The SDI^{light} OSGEO stack at ITC

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1 Introduction

The term Spatial Data Infrastructure (SDI) usually involves large regional or national spatial data warehouses, being developed using high-end geospatial software solutions and large corporate databases. The principles of SDI can be applied in simple and cost–effective ways just as well. Such an SDI^{light} approach is of particular interest to students, partners and clients of ITC, an institute that aims at capacity building and institutional development specifically in developing countries. At ITC, students and staff work with and build geo–webservices and –clients using an SDI software stack that is built out of free and open source components, which we are calling the **SDI^{light} OSGEO stack**. The set up of this software stack varies based on changing demands and developments, but its core components are:

- *A spatial database back–end* that stores the geometry and the attribute data: PostgreSQL with the PostGIS extension.
- A set of *interoperable middle ware web applications* that interface with the data back end and with each other, and fulfil tasks such as delivering maps for visualisation purposes or providing data and processing services. We use existing open source solutions, mainly *MapServer* and *GeoServer*, and we develop our own components, mostly in Java, using Apache Tomcat for deployment.
- Simple (thin) *browser-based clients* enabling access to the maps and data. We mainly use the *OpenLayers* API to develop these.
- Thick clients: We use *QuantumGIS* for map viewing and editing as well as our own *ILWIS* open source GIS software.

In the paper we first focus on how this stack is used in *education*. Next we describe how the OSGEO stack is part of the MSc and other *research*, where we use it both as a tool for prototyping and as a subject of research itself. Furthermore, we explain how ITC is actively engaged in the *development* of OSGEO components in the larger framework of the 52^{o} North Initiative. Finally, we show how we use the stack in our *project services*.

2 The OSGEO stack in education

ITC is first and foremost an international *educational* institute. The majority of the students come from developing countries, and they have a keen interest in OS solutions. Certainly in the geo–webservices field, the available OS solutions can compete in serious bussiness with proprietary software and in many cases fit our students' needs best. There are of course also curriculum parts where proprietary software is better suited, for example in professional digital photogrammetry and for certain end–user applications. To make sure the two worlds can be integrated as much as possible, we emphasise the use of OGC and other Open Standards in all our teaching and practicals.

Courses in all levels (MSc, Master and Diploma degrees) of the Geo–Informatics field now include a module in which students learn how to set up a MapServer that serves WMS and WFS. They use those services in existing clients (QuantumGIS and ESRI's ArcMap), but also develop their own web–clients using the OpenLayers API [6].

Spatial database theory and implementation platforms are a natural domain to be taught in a course in Geoinformatics. Students need to understand database technology from its declarative side, from its optimization side, and from its data management side. Certainly so with geospatial data. As platform, the PostGIS extension [9] to the object-relational DBMS PostgreSQL is then a most logical choice. First, because PostgreSQL is a rock-solid DBMS that is easy enough to start with, yet wonderfully appropriate for advanced database applications, and its documentation is really transparent [8]. PostGIS in addition, is the best open standards implementation of spatial vector management, and enjoys a lively and supportive user/developer community. The combination of the two (2PG) is enjoying an ever-growing user base, also in the domain of serious industrial applications.

3 The OSGEO stack in research

The OSGEO stack is also part of the MSc and other research, where we use it both as a tool for prototyping and as a subject of research itself.

An example of the former is *TimeMapper* [1], a proof–of–concept for online dissemination of spatial–temporal information. The novelty and interest of the TimeMapper project is that it generates "on the fly" interactive and animated vector maps from spatial databases, for use on the internet. The present prototype (as seen in figure 1) was developed for the exploration of moving object dynamics of Antarctic Icebergs.

The 2PG platform (see above) is a home base for some of the project work of our Master and MSc students. In the past, students worked on moving object database applications and SDI software stacks involving 2PG, amongst others, while more recently a student worked on an extension for TIN support, and another studied extending PostGIS with raster support. Both were successful projects, although the latter did not result in such an extension proper, as another solution to the problem domain, using INPE's TerraLib [7], was found to be more useful. Currently, we have students working on problems in the domains of dynamic routing and fleet management, TIN extension revisited, and also in SDI software stack design using 2PG with web frameworks like Django and GeoDjango.

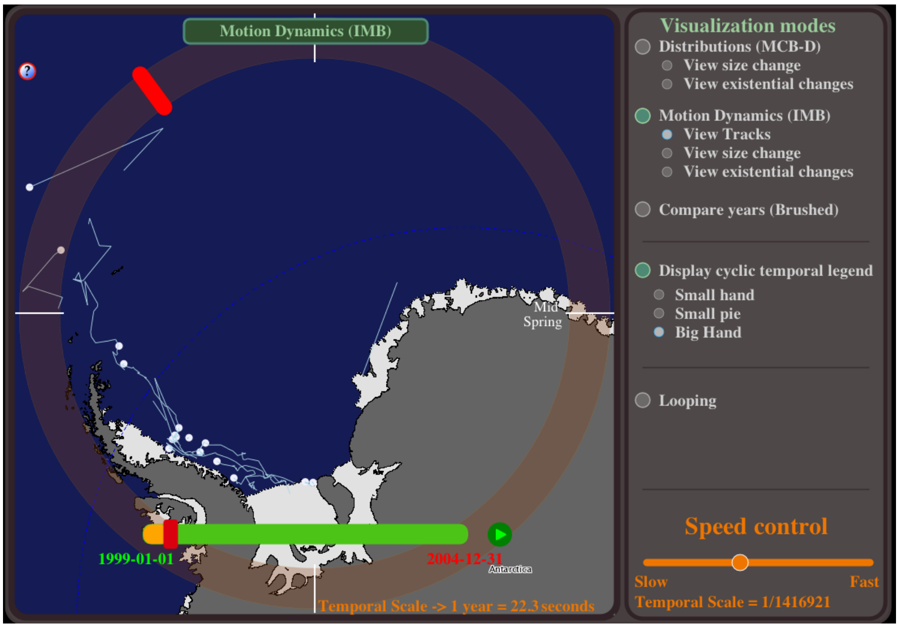

Fig. 1. Prototype of interactive SMIL animation of 19 icebergs in the Weddel Sea (Antarctica) from January 1, 1999 to December 31, 2004. The animation application offers various modes of animation. The currently selected one is 'Motion Dynamics', which shows not only measured positions (actually in the data), but also interpolates intermediate positions and shows the interpolated tracks. Interactive original can be loaded from [1].

4 Development of OSGEO components

As can be expected in research in a technology–oriented group, it often includes development of OSGEO components. Next to the sometimes fragmented work in various research efforts, we also participate actively in *52^o North*, an international research and development company whose mission is to promote the conception, development and application of free open source geo–software for research, education, training and practical use [2].

Since 2007, the development of ITC's ILWIS framework is done in the context of 52^o North. ILWIS is the Integrated Land and Water Information System [3], a PC-based GIS & Remote Sensing software. It comprises a complete package of image processing, spatial analysis and digital mapping. It is easy to learn and use, has full on–line help, extensive tutorials for direct use in courses and 25 case studies of various disciplines. ILWIS has established a wide user community over the years of its development. The core objective of the current ILWIS Open source project is to gradually provide a maintainable framework for researchers and software developers to implement up–to–date training components, scientific toolboxes and (web–)service implementations used in student projects, research and consulting projects.

Recent project efforts have migrated ILWIS into a modular, plug–in based software, and provide web–service support for OGC–based web mapping and processing. In this way, researchers, students and professional users are able to use ILWIS together with other software components seamlessly and extend its functionality relatively easily. This strategy is currently being applied successfully in the dissemination and processing of GEONETCast satellite imagery, as part of the emerging Global Earth Observation System of Systems (GEOSS), and for example in using ILWIS as client application for WMS and PostGIS data base access. Currently, we are embarking on making ILWIS functionality available through OGC WPS. We see such modular setup as a viable mechanism for anticipating on the continuously changing demands for GI-technology.

Furthermore we are active in 52^o North's *Geoprocessing Community*. An overview of the activities of the Geoprocessing Community is given in figure 2. In particular, the community aims at establishing a web service platform for orchestrating and executing geo–processes, as well as incorporating GRID technology and spatio–temporal data analysis. The developed platform provides sophisticated communication mechanisms and reflects established work on standards, such as the OGC Web Processing Service (WPS). To ensure the sustainablity of the platform, the Geoprocessing Community also addresses the integration with existing systems. Examples are Sextante (`http://www.sextantegis.com/`), GRASS (`http://grass.itc.it/`) and of course ILWIS. In the longer term, the community also strives for closer cooperation with the other communities of 52^o North (such as Sensor Web Enablement, Security and again ILWIS).

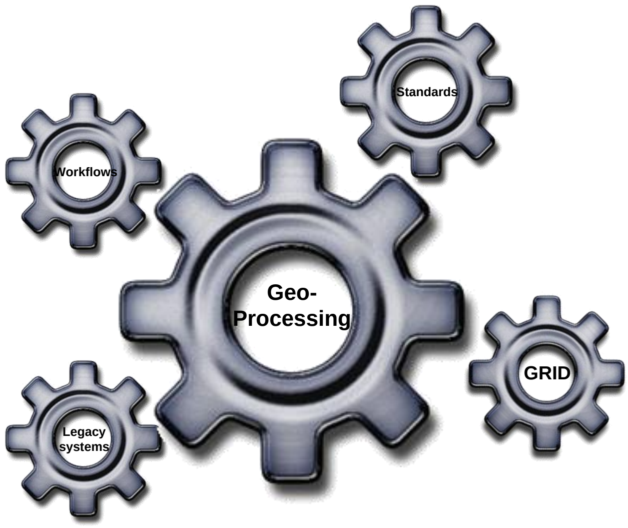

Fig. 2. Overview of the geoprocessing community of 52^o North.

5 The OSGEO stack in projects

One of the benefits of the stack is its direct applicability during the execution of project services. Clients are keen to see an implementation of the ideas that we bring to the table as an approach to address their needs. The software

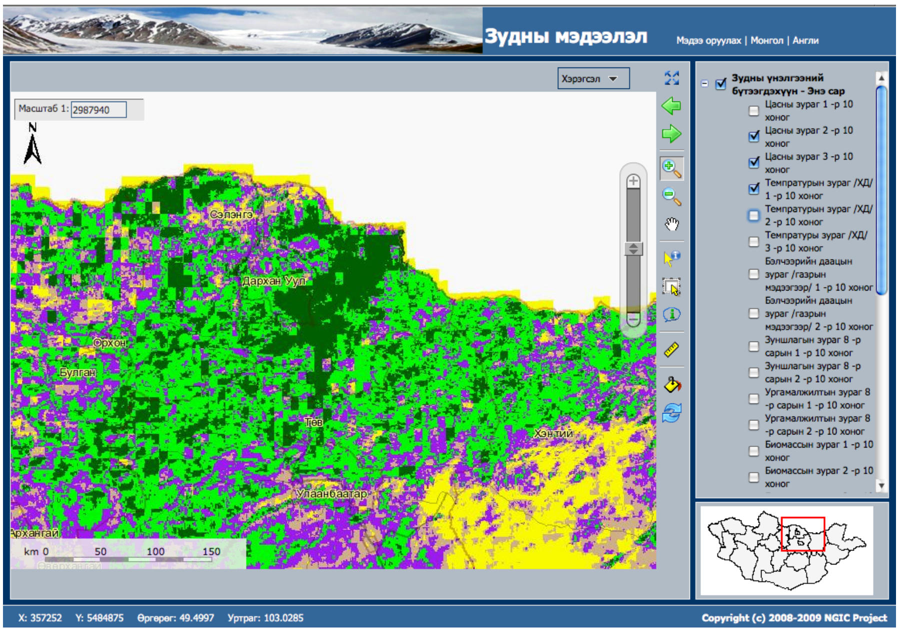

Fig. 3. Screendump of the *Zhud* management application (from [5]).

stack allows for such rapid prototyping, where implementations are developed at very early stages of a project, enabling clients to better define their interests, and also allowing us to better fit the technology to the situation.

Various examples of this scenario exist. One was a EU-funded project for establishing a *virtual museum* [4] for the Melka Kunture archaeological site in Ethiopia. For this we used the OSGEO stack to store the data of close to 50,000 archeological artefacts and make them accessible in the maps and info panels of the virtual museum on the Web.

Most recently we took part in a large project in Mongolia, called "The National Geoinformation Centre for Natural Resource Management". The project was jointly implemented by the Ministry of Nature, Environment and Tourism of Mongolia and the Ministry of Development Cooperation of the Dutch Government. The overall objective of the project is to support environmental policy and decision–making processes and to contribute to the sustainable development of Mongolia. The focus here was twofold: First the strengthening of the capacity of the agencies responsible for the generation, management and dissemination of environmental data. Secondly, enhancing the capacity of local governments to exploit such data resources to support their decision making processes.

First a unified Natural-Environmental data model was defined, to be used by the agencies involved in the generation of such data. The second step was the implementation of basic services based on the OSGEO stack in each of these agencies. Next was the design of applications on top of the existing services. These applications were tailor made for local (*Sum*) and provincial (*Aimag*) level governments. As a starting point, three important applications where developed [see figure 3 and url 5, for examples]: Fire Management, Drought Management and Managment of *Zhud*, a specific Mongolian word for a collection of natural hazards. Each of these applications consumes services from various data providers and interactively produces map–like views of critical situations in the field. These map-like views follow two presentation schemes, one for the screen and one for paper such that maps can be easily faxed to different locations. A national metadata profile was also produced as a result of this project.

6 Conclusion

In recent years, the OSGEO stack has become an integral part of geo–informatics teaching, research and projects at ITC. We feel the quality and flexibility of current OSGEO applications, especially in the back–end and services layers, provide to ITC students and staff a viable way of implementing geo–webservice components in a simple, stable and cost–effective setup that we deservedly can call SDI^{light} . . .

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