Some Considerations on Sub-national Spatial Data Infrastructures

Hartmut MÜLLER, Falk WÜRRIEHAUSEN, GERMANY

Key words: SDI, City, Citizen Interface, Geoportal

SUMMARY

Nowadays the need for the development of feasible Spatial Data Infrastructures (SDI) in general is widely recognised. Due to its complexity this subject experienced a subdivision into several narrower terms like Regional SDI, National SDI, Sub-national SDI etc. in order to address the topics under consideration more specifically.

The sub-national level is particularly important due to many facts. Decisions are taken autonomously by local authorities; local effects only become evident through sub-national data, which regularly are maintained at the local level, etc. Therefore, the efficient use of such data collected by space, ground, air and sea-borne systems and their integration with socio-economic information will depend on the availability of coordinated data policies and appropriate spatial data infrastructures at the sub-national level, in particular.

The sub-national level encompasses a large variety of areas of different size, of different economic power, of different needs and of branches of government i.e. municipalities, communities, districts, counties, provinces, regions etc. Substantial heterogeneity in the mandate, finance and functions at each level and within each level can be observed worldwide.

This paper outlines some developments in the special segment of Sub-national SDI.

ZUSAMMENFASSUNG

Die Notwendigkeit geeignete Geodateninfrastrukturen aufzubauen ist inzwischen allgemein anerkannt. Da es sich um eine komplexe Materie handelt, haben sich Begriffe wie ‚Regional SDI', ‚National SDI', ‚Sub-national SDI' herausgebildet, um die zu behandelnden Themen spezifischer ansprechen zu können.

Aus vielen Gründen ist die subnationale Ebene von besonderer Bedeutung. Entscheidungen werden autonom auf der lokalen Ebene getroffen, lokale Effekte werden erst auf der lokalen Datenebene sichtbar, die typischerweise auf der lokalen Ebene unterhalten wird etc. Die effektive Nutzung solcher Daten, erfasst aus dem Weltraum, am Boden, in der Luft oder auf See und ihre Verbindung mit sozioökonomischer Information hängt von einer koordinierter Datenpolitik und einer geeigneten Geodateninfrastruktur ab. Dies insbesondere auf der subnationalen Ebene mit der hier typischerweise großen Zahl beteiligter Stellen. Eine große Heterogenität was das Mandat, Finanzen und Funktionen angeht, lässt sich auf jeder Ebene und innerhalb einer Ebene feststellen.

Die subnationale Ebene umfasst eine große Bandbreite höchst unterschiedlicher Gebietsgröße, Wirtschaftkraft, unterschiedlichem Bedarf und Aufbau der öffentlichen Verwaltung, Städte, Verbünde, Verwaltungsgliederungen

Dieser Betrag beschreibt einige Entwicklungen im subnationalen SDI-Sektor.

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1. INTRODUCTION

The exchange of fundamental spatial data between stakeholders at different SDI levels in many cases turns out to be problematic for a variety of technical, institutional, political and economic reasons (McDougall et al, 2009). This situation impacts on the development of the efficient delivery of government and community services. At the country or national level much progress has been made in SDI development. At the sub-national level where many useful operational spatial data are maintained SDI in many cases is not yet well developed. There are many reasons for that situation, like the very disperse distribution of data among different units of public administration, lack of knowledge concerning existence of data sets, heterogeneous data formats, to name a few.

In that context horizontal data integration is an issue as is vertical data integration across multiple levels of government. Further efforts are needed to improve the effectiveness of data sharing in a multilevel SDI environment. The heterogeneous nature of government at the sub-national level raises particular challenges. There are many obstacles which may slow down the establishment of a fully operational cross level SDI, like lack of awareness of the benefits, lack of clear responsibilities of each partner, fear of losing of control of data, and so on.

2. SDI IN LARGE CITIES

Due to their economic, environmental and social importance large cities play a key role at the sub-national level across the world. UN Habitat (2010) claims for the 'simultaneous achievement of all human rights for all residents in any city.' The report continues with the statement 'This, in turn, means that all human rights – political, economic, social, and cultural – must receive equal priority in city governance, planning, management and implementation.' Figure 1 presents the complete framework of these issues.

Access to information, particularly to spatial information can support decision makers at the political level, managers at the operational level of city government and all citizens for citizen participation. Consequently, a fully operational SDI is critical for cities, in particular.

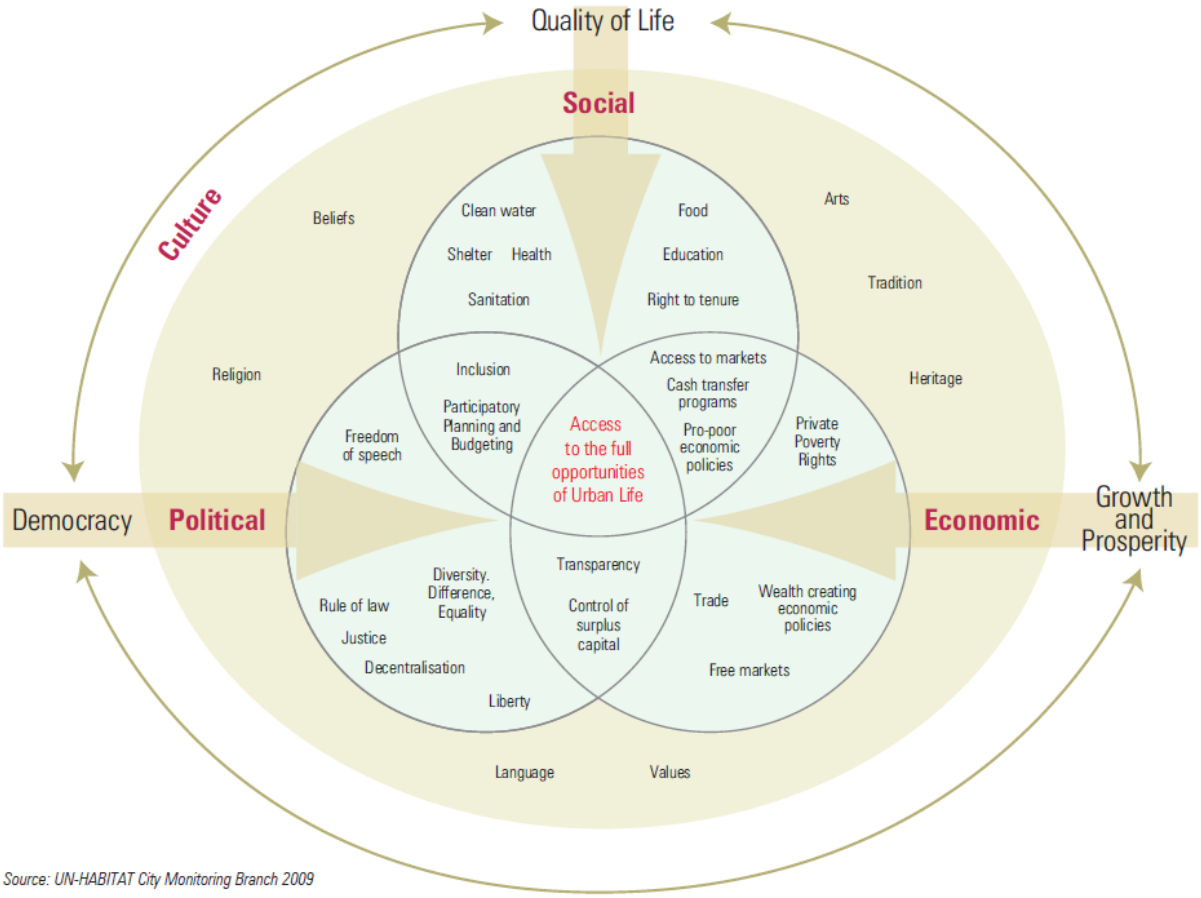

Figure 1 The right to the city (see UN Habitat, 2010)

In 2010, FIG published the results of a research study of FIG Commission 3 (FIG, 2010). The study has found that spatial information and technology is being recognised widely as one of the tools needed to understand and address the big urban problems. However, there is still a general lack of knowledge amongst communities of practice about what spatial solutions exist and how they can be used and prioritised.

Table 1 illustrates the need for qualified spatial information to support service delivery in cities.

Table 1 Service Delivery Using Spatial Data (Source: Kelly, 2007)

Urban Design	**Utility Services**
Planning codes Land zoning City-wide environmental plans Smart growth Sustainable neighbourhoods	Telemetry SCADA Micro-tunnelling Asset management and inventory Disaster preparedness, response and recovery
Urban Management	**Transport Planning**
Development and building permits Electronic lodgement of applications Automated valuation/taxes	Trip analysis Scenarios Integrated public transport networks Real-time monitoring of movements
Environmental Justice	**Economic Development**
Siting impacts Best use of land resources Placement of public facilities	Find available and suitable land Workforce demographics
Community Involvement	**Public Safety**
Scenario and impact analysis, option development 3D visualisation Fly-throughs	Emergency response management Crime modelling Emergency dispatch and routing
Environmental Services	
Optimising waste collection networks Water storage, allocation and distribution Environmental monitoring	

In principle, tools, techniques and policies are available to baseline and integrate the social, economic and environmental factors associated with territories of different kind, to monitor growth and change, to forecast areas of risk – all within short timeframes. Traditional needs such as land development, tenure and value applications have to be met, but be designed to be interoperable and integrated within the city wide, sub-national SDI as it evolves. Access to integrated spatial information from the SDI will lead to more validated decision making allowing employing of scarce resources to tackle the most urgent needs.

These tools should support the operation of land administration functions, but must support the management of key problems such as disaster management, flooding control, environmental management, health and transportation, for example, but also encourage economic development and reduce social inequalities.

Table 2 presents a number of examples in which way the various sectors of city administration can be supported by tools and techniques of spatial information processing.

Table 2 Examples of use of spatial data and products in city administration (Source: Kelly, 2007)

Environmental

Issue	*Use of spatial information*	*Examples*
Land use planning	Describe spatial extent of allowable land uses	Land zoning maps
Impact of development	Describe land capability and sustainability	Terrain maps showing vulnerability to land slippage
Impact of climate change	Vulnerability to rising sea level and tidal surges	Flood prone land mapping and real-time weather mapping
Access to water	Location of dams and fresh and waste water reticulation networks	Catchment terrain maps
Pollution and hazards	Location of broad and point specific pollution and hazardous wastes	Inventory of properties where hazardous wastes are stored

Social and economic infrastructure

Issue	*Use of spatial information*	*Examples*
Employment	Location of existing enterprises and land zoning for future business use based on predicted population growth	Maps showing land zoned for business use
Communal facilities	Location of land set aside for communal facilities	Street map showing location of communal facilities
Utility services	Location and attributes of fresh water, sewer, storm water, electricity and telephone networks	Cadastral maps showing utility services
Transport	Location and attributes of public roads	In car navigation device using up-to-date road network and GPS

Governance

Issue	*Use of spatial information*	*Examples*
Land allocation	Describe pattern of current land use	Digital cadastral database
Access to serviced land	Current location of serviced land	Cadastral map overlaid by current aerial photography and utility service networks
Secure property rights	Spatial extent of existing property rights	Land titles register containing all rights, restrictions and obligations for each property
Community participation	Public access to cadastral, planning and environmental information affecting individuals and the community	Public display of proposed developments, land suitability and other maps
Fiscal sustainability	Comprehensive and accurate records of the extent of existing property rights and land use	Land valuations shown on cadastral maps
Public safety	Comprehensive data about roads, properties and hazards	Emergency dispatch system; bushfire models
Slum reduction	Location of vacant or under-utilised land and population growth predictions	Current aerial photography, predictive modeling of land use
Measuring performance	Land change over time	Land change mapping

External effects

Issue	*Use of spatial information*	*Examples*
Rural sustainability	Location, size and productive capacity of rural properties	Satellite images of rural areas overlaid by cadastral boundaries
Access to raw materials	Location of sources of food and mineral production and transportation corridors for their movement to the city	Topographic mapping series

3. THE SUB-NATIONAL SDI LEVEL IN GERMANY

3.1 SDI at the different political levels in Germany

The SDI framework in a country from its very nature is closely linked to the political system of the country under consideration. In Germany there are five constitutionally distinct and legally independent political levels (Haschke, D.):

Level 1: The **European Union** as the association of 27 European nations.

Level 2: The **Federal Republic of Germany** as a nation with constitutional international sovereignty.

Level 3: The 16 **Länder** as member or subordinate states of the Federal Republic of Germany, including the state intermediate authorities.

Level 4: The **districts** and the **towns not belonging to a district**.

Level 5: The **towns and municipalities.**

Figure 2 Administrative structure of Germany (Level 2 units)
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SDI development at the European level (Level 1) is largely driven by the ongoing INSPIRE initiative (Infrastructure for Spatial Information in the European Community). The framework of INSPIRE is set by the INSPIRE Directive which entered in force in May 2007 European Union, 2007).

At the Federation level (Level 2) SDI development is supported by Geospatial Data Infrastructure GDI-DE, which is a joint initiative of the Federal Government, the Länder (German States) and the municipalities. In that way the institutional framework for the vertical integration of spatial data in Germany is set. GDI-DE adopted the concept of NGDB, the National GeoDataBase. NGDB is a collection of geospatial data, which cover the territory of Germany in its entirety meeting several quality criteria (Geoportal.de, 2012):

- referenced to the defined coordinate system
- representable via map services
- searchable through descriptive "metadata" and
- accessible via download services

Local autonomy in the Federal Republic of Germany is guaranteed in the Constitution, the so-called Basic Law and in the corresponding Land Constitutions. The municipalities possess local autonomy which means they own the right to manage all their own affairs on their own responsibility within the limits set by the law. Sovereignty includes the right to select, engage, promote and dismiss staff, to organise the administration independently, to organise and shape their territory under their own responsibility by drawing up urban development plans (land use and building plans), to pass municipality bylaws, to be responsible for managing their income and expenditure and, finally, to raise taxes (provided that this right has not been revoked by a higher law).

Consequently, a certain variety of administration processes amongst different Länder and between the municipalities of one and the same Land emerged over time.

This situation of heterogeneity causes serious demands for interoperability between different systems. To give an example, 17 Acts of Parliament had to enter into force to establish the Spatial Data Infrastructure in the Federation and in the 16 Länder forming the territory of Germany (see Table 3).

Table 3 SDI Establishment in Germany, List of Acts of Parliament
(Source: BDVI, 2011: http://bdvi.de/en/component/fileprotect/?task=download&fpid=2393)

	Geodatenzugangsgesetz	Inkrafttreten	Quelle	Link
EU	RICHTLINIE 2007/2/EG vom 14. März 2007 zur Schaffung einer Geodateninfrastruktur in der Europäischen Gemeinschaft (INSPIRE)	15.05.2007	Amtsblatt der Europäischen Union L 108/1 vom 25.04.2007	http://eur-lex.europa.eu/
Bund	Geodatenzugangsgesetz (GeoZG) vom 10.02.2009	14.02.2009	BGBl I Nr. 8 S. 278 vom 13.02.2009	http://bundesrecht.juris.de/geozg/
Baden-Württemberg	Landesgeodatenzugangsgesetz (LGeoZG) vom 17.12.2009	24.12.2009	GBl. 2009, 802	http://www.landesrecht-bw.de
Bayern	Bayerisches Geodateninfrastrukturgesetz (BayGDIG) vom 22.07.2008	01.08.2008	GVBl 2008, S. 453 vom 22.07.2008	http://by.juris.de/by/gesamt/GDIG_BY.htm
Berlin	Geodatenzugangsgesetz Berlin (GeoZG Bln) vom 03.12.2009	13.12.2009	GVBl. vom 12.12.2009 S. 682	http://www.stadtentwicklung.berlin.de/geoinformation/geodateninfrastruktur/download/GeoZG_Bln.pdf
Brandenburg	Brandenburgisches Geodateninfrastrukturgesetz (BbgGDIG) vom 13.04.2010	14.04.2010	GVBl. I - 2010, Nr. 17	http://www.bravors.brandenburg.de
Bremen	Bremisches Geodatenzugangsgesetz (BremGeoZG) vom 24.11.2009	10.12.2009	Brem. GBl. 65/2009 S. 531	http://www.gdi-sh.de/GeoZG-Bremen.pdf
Hamburg	Hamburgisches Geodateninfrastrukturgesetz (HmbGDIG) vom 15.12.2009	31.12.2009 (?)	HmbGVBl. Nr. 57/2009 S. 528 vom 30.12.2009	http://www.luewu.de/gvbl/2009/57.pdf
Hessen	Gesetz zur Änderung des Hessischen Vermessungs- und Geoinformationsgesetzes und des Denkmalschutzgesetzes v. 4.3.2010	17.03.2010	GVBl. I 2007, 548 v. 16.03.2010	http://www.rv.hessenrecht.hessen.de/
Mecklenburg-Vorpommern	Geoinformations- und Vermessungsgesetz (GeoVermG M-V) vom 16.12.2010	30.12.2010	GVOBl. M-V 2010, S. 713	http://www.landesrecht-mv.de/jportal/
Niedersachsen	Niedersächsisches Geodateninfrastruktur-gesetz (NGDIG) vom 17.12.2010	29.12.2010	Nds. GVBl. 2010, 624	http://www.nds-voris.de/jportal/
NRW	Geodatenzugangsgesetz (GeoZG NRW) vom 17.02.2009	18.02.2009	GV. NRW. 5/2009 S. 84	https://recht.nrw.de/
Rheinland-Pfalz	Landesgeodateninfrastrukturgesetz (LGDIG) vom 23.12.2010	31.12.2010	GVBl 2010, S. 548	http://rlp.juris.de/rlp/gesamt/GDIG_RP.htm
Saarland	Saarländisches Geodateninfrastrukturgesetz (SGDIG) vom 01.07.2009	28.08.2009 (befristet bis 31.12.2015)	Amtsbl. d. Saarl. vom 27.08.2009 S. 1426	http://sl.juris.de
Sachsen	Gesetz über die Geodateninfrastruktur im Freistaat Sachsen (SächsGDIG) v. 19.05.2010	05.06.2010	SächsGVBl. Nr. 6/2010 S. 134 v. 04.06.2010	http://www.gdi-de.org/download/inspire_gesetze/SaechsGDIG.pdf
Sachsen-Anhalt	Geodateninfrastrukturgesetz für das Land Sachsen-Anhalt (GDIG LSA) vom 14.07.2009	21.07.2009	GVBl. LSA 13/2009, S. 368 vom 20.07.2009	http://www.landesrecht.sachsen-anhalt.de
Schleswig-Holstein	Geodateninfrastrukturgesetz für das Land Schleswig-Holstein (GDIG) vom 15.12.2010	24.12.2010	GVOBl. 2010, 717	http://www.gesetze-rechtsprechung.sh.juris.de/
Thüringen	Thüringer Geodateninfrastrukturgesetz (ThürGDIG) vom 08.07.2009	31.07.2009	GVBl 10/2009 S.574	http://landesrecht.thueringen.de/

3.2 SDI at the sub-national level in Germany

In the following section the status of Spatial Data Infrastructure development will be outlined by considering the South-Western German Land Rhineland-Palatinate. Rhineland-Palatinates sub-national SDI named GDI-RP forms part of GDI-DE, a project jointly initiated by the federal government, federal state governments and municipal authorities with the aim to set up and make available a network of geo information. The purpose of GDI-RP is to enhance the field of geo information within Rhineland-Palatinate. By 24 May, 2005, the Council of Ministers decided to entrust IMAGI-RP with the political mandate of establishing a Geo Data Infrastructure in Rhineland-Palatinate (GeoPortal.rlp, 2012).

Within Spatial Data Infrastructure Rhineland-Palatinate, the GeoPortal.rlp was established to take the role of the service-oriented agent brokering geo data between geo users and geo service providers. The portal (http://www.geoportal.rlp.de/) is designed to provide only information about geospatial data and the data owners, not the data itself. The data as well as related metadata information remains with the data providers thus leaving full control on all provided information to the information provider.

GeoPortal offers the opportunity for federal state agencies, municipal authorities and private companies to present their data and services. Online-access to the distributed data sources of

each geospatial service- and product-provider ensures that information made available by these institutions on a joint platform is as up-to-date as possible. Instead of users having to copy the data, links to the original data sources enable them to have direct access. This metadata is managed by the providers themselves using the multi-client-capable administrative framework implemented by Mapbender.
GeoPortal.rlp provides information about geospatial data and the data owners, as well as offering integrated functionality for use in standard GIS viewers and in specific applications.

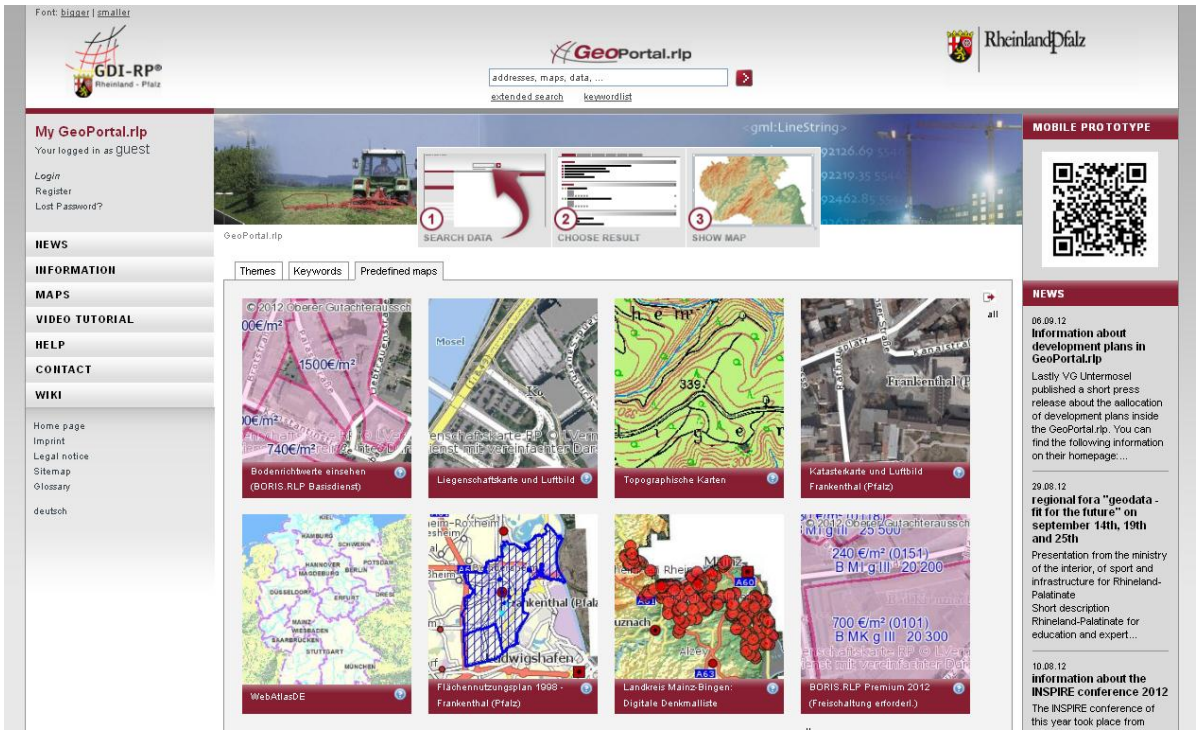

Figure 3 GeoPortal of the Land (Federal state) of Rhineland-Palatinate (Source GeoPortal.rlp, 2012)

The states' geoportal is embedded in the federal GDI-DE, and at the European level connects seamlessly into the emerging INSPIRE platform. Therefore all SDI Implementation should follow the common strategies, to have access to spatial data and information about a specified administration territory like the state of Rhineland-Palatinate.

Table 4 Structure of INSPIRE themes
(Source: http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.3_Definition_of_Annex_Themes_and_scope_v3.0.pdf)

Annex I

1. Coordinate reference systems
2. Geographical grid systems
3. Geographical names
4. Administrative units
5. Addresses
6. Cadastral parcels
7. Transport networks
8. Hydrography
9. Protected sites

Annex II

1. Elevation
2. Land cover
3. Orthoimagery
4. Geology

Annex III

1. Statistical units
2. Buildings
3. Soil
4. Land use
5. Human health and safety
6. Utility and Government services
7. Environmental monitoring facilities
8. Production and industrial facilities
9. Agricultural and aquaculture facilities
10. Population distribution – demography
11. Area management / restriction / regulation zones & reporting units
12. Natural risk zones
13. Atmospheric conditions
14. Meteorological geographical features
15. Oceanographic geographical features
16. Sea regions
17. Bio-geographical regions
18. Habitats and biotopes
19. Species distribution
20. Energy resources
21. Mineral resources

The INSPIRE Directive addresses 34 spatial data themes (see Table 4). One of the themes is 'Natural risk zones' (see Annex III, No. 12).

Figures 4 and 5 gives an example in which way spatial information about natural risk zones is accessible for all citizens by the geoportal.rlp. Figure 4 shows the extent of potential inundation areas at the banks of the river Mosella. Figure 5 illustrates the overlay of different themes by mapping the areas under risk of flooding together with the corresponding land values in Euro per square metre.

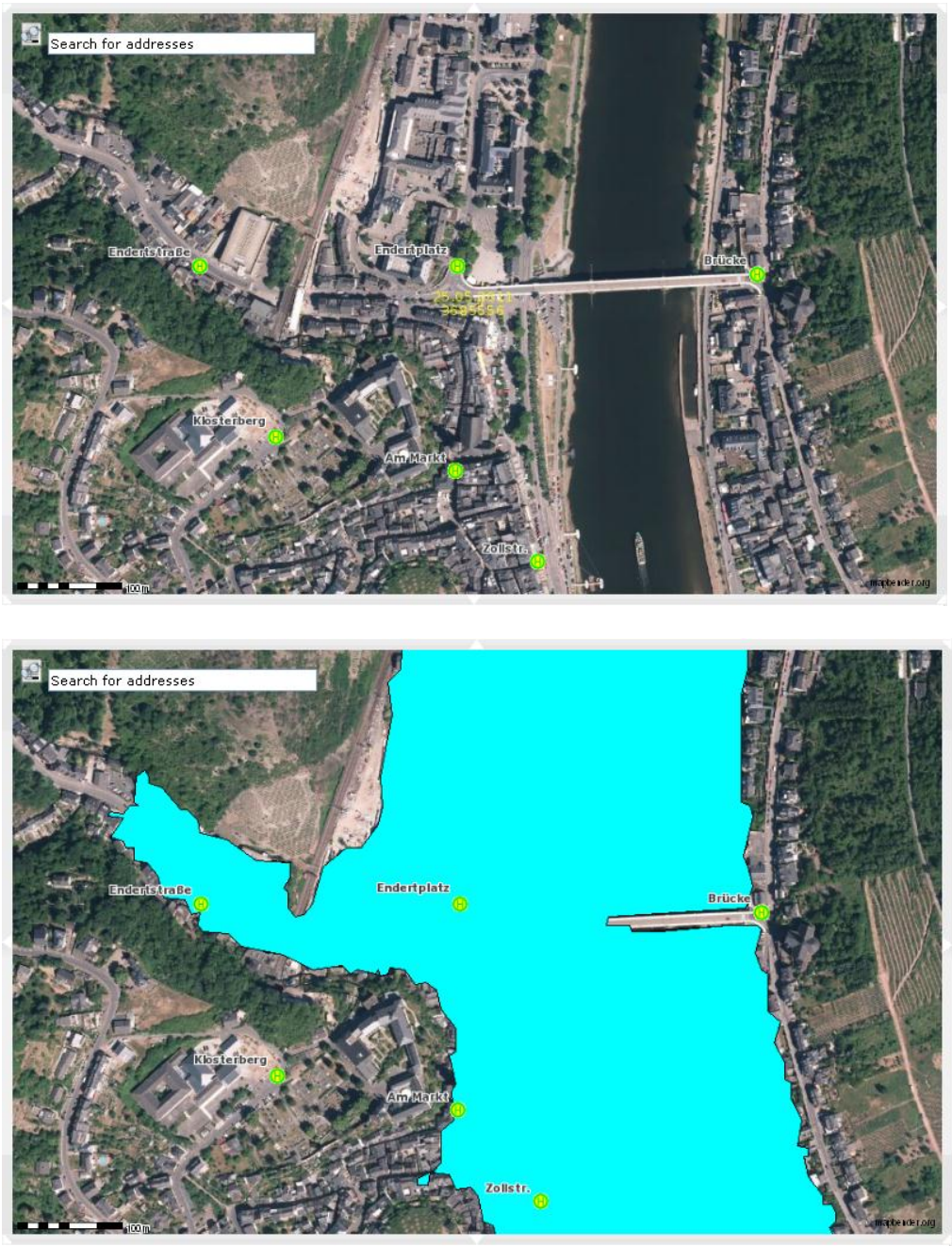

Figure 4 Flooing simulation for Mosella river in the Land (Federal state) of Rhineland-Palatinate (Source GeoPortal.rlp, 2012)

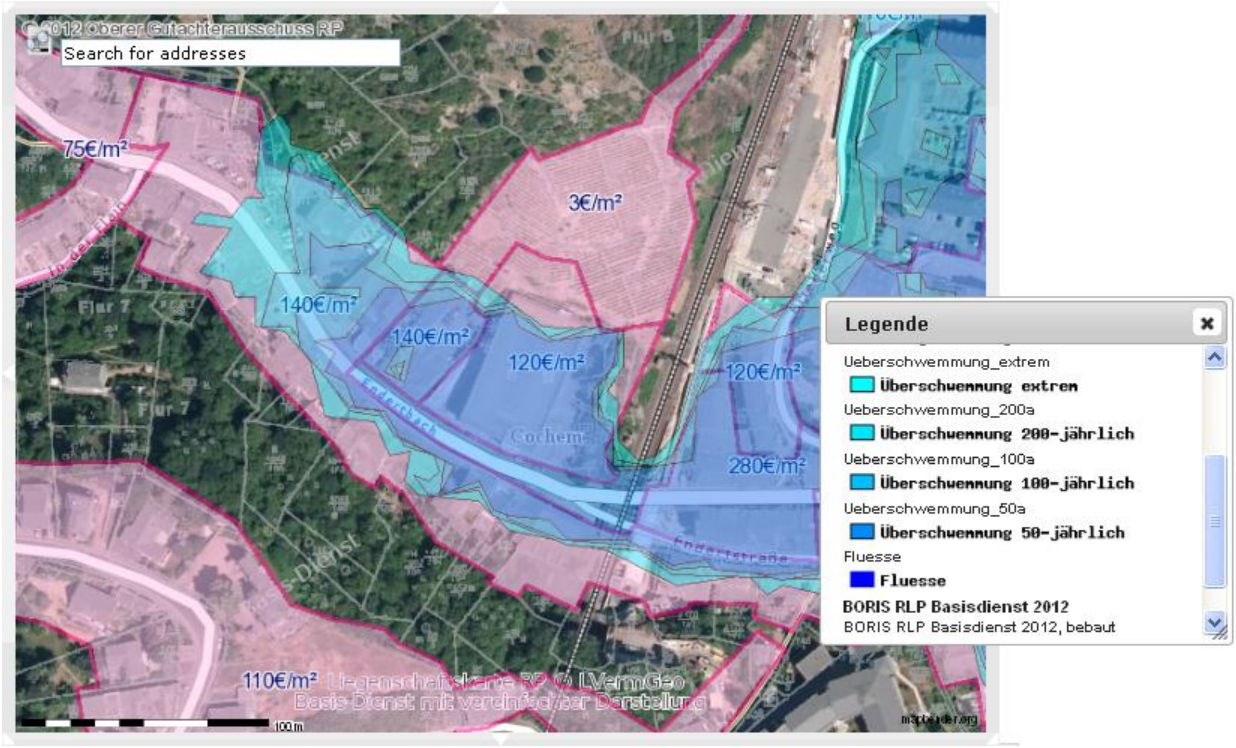

Figure 5 Overlay of flooding simulation for Mosella rive rand land values in the Land (Federal state) of Rhineland-Palatinate (Source GeoPortal.rlp, 2012)

Over the last years, geospatial data collection and management tools have become common in many organizations in the Land, both in public or private sector. Geospatial data are available at the involved institutions in a wide range of formats, partly in analogue form, or, if digitally available, filed in a considerable number of different file formats. Based on that, data of many different organizations exist, but it is relatively unknown where and how those data are available. Metadata which describe the data and the data owners are urgently needed to implement a data management within an SDI framework of different partners. If municipal authorities, local governments and private companies make their services accessible for the whole community, this will be a substantial step forward towards supporting spatial decisions at all levels and towards citizen participation in the decision processes, as well.

4. CONCLUSIONS

At the sub-national level many useful operational spatial data are maintained. That is why sub-national SDI development should be addressed in particular in the context of multilevel SDI environments. Major stimuli for SDI development in Europe come from the ongoing European SDI initiative INSPIRE. Obstacles like disperse distribution of data among different units of public administration, lack of knowledge concerning existence of data sets, heterogeneous data formats, etc. are still present. Nevertheless, progress at all SDI levels can be stated.

REFERENCES

Doytsher, Y., Kelly, P., Khouri, R., McLaren, R., Mueller, H., Potsiou, C. (2010) Rapid Urbanization and Mega Cities: The Need for Spatial Information Management. Research study by FIG Commission 3. FIG publication no. 48, 96pp. The International Federation of Surveyors (FIG), Copenhagen, Denmark.

Geoportal.de (2012): Geoportal GDI-DE
http://www.geoportal.de/EN/Geoportal/geoportal.html?lang=en

GeoPortal.rlp (2012): GeoPortal Rheinland-Pfalz
http://www.geoportal.rlp.de/portal/en/

Haschke, D.: Local Government Administration in Germany. German Law Archive, http://www.iuscomp.org/gla/literature/localgov.htm (accessed 5 Nov 2012).

Ho, S. and Rajabifard, A.: 3D Land and Property Information System: A Multilevel Infrastructure for Sustainable Urbanization and a Spatially Enabled Society. Centre for SDIs and Land Administration, the University of Melbourne, Australia

Hogrebe, D. and Dömming, A. von (2011): INSPIRE Coordination in Germany – Benefits of an integrative monitoring approach – INSPIRE conference 2011, Edinburgh, 28 June 2011. http://www.geoportal.de/SharedDocs/Downloads/DE/GDI-DE/Vortraege/INSPIRE_Conference_Edinburgh.pdf?__blob=publicationFile (accessed 05 Nov 2012)

European Union (2007): Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) http://inspire.jrc.ec.europa.eu/directive/l_10820070425en00010014.pdf

INSPIRE Geoportal (2012): The EU Portal for Geographic Information
http://www.inspire-geoportal.eu/

Kelly P. (2007) "Role of Spatial Data Infrastructures in Managing Our Cities", FIG Commission 3 Annual Meeting, Sounion, 2007

McDougall, K. Abbas Rajabifard, A. and Williamson, I. (2009): Local Government and SDI – Understanding their Capacity to Share Data. In: . B. van Loenen, J.W.J. Besemer, J.A. Zevenbergen (Editors), SDI Convergence. Research, Emerging Trends, and Critical Assessment. Nederlandse Commissie voor Geodesie Netherlands Geodetic Commission 48, 2009, 205-218

Steudler, D. and Rajabifard, A. (2012): Spatially Enabled Society. Joint publication of FIG-Task Force on "Spatially Enabled Society" in cooperation with GSDI Association and with the support of Working Group 3 of the PCGIAP, FIG publication No. 58. 2012, 72pp. The International Federation of Surveyors (FIG), Copenhagen, Denmark.

UN HABITAT (2010), State of The World's Cities 2010/2011: Bridging the Urban Divide, Report by the United Nations Human Settlements Programme. London, Sterling, VA, Earthscan.

BIOGRAPHICAL NOTES

Hartmut Müller got his diploma and doctoral degree at Karlsruhe University, Germany. After 8 years of research he turned into the marketing and software development departments of international enterprises for 6 years. Since 1991 he is a professor at Mainz University of Applied sciences. Since 1998 he is director of i3mainz, Institute for Spatial Information and Surveying Technology. In the DVW – German Association of Geodesy, Geoinformation and Land Management he is past chair of working group 2 –Spatial Information and Spatial Data Management. In FIG he is chair of working group 3.1 –Spatial Information Management Infrastructure. **Falk Würriehausen** holds a diploma in Geodesy. Since 2008 he is a research co-worker at the i3mainz Institute for Spatial Information and Surveying Technology of Mainz University of Applied Sciences.

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