INVISIP: Establishment of a Context Repository to Support the Site Planning Process

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Abstract: The EU-funded project INVISIP[1] aims to create a framework to support all involved parties in the site planning process: Municipal authorities and departments, planning offices, data suppliers and citizens. This paper describes the INVISIP approach, global aims and objectives as well as the current state of the project. Here, from the technical point of view first results achieved within the analysis phase of the project have shown different possibilities to enhance data mining and visualization tasks by information visualization techniques using metadata and familiar metaphors. On the other hand, from the application-driven point of view the necessity to establish an integrated framework for the site planning process providing not only data handling techniques but also context information concerning the workflow, tasks and objectives within the different site planning phases, is an important result of the case studies within the four INVISIP partner countries (Germany, Italy, Sweden and Poland). Concerning this issue, the establishment of a context repository and its usage within the proposed INVISIP architecture and the application scenario (site planning of a shopping center in a suburban area) will be discussed in detail.

Keywords: INVISIP; site planning; environmental geodata; metadata; information access

1. INTRODUCTION

A lot of persons and institutions are involved in the site planning process; each having a range of tasks. Usually municipal authorities initiate a project and determine global aims and tasks, engineers analyze different aspects and develop corresponding reports such as environmental and geological surveys or traffic and marketing-oriented reports. Finally, different plans are generated and presented to the public, before decision makers officially initiate the realization of the planned site.

Figure 1 illustrates the multi-step site planning process. Here, in addition to the central question *"Which is the best location to place an industrial estate or a new shopping center?"* further typical issues and tasks arise concerning the location of necessary data and maps, data integration and analysis aspects as well as juridical aspects such as laws and guidelines which have to be taken into account during the different planning steps.

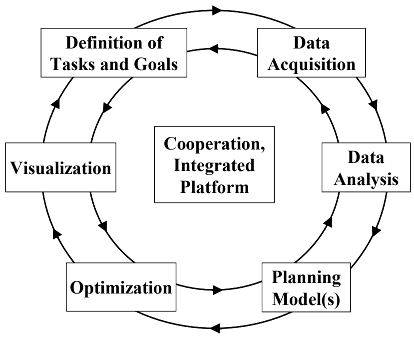

Figure 1. Workflow of Site Planning.

Existing approaches cover individual aspects and provide monolithic solutions to access data (e.g. metadata information systems for geodata, see [Göbel and Jasnoch, 2001a]), to analyze data (e.g. various visual data mining and analysis tools), to generate environmental or traffic reports or to visualize site plans (e.g. via web-based GIS components), but there are no integrated frameworks providing appropriate interfaces between

[1] INVISIP: Information Visualization in the Site Planning Process, IST-2000-29640 .

the different planning steps and corresponding software components.

The INVISIP approach addresses this lack of usability and aims to create an integrated framework combining the different monolithic approaches. This enables users (primarily planning engineers which are experts within a special application area, e.g. concerning market-oriented, traffic or environmental aspects) to use their local planning tools and to connect to the INVISIP platform providing various retrieval, analysis and integration components as additional instrument to facilitate their daily work. In this (figure 1), the focus is on the planning steps *Data Acquisition*, *Data Analysis* and *Visualization*. Further hints to *Planning Models* and *Optimization* [Tawfik and Fernando, 2001] are provided in an INVISIP context repository, although the project doesn't aim to design a modeling and simulation platform for evaluation and optimization of particular planning models.

Chapter 2 gives on overview of the INVISIP approach, while chapter 3 describes the context repository. In this context, "repository" represents both a database model and a collection of useful links and further information for the site planning process. Further on, the repository is connected to goedata sets and metadata (descriptions of the original geodata sources).

2. INVISIP FRAMEWORK

INVISIP has been initiated as technical project within the EU IST program, key action *"III.4.2 information visualization"* which aims to facilitate information access, data handling and navigation in (sometimes unfamiliar) information spaces.

The proposed technical architecture (see figure 2) is generic in the sense that it can be used in various application fields. However, the actual implementation within the project concentrates on site planning, in particular traffic, infrastructure and environment-related issues are given special attention. The INVISIP architecture consists of three major components: the *metadata browser*, the *analyser* and the *data integration* component. The repository is part of the analyser (*analyser III* – repository) and provides useful information which is taken into account within all other components (figure 2) during the different steps of the site planning process (figure 1).

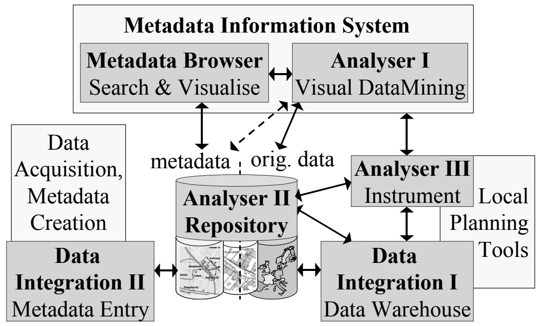

Figure 2. INVISIP framework.

From the technical point of view, the most innovative aspect within the INVISIP approach focuses on the development and usage of information visualization [Card et al., 1999] concepts and mechanisms to improve information retrieval and data mining aspects. Here, based on the infrastructure of the InGeo IC[2] and its theme-overlapping metadata information system for geodata a personalized *metadata browser* (see figure 2) will be established providing search and visualization functionality enhanced by metadata and further 2D/3D information visualization techniques and metaphors such as maps, information landscapes or books and libraries. The metadata browser will help planning engineers to search for appropriate data (e.g. socio-demographic and economic data, geospatial and environmental data) and offers interfaces to the different components of the *analyser* (*analyser I* – visual data mining component, *analyser II* – repository and *analyser III* – analysis instrument).

During the analysis phase of the INVISIP project (which started at 1st of December, 2001) several technical state-of-the-art analyses have underlined the necessity to improve existing metadata information systems with application-driven access variants and information visualization techniques providing visual feedback in all steps during the information retrieval process: Query formulation, search result presentation and query modification [Göbel and Jasnoch, 2000]. Concerning this issue, during the first development phase within the INVISIP project currently SuperTable [Klein et al., 2002] and GeoCrystal [Göbel et al., 2002] are developed as graphic-interactive information and visualization techniques in order to improve search result presentation [Mann and Reiterer, 1999] and comparison of result sets. These concepts and mechanisms will be implemented as Java-Applets

[2] InGeo IC: Information Center of the InGeoForum (Information and Cooperation Forum for Geodata, see http://www.ingeoforum.de).

and integrated into the web-based metadata browser.

From the application driven point of view, the analysis instrument (*analyser III*) represents the core of the INVISIP scenario/architecture. Planning engineers can use the analysis instrument as an add-on for local planning tools and can specify their individual tasks and objectives. For example, engineers looking for cadastral data (street maps, orthophotos) may need additional statistics and socio-demographic data concerning traffic flow in a special area. For this, they can interact with the analysis instrument (*analyser III*), specify their needs and formulate queries to search for appropriate data. Given this query, the analysis instrument contacts the analysis repository (*analyser II*) and looks for relevant application examples. Matching examples (reference applications) are loaded into the instruments in the form of an application profile. These profiles offer well-defined terminology for the application domain and provide useful hints such as application/domain-specific laws and guidelines to be taken into account during the planning process in the different INVISIP partner countries or appropriate (visual) data mining tools [Andrienko and Andrienko, 2000] and algorithms corresponding to necessary geodata (chapter 3 describes further details concerning the structure and functionality of the analysis repository).

Then users interact with the analysis instrument and search for appropriate data using predefined application-specific search terms. These search terms are sent to the (application-specific access variant/mode) search form of the metadata browser and transmitted to the query engine of the theme-overlapping metadata information system for geodata. That information system for geodata provides a semantic network for geodata [Göbel and Jasnoch, 2001b] based on *ISO 19115 geographic information – metadata* as standard to describe geospatial data [ISO, 2002]. Here, the ISO theme codes[3] are settled in the center of the semantic network corresponding to geodata application areas (domains, disciplines). All geodata archives, metadata formats or keywords are related to these thematic terms and are integrated into the network. Thus initial search terms are extended by a lot of relating terms within the same application area, which subsequently increase the probability of locating matching documents and datasets fulfilling the requirements of user tasks and objectives. The search results are presented in the visualization component of the metadata browser providing different views on the search result sets: overview lists, comparison views and detailed views in the form of HTML/XML based metadata sets. Hence, users can decide which datasets fit best and can follow the links of the metadata descriptions to download original (geospatial) datasets.

In the next step, the analyser (in form of the analysis instrument – *analyser III* as control unit of the complete INVISIP approach) offers two interfaces: Firstly there is an interface to the *(visual) data mining* component which provides algorithms and mechanisms to analyse the original data and extract necessary information [Malerba et al., 2001]. Secondly, the interface to the *data integration* component enables users to view original data in a web-based GIS component and combines different datasets required for a concrete site planning scenario. For example, in the context of planning a shopping center in a suburban area, cadastral vector datasets (streets, buildings, lakes, trees, forest, vegetation and protected areas or residual wastes), raster based orthophotos and master plans (some, but not all, countries also provide vector-based master plans.) or any further economic and socio-demographic geospatial referenced data could be integrated within different layers of the data integration component using data warehouse functionality. Simultaneously this data integration component could be used as a GIS viewer to present preliminary site plans to the public. Thus interested citizens can look at it and (depending on local and national laws/guidelines concerning site planning) influence further planning and realization aspects, by, for example, raising an objection.

Apart from the technical and application driven point of views, there is a supplemental third aspect within the INVISIP scenario which targets the data and the establishment of appropriate infrastructure to handle that geodata and metadata. Case studies in the partner countries have shown the necessity to provide adequate concepts and mechanisms to create appropriate metadata and to deal with these data with regard to information retrieval and data mining aspects. In Germany recently a lot of effort has been spent on the establishment of metadata infrastructures, including metadata information systems, metadata entry tools, and web portals to geodata. In Italy and Sweden there are only some metadata available, although these do not conform to a metadata format or standard such as UDK, CSDGM (FGDC format) or ISO 19115. In Poland no metadata currently exist, although there are some prospects as it moves to EU accession [Steinborn, 2001]. Therefore the *metadata entry*

[3] ISO theme codes: Classification of geodata application areas/disciplines.

tool of the data integration component enables data suppliers (such as the townships of Wiesbaden in Germany and Genova in Italy, as INVISIP partners) to describe original geodata and integrate the generated metadata into the semantic network of the metadata information system. Further on, this tool will provide application-specific templates (e.g. site planning) and (XML-based) interfaces which will enable users to communicate with other metadata servers or information systems such as the virtual environmental data catalogue in Germany and Austria or GELOS (Global Environment Information Locator Service) and EIONET (European Environment Information and Observation Network) on a European basis.

After finishing the case studies and specifying the architectural concepts of the INVISIP approach the next steps are focused on development aspects concerning the three main INVISIP components: *analyser*, *metadata browser* and *data integration* component (figure 2). First demonstrators will be available at the end of 2002, most of them publicly available on the INVISIP website, see http://www.invisip.de. A preliminary version of a web-based interface to the repository will be available at June, 2002. Thus, both INVISIP project partners and interested users can have a look at the different categories of links provided by the analysis repository. Further on, each user will be able to ask for a registered user account and so get privileges to insert new entries into the repository. Hence (if possible), the INVISIP team will establish some kind of user group/community for site planning.

3. REPOSITORY FOR SITE PLANNING

In addition to the basic INVISIP infrastructure (metadata information system, semantic network for geodata) and the main INVISIP components (metadata browser, analyser, data integration) described in the previous chapter, the analysis repository is the application-driven part of the INVISIP approach that especially supports users in their planning tasks by providing laws, guidelines, tools or examples of relevant case studies. From the planners point of view the following aspects and geodata types (for example topographical, environmental, demographical) should be taken into account in order to make a well informed decision where to place a planning object. Referring to these issues, questions about economical as well as physical location factors have to be considered in the multi-phase planning process, e.g.:

- Output-oriented: Is there a sales potential in the region? Does competition exist between another supermarket/shopping center in the trading area?
- Input-oriented: Factor includes questions about the cost of planning objects, the source of labour, the delivery of stocks, the infrastructure, the availibility of utilities and logistic service providers.
- Legally-oriented: Which land use does the zoning plan regulate regarding the future development? Are there any legal restrictions concerning the environment?
- Environmental-oriented: This aspect includes questions about the topography, geology, hydrology, climatology, noise emission, the past using of the site, pollution of water and air and the biodiversity of the biota.

For generating a report of potential sites and site plans these respective questions have to be answered. For the decision making process, economical, socio-demographical, legal and topographical data and information are commonly needed [Nattenberg, 2001]. Concerning the economic consideration factors, data such as customer request and behaviour, total purchasing power, potential volume of the sales, economic structure of the region, effects of synergy, worth of labour, trade income tax and leases, zoning plan and legal restricions are important. Regarding the infrastructure, the planner should have information about the availibility of parking and the access of personal and public transportation [Spiller, 2001]. Topographical data could be the quality of soil, the hydrological cycle, ground pollution and the relief of the site.

An important factor for a further evaluation of the potential site is the compliance with formalities and laws (e.g. BauGB and BauNVO[4]). For furnishing an environmental opinion the biodiversity of the biota, nature reserves as well as regional planning principles, the zoning plan and building laws (e.g. master-plan or urban land-use plan) should be considered.

The repository provides the possibility to store all this information, as shown in figure 3 (structure of the database model for the analysis repository). From the technical point of view, the repository is connected to both the metadata base of the INVISIP metadata information system, which is based on the ISO standard 19115 geographic

[4] BauGB (Building Code of Law) and BauNVO (Land Use Ordinance) are examples for actual laws and guidelines in Germany.

information – metadata, and the address database as a separate part of the metadata base. These connections indicate semantic relationships between meta datasets representing original data which is necessary in the site planning application scenario and additional information (within the repository) such as laws, guidelines, tools, links as well as relationships to various parties involved in the different planning steps, e.g. municipal authorities, planning engineers or data suppliers.

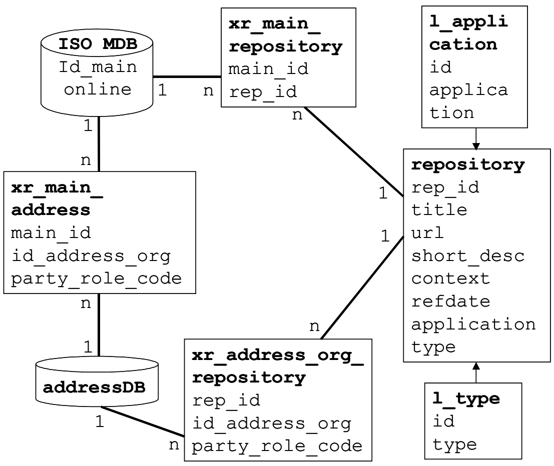

Figure 3. Entity relationship diagram for the analysis repository of the INVISIP database.

The core of the database model for the analysis repository is represented by the *repository* table, providing *a title, an URL, a short* description, a reference date and a comprehensive text field for different types of information for the various application areas. The title, URL and short description are used as brief summary to dynamically generate web-based reports (HTML pages), while the reference date and the long description are supplementary fields to support document management and administration tasks of the analysis repository. *Type* and *application* represent attributed fields, which domain values are dynamically loaded from the two additional tables *l_application* and *l_type*. Possible values for application areas are *"site planning"*, *"real estates"*, *"environment"*, *"traffic information"* or *"residual wastes"*. Typical representatives for types of repository entries are *"Application and Data"* providing information to relevant site planning scenarios and workflows, maps and data (e.g. cartography, economics, environmental protection and nature conservation, sociology, statistics, survey sciences or vegetation) and *"Tools"* providing information to (freely available) GIS ware, guidelines and laws, terms and terminology (buzzwords, thesauri such as the UDK-thesaurus or GEMET as multilingual thesaurus for environmental data or lexical and translation tools). These lists are not static and could be dynamically extended by the administrator of the INVISIP database. Besides, these lists facilitate the usage of information retrieval techniques to find documents and datasets, stored in the repository.

4. CONCLUSIONS

This paper describes the INVISIP approach as an EU-funded project to support users in the multi-step process of site planning.

From the technical point of view, INVISIP is focused on the establishment of a personalized metadata browser as a graphic-interactive user interface of a metadata based infrastructure for geodata (providing a semantic network and a query engine for the different geodata application areas/disciplines). A metadata entry tool enables data suppliers to describe their original data and to integrate it into the INVISIP framework. The browser enables users (e.g. planning engineers) to find appropriate data for their concrete tasks and objectives within theme-specific application scenarios such as site planning of a shopping center. Here, information visualization techniques are used to improve search and analysis tasks, and to facilitate the decision-making process where to place a site.

On the other hand, from the application-driven point of view, special access variants for application areas such as site planning will be established within the INVISIP approach. Here, an analysis instrument leads users through the multi-step planning process and provides interfaces to the different INVISIP components: A metadata browser to locate data, a (visual) data mining component to analyse data, and a data integration component to visualize various datasets which are necessary within the planning process in order to produce site plans (planning models). The analysis instrument, as a central component of the application, is connected to an analysis repository providing additional useful information which should be taken into account within the different steps of the multi-phase site planning process.

Future work of the INVISIP project will be investigated to provide enhanced application-oriented access variants of the metadata browser using different information visualization techniques such as metaphors or spatial landscapes. Another main stream targets the development of the analysis instrument taking into account the results of the case studies of the different INVISIP partner countries (e.g. concerning the site planning workflow, existing laws and guidelines or available tools such as GIS software, analysis tools or additional documents referring to reference models). Finally, a multilingual metadata entry tool will be developed based on the ISO metadata standard to describe original data. Further on, different environments for testing purposes will be established. These feasibility and usability tests will be public available at the INVISIP website, see http://www.invisip.de.

Altogether INVISIP will provide a technical platform as an aid to facilitate information access and data handling for the site planning process (time-saving, intuitive analysis): Geodata suppliers such as public agencies can use the metadata entry tool to describe data. Planning engineers can use the analysis and metadata browsing components to search for appropriate data and to facilitate their daily work. Decision makers such as local authorities can use the different components – especially the web-based viewer as part of the data integration component- to evaluate planning concepts and results. Other users such as citizens could also use these tools in order to get an idea about site planning, the existence of multi-faceted geodata and its potential use in various application areas.

The INVISIP goals are not to replace human beings in the site planning process, but to support them.

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