Development and Application of the WebGIS 'MossMet'

Lukas Kleppin, Winfried Schröder, Roland Pesch, Gunther Schmidt

Lehrstuhl für Landschaftsökologie, Hochschule Vechta, Germany
{lkleppin, wschroeder, rpesch, gschmidt}@iuw.uni-vechta.de

Abstract. Since 1990 'Heavy Metals in Mosses Surveys' are performed every five years in at least 21 European states, including Germany, in order to map spatial and temporal trends of the metal bioaccumulation in terrestrial ecosystems (Rühling et al. 1998, Schröder et al. 2002). The primary data collected in these surveys consist of measurement data on metal accumulation in the mosses, and site-specific metadata to characterize the sampling locations with regard to, e.g., vegetation, elevation or land use. To optimize the data handling for the moss survey 2005, the WebGIS `MossMet` was developed incorporating open source components. Thus, the metadata can be integrated with the information system via internet by the moss samplers. The WebGIS `MossMet` comprehensively documents the metadata, the measurement values and statistically derived metal bioaccumulation. In the German moss survey 2005, the WebGIS `MossMet` was applied routinely and is extended currently to a Europe wide application.

1 BACKGROUND

The use of mosses as biomonitors is a convenient method to determine levels of atmospheric deposition. Since 1990, chosen moss species are used to monitor the atmospheric metal accumulation in Europe every five years. Germany participated in all four moss surveys 1990, 1995, 2000 and 2005. The primary data collected in these surveys consist of measurement data on metal accumulation in the mosses, and site-specific metadata to characterize the sampling locations with regard to, e.g., vegetation, elevation or the distance of the sites to trees and emission sources. All these data are documented in a metadata or sampling protocol. In previous studies, this metadata was used to assess factors influencing the metal bioaccumulation (Pesch and Schröder 2006).

In Germany, the federal states are responsible for the moss collection and the federal government finances the coordination, the chemical analysis and the reporting of the monitoring results. Therefore, in previous surveys up to 10 different moss samplers performed the moss collection including the documentation of the sampling sites characteristics. Until 2000, all monitoring results were stored in ASCII, MS Excel and MS Access data files. In

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the campaign of 2000 all these data files were integrated into the German Moss Monitoring Information System (GEMMIS) relying on commercial software products (Schröder et al. 2002).

To optimize the compilation, quality control and integrated assessment of metadata and measurement data for future moss surveys, a centralized data handling approach is needed. We show that this goal can be achieved by a WebGIS that is entirely based on open source components. Open source products are prescribed to be free of charge and the source code is disclosed and free for modifications in opposite to proprietary software. The WebGIS should comprehensively document all monitoring results from previous surveys as well as additional geo-information on, e.g., related environmental monitoring activities and additional data like such on land use.

2 THE WEBGIS-APPLICATION 'MOSSMET'

The WebGIS-Application 'MossMet' consist of a WebGIS-Application (2.2) and a Metadata-Application (2.3). In the following, the system architecture is explained.

2.1 System Architecture and Software Components

The software components and the system architecture of the WebGIS 'MossMet' are illustrated in Figure 1. The big double-sided arrow named HTTP stands for the communication between the client and the server. The other thin arrows symbolize the data and the parameter flow. A combination of the Apache HTTP-Server with the WebGIS-Client Suite Mapbender, the UMN Mapserver and the database management system PostgreSQL including the spatial extension PostGIS was utilised. Mapbender was used to generate user interfaces on the internet and accomplishes the OGC-standards and OGC–specifications on processing the geodata. It offers various functions such as navigation within maps. To integrate the metadata into the PostgreSQL database, an interface was created using PHP embedded HTML-documents. This part of MossMet is referred to as "application" depicted in Figure 1.

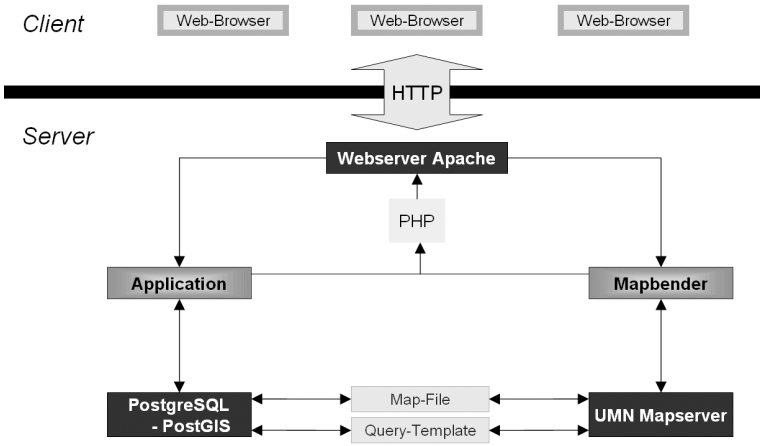

Figure 1: System Architecture and Software Components

2.2 Metadata-Application

The user interface of the web-database as depicted in Figure 2 is composed of three navigation bars. In navigation bar I all functions of the web application can be accessed. The interface of navigation bar II depends on the function chosen in navigation bar I. The Navigation bar III enables the interactive input, output and display of all measurement- and metadata.

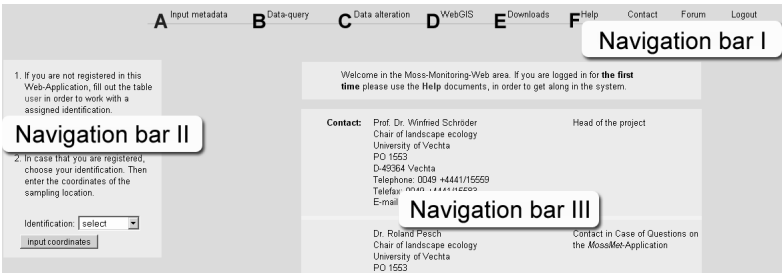

Figure 2: Navigation within the WebGIS `MossMet`

In order to fill out a sampling protocol for an ongoing survey, the section ‘Input metadata’ in navigation bar I must be activated. The following specific functions of the informationsystem were automized: 1. reviewing sampling sites for a possible resampling, 2. giving new titles to sampling sites. The sampling protocoll contains input fields for site-describing characteristics, which are significant in terms of the experimental protocol.

Through section 'Data query' of navigation bar I the PostgreSQL-database can be queried with regard to the chosen criteria. Furthermore, section 'Data alteration' allows changing the digitized metadata. Sections **'**Downloads**'** and **'**Help**'** give access to downloadable information like the monitoring manual or help documents for WebGIS.

2.3 WebGIS-Application

The section 'WebGIS' of the navigation bar I allows entering the WebGIS application which is depicted in Figure 3. A tool bar allows applying basic GIS techniques for instance automatic and interactive zooming or distance measurements. A detailed map shows the respective results with regard to the selected sampling site and its surroundings. The 'Maps & Layers' tool enables the layer-oriented management of all accessible geo-objects. In the checkboxes displayed in Figure 3 each layer can be visualised in the map window (left checkbox) and enabled to be queried (right checkbox).

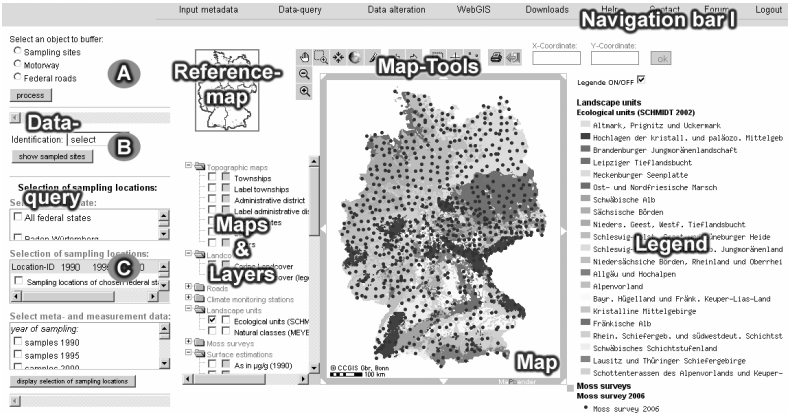

Figure 3: Tools and Display of the WebGIS `MossMet`

In the area referred to as A in the data query section, the user can interactively generate buffers around the sampling sites as well as federal roads and motorways. In this way, it is possible to check automatically whether the requirements of the experimental protocol were met.

In the areas B and C of the data query section all monitoring sites in the database can be searched by criteria of the sampling protocol. The results can be displayed in the map view.

3 OUTLOOK

Referring to users comments on the systems applicability we can conclude that the WebGIS `MossMet` effectively supports the compilation, quality control and integrated assessment of metadata and measurement data. In future surveys the moss samplers should be enabled to use 'MossMet' using mobile computing devices like Personal Digital Assistants (PDA). In this way, a mobile knowledge acquisition and checking system could be provided on the one hand. Furthermore, the finding of adequate monitoring sites could be improved with help of the GIS-routines and the geoinformation accessible through 'MossMet'

With regard to environmental monitoring issues `MossMet` will strengthen the integration of monitoring sites not only within the European moss monitoring but also between different monitoring networks. This is of particular relevance because the poor integration of ecosystem monitoring at the European level causes some overlap of efforts and a lack of harmonized data.

Additional services should be implemented to expand user interoperability in the WebGIS. These instruments should allow interactively operations, e.g., basic GIS procedures like intersecting, buffering, tabulate areas, as well as basic statistical procedures.

References

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