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A WebGIS Data Retrieval System for Use in Environmental Monitoring

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Abstract

One of the most demanding challenges in science and society today is to manage the enormous amount of information and data collected, e.g. by environmental monitoring networks, every single day. Problems coming up in this context, in general, do not differ from those people were confronted with since ancient times and have to be considered when performing an efficient information exchange: 1. Chosing a durable and commonly accessible data carrier; 2. Chosing a reliable data interpreter; 3. Chosing a universal information language; 4. Preventing data against falsification. Considering this, we have to accelerate efforts in data exchange because the development of the technical environment and the evolution of informatics cause vast amounts of inaccessible or hidden knowledge and information. According to this, a cheap and platform independent system is needed where data can be published quickly, where no special technical background by the user is needed and where user management ensures the data quality. A web-based information system which is filled up with geographical base maps, metadata and measurements is an appropiate technology for realising these standards. This article deals with the implementation of a WebGIS Data retrieval system which is developed for the use in the Long Term Ecological Research Network Germany (LTER-D). This system is used to collect data from different measurement networks and research projects in Germany. The aim is to analyse long term ecological impacts like global warming or forest dieback with integrated data from different environmental monitoring sites distributed over the whole territory of Germany.

1. Introduction

The use of web-based information systems in natural sciences and engineering are increasing rapidly. The range of applications is wide due to the heterogenous requirements of science and economy. Systems designed for the efficient retrieval and the visualisation of empirical data collected expensively in research projects on the one hand or for supporting land use planning and engineering on the other hand are only two major examples of application. In addition, those systems are appropriate vehicles for publishing and illustrating research results and to accomplish legally obligated report duties (in context of the EU-Water Framework Directive, for example). The access to and the documentation of environmental data should be as easy as possible. Therefore it is important to provide an user-friendly interface that could be used without specialized GIS-Software or a deeper understanding in information processing. To control and manage data access an user administration tool has to be implemented that allows to share different levels of information, from the spatial visualisation of monitoring sites and measurements to meta data analysis and up to data retrieval and download by spatial and logical queries.

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2. Methods

The establishment of such a flexible and multifunctional system fulfilling the above mentioned requirements is realised economically and technically best by using platform independent "open source" software components. At first a server programme is needed providing the functionality of a "spatial" communication. Clients send requests to a server to provide them with environmental data having a spatial reference. For this purpose a combination of the UMN Mapserver[3] with the Apache HTTP-Server represents a suitable solution. The UMN Mapserver is capable of reading several data sources like raster and vector data stored in files, databases or integrated into a GIS. With the help of the open source database the management system PostgreSQL[4] in conjunction with the spatial extension PostGIS and the use of the Geometry Engine Open Source (GEOS)[5] a spatial database backend could be build up and combined with metadata or other describing data. Within this backend "simple" GIS functionality such as buffering and intersecting is also provided. More specialised applications could be implemented with a "powerful" GIS-Backend like GRASS (Neteler & Mitasova 2004) (figure 1).

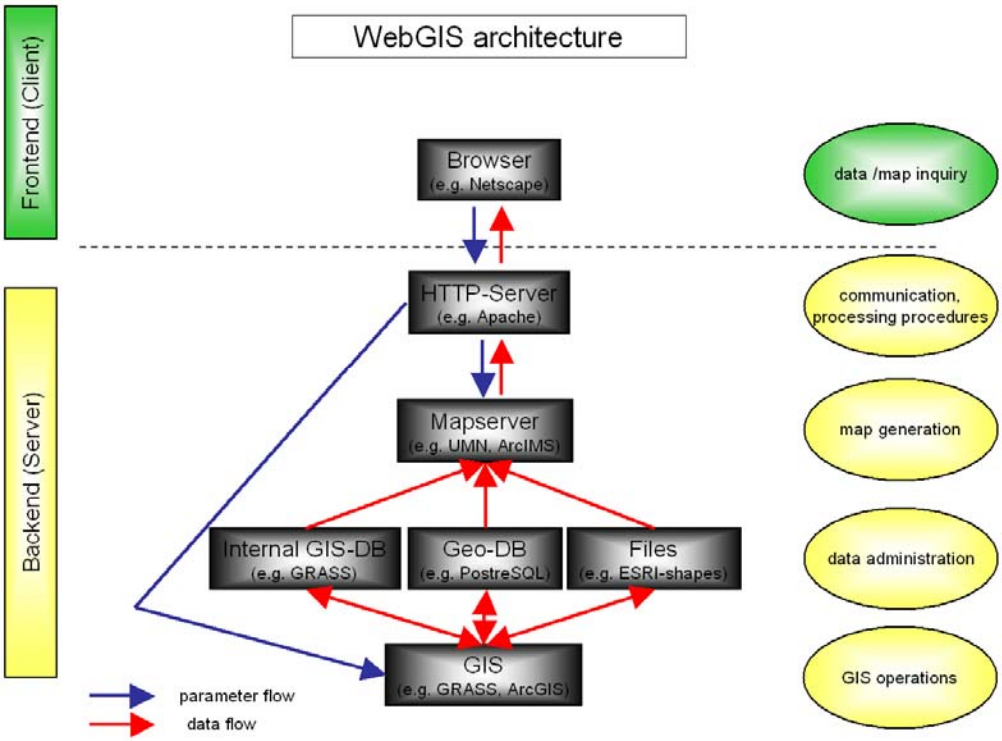

Fig. 1: WebGIS architecture

For collecting metadata that describe the whole bunch of monitored data like measured parameters, intervals and methods of measuring a web-based interface should be implemented that allows standardized data survey and efficient data processing. In this system metadata can be linked directly to the spatial in-

[3] http://mapserver.gis.umn.edu
[4] http://www.postgresql.org
[5] http://geos.refractions.net

formation of the monitoring sites by simultaneous databank use and access. The freeware “PHP-Surveyor” contributed by SourceForge.net offers such functionality and may easily be installed and used even by non-computer scientists (figure 2). For compiling relevant parameters the items of the questionnaire were adjusted to several data collection systems and concepts like GMES (Global System for Monitoring of Environment and Security)[6], GEOSS (Global Earth Observation System of Systems)[7], in gerneral, and MUDAB[8] (Marine Umweltdatenbank) and GOOS[9] (Global Ocean Observing System) for aquatic ecosystems and the so called “Kerndatensatz”for the integrated environmental monitoring in Germany (Mattern et al. 2005; Schröder et al. 2005). For harmonized data retrieval there was also an crosscheck with already established international environmental information systems which are united under the label of ILTER (see below), especially the Chinese Ecosystem Research Network (CERN)[10] and the UK Environmental Change Network (ECN)[11].

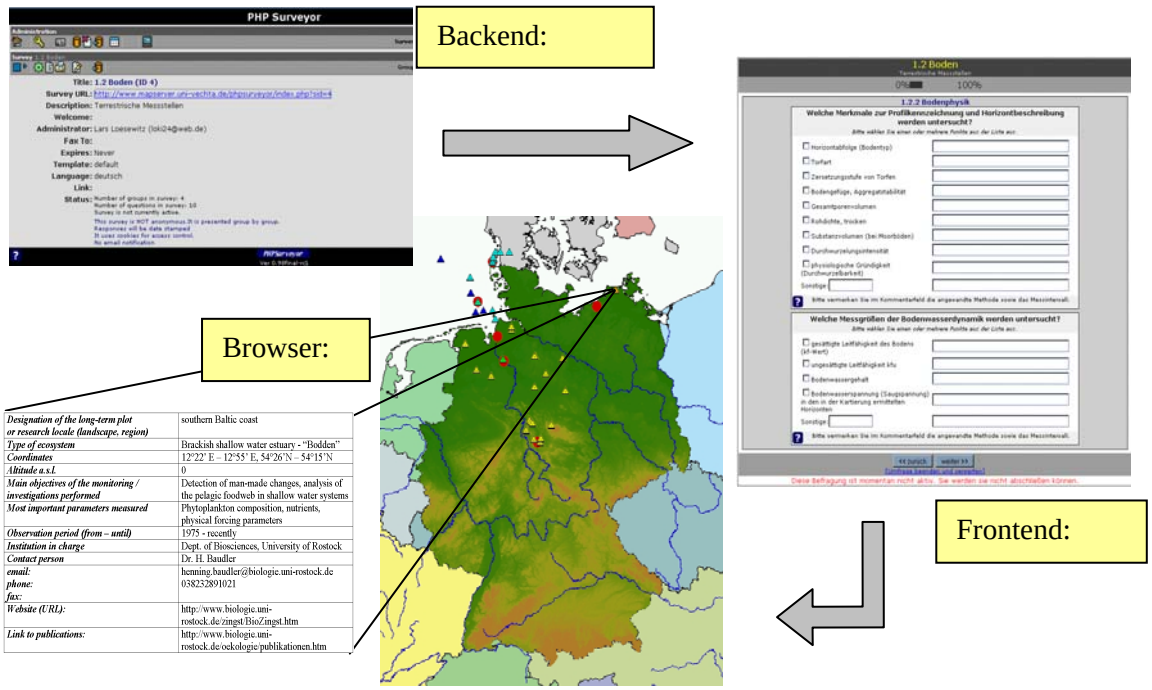

Fig. 2: Online questionaire: Metadata inquiry by PHP Surveyor

[6] http://earth.esa.int/gmes
[7] http://www.epa.gov/geoss
[8] http://www.bsh.de/de/Meeresdaten/Umweltschutz/MUDAB-Datenbank/index.jsp
[9] http://ioc.unesco.org/goos
[10] http://www.cern.ac.cn:8080/index.jsp
[11] http://www.ecn.ac.uk

3. First Results

The above desribed software architecture is tested first for the LTER-D (Long Term Ecological Research Network Germany). This network is part of the International Long Term Ecological Research Network (ILTER)[12] that consists of scientists in more than thirty countries, collectively engaged and dedicated to multi- and interdisciplinary long-term and large spatial scale research and monitoring in ecological science including human dimensions. The mission of this network is "to envelop and effectively deliver to the scientific community, policy makers, and society in general, sound scientific information and predictive understanding of ecological processes associated with large temporal and spatial scales needed to better conserve, protect, and manage ecosystems at local, regional and global scales, their biodiversity, and the services they provide".

Facilitating the access to data describing these long term processes is one major goal in this context. In LTER-D this aim will be realised in three steps of data acquisition. At first short descriptions are collected by filling out consistent templates to get an overview about the main objectives and the spatial distribution of related research studies. In a second step metadata of each monitoring site are surveyed by using an online questionnaire and linked to the respective network geometry in a GIS. At last metadata, measurements and spatial data are publised by using the PostgreSQL databank and the UMN mapserver. Now, according to requirements, it is possible to assemble datasets from different research studies by defining spatial or logical queries and to visualise them directly at the web interface.

4. Main conclusions

Web-based Geographical Information Systems help us to manage, to publish and to share environmental data efficiently and economically. Open source software like the UMN mapserver or GRASS allow the implementation of such systems without intense costs. The access to sensitive data sets can be controlled by user management and the client needs no sophisticated knowledge or equipment. Projected or current studies can be conducted and documented promptly and interactively by using online input masks or questionnaires.

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[12] http://www.ilternet.edu