept of single information space for tourism
        - Concept of Geoportal4everybody
            - How we could extended this concept for tourism
    - Related project, their portals and how to cooperate with them
        - SDI EDU
        - Habitats
        - EnviroGrids
3. Discussion
    - How to go for rest of project
    - Sustainability after end of the project

All trainings were organized for 10 to 30 stakeholders from each pilot region and additionally a second event for some of the countries took place – for target beneficiaries at national level - universities, VET centers, tourist agencies and operators etc.

Portal contents review

The review of the content of the NeturNet portal was organized as an inquiry-based assessment, and a special questionnaire was circulated among target beneficiaries.

NaturNet Plus validation questionnaire for stakeholders:

Welcome to the NaturNetplus WP4 Validation Questionnaire

This questionnaire (see Table 8) is carried out in the framework of the NatureNetplus project (http://www.naturnet.cz) as a source for validation, analysis and evaluation of existing content of the NaturNet portal (www.naturnet.org).

Name	
Organization	
Role in your organization	
Contact (e-mail; web page; skype; facebook page; telephone**)**	

1. **Using the scale of 1 to 10, please grade the NaturNet Plus portal according to the application to your professional life.**	
1.1. If your answer is above 6 please describe any positive features the portal gives to your profession (*optional*)	
1.1. If your answer is below 5 please describe any possible upgrades the portal should undergo (*optional*)	
2. **What is your evaluation on the qualities of the NaturNet Plus portal (using 1-10 scale)**	
2.1. If your answer is above 6 please mark the most countable features of the portal (*optional*)	
2.2. If your answer if below 5 please mark the most inappropriate features and discrepancies with the project objectives.	
3. **Please evaluate the contents of the 'About Natur Net Plus' section (using 1-10 scale)**	
3.1. Can you please describe any additional information, which could be positive and useful for this section?	
4. **Please evaluate the contents of the 'How to use the portal' section (using 1-10 scale)**	
4.1. Can you please describe any additional topics, which could be useful for this section?	

5. **Please evaluate the contents of the 'News and events' section (using 1-10 scale)**	
5.1. Do you think the information is up-to-date? Yes/No; any comments?	
5.2. Please comment the contents of the RSS news on the right side of the portal web page? Are they useful for you and your professional life? In what topics?	
6. **Please evaluate the contents of the 'Pilot regions' section (using 1-10 scale)**	
6.1. Do the information in this section is enough informative for you as a professional or as a tourist?	
6.2. Can you please describe any additional information, which could be useful for this section?	
7. **Please evaluate the contents of the 'Sustainable development' section (using 1-10 scale)**	
7.1. Can you please describe any additional topics, which could be useful for this section?	
8. **Please evaluate the contents of the 'Transfer of innovations' section (using 1-10 scale)**	
8.1. Do the information in the presentation is enough informative for you as a professional? Do you think the content of the presentations could be ungraded with additional data?	
8.2. Can you please describe any additional topics, which could be useful for this section?	
9. **Please evaluate the contents of the 'How to deal with data' section (using 1-10 scale)**	
9.1. Can you please describe any additional topics, which could be useful for this section?	
10. **Please evaluate the contents of the 'GeoGame' section (using 1-10 scale)**	
10.1. Do the game features are enough informative for you as a professional or as a tourist?	
11. Please evaluate the contents of the 'Environmental impact assessment (EIA)' section (using 1-10 scale)	
11.1. Do the integrated approach of the EIA developed in this section will be positive to you in your professional life?	
12. **Please evaluate the contents of the 'Tourism' section (using 1-10 scale)**	

12.1. Can you please describe any additional topics, which could be useful for this section?	
13. **Please evaluate the contents of the 'Related project' section (using 1-10 scale)**	
13.1. Did you found any important information is this section? Please suggest any topics, from projects which could be useful for you?	
14. **Please evaluate the contents of the 'Agriculture, Rural development' section (using 1-10 scale)**	
14.1. Can you please describe any additional topics, which could be useful for this section?	
15. **Please evaluate the usefulness of the supportive sections as user blogs, library, follow-us, newsletters etc. (using 1-10 scale)**	
15.1. Please evaluate the positive impact of the Web 2.0 technologies to this project.	
16. **Please evaluate the contents of the metadata search engine, located on top of the main page (using 1-10 scale)**	
16.1. Please evaluate the easiness for search and the comfort during the metadata search?	
16.2. Can you please describe any additional features, which could be useful for this section?	
17. **Please evaluate the contents of the map engine, located on top of the main page (using 1-10 scale)**	
17.1. Please evaluate the easiness for search of location in the Open Street Map and the comfort during exploring the spatial contents of the map?	
17.2. Can you please describe any additional features, which could be useful for this section?	
18. **Do you find useful for you in your professional life that some sections of the portal are translated at the local languages of the project partners?**	
19. **Please evaluate the user-friendly level of the interface? (using 1 -10 scale)**	
19.1. Additional comments of the interface.	
20. **Any additional comments on the content or the general benefit of the portal for the VET process?**	

Table 8: NaturNet Plus Validation Questionnaire.

During the validation process also were examined all active discussions concerning the project results on the project pages in the Facebook network and LinkedIn. Additionally short follow-up interviews with expects and participants in the project events were organized.

Validation findings

Expert review

The general review on the project outputs, namely the NaturNet Plus portal and the NatureNet applications has been organized by Ms Asya Assenova, assistant professor, PhD in Sofia University "St. Kliment Ohridski", Biology faculty, section "Methodology in education"; member of the University's centre for eLearning and distance learning.

As one of the main positive features of the project outputs which could be applicable in the field of environmental education and education for spatial information are the:

- Ability to create video lecturing courses and to organize trainings for future teachers and experts on the biology, geography, tourism. All of them, crucial for the process of development of rural and eco-tourism activities. Despite of the fact, the programs for video tutoring as the BizBiz application was presented at the end and as a future option for improvement of the educational program presented at NaturNet Plus portal as a set of PowerPoint presentation, this application shall be marked as one with many potentials.
- Additionally the ability to organize synchronous and asynchronous communication between lecturer and students is also something very important. As the project team has shown many times at much events potential to organize educational and training events, this potential feature shall be implemented as part of the NaturNet Plus portal.
- Another potential feature of NaturNet Plus is to organize and design new type of training using the blended learning methodology;
- The different tools and applications which can be used in training;
- The GeoGame tool has good chances to be used in organizing case studies within educational courses with students and also to present in attractive way specific touristic spot in any region. The last one is very important to draw new visitors in any rural area.

In general the qualities of the NaturNet Plus portal can be described in 9 main items:

- Content management – easy-to-use management system, where the new content can be presented to other users of the portal, to be organized in a friendly way and to be kept up-to-date for the needs of visitors in any regions featured in the portal. Also to be accessed fast by other trainers.
- Course management – this is an item, which gives good opportunity for the trainers to keep the educational program updated and to test and communicate new ideas with other users of the portal, supported by the portal communication services.
- Portal communications services – although, this item presents good options to collect easily feedback from the trainees and/or tourist from any region.

Another 6 items, which gives additional strength to the NaturNet Portal are:

- Document management;
- Tools for online training;
- Easy-to-use interface;
- Applications available from everywhere;
- Self-registration of new users;
- Content and device support.

All different sectors of the NaturNet portal including the available computer applications and tools are well presented and organized. Nevertheless, some of the features need improvements. They should not be much technical, but considered to be future needs of the portal users. The following add-ons could be described section by section:

- ‘About NaturNet Plus’ - It's necessary to determine the audience for the page more clearly, and to put it for the interest of the portal users.
- ‘How to use the portal’ - It could be focused on more specific information for different target groups, which are expected to be the portal users.
- ‘News and events’, RSS news and the blog – Any discussion on a topic should include multiple perspectives from a variety of views.
- ‘Pilot regions’ - the information in this section is well structured and useful. It is arranged and described in general algorithm, which allows comparative analysis for different regions.
- ‘Sustainable development’ - to demonstrate more practices for implementing the world SD strategy in different countries.
- ‘Transfer of innovations’ - The content is very complex and involves environmental, economic, political, social, cultural, and scientific context. The quality of the information within any section and in particular this one should be related more to the needs of the users. The option for inserting comments under each section is something very useful, especially is a dynamic subject as the sustainable development. This feature should be future developed is order to give to the users and trainees the opportunity to comment and improve the education content based on own knowledge and studies.
- ‘How to deal with data’ – it will be better for future improvement to present more detailed information about the type of data which the user is advantaged and the existing sources.
- The ‘GeoGame’ is very interesting and has good potentials to achieve many educational aims. It gives opportunity to show and evaluate specific student knowledge about different regions.
- IEIA - Certainly this approach will be very useful in students and adult education, but it needs long term survey in order to describe the real potentials in real of such tool.

- ‘Tourism’ – More regions need to be presented for future in order to reach national coverage. It is very important also more achieved for sustainable tourism products and practices to be presented.
- ‘Related project’ - to include more related information and scientific articles related to sustainable development and the role of sustainable tourism for the development of areas with marginal income.
- ‘the use of web 2.0 technologies to this project’ – as one of the main features of the web 2.0 technologies can be described the process of enabling users to collaboratively create, share and recreate knowledge from multiple sources. To leverage collective intelligence and organize action. With the assistance of the web 2.0, individual users are able to add their own data and services to collaborative web software, remixing the web 2.0 sites into increasingly useful tools. In order to reach all these characteristics working, more users for the portal from each partner country should be attracted. In order to reach the certain level and to see the real potentials of the web 2.0 the portal needs to triple the audience using the contents and to move the project outputs from the field of innovation to the fields of common use.
- ‘Open Street Map’ - searching with Open Street Map is very intuitive and easy for orientation and will be very useful during any educational process.
- ‘Translations in local languages’ – it is critical in order to reach the necessary number of users, to make the project results helpful to the pilot region and to start educating local visitors and/or professional in tourism. The translations make the portal more accessible and allow to be used by more people.

As a conclusion, the results of this innovation transfer project shall follow the expected forthcoming activities in order to spread all collected knowledge and methodologies to other regions. This will be useful for turning the project outcomes from innovation for a pilot region to applications with a common use in touristic areas and within the national educational systems for VET.

Stakeholders evaluation on design, content and impact

During the evaluation was used an inquiry based questionnaire with a scale from one to ten. Additionally each section in the questioner was evaluated on average basis with options for recommendations for improvement, and comments on the working and/or non-applicable parts of the NaturNet Plus portal and the NaturNet applications.

Stakeholder’s impact

General evaluation (*below/above average*)	**Appraisal** (*points*)
100 % above average	7,75

As one of the main impact presented by the people who took part in the survey, was presented the options for sharing of project results, articles and other media through the NaturNet Plus Portal and the social networks, where the project is presented as Linked-In, Facebook and the INSPIRE Forum. Although, the portal was presented, by many as useful because of information about tourism development in targeted regions, but with the main important elements, and new, actual, up-to-date and interesting information. Also, the potentials for the professional life of some of the interviewees have been marked.

In general the impact to the stakeholders and the general evaluation of the portal made by the inquiry can be stated as very good with its 7,75 appraisal points, and as one of the main and attractive features for the stakeholders at national and local level can be marked the news, the tools and the valid information sets regarding environmental issues and education published at the Nature Net Plus portal.

Portal features

General evaluation (*below/above average*)	**Appraisal** (*points*)
100 % above average	7.58

The portal qualities are visible for the stakeholders mainly in the links to social networks and options for receiving new and relative information, the metada catalogue, and the visualization of geographic features. Also as important part of the portal the simplicity of the navigation, clear graphic, the simple platform and the eye-catching background were marked. This leads to the conclusion that the portal is simple enough for professional and for tourists, and giving many tools and well described information in different fields makes the project outcomes suitable for the needs of VET education and for rural tourism.

Portal design

General evaluation (*below/above average*)	**Appraisal** (*points*)
100 % above average	7.58

Additional to the NaturNet Plus portal and tools qualities some suggestions for improvements were presented as part of the collected feedback. The main one is the suggested ***online guide and/or intuitive help*** with tooltips, which can be very useful while navigation by unexperienced person is performed and should make the portal contents more accessible for non-professional people. It is very important the guide to be able to run also in native language.

Portal content review

During the validation process the portal content also was evaluated section by section. Each section was compared to the needs and knowledge of each evaluator and was scored at different level. Below the average score calculated on base of 12 received questioners, is published discussion and recommendation based on additional feedback by the people included in the enquiry.

The following sections were examined: *about NaturNet Plus, how to use the portal, news and events, pilot regions, sustainable development, transfer of innovations, how to deal with data, GeoGame, environmental impact assessment (EIA), tourism, related project, agriculture, rural development, contents of the metadata search engine, map engine, translations at local languages.*

Estimation and discussion of the section '*About NaturNet Plus*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above average	8.42

As additional recommendation for improvement of this section a list of affiliated partners and organizations has been marked. Also more information about partners and practices in alternative tourism can be included. This could give to the portal user new ideas for new activities, but can be reached only by increasing the portal users and affiliated regions.

Estimation and discussion of the section '*How to use the portal*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above average	7.66

The work with the NaturNet Plus geoportal is similar to other content management systems (CMS) and the need for any specific detailed description of single action is not necessary. Even though several remarks were selected concerning mainly the technical structure of the text and the need of tutorials on 'how to deal with the CMS and to import data?'

Estimation and discussion of the section '*News and events*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above average	8.16

The valid information presented in this section is highly appreciated pay the people involved in the survey. Moreover, some of them are stressing the need for more specific news about the pilot regions included in the project. Also one small but important technical remarked, that the list of feeds could be a bit shorter and display for example only first two RSS news.

Estimation and discussion of the section '*Pilot regions*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above average	8.33

Some of the information in this section was parked as very useful. However, it is stressed that the quality level of each region is different, and the information needs to be edited. For some of the regions to be reduces, because at the moment it's exhaustive, and for some to be improved. Generally the information set was described by the interviewees as relative to tourists, but for education there is a space for improvements, as links to additional tourist web contents for each region. Also was marked ideas for positioning a tourist information centers (TIC) and more attractive historical and natural zones. Publishing of a SWOT analysis for each region was highly appreciated.

Estimation and discussion of the section '*Sustainable development*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above average	7.92

For this section the answers can be described as positive. The information for the interviewees seemed to be enough, but with suggestion for adding useful links presenting more detailed information what is sustainable development and the importance of this subject. Also, more information about what is planned in Europe is described as useful for future educational process as well as subjects on sustainable development in the context of rural settlements, declaring protected areas and the need for preserving the nature heritage and the local environment.

Estimation and discussion of the section '*Transfer of innovations*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above average	8.58

The section is described as very useful in the professional life of some of the involved people, but also for non-experienced travellers. Links to more detailed resources could be presented as example to web pages presenting the INSPIRE directive and the process of its implementation.

Estimation and discussion of the section '*How to deal with data*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
91.6% above average	6.58

The section should is selected as short. However, several ideas can be described for more extended information set by practical examples and tutorial lessons with additional information on each mentioned topic.

Estimation and discussion of the section '*GeoGame*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above average	8.16

The game features are enough informative for professionals and possible visitors in any region. It could be implemented also in schools, but also as an education for adult people preparing themselves for a visit in selected region or evaluating their experience.

Estimation and discussion of the section '*Environmental impact assessment*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
33% above average 67% below average	3.5

The portal feature is described as interesting matrix for simplifying the assessment method, but should not be used as an exclusive tool. However the matrix was not visible for some of the stakeholders included in the validation process, which is visible in the given recommendations. Some of the interviewees have selected that the tool was not accessible during their evaluation.

Estimation and discussion of the section '*Tourism*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
91.6% above average	6.92

The section is selected as useful for the project objectives and the portal frame, but more examples of good practices are needed.

Estimation and discussion of the section '*Related projects*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
83.3 % above average	7.17

The relations with similar projects dealing with spatial data are well described. It can be found important information as the information about metadata and the relating with the SDI and Habitat initiatives. Even though the section needs more related data about eLearning tools and rural tourism.

Estimation and discussion of the section '*Agriculture, Rural development*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above the average	7.42

No specific suggestions were selected or communicated during the validation process. Most of the people involved in the survey selected this section are very useful and clear.

Estimation and discussion of the section '*Follow-us*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100 % above average	7.83

The section is described as a perfect tool for dissemination and retrieval of feedback from stakeholders, and a perfect way for building and improving the local marketing strategies for any particular region presented at the NaturNet Plus portal.

Estimation and discussion of the section '*Contents of the metadata search engine*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100 % above average	7.83

The search engine was marked and simple and easy to search, but some examples and/or tips could be useful.

Estimation and discussion of the section '*Map engine*'

General evaluation (*below/above average*)	**Appraisal** (*points*)
100% above average	8.33

The map engine, based on OpenStreetMap is described as intuitive and flexible and also with good comfort for exploring spatial data. Some suggestions came on the usefulness of more layers with specific tourist information for any specific region.

Discussion of the section '*Translations at local languages*'

Within this section, no remarks for improvement of the content can be described. However it is highly appreciated as a very useful initiative, especially for people who struggle with foreign languages. It's suggested as much of the NaturNet Plus portal content to be translated into native languages.

Comments by stakeholders

Inappropriate equipment and weak computer skills in local professionals in tourism and/or trainers can be a handicap for the implementation of the project. More information for the rural areas should be collected on that issue in order to present and adequate support of the local VET.

During the validation process several discussions on the effects of ecotourism were initiated. They were stressing problems of involvement of national experts at local level and how advanced is their work on which type of ecotourism is best suited for a particular local community. As results many comments came, about bettering the communication channels between national and local administrations as well as with improving this new industry with more studies on animal behaviour as a result of different exposure to humans.

Recommendations by partners, national experts and NGOs

As main recommendation for future improvement of the NaturNet Plus portal and tool rest the proposal for implementing a set of video tutorials and lectures divided per section. It could benefit for better understanding the content many trainers who are not so skillful with CMS, technical data and specific gaming tools related to rural tourism.

Another recommendation came to the process of updating information, to make it more automatic in order to keep easily updated the news and any relative information flow in order to keep the NeturNet Plus portal and tools helpful for the work of all professionals involved in tourism and/or education as well as the local visitors.

Lessons learnt

Any future project shall be implemented on more detailed assessment on the local specifics for utilization of innovations especially in the field of environmental education, eLearning and spatial data. Also the level of conservancy of the professionals in any particular field, as the tourism is important to be estimated in detail before the project beginning. This will help building better strategy for presenting and implementing the new applications and tools in the new countries where the innovation is expected to integrate and grow.

Final validation opinion

The project results can be described as a true innovation for the regions, where presented. They could be considered as a trigger for integration in the national legislation and rules the subjects for educational practices for eLearning and blended education. Moreover the NaturNet Plus portal content was considered by the stakeholders as highly applicable for this regions. The use of the map for small and middle municipalities and by tourists active in all fields of alternative tourism as rural, agricultural, wine, adventure is also a great advantage for all of the participants.

As a conclusion, the results of this innovation transfer project shall follow the expected forthcoming activities in order to spread all collected knowledge and methodologies to other regions. This will be useful for turning the project outcomes from innovation for a pilot region to applications with a common use in touristic areas and within the national educational systems for VET.

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Plan4all experiences with harmonisation and deployment of spatial planning data

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Plan4all Harmonisation Process

Spatial planning data exist in very different formats and data structures across European countries. The Plan4all team proposed a harmonisation process in which source data from different countries are converted into a general data structure. At the beginning, the data structure was created on the basis of Plan4all conceptual models. Later, at the request of EC and JRC, Plan4all conceptual models were replaced by INSPIRE Technical Specifications with the intention to support INSPIRE TS testing. The harmonised data are presented as map layers in web map clients and through web services. In some cases, the data are also available in the GML form that is compatible with INSPIRE TS specifications. The following figure shows. A basic principle of the Plan4all spatial data harmonisation process is demonstrated at theFigure 33:

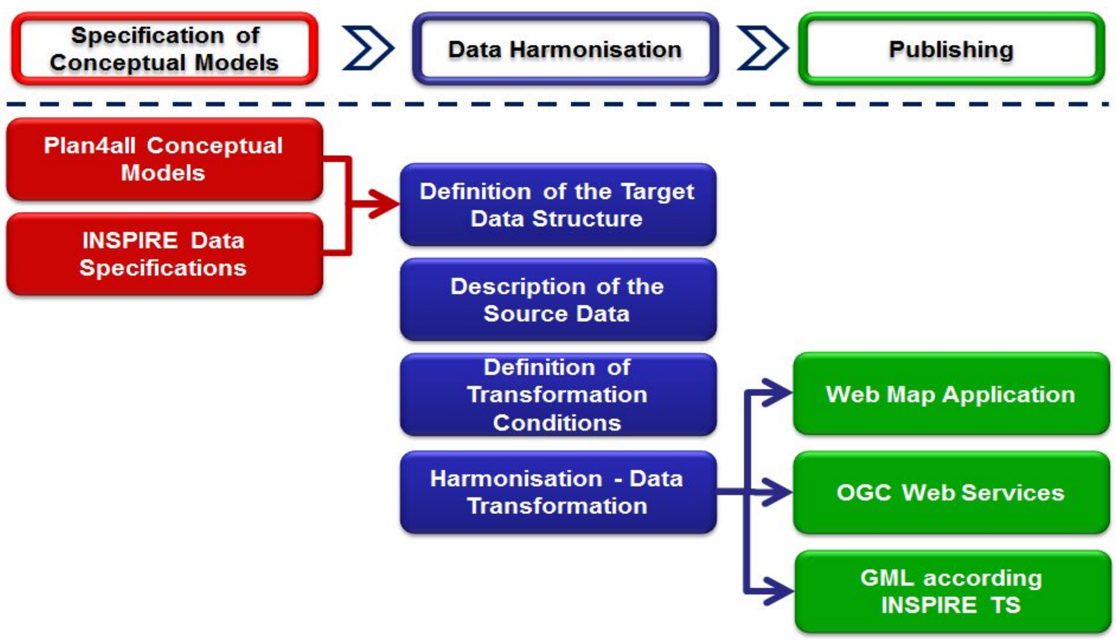

Figure 33: A basic principle of the Plan4all spatial data harmonisation

The harmonisation process has been divided into 4 steps:

1. Definition of target data structures based on the models.
2. 2. Description of the source data structure – the exact description of the source data enables better understanding of data and definition of the transformation table. The description includes a scheme of data structure, description of object types and Code lists or enumerations. Sometimes the spatial planning data is not in a GIS structure and needs to be modified or transformed into another format.
3. Definition of transformation conditions – description of matching tables for a transformation object, attributes and values from the source into the target structure. The transformation has two levels – at first, the transformation of features has to be specified and then also transformation of code lists or enumerations must be defined for each transformed attribute. The transformation can be achieved by means of transformation tools or directly through an SQL query.
4. Data transformation – the process of physical data transformation. At this point, the data from different sources are harmonised and may be published in the same style.

Publication

There are several ways how to publish harmonised data stored in the target structure. The Plan4all regions are testing the publication of harmonised spatial planning data in their own web map applications and have also provided data through OGC WMS and WFS web services. Although harmonised data are prepared in the structure according to INSPIRE specifications, they may not be fully applicable for the appropriate INSPIRE model. To guarantee a full compliance with the INSPIRE models, a further transformation is necessary. The output is a compatible GML according to the appropriate INSPIRE specification.

Technical Infrastructure

Each Plan4all partner involved in the spatial planning data testing is responsible for his own testing infrastructure and detailed methodology according to his technology and experience. A general Plan4all infrastructure covers mainly SW tools integrated into the Plan4all portal. The Plan4all portal design is based on the principles of the Service Oriented Architecture (SOA) and is INSPIRE compliant. The INSPIRE requirements give to the overall system architecture a loosely coupled integration based on the OGC standard usage, which allows to use any OGC-compliant software component and to easily replace it with another if necessary. In order to achieve interoperability, the main software interface between each particular component has to be based on ISO standards and OGC specifications, following the INSPIRE Directive. The Plan4all Geoportal was divided into four basic building blocks, which were implemented:

- Metadata management (editing, discovery, access, harvesting)
- Data management (upload, download, OGC service publishing)
- Data visualisation (local data, WMS, WFS, KML and management of Web Map Context)

- Content management (publishing of context and connection with social networks)
- Part from the Plan4all geoportal, the project partners used their own SW tools for modelling, mapping, harmonisation and publishing.

INSPIRE Data Specification for Plan4all

LandUse

Land Use is a specific thematic field included in Annex III. In the INSPIRE directive, Land Use is defined as Territory characterised according to its current and future planned functional dimension or socio-economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational). [Directive 2007/2/EC] It is the description of land in terms or its socio-economic and ecological purpose.

Land Use may be split into two different types:

1. The Existing Land Use (ELU: "current" Land Use in the above definition), which objectively depicts the use and functions of a territory as it has been and effectively still is in real life.
2. The Planned Land Use (PLU: "future planned" Land Use in the above definition), which is composed of spatial plans, defined by spatial planning authorities, depicting the possible utilisation of land in the future. PLU is regulated by spatial planning documents elaborated at various levels of administration. Land use regulation over a geographical area may be composed of an overall strategic orientation, a textual regulation and a cartographic representation. Spatial planning documents result from the spatial planning process, and therefore, once adopted, third parties must conform with them.

The main value of the INSPIRE Land Use model is its simple, yet flexible structure that allows data providers to publish their existing data in the most convenient way. In order to ensure consistency between data sets containing ELU information and PLU information, a core model was first designed.

LandCover

The Land Cover (LC) is included in the Annex II of the INSPIRE Directive where it is defined as "Physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies.".

Land Cover and Land Use themes are sometimes mixed up because they are frequently combined in practical applications. The main difference between them is that Land Use describes the human activities that take place on earth's surface while Land Cover focuses on its (bio-)physical characteristics. The data sets that combine both themes usually centered on land use in intensively populated areas and on land cover in extensively populated areas.

Mapping of Land Cover information is done through Land Cover Survey Initiatives. Examples of such campaigns have been carried out in the European Union, like the European Environment Agency CORINE Land Cover program and the Eurostat LUCAS survey. These bases and previous works have helped on the strength and completeness of the Land Cover data model.

Natural Risk Zones

INSPIRE Directive (2007/2/EC) defines Natural Risk Zones theme as: "Vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions."

The scope of the Natural Risk Zones data specification is potentially very large and chapter 2 of this report develops a scope for the work. Natural Risk Zones also involves significant engagement with other thematic areas from INSPIRE. This involvement stems from the nature of hazard, exposure, vulnerability and risk as defined later in this document. Several other thematic areas will input attributes vital to understanding the nature of hazard, yet others are vital in the understanding of exposure.

The approach taken to model Natural Risk Zones is generic in its treatment of each of hazard, exposure, vulnerability and risk, with a core model, whilst allowing extensibility to be more specific where possible and required. Flood risk is significantly more precisely defined than other hazards, due in part to the development of the Floods Directive (2007/60/EC).

Examples of Deployment in Regions

Help Forest Sumpek

Within the Plan4all project, Help Forest (HF) tested a pilot for LandUse data of Sumperk Municipality. The municipality's urban plan and its original were prepared by the Knesl+Kyncl Architects company and the data is available in DGN (graphical data) and DOC, PDF (textual data) formats. HF has modified the original data for publication in a web map application. HF has prepared referential raster data and shp files from the original dgn files. The form of the textual part of the urban planning documentation has been modified in order to connect graphical entities with the relevant text (see the scheme of joint publication of spatial planning data at the Figure 34).

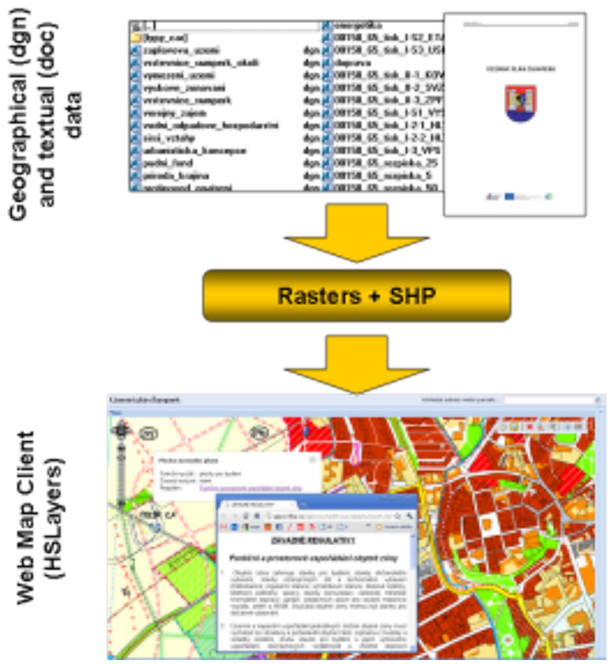

Figure 34: A process of joint publication of spatial planning data.

The spatial planning data are published through a web map application called “e-UP” (electronic Urban Plan) which is based on the HSLayers client. “e-UP” allows easy and user-friendly displaying of a local plan on the web. The main design of the local plan concept, which can be divided into several theme layers, is included among the data layers. A reconnaissance city map, a cadastral map or an orthophoto linked via the WMS web service can be displayed as referential data. Further information layers of the local plan concept – such as territory studies, public works, etc. – can be displayed over these basic layers. The e-UP application is offered in the form of a service. It is in this way that the un-harmonised data are published. These (SHP) data represent the input into the transformation and harmonisation process. The output data in a structure based on conceptual models can be published in the same way as the source data – in a web map client and also through WMS or WFS web services. In the case of Sumperk urban planning data, the harmonisation process is built up on the source data in the SHP file. This file contains all important data regarding the land use specification. The basic structure of the source data is presented in the Table 9. Originally, the boxes were filled out in Czech language, but for purposes of the Plan4all project a description in English and examples of values have been added.

Source_structure	Description	attribute_example
CISLO	Feature Number (ID)	345
NAZEV_Pl	Name of the Feature	.656
Cis_Pl	Name Number of the Feature (from Name of the Feature)	656
Kod_Vyuz	Land Use Code	SX
Pop_Vyuz	Land Use Description (from Land Use Code)	Plochy smíšené obytné
Kod_RP	Development Area Code	P11

Kat_RP	Development Area Category (from area code)	P
Pop_KatRP	Development Area Description (from D. Area Category)	Plocha přestavby
Cis_RP	Development Area Number (from (D. Area Code)	11
Vymera	Area	0,5
Zastav	Volume Indication	15-35 %
MAX_VYS_ZA	Height Indication	13/17
Kod_Strukt	Code of a structure of built-up area	B
Pop_Strukt	Description of a structure of built-up area	Blokový typ
Dalsi_Pod	Other requirements	hromadné garáže P+G; US-08
US	Studies	US-08: Jesenická ulice

Table 9: A basic structure of source spatial planning data in Sumperk.

The target structure for the HF pilot has been created in the SHP and DBF formats. The template files have been created on the basis of the INSPIRE LandUse Technical Specification. The database structure in the PostGIS is also available for data input.

The target structure includes the following files (Figure 35):

SHP

- PLU_plan_s.shp - a polygon shapefile in which geometry is constituted by a polygon delineating a spatial plan
- PLU_element_s.shp - zoning elements (land use areas)
- PLU_suplementary_x.shp - supplementary regulations should be point (p), line (l) and polygon (s) shapefiles with the same attributes. We use only polygon and line ones
- DBF
- PLU_document.dbf – a table of documents
- PLU_dimensioningIndications.dbf – a list of dimensioning indications (for zoning elements and supplementary regulations together)
- PLU_dimensions.dbf – a matching table between elements (zoning elements or supplementary regulations and dimensioning indications)
- PLU_textualRegulation.dbf – a list of textual regulations and legislationReference
- PLU_regulations.dbf – a matching table between elements and textual regulations

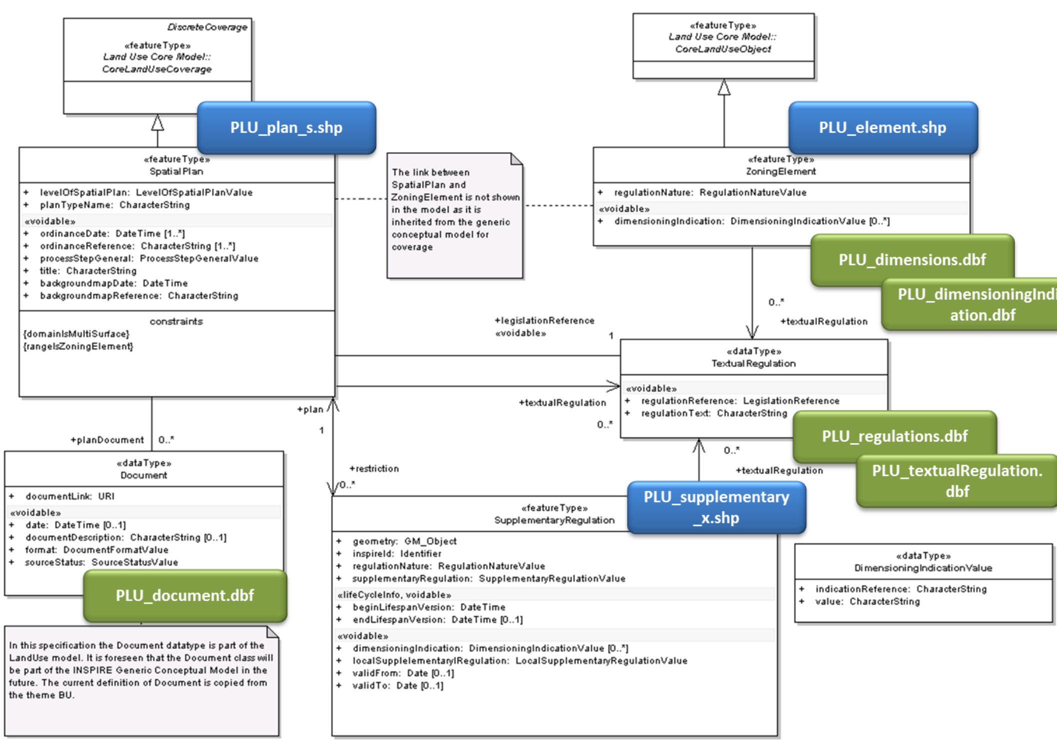

Figure 35: A position of target files within the INSPIRE Land Use model.

HF presents both source data and harmonised data in the web map application eUP (electronic Urban Plan) based on the HSLayers web client (Figure 36). The main design of the local plan, which is divided into several theme layers, is included among the data layers. A reconnaissance city map, a cadastral map or an orthophoto linked via the WMS web service can be displayed as referential data. Further information layers of the local plan concept – such as territory studies, public works, etc. – can be displayed over these basic layers. The application integrates also the extended possibility of an interactive contact between a user and the city-planning department, a connection to "Inspection of Real Estate Cadastre" in the Czech Republic and more.

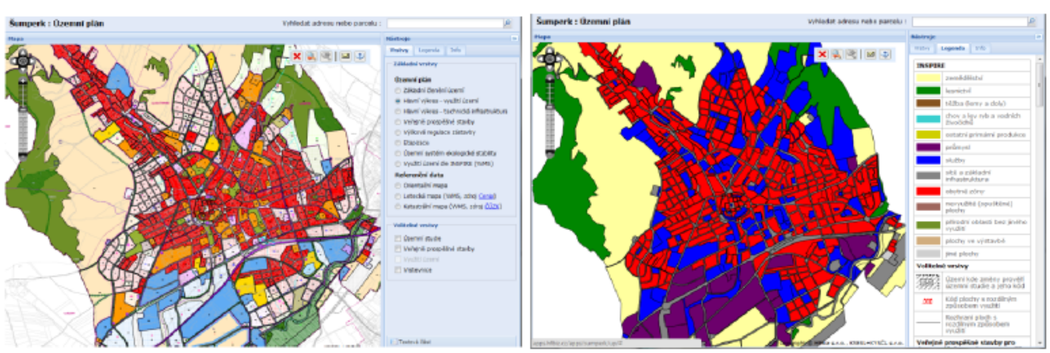

Figure 36: Examples of original and harmonised spatial planning data.

The web map application is available on the following address:

http://apps.hfbiz.cz/apps/sumperk/up/

Web services publishing is provided through Geohosting functionality on the Plan4all portal;

the services offered by the system are WMS and WFS. Metadata for data and services are registered in the Micka metadata system which is also included in the Plan4all portal.

By means of the web services, HF publishes spatial planning data in the target (harmonised) structure.

http://vm-glog.wirelessinfo.cz/cgi-bin/mapserv.exe?SERVICE=WMS&map=c:/ms4w/apps/glog/data/DataFiles/Plan4All/inspire/sumperk/sumperk.map&request=GetCapabilities

As mentioned above, HF publishes harmonised spatial planning data through WMS and WFS web services. The structure of this data has been defined in relation to the INSPIRE technical specification, but the output does not fully conform to the expected INSPIRE GML. To get a compatible INSPIRE GML, HF has developed a technology and service called the HFIT (HF INSPIRE Transformator – Figure 37). The HFIT is a technology aimed at offering a simple tool for data publication in the GML format according to the appropriate INSPIRE data specification.

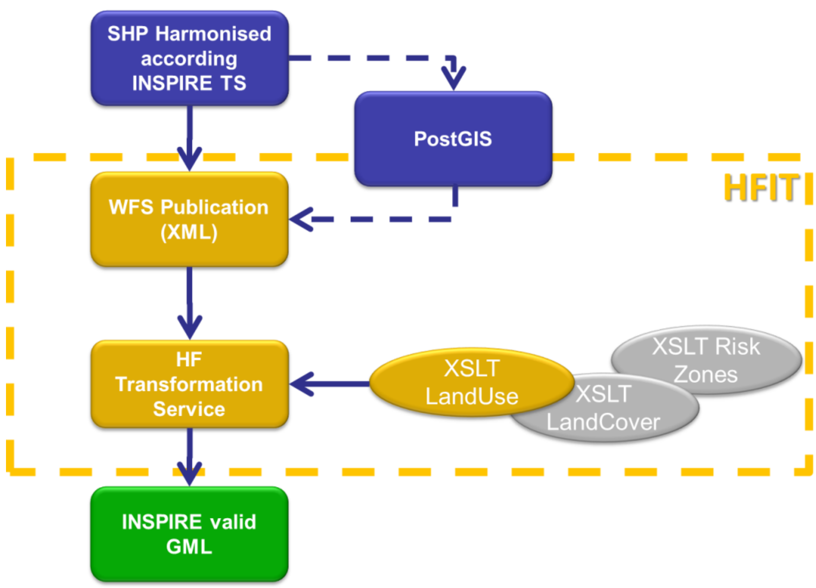

Figure 37: Help Forest INSPIRE Transformator scheme.

Harmonised data are stored in the PostGIS or alternatively in shp files and then published through the WFS. The HF Transformation Service transforms the XML coming from this WFS into a new GML which is compatible with appropriate INSPIRE Technical Specification. Description of the transformation process for each technical specification is indicated in a separate XSLT which is the parameter of the transformation.

HF has created the XSLT for Land Use, but the HFIT is usable also for other thematic transformations with a corresponding XLST.

A GML compatible with Land Use INSPIRE TS is available on the address:

http://vm-glog.wirelessinfo.cz/glog/Glog/Plan4All/XslTransform.php?project=Plan4All.Sumperk

There does not exist a shared obligatory standard for spatial planning data on a local level in the Czech Republic. The pilot with spatial planning data complies with general conventions and fully accepts Czech legislation for Land Use.

Tests have proved that it is possible to transform datasets from planning into the Land Use INSPIRE Data specification. Nevertheless some changes of the technical specification and an extension of code lists (mainly HILUCS) would be useful for better conformity to the INSPIRE TS and Czech spatial planning data.

Czech spatial planning data can be transformed into an INSPIRE valid GML. Because of some problems with implementation of available transformation tools, HF has developed its own technology for spatial data transformation into an INSPIRE valid GML. The technology is called the HFIT and was used for transformation of spatial planning data from Šumperk and Olomouc.

Recommendations regarding the HILUCS code list:

- add a value for "Leisure Time Activities"
- add a value for "Other Areas", which are known, but not listed in the code list

Recommendations regarding the Technical Specification:

- The existing Land Use seems to be useless in the Czech Republic and probably in most of other countries as well. Maybe it is not necessary to solve Existing Land Use when it is applicable in a few countries
- Implementation of featureType CoverageBy DomainAndRange is quite complicated for LandUse and a more simple solution would be better for widespread usage.
- Code lists and cartography should be defined also for other attributes that may be harmonised – e.g. exact specification of dimensioningIndications

Olomouc

As Olomouc within Plan4all project represents local planning authority, main presence was focused into Land Use theme. Planning system in The Czech republic is urbanistic, so Land use plans represents mainly planned land use theme according to INSPIRE terms.

For transformation to INSPIRE data specification Olomouc land use plan draft was used. The reason for this choice was, that plan is under elaboration and conditions for digital part enables further use in SDI and also there is still a chance to make changes to be more INSPIRE compliant if needed.

At this time Olomouc procured the new land-use plan for the entire area of Olomouc 103 km2 (scale 1:10.000) by the Knesl + Kyncl Architects company.

Olomouc Plan draft was prepared in CAD technology –using Bentley's Microstation design file format (DGN V8). Internal structure of plan follows national legislation - Building Act No. 183/2006 Coll. and subsequent Decrees. Responsible parts of Decree No.501/2006 Coll. describing basic categories of Land Use types in Czech planning practise were used as reference materials for preparing SpecificLandUseType Codelist.

Olomouc Plan draft (Figure 38) has more precise non-urbanised areas, like many other Czech land use plans.

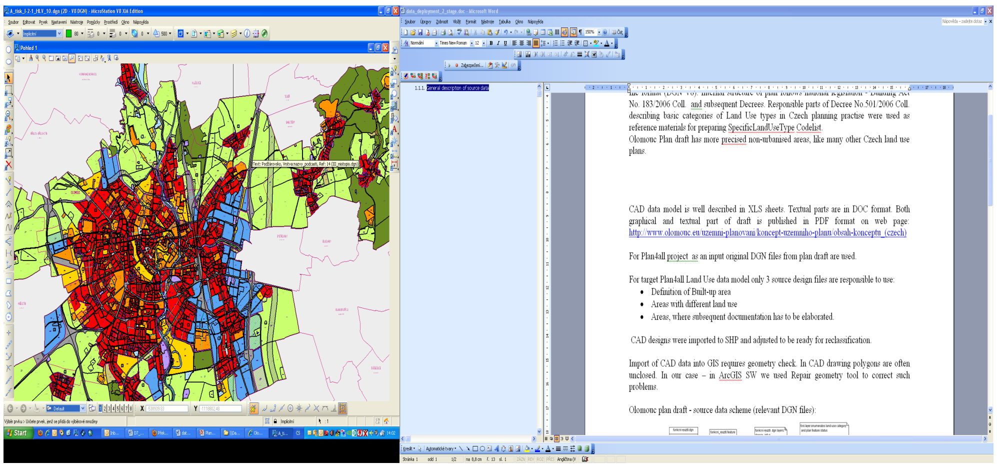

Figure 38: Land Use Plan of the Olomouc city.

CAD data model is well described in XLS sheets. Textual parts are in DOC format. Both graphical and textual part of draft is published in PDF format on web page: http://www.olomouc.eu/uzemni-planovani/koncept-uzemniho-planu/obsah-konceptu_(czech)

For Plan4all project as an input original DGN files from plan draft are used.

CAD designs were imported to SHP and adjusted to be ready for reclassification.

For INSPIRE Land Use theme data specification 4 source design files were used:

- Solved area (bounding polygon)
- Areas with different land use (zoning elements) and areas of stand by land resources (supplementary regulations).
- Areas and corridors for ecological networks components (supplementary regulations)
- Height regulation areas (supplementary regulations)

Import of CAD data into GIS required geometry check. In CAD drawing polygons are often unclosed. In our case – in ArcGIS SW we used Repair geometry tool to correct such problems. As for Land Use areas (polygons) with different values of land use were stored in different levels of design file, it was easy to transform local attributes to INSPIRE mandatory ones according to next matching tables.

For matching between attributes, it was crucial to study Inspire specification for Land Use very carefully. However Olomouc plan uses only part of Czech legislation based categories, it was more beneficial to make proposition of national codelists for some attributes and provide mapping for all categories not only those, used in Olomouc plan. Both CodeLists and mapping tables were discused with Czech partners outside Plan4all consortium, but involved in INSPIRE Land Use theme testing. As mapping of some vlues is not very clear, inconsistencies were reported in testing and commenting spreadsheets.

Mapping schemas:

Mapping Between HILUCS and Specific Land Use Type values (Figure 39)

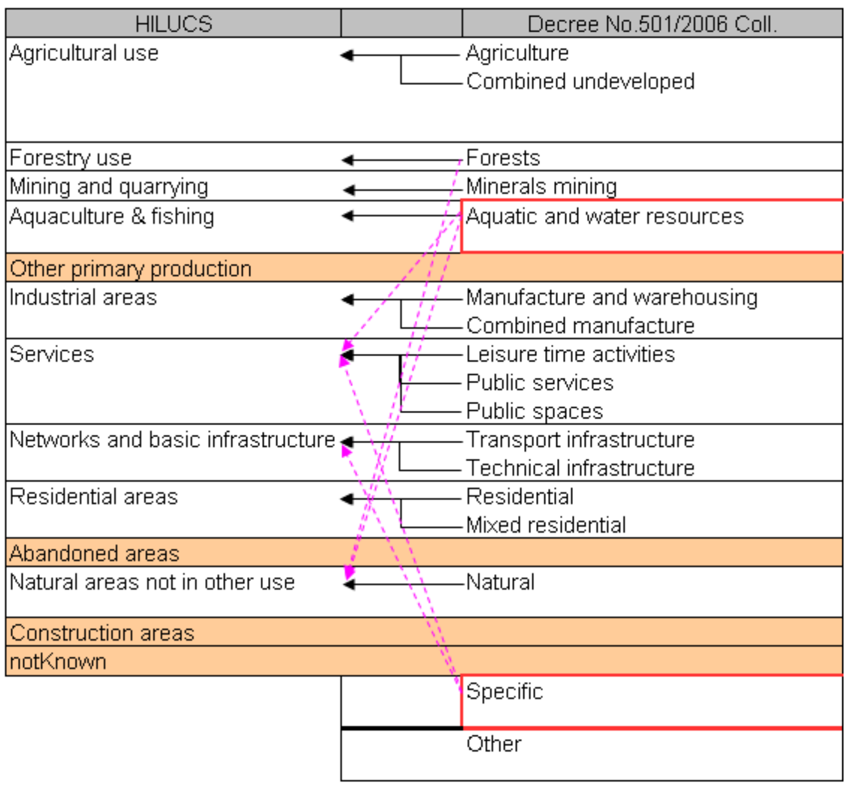

Figure 39: Mapping Between HILUCS and Specific Land Use Type values.

Code List for Specific Land Use Type – Czech example based on national legislation – Decree No. 501/2006 Col. on general land use requirements § 3 – 19 http://www.uur.cz/images/uzemnirozvoj/stavebnirad/vyhlasky/en/Decree501.pdf.

SpecificLandUseType	
Definition:	Specific indication on the land use of an area.
Stereotypes:	«codeList»
Value: Residential	
Definition:	Residential grounds are usually delimited separately in order to assure conditions for dwelling in a quality environment that offers undisturbed and safe stay and everyday recovery and relaxation of its inhabitants, accessibility of public spaces and public services..
Value: LeisureTimeActivities	
Definition:	Leisure time activities grounds are usually delimited separately in order to assure conditions for recovery and relaxation within a quality environment..
Value: PublicServices	
Definition:	Public services grounds are usually delimited separately in order to assure conditions for suitable situation, accessibility, and use of public services constructions, and to create conditions for their utilisation in accordance with their purpose..
Value: PublicSpaces	
Definition:	Public spaces grounds are usually delimited separately in order to assure conditions for adequate situation, extent, and accessibility of public spaces plots, and for their use in accordance with their importance and purpose..
Value: MixedResidential	
Definition:	Mixed residential grounds are usually delimited separately if it is not reasonable, taking into account the development character, its urban structure, and way of its use, to segment an area into residential grounds and public services, and it is necessary to exclude situating constructions and facilities, that degrade environment quality within the area, e.g. for mining, metallurgy, chemistry, heavy engineering, rehabilitation services..
Value: TransportInfrastructure	
Definition:	Transport infrastructure grounds are usually delimited separately if the use of transport infrastructure and facilities grounds due to heavy traffic and its negative impacts excludes ranking such grounds among areas with other way of use, and further when delimiting of transport grounds is necessary for transport accessibility assurance, e.g. production spaces, public services areas for retail shops, raw materials mining areas..
Value: TechnicalInfrastructure	
Definition:	Technical infrastructure grounds are usually delimited separately when use of these technical infrastructure grounds excludes their classification as grounds of other land use type, and when other use of these grounds is impossible. In other cases only the routes of technical infrastructure are delimited within the grounds of other land use type.
Value: ManufactureAndWarehousing	
Definition:	Manufacture and warehousing grounds are usually delimited separately if the use of grounds for e.g. manufacture constructions and warehousing, and agriculture constructions2, due to negative impacts over these grounds borders, excludes classification of the grounds with such impacts as areas of other land use type.

Value: CombinedManufacture	
Definition:	Combined manufacture grounds are usually delimited separately when it is not reasonable to segment the area, due to its character, into e.g. manufacture and warehousing grounds, transport and technical infrastructure grounds, minerals mining grounds, and specific grounds.
Value: AquaticAndWaterResources	
Definition:	Aquatic and water resources grounds are delimited in order to assure conditions for water management, protection against water harmful impacts or drought, regulation of area regimen, and other purposes stipulated by legal regulations dealing with water, landscape protection and preservation.
Value: Agriculture	
Definition:	Agriculture grounds are usually delimited separately in order to assure conditions for prevailing agriculture use.
Value: Forest	
Definition:	Forest grounds are usually delimited separately in order to assure land use conditions for forest.
Value: Natural	
Definition:	Natural grounds are usually delimited separately in order to assure conditions for landscape protection and preservation
Value: CombinedUndeveloped	
Definition:	Combined undeveloped grounds are usually delimited separately when it is not reasonable to segment the area, due to the undeveloped area character or its protection, into e.g. water areas, water resources, agriculture grounds, and forests.
Value: MineralsMining	
Definition:	Minerals mining grounds are usually delimited separately in order to assure conditions for economic minerals and raw materials use, and protection of environment at mining and minerals processing activities.
Value: Specific	
Definition:	Specific grounds are usually delimited separately in order to assure specific conditions required, in particular, for constructions and facilities of country defence and security, civil defence, prison service, storages of hazardous materials; related transport and technical infrastructure grounds may be included in the specific grounds.
Value: Other	
Definition:	In special, justified cases, provided that the reasons are included in the rationalization of a general nature measure by which a plan is issued, there may be specified grounds with different land use than stipulated above .

Harmonized datasets are published in map application using proposed colour schema for HILUCS value (Figure 40):

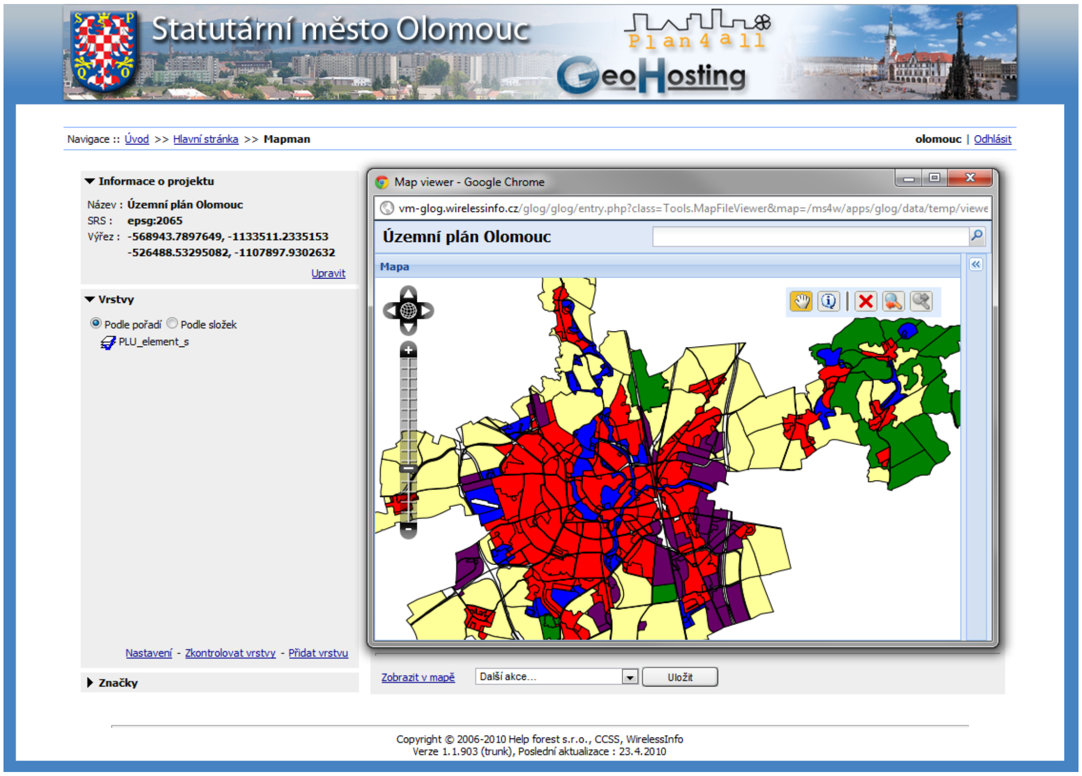

Figure 40: Harmonised dataset.

Datasets are published via WMS services:

http://vm-glog.wirelessinfo.cz/cgi-bin/mapserv.exe?SERVICE=WMS&map=c:/ms4w/apps/glog/data/DataFiles/Plan4All/inspire/olomouc_koncept/olomouc.map&request=GetCapabilities

Output GML is accessible at address:

http://vm-glog.wirelessinfo.cz/glog/Glog/Plan4All/XslTransform.php?project=Plan4All.OlomoucKoncept

It is possible to transform datasets from planning documentation based on Czech legislation into Land Use theme Data specification. Only problems there are to map some of Czech land use categories (especially mixed areas and “green” categories) into INSPIRE (HILUCS) ones. Recommendations for HILUCS 1st order Codelist extension/change is proposed in next chapter. The similar problem is in mapping Supplementary regulations values, but according to specification comment on Supplementary regulation value codelist, we expect its changes based on national requirements and practises. That is why proposed codelist for Local supplementary regulation value contains more entries than used in datasets from Olomouc land use plan draft. His codelist was part of Olomouc contribution to Inspire testing and we hope it will help to improve Supplementary regulation classification on European level.

GIJON

Focused on the Planned Land Use model, the data has been extracted from the spatial planning project of the city, called Plan General de Ordenación Urbana (PGOU, Figure 41), approved by the local government in 2011. So far, the zoning of the entire municipality has been published, but the particular conditions and regulations of each zone are pending publication and have not been included in the project yet.

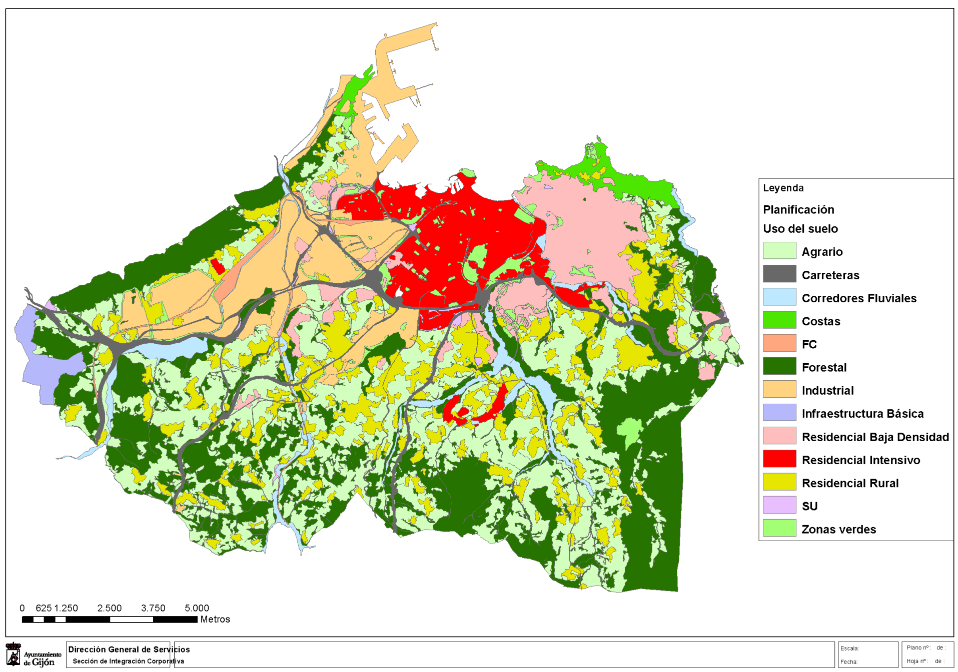

Figure 41: Plan General de Ordenación Urbana.

This data comes in the form of a polygon Shapefile with a field that classifies each zone according to the local classification system for land use and from joined database with the following tables:

- hilucs_local: this table contains the correspondence between the categories in the local classification system and INSPIRE's HILUCS.
- planespacial: it stores the data related to the Spatial Plans with all their attributes.
- planespacial_legislacion: it contains all the data of the Textual Regulations and Documents related to a Spatial Plan.
- textoregulacion: text (text of the regulation)

To carry out the transformation from our data sources to the INSPIRE Land Use data model, we use different tools, but the main one is the GeoServer 2.2 and its App-Schema extension (Figure 42).

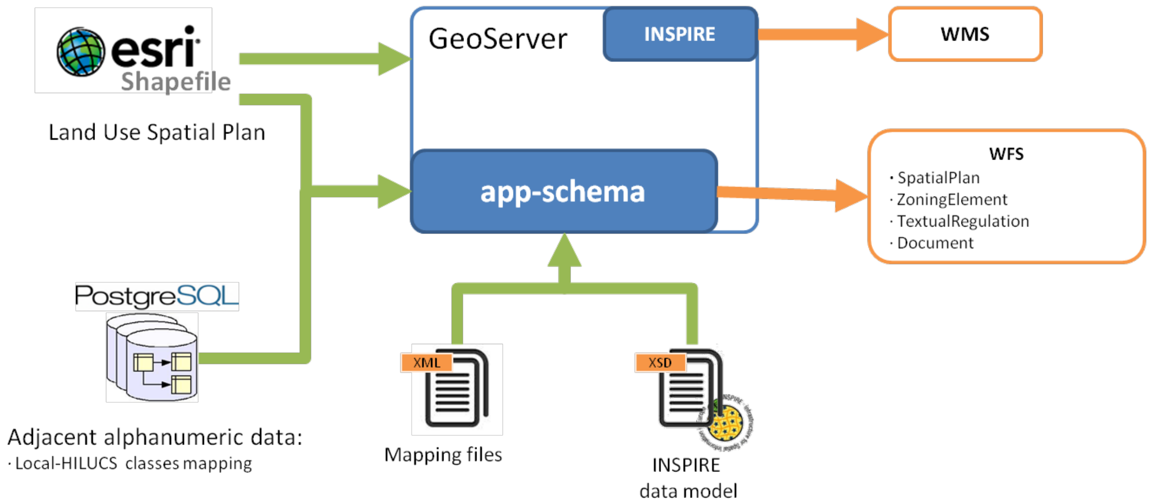

Figure 42: Gijon Plan4all deployment scheme.

The main responsibility of the transformation relies on the “Mapping Files”. These are XML files that lay down the correspondence of the data sources attributes with the INSPIRE data model objects (Figure 43).

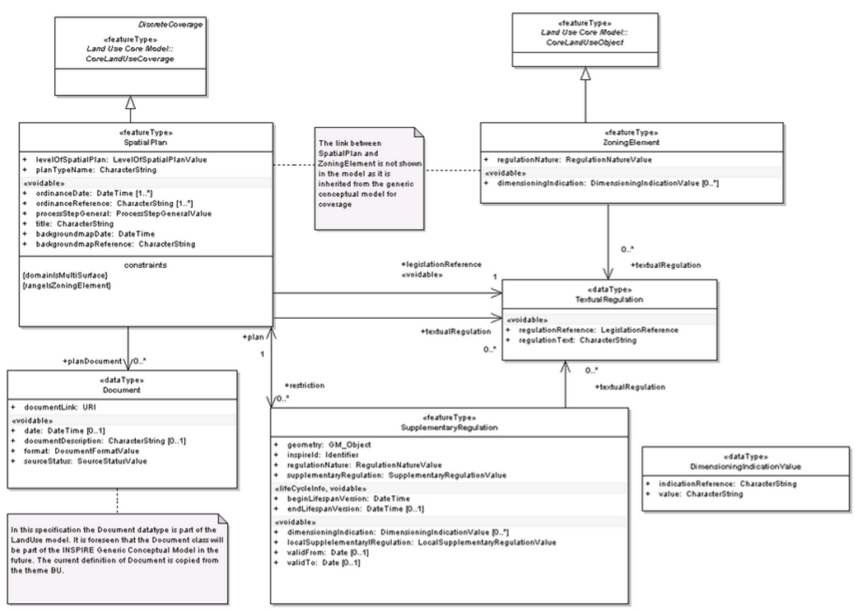

Figure 43: Gijon Mapping files within the INSPIRE Land Use model.

A complete description of this structure can be found at:

http://docs.geoserver.org/stable/en/user/data/app-schema/mapping-file.html

The correspondence between the local Land Use classification system and HILUCS, the one used in INSPIRE specification, is done using the following table (Table 10):

Local Class	HILUCS Class
Agrario	1_agriculture
Carreteras	8_networksAndBasisInfraestructure
Corredores_Fluviales	4_aquacultureAndFishing
Costas	11_naturalAreasNotInUse
FC	8_networksAndBasisInfraestructure
Forestal	2_forestry
INDUSTRIAL	6_industrialAreas
INFRASESTRUCTURA BASICA	8_networksAndBasisInfraestructure
RESIDENCIAL BAJA DENSIDAD	9_residentialAreas
RESIDENCIAL INTENSIVO	9_residentialAreas
RESIDENCIAL RURAL	9_residentialAreas
SU	8_networksAndBasisInfraestructure
ZONAS_VERDES	11_naturalAreasNotInUse

Table 10: The transformation table

The data is accessible through a web client (Figure 44) at this URL:

http://ide.gijon.es/visor/visor4.html?mapa=landuse

It is developed using the following Javascript libraries:

- OpenLayers 2.10
- GeoExtJS
- ExtJS 3.2.1

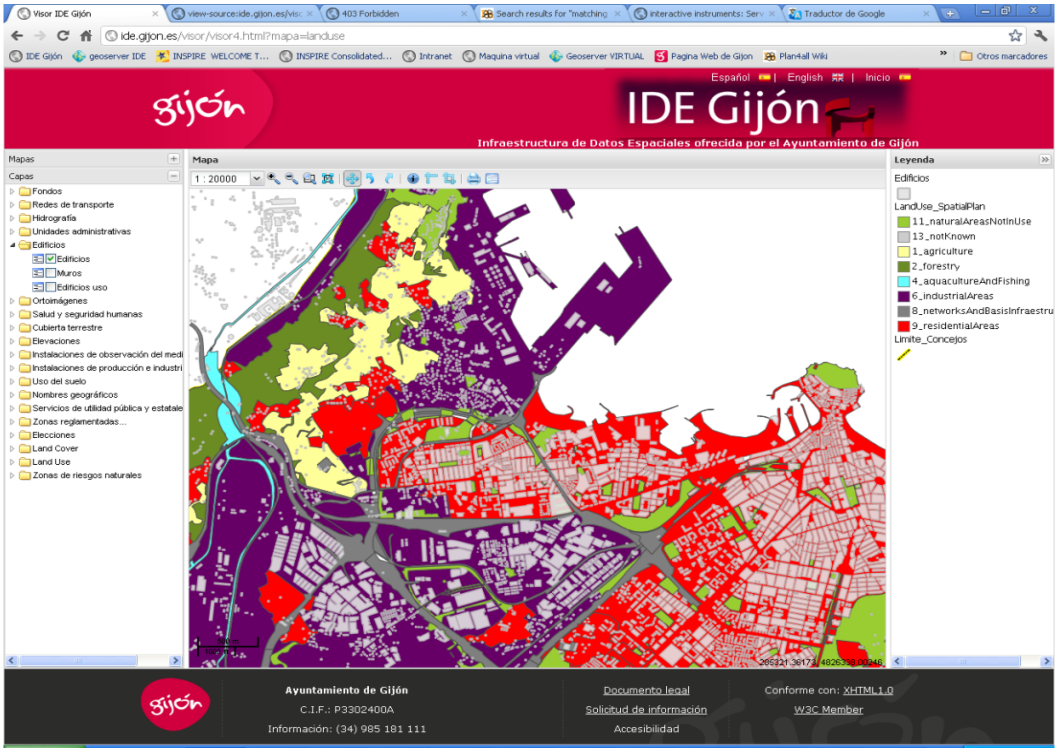

Figure 44: Harmonized dataset on the Gijon server.

OGC web services are published using GeoServer 2.2 at this URLs:

- WMS 1.3:
  - http://ide.gijon.es:8080/geoserver/wms
- WFS 1.1:
  - http://ide.gijon.es:8080/geoserver/wfs

GeoServer 2.2 can transform the published layers to many different projections, including the ETRS 89/ETRS-LAEA used by the Plan4All map viewer (Figure 45).

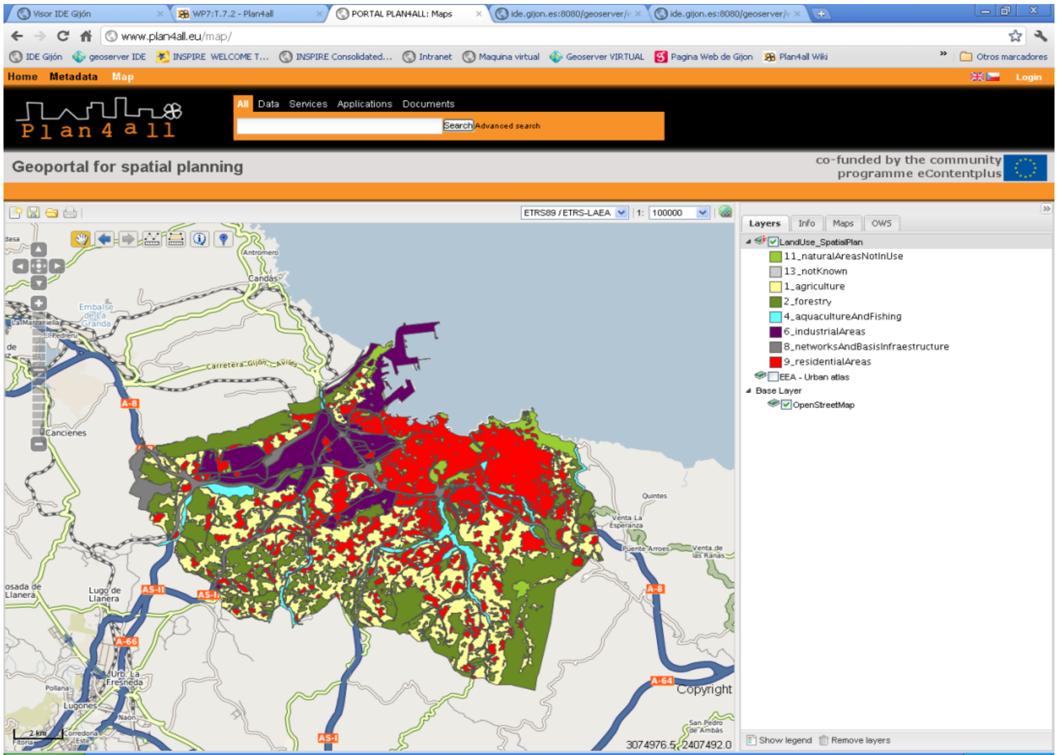

Figure 45: Harmonized dataset on the Plan4all portal.

Regarding data types and their attributes, the transformation has been perfectly feasible, but there are some issues about the Application Schemas:

- In Land Use Application Schemas, the relationship between types, specially between Spatial Plan and Zoning Elements, doesn't seem to be correct and clear.
- It seems like there is no possibility of storing Zoning Element geometry without changing the Application Schema.
- The use of non release versions of third party's Application Schemas (e.g. GeoSciML 3.0) causes some problems with the transformation software, probably due to failures in the structure of those schemas.
- A better definition of the relationship between types in the Application Schemas.
- Using only stable versions of third party application schemas should be mandatory.

Improving the identification of the movement barriers by means of the modelling processes of the spatial analyses

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Introduction

A lot of different barriers can make a movement of the people with a disability more difficult or even impossible. Inclusion of the all citizens belongs to the priorities of the contemporary society. Barrier-free environment can be even used as an indicator of the maturity of the city infrastructure. Evaluation of the level of barriers presence or absence and planning barrier-free environment belong to spatially-oriented problems which can be solved by means of spatial analyses. Unfortunately, preparatory phase of a spatially-oriented problems solving and decision-making is very often omitted, although it is a very important phase, which can significantly influence the successfulness of a project. During the preparatory phase, the significant decisions concerning data, analyses, software tools, visualisation methods, etc. must be made. Business processes modelling include all these necessary activities. The chapter is focused on the modelling steps of the spatial analyses usable for identification of all kinds of problematic places from the point of view of the barrier-free approach. The reason is that making suitable models can increase the level of understanding of the solved tasks. Many various means of expressions can be used for the modelling. Suitable diagrams belong to the most widespread modelling tools. In practice, diagrams used for business processes modelling or for information systems development modelling (e.g. EPC, flow-chart, use case and others) belong to the most often used diagrams. Possible ways of utilization of the above stated diagrams for the modelling spatial analyses are described in the text.

Spatial analyses

Spatial analyses are related to the studies of the spatial data. Mainly they deal with the searching for some new relations between the arrangement and attributes of the objects or the geo-element in the studied area and the modelling of these relations. The aim is to reach their better understanding and knowledge of the development of the area. Spatial analyses are solved in the environment of the geographic information systems (GIS) very often. GIS is understood as a tool for decision-making support.

In theory of spatial analyses, the different viewpoints are approached for their segmentation. The main different is the fact that not every software product can process all the spatial analyses and also some of the functions can be used only for a specific type of data. In general, GIS can provide many types of analyses, e.g. (Konecny, 2003; Longley, 2001): measuring functions, tools for searching the database, topologist overlay, mapping algebra, distance analyses, network analyses, modelling and analyses of terrain, statistical analyses and images analyses. The spatial analyses can be used in many fields of the human activities (infrastructure, epidemiology, criminalist, urbanization, urbanism etc.). In the case survey it is described their usage when solving the questions of barrier-free.

The characteristic can be defined within the spatial analyses, which pay for any type of the analyses:

- A determined area of interest is specified: in case of the spatial analyses it is the spatial data,
- The analyses are done using the appropriate methods and technology,
- Methods and procedure use some different tools: tolls can be textual, graphic, mathematical etc.

When modelling the spatial analyses there is a question if it is necessary to develop and use a special procedure and tools determined for the spatial analyses or if it is possible to use the procedures from the other thematic areas. There are many analytical and modelling approaches. However, our interest is oriented to well-tried procedures and tools in practice, which are accepted by the wide range of users. They are sophisticated procedures of procedural and data modelling. The text aims if the procedures and tools of the procedural and data modelling of the spatial analyses can be used and how.

Modelling

Modelling is a thought abstraction, reproduction of the existing system using the special constructed models (Polák, Merunka and Carda, 2003). Modelling is the means for viewing the real world and a specific form of knowledge of rightfulness operating inside. Modelling is a fundamental process for any area of the development or projecting. Complexity of the system is expressed by sets of models using the modelling procedures (Šimonová, 2009). Model is the abstract of the system; its aim is understanding, communication, explanation and suggestion of significant aspects of this system (Dori, 2002). It is a tool, which enables to think about the problem and asks questions leading to the interception of the fundamental elements of the system. A model is a formalized system which serves the illustration of the studied process. It allows the illustrating and optimizing structure of the processes and removing unnecessary processes. A simple graphical representation of the model is usually not sufficient. A word description tends to be attached, which describes the purpose of creation and describes the process as a unit (Harmon, 2007; Havey, 2005). The models are developed using the special approaches and methods, which are headed towards the selected problem area. From our point of views we focus on well-tried modelling methods of the business practice, i.e. methods of the procedural and data modelling.

Analytical and modelling techniques

Each analytical/modelling method recommends specific techniques (tools) to its realization. Technique is determined how to reach the needed result; usually it determines the precise procedure of single activities, method of tools usage, variation of decision-making in different situations and what arises from it, it also defines the sphere of force etc. (Šimonová, 2009). Compared to the method, the technique is more precise in the results and more limited in the sphere of usage.

There are many techniques, where of course some mingle or relate to each other. Used techniques are e.g. (Řepa, 2007; Šimonová, 2009):

- Top-down decomposition: from the global view the decomposition/disintegration of the problem area is done to lower – more detailed levels; the risk is that the global decision about the structure is done without enough knowledge of details, i.e. later knowledge of the details can cause the revision of the whole model,
- Down-top composition: according to the known details of the partial areas the composition is done to the higher "superior" units; the risk is that the model is made without the knowledge of global elements and output can be misguiding,
- Hierarchical disintegration: the technique is closer to the top-down decomposition; it is a gradual disintegration of the "more complicated" unit to the simpler parts, which are then better used for the solution, hierarchical disintegration can be used for specification of the functionalities structure, aims, human resources, data, objects etc.,
- The functional follow up: technique is used for expressing the partial elements which follow functionally to each other, i.e. which functionality precedes and which "waits" for the output, - Time follow up: time follow up can be related to the functional follow up, but it is not a precondition; time follow up and also time dependence express the sequence of objects in time and can also express the time requirements,
- Sequence: sequence expresses the sequence and follow up the elements in time, but compared to the time follow up the time length itself is not important; the vital is the detection of the elements sequence and it is not important, how much time is "used",
- Elements communication: the elements in the watched problem area are related to each other in some way, influence themselves, i.e. communicate together; therefore communication delimitation is an important technique for a closer identification of the parts and their integration in the unit,
- Global delimitation of the unit: global characteristic is possible to use for the analysed problem as a unit, as well as for any sub-part; it means the delimitation of the all important features, which influence the element and are also necessary for realization of the element,
- A detailed delimitation of the content („inside"): technique describes the detailed description of the "inner" parts of the given element, i.e. everything what and which relations it happens, - Interconnection of the context view and detailed sequence: it is the interconnection of the previous two techniques, i.e. the element is characterized by the view of "outside" (contextual delimitation) and then it is described in details its "inner" side (detailed delimitation), where the objects appearing in the contextual view must also have its role in the detailed delimitation,
- Delimitation of the functionality: the user manipulates the theme as if the result of the solution was the offered functionality which is needed by the user or the other target group; therefore the precise characteristic of "what I ask for", i.e. the precise characteristic of the asked functionalities is the necessary and the only step of the analyses; functionality can be delimited firstly by global and then by detailed delimitation,

- Watching the data flow: every problem area uses the data (gain them, provide them, process them etc.), therefore the watching the data flow for the given problem area is an important technique contributed to understand the unit,
- Watching the event influencing the problem area: the important characteristic are events, which influence the run of the solved problematic; at the events can be determined their sequence, influence to the elements of the system, their influence on the system behaviour etc.

Different techniques are the basics of the procedures and methods, which are suggested and used in analyses and modelling of the solved problem areas. Moreover, the same techniques can be used in more modelling methods, i.e., e.g. when process modelling or modelling connected to the development of the information system.

Techniques and tools of the procedural modelling

Modelling of the business processes is a sophisticated discipline, which is an integral part of the procedural management of the business. Every organization wants to improve its production permanently, those can be products in the producing companies as well as the services in the organizations of the public administration. According to the present trends expressed by the models of quality or ISO norms, the permanent business improvement can be reached only when applied those processes together with procedural modelling.

Currently, there is a number of definitions of the term process (see for example Kirchmer, 2008; Weske, 2007), which vary in viewpoint or date of origination. Based on the individual definitions we can state that a process is an ordered set of steps or activities performed in the certain place in the certain time which has one or more inputs and generates the measurable outputs. The main goal of the process outputs (usually the product or the service) is to fulfil the tasks of the external or internal process customer. Processes should comply with the strategic targets of an organization. A process always consists of activities interconnected to each other. Process can also consists of individual functions – so called sub-processes. Individual processes are triggered based on certain stimulations (reasons). Stimuli for triggering the process can be an internal or external event. The external events for the process triggering come from the process environment. The internal stimuli refer rather to the individual activities. It is given by the situation in which the activity currently is – by its state. Individual activities are interconnected and are described by means of relations. The output and the record book of the process and its customer are also important. (Harmon, 2007, Havey, 2005)

Each process has some certain characteristic elements which can be described by the following basic characteristics (Weske, 2007; Řepa, 2007; Mili, et al., 2009; Kirchmer, 2008; Dumas, Van der Aalst and Hofstede, 2005):

- Process is constituted by an ordered set of activities,
- Activities are done by actors realizing certain work roles,
- Actors work within certain business units.
- Process has clearly defined the start and the end,

- Start of the process is triggered by external, eventually internal event,
- Process transforms inputs to outputs,
- Output of a process represents the value to the internal or external customer,
- Based on the output we can measure the process efficiency,
- Resources such as information, technologies or tools are used,
- Process output is repeatable.

The description and modelling of the business processes can be found out via using some different methods together with the different techniques and tools. Methodology follows the given theoretical base, or SW tool, which offers the particular set of modelling tools (consisting mainly of graphic diagrams and structured textual descriptions). As examples the methods and procedures used for the modelling of business processes can be these (Šimonová, 2009; Eriksson, et al., 2004):

- Method of Business System Planning (BSP): It is determined to the analyses and the suggestions i.e. information architecture of the organization in realization of its information system.
- Standard Business Process Modelling Notation (BPMN): defines the graphic notation of the business processes; the supplement is language Business Process Modelling Language (BPML) for the process description.
- Standard IDEF (the Integrated DEFinition): represents the family of methods for complex support of the business architecture modelling.
- Method ARIS (Architecture of Integrated Information Systems): method of procedural modelling, i.e. methodology connected to the same software case tools ARIS (Software AG).
- Method LBMS Development Method: relates to SW CASE tool Select Architect (of the business LBMS), which is for the object-oriented development of applications in multi-tier architecture.
- Method Lean Six Sigma: provides the way, how to make less mistakes in the overall activities, by eliminating the discrepancies earlier than they appear.
- Standard UML (Unified Modelling Language): helps to specify, visualize and document the models of applications suggestions and architectures, but also data structures and business processes.

Modelling is a tool for representation of the real world and a certain form of knowledge about the functions inside. Process modelling records all the characteristic of a process, usually by means of the diagrams. (Harmon, 2007)

Every models use different techniques. As it was mentioned above, tools (diagrams) of procedural modelling are a big amount, they relate to the used methods, customs of analytical team, with used SW modelling means and so on.

Among the usual modelling tools and techniques of the procedural modelling belong these ones (Šimonová, 2009):

- Hierarchical delimitation of the processes and sub-processes: For expression of the process decomposition model can be used the tool such as Diagram of the process hierarchy (from the method LBMS), Functional tree (from the method ARIS) or the hierarchy can be expressed by the chosen objects "common simple" diagram (e.g. using the objects of the developmental diagram).
- Follow up the processes, procedure of the added value creation. For the expression of the model can be used the tool such as diagram with the name Model of the value added chain diagram: (from the method ARIS), diagram of activities (from the standard UML) or the diagram called Map of value flow (from the method Lean Six Sigma). Model shows the time and technological relation of the processes and sub-processes. Processes can be put in hierarchy.
- List of contexts/characteristic of the processes: For the expression of the model can be used the tool such as diagram called Model of the functions assignment (from the method ARIS), diagram IDEF0 (from the standard IDEF), diagram SIPOC (from Lean Six Sigma).
- List of activities/process operations: For expressing the model of procedural activities controlled by the events can be used the tool such as Diagram of the business process (from the standard BPMN), Diagram of procedural chains (from the method LBMS), Activity diagram (from the standard UML) or Diagram of the procedural chain controlled by the events (EPC, Event-driven Process Chain).

Techniques and tools of the modelling of the information system development

There is another sophisticated discipline following the business processes modelling, i.e. modelling of the information system development. Both modelling disciplines create the models, where the same modelling techniques are used for their creation.

Many activities are based on data or information within the certain information environment. It is created by the information system or several more or less connected information systems. In course of information system development it is necessary to define the data that users need to support their business activities; we are talking about data modelling. Data modelling has two delimited approaches – a structured approach and an object oriented approach.

Basic characteristics of both approaches are the following (Date, 2004; Eriksson, 2004):

- Structured approach, which is older and created for requirements of the database creation or for a design and an implementation of the information system within the database system. Analysis by this approach is realized by ERD (Entity Relationship

Diagram). ERD records basic business data objects, so called entities and relationships among these entities. There are many alternatives of these diagrams and therefore we are talking about the ERD family.

- Object oriented approach which is newer and uses the UML (Unified Modelling Language) standard. UML helps to specify, visualize and document models of application and architecture design, but also design of the data structures and the business processes. It is, therefore, a general modelling language with wide range of usage. The standard includes a specification of basic set of diagrams including the possibility of extending (further application), language for specification of input/output conditions and also the description of the possibilities of the interchanging particular models among modelling tools.

Among the usual modelling tools and techniques of the data modelling belong:

- Hierarchical delimitation: For expression of the hierarchy structure of the objects or functions can be used the function structure diagram or the data structure diagram (structured approach).
- Determining the data objects and relations between them: For expression of the model can be used the tool such as entity relational diagram ERD (structured approach), class diagram (object oriented approach).
- Delimitation of the functionalities and closer characteristic: For expression of the model can be used the tool such as use case diagram (object oriented approach), where there are every use case characterized by the scenario.
- Sequence of the practiced activities. For the expression of the model can be used the tool such as sequence diagram (object oriented approach).

Aspects of the technique and tools usage for the creation of the graphic models within the spatial analyses

As it was mentioned above, our aim is to suggest such modelling tools for the spatial analyses, which would be proved in the common practice. We have oriented to the well-tried modelling methods, suggested for the improvement of the business practice, i.e. the methods of the process modelling and related methods of the information system development.

At the introduction consideration we went out with these considerations and preconditions: The certain types of the spatial analyses have the same sequences as the performed activities therefore they can be marked as instances or, in other words, events of the process. In this case, it is an instance of a process of the certain type of the spatial analyses. Therefore, it can be presumed that the process approach including the tools of the process modelling can be applied.

- Spatial analyses are processed based on the certain demand – that means the request of a submitter or, in other words "customer", for whom the spatial analysis is created.

Mapping of customer requirements is the key factor because if customers present their requirements well and clearly, there is a high probability that the customer will be satisfied with the outputs of the spatial analyses.

- Formulation of the requirements on the spatial analysis means the type of information which the customer needs to obtain.
- Formulation of the requirements on the spatial analysis is focused on characteristics of the required outputs (information and ways of presentation). For the spatial realization of the individual types of the spatial analyses, the input data of the corresponding quality is always necessary. There is, therefore, the presumption that processes and tools of the data modelling can be applied.

From the point of view of the spatial analysis it was very important for us to find out which mental procedures and techniques are the most convenient for the potential users so that they could use them also for the spatial analyses and their modelling. We have defined these terms due to it:

- Convenient technique = technique which is intelligible, quickly understandable, the user has already known this from his job experience when modelling the other different problem areas,
- Potential user = user solving the problems related to the spatial data, but he/she is not an analyst specialist.

The first step for the first selection of the convenient techniques was a finding of the opinion of the potential users. During the year 2011 the inquiry was realized, when the workers from the different professions working with spatial data were asked. Some respondents met the analyses and the modelling in their jobs. Mostly it was about the situations where they partly participated in agreement of the process and data models. These were partly models related to their particular categorization. Survey was limited so that we want to find out the modelling techniques which are well understandable according to their subjective opinion. The understanding of the problem was required from the viewpoint of model creation by the given technique as well as from the viewpoint of its following interpretation, i.e. understanding the content of the model.

From the results of the survey flows that these techniques would be useful:

- Hierarchical disintegration: delimitation of the functions structures, activities, responsibilities, aims, human resources, material elements etc.,
- Delimitation of the functionality and following detailed description: simple global delimitation of the asked functionalities, in other words, asked outputs of the solved area and their following structured description in details,
- Identification of the relations: expression of the functionalities also time relation of each elements, activities, data sources, data outputs etc.

- Contextual characterization of the activity which is followed by the detailed list of its content: each activity is convenient to delimit first in the general wider context without the concentration on its own activity progress, then the detailed description of the activity progress follows where the elements from the contextual viewpoint must be used.

Another aspect is a usage of the technique within the particular modelling tool. Modelling tools generally – including tools for the modelling process and the data models – have the different characteristic. They are dependent on whether they are bound to a certain methodology, whether they are strictly delimited or whether they are tangible.

In modelling tools we can identify following characteristic:

- Factor – "applicability limitation to certain method/methodology ": Certain tools are firmly bound to certain method or methodology; their syntax is precisely delimited. That means a demand on the users who need to get to know how to use them well. There are also tools which are tangible more freely and it is simpler for users to use them.
- Factor – "tool awareness": some tools are known to "wider public", but that does not have to mean that the public use them correctly. Other tools can seem intangible and, therefore, they are less well known.

It is a question whether to use well-proved standards (and keep the precise syntax) or whether to use our own alternative.

In practice, there are many standards, methods or tools on the various levels of the formalized languages suitable for the modelling processes. Individual tools differ mostly by their purpose and range. A number of them are influenced by the information systems and technologies.

Suggested models and diagrams for the spatial analyses

For the analysis and modelling within the using the spatial data seems to be convenient to use these procedures and tools:

- Hierarchical disintegration (of the activities or the data): the convenient tool can be function tree diagram (from the method ARIS), Diagram hierarchy of the processes (from the method LBMS), or the common flow chart diagram,
- Contextual characteristic of the activity: the convenient tool can be the Model of the functions assignment (from the method ARIS) or the diagram IDEF0 (from the standard IDEF),
- Detailed description of the activity progress: the convenient tool is Diagram of the business process (from the standard BPMN), Diagram of the procedural chains (from the method LBMS), activity diagram (from the standard UML) or Diagram of the procedural chain controlled by the events (EPC, Event-driven Process Chain),

- Delimitation of the functionality and following detailed description: the tool can be the use case diagram (from standard UML), where each use case is characterized in details with the so called scenario.
- Identification of the relations (activities, objects etc.): the tool can be function tree diagram (from the method ARIS), Model of the additional value creation (from the method ARIS), activity (from the standard UML) or the common flow chart diagram.

In this chapter we consider the following diagrams – the function tree model, IDEF, the flow chart diagram, EPC diagram and the use case diagram.

Spatial analyses for barrier-free environment

This chapter shows in the examples how the selected process diagrams and tools can be used, which can cause the better insight into the problem before or during the spatial analyses and lead to their better understanding. They can also contribute to the automation of the analyses and to the increase in quality of the repeated analyses. The solved situation deals with the barrier detection on the pavements.

Introductory viewpoint of the spatial analyses

The contextual characteristic of the functionality was used for the introductory viewpoint of the given spatial analyses. Diagram IDEF0 was used as a tool (from the standard IDEF) and the modelling software MS Visio was used. In the diagram every function has the numbered identification (ID) and pertinently also diagram labelling, where the function is developed into other sub-functions. Due to that it is possible to create the hierarchy of diagrams corresponding to the decomposition of functions to their sub-functions (structured approach). The top of this hierarchy is defined as so called contextual diagram labelled with number 0 (see Figure 46). When forming the diagrams, the principles of their structuring diagonally is followed, and the diagram should not have less than three and more than six functions. There are some characteristic of these diagrams, when outputs of the given function can be the inputs, control or mechanism of the other functions. The mutual dependences are defined this way between the functions (IDEF0, 2010; Marca, 2006).

Diagram has the inputs "Requirements of the people with a disability" – they are the requirements which depends on the disabled person's possibilities and abilities to find the optimal route. Another input is "Requirement of the spatial analyses accomplishment". The necessary input for the analysis is the Data, which will be used in the spatial analyses. (Sedlák, Komárková and Piverková, 2010; Sedlák, et al., 2011)

Another used technique for the modelling of spatial analyses realization was the technique of the relations identification and hierarchical disintegration. The used tool was the diagram Function tree from the method ARIS. The own diagram (Figure 47) was created in the environment ARIS Express. The diagram realizes the identification of the problem, collection and data preparation, spatial analysis and results.

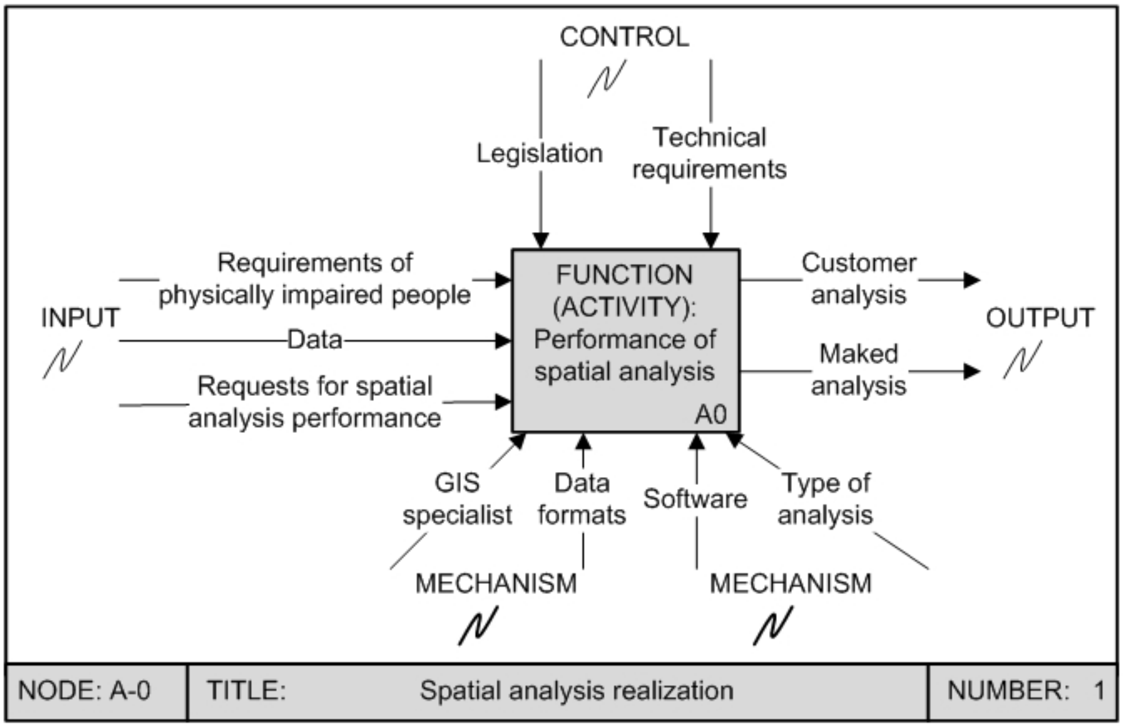

Figure 46: Model for the Context diagram of the spatial analysis realization for the people with physical impairment; used technique = contextual characteristic of the functionality, used tool = diagram IDEF0 (from the standard IDEF), used modelling SW = MS Visio (remade by Sedlák, et al., 2011)

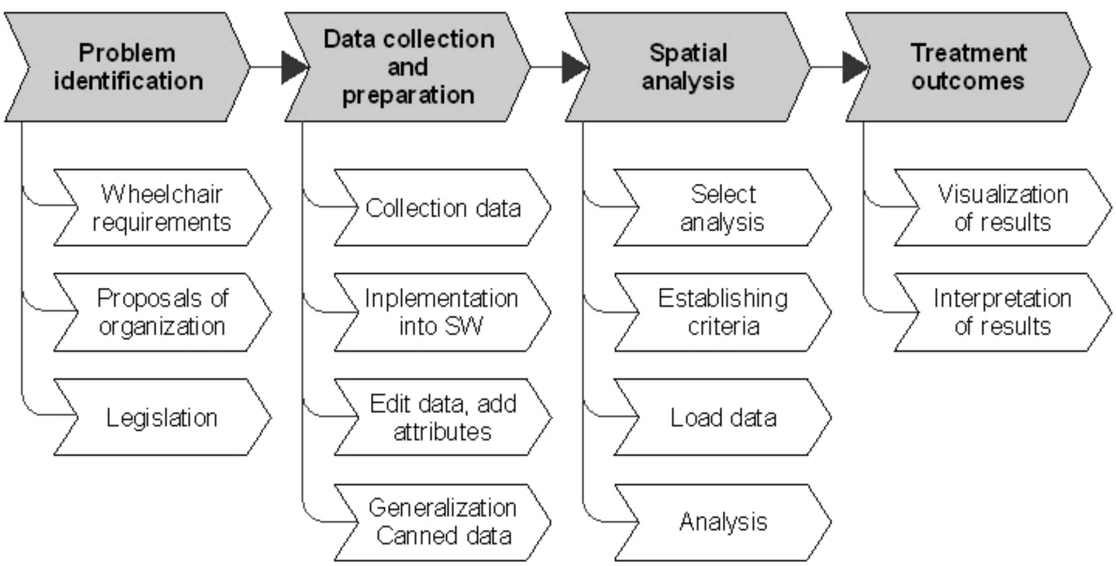

Figure 47: Model for Realization of the spatial analysis; used techniques = identification of the relations and hierarchical disintegration, used tool = diagram Function tree (from the method ARIS), used modelling SW = ARIS Express (remade by Sedlák, et al., 2011)

Searching for the optimal route

Another case study led towards the particular analysis, the analysis of network. The network can be defined as the set of line objects, which some sources go through. Analyses of the network (network analysis) can be used only at the vector representation. The own searching for the route was realized in the program ArcGIS Desktop (ArcGIS Desktop Help 9.2, 2010). For the interception of the own spatial analysis of the searching for the optimal route the technique of the detailed description of process activities was used. The tool diagram EPC was used (from the method ARIS). The diagram was modelled thanks to the software MS Visio (Figure 48).

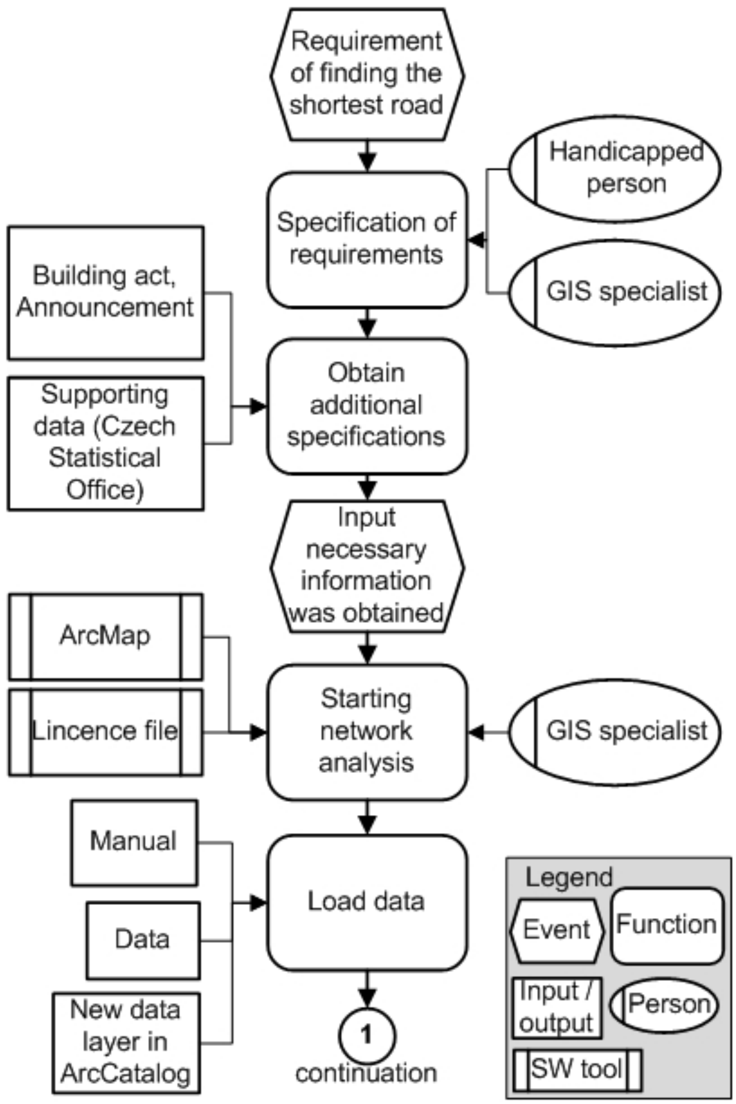

Figure 48: Model for the Process of searching for the optimal route; used technique = detailed description of the activities process, used tool = diagram EPC (from the method ARIS), used modelling SW = MS Visio (remade by Sedlák, et al., 2011)

Conclusion

The aim was to suggest the usage of such modelling tools for the spatial analyses, which would be proved in the common practice. The well-tried modelling methods were used, which are suggested for the permanent improvement of the business practice, to the methods of process modelling and related methods of the information system development.

From the results of the survey it has arisen that these techniques were useful within the analysis of the spatial data: hierarchical disintegration, delimitation of the functionality and following detailed description, identification of relations, contextual characteristic of activity, which is followed by detailed list of its content.

Another aspect was the usage of technology within the particular modelling tool. As it was indicated above, in practice there are a huge amount of standards, methods, tools at a different levels of formalized languages, which are convenient for process modelling. Every mean differs only by its range and purpose. A lot of them are influenced by the information systems and technologies.

For the analyses and modelling within the usage of the spatial data these methods and tools seem to be convenient. For the hierarchical disintegration, function tree diagram from the method ARIS or Diagram of the processes hierarchy from the method LBMS or a common flow chart diagram can be a useful tool. For the contextual characteristic of the activity can be convenient a tool Model of assigned functions from the method ARIS or the diagram IDEF0 from the standard IDEF. For the detailed description of the activity progress the convenient tool is Diagram of the business progress from the standard BPMN, Diagram of the procedural chains from the method LBMS, activity diagram from the standard UML or Diagram of the procedural chain controlled by the events (EPC, Event-driven Process Chain). For the delimitation of the functionality and related detailed description it can be used use case diagram from the standard UML as the tool, where every use case is characterized in details by so called scenario. For the identification of the relations the tool function tree can be used, diagram from the method ARIS, Model of the added value creation from the method ARIS, activity from the standard UML or the common flow chart diagram.

In this chapter, diagrams for the solution of spatial analyses when solving the questions of barrier-free were presented. Namely, the function tree model, IDEF and EPC were shown.

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