Promoting Land Administration and Good Governance by SDI – The European Way

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Key words: SDI, INSPIRE, Geo-spatial Basic Data, Geo-spatial Municipal Data

SUMMARY

The INSPIRE - Infrastructure for Spatial Information in Europe initiative lays down general rules for the establishment of an infrastructure for spatial information in Europe focussing on environmental issues. The INSPIRE work programme comprises three phases, namely the Preparatory phase (2005-2006), the Transposition phase(2007-2008) and the Implementation phase (2009-2013). The most important goal of the preparatory phase starting in 2005 is to formulate so called ‚Implementing Rules'. To support the whole INSPIRE process pilots and prototypes will be used for test purposes.

In this context the paper will present a current project initiative in Germany, which is one of the INSPIRE member states. Within the project user needs were identified for a specified project domain, use case scenarios were described and benefit of implementing an interoperability-based solution in a real case were determined. In the current pre-operational stage of INSPIRE such a project can help to gain real case implementation knowledge, in that case mainly at the local administration level. The following components are addressed in the project, partly at the original local level, partly in conjunction with the national and regional levels, respectively: metadata, spatial data themes subdivided into the basic data domain and into the municipal data domain, spatial data services, agreements on access and use.

ZUSAMMENFASSUNG

Die INSPIRE - Infrastructure for Spatial Information in Europe Initiative beschreibt allgemeine Regeln für den Aufbau einer europäischen Geodateninfrastruktur mit dem Themenschwerpunkt Umwelt. Das INSPIRE Arbeitsprogramm besteht aus drei Phasen: der Vorbereitungsphase (2005-2006), der Übergangsphase (2007-2008) und der Einführungsphase (2009-2013). Der Beitrag beschreibt eine aktuelle Projektinitiative in Deutschland, einem der Mitgliedsstaaten von INSPIRE. Nutzeranforderungen werden für einen speziellen Anwendungsfall erhoben, Anwendungsszenarien werden beschrieben und der Nutzen der Implementierung einer interoperablen Lösung wird für einen Realfall bestimmt. In der derzeitigen voroperationellen Phase von INSPIRE können derartige Projekte helfen, an Hand konkreter Anwendungsfälle wertvolles Wissen aufzubauen, wie es für den Aufbau einer leistungsfähigen Geodateninfrastruktur unbedingt benötigt wird.

Promoting Land Administration and Good Governance by SDI – The European Way

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1. SDI LEVELS

The term Spatial Data Infrastructure (SDI) encompasses the policies, standards and institutional arrangements involved in delivering spatially related information from all available sources to all potential users. A spatial data infrastructure provides for a basis for spatial data discovery, evaluation, download and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and the general public. Currently, many regional and national Spatial Data Infrastructure initiatives are taking place. According to Smits et al. (2002), most of those initiatives are very much in line with the ISO/TC211 and the OpenGIS Consortium developments. In order to get regional and national SDIs interoperable, the INSPIRE - Infrastructure for Spatial Information in Europe initiative was founded (INSPIRE, 2006). One of its outcomes is an architecture reference model and foundation standards (see Figure 1) proposed in a Position Paper of the AST - Architecture And Standards Working Group (Smits et al, 2002).

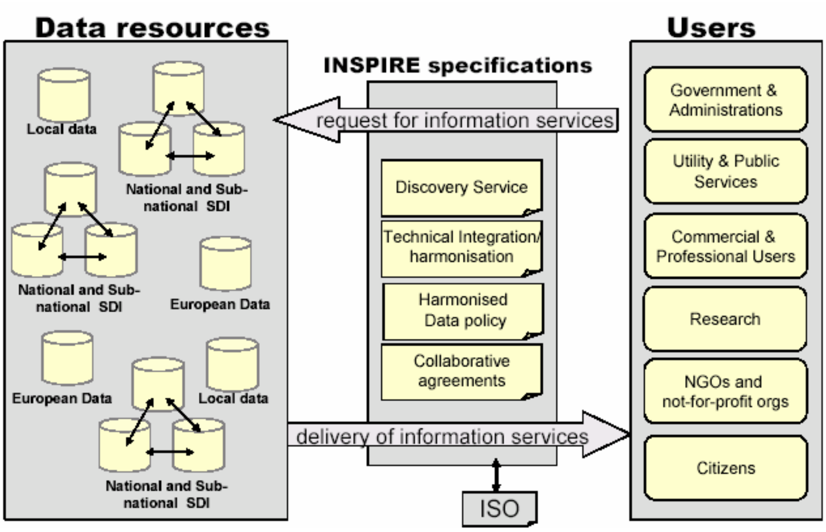

Figure 1: INSPIRE Information Flow (Source: Smits et al. 2002)

ISO as the "International Organisation for Standardisation" is a network of national standards institutes from 147 countries working in partnership with international organisations, governments, industry, business and consumer representatives. The Open GIS Consortium, Inc. (OGC) is a member-driven, non-profit international trade association fostering the development of geoprocessing interoperability computing standards (Open Geospatial Consortium, 2005).

INSPIRE is the large current initiative of the European Commission to promote the multipurpose availability of feasible geographic information. The purpose of this initiative is to support European Community policies with a territorial dimension or impact. INSPIRE is supposed to address technical standards and protocols, organisational and co-ordination issues, data policy issues including data access and the creation and maintenance of spatial information in the context of a European Spatial Data Infrastructure ESDI. The INSPIRE vision outlines a Spatial Data Infrastructure which addresses data resources at the European level, at the national and sub-national level and at the local level, as well. The INSPIRE initiative even links with relevant initiatives at the global level such as the work concerned with a Global Spatial Data Infrastructure (GSDI). Therefore, the INSPIRE principles should be considered at all levels of an SDI implementation. At the sub-national or regional level, one of the main goals is to process all relevant geographic information by jointly linking it to the information available at the two adjacent administrative levels, namely to the national level at the one hand and to the local level at the other hand, respectively. The needs of potential users have to be elaborated in detail with regard to access to transformed data, pictures, maps, reports, multi-media content, to metadata search and retrieval for data and services, to data access at distributed content repositories located at different geo-spatial data servers and so forth. The following sections describe a project initiative which supports the implementation of a regional level SDI starting from the given administration structures. Special credit is given to the situation in one of the German Laender, Rheinland-Pfalz.

2. GERMAN ADMINISTRATION STRUCTURES AT THE REGIONAL LEVEL

2.1 Given situation

Germany is a federal republic consisting of 16 states (so called "Laender"). One of these federal states is Rheinland-Pfalz with 4 million inhabitants. Rheinland-Pfalz itself consists of 24 rural district areas (see Figure 2). The Nomenclature of Territorial Units for Statistics (NUTS) was established by Eurostat in order to provide a single uniform breakdown of territorial units for the production of regional statistics for the whole European Union (Eurostat, 2005). Every NUTS territory has an individual alphanumeric code attached. The German Laender form the German part of the European NUTS 1 level territories, the same holds for the German rural district areas forming the NUTS 3 level territories. For all 24 rural district areas (NUTS 3) forming the Land Rheinland-Pfalz (NUTS 1) a Geo Information System (GIS) implementation is planned. Geo Information Systems provide for one important, may be the most important, part needed to realise the operability of an SDI. The federal state of Rheinland-Pfalz, like entire Germany, faces two big challenges. It has to work with less financial resources and, at the same time, it should change the service for the citizens and for the economy for the better. The intention is to achieve a modern public administration which is efficient and transparent, which accomplishes more and costs less. The implementation of a GIS System which a spatial data infrastructure demands for can help to reach these goals. The government of the federal state Rheinland-Pfalz intends to promote the GIS-implementation in context of an overall e-government solution.

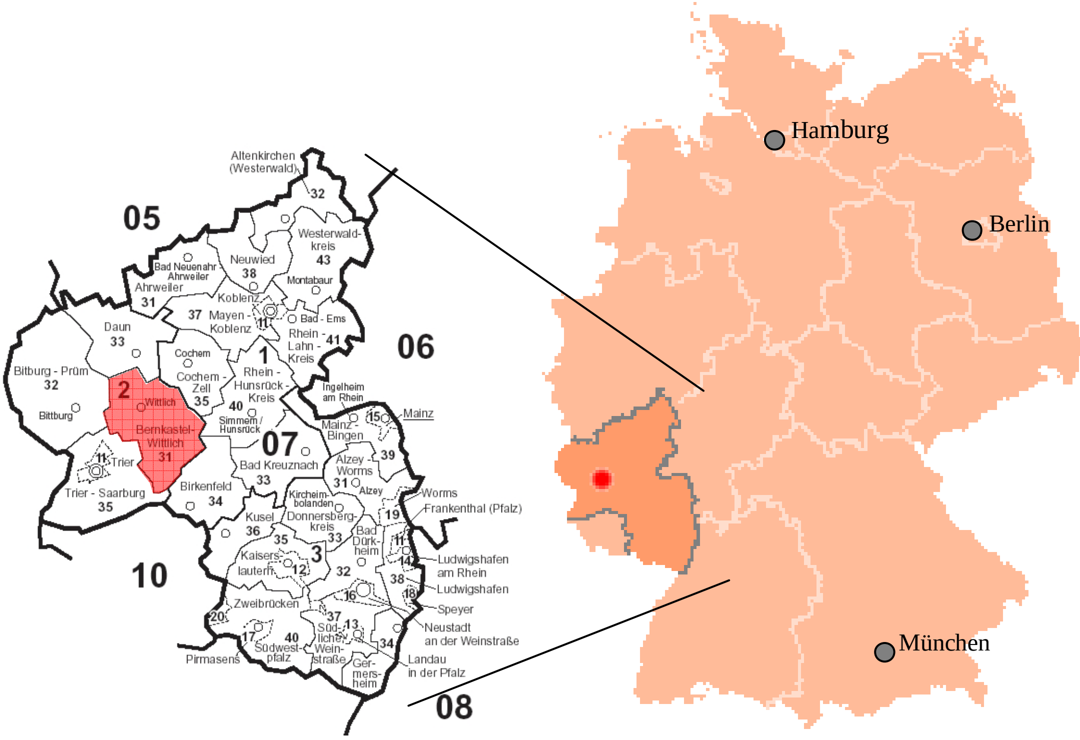

Figure 2: Administration Levels of Federal Republic of Germany

The tasks of a local authority, one for each rural district area, are complex. Several hundred employees care about the needs of the citizens in many fields of life: education, sports, civil protection, nature conservation, preservation of ancient monuments, building inspection, motorcar permit, social welfare, youth matters, decrees, to name a few of them. In the past, the local authorities had invested – if they had done so – into systems which are able to work with structured data only inside a closed local authority unit. Important information, which is of prime importance for these organisations, is available in a wide range of different formats and is maintained either on incompatible systems like special data-servers, general purpose web-servers, data bases or is still available only in an analogue form like on paper sheets and on paper maps. As a result, co-workers of public administration units spend 30 % of their time to search for information, according to a study of the DELPHI-group (DELPHI Group, 2005).

2.2 Usability of Geo-Spatial Basic Data

In Rheinland-Pfalz there is one regional authority, called LVermGeo, which provides for the geo-spatial basic data of the whole state,. In 2002 the LVermGeo contracted with the Landkreistag Rheinland-Pfalz, the umbrella organisation of all 24 local authorities. According to this contract the local authorities are licensed to use all geo-spatial public administration basic data available in

- the Automated Real Estate Register – ALB, which includes information about land parcels (e.g. key numbers, location, ...), type of property, ownership, etc.,

- the Automated Real Estate Map – ALK, which comprises cadastral boundaries, landscape parcels, type of landuse, buildings, special topographic features, house numbers, etc.,
- Digital Landscape Models – DLM,
- Digital Topographic Maps – DTK,
- Digital Terrain Models – DGM,
- Digital Orthophotos – DOP.

In the past every local authority had to accept the payment of specific licence fees to the LVermGeo for every data set they needed. As a result of the new contract all local authorities get the right to use all the data they need for a lump sum which is to be transferred once a year from the authorities responsible for them at the state level to the authorities providing for the geo-spatial data.

3. A PROJECT INITIATIVE AT THE REGIONAL LEVEL

The umbrella organisation of the local authorities, Landkreistag Rheinland-Pfalz, started a broad state-wide project initiative. The main goal of the project initiative is to develop a conceptual model, where the business processes of a local authority are mapped as far as they are directly linked to GIS items. The benefit and the application potential of a GIS will be clarified by documentation and analysis of these business processes. The conceptual model has to be compatible with the ISO-standards and the recommendations of the OpenGIS-Consortium. It was assumed that in all the 24 local authorities the same business processes (combined intersection) are running – which in the meantime could be proved to be close to reality. Moreover, the project develops a GIS implementation strategy for one exemplary local authority. The strategy has to support the modular build-up of a GIS. The requirements for the GIS solution are described in detail in a set of specifications. This set becomes the basis for the subsequent tendering procedure. By reason of its modular build-up the study supports all local authorities at the same time:
- Authorities which have still no GIS in use,
- Authorities which already use a GIS, and want to optimise it,
- Authorities which use a GIS and want to adapt it to additional requirements.

This set-up ensures that all local authorities addressed by the study can take their benefits from the project no matter in which stage of the GIS implementation they are. Another goal of the study is to prepare a strategy how to build up a spatial data infrastructure for the co-operation and the data exchange within the local authorities themselves on the one side, and in between the local authorities and other public administration bodies on the other side. All existing spatial data which are generated in the different administration bodies have to be integrated in future (see INSPIRE, for instance).

4. PROJECT ORGANISATION

The following section outlines the principles of project organisation as agreed upon all participants (see Figure 3). The project group consists of approximately 20 experts. The group members are co-workers of those local authorities which already got experience in the implementation and maintenance of a Spatial Data Infrastructure. This group is responsible for the continuos audit of the attained results, with the purpose to achieve transferable results from the pilot unit to the other 23 local authorities. One of the 24 local authorities, Bernkastel-Wittlich (for the location see Figure 2), acts as a pilot authority. i3mainz completes the work for every item of the principal workplan (see next section), mainly for the pilot authority unit. All work results are audited by the project group (project steering committee, see Figure 3) on a regular 2 months time basis. After passing the project group audit, the results are presented to all authorities and to the GIS plenum which meets twice a year. The GIS plenum consists of more than 50 members, mainly of 2 responsible from each of all affected 24 local authorities. The members of this group transfer the project results to their own local authority.

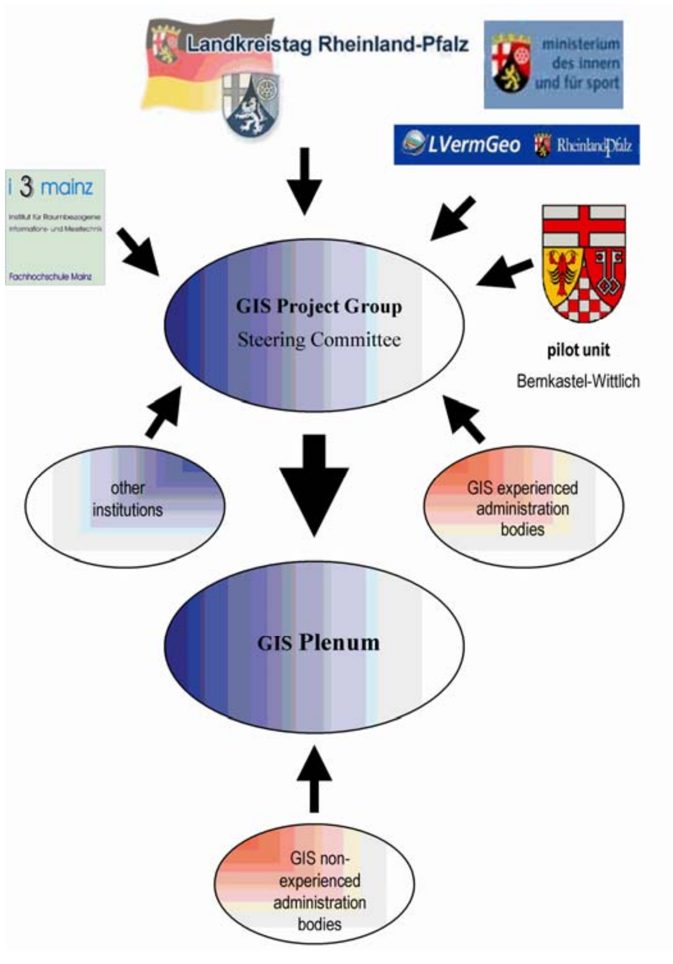

Figure 3: Project organisation chart

5. PRINCIPAL WORKPLAN

According to Behr (1998) the principal project workplan was set up as follows (see Table 1)

System analysis	System selection	System implementation
Strategic planning	Public tender	System installation, system acceptance
Field research and analysis	Offer rating	Data acquisition, data migration
Conceptional modelling	Functional tests	System use
Professional concept	System rating, system recommendation	
IT-concept		
Cost benefit analysis		

Table 1: Principal work plan

6. ACTUALLY COMPLETED TASKS

At the moment of writing this paper, all activities linked to the tasks which are listed under 'System analysis' and 'System selection' (see Table 1) had been completed for the pilot authority.

6.1 System Analysis - Strategic Planning

The complete project runs in joint co-operation with the project group. All elaborated documents are collected and archived to generate medium-term and long-term valid guidelines for the GIS implementation in Rheinland-Pfalz, Germany.

6.2 System Analysis - Field Research and Analysis

The practical field work was done at the local authority of Bernkastel-Wittlich acting as the pilot authority. The whole administration unit consists of 20 departments. Like in a production environment, the work results of administration offices can be labelled with the term 'products'. Every department is responsible for a specific list of such 'products'. The field research bases upon the 'products' as its principal unit. The reasons for that decision are:

- The meaning of the term 'product' is well established and well understood by the potential users in all offices.
- Project results obtained for 'products' can be easily transferred to the other 23 local authorities.
- 'Products' are well suited to prove the GIS application potential to the political decision level (e.g., district administrators).

Altogether about 170 different 'products' were identified. 'Products' for example are:

- Tourism — support of tourism in the region
- Building administration — management of the buildings owned by the authority
- Finances — bank credits, safeguard credits, financial statistics
- Roadwork — to ensure save roads
- Traffics — organisation of school buses, public traffic
- Heavy loads — control of heavy loads crossing the region

–	Infection prevention	avoidance of infectious illnesses
–	Land use regulation	control of land use in the region
–	Landscape architecture	to guarantee for a feasible development of cities and villages
–	Protection of species	protection of wildlife habitats
–	Drinking water control	to guarantee for the quality of drinking water
–	Agrarian subsidy	to distribute special subsidies for farmers

To analyse the user requirements for all 'products' a two-step questionnaire was developed. Questionnaire A was developed to generate a general overview about all 'products' by collecting answers to a list of questions (see Table 2).

- What is the purpose of the product?	- Is it possible to support this product by a GIS application?
- Which data are in use ?	- Is it possible to use the geo-spatial basic data provided by LVermGeo ?
- How is the spatial data reference defined?	- Which other authorities profit from the results?
- Which software will be established ?	- How many people access the data ?
- Which formats will be used ?	- Are there any special problems to be observed?
- Is a GIS / Online-GIS already in use?	

Table 2: Questionnaire A, overview of contents

After survey completion all products were classified to identify their overall GIS potential (see Table 2).

Evaluation category	Number of products	Percentage
1	**8**	**5 %**
2	**8**	**5 %**
3	**134**	**77 %**
4	**3**	**2 %**
5	**19**	**11 %**
Sum of 'products':	**172**	**100 %**
Evaluation category 1	own spatial data processing – GIS applications already in use	
Evaluation category 2	own spatial data processing – user-potential clearly identified – highest priority for GIS implementation	
Evaluation category 3	own spatial data processing – GIS implementation priority to be defined after the cost-benefit-analysis	
Evaluation category 4	no own spatial data processing – only results from other GIS users to be used	
Evaluation category 5	no own spatial data processing – only administration procedures, no GIS benefit	

Table 3: Results of general product evaluation

As a result of this survey, most of the 'products' ended up in category 3. That means that the application of GIS theoretically would be possible in most cases. However, before investing financial and personal resources the feasibility of such a GIS application has to be checked for those products to guarantee a reasonable cost/benefit ratio (see next section). The next step was to develop the more detailed Questionnaire B for all products in the evaluation categories 1 till 3. The Questionnaire B was only applied to the products in categories 1 to 3, because only these 'products' have their own GIS potential, thus reducing the amount of exploration work for many project participants. Questionnaire B is dedicated to gather more in-depth information concerning data structures (Table 4).

-	Notation of the data	-	Have the data for the same subject to be maintained with different time validity (historical data)?
-	How many analogue, how many digital data are available?	-	Which metadata are involved ?
-	Is it graphic or alphanumeric data ?	-	How good is the data availability ?
-	Where does the data come from, who is the producer ?	-	Are there any synergy effects with other products?
-	How accurate are the spatial data ?	-	Which is the data protection / privacy policy?
-	Are there any regular data updates ?		

Table 4: Questionnaire B, overview of contents

The questionnaire was filled by a GIS expert performing personal interviews with the professionals who produce the products. Thanks to the fact that the interviewed persons had joined a presentation about GIS at the beginning of the project, they knew what a geo information system (GIS) could do for them, which helped to speed up the interview process. General information concerning the IT infrastructure was gathered directly from the IT department. Some interesting information which is still missing like currently available skills of the potential users, for instance, will be collected in a later project phase. Following the principal work plan the results were presented to the project steering committee (see Figure 3), passed the audit and, after that, was presented to the GIS plenum to disseminate the information among all potential users all over the Land Rheinland-Pfalz.

6.3 System Analysis - Conceptional Modelling, Professional Concept, IT-Concept

Commercial systems are available to meet the needs of a public administration institution, in general. That is why the aim of the project was to develop a specification rather than a software package. The work concentrated strictly to the definition of the specific needs of the organisation under consideration. The final software solution should be defined in close co-operation with an experienced software system provider. The work specifically done for the pilot authority mainly focuses on the conceptional modelling step resulting in a detailed requirements specification. Actually, the professional concept mainly follows the current workflow. Its further development will be left to future project stages. The main decision concerning the overall IT strategy was to hold all data owned by the district administration office itself in house rather than to rely on an external service provider. The user requirements for all products for which a high or medium benefit potential of spatial data processing capabilities was identified (see next section) were collected in a comprehensive document consisting of the complete set of specifications. A formalised presentation method was used, namely the graphical needs presentation in the form of use case diagrams, one for each product (see Figure 4). The formal description language UML provides for the tools to generate such diagrams. The Object Management Group (OMG), a not-for-profit computer industry specifications consortium, provides for free download of many modeling specifications, the most-used of which is the Unified Modeling Language™ - UML (UML, 2006). The OMG members define and maintain the UML specification which is published in the form of documents available for free download. The UML has become an industry standard to specify, to visualise, to construct, and to document the artefacts of models for software-systems, business-models and other non-software-systems. The following reasons why to use UML in this project were identified.

- Relations between actors and use cases can be shown.
- Relations between different use cases can be shown.
- When modelling the system one can follow an object-oriented approach.
- UML is in use in a new conceptual model for the German geospatial basic-data.
- UML helps to structure the problem.
- UML helps to generate the documentation.
- UML helps to prepare for the functional specifications.

As the main diagram class, we used the use case diagram class, which shows the relations in an easily understandable way. Use case diagrams, therefore, are very well suited to link the users point of view on the one hand to the needs of the precise IT specification on the other hand. Figure 4 shows the requirement specification for the product 'Danger precaution' which is one of the services delivered by the administration office under consideration. The graph makes clear which data sets have to be accessed in which way to produce the desired results.

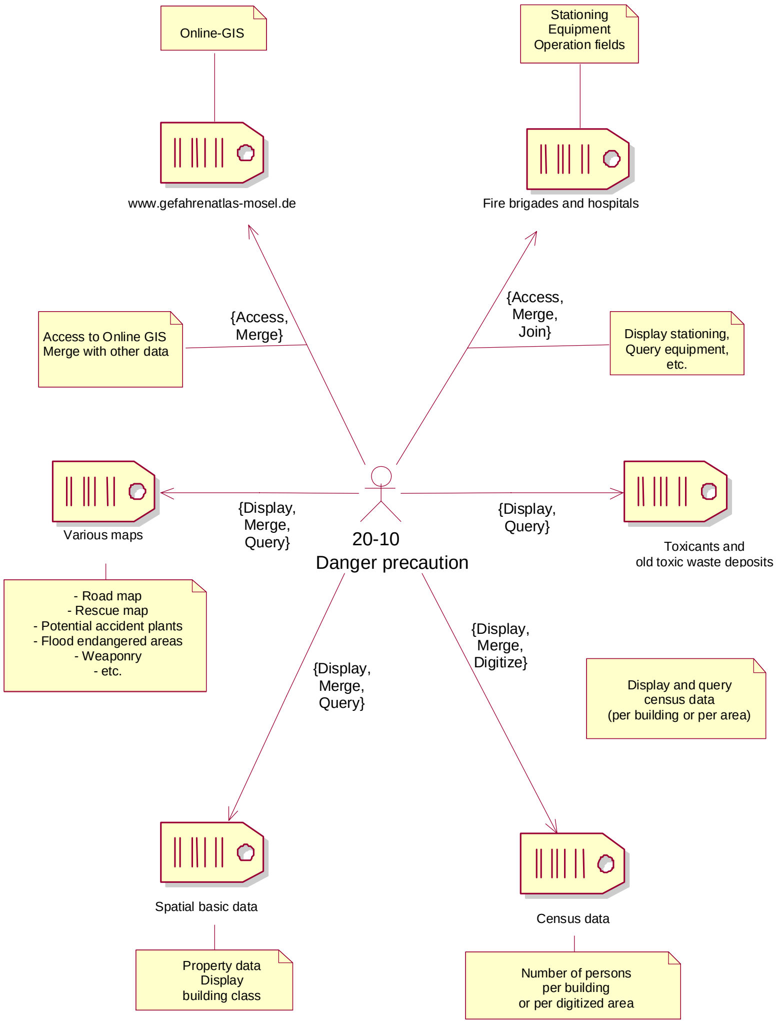

Figure 4: Use-case diagram for the public service product 'Danger precaution'

6.4 System Analysis – Cost Benefit Analysis

To keep the efforts for cost benefit investigation at a reasonable level no detailed analysis was performed. Instead of that the benefit potential of the identified subset of service products was ranked (see Figure 5). The purpose of this ranking is to provide for a list of priorities for the GIS implementation: highly ranked products should be supported by GIS capabilities first. Even if the chosen simple ranking method does not consider any possible synergies between different products leading to a potentially changed ranking list, it helps to support management decisions concerning the stepwise introduction of GIS technology in the whole administration unit. Figure 5 shows the results for a subset of 147 products, which means for 85% of all 170 products. As can be seen for about 30% of the investigated products the use of GIS promises a high profit in terms of the ranking of the benefit potential.

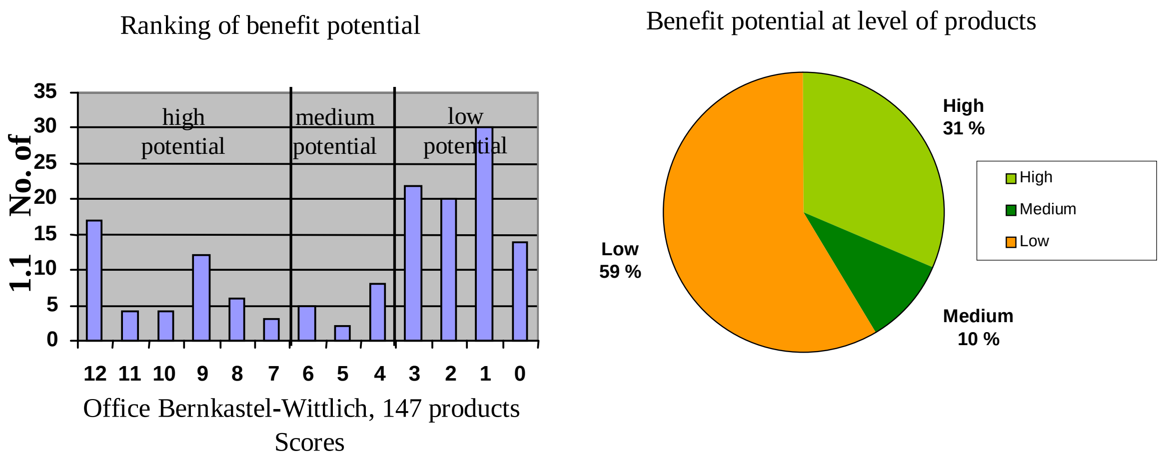

Figure 5: GIS benefit potential, district administration office

6.5 System Selection – Public Tender, Offer Rating, Functional Tests, System Rating and Recommendation

The tender procedure was performed according to the provided German regulations. To guarantee for a correct result of the rating procedure a catalogue comprising a large set of decision criteria was developed. Based on the content of this catalogue all offers of system vendors were ranked. The ranking list served as input for the final resolution of the political committee deciding on which software system seller to award the contract. The resolution passed in November 2005.

7. PILOT APPLICATIONS

To prove the feasibility of the concept, in their diploma work two students developed a GIS supported workflow for several selected products. This work took place before the overall system was implemented. The produced digital data and workflow results were used in the system selection process as input data for the tests to be passed by potential software providers.

In that way it was possible to define the test procedures in an early stage by using real data and realistic workflow. This procedure was of great help to get a safe base for the decision which of the offered systems to select. Figure 6 shows two graphs supporting the planning process for a wind power plant. The left-hand image shows the formally protected areas to be considered in the planning process. Visualised digital orthophotos in the background help to get the orientation in space. The right-hand image shows the surrounding area taken from the development plan of the Land Rheinland-Pfalz which has to be considered in the planning process, as well.

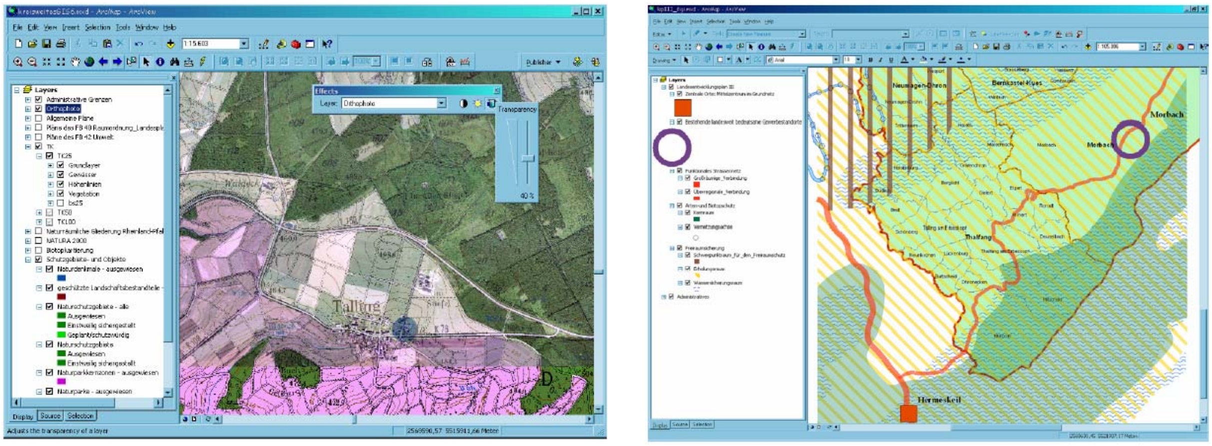

Figure 6: GIS pilot applications, district administration office
(Source: Brück, C., Orth, A., diploma thesis, Mainz, 2005, unpublished)

8. UPCOMING ACTIVITIES

The next stage in the project will comprise the implementation of the selected software system which provides for the needed functionality to manage the available spatial data. A 5 month test phase is planned to be passed by the selected system before the formal system acceptance tests will be performed. In that way for both parties, for system users as well as for the system provider a reasonable time span is available to ensure for the proper system functionality which will be adapted best to the users needs. At the same time a large number of paper maps will have to be transferred into a digital form in order to be processed by the GIS. This task is crucial as well because the large majority of employees use computers only in order to support and to facilitate their daily work rather than being interested in introducing new technologies. That is why such users will only accept a system filled with complete and up to date data sets from the very beginning. Contracts between partners at he regional and the local administration levels are under preparation to perform this work in close co-operation in order to share the costs among several partners involved in the project.

9. CONCLUSIONS

All over the world the construction of powerful SDIs is an item under discussion. When coming to the details, the implementation of a feasible SDI often turns out to be a complex task. Therefore, only a step by step approach following a clearly defined strategy will lead to success. Special credit has to be given to the fact, that all modules created by local implementation processes should fit into the overall concepts of SDI.

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BIOGRAPHICAL NOTES

Hartmut Müller got his diploma and doctoral degree at Karlsruhe University. After 8 years of research he turned into the marketing and software development departments of international enterprises for 6 years. Since 1991 he has been working as a professor at Mainz University of Applied sciences. Since 1998 he has been a member of the board of i3mainz, Institute for Spatial Information and Surveying Technology. In the DVW – German Association of Geodesy, Geoinformation and Land Management he is the chair of working group 2 -Geoinformation and Geodata Management.

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