Integrating Open-Source Applications for Spatio-Temporal Data Management in the Environmental Sciences

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Outline

- Background
- Goals
- Data at CRTE - Henri Tudor
- Geospatial data infrastructure
- Meta data management system
- Examples
- Discussion
- Conclusions
- Next steps
An efficient water resource management is a compulsory component of sustainable development.

Management of water supplies and water cycle is reflected in European legislation:
- Urban Waste Water Treatment directive
- Drinking Water directive
- Water Framework directive
- Integrated Pollution Prevention and Control (IPPC) directive
In 2000: Water programme by NSF Luxembourg
- better understanding of the natural water cycle and the evaluation of ways to protect natural water resources

Development and implementation of new management concepts and technologies in a global and national environment

Knowledge of different projects in interdisciplinary fields has to be linked and presented in a comprehensive way to public and stakeholders

Idea of a centralised system to store relevant data
Project Goals

- Improve transfer of knowledge and results of research project in Luxembourg

- Set up of a geospatial data infrastructure (GDI)
  - Make use of open-source to minimize costs and assure interoperability by using open standards
  - Provide a database driven system to make spatio-temporal data available to various users
  - Store spatio-temporal data and associated meta data
  - Data should be accessible with different clients according to the user needs to retrieve and/or further process data
  - Extend the geospatial database to all available environmental data for internal use at Henri Tudor
Data at CRTE Henri Tudor

- Spatio-temporal data in the fields of:
  - Geology
  - Hydrology
  - Meteorology
  - Remote sensing
  - Soil Science
  - Urban water management
  - Renewable energies
  - Noise pollution

- Raster, Vector (polygon, point)
- 2d and in near future 3d
Software chosen

- GDI based on following open-source software

  Ubuntu Linux 7.04 Server

  PostgreSQL & PostGIS, Linux File system

  UMN Mapserver, GDAL/OGR

  GRASS GIS, QGIS, p.mapper, R
GDI Design

**Clients / Desktop**
- View / query data
- Webclients / Browser „GIS-light“ / QGIS, uDIG, etc.
- Provide / analyze data
- Desktop-GIS GRASS, ArcGIS
- Administrate data
- pgAdmin phpPgAdmin

**External Server**
- OGC-Server e.g. WaterGIS
  - WMS WFS

**Intranet / Internet**

**Server**
- Web-Application (CMS)
- Interface / Services
  - ODBC SQL
- UMN Mapserver / OGC-Server
  - WMS WFS WCS

**Geodatabase**
- Filesystem
- PostgreSQL
- PostGIS
  - Raster data
  - Meta data
  - Vector data

**Application Server**
- Applications Models, Statistics

**File Server**
- Data loader
- Data export
User access

- User interfaces to interact with the GDI
- Scalable and adoptable to the user's needs

<table>
<thead>
<tr>
<th>Complexity of user interaction</th>
<th>Access rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple <strong>data browsing</strong> and <strong>visualization</strong></td>
<td>WebGIS Client based on pmapper</td>
</tr>
<tr>
<td><strong>Visualization, advanced browsing/mining</strong> of data and <strong>simple analysis</strong></td>
<td>QGIS, UDIG, Spatial Commander etc.</td>
</tr>
<tr>
<td><strong>Advanced queries and analysis of data, generation of new data sets</strong></td>
<td>GRASS, ArcGIS</td>
</tr>
<tr>
<td><strong>Administration</strong> of database system, <strong>user setup</strong> etc.</td>
<td>pgAdmin, phpPgAdmin</td>
</tr>
</tbody>
</table>
GDI advantages

- No use of proprietary software
  - Platform independent
  - Various clients available for connection
  - Extendible system by adding new modules, plug-ins,...

- Use of standard software products
  - Ongoing development of all software components
  - Updates and upgrades easy to manage via package manager
  - Support of community

- Connectivity to external data services
  - Use of Web Services (WMS, WFS, WCS) of neighbouring countries is important for Luxembourg
Meta data management system

- Meta data
  - „[..] provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographic data.”

- A need for documented datasets to make best use of available data and information
Design - meta data management system

- Core elements of ISO19115 and additional individual fields for CRTE (~50 fields of information)
  - Dataset identification
  - Distribution information
  - Temporal resolution
  - Spatial scale and resolution
  - Error information
  - Other information (e.g. language, encoding, methodology)
  - Extendible to further information if required

- Automated meta data collection from
  - Vector data
  - Raster data
  Reduce completion time and typos of users

- Integration with p.mapper
- Export of meta data as xml based format
Meta data management system

• Cross-platform support of system
  • Ubuntu Linux, Apache 2
  • MS Windows, IIS 2003
  • PostgreSQL 8.x including PostGIS

• Client side
  • Javascript, CSS, HTML
  • Prototype 1.5.1 library for extended Javascript- and AJAX-Functions
Meta data management system

- **Server side language**
  - PHP5
  - ADOdb Data Abstraction Library for DB connection
  - Class upload 0.24 for file upload
  - TAR/GZIP/BZIP2/ZIP Archive Classes 2.1 for archive Shape export

- **Server side execution of external programs**
  - gdalinfo – GeoTIF raster meta data
  - PostgreSQL/PostGIS – meta information from vector data
  - pgsql2shp – dynamic shape export by extent
GDI in action – WebGIS Client

➤ Easy to use interface

➤ Presentation of basic map layers and advanced data

➤ Functions for searching, exporting and printing data sets

➤ Info button per layer which we use to link to meta data management system
<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th>Corine land cover 2000 (CLC2000) 100 m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative title</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Brief abstract</strong></td>
<td>A comprehensive land cover database for the 25 EC Member States and other European countries, at an original scale of 1: 100 000, using 44 classes of the 3-level Corine nomenclature.</td>
</tr>
</tbody>
</table>
| **Abstract** | One of the major tasks undertaken in the framework of the Corine programme has been the establishment of a computerised inventory on the land cover. The objectives of the land cover project are:  
- to provide those responsible for and interested in the European policy on the environment with quantitative data on land cover, consistent and comparable across Europe;  
- to prepare one comprehensive land cover database for the 25 EC Member States and other European countries, at an original scale of 1: 100 000, using 44 classes of the 3-level Corine nomenclature. |
| **Purpose** | landcover of europe |
| **Keyword** | CLC2000, Corine, geographic, landcover |

Done
## List meta data

<table>
<thead>
<tr>
<th>Metadata title</th>
<th>last modified</th>
<th>database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communities</td>
<td>2007-09-14 16:00:00</td>
<td>mygisdb (postgis)</td>
</tr>
<tr>
<td>Rivers in Luxembourg</td>
<td>2007-09-14 16:07:00</td>
<td>mygisdb (postgis)</td>
</tr>
<tr>
<td>FLUXALZETTE Measurement sites</td>
<td>2007-09-14 16:57:00</td>
<td>mygisdb (postgis)</td>
</tr>
<tr>
<td>Kilometer mileage streams</td>
<td>2007-09-14 17:04:00</td>
<td>mygisdb (postgis)</td>
</tr>
<tr>
<td>Kilometer mileage rivers</td>
<td>2007-09-14 17:05:00</td>
<td>mygisdb (postgis)</td>
</tr>
<tr>
<td>Corine land cover 2000 (CLC2000) 100 m</td>
<td>2007-09-14 17:06:00</td>
<td>mygisdb (postgis)</td>
</tr>
</tbody>
</table>
Insert meta data – step 1

Step 1: Insert new metadata

* Title
  - Test

* Database or Filesystem
  - filesystem
    - please select
    - filesystem
    - mygisdb

>> next step
Step 2: Insert Metadata for data in a filesystem (raster)

Title:

Data path: /data/raster/dem

root

- 5mDEM.tif 84028.11 KB 2007-09-14 05:08:28 gdal
- 2mrelief.tif 96922.72 KB 2007-09-14 05:08:37 gdal
- dem_5m_uint16.tif 93827.56 KB 2007-09-14 05:08:47 gdal
- dem_5m_flt32.tif 0.09 KB 2007-09-14 05:08:47 gdal
- dem_5m_uint16.tif 0.09 KB 2007-09-14 05:08:47 gdal
- 2mrelief.tif 0.22 KB 2007-09-14 05:08:47 gdal
- dem_5m_flt32.tif 388072.2 KB 2007-09-14 05:09:25 gdal
- 5mDEM.tif 0.22 KB 2007-09-14 05:09:25 gdal
Insert meta data - step 2 - spatial info
Gdalinfo

Driver: GTiff/GeoTIFF
Size is 15412, 16820
Coordinate System is \
Origin = (38255.016143610002473,139981.335969120002119)
Pixel Size = (5.000002110000000,-5.000047720000000)
Image Structure Metadata:
COMPRESSION=DEFLATE
Corner Coordinates:
Upper Left (38255.016, 139981.336)
Lower Left (38255.016, 55880.533)
Upper Right (115315.049, 139981.336)
Lower Right (115315.049, 55880.533)
Center (76785.032, 97930.935)
Band 1 Block=15412x1 Type=Byte, ColorInterp=Red
Overviews: 7706x8410, 3853x4205, 1927x2103, 964x1052, 482x526, 241x263, 121x132
Band 2 Block=15412x1 Type=Byte, ColorInterp=Green
Overviews: 7706x8410, 3853x4205, 1927x2103, 964x1052, 482x526, 241x263, 121x132
Band 3 Block=15412x1 Type=Byte, ColorInterp=Blue
Overviews: 7706x8410, 3853x4205, 1927x2103, 964x1052, 482x526, 241x263, 121x132
query success
### Step 2: Insert Metadata for data in a geodatabase (vector)

**Title:** Test

>> next step (no calculation)

#### Calculate temporal resolution:

Select a table:

- please select a table

Selected table: reseauasurement_1_heiderscheidergrund

- date >> calculate

From 2003-07-24 00:00:00 to 2006-07-23 23:55:00 Format (Date): YYYY-MM-DD

>> next step (send calculation)
Insert meta data – step 3
## Metadata on metadata

### Points of contact
- CRP/CRT | Christian Braun

### Last modifying metadata
- 2007-09-14 17:06:00
- New date/time: 2007-09-26 07:26

## Dataset identification

## Distribution information

### Owner
- European Environment Agency | NA

### Originator
- European Environment Agency | NA

### Processor
- EIONET | NA

### Distributor
- -- please select --

### Type of constraint
- restricted

### Restriction
- no commercial use

## Spatial scale and resolution

## Temporal resolution

## Error information

## Other dataset information

### Database
- mygisdb

### Link to mapserver client
- http://localhost/apache2-default/umn/pmapper-dev/map.phtml?dg=corine_100&me=2300

### Layername of client
- corine_100

### Linked Table(s)
- [edit]
Discussion

- Prototype of Geospatial Data Infrastructure is functional on all levels
- Data can be exported via Web client as CSV, GeoTIF and SHAPE
- Visualisation via WebGIS, GRASS and QGIS
- Direct data processing is limited for GRASS since GRASS does not integrate ideally with PostGIS and cannot process directly GeoTIF

Import/Export is necessary:
- Raster -> r.in.gdal, r.out.gdal
- Vector -> v.in.ogr, v.out.ogr (,v.external)
Future steps

- Advanced analysis functions for WebGIS Client
  - Buffer, simple map queries, ...

- Connection and integration of statistic tools
  - Connection of R and database to compute summary statistics, histograms, boxplots, time series statistics
  - Access from WebGIS client to spatio-temporal summary statistics and graphs implemented as R CGI-script

- Spatial Database
  - Improve handling of versioned spatio-temporal raster data sets
  - Better implementation of GRASS database structure
    - Raster data: direct or automated r/w access to GeoTiffs
    - Vector data: lock data sets edited by multiple users

- Improvements of meta data system
  - Exchange of meta data sets through XML im/export
  - User authentication
Thank you for your attention!

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