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Internal Revenue Service
SE:T:EO:RA:T:3
Peter A. Holiat (Room 3N4)
1111 Constitution Ave, N.W.
Washington, DC 20224

March 18, 2010

Re: Exempt status – additional questions

Dear Mr. Holiat,

Here is our response to the January 15, 2010 questions we received from your regarding our tax exempt application. Thank you for providing the extension we required to respond by March 19, 2010.

We have collected a large amount of information in this response and hope that it meets your needs. If additional or more detailed information is required, please do not hesitate to let us know.

Sincerely,

**Tyler Mitchell**
**Executive Director & Secretary**
**Open Source Geospatial Foundation**
**tmitchell@osgeo.org**

*1.Provide a hardcopy of the information contained on your website(s) along with a statement that these documents accurately reflect your tax-exempt activities, purposes, and accomplishments.*

See attached hardcopies (“***Question 1 – Website Documents”***) - they represent the OSGeo “About” and “FAQ” pages from http://osgeo.org. Further information about sponsorship activities is available under Question 10. These summarize our mission, goals and accomplishments.

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*2.Describe in laypersons terms both the differences and similarities between OSGeo software and commercial geospatial data management, analysis, image processing, graphics/maps production, spatial modeling and visualization software.*

For clarity sake, a brief word about definitions. "Commercial software" is probably not the intended title here. Instead, we call it “proprietary” to differentiate it from Free and Open Source; proprietary meaning the source code is not publicly accessible. OSGeo software is often used a basis for *commercial* service offerings, so it too could be referred to as commercial. Herein, “proprietary” is used to describe the opposite of “open source” software.

OSGeo software and proprietary software are very similar in what they can do and how they work. They generally do not differ in their technical aspects. Our open source tools aim to allow users to do the same as proprietary geospatial data management, analysis, image processing, graphics/maps production, spatial modeling and visualization. The theories and practices of these features is generally the same and definitely share the same end goal of enabling professionals to have powerful tools for geospatial data management, etc. The same types of users are targeted by both OSGeo and proprietary developers.

The main differentiation is in how the software is produced, using a community-driven model, and also how it is distributed, openly and freely available for all users, developers and proponents. As opposed to proprietary software that is developed by a sole company, distributed for cost, includes restrictive licenses on use and does not interact with a public community of developers.

OSGeo software provides a range of functions that are mostly similar to that of proprietary products that serve the Geographic Information Systems (GIS) and Remote Sensing domains. Our stack of tools addresses various GIS and remote sensing needs: (These cateogories also apply to proprietary: GIS software)

1. They include programming tools that allow developers to write applications that interact with geographic/geospatial information. This might be for converting data between formats or preparing it to be used in a visualization application.
2. Our tools also include desktop software that allows analysts to load geographic datasets, view them on a map, analyze them for such things as distances, topographic relief, computing areas around a certain site, finding overlaps with other features, collecting planning information for road networks and much much more. These applications essentially deal with information technology relating to data about earth-based geography.
3. We also have tools that extend these viewing and analysis features onto the Internet - so that remote users can access complex data without having to download large datasets or install any additional software, instead using a web browser.
4. Additional features included here allow users to interact with a large variety of Internet based "web services" - where we can load maps from multiple Internet accessible servers and collate it into a single user experience.

5. Our tools also enable users to store and catalog geographic data using enterprise relational databases.

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*3.3. In your Articles of Incorporation and Narrative Description of Activities, you describe yourself as organized for educational purposes. Describe in detail how you meet the requirements of a tax-exempt educational organization as defined in section 501(c)(3) of the Code and section 1.501(c)(3)-1(d)(3) of the Treasury Regulations. Specifically, a qualifying 501(c)(3) educational organization must be operated to (i) instruct or train the individual for the purposes of improving or developing his/her capabilities, or (ii) instruct the public on subjects useful to the individual and beneficial to the community. Provide citations to all legal authorities that you are using to support your position.*

We instruct and inform the public about mapping, software and related scientific topics. We also instruct the public by providing resources for training material on these topics and providing community support forums. We directly instruct the public by hosting workshops and presentations on specific topics of interest to a wide range of communities and new users around the world.

Our organization has a very strong focus on educating individuals and helping their related communities. Individual students have several ways to learn from our activities. We host an online training material database that they can use to find material for self-study. A representative sample of some of this material is attached. By using these resources they learn how to make maps, access online map data sources, analysis geographic information and more - all using our free software products as a base. This self service option helps the student pace his training according to his needs. This also allows communities of students to also learn in tandem with one another, without having to attend any particular location.

However, the primary way that we educate the public is through the leading of workshops and presentations. Our members and volunteers lead more than a dozen, 3 hour, workshops and more than 100, half hour, presentations each year at our annual conference. Students can register for these hands-on technical workshops to learn how to operate the software and even take a copy of it back to their homes or offices to use in their own projects. All conference attendees have access to presentations by professionals in various fields of expertise, from building government infrastructures for data management, down to the technical details of handling geospatial information. Our workshop training materials and presentation slideshows are made available after the annual event and are free to access.

We help encourage the student and user communities by allowing them to focus on their problem/task, instead of having to find and fund new software tools. Coupling our free software with our training opportunities makes a significant impact on both the bottom line and the ultimate success of any community of interest or student that comes to us. Because we train only on the use of free and open source software, students and communities can customize and redistribute both the training material and the software tools. These freedoms make for a powerful combination for learners.

In essence we provide tools and knowledge that allows students to learn to manage the world around them - this could include participating in land use planning, analyzing geographic areas for market potential, tracking wildlife in a mapping environment or analyzing satellite imagery to take stock of a natural resource. The possibilities and applications are endless since our world is ultimately governed by geography - we help make these possibilities happen.

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*4.Provide the following information in reference to your educational activities:*

*a. Describe in detail on what topic(s) you are attempting to educate the public.*

We train on open source software in general, but specifically as it applies to geographic information system (GIS) data management and application building.

Generally speaking we train the public in understanding Free Software licensing and the Open Source Development model. In particular, we teach on the advantages of using Open Source - including the freedom to understand what the code is doing, the option to improve the code and to pass it on to others without encumbering restrictive proprietary licenses.

While all instructors share a commitment to the above, our specific courses focus on how to use certain geographic information management software (GIS). A student might learn how to download a tool for making maps on their computer, or learn to build a web-based application that allows users to interact with mapping information. They also learn how to program using our tools so that customized applications can be built for their particular need and type of information. They learn how to prepare their mapping information so that it can be easily cataloged and later searched for in online Internet systems. They also learn how to 'load' their data into relational databases so that it may be queried later on and manipulated according to the users' needs.

We also help them learn to use community-based support systems - for example, public mailing lists, real time discussion forums and documentation. We also encourage local groups to form and support each other. Likewise, we teach them how to find free, publicly accessible geographic information that will help them meet their needs. For example, an ecologist in Europe may be looking for environmental data for a project and contact our membership to find a data other ecologists may have used. In fact, we also encourage the sharing of public information, so in the end one member may be able to share processed information directly with others in need.

Our training events usually include a special track for academic related publication, presentations and posters. As such we provide a research extension mechanism that is important for educational institutions that also use related software. Additionally, we publish some of these papers in our "OSGeo Journal" (more on the Journal in Question #5 below).

All our live training material is produced and delivered by professionals in the field or from academia. We use a review process to select the most valuable workshops and presentations, to ensure applicability and interest to the students and communities to attend our events.

Typical GIS and Remote Sensing training is done through education institutions, whereas developing such software is done through both the proprietary and open source methodologies. Here, we leverage the benefit of open source software for the student (no cost, usable on whatever platform/computer they need) along with providing learning opportunities, material, etc. directed at that software and their skill level. The end result is a flexible, affordable and powerful combination of student skills, accessible software and affordable tools - all which help the student to engage with their geography in a meaningful and productive way.

*b. Provide a list of and copies of all individual training, instructional material or educational material you will utilize in achieving your educational purpose.*

Workshops and presentations are delivered by an extensive network of instructors through our annual conference event. Their training material is developed for this purpose and improved from year to year. All the material is published online and freely available for students to refer back to or for new students to learn from.

See 4.c response for material examples, as all material used is also published.

The material is based on work by academic and research organizations as well as geospatial professionals from around the world. Some of our material is delivered in multiple languages.

*c. Provide a list of and copies of all individual training, instructional material or educational material you publish as part of your educational activities.*

We maintain material from past workshops and presentations. These are organized by our event managers for each annual event. All the material from 2009 is listed in the attached sheet (*Question 4.c 2009 Workshops & Presentations),* as well as a representative sample of a workshop and presentation material (*Education Samples*). There are hundreds of items and we are glad to provide you with more if required. Many workshops also include software and data as part of the material we publish.

We also publish a semi-annual journal with articles, case studies and some training material included. See Question 4.e below for more information.

We have also started a catalog for known training material that students and professionals can search. This catalog is available at http://osgeo.org/educational_content A list of items from that catalog are provided as an attachment "*Question 4.c Education Database Listing*".

*d. Provide a schedule of dates, times, and locations of all educational lectures, seminars, forums, classroom instruction or similar programs you sponsored for the purpose of meeting your educational requirement.*

Past and future conference workshops and presentations:

- September 6-9, 2010, Palacio de Congresos de Barcelona, Spain
- October 20-23, 2009, Sydney Convention & Exhibition Centre, Australia
- September 29-October 4, 2008, Cape Town International Convention Centre (CTICC), South Africa
- September 24-27, 2007, Victoria Conference Centre, Canada
- September 11-15, 2006, Swiss Federal Institute of Technology (EPFL) and the University of Lausanne (UNIL), Switzerland

See list of past workshops from 2009 in *Questions 4.c "Workshops & Presentations"* above for a representative sample of the more than 500 presentations and approximately 100 workshops that were delivered at our annual event.

*e. Provide a list of all your instructors and their curricula vita.*

See attached *"Question 4.c 2009 Workshops & Presentations"* for a list of the teachers/speakers and their bio statements.

We use a range of instructors from around the world, though we do not maintain a detailed list of their CVs as our instructors change from year to year. Attached is our extensive list of speakers and workshop leaders from our annual event in 2009. Included are brief bio statements, though most speakers are well known to the community of attendees that come.

We accept proposals from potential instructors and judge them for suitability and potential interest by the students. We selectively choose instructors to ensure that the resulting training opportunities fall in line with our mission and target community in general.

*5. Do you publish an educational journal? If so, provide a copy.*

Yes, we do. We publish an electronic version of the journal but do get some printed from time to time for promotional purposes. Our journal **"OSGeo Journal"** is used for both communications within our community and also for publishing articles between peers.

We are currently working on developing our academic peer reviewed process, to be used early in 2010 for the first time. This will provide an educational outreach opportunity with the GIS / Remote Sensing academic environment that has not existed before, by providing a focus on open source software-based mapping technologies and processes.

We have used the Journal as a means for publishing proceedings from our conference as well, and hope to do so again in the future.

A printed sample of the Journal is included in its original form for the mail-in of this response. A compressed version is attached for immediate viewing (*Question 5 – Journal Sample*). All Journal versions are downloadable from http://osgeo.org/ojs

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*6. Do you have a physical location to which the public arrives to receive education? If not, describe where you educate the public.*

Yes, we meet at a physical location for our annual conference where the public arrives to attend and participate in presentations, workshops and programmer focused events.

In addition, we internet technologies for communications, outreach and delivering educational materials.

We also use conferences organized by other groups to promote and present our education opportunities to new audiences.

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*7. If educational material is presented via the organization's website, provide links to the web sites, along with hard copies of materials posted on the website (if not already provided).*

We host all our presentation and workshop material on public websites. Our material from 2009 is available at: http://2009.foss4g.org

We also provide a catalog service for finding additional resources:

- http://www.osgeo.org/educational_content

For examples and listings from both of these resources, please see the "*Question 4.c*" attachments.

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*8. If you provide an internet forum for the public to ask questions about your activities, then provide the following information:*

*a. Will the public have to register to post questions on your Internet forum?*

There are different options for interacting with us, some of them need people to register, some not. Our end goal

in all communications is to be as openly accessible as possible. Depending on the collaborative tools we use, some require user registration simply to keep spam and mis-use to a minimum, but we encourage everyone to join and contribute in the following ways:

- Real-time online chatting channel (use Internet Relay Chat) - no registration required
- Mailing Lists - registration required for posting messages, archives open for all to read – all links to the lists and their archives are available online: http://lists.osgeo.org
- Collaborative "wiki" web pages - no registration required to read, but required to edit/contribute

*b. Can members of the public post answers to questions posted on the Internet forum?*

Yes and our members specifically participate to help answer questions posted by the public on these Internet forums.

*c. What percentage of your educational activities are conducted via the Internet forum?*

Most educational material is delivered during our annual conference event where face-to-face training occurs over a 5 day period.

The remainder of our activities occurring via the Internet are hard to quantify due to the self-service approach that the public uses to access our information. It may be estimated that 20% of our educational activities could be seen as being delivered via the Internet. Planned online education activities like live webinars are rare, though students download information regularly. Most of the training that is not delivered during our annual conference event occurs through the Internet, but it is not as concentrated.

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*9. If you are no longer claiming educational activities as part of your tax-exempt purpose, kindly provide a statement to this effect.*

We continue to claim educational activities as part of our tax-exempt purpose.

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*10. Pursuant to your website, you state you are supported by various sponsors. Provide the following information:*

*a. Describe in detail your relationship, if any, with your sponsors.*

See the attached “Question 10 - Sponsors”

*b. Provide copies of all agreements between you and your sponsors.*

We do not have signed agreements with foundation or project sponsors. See the attached sponsor program descriptions.

*c. Describe what benefits, if any, sponsors receive in exchange for sponsorship.*

- Sponsors receive recognition for their sponsorship on the website and publications. They

additionally receive a hard copy of the annual OSGeo Journal.
- FOSS4G Sponsors receive additional promotional benefits at the conference as listed in the previous response.

*d. Describe what discretion and control sponsors may exercise over your activities via your "project sponsorship" program. Include copies of all agreements, guidelines, and procedures relating to your "project sponsorship" program.*

Sponsors have no control over projects. In particular they receive no representation on the project steering committee and they are not able to direct development activities.

- OSGeo does not sign legal agreements with sponsors.
- OSGeo's project sponsorship program is operated on the basis of the OSGeo Project Sponsorship program, guidelines included above.
- Each project has it's own detailed guidelines, though these tend to be quite similar. The Sponsorship Benefits section for each project is included below.
- Sponsorship benefits are primarily promotional.
- Sponsors are generally provided with a sponsorship survey annually in which they can provide feedback on areas of focus they see for the project. This advisory material is reviewed by the Project Steering Committee and may help guide decisions on where to focus software maintenance and development activities.
- Sponsors are offered a "degree of priority" with regard to fixes of bugs by sponsorship supported maintainers. In practice this means that the project member responsible for triaging bugs and managing a paid maintainer may choose to have the paid maintainer address bugs important to sponsors ahead of those not important to sponsors yet only if they judge both bugs to be of similar importance to the project and the user community in general.

*e. Provide a list of your sponsors and indicate which sponsors are corporate, government, and non-profit.*

Foundation Sponsors:

* Autodesk (corporate)
* INPE (government)
* INGRES (corporate)
* Ordnance Survey (government)
* GEOCAT (corporate)
* Astun Technology (corporate)
* Borealis (corporate)
* IGN (government)
* PCI Geomatics (corporate)
* camp to camp (corporate)
* Lizardtech (corporate)
* 1Spatial (corporate)
* First Base Solutions (corporate)

Project Sponsors (GDAL):

* Cadcorp (corporate)
* Safe Software (corporate)
* SRC (corporate)
* Applied Coherent Technology (corporate)
* i-cubed (corporate)
* Waypoint (corporate)
* INGRES (corporate)

Project Sponsors (MapGuide)

 * OTX Systems (corporate)

FOSS4G 2009 Sponsors:

 * Autodesk (corporate)
 * OpenGeo (non profit)
 * INGRES (corporate)
 * LISAsoft (corporate)
 * Google (corporate)
 * Landgate (government)
 * GEOCAT (corporate)
 * latlon (non profit)
 * MapGears (corporate)
 * GeoSolutions (corporate)
 * geosparc (corporate)
 * Australian Office of Spatial Data Management (government)
 * Australian Bureau of Meteorology (government)
 * 52 North (non profit)
 * Open Geospatial Consortium (non profit)
 * CSIRO (government)
 * Sun Microsystems (corporate)
 * Ardec International (corporate)
 * aarenet (corporate)

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*11. Provide the following information in reference to the operation of the OSGeo Store.*

*a. Describe in detail the merchandise sold through your store.*

Our store uses the website http://cafepress.com to allows supports to buy basic branded (with OSGeo logo) clothing and merchandise: t-shirts, cups, buttons, stickers and other low price gimmicks with the OSGeo compass logo intended for promotional purposes. Part of our mission is to promote the use of our software, so the sale of our merchandise helps to raise awareness and build our community ethos.  A screenshot of the storefront is included below.


*b. Describe in detail whether the sale of this merchandise is substantially related to your tax-exempt purpose.*

Yes. It relates directly to our purpose of promotion, though it is an insignificant part of the overall program.

*c. Describe the amount of resources (including but not limited to personnel and financial resources) that are allocate to the sale of merchandise.*

All merchandise is sold via an existing commercial web portal that hosts our designs through a funded program. We pay less than $200 per year. Volunteers maintain our design files on the web site, spending less than a day or two per year, as-needed.

*d. State whether the OSGeo Store is a web-based only store.*

Yes it is a web-based only store.

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*12. In reference to your logo, provide the following information: a. Do you receive any form of compensation in return for the use of your logo?*

We receive no compensation for using the logo.

*b. Do you provide any goods or services to organizations in conjunction with the use of your logo? If yes, describe in detail.*

No we do not provide any goods or services to organizations who use our logo. Logos are made available for our sponsors, projects and members to use to identify their support, but we provide nothing to them in exchange.

*c. Provide copies of all agreements between you and authorized users of your logo.*

We have no agreements for logo usage.

We do have some guidelines for people who want to use them, as supplied in original application Part VIII-10 "*Trademark Guidelines*", but adherence is voluntary.

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*13. Do you provide any goods or services for any form of compensation? If yes, describe the goods and services, compensation received, and how providing these goods and services further your tax-exempt purposes.*

Yes, we host/run our annual event for a fee. Each year, we hold the global conference for the purpose of education and dissemination of information regarding the products to which OSGeo is a hosting organization. Attendees pay to attend workshops and training events. This conference is a for-fee conference for attendees, with the fees used to support the organization and in the running of the conference. This conference is our primary educational vehicle, with several hundred annual attendees (1,000 or more attendees expected for 2010 event) participating in several days of workshops, seminars, and other educational opportunities. Providing

these education opportunities is core to our purpose. Throughout the year, we work to support the open source development of the software that is most prominent at the conference; this is done through the mailing lists, online forums, and other services which the OSGeo Foundation provides. As a result, some proceeds of the conference are used to maintain and fund the other activities of OSGeo throughout the year.

We also assist students directly through the Google Summer of Code program. OSGeo provides volunteer mentors to oversee programming/development work by students. In exchange, OSGeo students and mentors receive funding from Google as the sponsor of their program. This is not service-for-hire, but rather done through an honorarium method and gives no benefits directly to Google.

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*14. In your Articles of Incorporation, you state that you are also organized for charitable purposes. Describe in detail how you meet the requirements of a tax-exempt charitable organization as defined in section 501(c)(3) of the Code and section 1.501(c)(3)-1(d)(2) of the Treasury Regulations. Provide citations to all legal authorities that you are using to support your position.*

Our charitable purposes are focused on maintaining the free, no-cost, ability to use our software tools, thus making them available for all people regardless of income, employment status, educational status or where they live. If our software was not available in such a way, then it would much harder for unfunded or low income individuals, companies, organizations or nations to participate in the discussion.

This overlaps with our educational purposes in that all students are able to not only get free training or support, but may also have access to free software now and into the future. We help to build professional geospatial technology users around the world.

Our charitable goals are to ensure the general public (including developing nations and the unemployed) has access to much needed tools for managing geographic information. We do so in several ways. The most important is by providing software at no cost, all people have equal access to tools that are integral for managing the world around us. This applies specifically to individuals who need to use these tools, but also helps other organizations such as Government, Non-Government Organizations, non-profit charities and small business.

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*15. In reference to your charitable activities, describe the charitable class your activities serve as part of your charitable purpose.*

Our charitable activities serve low income people including students, and other low income people as well as charitable non-profit organizations who otherwise would not be able to afford to purchase or be trained to use existing proprietary software.

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*16. If you are no longer claiming charitable activities as part of your tax-exempt purpose, kindly provide a statement to this effect.*

We continue to make the claim.

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*17. Describe whether you will retain (directly or indirectly) the ownership or control of any patents, copyrights, processes, or formulae resulting from your tax-exempt activities (including but not limited to open source software).*

OSGeo will continue to retain copyrights on existing and newly created open source projects hosted by OSGeo. This copyright is held solely for the purpose of making the software available under an open source license, to be freely used and disseminated. No non-open source software copyrights will be held by OSGeo, at any point.

Educational materials substantially related to our tax exempt purpose are generally held by their creators; in cases where OSGeo holds copyright, that is again only to fulfill open dissemination of the educational materials to the appropriate audience.

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*18. If you retain ownership or control of any patents, copyrights, processes, or formulae, will you make public on a nondiscriminatory basis any patents, copyrights, processes, formulas, which results from your tax-exempt activities?*
*a. If yes, describe in detail how you intend to make this information public, including a list of publications and websites where this information will be disseminated.*

Yes, in various ways:

- All OSGeo software projects have to be published under an Open Source license that is listed by the Open Source Initiative at http://opensource.org/licenses/alphabetical
- All code from projects are available through publicly accessible code repositories. Some of the repositories are hosted on OSGeo servers under: http://trac.osgeo.org/ others are hosted in project specific websites.
- The main OSGeo web site contains links to the code repositories of all projects: http://osgeo.org (right sidebar)
- All training material delivered through workshops is available through our conference websites: http://2009.foss4g.org/workshops/
- All catalog training material is available through a database search tool at: http://www.osgeo.org/educational_content

*b. If no, describe what restrictions will be placed on the dissemination of this information.*

There are no restrictions.

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*19. Provide a sample copy of all types of licenses (not limited to open source licenses) you plan to issue.*

- All our software adheres to one or more standard license from the Open Source Initiative list: http://opensource.org/licenses/alphabetical
- Currently projects are licenses under LGPL, GPL, BSD, and CC-By / CC-By-SA licenses or related licenses. See attached *"Question 19 – License Samples"* for a representative sample of the licenses we use.
- We have no plans to release any materials not under a license which allows open redistribution.

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*20. Provide a list of software that you have developed (including open source software). Include a description of the software, its purpose, how it was developed, and how it furthers your tax-exempt activities.*

There are currently 20 software projects that we promote and support. Each one is developed under different circumstances, some came from previously proprietary (closed source) commercial products, others were developed initially through academia, yet others were personal projects started by independent developers.

All the projects contribute to our tax-exempt purposes of education and charity – they are all used for training new users of geographic information management tools and they are all made/supported as no-cost, free, tools for all to use.

When a project approaches OSGeo to join, they enter into a process of review by an internal committee. We do not take on the creation of new software as a project, but rather adopt existing software projects that come to us, if they passes our review process. At that point the project becomes an OSGeo project. From then on the project participants work with the organization to develop according to a common model.

By supporting and promoting the use of existing software, we help to make it more readily accessible to the general public - for both educational and scientific uses according to our tax-exempt purpose. All the projects are free and open source, all provide tools for geospatial data management, programming, cataloging or mapping.

These are the specific OSGeo software projects and their related categories:

**Web Mapping**
deegree
geomajas
GeoServer
Mapbender
MapBuilder
MapFish
MapGuide Open Source
MapServer
OpenLayers

**Desktop Applications**
GRASS GIS
OSSIM
Quantum GIS
gvSIG

**Geospatial Libraries**
FDO
GDAL/OGR
GEOS
GeoTools
MetaCRS
PostGIS

**Metadata Catalog**
GeoNetwork

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*21. What other types of software do you intended to develop? Provide a description of all software you intend to develop as part of your tax-exempt activities.*

In all cases the software in question will always deal with geographic/geospatial information and must also be freely/openly accessible through open source software licenses. Only software that meets the above requirements may be accepted into adoption by OSGeo's incubation review process.

OSGeo will not itself develop other types of software but will continue to act as an enabler and host for projects who decide to contribute it back to us.

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*22. What percentage of your resources, such as financial and personnel, are allocated to charitable and educational activities?*

- 100%

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*23. If you utilize volunteers, provide the following information: a. What percentage of your labor force is comprised of volunteers?*

- 99%
- OSGeo has only one paid position, in the form of the Executive Director; all other effort is performed by volunteers, both in the foundation directly, and outside the foundation in the various software development projects, supporting our Charitable and Educational activities.

*b. What range of duties do the volunteers undertake?*

- Systems administration.
- Software development.
- Promotion through booths at conferences and trade shows.
- Give talks, presentations and workshop training at conferences and trade shows.
- Maintaining web sites.
- Internationalize material.
- Create or catalog educational material.
- Maintain the health of the organization through community discussions.
- Communicate through various forums, mailing lists, etc.
- Run organization committees.

*c. What percentage of your volunteers have fixed hours or days on which they are required to be present for organizational activities?*

- 0%

*d. What percentage of your volunteers report to your physical location to volunteer?*

- 0%

*e. What percentage of your volunteers perform their volunteer activities via the internet and/or email?*

- 80% - except for face-to-face training during our annual conference and planning related to that.

*24.Update the names and compensation amounts of the persons referenced in Part V of your 1023 Application.*

- See attachment ("*Question 24 – Part V 1a – Officers &* Compensation")

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*25.Provide the information requested in question 4g of Part V of your 1023 Application.*

*"Describe how you set compensation that is* ***reasonable*** *for your officers, directors, trustees, highest compensated employees, and highest compensated independent contractors listed in Part V, linnes 1a, 1b, and 1c."*

- Before hiring of staff was undertaken, a review of other similar sized non-profits was done by the OSGeo Treasurer. A reasonable salary was chosen based on values from other organizations and adjusted based on individual staff experience. This salary was approved by the Board of Directors prior to commitment.
- There has only been 1 staff hired since this early determination was made. Future hiring practices will be done following a salary policy review and is expected to include a salary research process to prove the reasonable nature of the compensation.

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*26.Provide the information requested in question 12b -12d of Part VIII of your 1023 Application.*

In the initial application we answered "yes" to "*Do you or will you operate in a foreign country or countries.*"

*b. Name the foreign countries and regions within the countries in which you operate.*

- British Columbia, Canada.
- Globally

*c. Describe your operations in each country and region in which you operate.*

- British Columbia, Canada - our executive directors works from an office there.
- Globally, we run our annual conference event in a different region each year.
- Globally, some of our members in other countries organize into local "chapters", informal user groups to help support one another. They are not run by OSGeo and do not represent OSGeo "operating" in those countries, but they are affiliated as supporters of OSGeo.

*d. Describe how your operations in each country and region further your exempt purpose.*

- The executive director in British Columbia, Canada runs programs and manages all the administrative needs of the organization.
- Our annual conference is our main educational event and furthers that aspect of the organization's exempt purpose.

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*27.Provide an updated copy of the Financial Data referenced on Part IX of your 1023 Application.*

**Statement of Revenues and Expenses**

- See attachment ("***Question 27 – Part IX – Updated Financial Data***")

Please note that since the time of the initial application (2008) we have more refined financial statements and a clearer understanding of how to categorize the items. Further comments below.

*28. Describe in detail your income listed on line 9 of Part IX of your 1023 Application.*

*Line 9: Gross receipts from admissions, merchandise sold or services performed, or furnishing of facilities in any activity that is related to your exempt purposes*

- This line includes all the annual conference related revenue. The following is reported in Australian dollars, local to the event report:

  **Registrations**: 303,765
  **Sponsorships**: 83,734
  **Exhibition rentals**: 28,490
- These all contributed to delivering our educational outreach through our primary annual event.

---

*29. Describe in detail your income listed on line 12 of Part IX of your 1023 Application.*

Line 12: Unusual grants.

- In 2007 we listed erroneously attributed 135,000 as "unusual grants". This included regular sponsorship donations. In the updated report ("***Question 27 – Part IX – Updated Financial Data***") we have moved all sponsor related income to line 1 "gifts,grants and contributions"
- Sponsors falling under this category are listed under question 10.e above.

---

*30. Describe in detail your expenses listed on line 17 of Part IX of your 1023 Application.*

Line 17: Compensation of officers, directors, and trustees

- The expenses originally placed on line 17 were staff (Executive Director) salary and benefits. No compensation is provided for any other director or officer of the organization.
- All staff salary has been moved to line 18 “other salaries and wages”.
- Salary is budgeted as USD$90,000 but varies as it is paid in annualized CAD$. Group benefits and payroll costs make up the additional amounts reported.

---

*31. Describe in detail your expenses listed on line 23 of Part IX of your 1023 Application.*

Line 23: Any expense not otherwise classified, such as program services

- See attachment (“***Question 31 – Line 23 Expenses***”) for the itemized list of expenses on line 23.

---

*32.Do your members, directors, officers, employees or volunteers provide (or will provide) any goods or services for a fee related to your open source software. If yes, describe in detail.*

No member of the Foundation, volunteer or employee, is able to charge a fee for providing access to our open source software. Any member of the public, however, are free to use our open source software in the course of their employment as a government agent, non-profit organization, school or business.

# ATTACHMENTS

# Question 1 – Website Documents

The following hardcopies from the osgeo.org website accurately reflect our tax-exempt activities, purposes and accomplishments.

| _____ | _Executive Director & Secretary_ | _____ |
|---|---|---|
| **Signed** | **Position** | **Date** |

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# About the Open Source Geospatial Foundation

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The Open Source Geospatial Foundation, or OSGeo, is a not-for-profit organization whose mission is to support and promote the collaborative development of open geospatial technologies and data. The foundation provides financial, organizational and legal support to the broader open source geospatial community. It also serves as an independent legal entity to which community members can contribute code, funding and other resources, secure in the knowledge that their contributions will be maintained for public benefit. OSGeo also serves as an outreach and advocacy organization for the open source geospatial community, and provides a common forum and shared infrastructure for improving cross-project collaboration.

The foundation's projects are all freely available and useable under an OSI-certified open source license.

OSGeo is seeking US 501(c)(3) legal status.

## OSGeo Mission Statement

To support the development of open source geospatial software, and promote its widespread use.

## OSGeo Goals

The following more detailed goals support the overall mission:

- To provide resources for foundation projects - eg. infrastructure, funding, legal.
- To promote freely available geodata - free software is useless without data.
- To promote the use of open source software in the geospatial industry (not just foundation software) - eg. PR, training, outreach.
- To encourage the implementation of open standards and standards-based interoperability in foundation projects.
- To ensure a high degree of quality in foundation projects in order to build and preserve the foundation "brand".
- To make foundation and related software more accessible to end users - eg. binary "stack" builds, cross package documentation.
- To provide support for the use of OSGeo software in education via curriculum development, outreach, and support.
- To encourage communication and cooperation between OSGeo communities on different language (eg. Java/C/Python) and operating system (eg. Win32, Unix, MacOS) platforms.
- To support use and contribution to foundation projects from the worldwide community through internationalization of software and community outreach.
- To operate an annual OSGeo Conference, possibly in cooperation with related efforts (eg. EOGEO).
- To award the Sol Katz award for service to the OSGeo community.

## Foundation Details

The following links lead to detailed information about OSGeo and how it is governed. Some of this information is not yet finalized, and will be linked when it is available.

**OSGeo Frequently Asked Questions (FAQ)**

**Governance**

- Certificate of Incorporation (pdf)
- Bylaws
- Organizational Meeting held February 4, 2006 in Chicago, IL - Press release
- Board Meeting Archives
- Membership Meeting Archives

**Bodies**

- Board of Directors and Officers
- Membership Categories & Rules
- Charter Members
- Local Chapters
- Committees

**Legal**

- Trademark Guidelines

**Media and News**



**OSGeo Projects**

Web Mapping
- deegree
- GeoServer
- Mapbender
- MapBuilder
- MapFish
- MapGuide Open Source
- MapServer
- OpenLayers

Desktop Applications
- GRASS GIS
- OSSIM
- Quantum GIS
- gvSIG

Geospatial Libraries
- FDO
- GDAL/OGR
- GEOS
- GeoTools
- MetaCRS
- PostGIS

Metadata Catalog
- GeoNetwork

Other Projects
- Public Geospatial Data
- Education and Curriculum

Project in incubation

- News and Events
- Media Kit
- OSGeo Logo: Usage, History, and Downloads
- Annual reports

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# OSGeo FAQ

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*The following are the frequently asked questions for the the OSGeo Foundation. If you have a question not answered here, send a message with your question to info@osgeo.org*

## Contents



## Structure and Governance

What is the Open Source Geospatial Foundation?

The foundation, or "OSGeo" for short, is an independent nonprofit legal entity established to support the needs of the ope source geospatial community. The foundation will serve as an organizing body, a public technology commons, a development community manager, and event sponsor. Once fully established, the foundation will provide a legal and administrative framework to better support the ongoing development and promotion of open source geospatial data and technologies.

What is the legal form of the foundation?

The foundation is a membership-based corporation incorporated under the laws of the State of Delaware, USA. The foundation was expressly incorporated as a not-for-profit corporation, and intends to apply for tax exempt status under Section 501(c)(3) of the United States Internal Revenue Code so that financial contributions will be tax deductible in the United States.

Who owns/controls the foundation?

The foundation is a nonprofit entity and has no shareholders. Thus, nobody "owns" the foundation. However, the foundation does have charter members who, like the shareholders in a for-profit company, elect the foundation's board o directors. The board of directors, acting together, manages the affairs of the foundation.

Who are the members?

The membership is composed from users, supporters, promoters, and developers of open source geospatial software. Becoming a member is as easy as joining the site and contributing to the foundation goals. Beyond members, there are currently 73 charter members.

Can I become a charter member?

Beyond selecting the initial charter membership of 45 members, details of the membership process have not been determined. However, all members of the open source geospatial community are encouraged to participate in foundation mailing lists, committees, and projects. Charter membership is not required for most forms of participation.

Can a regular member have any influence?

Yes! First, a regular member can do everything a charter member can do, except vote in board elections. They can be members of committees and vote on them. They can speak up, and contribute in every other way. The foundation aims be a *do-acracy*, and so the way to have influence is to *do* things! Ultimately, of course, the foundation will *only* succeed its mission if the entire community gets involved -- so please don't hesitate! We need your help!

Who are the board of directors?

The Board of Directors were voted in an initial round by the initial foundation membership and then by the elected foundation members.

Is the foundation controlled by Autodesk?

No. Autodesk has provided generous support (legal, organizational and financial) to help establish the foundation, but onl two charter members (including one board member) are from Autodesk. MapGuide Open Source, initially contributed to tl foundation by Autodesk, is only one of eight initial foundation projects.

What are the detailed rules of governance of the foundation?

The foundation's governance model is still being developed, but it is expected that the foundation will emulate certain features of the governance models employed by other successful open source projects such as Apache. Individual foundation projects are expected to be governed by their own Project Steering Committees (PSCs), which will be appointed by the foundation's Board of Directors.

What is the relationship between OSGeo and OGC?

OGC is a organization for creating geospatial standards, while OSGeo is an organization for promoting open source geospatial software and data. It is also an explicit goal of OSGeo to support and promote standards, including OGC standards. Towards that end OGC and OSGeo have signed a memorandum of understanding to facilitate cooperation, including OSGeo cooperation on implementing reference standards of OGC standards, and a mechanism for open source developers to participate in OGC standards development.

## Open Source

What is Open Source Software?

On its formation, the GDAL/OGR, GeoTools, GRASS GIS, Mapbender, MapBuilder, MapGuide Open Source, MapServer and OSSIM projects declared their support, and joined as projects in incubation. Since then GDAL/OGR, GRASS GIS, Mapbender, MapBuilder, and MapGuide Open Source have graduated as full projects from this list. Further projects have entered incubation and some have also graduated. See the "OSGeo Projects" for an official list.

What does a project need to do to join?

Projects need to go through the Incubation process to join the foundation. Details on how to apply, and how the process works are available on the Incubator web page.

So when can my project join?

The Incubator is now accepting applications to join the foundation. Only a limited number of projects can be effectively handled in the incubation process at a time, so please be patient.

Do foundation projects need to sign over copyright to the foundation?

No. Copyright to individual contributions in foundation projects is expected to remain with the original developer. Howeve assigning copyright to the foundation is an available option.

Do project developers need to sign a legal agreement?

No. Generally speaking this is not required, but some specific projects may require developers or their employers to sign contributor agreement.

Do foundation projects need to turn over project control to the foundation?

No. The foundation is not interested in controlling foundation projects. However, foundation projects are expected to follo some foundation rules, mostly around the need to ensure that project code is not legally encumbered (*e.g.*, not stolen, o improperly contributed), and that appropriate controls are in place to ensure code is properly contributed. Some additiona expectations may exist around projects operating in an open and accountable fashion, handling foundation-provided funding appropriately and not taking actions that will cause legal problems or negative goodwill for the foundation. The foundation also encourages, but does not require, projects to support foundation goals, such as implementing standards-based interoperability.

Can my project operate as a *benevolent dictatorship*?

Detailed requirements for project administration have not yet been worked out, but it is anticipated that rules somewhat related to those for Apache will be followed. Projects should have a *Project Steering Committee* responsible for technical decisions and these committees should operate openly and with a consensus based approach. A benevolent dictatorship is not likely to be considered suitably open and consensus based.

Do I have to use mandated source control / web system / bug system / mailing list from the foundation?

No. Projects joining the foundation can continue to use their traditional source control system, web site system, bug tracker and mailing list software. However, the foundation does offer these infrastructural components, and encourages their use to provide a more consistent way for users and developers to interact with the different foundation projects.

Does the foundation mandate a particular license for software?

The foundation only accepts projects that use OSI-certified licenses for their software, and requires that projects stick to OSI-certified licenses. This includes common licenses such as MIT/X, BSD, GPL, and LGPL. The foundation encourage library projects to use the LGPL or a more permissive license (such as MIT/X or BSD) rather than the GPL so that the libraries can be reused by non-GPL projects, but does not require it. The foundation also discourages a proliferation of ne and incompatible licenses.

Does the foundation mandate a particular license for content other than software, such as geodata, educational materials, documentation, etc.?

The foundation accepts non-software projects that use Creative Commons or similar licenses for their public geodata, educational material, or promotional material. The foundation also discourages a proliferation of new and incompatible licenses.

## Participation

What can I do to get involved?

Visit the OSGeo web site. Join the main foundation *discuss* list. Check out the Volunteers Needed wiki. You don't need t be a programmer.

How can I contribute code?

The governance model currently being formulated will define the legal and related issues concerning how code will be accepted into foundation software projects. Individual Project Steering Committees will determine the criteria for acceptir contributions within this broader legal framework. In the meantime, you are encouraged to participate on the mailing lists for the foundation projects.

Does the foundation need money?

The foundation is soliciting organizational sponsorships now. Once some organizational and financial details are worked out it will also be possible for individuals to make tax deductible (if in the USA) donations. However, contributions of time for commmittee work, development, documentation, testing, user support, and advocacy are the preferred form of contribution from individuals. Some countries have tax exempt organisations with similar goals to OSGeo that may be candidates for donations or that are willing to receive donations for OSGeo.

May I used the OSGeo logo and name freely?

Yes, but the foundation considers the OSGeo name, and logo to be trademarks, so please review the trademark guidelin and FAQ. The logos page has logos in a variety of styles and formats.

***Question 4.c - 2009 Workshops & Presentations***

# FOSS4G 2009 Keynote Speakers

**Warwick Watkins** is Director General of the NSW Department of Lands, Surveyor General of NSW and Registrar General of NSW. Warwick holds a number of positions in the Australian spatial industry: Chair of the Australian and New Zealand Land Information Council (ANZLIC); Chair of the Australian Spatial Council; Chair, Spatial Information Systems Limited; Director, AuScope Limited; Commissioner of Soil Conservation; Norfolk Island Surveyor General; Deputy Chancellor of the University of Technology, Sydney; President of the Board of Surveying and Spatial Information (BOSSI); and Deputy Chair of the CSIRO Water for a Healthy Country National Research Flagship Advisory Council Advisory Board.

Download files for Keynote: The Australian Spatial Market
Watch the video of Keynote: The Australian Spatial Market

**Raj Singh** is Director of Interoperability Programs at the Open Geospatial Consortium. He works on multi-firm software prototyping projects, helps design information architectures, and manages ogcnetwork.net, a web site developed by and for geospatial developers. He is one of the designers of GeoRSS (georss.org) and helped develop the Geospatial Profile of the Federal Enterprise Architecture. Currently Dr. Singh is leading leading a major project to advance information sharing in building construction and design software. His passion is aligning geospatial standards with the general IT industry, and increasing the pervasiveness of geospatial services throughout society. Dr. Singh obtained a Masters in City Planning and a PhD in Urban Studies & Planning from MIT, and a BA in Economics from Brown University.

Download files for Keynote: OGC and the Climate Challenge Integration Plugfest

**Paul Ramsey** is an geospatial consultant with OpenGeo, an expert in open source software, and a founder of the PostGIS open source spatial database project. Paul is a director of the Open Source Geospatial Foundation, and has been a long time advocate for making intelligent use of open source in systems design. Paul speaks and teaches frequently at conferences on the use and abuse of open source geospatial software." His keynote is titled: **Beyond Nerds Bearing Gifts: The Future of the Open Source Economy**

Download files for Keynote: Beyond Nerds Bearing Gifts: The Future of the Open Source Economy (camera phone footage)
Watch the video of Keynote: Beyond Nerds Bearing Gifts: The Future of the Open Source Economy (camera phone footage)
Watch the video of Keynote by Paul Ramsey on Blip.tv (Partial)

Raul vera 100x100

**Raul Vera** began his career at Google in July 2007. Raul has been involved in digital-media technology (video animation, graphics, image processing, printing) for over 25 years, as software developer, architect, entrepreneur, and team leader. Raul's management experience spans both Australia and the USA. Raul is responsible for leading and expanding the Geo team at Google Australia, and works extensively in new product development.

Download files for Keynote: Google, Android, and next phones
Watch the video of Keynote: Google, Android, and next phones

Senator lundy 100

**Senator Kate Lundy** has represented the Australian Capital Territory in the Australian Federal Parliament since 1996. In that time she had many portfolios in opposition including IT, Manufacturing, Consumer Affairs, Sport and Health Promotion. Senator Lundy is currently Chair of the Joint Standing Committee for the National Capital and External Territories. She is a long-standing member of the Senate Environment, Communications and the Arts Committee. Senator Lundy has participated in every Senate



Inquiry relating to telecommunications and Information Technology of the last thirteen years and continues to be a strong advocate for the use of digital technology and ICT innovation to strengthen and transform the economy for future growth and enhance social inclusion within society.

Download files for Keynote: Gov 2.0
Watch the video of Keynote: Gov 2.0

Apitman

**Andy Pitman** is a Professor in atmospheric science and co-director of the Climate Change Research Centre at the University of New South Wales. His expertise is in climate modelling, with broad interests extending across climate change, climate impacts and land cover change. He is a lead author on the Intergovernmental Panel on Climate Change, national lead of the International Geosphere Biosphere Program, Chair of a major committee of the World Climate Research Program and the convenor of the ARC Research Network for Earth System Science. He is a member of the advisory board of Risk Frontiers - an industry funded centre that explores questions of climate, volcanic and hydrological risk for the insurance industry.

Download files for Keynote: Climate Change
Watch the video of Keynote: Climate Change

Richardmarles

**The Hon Richard Marles MP** is the Australian federal Parliamentary Secretary for Innovation and Industry. The Innovation, Industry, Science and Research portfolio covers a range of functions and responsibilities including the sustainable growth of Australian industries, by developing a national innovation system that drives knowledge creation, cutting edge science and research, international competitiveness and greater productivity. In his role, Parliamentary Secretary Marles has administrative responsibility for Australian Intellectual Property, the National Measurement Institute and the Australian Building Codes Board.

Download files for Keynote

Cameronshorter 100

**Cameron Shorter** is the FOSS4G 2009 chair, and will open the FOSS4G conference. He is the GeoSpatial Solutions Manager at LISAsoft where he leads software development teams in the integration of Open Source with Proprietary systems using Open Standards. He has been on the Project Steering Committee of three OSGeo projects, mentored GeoTools through incubation and chairs the Australian/New Zealand chapter of OSGeo. He writes and presents on the intersection and tensions between Business Drivers, Open Standards, and integrating Open Source with Proprietary solutions.

Download files for Chair Welcome
Watch the video of Chair Welcome

# Session Presenters

**Thierry Badard**

Dr. Thierry Badard is professor in geoinformatics at the Department of geomatics sciences of Laval University in Quebec City (Canada). He heads the GeoSOA research group and is a full time researcher and a member of the steering committee of the Centre for Research in Geomatics (CRG). He is also a regular researcher of the GEOIDE Network of Centres of Excellence in geomatics. He has more than 13 years of experience and he has been involved and has led national and international R & D projects of importance. His research interest deals with geospatial (Web) Services Oriented Architectures (SOA), location-based and context-aware web services, geospatial Business Intelligence and geo-analytical tools and the design of intelligent mobile applications for better decision support. Dr. Thierry Badard is also involved in the geospatial free and open source community. He is administrator and project coordinator of the GeOxygene, GeoKettle, GeoMondrian and Spatialytics open source projects. He is an OSGeo charter member and acts as a member of the OSGeo conference committee. He is in charge of the free software commission in the OSGeo Francophone local chapter and he co-chairs the OSGeo Quebec local chapter. He is also a co-chair of the ICA (International Cartographic Association) working group on open source geospatial technologies.

Location: Quebec City, QC, Canada

Sessions: Geospatial BI with FOSS: an introduction to GeoMondrian and Spatialytics

permalink

**Etienne Dubé**

Etienne works at the Department of Geomatic Sciences, Laval University, Quebec, Canada and has contributed to a number of open source projects

Location: Quebec City, QC, Canada

Sessions: Geospatial BI with FOSS: an introduction to GeoMondrian and Spatialytics

permalink

**Jeff McKenna**

In 2008 Jeff started his own consulting company based around FOSS4G, Gateway Geomatics, and is actively contributing to OSGeo. Founding and Charter member of OSGeo Maintainer for Maptools.org Developer for MS4W Developer for OSGeo4W MapServer Project Steering Committee (PSC) member MapServer documentation lead OSGeo FOSS4G conference committee chair FOSS4G Workshop committee member founding co-chair of OSGeo Ottawa Local Chapter

Location: Lunenburg, NS, Canada

Sessions: Getting Started with MapServer

permalink

**Tyler Mitchell**

Tyler has been working in the Geographic Information Systems (GIS) industry for over a decade, with a focus on natural resource management and forestry. Most recently, he became the Executive Director for the Open Source Geospatial Foundation - whose mission is to promote and support the development of open source tools focused on mapping and geospatial analysis. He is responsible for helping the board of directors, committees and members reach these goals. He is also the author of an O'Reilly book on open source GIS and web mapping tools: Web Mapping Illustrated. The book teaches introductory geospatial data management and map projections, building a simple MapServer-based web map, using PostGIS, programming with MapScript, using web services and more.

Location: Williams Lake, British Columbia, Canada

Sessions: Getting Started with MapServer

permalink

**Pericles Nacionales**

Perry is a Assistant Scientist in Conservation Biology program at the University of Minnesota - Twin Cities. He is interested in finding ways to integrate geospatial technologies into community-based conservation processes. You can reach him at pnaciona at gee mail dot com. :) Or at naci0002 at umn dot edu.

Location: Ottawa, ON, Canada

Sessions: Getting Started with MapServer

permalink

**Mark Leslie**



Mark Leslie has broad experience integrating Proprietary and Open Source products into customer infrastructures. He has developed and extended software across the Open Source Geospatial stack, including UMN MapServer, PostGIS, uDig and GeoTools and is now Software Architect at LISAsoft.

Location: Sydney, NSW, Australia

Sessions: Introduction to PostGIS, A Friendly Hands-on Survey of Popular Geospatial Services

permalink

**Paul Ramsey**

Paul Ramsey is an geospatial consultant with OpenGeo, an expert in open source software, and a founder of the PostGIS open source spatial database project. Paul is a director of the Open Source Geospatial Foundation, and has been a long time advocate for making intelligent use of open source in systems design. Paul speaks and teaches frequently at conferences on the use and abuse of open source geospatial software." His foss4g2009 keynote is titled: Beyond Nerds Bearing Gifts: The Future of the Open Source Economy

Location: Victoria, BC, Canada

Sessions: Introduction to PostGIS, Introduction to the Open GeoStack: PostGIS, GeoServer, GeoWebCache, and OpenLayers

permalink

**Justin Deoliveira**

Justin has been active in the open source community for a number of years. He is a charter member of the Open Source Geospatial Foundation (OSGEO), as well as a committer on projects such as GeoTools, GeoServer, and uDig.

Location: New York, NY, USA

Sessions: Introduction to the Open GeoStack: PostGIS, GeoServer, GeoWebCache, and OpenLayers, Working with GeoServer

permalink

**Andrea Aime**

Biography comming soon...

Location: New York, NY, USA

Sessions: Introduction to the Open GeoStack: PostGIS, GeoServer, GeoWebCache, and OpenLayers, Working with GeoServer, Making Maps Pretty with Style Layer Descriptor

permalink

**Tim Schaub**

Mr. Schaub works as a geospatial solutions engineer for The Open Planning Project. He serves as on the Project Steering Committee and is a core developer of OpenLayers.

Location: Bozeman, MT, USA

Sessions: Introduction to the Open GeoStack: PostGIS, GeoServer, GeoWebCache, and OpenLayers, OpenLayers - Your Foundation for Browser Based Mapping

permalink

**Arne Kepp**

Arne Kepp is a Software Engineer at OpenGeo and lead developer of GeoWebCache. He became a user and proponent of Open Source software while filling the role as system administrator for a GIS consulting

firm in 2000. Since then he has been studying hardware architecture and used his experience to improve the performance and reliability of several web services.

Location: Asker, Norway

Sessions: Making Maps Fast - Performance tuning and Tile Caching, Making Maps Fast - Performance tuning and Tile Caching

permalink

**Jim Groffen**

Jim Groffen is a Senior Software Engineer at LISAsoft. Working in IT since 1998, Jim has been with LISAsoft since 2005 working on various Spatial projects. Jim participated in OGC projects such as CGDI-IP and OWS-6. As part of OWS-6 Jim will be contributing updated WMTS support to the TileCache open source project. Other relevant areas of interest include spatial catalogues and registries, OpenLS and all things Python.

Location: Adelaide, SA, Australia

Sessions: Making Maps Fast - Performance tuning and Tile Caching, Making Maps Fast - Performance tuning and Tile Caching, Making Maps Pretty with Style Layer Descriptor

permalink

**Roald de Wit**

Roald is a software engineer/team lead for LISAsoft, a geospatial systems integration, software development and consulting company. His main area of expertise lies in the visualization of geospatial information through innovative and user friendly interfaces using web-based thin clients.

Location: Melbourne, VIC, Australia

Sessions: OpenLayers - Your Foundation for Browser Based Mapping

permalink

**Jeroen Ticheler**

Jeroen Ticheler is passionate about Africa, people, maps and technology. He's convinced that open source software is the best option to help sustainable development. Making geospatial data more accessible caused him to start the development of GeoNetwork opensource in 2001 at the Food and Agriculture Organization of the UN, the first fully open source software in the organization. He has been pushing for geospatial data sharing within the United Nations for years as task group manager on interoperable services in the UN Geographic Information Working Group and pushed the concept of a UN Spatial Data Infrastructure in that same group. In 2008 he started GeoCat bv to provide commercial services for GeoNetwork opensource. In his nightlife he supports OSGeo activities, marketing and a hacking event.

Location: Enschede, The Netherlands

Sessions: Organizing your geospatial data and services using GeoNetwork opensource

permalink

**François Prunayre**

Francois Prunayre been a user and contributor to several open source projects over the past few years: Geonetwork, SpatialDataIntegrator, Cartoweb, Mapserver

Location: comming soon...

Sessions: Organizing your geospatial data and services using GeoNetwork opensource

permalink

**Paolo Zatelli**



Paolo Zatelli,. PhD in Topographic and Geodetic Science, Assistant professor in Topography and Cartography at the University of Trento. Research and education: survey, statistics photogrammetry, numerical cartography and GIS, remote sensing.

Location: Trento, Italy

Sessions: Practical Introduction to GRASS and related software for beginners

permalink

**Marco Ciolli**

Marco Ciolli, PhD in Forest Management, Assistant professor in Forest management and planning at the University of Trento. Research and education: sustainable landscape planning and development, applied GIS , ecology, tropical ecosystems.

Location: Trento, Italy

Sessions: Practical Introduction to GRASS and related software for beginners

permalink

**Clara Tattoni**

Clara Tattoni, PhD in Analysis, protection and management of biodiversity, is now cooperating with the University of Trento. Main research topic: GIS in wildlife management, forestry and ecology. She is part of the OSGeo educational committee.

Location: Trento, Italy

Sessions: Practical Introduction to GRASS and related software for beginners

permalink

**Claude Philipona**

Claude Philipona is co-founder of Camptocamp SA and professor at the University of Applied Sciences Western Switzerland (HES-SO).

Location: Lausanne, Switzerland

Sessions: Practical introduction to MapFish, the web 2.0 mapping application framework

permalink

**Cédric Moullet**

Cédric Moullet is CTO Geospatial of Camptocamp SA and member of the GeoExt PSC.

Location: Lausanne, Switzerland

Sessions: Practical introduction to MapFish, the web 2.0 mapping application framework

permalink

**Frédéric Junod**

Fréderic Junod is developer at Camptocamp SA and committer for MapFish, OpenLayers and GeoExt.

Location: Lausanne, Switzerland

Sessions: Practical introduction to MapFish, the web 2.0 mapping application framework

permalink

**Eric Lemoine**

Eric Lemoine is senior developer at Camptocamp France SAS and committer for MapFish, OpenLayers and GeoExt. Member of the GeoExt and OpenLayers PSC.

Location: Chambéry, France

Sessions: Practical introduction to MapFish, the web 2.0 mapping application framework

permalink

**Jody Garnett**

Jody Garnett is the lead uDig architect and on the steering committee for GeoTools; GeoServer and uDig. Jody Garnett is an employee of LISAsoft with a background in training and mentoring.

Location: Sydney, Australia

Sessions: A Friendly Hands-on Survey of Popular Geospatial Services, How to Cope with GeoSpatial - Intro to GeoTools for the Java Developer

permalink

**Andrea Antonello**

Andrea Antonello from HydroloGIS developers geospatial open source solutions for environmental analysis. Andrea is well known as the lead developer of the JGrass project and is part of the uDig project steering committee.

Location: Bolzano, Italy

Sessions: A Friendly Hands-on Survey of Popular Geospatial Services

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**Rob Atkinson**

Rob Atkinson is a distributed systems architecture with a long-term interest in sustainability, and the need to integrate systems across multiple application domains. He is a co-author of the original OGC Web Map Server 1.0 specification, and has been involved in numerous other OGC specifications and data standards. Rob has been driving a long-term agenda to make GeoServer capable of delivering data within a Spatial Data Infrastructure.

Location: Wollongong, Australia

Sessions: Delivering data using published application schemas

permalink

**Dan Ames**

Daniel P. Ames is an associate professor of Geosciences and Civil Engineering at Idaho State University – Idaho Falls where he directs the Geospatial Software Lab and leads the open source MapWindow GIS project. Dr. Ames has been an advocate of OSGeo since its inception and has actively participated in the OSGeo Journal effort, OSGeo Education Committee, FOSS4G 2006 (workshop presentation) and FOSS4G 2008 (booth sponsor and workshop and lab presented by Dr. Ames' students). With a primary interest in developing programmer tools Windows platform, Dr. Ames' GIS software projects have included work for many U.S. agencies and international collaborators.

Location: Idaho Falls, Idaho, USA

Sessions: Getting Started with MapWindow: An easy-to-install, easy-to-use free GIS for Windows

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**Ted Dunsford**

Ted Dunsford is a PhD Candidate in Engineering and Applied Sciences at ISU and will help deliver the workshop.

Location: Idaho Falls, Idaho, USA

Sessions: Getting Started with MapWindow: An easy-to-install, easy-to-use free GIS for Windows



**Michael Bedward**

Biography comming soon...

Location: Sydney, Australia

Sessions: How to Cope with GeoSpatial - Intro to GeoTools for the Java Developer

**Hanko Rubach**

Hanko Rubach holds a university degree in environmental sciences (University of Lüneburg, Germany, http://www.uni-lueneburg.de/fb4/). Since 2006 he is working as consultant with lat/lon GmbH in Bonn, Germany. Hanko is deeply involved in SDI projects where deegree components play an important role. Within the deegree project he was involved with preparing the 2.x releases where he made significant contributions to the quality management within the whole project. More specifically, he has been managing the demo packages production.

Location: Bonn, Germany

Sessions: Introduction to deegree iGeoDesktop

**Andreas Hocevar**

Andreas is a core committer to MapBuilder, OpenLayers and GeoExt. Coming from an urban and regional planning background, he knows the requirements of maps and mapping applications for planners and governments. Improving the way users can apply design principles and good practices of cartography to open maps has been the driving force behind his efforts in FOSS4G, especially in building SLD support into OpenLayers and GeoExt. As a consultant for OpenGeo, he enjoys being part of an international team of experienced FOSS4G developers devoted to well established projects like GeoServer, PostGIS and OpenLayers.

Location: Graz, Austria

Sessions: Leveraging OGC Services with GeoExt

**Jan Drewnak**

From March 2003 until October 2005 Jan Drewnak worked as a research associate at the Institute for Geoinformatics, Muenster, Germany. He is engaged in the German regional initiative "Spatial Data Infrustructure North Rhine-Westfalia" (GDI NRW) as a security architect and engineer. Since May 2005 he works as software consultant and engineer for the con terra GmbH, Muenster, with focus on security in spatial data infrastructures. He also heads the 52°North Open Source Initiative's "Security Community".

Location: Muenster, Germany

Sessions: Protecting OGC Web Services with the 52°North Security System

**Arne Broering**

Arne is working as a research associate for the Sensor Web and Simulation Lab (http://swsl.uni-muenster.de) at the University of Muenster. His research interests include middleware concepts for the Sensor Web, visualization of geodata (and especially sensor data) as well as the Human Sensor Web. He is as well an associated software developer of the open source initiative 52°North, an international R&D consortium based in Germany. Further on, Arne is strongly involved in the development of OGC's Sensor Web Enablement standards. He is the current chair of the Sensor Observation Service working group.

Location: Muenster, Germany

Sessions: Sensor Web Enablement - Bringing Sensors into SDIs

**Simon Jirka**

Biography comming soon...

Location: Muenster, Germany

Sessions: Sensor Web Enablement - Bringing Sensors into SDIs

**Chirstoph Stasch**

Biography comming soon...

Location: Muenster, Germany

Sessions: Sensor Web Enablement - Bringing Sensors into SDIs

**Thomas Everding**

Biography comming soon...

Location: Muenster, Germany

Sessions: Sensor Web Enablement - Bringing Sensors into SDIs

**Rob Lemmens**

Rob Lemmens is Assistant Professor Applied Computer Science in the Department of Geoinformation Processing at ITC. He has expertise and a publication record on GI open source projects, Internet GIS, Spatial Data Infrastructures and semantic modelling of distributed geo-webservices and ontology-based geo-information. Rob is ITC's representative for the Open Geospatial Consortium (OGC) and community leader of the ILWIS open source GIS software at 52°North, where he coordinates project-based open source software development. He has initiated and participated in courses on interoperable web mapping around the world. He is project participant in the GEOSS open source for capacity building work package.

Location: Enschede, The Netherlands

Sessions: Using ILWIS with its PostGIS plug-in for raster-vector applications

**Richard Chirgwin**

Richard Chirgwin is a telecommunications journalist and analyst, and is an associate consultant at Market Clarity. He has developed a strong interest in FOSS4G since 2006 when he first started working with Grass-GIS. In that time, Richard has applied Grass-GIS to a range of telecommunications infrastructure analysis problems, and in teaching colleagues the applications of Grass-GIS, he has become familiar with common problems and errors confronting the new user.

Location: Sydney, Australia

Sessions: Working with GRASS-GIS Vectors and Databases

**Mike Pumphrey**

Mike Pumphrey has a love of maps stretching back to childhood, and has spent over a decade in the fields of support and training. In his current vocation as Outreach Engineer for OpenGeo, he is the curator of the GeoServer Blog, the lead documentation writer for GeoServer, and the maintainer of the GeoServer Windows Installer. He is currently developing training classes for building and maintaining an open source geospatial stack.

Location: Brooklyn, NY, USA

Sessions: Introduction to PostGIS

# Academic Papers

### Collaborative Web-Based Mapping of Real-Time Flight Simulator and Sensor Data



Google Maps is an example of howWeb 2.0 technology such as AJAX can be used to create online map services that are easy to access, user-friendly and fast. Thanks to flexible web-based mapping APIs, it is now possible for non-experts to plot and distribute GIS (Geographic Information System) data to a large audience. Most data plotted so far, however, has been relatively static. In addition, the typical webpage layout has limited the interaction possibilities for online maps when compared with windowed applications. This paper will present a JEE-based publish/ subscribe architecture that allows real-time sensor data to be displayed collaboratively on the web, requiring users to have nothing more than a web browser and Internet connectivity to gain access to that data. The architecture is tested using live data from Microsoft Flight Simulator and data conforming to the OGC Sensor Observation Service (SOS) standard. By using the latest web-based technology from open source projects like OpenLayers and 52North, this paper shows how maps and GIS data can be made more accessible, more social and generally more useful.

**Authors:** Rabih Dagher, Cristian Gadea, Bogdan Ionescu, Dan Ionescu and Robin Tropper

**Biography:**

Rabih Dagher is currently doing his Master's in Computer Science at the University of Ottawa, where he also received his BASc. in Software Engineering in 2006. He's a certified Java Programmer, and is specialized in the back-end development of JEE Web-based systems.Cristian Gadea is a Computer Science Master's student at the School of Information Technology and Engineering at the University of Ottawa, Canada, where he also obtained his undergraduate degree in Software Engineering (2007). His research interests include Web 2.0, GIS, mobile computing, human-computer interaction and video game technologies.Dr. Dan Ionescu received Dipl. Ing. and Dr. Ing. degrees from the Polytechnic Institute of Bucharest, Romania, and a Diploma in Mathematics from the University of Timisoara, Romania. He has been with the University of Ottawa since 1985, where he is currently Professor in Computer Engineering and the Director of the Network Computing and Control Technologies ( NCCT) Laboratory. His current research interests are distributed systems and applications for the automation of the information technology infrastructure, with applications to autonomic computing.Bogdan Ionescu received his undergraduate degree in Computer Engineering from the School of Information Technology and Engineering at the University of Ottawa and is currently doing his Master's there. His research interests include networking, data mining, and distributed computing.Robin Tropper graduated with a B.A.Sc. in Software Engineering in 2006, a B.Ed. in Education in 1996 from University of Ottawa and a B.Mus. in Classical Music in 1994 from McGill University. He is now pursuing an M.A.Sc. in Computer Engineering while working at the NCCT Laboratory. Robin's work focuses on a component-based architecture for a scalable and extensible Real-Time collaborative applications platform. He further aims to facilitate and promote musical performance (as opposed to consumption) with the help of modern technologies.

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### MapWindow Modeler - A Modular Spatial Modeling Environment for GIS

Download files for MapWindow Modeler - A Modular Spatial Modeling Environment for GIS

Development of an open source modeling environment for use with spatial data in a Geographic Information System (GIS) is presented. To date, legacy versions of MapWindow have lacked an integrated modeling environment suitable for linking together independent geospatial and temporal processes at a granular level. This new modeling environment allows users to easily create models which can take advantage of spatial data objects and analytical tools. The design approach focuses on an ITool interface that serves as an independent point for the run-time discovery of geoprocessing extensions. The user interface is automatically generated by the modeler when their tool is instantiated based on parameter characteristics on the ITool interface. The design is also versatile, allowing processes to also be run through a more traditional method of adding a reference and calling the processes as functions programatically.

**Authors:** Brian Marchionni, Daniel P. Ames, Harold Dunsford

**Biography:**

Brian Marchionni is a Master's student at Idaho State University where he is studying Geographic Information Science. Presently he is the lead developer of the MapWindow GIS Modeler, the MapWindow Print Engine and is one of the maintainers of the MapWindow GIS desktop application. He has a Bachelor's of Computer Science from Concordia University in Montreal with a minor in Geography and has work experience as a professional cartographer.Daniel P. Ames, Ph.D. is the director of the Geospatial Software Lab at the Department of Energy Center for Advanced Energy Studies in Idaho Falls, Idaho where he leads the open source MapWindow GIS software project. He is also an Associate Professor in Geosciences and

Civil Engineering at Idaho State University and is the director of ISU's graduate programs in GIS. Harold (Ted) Dunsford is a Ph.D. student in Engineering and Applied Science at Idaho State University. He is currently the lead developer of the MapWindow 6.0 open source GIS project, a C# .Net project that can run on other platforms using mono. He has a Masters of Physics from Mississippi State University. He also has several years of experience working in industry, including an environmental engineering firm where he worked with geographic information systems, developed custom software, and managed large scale remediation projects in the field.

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### Media Mapping: Using Georeferenced Images and Audio to provide supporting information for the Analysis of Environmental Sensor Datasets

Download files for Media Mapping: Using Georeferenced Images and Audio to provide supporting information for the Analysis of Environmental Sensor Datasets

Field based environmental monitoring projects often fail to gather supporting temporal information on the surroundings, yet these external factors may play a significant part in understanding variations in the collected datasets. For example when sampling air quality the values may change as a result of a bus passing the sampling point, yet this temporal local information is difficult to capture at a consistently high resolution over extended time periods. Here we develop an application which runs on a mobile phone able to capture visual and audio data with corresponding time and location details. We also develop a desktop analysis tool which synchronises the display of this dataset with those captured from environmental sensors. The result is a tool able to assist researchers in understanding local changes in environmental datasets as a result of changes in the nearby surrounding environment.

**Authors:** Phil Bartie, Simon Kingham

**Biography:**

Phil Bartie is a PhD candidate at the Geospatial Research Centre, University of Canterbury, NZ. Previously he has worked in government and commercial sectors designing and implementing GIS solutions. He holds a BSc(Hons) in Human and Physical Geography, and MSc in GIS. His research interests include location based services, interface design, and visibility analysis.Dr Simon Kingham is an Associate Professor in the Department of Geography at the University of Canterbury. He came to the to the University of Canterbury in 2000 having completed his PhD at Lancaster University and having worked at the Universities of Newcastle, Huddersfield and Hertfordshire in the UK. In New Zealand Simon has been involved in a variety of pollution related project. He was an author and key contributor to the Fisher et al, 2002, Health effects due to motor vehicle air pollution in New Zealand. Report to the Ministry of Transport. Following this he worked on the Urban air quality processes 2002-04 (funded by the Foundation for Research Science and Technology, NZ), the Health and air pollution in New Zealand (HAPINZ) 2002-2005 (funded by Ministries of/for Health, Transport and Environment), and the Protecting New Zealand's clean air 2004-08 (funded by the Foundation for Research Science and Technology, NZ).

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### MapWindow 6.0: An Extensible Architecture for Cartographic Symbology

Download files for MapWindow 6.0: An Extensible Architecture for Cartographic Symbology

A robust, extensible architecture is critical to open source projects that have a distributed developer and user base. The MapWindow 6.0 project is using a new architectural paradigm where extensibility is handled from several different plug-in points, rather than a single, application wide design. This allows new kinds of extensibility to be explored such as tools and data providers in addition to the more conventional application wide extensibility. This presentation outlines some of the improvements in the built in cartography, but primarily addresses the .Net architectural decisions that permit run-time discovery of new kinds of custom symbology. Improvements include layering of different kinds of symbols to make a compound symbol as well as establishing cartographic sub-categories based on vector attributes or raster values. The open ended framework allows for an extremely flexible system of run-time discovery so that the core libraries do not have to be recompiled each time an external cartographic improvement is developed.

**Authors:** Harold A. Dunsford Jr., Daniel P. Ames

**Biography:**



Daniel P. Ames, Ph.D. is the director of the Geospatial Software Lab at the Department of Energy Center for Advanced Energy Studies in Idaho Falls, Idaho where he leads the open source MapWindow GIS software project. He is also an Associate Professor in Geosciences and Civil Engineering at Idaho State University and is the director of ISU's graduate programs in GIS. Harold (Ted) Dunsford is a Ph.D. student in Engineering and Applied Science at Idaho State University. He is currently the lead developer of the MapWindow 6.0 open source GIS project, a C# .Net project that can run on other platforms using mono. He has a Masters of Physics from Mississippi State University. He also has several years of experience working in industry, including an environmental engineering firm where he worked with geographic information systems, developed custom software, and managed large scale remediation projects in the field.

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### A Data System for Visualizing 4-D Atmospheric CO2 Models and Data

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This paper describes a geospatial data system that produces KML representations of complex spatio-temporal datasets related to modeling the atmospheric carbon cycle. KML is an open standard language for transferring annotated geospatial data that can be used by many modern geospatial software packages, particularly virtual globe applications. The server component of the data system is built using a variety of open source software packages, which provide flexibility for creating custom geospatial representations of the datasets. The paper shows examples of how Google Earth, a popular virtual globe with a user-friendly interface, can be used by a diverse group of users as a visualization client to explore the complex scientific datasets that are central to the discussion of climate change and global warming.

**Authors:** Tyler A. Erickson 1, Anna M. Michalak 2, John C. Lin 3

**Biography:**

Dr. Tyler Erickson is a Research Scientist at the Michigan Tech Research Institute, and holds an Adjunct Assistant Professor appointment in the Department of Civil and Engineering at Michigan Technological University, USA. Dr. Erickson holds a B.S. from Colorado State University, a M.S. for the California Institute of Technology, an Engineer Degree from Stanford University, and a Ph.D. from the University of Colorado. His research interests include algorithm development for geostatistical analysis and designing internet-based geospatial information systems using open source technologies, primarily for managing datasets and models for environmental monitoring. In 2009, he was selected as one of the professional winners in Google's KML in Research Competition.Dr. Anna M. Michalak is an Associate Professor in the Department of Civil and Environmental Engineering, and holds a joint appointment in the Department of Atmospheric Oceanic and Space Sciences at the University of Michigan, USA. The common theme of her research is the development and application of statistical and geostatistical data fusion methods for optimizing the use of limited in situ and remote sensing environmental data. Dr. Michalak holds a B.Sc. from the University of Guelph, Canada, and M.S. and Ph.D. degrees from Stanford University, California, USA. She is the recipient of the Presidential Early Career Award for Scientists and Engineers, the National Science Foundation CAREER Award, and the Association of Environmental Engineering and Science Professors Outstanding Educator Award. Dr. John C. Lin is an Assistant Professor in the Department of Earth and Environmental Sciences at the University of Waterloo in Canada. He grew up in Taiwan and Japan and went on to receive his A.B., A.M., and Ph.D. from Harvard University. His research interests include 1) atmospheric modelling using Lagrangian methods; 2) carbon cycle science; and 3) exchanges of pollutants, energy, and momentum at the land-atmosphere interface. He has received an Ontario Early Researcher Award, a NOAA Postdoctoral Fellowship in Climate and Global Change, and a Harvard University Distinction in Teaching Award.

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### Use of Cloud computing in impact assessment of climate change

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Climate change could have a pronounced impact on natural and agricultural ecosystems. To assess the impact of climate change, projected climate data have been used as inputs to models. Because such studies are conducted occasionally, it would be useful to employ Cloud computing, which provides multiple instances of operating systems in a virtual environment to do processing on demand without building or

maintaining physical computing resources. Furthermore, it would be advantageous to use open source geospatial applications in order to avoid the limitations of proprietary software when Cloud computing is used. In our pilot study, Amazon Web Service – Elastic Compute Cloud (EC2) was used to calculate the number of days with rain in a given month. Daily sets of climate projection data, which were about 70 gigabytes in total, were processed using virtual machines with a customized database transaction application. The application was linked against open source libraries for the climate data and database access. In our study, it took about 32 hours to process 17 billion rows of record in order to calculate the rain day on a global scale over the next 100 years using ten clients and one server instances. Our study showed that Cloud computing could provide the high level of performace for impact assessment studies of climate change that require considerable amount of data.

**Authors:** Kwang Soo Kim, Doug MacKenzie

**Biography:**

Kwang Soo Kim, Ph.D. is a scientist at Plant and Food research where he is working on climate risk assessment models. Doug MacKenzie, NDBC. Currently working for Plant & Food Research as an IT Network and Services Analyst. Prevously at Auckland University of Technology – School of Computing and Mathematical Sciences as a lecturer in Networking, Internet Technologies and Network Security.

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## Development of Track Log & POI Management System using Free and Open Source Software

Download files for Development of Track Log & POI Management System using Free and Open Source Software

Recent advanced performance of low-cost GPS and GPS-enabled cell phone has contributed a great deal to the development of location-aware services and systems. The broadband environment has promoted collaborative projects such as OpenStreetMap or other User Generated Contents services. In this research, a web-based prototype system for GPS track log and POI management was developed to archive a collaborative framework in field survey. The main functionalities of the system can be separated by 3 parts; data collection, data management and data quality enhancement. The system supports real-time data collection for the future ubiquitous environment and also can monitor real-time GPS position. This research shows functionalities which can minimize GPS errors using DOP filtering and data quality enhancing techniques using Douglas-Peucker algorithm and PgRouting. The research introduces a system that provides an interoperable framework to work with other geospatial services through open geospatial standards.

**Authors:** 1 Daisuke Yoshida, 1,2 Xianfeng Song, 1 Venkatesh Raghavan

**Biography:**

Daisuke Yoshida is a doctoral student at the Graduate School of Creative Cities, Osaka City University and works at the Faculty of Liberal Arts, Tezukayama Gakuin University as a lecturer. He has participated on a Japanese volunteer program, JICA in the Philippines to provide technical assistance for implementing SDI prototype using FOSS4G tools. His research interests are Web-GIS development, LBS, Real-time GPS, Mobile GIS and digital archives. He has also been a FOSS4G trainer at several international workshops. He is a board member OSGeo-Japan Chapter and an organizer for FOSS4G-Osaka annual events.Xianfeng Song research interest is Geo-Processing Workflow and their applications in infrastructure management and environment modeling. His current research include (1) Optimizing geospatial Web services chain based on QoS (2) SWAT model for hydrology simulation and sediment yield estimation (3)Map-Matching and LBS Services. He is presently Associate Professor at the Graduate University of Chinese Academy of Sciences. He is an active member of the OSGeo-China Chapter.Venkatesh Raghavan (Venka) has been involved in OSGeo since its inception. He was one of the Directors in the first OSGeo Board and is currently a Charter Member. He is deeply involved in OSGeo Local Chapters in Asia. Presently based in Japan as Professor of Geoinformatics at Osaka City University. His research interest include distributed geoprocessing, Sensor Net and Remote Sensing for change detection.

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## Geoprocessing in the Clouds

Download files for Geoprocessing in the Clouds



Cloud Computing is one of the latest hypes in the mainstream IT world. Spatial Data Infrastructures (SDI) with its classical publish-find-bind paradigm have not been affected yet by this emerging trend. This paper reviews this novel technology and tries to identify the paradigm behind it. In particular, the scalability aspect for a cloud enabled 52°North Open Source Web Processing Service is challenged and proven in the exemplary Google Cloud. On this basis, future direction for SDIs and Cloud Computing paradigm are identified.

**Authors:** Bastian Baranski, Bastian Schäffer, Richard Redweik

**Biography:**

Bastian Baranski is a research associate at Institute for Geoinformatics (IfGI). His major research focuses on the merger of Spatial Data Infrastructures (SDI) and Grid and Cloud Computing with a special focus in SLAs.Bastian Schäffer is the head of the geoprocessing community at the open source initiative 52°North. He is also a research associate at Institute for Geoinformatics (IfGI). His reseach interests focus on interoperability, SDIs, Geoprocessing Workflows and Cloud Computing.Richard Redweik is a student assistant at the Institute for Geoinformatics (ifgi). He is also working for the open-source initiative 52°North. Currently he is elaborating the use of cloud-computing in geoinformatics.

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## User-friendly interactive WPS programming

Download files for User-friendly interactive WPS programming

A number of mission critical activities, such as environmental manage ment and risk assessment, heavily depend upon the availability of effective software solutions capable of simulating complex phenomena occurring over a territory. Typically, operators have to utilize multiple software components in order to explore different parts of the same problem. Furthermore, switching the context between applications is often an expensive process (e.g. conversions and transfer of data between the applications) that can lead to human errors. We present an extensible 3D framework, which allows operators to visually build complex routines within the 3D scene by composing articulated graphs, from a set of elementary processing units made available in an interoperable way through web services. Additionally, operators can visually program and deploy new algorithms. This is an important issue within collaborative activities, where is often necessary to create new bridges between different knowledge areas in response to unexpected situations.

**Authors:** Raffaele de Amicis, Giuseppe Conti, Bruno Simões, Stefano Piffer

**Biography:**

Raffaele De Amicis is the GraphiTech's Director. He holds a MEng in Mechanical Engineering and a Ph.D. from University of Bologna, Italy. He has been research fellow at the Fraunhofer Institute for Computer Graphics in Darmstadt, and senior researcher at the Interactive Graphics Systems Group, at Technical University of Darmstadt, Germany. He has been involved in several projects funded by the European Commission, NATO/OTAN, Government Institutions and by industries. His interests are in virtual reality, virtual engineering, geovisual analytics, science and technology policy. He has authored 2 books, contributed to 11 scientific texts, and he is co-author of more than 100 scientific papers. He also serves as Consulting Professor, in computer graphics, at the University of Trento, Italy. Giuseppe Conti is a senior researcher at GraphiTech. In November 2002 he received a PhD degree at the Abacus Unit, University of Strathclyde, UK from which he graduated with a research thesis on the implementation of a 3D interfaces for a Virtual Reality systems for architecture. He holds a masters MEng in Civil Engineering from the University of Palermo with a thesis developed at the CAD department of the Technical University of Lund – Sweden. He has been functional project leader of several projects at Graphitech in the area of Cultural Heritage, client-server systems for 3D geographical information system both as EU, national project as well as industrial projects.Bruno Simões was born in Ourém, Portugal in July of 1984. He holds a MSc in Computer Science at University of Évora, Portugal, and he is currently working as a software engineering at Fondazione Graphitech in Italy. In 2007 he worked as Junior Investigator in Bioinformatics at University of Évora and also in some free lancer projects. His research interests include all areas of Computer Graphics, advanced 3D interaction techniques, visual analytics and image processing. More details about him or his projects can be found at the following web site http://www.brunosimoes.org. Stefano Piffer is a member of the technical staff at Fondazione Graphitech, where he works on issue related to high-quality interactive graphics in Geographical environment. He received the M.D.in Telecommunications Engineering in 2004 from the University of Trento, Italy with a work on the adaptive antennas synthesis, antenna design, adaptive signal processing and adaptive beamforming. His work covered a wide variety of

computer graphics topics, including real-time simulation, general-purpose computation on GPUs and shading language. Nowadays he is working on NASA World Wind API and Virtual Terrain Project Tool for the fruition of Spatial Data Infrastructure in Public Administration context.

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### Two-dimensional dam break flooding simulation: a GIS embedded approach

Download files for Two-dimensional dam break flooding simulation: a GIS embedded approach

In the XXI century around 200 notable dam and reservoir failures happened worldwide causing massive fatalities and economic costs. In order to reduce the losses, managers usually identify flooding area due to dam break using standalone hydrodynamic models and then import the results within a GIS to perform risk analysis. This two step procedure is time expensive, error prone, due to export/import requirements, and not user friendly. For this reason with this work, a new numerical model for the solution of the two-dimensional dam break problem has been implemented in the GRASS GIS as a GIS embedded module. The model solves the conservative form of the 2D Shallow Water Equations (SWE) using a Finite Volume Method (FVM); the inter-cell flux is computed by one-side upwind conservative scheme extended to a two-dimensional problem. The new developed GIS module, among others outputs, allows to derive maximum intensity maps that can be directly used for risk assessment. Finally, the model has been tested with two standard synthetic problems referenced in literature and verified in a real dam case using existing official flooding maps. The problem formulation, the new GRASS module and its validation is presented.

**Authors:** Roberto Marzocchi, Massimiliano Cannata

**Biography:**

Massimiliano Cannata received his PhD in Geodesy and Geomatic Engineering at the Polytechnic of Milano after a MSc degree in Georesource Environmental Engineering. He’s currently the the head of the Geomatics Division at the Earth Science Institute (http://istgeo.ist.supsi.ch) where is responsible for a number of international research projects. He’s also an active member of the Open Source Software for Geography community, being contributors of new GIS developments and member of the GRASS GIS Project Steering Committee. At a local level, Massimiliano fostered the creation of the OSGeo Italian language Chapter. His main research fields are Geographical Information Systems, Geographical Web Services and GIS applications, particularly risk assessment and environmental modeling. Roberto Marzocchi achieves a Master of Science in Soil Protection and Water Engineering at the University of Genoa in 2007 with a final project about GIS and hydrodynamic flooding model. Currently he is following a Ph.D. in Hydrogeology at the Institute of Earth Science (Lugano) with the University of Lausanne. He is interested in surface or ground water flow model and GIS.

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### Images analysis improvement by variational segmentation in GRASS GIS

Download files for Images analysis improvement by variational segmentation in GRASS GIS

This work deals with the study of the variational approach to the image segmentation problem in GRASS GIS. Segmentation is the process of partitioning a domain into disjoint and homogeneous regions according to some criteria. These regions can be requested to be smoother than the original data, while the smoothing is restrained not to act on the boundaries of the segmented regions, thus preserving the main data features and making them easier to analyze. An original library and a new module for the GRASS GIS have been developed. Details on the underlying theory, the new algorithms, the development and the use of a new GRASS GIS module are given. The advantages provided by this new approach are assessed in practical applications, such as image classification and raster to vector conversion, with remarkable results. Practical evidence of the theoretically foreseen capabilities of the variational model is also given.

**Authors:** Alfonso Vitti, Paolo Zatelli

**Biography:**

Alfonso Vitti received his MSc degree in Environmental Engineering from the University of Trento in Italy in 2002. He received a Ph.D. degree in Environmental Engineering from the University of Trento in Italy in 2007. The Ph.D. degree thesis was in the field of image and signal segmentation by variational methods and on the numerical implementation, application, and integration of such methods in the GRASS GIS.



~From January 2005 is Assistant Professor in Topography and Cartography at the Engineering Faculty of the University of Trento, he is a member of the Civil and Environmental Engineering Department. Paolo Zatelli, born in Pavia, Italy the 2 March 1968. PhD in Topographic and Geodetic Science (1998). From 2001 Assistant professor in Topography and cartography at the DICA of the Engineering Faculty of the University of Trento. University and PhD courses: Survey and statistical data treatment, Photogrammetry, Numerical cartography and GIS, Remote sensing and GIS, Mathematical and statistical methods, Environmental data management and analysis. Research topics: Land survey, efficient elaboration and integrated data management techniques, multiresolution data analysis for efficient data representation and filtering, Web geoservices and databases.

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### Wetland Ecosystem Computational Model Sharing and Integration based on Open Standards

Download files for Wetland Ecosystem Computational Model Sharing and Integration based on Open Standards

Wetlands are arguably one of the most important ecological structures in existence. In order to simulation the interdisciplinary changes for wetland, models for different disciplinary are needed. Numerous wetlands related computational models have been developed based on sound principles and published in journals or presented in conferences. However, modelers have made few advances in development of computable modules that facilitate sharing during model development or utilization. Constraints hampering development of model sharing technology includes limitations on computing, storage, and connectivity; traditional stand-alone and closed network systems cannot fully support sharing and integrating geospatial models. To address this need, we have identified methods for sharing and integration geospatial computational models using distributed GIS techniques and open standards. Computational models shared through services compliant with Web Processing Service (WPS), and we also developed a platform to help modelers publish individual models in a simplified and efficient way. Finally, we illustrate our technique using four wetland related models and the time-driving simulation system we developed for the prairie pothole region of North America.

**Authors:** 1,2 Min Feng, 3 Shuguang Liu

**Biography:**

Dr. Min Feng, Senior Scientist at Global Land Cover Facility ( GLCF) University of Maryland (UMD), Assistant Research at Institute of Geographic Sciences and Nature Resources Research ( IGSNRR) Chinese Academy of Sciences (CAS), specializes in distributed geospatial data/model sharing and integrating to simulate ecosystem interactions and environmental changes. Dr. Feng has a Ph.D. in Geographic Information System and Mapping with an emphasis on geospatial model sharing and integration from IGSNRR, CAS. Dr. Shuguang (Leo) Liu, Research Ecologist at USGS (U.S. Geological Survey) Earth Resources Observation and Science (EROS), specializes in development and applications of complex modeling and decision-support systems to simulate human-land-atmosphere interactions and environmental consequences at the site to global scales. Dr. Liu has a Ph.D. in Forestry with an emphasis on watershed management and hydrology from the University of Florida.

permalink

# FOSS4G 2009 Tutorials

#### A Friendly Hands-on Survey of Popular Geospatial Services

Download files for A Friendly Hands-on Survey of Popular Geospatial Services

Would you like to get started with free and open source software for geomatics? This workshop will get you started from the comfort of a desktop application! This workshop provides a survey of popular open source geospatial software allowing you to plan the rest of your week based on firsthand experience. The background of each project will be provided and you will have a chance to see how the different applications perform and what they are capable of. The User-friendly Desktop Internet GIS (uDig) application is used to provide an introduction to geospatial concepts and ideas. The uDig application is integrated with the desktop experience with drag and drop support, features an embedded internet browser, and is available on a range of platforms. For those new to the geospatial field we will cover how Features and Projections are used to draw your information onto a Map. We will also look into your

enterprise needs ranging from use of PostGIS to working with simple Shapefiles. With access to more powerful data sources we will explore the range of styling and visualisation options. Plenty of time will be set aside for questions – welcome to FOSS4G!

Presenters: Jody Garnett, Mark Leslie, Andrea Antonello

permalink

**Delivering data using published application schemas**

Download files for Delivering data using published application schemas

This tutorial will introduce and explain the use and configuration of GeoServer with formal application schemas, such as those underpinning Spatial Data Infrastructures. The tutorial will provide a step-by-step explanation of the functionality and usage of the application-schemas DataAccess module, brand new to GeoServer 2.x Attendees will be encouraged to create their own configured installation of GeoServer 2.0.

Presenters: Rob Atkinson

permalink

**Getting Started with MapWindow: An easy-to-install, easy-to-use free GIS for Windows**

Download files for Getting Started with MapWindow: An easy-to-install, easy-to-use free GIS for Windows

MapWindow GIS (www.mapwindow.org) is a widely used free GIS for the Microsoft Windows operating system. With an easy-to-use installer and a number of plug-ins for geoprocessing, data manipulation, and visualization, MapWindow is an excellent GIS for a many applications. This tutorial will introduce novice GIS users to the MapWindow GIS application and several key plug-ins. A copy of the e-Book, "A Practical Look at MapWindow" which includes several introductory exercises will be supplied to attendees. Specific exercises that make use of the data from the Climate Change Integration Plugfest (CCIP) will be used during the tutorial.

Presenters: Dan Ames, Ted Dunsford

permalink

**How to Cope with GeoSpatial - Intro to GeoTools for the Java Developer**

Download files for How to Cope with GeoSpatial - Intro to GeoTools for the Java Developer

Are you new to GeoSpatial? Are you not cool enough to be a Neo-Geographer AJAX empowered meta tagging Ruby wunderkind ? Does scientific mumbo-jumbo make your head hurt? Are you (gasp!) just out to get the job done? Come to this tutorial and go home happy. This Java tutorial is developers who are new to the GeoSpatial scene - it offers an introduction to concepts, projects, and how to avoid common pitfalls. We will start with something nice, fun and visual - fetching content from Web Map Servers. The focus is on you and the code you need to get the job done. We will explore what maps are made of: Features (literally things you can draw on a Map), Geometry (what to actually draw) and details like units and coordinate reference systems. These ideas are represented as nice normal Java objects by the GeoTools and Java Topology Suite projects. We will work with common data formats and show how to make queries and modify information. For visualisation we will use a nice Swing widget and show how to control the rendering system with style. Attend this tutorial - it will be very much hands on – and fun.

Presenters: Jody Garnett, Michael Bedward

permalink

**Introduction to deegree iGeoDesktop**

Download files for Introduction to deegree iGeoDesktop

iGeoDesktop is the brand-new desktop GIS component in the deegree project (http://deegree.org). It is based on established deegree technology and modular by design to allow for flexible and use-case dependant configuration, standards-based SDI integration, integration with other third-party desktop components. In this hands-on tutorial participants will get to know basic usage patterns of the tool, along with an insight to configuration. Based on services and data which are being made available within the Climate Change Integration Plugfest, participants will learn how to use iGeoDesktop in order to integrate



SDI resources from various sources (local data and OGC services like WCS, WFS and WMS), including resource metadata, map layout and basic analysis issues. The concept of an iGeoDesktop project will be introduced as a combined definition of geospatial contents, functions and tools available to the user, and overall layout.

Presenters: Hanko Rubach

permalink

**Leveraging OGC Services with GeoExt**

Download files for Leveraging OGC Services with GeoExt

GeoExt is a pure JavaScript toolkit for building rich web-based GIS applications. Built upon ExtJS and OpenLayers, it supports all common proprietary and open data formats and maps, including many of the Open Geospatial Consortium's (OGC) specifications like Web Mapping (WMS), Web Feature (WFS) services, and Styled Layer Descriptor (SLD). This tutorial will walk participants through the usage of the GeoExt widgets of a simple GIS application entirely based on OGC services. Available widgets include functionality for adding layers from arbitrary WMS servers, editing layer styles based on the SLD standard, and querying data using the WFS protocol. On-site data from the Climate Change Integration Plugfest (CCIP) will be used. The target audience for this tutorial are decision makers and users interested in the state of the art of web-based GIS applications using open standards. In addition to seeing GeoExt in action, participants will gain an understanding of its modular design by browsing code snippets and making configuration changes. To make the latter a fun experience, some basic knowledge of JavaScript and/or JSON is beneficial.

Presenters: Andreas Hocevar

permalink

**Making Maps Fast - Performance tuning and Tile Caching**

Download files for Making Maps Fast - Performance tuning and Tile Caching

Speed of response is critical to a user experience. While hardware and platform considerations are briefly discussed, the focus of this tutorial is on what can be done at the data level, the service level and especially caching. Participants will see how small changes in design and implementation can reap big benefits. The topics of the tutorial include: The Data: Spatial data stores. Attribute and spatial indexes. The Map: Limiting what gets rendered. Image size vs. quality. The Cache: Google does it, so can you. The OS: Scalability and concurrency. Once we have data loaded into PostGIS and served by GeoServer we will move on to the main focus of the workshop: tile caching. Installing TileCache. Setting up your layer. Configuring GeoWebCache in GeoServer. Metatiling. How it works with HTTP, caching proxies and caching clients. OpenLayers will be used throughout the workshop to verify the effects of our changes.

Presenters: Arne Kepp, Jim Groffen

permalink

**Making Maps Pretty with Style Layer Descriptor**

Download files for Making Maps Pretty with Style Layer Descriptor

Tips and tricks to get your maps looking great. Supported by many GIS packages today, Styled Layer Descriptor (SLD) uncouples map styling from the mapping services. Learn how to make and apply SLD using freely available tools. SLD is an OGC standard that allow users to define symbolisation and colouring of spatial data. During the tutorial participants learn the basics of SLD, and some tips and tricks: SLD editing with uDig. The GeoExt based SLD editor in GeoServer. What you can do with SLD rules. How filters control what gets styled. Styling tricks. Performance considerations. The exercises performed build up a case for the benefits of SLD and the best practices for using it. There will also be an opportunity to compare SLD support in OpenJUMP, OpenLayers and other open source packages. An information sheet on SLD support in existing GIS packages and a quick reference guide for both SLD and the Filter Encoding Specification will be provided.

Presenters: Andrea Aime, Jim Groffen

permalink

**Protecting OGC Web Services with the 52°North Security System**

Download files for Protecting OGC Web Services with the 52°North Security System

After a brief introduction into the basic concepts of the 52°North security system solution, the participants will set up a scenario installation of the system to restrict access to an example Web Map Service. Setting up the scenario implies: Deployment and configuration of the WAS web application on an Apache Tomcat server Deployment and configuration of the WSS web application on an Apache Tomcat server Installation and configuration of the WSC desktop application As part of the service configuration the participants will add users to the user repository for the WAS as well as define access policies for layers and/or operations of the protected WMS for the WSS. After successful deployment and installation the protected service will be loaded into a web map client using different user profiles to visualize the effect of policy enforcement.

Presenters: Jan Drewnak

permalink

**Sensor Web Enablement - Bringing Sensors into SDIs**

Download files for Sensor Web Enablement - Bringing Sensors into SDIs

This tutorial gives an introduction to the specification framework of OGC's Sensor Web Enablement (SWE) initiative. The SWE framework offers a well-defined set of specifications which provide data models and corresponding data encodings as well as service interfaces to make use of the sensors. These interface specifications include services which can be utilized for example to access sensor data, to task sensors and to register for alerts in case of certain events. Firstly, the tutorial will consist of a presentation to give an overview of the different SWE specifications. Afterwards, practical SWE use-cases and applications will be shown to demonstrate how SWE technology can be utilized. These demonstration scenarios range from water management, pollution monitoring, early warning systems to fire fighting applications. Finally, we will demonstrate the 52° North suite of SWE service and client implementations to show the current state of art in SWE software development. It is planned to demonstrate a set of existing SWE applications that are available on the Web. For the demonstration part it is recommended (although not necessary) to bring a laptop so that the participant will be able to make hands-on experiences with the presented SWE applications.

Presenters: Arne Broering, Simon Jirka, Chirstoph Stasch, Thomas Everding

permalink

**Using ILWIS with its PostGIS plug-in for raster-vector applications**

Download files for Using ILWIS with its PostGIS plug-in for raster-vector applications

Tutorial objective: To provide participants a hands-on insight into the power of combining functionality of our user-friendly and highly functional GIS software with PostGIS. Our GIS software is ILWIS which has been developed over 15 years by ITC as closed source software and has a large user community in developing countries, and recently has been migrated to open source software. ILWIS comprises a complete package of image processing, spatial analysis and digital mapping. It is easy to learn and use; it has full on-line help, and has extensive tutorials for direct use in various disciplines. Recent project efforts have migrated ILWIS into a modular, plug-in-based software, providing web-service support for OGC-based web mapping and links with other software such as PostGIS. ILWIS is being developed as a versatile geosoftware which is interoperable with other state-of-the-art open sources platforms. The development of this framework is done since 2007 in the context of 52°North (http://52north.org/). We will demonstrate the software's functionality with the help of a use case. The tutorial will take the participant on a comprehensive tour through an application developed for UN-Habitat, which enables local governments to register land ownership on the basis of satellite images and simple field sketches.

Presenters: Rob Lemmens

permalink

**Working with GRASS-GIS Vectors and Databases**

Download files for Working with GRASS-GIS Vectors and Databases



The demonstrations will cover: A brief outline of Grass-GIS Basics of Grass-GIS vector-database connections Buffering in Grass-GIS – producing border-constrained buffers Simple command-line looping for bulk vector processing Grass-GIS georectification processes. This is the description of the tutorial as it will appear in the program. This is also the primary resource used to evaluate the tutorial for inclusion in the conference or for determining attendee interest.

Presenters: Richard Chirgwin

permalink

# Workshops

**Geospatial BI with FOSS: an introduction to GeoMondrian and Spatialytics**

Download files for Geospatial BI with FOSS: an introduction to GeoMondrian and Spatialytics

Open Source Business Intelligence (BI) software has begun permeating the market thanks to offers from companies such as Pentaho, Jaspersoft, Talend and Spago Solutions. Geospatial BI, combining GIS and BI technologies, has recently stirred marked interest for the huge potential of combining spatial analysis and map visualization with proven BI tools and techniques such as data warehousing, Online Analytical Processing (OLAP) and data mining. It is in this perspective that we, the GeoSOA Research Group at Laval University, started to work on integrating geospatial functionality in existing open source BI software. This has led to the release of GeoKettle, a spatial ETL tool based on Pentaho Data Integration (Kettle) and targeted for analytic data warehousing, and more recently GeoMondrian, a Spatial OLAP server which extends the open source Mondrian OLAP server with GIS data types and functions. On the client side, Spatialytics has been developed, initially during a Google Summer of Code project mentored by Dr. Thierry Badard under the umbrella of the OSGeo and later as part of works within our research group. Spatialytics provides a client visualization component for Spatial OLAP data, using GeoMondrian as a data source and OpenLayers as the web mapping front-end. It enables the creation of drillable, interactive thematic maps based on multidimensional OLAP cubes and can be embedded in Geo BI web applications such as geo-analytical dashboards. This workshop proposes a practical introduction to GeoMondrian and Spatialytics. A short intro to the fundamental concepts of data warehousing and OLAP will be part of the program, so deep knowledge of this field is not required to participate. From an already constructed spatial data warehouse, the attendees will learn how to build a cube schema, which is a relational-to-multidimensional mapping used by Mondrian (and by extension GeoMondrian) for querying the relational data warehouse (in SQL) by the means of multidimensional MDX queries. The users will then have a chance to issue simple queries on this cube, with focus given on the geospatial extensions to MDX offered by GeoMondrian. Finally, the attendees will experiment with Spatialytics, for the visualization of the cube's data using its spatial dimensions. This will also demonstrate its integration in the familiar OpenLayers web mapping client, with easy to use navigation widgets for drilling across the cube's hierarchical presentation of data and configurable choice of thematic mapping styles. At the end, the attendees should have a working knowledge of GeoMondrian and Spatialytics, in order to build rich Geo BI applications.

Presenters: Thierry Badard, Etienne Dubé

permalink

**Getting Started with MapServer**

Download files for Getting Started with MapServer
Watch the video of Getting Started with MapServer

This hands-on workshop is intended as an introduction to Web mapping with the University of Minnesota MapServer. The participants will go through the process of setting up a MapServer environment which includes configuring a Web server and creating a MapServer application. The creation of a MapServer application will include step-by-step examples of building a map file, including defining the WEB object, the LAYER objects, and assigning symbology to these objects. Once a map file is created, the participants will then go through the process of creating a web-based interface. Important MapServer and Web mapping concepts will be discussed throughout the workshop. A significant portion of the workshop will involve accessing data from several different data types and incorporating them into a MapServer map file.

Presenters: Jeff McKenna, Tyler Mitchell, Pericles Nacionales

permalink

**Introduction to PostGIS**

Download files for Introduction to PostGIS

This workshop will include a short instructional component in addition at the hands-on work. You will follow the instructor through a series of tasks starting with the installation of PostgreSQL and PostGIS, configuration and basic tuning of the system, creating databases and users and loading spatial data into the database. From there a number of problems will be posed that will walk you through vital concepts such as spatial indices, spatially enabled queries and query tuning as well as visualization of data.

Presenters: Mark Leslie, Paul Ramsey, Mike Pumphrey

permalink

**Introduction to the Open GeoStack: PostGIS, GeoServer, GeoWebCache, and OpenLayers**

Download files for Introduction to the Open GeoStack: PostGIS, GeoServer, GeoWebCache, and OpenLayers

The workshop will begin with an introduction of the stack, providing an overview of each of the major components: PostGIS: A spatially enabled relational database based on PostgreSQL. PostGIS is the backbone of many open source and non-open source based GIS systems. GeoServer: A feature rich standards compliant server that connects information to the geospatial web. GeoServer reads a variety of spatial formats and publishes that data on the web through standard services and formats. GeoWebCache: A WMS tile-caching library that provides an effective solution for the efficient serving of web maps. OpenLayers: A web based mapping toolkit built on Ajax technology. OpenLayers provides a web based front end for a number of web mapping technologies such as WMS and WFS. Following the introduction workshop attendees will begin the hands-on component. Exercises will cumulatively build off each other and work toward the goal of setting up a simple base map of the Manhattan area. Initial exercises will focus on performing simple tasks with GeoServer such as publishing shapefiles, setting up styles for map visualization, and use of the map preview tool. Once the basics of GeoServer have been covered attendees will be exposed to PostGIS. These exercises will focus on loading spatial data into PostGIS, as well as configuring GeoServer to connect to a PostGIS database. With a functioning GeoServer setup on top of PostGIS focus will shift to the creation of the Manhattan base map. This section will focus mainly on map style configuration and exploring the capabilities of Styled Layer Descriptor (SLD) for the visualization of spatial data. Once the base map has been set up attendees will build a simple web based map using the OpenLayers library. This component involves some web scripting with JavaScript, in which attendees will learn how to visualize a GeoServer WMS with OpenLayers. Additionally some of the OpenLayers styling capabilities will also be explored. The final part of the workshop will focus on GeoWebCache, using it to add tile-caching capabilities to the base map.

Presenters: Justin Deoliveira, Andrea Aime, Paul Ramsey, Tim Schaub

permalink

**Making Maps Fast - Performance tuning and Tile Caching**

Download files for Making Maps Fast - Performance tuning and Tile Caching

Speed of response is critical to a user experience. While hardware and platform considerations are briefly discussed, the focus of this workshop is on what can be done at the data level, the service level and especially caching. Participants will see how small changes in design and implementation can reap big benefits. The topics of the workshop include: The Data: Spatial data stores. Attribute and spatial indexes. The Map: Limiting what gets rendered. Image size vs. quality. The Cache: Google does it, so can you. The OS: Scalability and concurrency. Once we have data loaded into PostGIS and served by GeoServer we will move on to the main focus of the workshop: tile caching. Installing TileCache. Setting up your layer. Configuring GeoWebCache in GeoServer. Metatiling. How it works with HTTP, caching proxies and caching clients. OpenLayers will be used throughout the workshop to verify the effects of our changes.

Presenters: Arne Kepp, Jim Groffen

permalink



**OpenLayers - Your Foundation for Browser Based Mapping**

Download files for OpenLayers - Your Foundation for Browser Based Mapping

OpenLayers provides a full featured library for building browser based mapping applications. This workshop will guide participants through the library core, providing the experience necessary to build interactive mapping applications. We will cover best practices for dealing with a variety of raster and vector data sources, investigate client side styling, and discuss options for integrating OpenLayers with other JavaScript libraries. The hands-on workshop will include detailed exercises divided into five modules: Map Basics - Understand how maps are created and configured. Layer Types - Add data to your map from a variety of sources. User Interaction - Set up controls to manage user interaction. Editing & Styling - Focusing on vector data, read data from remote sources, allow for creation and editing of new data, and explore options for styling data client side. Integration - OpenLayers provides the mapping core for your application. Build rich widgets with mapping functionality by integrating OpenLayers with other JavaScript libraries. The modules will be presented by core OpenLayers developers who will be available for support throughout the workshop. Participants will be guided through exercises that result in working examples of a wide range of OpenLayers functionality. Printed materials will be provided that demonstrate advanced concepts in addition to workshop exercises. This year's materials will be a complete rewrite of previously presented workshops - including coverage of recently added functionality.

Presenters: Tim Schaub, Roald de Wit

permalink

**Organizing your geospatial data and services using GeoNetwork opensource**

Download files for Organizing your geospatial data and services using GeoNetwork opensource

The half-day workshop will focus on the implementation of a catalogue to serve and access geospatial data through the Web. A local catalogue will be installed and configured. Harvesting of spatial data resources from remote servers will be configured and geospatial web map services will be set up using the embedded GeoServer and will be configured for access through the catalogue web interface. Participants will use the catalogue in different ways, including the web interface and OGC-CSW ISO, the new ebRIM CSW ISO, OAI-MHP and GeoRSS protocols. The user will learn how to use the catalogue to receive automatic updates when new resources of interest become available using news feeds in different client applications (news readers, Open Layers, Google Maps and Virtual Earth). The use of user feedback mechanisms including data rating and social book marking will be discussed. Attention will be given to import and export functionality of the catalogue that allow integration of the publishing process in existing workflows like desktop GIS or operational data processing servers.

Presenters: Jeroen Ticheler, François Prunayre

permalink

**Practical Introduction to GRASS and related software for beginners**

Download files for Practical Introduction to GRASS and related software for beginners

GRASS is the leading FOSS GIS and its wide ranging analysis capabilities make it an ideal tool to set up environmental models, as well as to support land planning and management. Therefore, GRASS can be an important tool in general for environmental researchers and in particular for scientists and planners in Developing Countries. In fact, GRASS has been already successfully used in many projects in Africa, Asia and Latin America. However, its steep learning curve makes the first approach to GRASS sometimes tricky for beginners: this workshop aims to overcome the initial barrier between GRASS and its potential users. The workshop has two parts: a brief GRASS overview and a hands-on session by the attendees. The aim is to allow the first users to understand the logic of the software and to experiment some significant, although necessarily limited, data elaboration for technical and environmental GIS applications. The workshop provides a brief introduction to GRASS and then it is structured as a step by step tutorial to guide beginners in the basic applications of the software, stressing the interoperability with other FOSS and proprietary software. The tutorial is structured in a growing difficulty level to make the participants gradually familiar with the software. It will be possible for the participants to follow different paths depending on their skills and interests.

Presenters: Paolo Zatelli, Marco Ciolli, Clara Tattoni

permalink

**Practical introduction to MapFish, the web 2.0 mapping application framework**

Download files for Practical introduction to MapFish, the web 2.0 mapping application framework

MapFish is an open-source development framework for building web-mapping applications. MapFish is based on the GeoExt library which is a combination of ExtJS and OpenLayers, and extends the Pylons general-purpose web development framework with geo-specific functionalities. This workshop will introduce the usage of the MapFish development framework and will demonstrate how it can help developers implement rich web-mapping applications. On the client side, several MapFish widgets and components will be presented: The map panel for the representation of geographical information through OGC web services like WMS, WFS or TMS. The toolbar for the access to the functions within the GUI The layer tree for the organization and management of the geospatial layers The 3D widget for the 3D representation of geographical data using Google Earth The print widget for the creation of reports. The geostat widget for the creation of advanced representations of the data through chloropleth or proportional symbols The edit functions for the creation and update of data sets. The search and recenter widget for advanced navigation within the data. The query widget for getting information about the represented data The offline mode for allowing an usage of MapFish without Internet connection The templating system for the definition of reusable GUI On the server side, the following things will be practically introduced: The creation of RESTful services for the data access and data manipulation. Usage of SQLAlchemy and Shapely will be highlighted. The configuration of the print server component for the definition of reports. The presentation of other development environment working together with MapFish: PHP, Java, Ruby on rails and the integration with Symfony

Presenters: Claude Philipona, Cédric Moullet, Eric Lemoine

permalink

**Working with GeoServer**

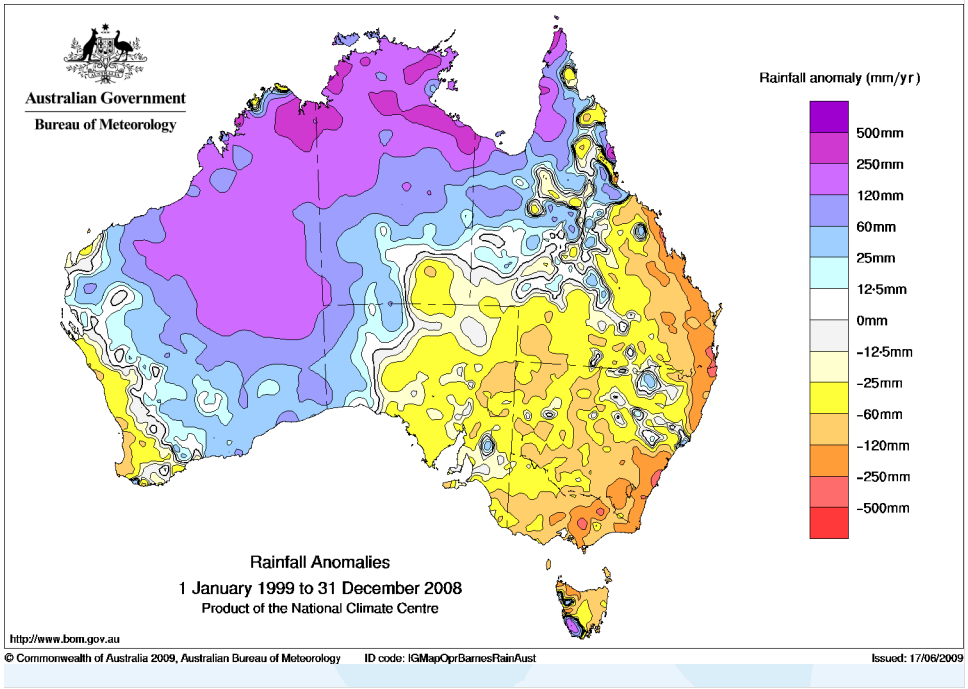
Download files for Working with GeoServer

GeoServer is a feature rich geospatial web server built on top of open standards. A Web Map Service, Web Feature Service, and Web Coverage Service, GeoServer is a technology built for publishing data on the geospatial web. Initial exercises will focus mainly on basic tasks such as installation of GeoServer and the publishing of some simple data sets. Attendees will learn how to publish a variety of data sets in different formats. From Shapefiles, to a PostGIS spatial database, to raster data formats such as GeoTIFF. Workshop exercises will focus mainly on the GeoServer WMS, and its cartographic capabilities. Workshop attendees will be given an introduction to the GeoServer styling engine (SLD), and work through some simple examples. More advanced features such as labelling options, raster symbolization, and dynamic symbolization will also be covered. Later exercises will shift more toward GeoServer "geoweb" oriented capabilities such as KML output and Google Earth support. Initial exercises will illustrate how to publish data from GeoServer in Google Earth, moving to advanced features such as KML templates, 2.5 dimensional height support, and regionation. Time permitting other topics covered may include tile caching with GeoWebCache, WMS optimization with paletted images, and image watermarking.

Presenters: Justin Deoliveira, Andrea Aime

permalink

***Question 4.c – Education Samples***




Australian Government
Bureau of Meteorology

Water Information
DATA › INFORMATION › INSIGHT

# Open Access to Australia's Water Information

Tony Boston
Assistant Director
Water Data Services

21 October 2009

FOSS4G Sydney 2009
20 - 23 October
Free and Open Source Software for Geospatial
Sydney Convention & Exhibition Center

Australian Government
Bureau of Meteorology

## Our mandate

- 10-year Australian Government program began July 2007
- $450m funding
  - 110 new staff + systems + research and development
  - Administered funding support for data providers
- Legislative backing
  - *Water Act 2007*
  - Water Regulations 2008
- Relies on collaboration with data providers.

Water Information
DATA › INFORMATION › INSIGHT

# The water information value ladder

Data >>> Information >>> Insight

>>> Increasing value >>>

Forecasting

Reporting

Analysis

**Rarely done**

Distribution

Integration

**Generally done poorly**

Archiving in house

Quality assurance

Measurement

**Generally done well, by over 100 groups, but could be vastly improved with new technology**

Australian Government
Bureau of Meteorology

Water Information
DATA › INFORMATION › INSIGHT

# Functions of the Bureau of Meteorology

Australian Government
Bureau of Meteorology

National Weather Service

Climate and Meteorological Research (with CSIRO)

National Climate Monitoring System

National Water Information Service

Australian Government
Bureau of Meteorology

National Flood Warning and Forecasting Service

National Tidal Centre

National Ocean Current Prediction

National Tsunami Alert Service

Water Information
DATA › INFORMATION › INSIGHT

PROVIDER DATA → AWRIS → INFORMATION PRODUCTS

Streamflow

Diversions

Groundwater

Water quality

Storage

Water use

Entitlements and trades

Restrictions

Various gridded data products

Climate DB

Water Data Geofabric

Enterprise GIS

Hydro DB

**Dynamic**

- Data download
- Data dashboard
- Forecasting services

**Static**

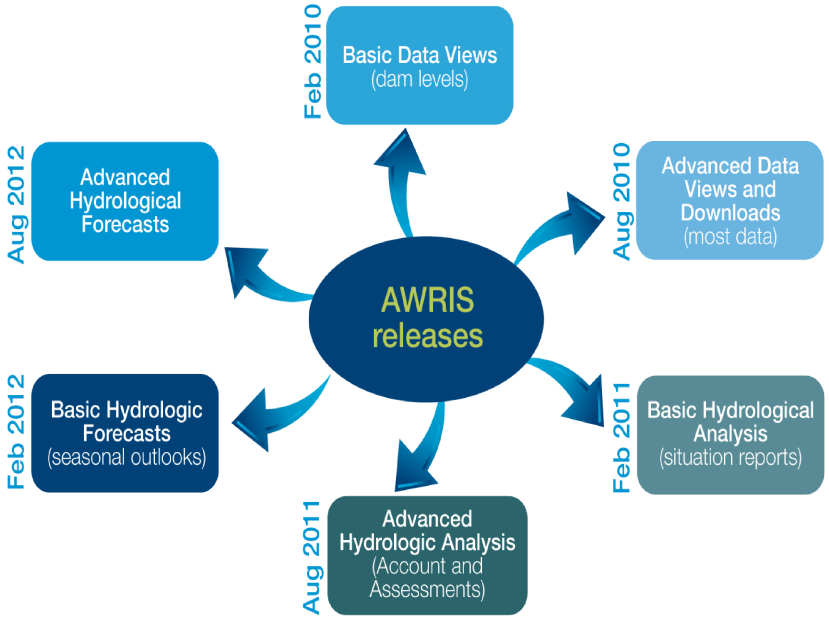
- Situation Reports
- National Water Accounts
- Water Resources Assessments

# Our new functions

Australian Government
Bureau of Meteorology

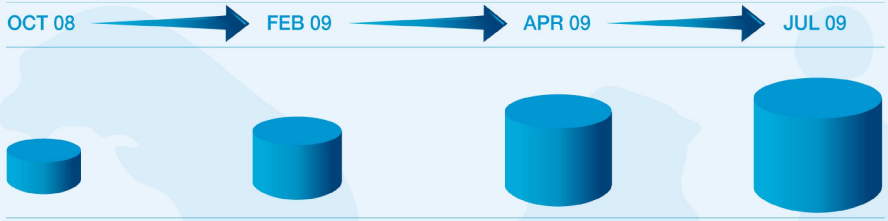
1. Set standards for water data.
2. Collect primary information from water data holders and build a national repository.
3. Provide a range of value-added water information products and services for the nation.
4. Assist water data collecting agencies to modernise their observing systems.
5. Invest in water information research and development

Water Information
DATA › INFORMATION › INSIGHT




Australian Government
Bureau of Meteorology

# Water Regulations 2008




- Ten primary categories of data (~65 variables)
- Eight categories of '*person*' (242 persons in total)
- $10^4$-$10^5$ observation points with time series
- Entire historical archive provided at first
- Updated thereafter real time, daily, weekly, monthly or yearly.

Water Information
DATA › INFORMATION › INSIGHT

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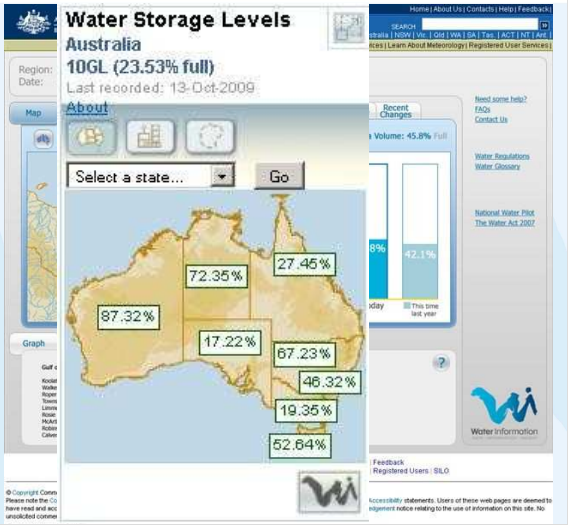
# National Dam Levels and Storage Volumes

- National coverage of major storages
- Regular updating
- Zooming in to state, region, city or storage detail
- Ready comparison of different times and places
- Standardised calculation of water available, expressed as % of Total Storage Capacity




Australian Government
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## Contents



Water Information
DATA › INFORMATION › INSIGHT


Australian Government
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# Water Information Licensing

- The *Water Act (2007)* allows the Bureau to publish water information on its website without the need to obtain agreement
- This does not extend to granting any explicit usage rights to third parties
- Bureau recommends *Creative Commons Attribution 2.5*
- Use of CC-BY for other Bureau information being considered


Water Information
DATA › INFORMATION › INSIGHT



Australian Government
Bureau of Meteorology


## Copyright in the Water Context

The Act permits the Bureau to collect and distribute water data.

The Act places certain restrictions on the Bureau in distributing water data

Its collection though, is unhindered

For the time being, there may be copyright in some water information

More so where its *information*, not *data*

The licensing decision needs to be made by the rights holder (in this case, not the Bureau)

Least restrictive, Internet compatible licence should be applied to water data supplied to the Bureau

The Bureau indicated support for the Creative Commons Attribution Licence as a potential low to no cost approach


Water Information
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# Creative Commons Licensing of Water Data


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Government Information Licensing Framework
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## What Does CC Look Like?

http://creativecommons.org/licenses/by/2.5/au/



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## GILF - Government Information Licensing Framework

Product of 5 years of research in Queensland Government / QUT

Cross Jurisdictional Chief Information Officers Committee funded the creation of www.gilf.gov.au

Incorporates:

- a policy statement,
- 7 licences (6 Creative Commons Licences and 1 Restrictive Licence)
- Licensing review
- Website with additional resources

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## Benefits of Adopting Creative Commons

Creative Commons is now sufficiently established as a de-facto international standard of licensing electronic information (eg. wikipedia, flickr);

Operates in accordance with Australian copyright law;

Requires attribution of the rights holder;

Is already in use by governments internationally, and by the ABS and Geoscience Australia;

Contains the strongest limitation of liability and warranty clauses;

Takes the form of a plain English deed (in numerous languages), a legal code;

Has a low to no cost of implementation;

May be used as a search parameter when looking for information licensed with Creative Commons on the Internet; and

Is one of the few licence schemes compatible with Web 2.0.

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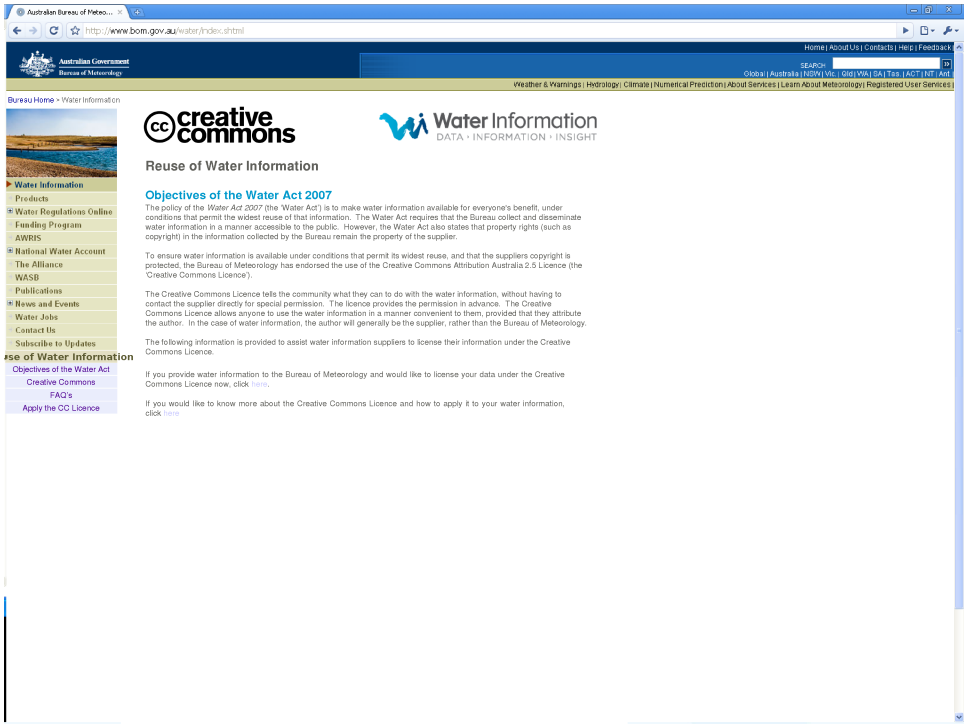



creative commons
LEGAL CODE

**Attribution 2.5 Australia**

CREATIVE COMMONS CORPORATION IS NOT A LAW FIRM AND DOES NOT PROVIDE LEGAL SERVICES. DISTRIBUTION OF THIS LICENCE DOES NOT CREATE AN ATTORNEY-CLIENT RELATIONSHIP. CREATIVE COMMONS PROVIDES THIS INFORMATION ON AN "AS-IS" BASIS. CREATIVE COMMONS MAKES NO WARRANTIES REGARDING THE INFORMATION PROVIDED, AND DISCLAIMS LIABILITY FOR DAMAGES RESULTING FROM ITS USE.

*Licence*

THE WORK (AS DEFINED BELOW) IS PROVIDED UNDER THE TERMS OF THIS CREATIVE COMMONS PUBLIC LICENCE ("CCPL" OR "LICENCE"). THE WORK IS PROTECTED BY COPYRIGHT AND/OR OTHER APPLICABLE LAW. ANY USE OF THE WORK OTHER THAN AS AUTHORISED UNDER THIS LICENCE AND/OR APPLICABLE LAW IS PROHIBITED.

BY EXERCISING ANY RIGHTS TO THE WORK PROVIDED HERE, YOU ACCEPT AND AGREE TO BE BOUND BY THE TERMS OF THIS LICENCE. THE LICENSOR GRANTS YOU THE RIGHTS CONTAINED HERE IN CONSIDERATION OF YOUR ACCEPTANCE OF SUCH TERMS AND CONDITIONS.

**1. Definitions**

a. **"Collective Work"** means a work, such as a periodical issue, anthology or encyclopaedia, in which the Work in its entirety in unmodified form, along with a number of other contributions, constituting separate and independent works in themselves, are assembled into a collective whole. A work that constitutes a Collective Work will not be considered a Derivative Work (as defined below) for the purposes of this Licence.

b. **"Derivative Work"** means a work that reproduces a substantial part of the Work, or of the Work and other pre-existing works protected by copyright, or that is an adaptation of a Work that is a literary, dramatic, musical or artistic work. Derivative Works include a translation, musical arrangement, dramatisation, motion picture version, sound recording, art reproduction, abridgment, condensation, or any other form in which a work may be adapted, except that a work that constitutes a Collective Work will not be considered a Derivative Work for the purpose of this Licence. For the avoidance of doubt, where the Work is a musical composition or sound recording, the synchronisation of the Work in timed-relation with a moving image ("synching") will be considered a Derivative Work for the purpose of this Licence.

c. **"Licensor"** means the individual or entity that offers the Work under the terms of this Licence.

d. **"Moral rights law"** means laws under which an individual who creates a work protected by copyright has rights of integrity of authorship of the work, rights of attribution of authorship of the work, rights of not to have authorship of the work falsely attributed, or rights of a similar or analogous nature in the work anywhere in the world.

e. **"Original Author"** means the individual or entity who created the Work.

f. **"Work"** means the work or other subject-matter protected by copyright that is offered under the terms of this Licence, which may include (without limitation) a literary, dramatic, musical or artistic work; a sound recording or cinematograph film, a published edition of a literary, dramatic, musical or artistic work or a television or sound broadcast.

g. **"You"** means an individual or entity exercising rights under this Licence who has not previously violated the terms of this Licence with respect to the Work, or who has received express permission from the Licensor to exercise rights under this Licence despite a previous violation.

h. **"Licence Elements"** means the following high-level licence attributes as selected by Licensor and indicated in the title of this Licence: Attribution, NonCommercial, NoDerivatives, ShareAlike.

**2. Fair Dealing and Other Rights.** Nothing in this Licence excludes or modifies, or is intended to exclude or modify, (including by reducing, limiting, or restricting) the rights of You or others to use the Work arising from fair dealings or other limitations on the rights of the copyright owner or the Original Author under copyright law, moral rights law or other applicable laws.

**3. Licence Grant.** Subject to the terms and conditions of this Licence, Licensor hereby grants You a worldwide, royalty-free, non-exclusive, perpetual (for the duration of the applicable copyright) licence to exercise the rights in the Work as stated below:

a. to reproduce the Work, to incorporate the Work into one or more Collective Works, and to reproduce the Work as incorporated in the Collective Works;

b. to create and reproduce Derivative Works;

c. to publish, communicate to the public, distribute copies or records of, exhibit or display publicly, perform publicly and perform publicly by means of a digital audio transmission the Work including as incorporated in Collective Works;

d. to publish, communicate to the public, distribute copies or records of, exhibit or display publicly, perform publicly, and perform publicly by means of a digital audio transmission Derivative Works;

e. For the avoidance of doubt, where the Work is a musical composition:

i. **Performance Royalties Under Blanket Licences.** Licensor will not collect, whether individually or via a performance rights society, royalties for Your communication to the public, broadcast, public performance or public digital performance (e.g. webcast) of the Work.

ii. **Mechanical Rights and Statutory Royalties.** Licensor will not collect, whether individually or via a music rights agency, designated agent or a music publisher, royalties for any record You create from the Work ("cover version") and distribute, subject to the compulsory licence created by 17 USC Section 115 of the US Copyright Act (or an equivalent statutory licence under the Australian Copyright Act or in other jurisdictions).

f. **Webcasting Rights and Statutory Royalties.** For the avoidance of doubt, where the Work is a sound recording, Licensor will not collect, whether individually or via a performance-rights society, royalties for Your public digital performance (e.g. webcast) of the Work, subject to the compulsory licence created by 17 USC Section 114 of the US Copyright Act (or the equivalent in other jurisdictions).

g. The above rights may be exercised in all media and formats whether now known or hereafter devised. The above rights include the right to make such modifications as are technically necessary to exercise the rights in other media and formats. All rights not expressly granted by Licensor under this Licence are hereby reserved.

**4. Restrictions.** The licence granted in Section 3 above is expressly made subject to and limited by the following restrictions:

a. You may publish, communicate to the public, distribute, publicly exhibit or display, publicly perform, or publicly digitally perform the Work only under the terms of this Licence, and You must include a copy of, or the Uniform Resource Identifier for, this Licence with every copy or record of the Work You publish, communicate to the public, distribute, publicly exhibit or display, publicly perform or publicly digitally perform. You may not offer or impose any terms on the Work that exclude, alter or restrict the terms of this Licence or the recipients' exercise of the rights granted hereunder. You may not sublicense the Work. You must keep intact all notices that refer to this Licence and to the disclaimer of representations and warranties. You may not publish, communicate to the public, distribute, publicly exhibit or display, publicly perform, or publicly digitally perform the Work with any technological measures that control access or use of the Work in a manner inconsistent with the terms of this Licence. The above applies to the Work as incorporated in a Collective Work, but this does not require the Collective Work apart from the Work itself to be made subject to the terms of this Licence. If You create a Collective Work, upon notice from any Licensor You must, to the extent practicable, remove from the Collective Work any credit as required by Section 4(b), as requested. If You create a Derivative Work, upon notice from any Licensor You must, to the extent practicable, remove from the Derivative Work any credit as required by Section 4(b), as requested.

b. If you publish, communicate to the public, distribute, publicly exhibit or display, publicly perform, or publicly digitally perform the Work or any Derivative Works or Collective Works, You must keep intact all copyright notices for the Work. You must also give clear and reasonably prominent credit to (i) the Original Author (by name or pseudonym if applicable), if the name or pseudonym is supplied; and (ii) if another party or parties (eg a sponsor institute, publishing entity or journal) is designated for attribution in the copyright notice, terms of service or other reasonable means associated with the Work, such party or parties, if applicable, that credit must be given in the particular way made known by the Original Author and otherwise as reasonable to the medium or means You are utilizing, by conveying the identity of the Original Author and the other designated party or parties (if applicable); the title of the Work if supplied; to the extent reasonably practicable, the URI that Licensor specifies to be associated with the Work, unless such URI does not refer to the copyright notice or licensing information for the Work; and in the case of a Derivative Work, a credit identifying the use of the Work in the Derivative Work (e.g., "French translation of the Work by Original Author," or "Screenplay based on original Work by Original Author"). Such credit may be implemented in any reasonable manner; provided, however, that in the case of a Derivative Work or Collective Work, at a minimum such credit will appear where any other comparable authorship credit appears and in a manner at least as prominent as such other comparable authorship credit.

**b. False attribution prohibited.** Except as otherwise agreed in writing by the Licensor, if You publish, communicate to the public, distribute, publicly exhibit or display, publicly perform, or publicly digitally perform the Work or any Derivative Works or Collective Works in accordance with this Licence, You must not falsely attribute the Work to someone other than the Original Author.

**c. Prejudice to honour or reputation prohibited.** Except as otherwise agreed in writing by the Licensor, if you publish, communicate to the public, distribute, publicly exhibit or display, publicly perform, or publicly digitally perform the Work or any Derivative Works or Collective Works, You must not do anything that results in a material distortion of, the mutilation of, or a material alteration to, the Work that is prejudicial to the Original Author's honour or reputation, and You must not do anything else in relation to the Work that is prejudicial to the Original Author's honour or reputation.

**5. Disclaimer.**

EXCEPT AS EXPRESSLY STATED IN THIS LICENCE OR OTHERWISE MUTUALLY AGREED TO BY THE PARTIES IN WRITING, AND TO THE FULL EXTENT PERMITTED BY APPLICABLE LAW, LICENSOR OFFERS THE WORK "AS-IS" AND MAKES NO REPRESENTATIONS, WARRANTIES OR CONDITIONS OF ANY KIND CONCERNING THE WORK, EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, ANY REPRESENTATIONS, WARRANTIES OR CONDITIONS REGARDING THE CONTENTS OR ACCURACY OF THE WORK, OR OF TITLE, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT, THE ABSENCE OF LATENT OR OTHER DEFECTS, OR THE PRESENCE OR ABSENCE OF ERRORS, WHETHER OR NOT DISCOVERABLE.

**6. Limitation on Liability.**

TO THE FULL EXTENT PERMITTED BY APPLICABLE LAW, AND EXCEPT FOR ANY LIABILITY ARISING FROM CONTRARY MUTUAL AGREEMENT AS REFERRED TO IN SECTION 5, IN NO EVENT WILL LICENSOR BE LIABLE TO YOU ON ANY LEGAL THEORY (INCLUDING, WITHOUT LIMITATION, NEGLIGENCE) FOR ANY LOSS OR DAMAGE WHATSOEVER, INCLUDING (WITHOUT LIMITATION) LOSS OF PRODUCTION OR OPERATION TIME, LOSS, DAMAGE OR CORRUPTION OF DATA OR RECORDS; OR LOSS OF ANTICIPATED SAVINGS, OPPORTUNITY, REVENUE, PROFIT OR GOODWILL, OR OTHER ECONOMIC LOSS; OR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES ARISING OUT OF OR IN CONNECTION WITH THIS LICENCE OR THE USE OF THE WORK, EVEN IF LICENSOR HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

If applicable legislation implies warranties or conditions, or imposes obligations or liability on the Licensor in respect of this Licence that cannot be wholly or partly excluded, restricted or modified, the Licensor's liability is limited, to the full extent permitted by the applicable legislation, at its option, to:

a. in the case of goods, any one or more of the following:

i. the replacement of the goods or the supply of equivalent goods;

ii. the repair of the goods;

iii. the payment of the cost of replacing the goods or of acquiring equivalent goods;

iv. the payment of the cost of having the goods repaired; or

b. in the case of services:

i. the supplying of the services again; or

ii. the payment of the cost of having the services supplied again.

**7. Termination**

a. This Licence and the rights granted hereunder will terminate automatically upon any breach by You of the terms of this Licence. Individuals or entities who have received Derivative Works or Collective Works from You under this Licence, however, will not have their licences terminated provided such individuals or entities remain in full compliance with those licences. Sections 1, 2, 5, 6, 7, and 8 will survive any termination of this Licence.

b. Subject to the above terms and conditions, the licence granted here is perpetual (for the duration of the applicable copyright in the Work). Notwithstanding the above, Licensor reserves the right to release the Work under different licence terms or to stop distributing the Work at any time; provided, however that any such election will not serve to withdraw this Licence (or any other licence that has been, or is required to be, granted under the terms of this Licence), and this Licence will continue in full force and effect unless terminated as stated above.

**8. Miscellaneous.**

a. Each time You publish, communicate to the public, distribute or publicly digitally perform the Work or a Collective Work, the Licensor offers to the recipient a licence to the Work on the same terms and conditions as the licence granted to You under this Licence.

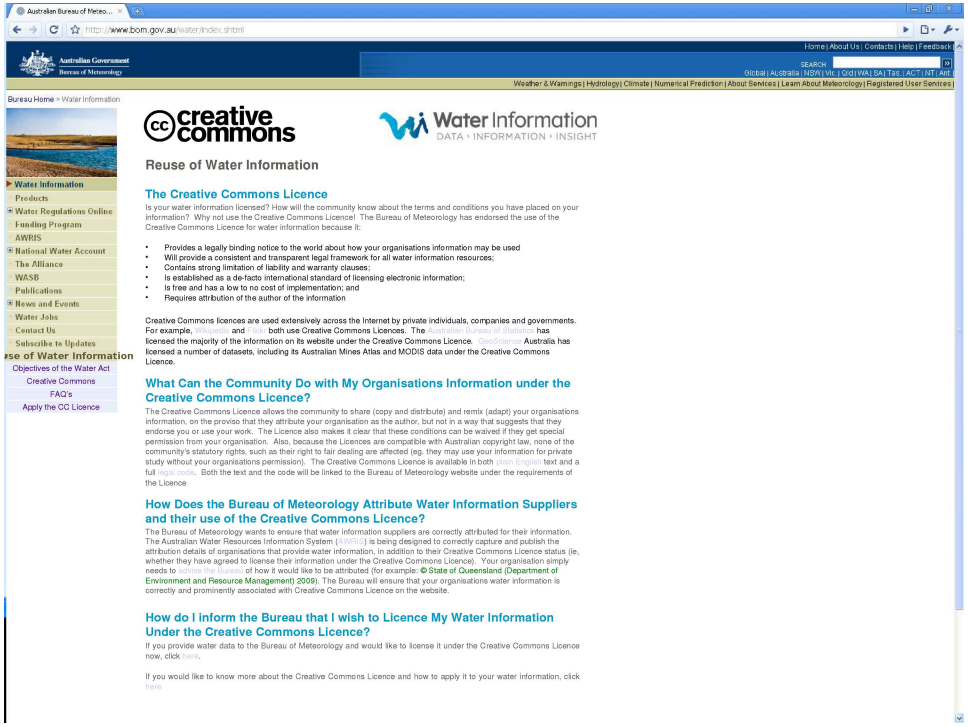
b. Each time You publish, communicate to the public, distribute or publicly digitally perform a Derivative Work, Licensor offers to the recipient a licence to the original Work on the same terms and conditions as the licence granted to You under this Licence.

c. If any provision of this Licence is invalid or unenforceable under applicable law, it shall not affect the validity or enforceability of the remainder of the terms of this Licence, and without further action by the parties to this agreement, such provision shall be reformed to the minimum extent necessary to make such provision valid and enforceable.

d. No term or provision of this Licence shall be deemed waived and no breach consented to unless such waiver or consent shall be in writing and signed by the party to be charged with such waiver or consent.

e. This Licence constitutes the entire agreement between the parties with respect to the Work licensed here. To the full extent permitted by applicable law, there are no understandings, agreements or representations with respect to the Work not specified here. Licensor shall not be bound by any additional provisions that may appear in any communication from You. This Licence may not be modified without the mutual written agreement of the Licensor and You.

a. The construction, validity and performance of this Licence shall be governed by the laws in force in New South Wales, Australia.

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# Implementing the Approach to Licensing

Update the Bureau website information to include content on the objectives of the Water Act, Creative Commons Licence, FAQ's, and information about how attribution will work, etc.

Copyright / Disclaimer to be amended

Bureau to write to each of the named parties seeking decision as to water licensing. A link to the Report will also be provided

If the named party decides to adopt the Creative Commons Licence, the Bureau will confirm their requested attribution (eg. *© Commonwealth of Australia (Bureau of Meteorology) 2009)*

If the named party decides against the Creative Commons Licence, the Bureau will provide the party's preferred contact details on the website

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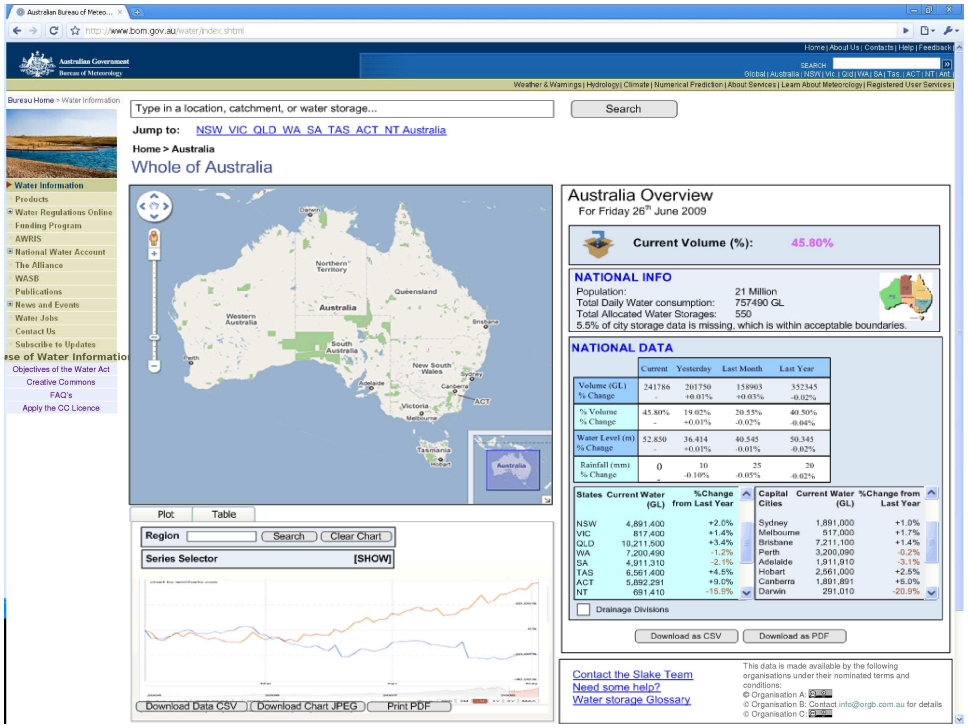
Australian Bureau of Meteo...
http://www.bom.gov.au/water/index.shtml
Australian Government
Bureau of Meteorology
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SEARCH
Global | Australia | NSW | Vic | Qld | WA | SA | Tas | ACT | NT | Ant
Weather & Warnings | Hydrology | Climate | Numerical Prediction | About Services | Learn About Meteorology | Registered User Services
Bureau Home > Water Information
Type in a location, catchment, or water storage...
Search
Jump to: NSW VIC QLD WA SA TAS ACT NT Australia
Home > Australia
Whole of Australia
Water Information
Products
Water Regulations Online
Funding Program
AWRIS
National Water Account
The Alliance
WASB
Publications
News and Events
Water Jobs
Contact Us
Subscribe to Updates
Use of Water Information
Objectives of the Water Act
Creative Commons
FAQ's
Apply the CC Licence
Australia Overview
For Friday 26th June 2009
Current Volume (%): 45.80%
NATIONAL INFO
Population: 21 Million
Total Daily Water consumption: 757490 GL
Total Allocated Water Storages: 550
5.5% of city storage data is missing, which is within acceptable boundaries.
NATIONAL DATA
Current Yesterday Last Month Last Year
Volume (GL) 241786 201750 158903 352345
% Change - +0.01% +0.03% -0.02%
% Volume 45.80% 19.02% 20.55% 40.50%
% Change - +0.01% -0.02% -0.04%
Water Level (m) 52.850 36.414 40.545 50.345
% Change - +0.01% -0.01% -0.02%
Rainfall (mm) 0 10 25 20
% Change - -0.10% -0.05% -0.02%
States Current Water (GL) %Change from Last Year
NSW 4,891,400 +2.0%
VIC 817,400 +1.4%
QLD 10,211,500 +3.4%
WA 7,200,490 -1.2%
SA 4,911,310 -2.1%
TAS 6,561,400 +4.5%
ACT 5,892,291 +9.0%
NT 691,410 -15.9%
Capital Cities Current Water (GL) %Change from Last Year
Sydney 1,891,000 +1.0%
Melbourne 517,000 +1.7%
Brisbane 7,211,100 +1.4%
Perth 3,200,090 -0.2%
Adelaide 1,911,910 -3.1%
Hobart 2,561,000 +2.5%
Canberra 1,891,891 +5.0%
Darwin 291,010 -20.9%
Drainage Divisions
Download as CSV
Download as PDF
Plot
Table
Region
Search
Clear Chart
Series Selector
[SHOW]
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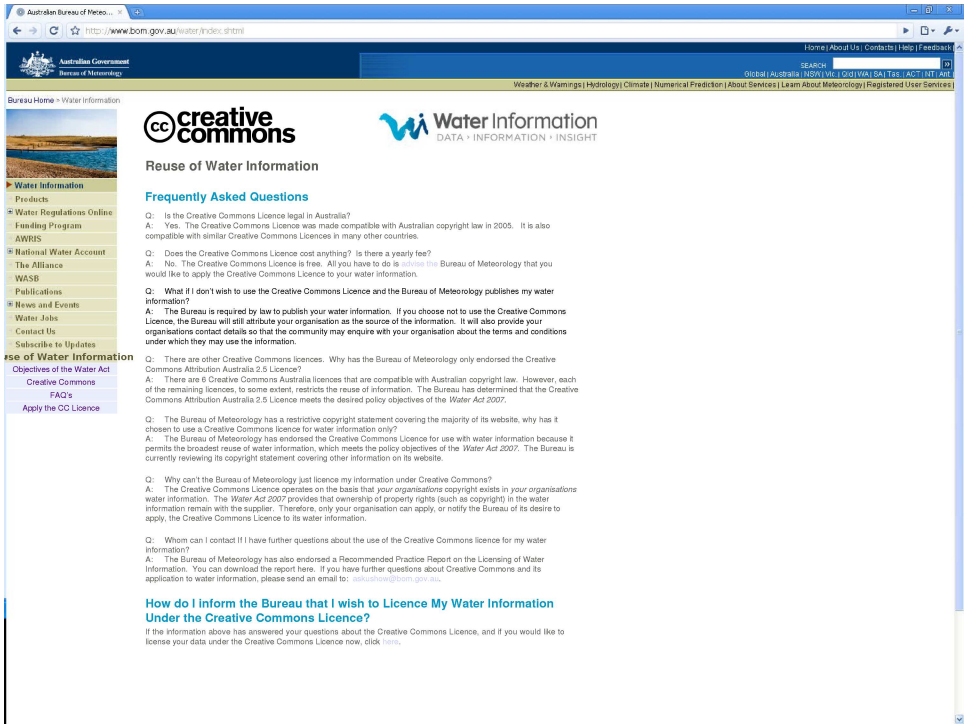
Print PDF
Contact the Slake Team
Need some help?
Water storage Glossary
This data is made available by the following organisations under their nominated terms and conditions:
© Organisation A:
© Organisation B: Contact info@orgb.com.au for details
© Organisation C: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http://www.bom.gov.au/water/index.shtml
Bureau Home > Water Information
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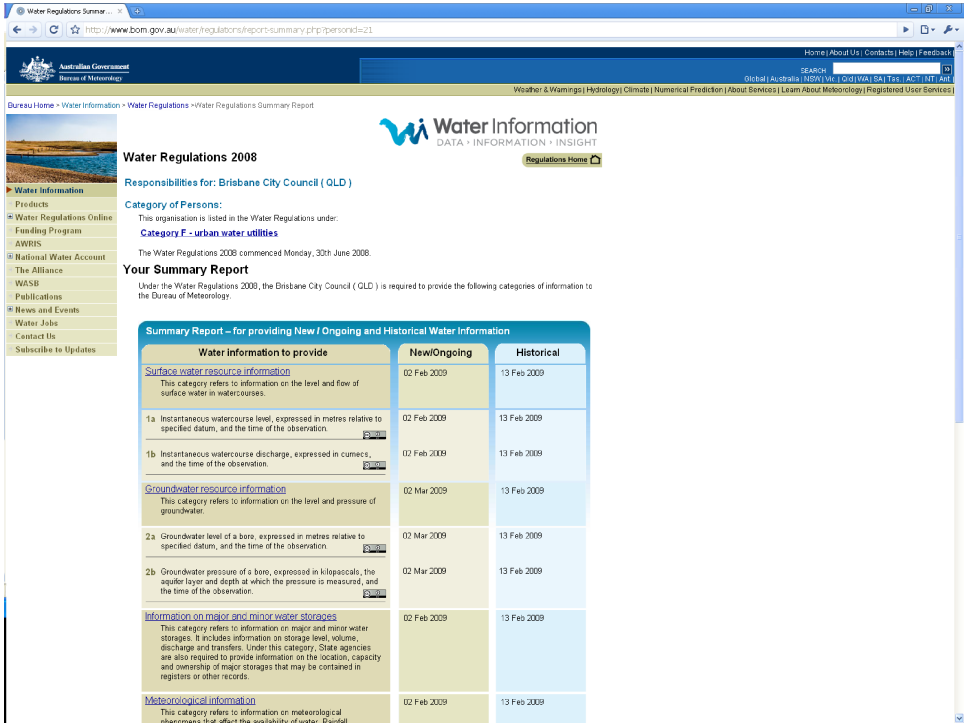
Reuse of Water Information
Frequently Asked Questions
Q: Is the Creative Commons Licence legal in Australia?
A: Yes. The Creative Commons Licence was made compatible with Australian copyright law in 2005. It is also compatible with similar Creative Commons Licences in many other countries.
Q: Does the Creative Commons Licence cost anything? Is there a yearly fee?
A: No. The Creative Commons Licence is free. All you have to do is advise the Bureau of Meteorology that you would like to apply the Creative Commons Licence to your water information.
Q: What if I don't wish to use the Creative Commons Licence and the Bureau of Meteorology publishes my water information?
A: The Bureau is required by law to publish your water information. If you choose not to use the Creative Commons Licence, the Bureau will still attribute your organisation as the source of the information. It will also provide your organisations contact details so that the community may enquire with your organisation about the terms and conditions under which they may use the information.
Q: There are other Creative Commons licences. Why has the Bureau of Meteorology only endorsed the Creative Commons Attribution Australia 2.5 Licence?
A: There are 6 Creative Commons Australia licences that are compatible with Australian copyright law. However, each of the remaining licences, to some extent, restricts the reuse of information. The Bureau has determined that the Creative Commons Attribution Australia 2.5 Licence meets the desired policy objectives of the Water Act 2007.
Q: The Bureau of Meteorology has a restrictive copyright statement covering the majority of its website, why has it chosen to use a Creative Commons licence for water information only?
A: The Bureau of Meteorology has endorsed the Creative Commons Licence for use with water information because it permits the broadest reuse of water information, which meets the policy objectives of the Water Act 2007. The Bureau is currently reviewing its copyright statement covering other information on its website.
Q: Why can't the Bureau of Meteorology just licence my information under Creative Commons?
A: The Creative Commons Licence operates on the basis that your organisations copyright exists in your organisations water information. The Water Act 2007 provides that ownership of property rights (such as copyright) in the water information remain with the supplier. Therefore, only your organisation can apply, or notify the Bureau of its desire to apply, the Creative Commons Licence to its water information.
Q: Whom can I contact if I have further questions about the use of the Creative Commons licence for my water information?
A: The Bureau of Meteorology has also endorsed a Recommended Practice Report on the Licensing of Water Information. You can download the report here. If you have further questions about Creative Commons and its application to water information, please send an email to: askushow@bom.gov.au.
How do I inform the Bureau that I wish to Licence My Water Information Under the Creative Commons Licence?
If the information above has answered your questions about the Creative Commons Licence, and if you would like to license your data under the Creative Commons Licence now, click here.


Water Regulations Summar...
http://www.bom.gov.au/water/regulations/report-summary.php?personid=21
Bureau Home > Water Information > Water Regulations > Water Regulations Summary Report
Water Information
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Regulations Home
Water Regulations 2008
Responsibilities for: Brisbane City Council ( QLD )
Category of Persons:
This organisation is listed in the Water Regulations under:
Category F - urban water utilities
The Water Regulations 2008 commenced Monday, 30th June 2008.
Your Summary Report
Under the Water Regulations 2008, the Brisbane City Council ( QLD ) is required to provide the following categories of information to the Bureau of Meteorology.
Summary Report – for providing New / Ongoing and Historical Water Information
Water information to provide
New/Ongoing
Historical
Surface water resource information
This category refers to information on the level and flow of surface water in watercourses.
02 Feb 2009
13 Feb 2009
1a Instantaneous watercourse level, expressed in metres relative to specified datum, and the time of the observation.
02 Feb 2009
13 Feb 2009
1b Instantaneous watercourse discharge, expressed in cumecs, and the time of the observation.
02 Feb 2009
13 Feb 2009
Groundwater resource information
This category refers to information on the level and pressure of groundwater.
02 Mar 2009
13 Feb 2009
2a Groundwater level of a bore, expressed in metres relative to specified datum, and the time of the observation.
02 Mar 2009
13 Feb 2009
2b Groundwater pressure of a bore, expressed in kilopascals, the aquifer layer and depth at which the pressure is measured, and the time of the observation.
02 Mar 2009
13 Feb 2009
Information on major and minor water storages
This category refers to information on major and minor water storages. It includes information on storage level, volume, discharge and transfers. Under this category, State agencies are also required to provide information on the location, capacity and ownership of major storages that may be contained in registers or other records.
02 Feb 2009
13 Feb 2009
Meteorological information
This category refers to information on meteorological phenomena that affect the availability of water. Rainfall
02 Feb 2009
13 Feb 2009

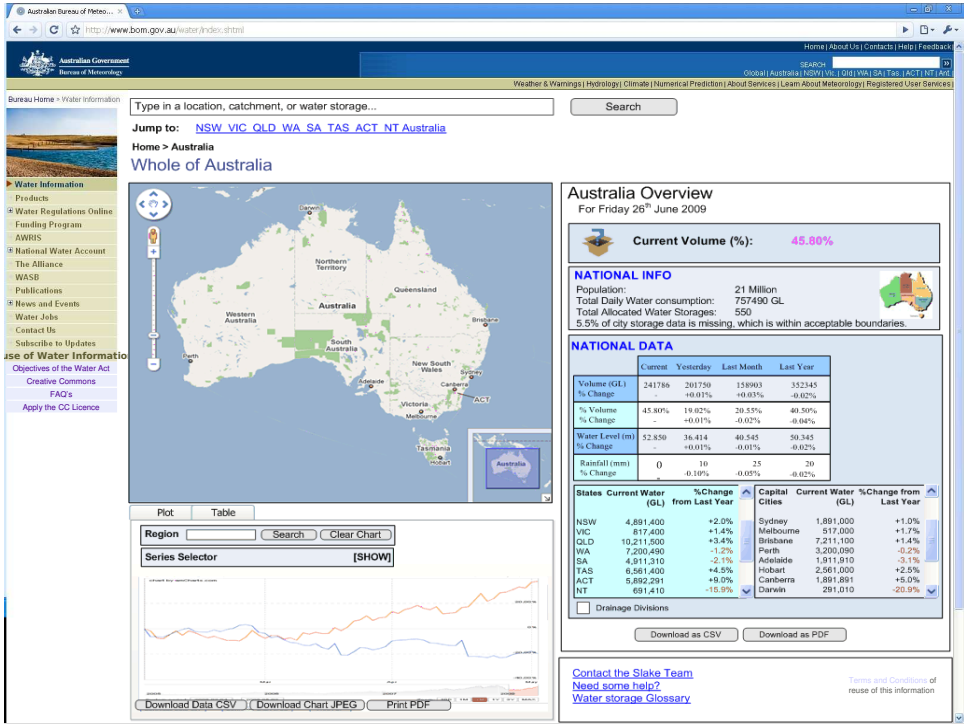
Australian Bureau of Meteo...
http://www.bom.gov.au/water/index.shtml
Bureau Home > Water Information
Type in a location, catchment, or water storage...
Search
Jump to: NSW VIC QLD WA SA TAS ACT NT Australia
Home > Australia
Whole of Australia
Australia Overview
For Friday 26th June 2009
Current Volume (%): 45.80%
NATIONAL INFO
Population: 21 Million
Total Daily Water consumption: 757490 GL
Total Allocated Water Storages: 550
5.5% of city storage data is missing, which is within acceptable boundaries.
NATIONAL DATA
Current Yesterday Last Month Last Year
Volume (GL) 241786 201750 158903 352345
% Change - +0.01% +0.03% -0.02%
% Volume 45.80% 19.02% 20.55% 40.50%
% Change - +0.01% -0.02% -0.04%
Water Level (m) 52.850 36.414 40.545 50.345
% Change - +0.01% -0.01% -0.02%
Rainfall (mm) 0 10 25 20
% Change - -0.10% -0.05% -0.02%
States Current Water (GL) %Change from Last Year
NSW 4,891,400 +2.0%
VIC 817,400 +1.4%
QLD 10,211,500 +3.4%
WA 7,200,490 -1.2%
SA 4,911,310 -2.1%
TAS 6,561,400 +4.5%
ACT 5,892,291 +9.0%
NT 691,410 -15.9%
Capital Cities Current Water (GL) %Change from Last Year
Sydney 1,891,000 +1.0%
Melbourne 517,000 +1.7%
Brisbane 7,211,100 +1.4%
Perth 3,200,090 -0.2%
Adelaide 1,911,910 -3.1%
Hobart 2,561,000 +2.5%
Canberra 1,891,891 +5.0%
Darwin 291,010 -20.9%
Drainage Divisions
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Table
Region
Search
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Series Selector
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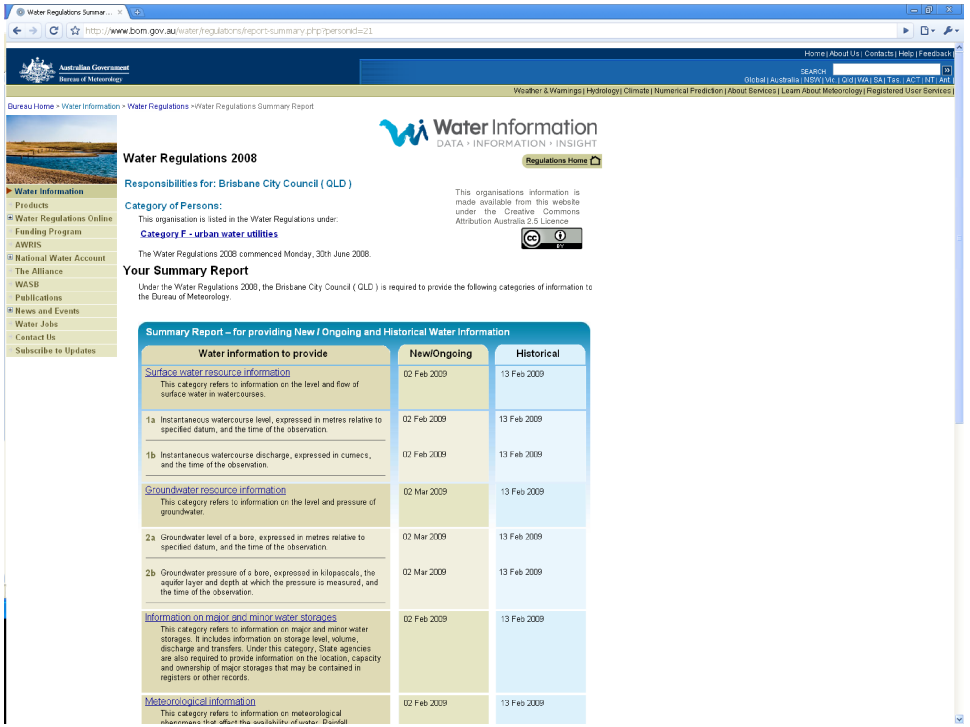


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# Thank you

**Baden Appleyard**
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baden.appleyard@derm.qld.gov.au

Using GDAL – Geospatial Data Abstraction Library – from high-level programming languages

OSGIS 2009 Workshop

June 22, 2009

Ari Jolma, Helsinki University of Technology

ari.jolma@tkk.fi

## The scope of the workshop

GDAL is a modular and extensible library for geospatial raster and vector data; providing a generic data model, classes for spatial reference systems and functions for coordinate transformations and geospatial algorithms among other things. GDAL is typically used as middleware between low-level data management libraries (file systems, databases, networking software, and specific libraries for geospatial data) and analytical software or user-oriented applications. GDAL defines a format independent storage for geospatial data for programmers. GDAL is written in C++, but it is recommended to use it through its C API, which is more stable than the C++ API. The GDAL distribution contains an object-oriented, high-level programming language API for GDAL developed using the interface generator Swig. The Swig API is built on top of the C API. The Swig API allows GDAL to be used from programming languages such as Perl, Python, Ruby, and C#. Perl is used in this workshop, but there are strong similarities between using GDAL from all supported languages.

The workshop covers the following tasks:

- Finding out information about geospatial datasets
- Reading in and accessing geospatial data
- Creating and writing out geospatial data
- Using geo-analytical functions
- Using built-in algorithms



## Preliminary knowledge and abilities

### Perl

The GDAL Swig API classes are packages in Perl. The subroutines in the packages are either functions, class methods, or object methods. The class methods may expect the class name as the first parameter (it is included automatically when the "->" notation is used). The object methods expect the object to be the first parameter (it is included automatically when the "->" notation is used).

Swig generated Perl objects for the underlying GDAL objects are opaque scalars. Some attributes (those known to Swig) of the objects are accessed using the "->{attribute}" notation.

The Perl GDAL API has two layers of conventions. The first is due to the common GDAL Swig API and the second is built on top of that in Perl. The first is characterized with numeric constants, separate Get/Set methods, and, in many cases, the use of list references instead of lists. The second is characterized with string constants, single methods for getting and setting properties, and the use of lists.

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### GDAL

The GDAL data model is depicted in figure 1 and the OGR data model in figure 2.

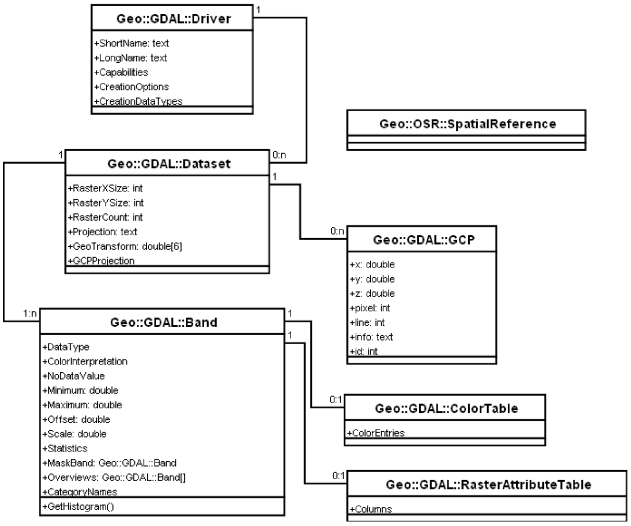


Figure 1. The (somewhat idealized presentation of the) GDAL raster data model in the Swig API.



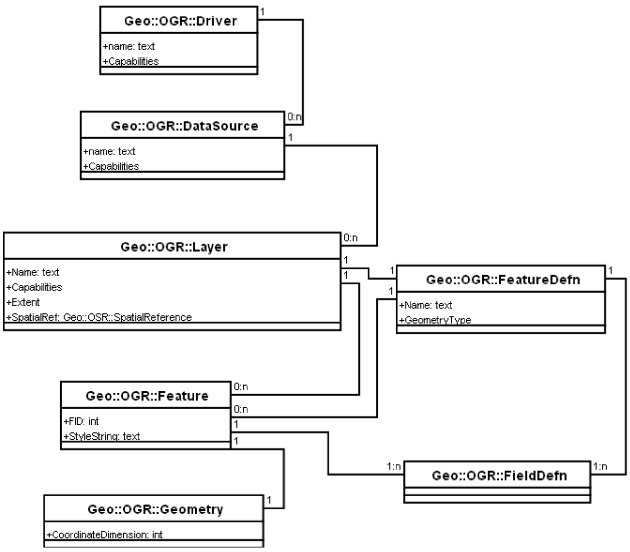


Figure 2. The (somewhat idealized presentation of the) GDAL vector data model in the Swig API.

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## Documentation

The documentation for Perl is, for example, at http://perldoc.perl.org/

The documentation for GDAL is at http://www.gdal.org/annotated.html and http://www.gdal.org/ogr/annotated.html. The format docs are at http://www.gdal.org/formats_list.html and http://www.gdal.org/ogr/ogr_formats.html

The documentation for GDAL Perl is at http://map.hut.fi/doc/Geo-GDAL/html/

## Writing and running the Perl programs of this workshop

This workshop uses computers running the MS Windows® operating system. The software stack that is installed on the computers is the Geoinformatica, specifically, the MinGW/MSYS build of Geoinformatica packaged May 18. 2009. The installation package is available from http://map.hut.fi/files/Geoinformatica/. The stack is shown in Figure 3.

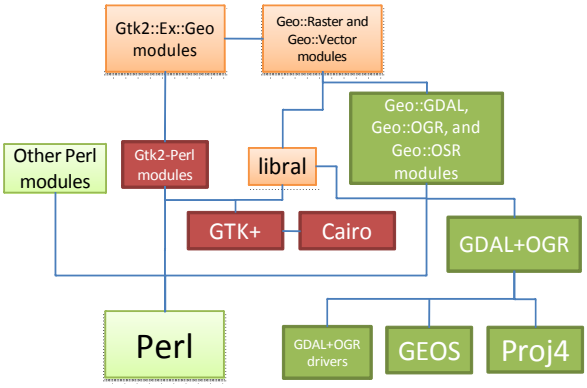


Figure 3. The composition of the Geoinformatica stack.

The Geoinformatica installation package for Windows® contains a directory tree. The main contents of the tree are listed and described in table 1.



Table 1. The contents of the Geoinformatica installation package for Windows®

| *item* | *Contents and description* |
|---|---|
| bin | DLLs and EXEs for GDAL, Perl, GTK+ and their dependencies |
| bin/gui.pl | the simple graphical program |
| doc | Documentation for libral, Perl GDAL, and other Geoinformatica Perl modules |
| etc | files needed by GTK+ |
| html | Perl documentation (from Perl distribution) |
| lib | Perl core modules (from Perl distribution) |
| share/doc | licence files |
| share/gdal | GDAL spatial reference system files and other GDAL files |
| share/locale | GTK+ locale files |
| share/themes | GTK+ theme files |
| site | Perl modules for GDAL, Geoinformatica, GTK+, and miscellaneous included modules |
| G-shell.bat | A Microsoft batch file, which sets environment variables for GDAL, adds bin to PATH, and starts a Windows command line interpreter |

The Geoinformatica graphical program is started with the command line

```
wperl.exe gui.pl
```

in the bin directory. There should be a menu entry in the computer based on this command line. The command line interpreter is needed for running the Perl programs that are written in this workshop. The best way to start a suitable command line interpreter is to execute the G-shell.bat batch file from the root of the Geoinformatica installation. This probably needs to be done manually using a file manager as there is no menu entry for this.

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The programs can be written using any text editor, even Notepad. Once the program is written (or copy pasted & edited as necessary from this document) it is executed in the command line interpreter with the command

```
perl program.pl
```

Assuming the program was stored into the disk as program.pl.

## The data for the workshop

The data for the workshop has been downloaded from various sources in the Internet and it should be freely usable. The data is packaged into a zip file and is available from http://map.hut.fi/files/course_materials/data.zip

# Common geospatial programming tasks

## Finding out information about geospatial datasets

The starting point for finding out information about a geospatial dataset with GDAL is the Dataset object in the case of Raster data and the DataSource object in the case of vector data. When creating a Dataset or a DataSource object for an existing dataset the only requirement is to know the resource identifier of it. The resource identifier is typically a filename for raster datasets and a filename or a driver specific string in the case of vector datasets. In the case of formats with more than one file, the filename to give to the constructor is driver-specific. It is the task of each GDAL driver to clearly, i.e., without false positives and false negatives, and without problems, i.e., not spending too much time nor crash when examining alien files, recognize its "own" datasets.

To iterate over a set of datasets of file based formats it is necessary to use the file system reading functions of the programming language. In other cases the iteration methods vary.

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Here's a recursive function to iterate a directory tree and report recognized geospatial raster files:

```
sub list_raster_datasets {
    my ($dir) = @_;
    print "In directory '$dir':\n";

    # read in the contents of $dir
    opendir(DIR, $dir) || die "can't opendir $dir: $!";
    my @dir = readdir(DIR);
    closedir DIR;

    # iterate over regular files
    for my $file (grep { -f "$dir/$_" } @dir) {
        my $r;
        eval {
            $r = Geo::GDAL::Dataset::Open("$dir/$file");
        };
        print "  '$file' is a ",$r->GetDriver->{LongName}," file\n" if $r;
    }

    # iterate over directories, but not those, whose name starts with '.'
    for my $d (grep { !/^\./ && -d "$dir/$_" } @dir) {
        list_raster_datasets("$dir/$d");
    }
}
```

Noteworthy in this code snippet:

- Opening the dataset is put within eval{} as it may fail

Once we have the dataset object we can query things like the geotransform. For example:

```
my @transform = $r->GeoTransform;
my $width = $r->{RasterXSize};
print "Upper right: (",$transform[0]+$width*$transform[1],", ",$transform[3],")\n";
```

Noteworthy in this code snippet:

- The transform list contains six coefficients, which define an affine transformation between the raster coordinates (integer values) and the projection coordinates (real values)

The ESRI Shapefile and MapInfo File drivers are able to both open a directory or a file as a data source. If there are both shapefiles and mapinfo files in a directory, the directory is opened as a shapefile data source simply because GDAL tries it before the mapinfo file driver.

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Here's a recursive function to iterate over a directory tree containing shapefiles or mapinfo files:

```
sub list_vector_datasets {
    my ($dir) = @_;
    print "In directory '$dir':\n";

    my $r;
    eval {
        $r = Geo::OGR::DataSource::Open("$dir");
    };
    if ($r) {
        my @layers = $r->Layers;
        print "@layers\n";
    }

    # read in the contents of $dir
    opendir(DIR, $dir) || die "can't opendir $dir: $!";
    my @dir = readdir(DIR);
    closedir DIR;

    # iterate over directories, but not those, whose name starts with '.'
    for my $d (grep { !/^\./ && -d "$dir/$_" } @dir) {
        list_vector_datasets("$dir/$d");
    }
}
```

Noteworthy in this code snippet:

- Opening the data source is put within eval{} as it may fail
- The Layers method returns layer names (instead of Layer objects)

Once we have the data source object, we can create layer objects for the data layers in it, and find out things like the number of features and the extent of the layer:

```
my @layers = $r->Layers;
for my $name (@layers) {
      print "  $name:\n";
       my $layer = $r->Layer($name);
       my $n = $layer->GetFeatureCount;
       my $e = $layer->GetExtent;
       print "$n features, extent is @$e\n";
}
```

## Reading in and accessing geospatial data

The raster data is accessed through a Band object and the vector data is accessed through Feature and Geometry objects. Every Dataset contains one or more Bands. Bands typically represent images obtained using specific wavelengths, for example common pictures have red, green, and blue channels. Every layer



contains an arbitrary, possibly a huge number of features. On the other hand, each feature may contain only one geometry object, which, however, can be a geometry collection.

The main pair of methods in GDAL Swig API for raster data is WriteRaster and ReadRaster. The raster data is copied from or read from a binary buffer, which contains the data in binary format. Each high level language provides its particular methods for encoding and decoding data between their native format and such a binary buffer. For Perl these functions are pack and unpack, which requires a data format parameter. A method for determining the correct character for the format parameter is Geo::GDAL::PackCharacter. However, for the Perl bindings two simpler methods for accessing the band data have been defined: WriteTile and ReadTile[1], which copy the data from or to a two-dimensional Perl array. As Perl arrays know their sizes, it is often only needed to specify the offsets for the data. This is a simple program which computes the time series of spatial average of a spatiotemporal dataset:

```
for my $year (1990..2002) {
    for my $month (1..12) {
        $month = '0'.$month if $month < 10;
        my $r = Geo::GDAL::Dataset::Open("LAN/data".$year.$month.".lan");
        my $data = $r->Band(1)->ReadTile;
        my $average = 0;
        my $n = 0;
        for my $row (@$data) {
            for my $value (@$row) {
                $average += $value;
                $n++;
            }
        }
        $average /= $n;
        print "$year $month $average\n";
    }
}
```

Noteworthy in this code snippet:

- The ReadTile returns the whole raster in an anonymous array when no offsets nor the size of the tile to be read are given

Vector data is stored as features. A feature contains a set of non-spatial attributes and one spatial attribute. It is possible to iterate through the non-spatial attributes or retrieve a specific attribute, if the name of the attribute is known. The value of an attribute may also be NULL (undef in Perl), i.e., not set. The spatial attribute is a geometry object. Depending on the actual type of the object, the coordinates (of vertices) are stored in the geometry, in a geometry that is within the geometry, or even deeper in the structure. For example multipolygons are composed of multiple polygons, which are composed of one or more rings, which are composed of vertices, which have coordinates.

1In Geoinformatica it is also possible to use the Geo::Raster class, which provides in-memory rasters, raster algebra, and integration with GDAL rasters.



Here is code, which iterates through a set of point datasets looking for cases of H1N1 in UK:

```
my $r = Geo::OGR::DataSource::Open("H1N1");
my @layers = $r->Layers;
my %data;
for my $name (@layers) {
    if ($name =~ /(\d\d)(\d\d)09/) {
        my $month = $1;
        my $day = $2;
        my $layer = $r->Layer($name);
        $layer->ResetReading;
        while (my $feature = $layer->GetNextFeature) {
            next unless $feature->GetField('COUNTRY') eq 'GB';
            next unless $feature->IsFieldSet('CONFIRMED') and
                $feature->GetField('CONFIRMED') > 0;
            my $incident = {
                confirmed => $feature->GetField('CONFIRMED'),
                location => $feature->Geometry->AsText()
            };
            $i++;
            push @{$data{$month}{$day}}, $incident;
        }
    }
}

for my $month (sort {$a<=>$b} keys %data) {
    for my $day (sort {$a<=>$b} keys %{$data{$month}}) {
        for my $incident (@{$data{$month}{$day}}) {
            print "$day/$month: cases: $incident->{confirmed} ".
              "location: $incident->{location}\n";
        }
    }
}
```

Noteworthy in this code snippet:

- GDAL supports iteration through the features within a layer with the methods ResetReading and GetNextFeature. Additionally, filters can be installed for the iteration.
- The data is first collected and then reported as the layers are accessed in an arbitrary order.

## Creating and writing out geospatial data

To create a raster dataset with GDAL is the same as creating a dataset object. The "Create" (aka "CreateDataset") method of a raster driver class creates a new raster dataset. The minimum knowledge needed when calling the method is the name (a file name) and size (width and height) for the new raster. A raster driver object can be obtained using the "Driver" (aka "GetDriverByName") function (implemented as a class method of the GDAL root class Geo::GDAL). The "Driver" method requires the "GDAL short name" of the driver, which one needs to look up from the documentation or find using some other means.



Here's interactive code for creating a new raster dataset:

```
my @list;
for my $driver (Geo::GDAL::Drivers) {
    next unless $driver->TestCapability('Create');
    push @list, $driver->{ShortName};
}
my $i = 1;
for my $name (sort @list) {
    $list{$i} = $name;
    printf("%2i: %-8s ",$i,$name);
    print "\n" if $i % 4 == 0;
    $i++;
}
my $driver;
do {
    print "\nSelect driver:";
    $driver = <STDIN>;
    $driver =~ s/[\r\n]//;
} until $list{$driver};

$driver = Geo::GDAL::Driver($list{$driver});
my $ext = $driver->Extension;
($ext) = split /\//, $ext;
print "\nUsing $driver->{ShortName}. Extension will be $ext\n";
do {
    print "\nSpecify the size for the image (width,height):";
    $size = <STDIN>;
    $size =~ s/[\r\n]//;
    @size = split /,/, $size; # /
} until $size[0] > 0 and $size[1] > 0;
print "\nUsing size @size\n";
$driver->Create('test.'.$ext,@size);
print "Created test.$ext\n";
```

Noteworthy in this code snippet:

- The first loop creates a list of raster driver names. Only drivers, which can create new rasters are included.
- The second loop creates a menu.
- The third loop retrieves the user's selection.
- The file name extension is then retrieved from the driver. There may be more than one extension and if so, they are returned as a list ext1/ext2/…
- The fourth loop retrieves the user's wish for the size of the raster.
- The new raster can then be created.
- The new raster will have only one band. The number of bands can be specified as the fourth parameter to Create.
- The new raster will be of type 'Byte'. Another type can be specified as the fifth parameter to Create.
- Each driver has a particular list of options (key – value pairs) that can be used to control the dataset creation. The options are the sixth parameter to Create.

Creating a vector dataset is, similarly to raster datasets, the same as creating a DataSource object. To create a Geo::OGR::DataSource, a Geo::OGR::Driver (note that Geo::OGR::Driver is different from Geo::GDAL::Driver) object is needed. Similar to raster drivers, the available vector drivers depends on the GDAL build and distribution. One can list the available vector drivers that can be used to create datasets with this code:

```
for my $driver (Geo::OGR::Drivers) {
    my %cap = map { $_ => 1 } $driver->Capabilities;
    print "$driver->{name}\n" if $cap{CreateDataSource};
}
```

Noteworthy in this code snippet:

- The Geo::OGR::Drivers is a Perl-only function that internally calls Geo::OGR::GetDriverCount and Geo::OGR::GetDriver
- The PostgreSQL is erroneously listed

A new vector data source is created using either the Create (aka CreateDataSource) or Copy (aka CopyDataSource) method of the driver. The only required parameter is the name of the new data source (and the data source to be copied in the case of the Copy method). Both methods accept a reference to a hash containing data source creation options, which are driver dependent.

The DataSource object is mostly useful only as a stepping stone to accessing the layers. Many DataSource classes are capable of creating new layers. Thus, it is usually not needed to create new data sources, only new layers. The information to be provided for the CreateLayer method of DataSource class includes: a name, a spatial reference system, a data model, and creation options. Only the name is a required parameter. A GDAL layer has a data model, which is shared by each feature in the layer. The data model consists of non-spatial attributes, which are represented by FieldDefn objects, and of a geometry type, which is either a numeric constant or a string (in Perl API). There is a geometry type “Unknown”, which allows features with differing geometries to exist in a same layer. Typically the non-spatial data model of a layer is built using the CreateField method, which assumes FieldDefn object as a parameter. In Perl the whole schema can be defined in the CreateLayer method using a complex data structure.

Features are added to the layer using the method CreateFeature, which requires a Feature object as a parameter. Thus the Feature object needs to be constructed first. The construction happens in two steps: instantiation of a new object (this requires the schema) and setting the attributes.

The GDAL Perl contains many methods, which simplifies this procedure.



This code creates a polygon layer with non-spatial fields and adds two polygons into the layer.

```
my $ds = Geo::OGR::Open('H1N1', 1);

my $layer = $ds->CreateLayer({
                            Name => 'new_layer',
                            Schema => [ Fields => [
                                        { Name => 'nr',
                                        Type => 'Integer',
                                        Width => 8 },
                                        { Name => 'name',
                                        Type => 'String' }
                                        ] },
                             GeometryType => 'Polygon'
                           });

my @data = ({name => 'area A', points => [[0,0],[1,0],[1,1],[0,1]]},
            {name => 'area B', points => [[5,5],[7,5],[7,6],[5,6]]});

my $i = 0;
for my $item (@data) {

    my @ring = ( $item->{points}[0],
                 $item->{points}[1],
                 $item->{points}[2],
                 $item->{points}[3],
                 $item->{points}[0] );

    $layer->InsertFeature({
        nr => $i,
        name => $item->{name},
        Geometry => { Points => [ \@ring ] }
      });
    $i++;
}
```

Noteworthy in this code snippet:

- The function for opening a data source is called with the second parameter (update) set to True.
- The CreateLayer method is called using named parameters.
- The Schema parameter is used to specify the non-spatial fields.
- To create valid rings, the first point (vertex) is added also as the last point.
- The InsertFeature method of Layer class is used. This method accepts also anonymous hashes from which it can internally create Feature objects.
- The special key “Geometry” is used to specify the spatial data.
- The spatial data is specified as Points, which denotes a reference to a Perl list of lists.

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## Using geo-analytical functions

Geometry objects and Feature objects can be created also outside of a Layer object. This may make sense for example in applications, which perform spatial computations, e.g., using GEOS.

Here is an example, which computes a polygon intersection of two polygons:

```
my $ring_a = [[0,0],[1,0],[6,6],[0,1]];
my $ring_b = [[5,5],[7,5],[7,7],[5,7]];

my $a = Geo::OGR::Geometry->create(GeometryType => 'Polygon', Points => [$ring_a]);
my $b = Geo::OGR::Geometry->create(GeometryType => 'Polygon', Points => [$ring_b]);

$a->CloseRings;
$b->CloseRings;

my $c = $a->Intersection($b);

print $c->AsText,"\n";
```

Noteworthy in this code snippet:

- The outer rings of the polygons are defined as Perl lists of lists.
- The Geometry objects are constructed using the create method, which allows named parameters.
- The rings need to be explicitly closed.
- The standard Intersection method is used from GEOS - this is done by GDAL under the hood.
- AsText is an alias to ExportToWkt.

Testing this in the graphical program of Geoinformatica produces the following image:

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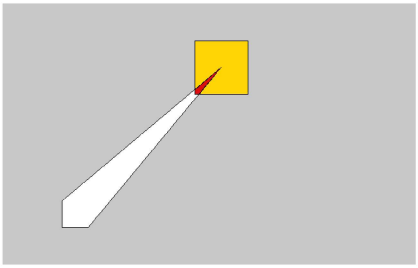

Figure 4. A screenshot illustrating two polygons and their intersection that is computed using GEOS through GDAL.

The commands that need to be typed into the command prompt are:

```
$ring_a = [[0,0],[1,0],[6,6],[0,1]]
$ring_b = [[5,5],[7,5],[7,7],[5,7]]
$a = Geo::OGR::Geometry->create(GeometryType => 'Polygon', Points => [$ring_a])
$b = Geo::OGR::Geometry->create(GeometryType => 'Polygon', Points => [$ring_b])
$a->CloseRings
$b->CloseRings
$c = $a->Intersection($b)
$x = Geo::Vector::Layer->new(name=>'x')
$x->add_feature(geometry => $a)
$x->add_feature(geometry => $b)
$x->add_feature(geometry => $c)
```

Noteworthy in this code snippet:

- The variable $x is a Geoinformatica vector layer object, which may contain either an OGR layer or a Perl array of OGR features. In this case $x contains an OGR layer created with the Memory driver.
- The color coding in the picture was created using the colors dialog box and color table palette and binding white, yellow and red to FIDs of the features.

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## Using built-in algorithms

The built-in algorithms that are available in GDAL and are exposed through Swig include

- ComputeMedianCutPCT
  - Compute an "optimal" color table for a three band image.
- DitherRGB2PCT
  - Dither a three band image into one band using a color table.
- ReprojectImage
  - Reproject an image
- ComputeProximity
  - Compute the proximity of all pixels in the image to a set of pixels in the source image.
- RasterizeLayer
  - Burn geometries into raster.
- Polygonize
  - Create polygon coverage from raster data.
- SieveFilter
  - Remove small raster polygons.



Here is an example of using the Polygonize method:

```
my $tif = Geo::GDAL::Dataset::Open('AUS00605/C00605.tif');
my $band = $tif->Band(1);

my $s = Geo::OGR::Driver('ESRI Shapefile')->Create('AUS00605');
my $l = $s->CreateLayer({ Name => 'land',
                          Schema => {
                              Fields => [ { Name => 'pixel',
                                            Type => 'Integer',
                                            Width => 8
                                          } ] } });

my $d = $band->ReadTile;
for my $col (@$d) {
    for (@$col) {
        $_ = 0 unless $_ == 7;
    }
}
$band->WriteTile($d);

sub progress {
    my($progress) = @_;
    print "$progress\n";
}

Geo::GDAL::Polygonize($band, undef, $l, 'pixel', undef, \&progress, undef);
```

Noteworthy in this code snippet:

- The vector data source object needs to be created since there are no shapefiles in the AUS00605 directory initially
- The width of the integer field needs to be set, this is a peculiarity of the shapefile driver
- The band data is reclassified to 7 (land) and 0 (not land) before polygonizing.
- A progress function is used. The $progress variable gets values from 0 to ~1.

The code produces a shapefile with 2233 polygon features. The only problem now is to determine which one is the coastline. That is left as an exercise to the reader.

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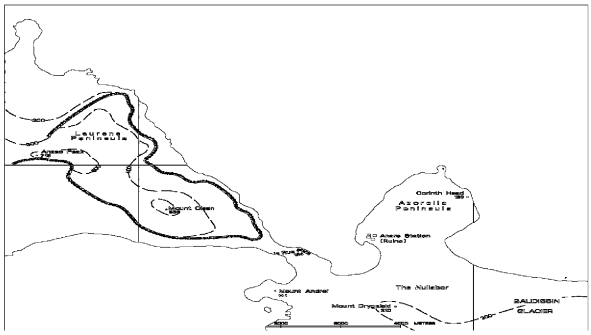


Figure 5. The polygon features from `AUS00605/C00605.tif`.

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## *Question 4.c – Education Database Listing*

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- Italiano
- 日本語
- □□□
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|---|---|---|
| Open Source GIS: A GRASS GIS Approach. Third Edition | A Romanian review for the "Open Source GIS: A GRASS GIS Approach. Third Edition" book | Mihai Terente | 2009-09-27 19:58 |
| Realizarea unui "super mozaic" raster folosind instrumente open source | Tutorial for creating very large image mosaics using GDAL | Vasile Crăciunescu | 2009-09-27 19:55 |
| Extragerea de profile din fişiere de tip grid şi vector | Tutorial for creating terrain profiles using several GIS software including QGIS | Florin Iosub | 2009-09-27 19:50 |
| Soluţii WMS open source - Partea I | A tutorial describing how to publish standard web mapping services using GeoServer | Marius Jigmond | 2009-09-27 19:45 |
| Dezvoltarea de aplicaţii WEBGIS folosind soluţii open source. Partea I: Introducere OpenLayers | First part from a series of tutorials focused on learning how to develop webmapping applications using OpenLayers | Vasile Crăciunescu | 2009-09-27 19:41 |
| Adăugarea coordonatelor X şi Y unui set de puncte | Tutorial for adding XY coordinates to a vector database (point) using SAGA GIS | Mihai Terente | 2009-09-27 19:36 |
| Utilizare Quantum GIS. Partea a II-a: Digitizarea şi editarea datelor | Tutorial for vector data editing using QGIS | Cornel Tudose | 2009-09-27 19:32 |
| Open Web Mapping | A Master's level course in web mapping using open standards and opensoftware. The examples use GeoServer and OpenLayers but the skills are applicable to other servers and clients (even proprietary ones) | Ian Turton | 2009-09-16 17:45 |
| Introdução ao MapServer | O objetivo principal do curso Introdução ao MapServer é fazer com que o participante possa compreender os princípios básicos envolvidos na criação de uma aplicação webmapping e consiga realizar os seus primeiros passos no desenvolvimento de aplicações MapServer. Este material foi desenvolvido e publicado por Eduardo Patto Kanegae no ano de 2005. | Eduardo Patto Kanegae | 2009-07-23 03:18 |
| INTRODUCCIÓN A BASES DE DATOS ESPACIALES DE USO LIBRE | SQL SOBRE POSTGRESQL + POSTGIS USANDO EL CLIENTE PSQL Introduction to FOSS spatial databases: SQL with PostGreSQL and PostGIS | Alexys Herleym Rodríguez Avellaneda | 2009-07-21 20:03 |
| CURSO DE MODELOS DE DISTRIBUCIÓN DE ESPECIES | En este curso se utiliza software libre (OpenModeller, GRASS GIS, Octave y Open Office, entre otros) para aprender a generar modelos de distribución de especies biológicas. Estos modelos sirven para pronosticar los lugares en los que pueden aparecer nuevas poblaciones de plantas o animales, y sus objetivos son variados: diseño de reservas, búsqueda de nuevas poblaciones, predicción de invasiones biológicas, o análisis de impacto potencial del cambio climático en la distribución geográfica de las especies. El material, que se compone del software, tutorial y datos de prueba, se confeccionó para un curso de la Sociedad Española de la Biología de Conservación de Plantas que tuvo lugar en Septiembre de 2008. Por requerimientos del aula en la que se desarrolló el curso, el material disponible está preparado para un Sistema Operativo Windows XP, aunque todo el | Blas Benito de Pando | 2009-07-21 13:03 |

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|---|---|---|---|
| | software está disponible también para Linux, por lo que es relativamente sencillo seguirlo desde esta plataforma libre. | | |
| A Gentle Introduction to GIS | A resource for learners and educators that tries to take a more gentle road to introducing GIS key concepts. | Tim Sutton, Otto Dassau, Marcelle Sutton | 2009-07-15 21:10 |
| Using GDAL – Geospatial Data Abstraction Library – from a high-level programming language Perl | Materials for a workshop that was held in OSGIS 2009 UK. Contains a hand-out, slides, and data. | Ari Jolma | 2009-06-29 07:37 |
| SigLibres - French-language moodle course site on FOSSGIS | Eclectic, and sometimes only in draft state, collection of French-language training material on FOSSGIS developed for a local training course, mostly using GRASS. | Moritz Lennert | 2009-05-18 07:25 |
| Руководство пользователя gvSIG 1.1 | Перевод официального руководства gvSIG 1.1 | GIS-Lab.info (see link for full list) | 2009-04-20 23:33 |
| Начало работы с GeoServer | Описание начала работы с GeoServer, использующее материалы с официального сайта программы. | Dmitry Kolesov | 2009-04-20 23:30 |
| Учебное руководство по GRASS 6.0 | Перевод на русский язык "An introduction to the practical use of the Free Geographical Information System GRASS 6.0" | GIS-Lab.info (see link for full list) | 2009-04-20 23:24 |
| MapServer OGC Web Services Workshop | Interoperability is increasingly becoming a focus point for organizations that distribute and share data over the Internet. The Open Geospatial Consortium (OGC) focuses on the development of publicly available geospatial web standards. MapServer supports numerous OGC specifications, allowing users to publish their data services in an interoperable manner. This workshop will review the OGC specfications supported in MapServer as well as provide information on implementation options and issues, as well as what the future holds for OGC support in MapServer | Yewondwossen Assefa, Jean-François Doyon, Tom Kralidis, Steve Lime, Jeff McKenna, Daniel Morissette, Bart van den Eijnden | 2009-04-20 21:41 |
| Introduction to GIS: QGIS, GRASS & R | 10 Labs for use with an introductory GIS course at the undergraduate level. | Richard Plant PhD | 2009-04-14 02:38 |
| FOSS4G 2008 GRASS beginners Workshop DVD | This live DVD, based on Kubuntu live, contains slides, programs and data for the FOSS4G 2008 "Practical Introduction to GRASS and related software for beginners" Workshop, Cape Town, South Africa, October 2008. GNU/Linux OS, GRASS and other software can be installed directly from the DVD. | Paolo Zatelli | 2009-03-12 15:20 |
| GRASS Tutorial | GRASS HTML Tutorial, based on freely available (and distributable) data. The structure of this tutorial is functional both for a new GRASS user and for a GRASS expert. The purpose of this work is to simplify the first approaches to GRASS, trough a series of examples and practical environmental applications of this GIS. Data is the free data set Spearfish60 downloadable from official GRASS website. A troubleshooting FAQ page is also available. | Marco Ciolli, Paolo Zatelli, Alfonso Vitti, Fabio Zottele, Clara Tattoni | 2009-03-11 18:38 |
| GRASS Tutorial | GRASS HTML Tutorial, based on freely available (and distributable) data. The structure of this tutorial is functional both for a new GRASS user and for a GRASS expert. The purpose of this work is to simplify the first approaches to GRASS, trough a series of examples and practical environmental applications of this GIS. Data is the free data set Spearfish60 downloadable from official GRASS website. A troubleshooting FAQ page is also available. | Marco Ciolli, Paolo Zatelli, Alfonso Vitti, Fabio Zottele, Clara Tattoni | 2009-03-11 18:38 |
| QGIS tutorial | Self-education tutorial for learning how to visualise, query, edit and print maps with QGIS, plus an introduction to grass plugin. Based on the free data set Spearfish60. | Clara Tattoni | 2009-03-04 16:25 |
| GIS e Cartografia numerica | Slides from university course in PDF format, organised per lessons | Paolo Zatelli, Battista Benciolini and Marco Ciolli | 2009-03-04 16:20 |
| Italian GRASS DVD 3.0 | Kubuntu live DVD in Italian with various FOSS4G software and GRASS 6.2 tutorial in italian; Kubuntu installer in Italian; GRASS 6.2 for Windows with Cygwin; Qgis 0.8.0 for Windows and other FOSS programs for Windows and relative documentation; | Paolo Zatelli | 2009-03-04 16:13 |
| FOSS4G 2007 GRASS and RDBMS Workshop DVD | a DVD based on Kubuntu 7.0 containing slides, programs and data for the FOSS4G 2007 GRASS and DBMS Workshop, Victoria, Canada. | Paolo Zatelli | 2009-03-04 16:03 |
| Tutorial for wildlife habitat suitability evaluation using GRASS and FOSS | tar.gz package containing a HTML tutorial and relative dataset. This tutorial that can be followed during class or for self-education. Two examples are proposed in order to evaluate the habitat suitability for 2 mammal species, based on presence data and environmental variables using GRASS for geographic analysis and R for statistics. | Clara Tattoni and Damiano G. Preatoni | 2009-03-04 15:57 |
| Introduction to QGIS 0.9 and GRASS 6.2 | Introductory tutorial designed for workshop use, concentrates on analysis, and integration of GRASS with QGIS | Scott Mitchell | 2009-02-27 14:19 |
| Introduction to the Event Visualization Tool (eVis) | Tutorial for using the Event Visualization Tool (eVis) - a plugin for QGIS - which allows a user to link geographic coordinates to photos or other images in QGIS. | Kevin Koy | 2009-02-26 12:02 |

| | | | added |
|---|---|---|---|
| Introduction to QGIS v.11 | This contains exercises that can be used in a classroom or for self-study as well as homework assignments and datasets needed for the exercises. This was developed for use in a 200-level undergraduate class in a Natural Resources Conservation program. It utilizes data from the Massachusett's GIS group (www.mass.gov/mgis). | Charlie Schweik, Maili Page, Alexander Stepanov, Maria Fernandez, Mike Hamel, Quentin Lewis | 2009-02-25 13:58 |
| Accesarea datelor PostgreSQL în ArcMap prin PostGIS şi zigGIS | Tutorial for using zigGIS to access date stored inside PostgreSQL+PostGIS from ArcMap. | Marius Jigmond | 2009-01-08 13:54 |
| Navigare 3D într-o pagină web folosind controlul ActiveX VTP (vtocx) | Tutorial for using VTP ActiveX vtocx for 3D visualization inside browser. | Vasile Crăciunescu | 2009-01-08 13:50 |
| Explorarea 3D a realităţii geografice folosind VTP. Primii paşi. | Introduction tutorial in using VTP (Virtual Terrain Project) suite for realistic 3D landscape visualization. | Vasile Crăciunescu | 2009-01-08 13:47 |
| Obţinerea unui fundal topografic/batimetric global folosind datele ETOPO2 | Step-by-step tutorial on creating a global shaded relief map using SAGA GIS. | Vasile Crăciunescu | 2009-01-08 13:44 |
| Decuparea unui set de date grid folosind o mască vectorială | Tutorial describing how to crop a GRID/DEM file using a vector mask in SAGA GIS. | Vasile Crăciunescu | 2009-01-08 13:41 |
| Harta temperaturii medii lunare: metoda detrended kriging | Tutorial describing how interpolate temperature values using detrended kriging method in SAGA GIS. | Alexandru Dumitrescu | 2009-01-08 10:25 |
| Utilizare PostGIS. Partea I: Instalare PostgreSQL + PostGIS. | Romanian tutorial for installing and configuring PostgreSQl and PostGIS. | Ion Nedelcu | 2009-01-08 10:17 |
| Definirea proiecţiei Stereo 70 pentru ILWIS | omanian tutorial describing how the Stereo70 coordinate system can be defined in ILWIS. | Mihai Terente | 2009-01-08 10:13 |
| Georeferenţierea unei hărţi scanate | Romanian tutorial describing how to georeference a map using QGIS. | Mihai Terente | 2009-01-08 10:06 |
| Instalarea GRASS pe platforme Windows | Romanian tutorial for installing GRASS on Windows platfoms. | Vasile Crăciunescu | 2009-01-08 10:03 |
| Instalare GRASS pe platforme MacOSX | Romanian tutorial for installing GRASS on MacOSX platfoms. | Vasile Crăciunescu | 2009-01-08 10:00 |
| Manipularea datelor spaţiale folosind GDAL. I Date raster. | Tutorial on using GDAL for raster data manipulation. | Cristian Balint | 2009-01-08 09:58 |
| Realizarea şi adăugarea de noi simboluri în Quantum GIS | Tutorial describing how a user can create and use custom cartographic symbols in QGIS. | Mihai-Daniel Niţă | 2009-01-08 09:54 |
| Delinierea unui bazin hidrografic - O soluţie open-source completă. | Step by step tutorial describing how the QGIS + GRASS combination can be use for hydrological watershed delineation based on DEMs. | Marius Jigmond | 2009-01-08 09:51 |
| Utilizare Quantum GIS. Partea I: Introducere, vizualizare date, lucrul cu date raster. | First part of the translation and adaptation in Romanian language of Gary Sherman's “Shuffling Quantum GIS into the Open Source GIS Stack” tutorial. | Vasile Crăciunescu | 2009-01-08 09:38 |
| II. Software GIS open-source, o alternativă completă la soluţiile proprietare. Aplicaţii desktop. | Review of desktop FOSS4G applications. | Vasile Crăciunescu | 2009-01-08 09:31 |
| Software GIS open-source, o alternativă completă la soluţiile proprietare. Introducere, librării şi toolkit-uri de dezvoltare | A gentle introduction to the open source concepts and continue with an overview of principal geospatial libraries and toolkits. | Vasile Crăciunescu | 2009-01-07 20:05 |
| Supporting sustainable development: the GRASS GIS opportunity | Two environmental relevant examples are worked out in this lab: 1)estimation of the quantity of potential solar energy that could be produced with solar panels using as input information the landscape morphology and the characteristics of building roofs obtainable from LiDAR (Light Detection and Ranging) Digital Surface Models and Digital Terrain Models. 2)risk assessment due to tsunami events: hazard, vulnerability and expected damages maps are computed. Specifically the exercise consists in the estimation of the maximum vertical height of the tsunami waves hitting the coast (run-up) and the subsequent diffusion over the inland areas, as a function of morphology, vegetation, and of coastal area urbanization. The results are used to estimate hazard corresponding to different return period events, associated exposition and vulnerability . | Maria Antonia Brovelli, Massimiliano Cannata and Monia Molinari | 2009-01-06 13:34 |

| | | | added |
|---|---|---|---|
| Introduction to FOSS GIS using QGIS .8, PostgreSQL, PostGIS, and the Grass plugin for QGIS | This contains exercises that can be used in a classroom or for self-study as well as homework assignments and datasets needed for the exercises. The one open issue is that some of the PostGIS/PostgreSQL exercises require the use of an external dataset hosted on a server at the University of Massachusetts, Amherst. | Charlie Schweik, Alexander Stepanov, Maria Fernandez, Mike Hamel, Quentin Lewis | 2008-12-09 18:10 |

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***Question 5 – Journal Sample***

# OSGeo Journal

The Journal of the Open Source Geospatial Foundation — Volume 3 / December 2007


2007 FREE AND OPEN SOURCE SOFTWARE FOR GEOSPATIAL (FOSS4G) CONFERENCE
VICTORIA CANADA SEPTEMBER 24 TO 27, 2007

## Proceedings of FOSS4G 2007





# From the Editor...

As promised, here it is — the conference proceedings from the biggest and best FOSS4G conference yet. This is a special edition of the OSGeo Journal, dedicated to bringing you a very small sampling of some of the hundreds of papers and topics presented at the event. For more information, conference summaries and discussion see the various blogs and reports available on the reviews page of the `foss4g2007.org` web-site.

The local organising committee is already well into preparing for next year's event in Cape Town, South Africa. For more information see the `foss4g2008.org` web-site. Meanwhile, as you read this, the contenders for the FOSS4G **2009** bid are speedily writing up their proposals for hosting the event — best wishes to all proposals!

The next issue of the Journal will be back to normal. This is your invitation to contribute an article, code examples, tutorial, case studies and more. If you are interested in submitting an article, please add yourself to the Volume 4 wiki page[1] and an editor will be in touch with you. Contact me directly if you are wondering how your article might fit into the Journal.

As always, thank you to the rest of the Editorial team, proof-readers and **the 37 contributors** to this volume. Enjoy the articles!


*Tyler Mitchell*
*Editor in Chief*
`http://www.osgeo.org`
`tmitchell AT osgeo.org`




## Contents of this volume:



[1] `http://wiki.osgeo.org/index.php/Journal_Volume_4`


ISSN 1994-1897






# FOSS4G 2007 Sponsors & Supporters

**Reflections from two supporters**

The Free and Open Source Software for Geospatial Conference (FOSS4G), with the involvement of the Open Source Geospatial (OSGeo) Foundation, has become the premiere event for the open source geospatial community. This year I was asked to provide a "wrap up" as part of the closing session. These are the themes I presented, which all neatly fall under an overarching theme of "maturity."

The experiences of the last few years (from the development of projects, to the creation of OSGeo, among other things) have given the FOSS4G community a confidence that I didn't feel in the past. While I've missed a few meetings in this series, notably the last edition of this event, the 2007 event struck me as a "real" conference. I see a change in the answer to this question, which I've posed to attendees over the last few years: "What software stack are you working with?" I suggest that the proportion of attendees new to GIS or new to geospatial was rather high. The FOSS4G community is "just like" the rest of the GIS community. I would identify the pursuit of effective business models and development funding as far "calmer" than in past years. The demand for open source geospatial education is growing.

*Adena Schutzberg*
*Executive Editor, Directions Magazine*

The Open Planning Project wishes to thank FOSS4G 2007 conference organizers and especially attendees for making a terrific event. We had a great time connecting with colleagues and meeting new users of our collective technologies.

We were particularly excited to see the increasing popularity of GeoServer and OpenLayers, and enjoyed the opportunity to demonstrate the new feature development that we have been supporting in those projects. We look forward to another great year of advances in the open geo-stack and will be back with more exciting developments at the next conference.

*Chris Holmes, The Open Planning Project*

2007 FREE AND OPEN SOURCE SOFTWARE FOR GEOSPATIAL (FOSS4G) CONFERENCE
VICTORIA CANADA SEPTEMBER 24 TO 27, 2007

Thank you to all the FOSS4G 2007 Sponsors for their support!

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## Integration & Development

# Portable GIS: GIS on a USB Stick


*Jo Cook*



### Summary

This is a suite of GIS programmes that can be run from a USB stick (and hence are totally portable) amongst computers running Microsoft Windows. This leads to a package that can be quickly and easily deployed by individuals with no prior experience; in a range of different environments; and provides an easy and cost-efficient method for companies and individuals to evaluate these packages in comparison to costly proprietary alternatives.


### Introduction

The term "Portable GIS" refers to a full suite of Geographic Information Systems (GIS) Programmes that can be run from a USB stick. This allows them to be used on any Windows PC with no need for installation or configuration. Some alterations were made to the existing code, where necessary, to allow the programmes to run in this way, such as removing the need for a fixed drive letter. Furthermore the individual packages have been worked into a single "suite", with a menu system for operating them, and full documentation.

Open source programmes are often difficult to install compared to proprietary Windows alternatives. Developers often seem to assume a much greater level of prior knowledge than the average new user has, and options for getting help, such as mailing lists and online discussion groups can be intimidating. I believe, from personal experience and anecdotal evidence, that many new users are put off using open source software because they cannot install it, let alone use it.

Live CDs are often used in these situations, but the advantage to the "Portable GIS" approach is that it works in the same operating system that the user is familiar with, with access to their file system (and hence data) rather than in a self-contained sandbox environment.

There are two further advantages to the "Portable GIS" approach. The fact that it runs on a USB stick means that it can be deployed quickly and easily in a number of situations, and the fact that it requires no

end-user installation and configuration makes it an attractive proposition for companies and individuals wishing to evaluate open source GIS.

## Products Included on the stick

The programmes can be split into two modules, desk-based and web-based. Every aspect of the suite is open source, including the documentation and the menu system. The programmes are as follows:

**Desk-based:** GRASS, QGIS, FWTools
**Web-based:** XAMPPlite (full apache/MySQL/PHP web server stack), PostgreSQL with PostGIS, MapServer, OpenLayers, Tilecache.

The documentation has been written in the form of a tiddlywiki. This is single-page html wiki, so can be edited by users to add their own notes as they see fit. The menu system is based on the "daily cup of tech" menu, built by Tim Fehlman. It is built using autoit, and runs from the system tray. It provides links to the setup programmes (where necessary), and to the start and stop executables for each package. It also allows the user to browse the drive file system in the normal fashion.

## Problems and Learning Curves

Whilst some of the programmes, such as XAMPPlite, were designed to run in this way, and others, such as QGIS were known to work, others needed a degree of alteration in order to run without the need for a fixed drive letter. In many cases this was achieved by editing the batch files that set up the working environment for the programme, or by installing in the traditional way on a Windows PC and copying the programme folder over (the trial and error approach).

Furthermore, the native Windows installation of GRASS is complex. Understanding the syntax of batch files, and in particular how programmes like GRASS use them, was the main problem that had to be overcome in the construction of the "Portable GIS" suite.

In other cases, such as PostgreSQL, where traditionally a particular user was required to run the programme, the situation appeared hopeless until a chance post on the mailing list indicated that this was no longer the case. PostgreSQL could now be installed and run as the user logged on to the PC, and no longer needed to be run as a service. This made the process of installation on a USB stick relatively simple.

Some problems still remain. Windows machines in work or academic environments are often locked down to prevent services from running or setting environment variables. In these cases, many aspects of the suite will not work. Currently it is difficult to see a way round this issue, other than to bring it to the attention of end users!

## The way forward

As well as generally streamlining the suite, there are several ways forward. More programmes can be added, where there is a need. One issue with this is the increasing size of the package (currently 800MB).

A transparent and straightforward procedure for updating the individual packages needs to be identified. Either detailed documentation for updating each package needs to be provided, including those files that should NOT be updated (those that have been modified to allow the programme to run portably for example), or the author needs to take responsibility for producing a new suite when programmes are updated.

It may be possible to streamline the installation by removing duplicate libraries and hence reduce the size of the overall package. For example, mapserver is included both as a web programme and also in the FWTools application, and GRASS is included in it's own right and as part of the QGIS installation. However, this would prevent users from updating individual programmes as outlined above.

Requests have been made to provide cross-platform versions of the suite. This would be an interesting challenge, but to a certain extent it is assumed that Linux users will be more familiar with the installation of open source software and the community around it!

At the moment it is not publicly available due to it's large size and the bandwidth required for hosting. Obviously if it is to be used, then it needs to be hosted. Various options for this are available and being investigated at this time. For more information see the Archaeogeek blog discussion thread.[2].

*Jo Cook*
*Oxford Archaeology North*
*http://www.oxfordarchaeology.co.uk*
j.cook AT oxfordarch.co.uk

[2] Archaeogeek blog discussion thread: http://www.archaeogeek.com/blog/portable-gis/





# Automatic Generation of Web-Based GIS/Database Applications

*Nirut Chalainanont, Junya Sano and Toshimi Minoura*

## Abstract

We have been developing *web-based GIS/database* (WebGD) applications that allow users to *insert*, *query*, *update*, and *delete geographical features* and the data associated with them from standard Web browsers. The code shared by these applications is organized as the WebGD framework. The behavior of the map interface of a WebGD application is defined by *configuration files*. We have built also the WebGD application generator (WebGD-Gen) that *automatically* produces those configuration files from the database metadata, including those in tables `geometry_columns` and `spatial_ref_sys`. WebGD-Gen can generate also Web scripts that interact with the map interface and the database. Thus the WebGD framework and WebGD-Gen can significantly reduce the development time and the maintenance cost of a complex Web-based GIS/database application.

## Introduction

The Internet has become the major venue for sharing information. A dynamic Web-based mapping application allows users without desktop-based GIS software to perform *spatial queries* and produce maps with standard Web browsers.

However, a typical web-based GIS application allows only the retrieval of maps and map-related data. A web server provides information to the client, but the client cannot feed information back to the server (3). This *unidirectional* flow of information is a major problem with a current typical map-server application. Furthermore, creating an interactive web application with a map interface is time-consuming. Commercial map servers and geographical database management systems are expensive. This situation hinders use of Web-based GIS applications in data gathering, analysis and decision-making.

We have been developing a set of tools that significantly reduces the cost of application development (14; 16; 9; 15). The code shared by interactive Internet GIS applications is organized as the Web-based GIS/database (WebGD) framework. Most of the complex workings for delivering GIS functions over the Web are included in this framework. With the WebGD framework, we can create a map interface through which users can *insert*, *query*, and *delete* geographical features and the data associated with them only by providing *configuration files*.

An important feature of a WebGD application is that it tightly integrates spatial data and associated tabular data, enabling analyses involving location-based data (13). These functions are available to users at different geographical locations for economical and timely data management.

We developed several years ago a *Web-form generator* that automatically generates scripts for traditional Web-forms from the *schema* of a relational database (4). This functionality was recently extended as the WebGD application generator (WebGD-Gen). The new application generator can produce most of the code for an entire WebGD application from the schema of a relational database and the information on *geometry columns*. With the map interface and the Web scripts automatically generated, geographical features (i.e., points, linestrings and polygons) can be *inserted*, *queried*, and *deleted*. Thus, when a relational schema and the GIS metadata for the map layers are available, a *non-customized* application can be quickly assembled with the WebGD framework and the WebGD-Gen application generator.

The automatic generation of the map interface and Web-form scripts make possible *incremental* and *iterative* development of complex web-based GIS applications. When a map layer is added or modified, we only need to create or update the configuration file for that layer and then regenerate the Web forms for that layer. When a database schema is modified, we can regenerate the entire set of Web scripts in several minutes. Therefore, even with an incomplete set of map layers and a database schema, we can generate a working prototype for an initial review. Furthermore, we can fix most of the software bugs by modifying only the shared code in the WebGD framework or WebGD-Gen and then by regenerating Web scripts for each application.

WebGD applications use the following *open-source* software components. PostgreSQL, an *object-relational* database, and PostGIS together manage geospatial data. PostGIS is an extension of Post-





greSQL for GIS applications (11). MapServer (12) generates maps to be displayed on a web browser by using geospatial data provided by PostGIS. Web pages, including the one that displays the maps, are generated by server-side scripts written in PHP. The PHP MapScript module interacts with MapServer (6; 2). When a request to insert or delete a map feature is received by a PHP script, the script directly accesses the PostgreSQL database, using the PostGIS extension. An application developed runs on a PC without any licensed software.

We explain the features supported by the WebGD framework in Section **WebGD Applications**. The process of generating map-layer configuration files is explained in Section **WebGD Framework**, and that of generating Web scripts in Section 4. The process of automatic generation of map-layer configuration files is explained in Section **Automatic Generation of Map-Layer Configuration Files**. In Section **WebGD Development History**, we describe a brief history of the development of the WebGD framework and WebGD-Gen. Section **Conclusions and Future-Work** concludes this paper.

## WebGD Applications

The Web interface of one of the WebGD applications, Natural Heritage Information System (NHIS) for North Carolina, is shown in Figure 1. This application provides a map interface for a copy of the Biotics 4.0 database maintained by the North Carolina Natural Heritage Program. Biotics 4.0 is a desktop GIS application built on the database developed by NatureServe. The key elements in this database are *element occurrences* (EOs), which are *areas* of land and/or water in which species are, or were present (7). EO records have both *spatial* and *tabular* data, and the database contain approximately 700 relational tables (5). The Biotics Mapper implemented with ArcView by NatureServe provides a map interface that allows EO representations and associated data to be created, updated, and deleted (8). In our implementation, we can perform these operations with standard Web browsers. Also, Web forms, approximately 3500 in total, are provided for all tables in the database.

The NHIS application enables *bi-directional* movement of *geospatial data* as well as ordinary data. Scientists and others with proper authentication can *insert*, *query*, and *delete* geographical features such as EO polygons, lines, and points, as well as the data associated with them. Queries can be executed by spatially *selecting an area* on the map or by using a traditional web form. In addition, one-meter resolution *digital orthographic quadrangles* DOQ, or aerial images, are included as a layer. When DOQ images are combined with other map layers such as highways, county boundaries, streams, and streets, locations can be easily pinpointed by taking advantage of features between map layers (16).

The major operations supported by the map interface of a WebGD application are as follows:

1. To retrieve information on the geographical features in the area of interest, the user can zoom in/out to that area by using the map navigation tools. If the user zoom-in enough, one-meter resolution aerial photos are displayed. The user can also go to a new area by selecting an entry in the **Quick View** menu.
2. To get information about a geographical feature, the user can select a layer in the legend and **Information** in the function menu, and then click the boundary of the feature.
3. Function **Insert** allows a geographical feature to be added with mouse clicks on the map. **Done** need be pressed after all points are entered.
4. Function **Search by Area** allows the user to retrieve the list of features that are within a *bounding box* specified on the map and that satisfy a search condition. The features that satisfy the search condition are *highlighted* on the map. Furthermore, the user can select features in the list by marking the checkboxes associated with them. Then, if the map is refreshed, the selected features are highlighted.
5. The data administration interface can be activated by clicking on the **Database** entry in the menu bar below the banner. A tree icon can be clicked to display a *treeview* for browsing. The treeview for **Higher Taxonomy** is the major one. To access the data of this application, a user must login with a password as some data on endangered species are confidential.

Several WebGD applications created with the WebGD framework and WebGD-Gen can be accessed from this page.[3]

[3] WebGD sample applications: http://yukon.een.orst.edu/index_webgd.html You may insert/query/update/delete data. However, please DO NOT disturb existing data. If login is required, use user name `cs540` and password `CSxyz540`. You may have to login twice, once for the server and then for an application.





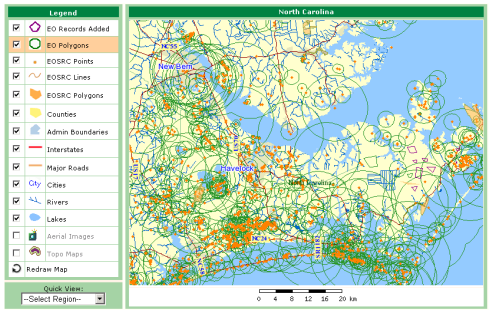


Figure 1: Interface of the NHIS Application for North Carolina

The first application is Natural Heritage Information System. Although this application can cover the whole USA or the world, the data are currently available only for North Carolina. The second application provides a map interface for an application that keeps track of conservation practices on land parcels. The third one is a Web-based mapping application for plant germplasm collection maintained at Western Regional Plant Introduction Station (USDA-ARS). The fourth one allows the soil information at the location where a mouse click occurs on the map interface to be retrieved.

One salient feature of the current WebGD framework is *dynamic switching of spatial references*. Typically, different geographic regions and localities have preferred *map projections* in order to avoid distortions in the maps created (1). The framework allows the whole world to be covered with multiple-levels of maps, e.g., the world map, continent maps, and region maps. The map interface then automatically selects the most suitable projection for the region whose portion is displayed. For example, the world can use the *geographical coordinate system*, the United States the *Albers equal-area projection*, and Oregon the *Lambert conformal conic projection*. Thus, spatial analysis can be performed with the most appropriate projection for a particular area. The *dynamic switching* of the *spatial reference*, the *map file*, the *legend*, and the *quick view menu* supported by the current WebGD framework allows any part of the world to be covered with its own scale and spatial reference, including regions with one-meter resolution aerial images. This is a very important feature, especially now that the cost of storing aerial images for the entire US has dropped to affordable levels (10 terabytes needed to store aerial images for the entire US now cost around $10,000). Furthermore, many states are putting aerial images in the public domain.

## WebGD Framework

The WebGD framework supports common features required by the map interface of a WebGD application such as zoom in/out, pan, and insert/query/update/delete operations of geographical features. The organization of a WebGD application is shown in Figure 2.

A map operation that does not manipulate geometry features, *e.g.*, *zoom-in*, *zoom-out*, or *panning*, is processed as follows:

1. The user action on the map is transmitted from the Web browser to the Web server as an HTTP GET request.
2. The Web server activates a PHP script that handles the user action.
3. Inside the PHP script, various methods in PHP MapScript are called to prepare the new map

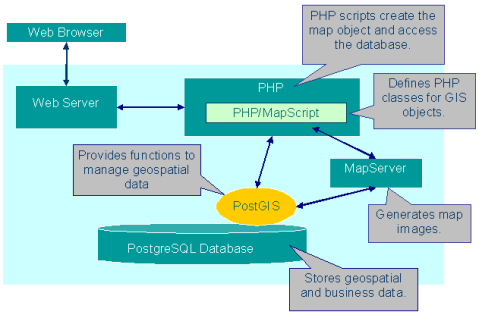


Figure 2: Organization of a WebGD Application

parameters, such as the special reference and the extent of the map and the names of the layers to be displayed. The map drawing method in PHP MapScript is then called to instruct the MapServer to create the map image.

4. The MapServer requests data for the map layers whose data are stored in the PostgreSQL database.
5. The data for the layers are returned.
6. The map image created is returned to the PHP script.
7. The HTML page generated by the PHP script is returned to the Web server.
8. The Web server transmits the HTML page including the new map image to the Web browser.

For a map operation that accesses or manipulates geometry features, i.e., *search by area*, *insert*, or *move point*, is processed as explained above, except between steps 2 and 3 the following operations are performed.

a The PHP script connects to the PostgreSQL database to perform a spatial operation with PostGIS-enabled SQL statements.
b The result of the spatial operation is returned to the PHP script by the SQL statements.

Furthermore, *configuration files* are user extensively as part of the WebGD framework for application customization. Major configuration files are *region configuration files*, *map layer configuration files*, and a *quick view configuration file*.

## Region Configuration Files

In order to minimize map distortion, different map areas can be displayed with different spatial references. The *current region* is determined to be the *smallest* one that encompass the extent of the map to be generated. The *spatial reference* is then automatically switched to that of the new region. Then the layers in the map legend, the list of the map-navigation and data-manipulation commands, and the *quick view* list are reconfigured for the new region. These reconfigurations are necessary because different regions may require different sets of map layers, command, and quick view list.

A *region configuration file* for each map region includes the following definitions:

1. the special reference for the region,
2. the *name of the region* displayed on the map interface,
3. the *unit of distance measurement*,
4. the *name of the map layer configuration file* for the region, and
5. the *name of the quick view configuration file*.





For example, the region configuration file for the world is as follows:

```
$region = array(
   "gid" => 1,
   "name" => "world",
   "display_name => "World",
   "srid" => 4326,
   "rank" => 1,
   "units" => "MS_DD",
   "mapfile" => "gmap75_world.map",
   "quickview" => "world_gview.php",
   "legend" => "world_maplayers.php",
   "proj4text" => "+proj=longlat +ellps=WGS84
         +datum=WGS84"
);
```

The following options can be specified in a configuration file:

**gid** – the unique number assigned to each region, which is the primary key value of the row representing the region in table `regions` in the database.
**name** – the name of the region for programming.
**display_name** – the name of the region used on the map interface. This name may include capital letters, white spaces, and other punctuation marks.
**srid** – the *spatial reference identifier* for the map projection assigned with this region.
**rank** – the priority number used in determining the region for the map area to be viewed. The region with the highest rank number is selected among the regions that completely encompass the map area to be viewed. Regions with higher rank numbers cover smaller areas.
**units** – the unit of measurement associated with the region.
**mapfile** – the map file to be loaded when this region is selected.
**quickview** – the name of the quick view configuration file for the region.
**legend** – the name of the map layer configuration file for the region.
**proj4text** – the projection string used for the region.

Whenever the map region changes due to a user action on the map interface, the region configuration file for the new region is loaded dynamically. Then the map interface is customized according to the new region configuration file.

The region configuration file for Oregon, for example, contains the following definitions:

```
$region = array(
   "gid" => 150137,
   "name" => "oregon",
   "display_name" => "Oregon",
   "srid" => 6010,
   "rank" => 150137,
   "units" => "MS_FEET",
   "mapfile" => "gmap75_oregon.map",
   "quickview" => "oregon_gview.php",
   "legend" => "oregon_maplayers.php",
   "proj4text" => "+proj=lcc +lat_1=43.0
         +lat_2=45.5 +lat_0=41.75
         +lon_0=-120.5
         +x_0=400000.00000 +y_0=0.0"
);
```

## Map Layer Configuration Files

The *map layer configuration file* provided for a region specifies the layers to be included in the legend and their characteristics. It is possible for multiple map regions to share one map layer configuration file.

The map layer configuration file for the Oregon region, for example, contains the following definitions:

```
$layer_groups = array (
  'grp_eo_py' => array(
     'geom_type' => 'polygon',
     'table' => 'eo_py',
     'layer_selectable' => true,
     'gid_column' => 'gid',
     'geom_col' => 'the_geom',
     'legend_label' => 'EO Polygons',
     'search_script' =>
      'forms/eo/eo_py_eo_search.phtml',
     'select_script' =>
      'forms/eo/eo_py_eo_select.phtml',
     'edit_script' =>
      'forms/eo/eo_py_edit.phtml',
     'normal_layer' => 'eo_py',
     'searched_layer' => 'eo_py_searched',
     'checked_layer' => 'eo_py_checked',
     'selected_layer' => 'eo_py_selected',
     'img_src' => 'images/eo_poly.png',
     'img_width' => 26,
     'img_height' => 26,
     'onclick' => 'activate_layer("grp_eo_py")',
     'data_srid' => 32119
  ),
  'grp_eosrc_pt' => array(
     'geom_type' => 'point',
     'table' => 'eosrc_pt',
     'layer_selectable' => true,
     'gid_column' => 'gid',
     'geom_col' => 'the_geom',
     'legend_label' => 'EOSRC Points',
     'search_script' =>
      'forms/eo/eosrc_pt_search.phtml',
     'select_script' =>
      'forms/eo/eosrc_pt_select.phtml',
     'edit_script' =>
      'forms/eo/eosrc_pt_edit.phtml',
     'normal_layer' => 'eosrc_pt',
     'searched_layer' => 'eosrc_pt_searched',
     'checked_layer' => 'eosrc_pt_checked',
     'selected_layer' => 'eosrc_pt_selected',
```





```
     'img_width' => 5,
     'img_height' => 5,
     'onclick' => 'activate_layer("grp_eosrc_pt")',
     'data_srid' => 32119
  ),
...
```

According to the above configuration file, the map legend shown in Figure 3 is produced.

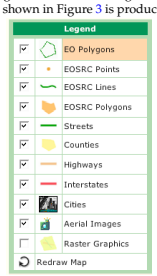


Figure 3: Map Legend of WebGD Application NHIS

We now explain each option used in map-layer configuration:

**geom_type** – the type of geometry features contained in the layer. The value can be `polygon`, `multipolygon`, `linestring`, `multilinestring`, `point` or `multipoint`. Exact spatial operations performed depend on this type. For example, if the type is `point`, a point is inserted on the map with an insert operation. On the other hand, if the type is `polygon`, a polygon feature can be inserted.
**table** – the name of the table in the database that contains the geometry column for the layer.
**layer_selectable** – the boolean option that determines whether spatial operations can be performed on the layer or not. Some layers, such as those for counties and highways in the above example, are static, and they are not selectable for spatial operations.
**gid_column** – the name of the column that contains the identifiers for the geometry features in the map layer.
**geom_col** – the name of the geometry column for the geometry features contained in the layer. The default name is `the_geom`.
**legend_label** – the name of the layer in the legend.
**search_script** – the name and the location of the search form associated with the layer.
**select_script** – the name and the location of the select form associated with the layer.
**edit_script** – the name and the location of the edit form associated with the layer.
**normal_layer** – the name of the map layer displayed when no highlighting occurs.
**searched_layer, checked_layer, selected_layer** – the names of the layers used to highlight the geometry features *searched for*, *checked*, or *selected*, respectively. The geometry features returned by a search operation is *searched for*, those whose checkboxes are turned on in search result form are *selected*, and the geometry feature chosen for editing is *selected*.
**img_src, img_width, img_height** – the file name, the width, and the height of the icon in the legend.
**onclick** – the name of the javascript event handler activated when the user selects the layer in the legend.
**data_srid** – the *spatial reference identifier (srid)* that designates the map projection used by the geometry features in the map layer. If this srid is different from that of the map region, then geometry features in the layer are reprojected before they are displayed on the map.

## Quick View Configuration File

The *quick view* mechanism allows the user to select the map area of her interest. That is, the user can switch to a new map area quickly by selecting the map area from the quick-view dropdown list.

Each entry in a *quick view configuration file* describes the name of the map area represented by the entry, the map projection used by the *extent* of the map area, and the extent. The quick view configuration file for the Oregon region shown in Figure 4, for example, can be as follows:

```
$qview = array(
  array(
    'name' => 'World',
    'srid' => 4326,
    'extent' => '-180,-90,180,90'
  ),
  array(
    'name' => 'United States',
    'srid' => 4326,
    'extent' => '-125,13,-65,53'
  ),
  array(
    'name' => 'United States, East',
```





```
    'srid' => 4326,
    'extent' => '-102,22,-60,50'
  ),
  array(
    'name' => 'United States, West',
    'srid' => 4326,
    'extent' => '-135,30,-105,50'
  ),
  array(
    'name' => 'Whole Oregon',
    'srid' => 6010,
    'extent' => '46461.662375,-43912.968464,
      2487069.754184,1785176.331408',
  ),
...
```

The quick view list of regions as displayed in the map interface corresponding to the configuration file above:

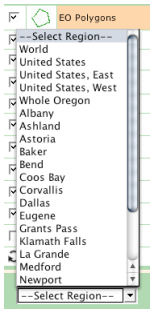


Figure 4: Quick View Selection of WebGD Application NHIS

Each entry in a quick view configuration file can specify the following options:

**name** – the name of the map area.
**srid** – the spatial reference identifier for the extent explained below.
**extent** – the `xmin`, `ymin`, `xmax`, and `ymax` values describing the positions of the lower left and upper right corners of the map area.

[4] 700 x 50



## Automatic Generation of Web-Form Scripts

Several tools have been developed to augment the WebGD framework and simplify application development. The WebGD Web-site generator (WebGD-Gen) can create an entire WebGD application, including a web-based mapping interface. WebGD-Gen *automatically* generates a consistent set of Web scripts from *configuration files*, which are again automatically generated from a relational database schema. Since form generation is automatic, the cost of application development is greatly reduced. For a database such as Biotics that contains approximately 700 tables, programming all the required 3,500[4] forms manually can be very costly, even unfeasible.

WebGD-Gen is implemented as a collection of *templates*. Each template, combined with a corresponding *configuration file*, generates one of the following six types of Web scripts: *search*, *select*, *edit*, *information*, *action*, and *treeview* scripts. Templates and configuration files are written in PHP. The Web scripts generated by them are also in PHP. The generated scripts are executed on a Web server by a PHP interpreter. Each script, except for an action script, creates a Web form that is displayed on a client computer by a Web browser. Figure 5 illustrates the interactions among the Web scripts and forms.

Furthermore, WebGD-Gen can automatically generate the statements for inserting, searching, and deleting *geographical features* if the following lines, for example, are added to a configuration file:

```
 // type of geographical features
$web_gd = 'MULTIPOLYGON';
// layer group in legend
$layer_name = 'grp_eo_py';
// geometry column containing shapes
$geometry_column = 'the_geom';
//geographical feature IDs
$gid_column = 'gid';
// epsg spatial reference
$db_table_srid = 32119;
```

The forms generated for geographical features can perform the following additional functions compared to those for ordinary database tables:

1. A search form can be activated from a map interface. In this case, the extent of a search box specified on the map is passed as additional search parameters.
2. A select form includes additional JavaScript code for highlighting geographical features retrieved or selected by the user.

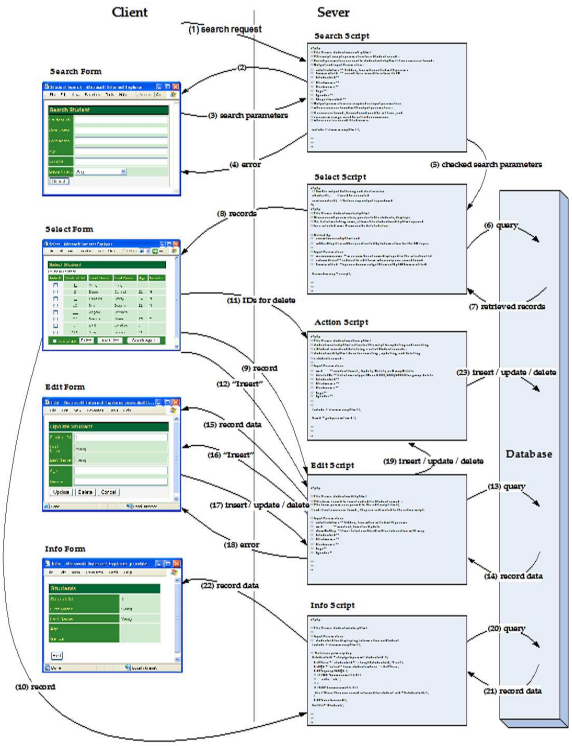


Figure 5: Interactions among Web Scripts and Forms





3. An edit form can insert a record for a geographical feature, after transforming the coordinate values from the spatial reference used by the current map interface to the one used by the geometry column for the record.

The forms related are automatically linked to each other. Figure 6 shows, as an example, the *edit* form for a Student table. From this edit form, the user can open the forms for the department and courses related to the student. The information needed to create the links are extracted from the *primary-key/foreign-key relationships* among the tables in the database.

In order to generate the Student edit form shown in Figure 6, the following entry is provided in the configuration file.

```
$edit_fields=array(
  array("column"=>"student_id",
    "label"=>"Student Id", "type"=>"numeric",
    "maxlen"=>"40", "size"=>"40"),
  array("column"=>"first_name",
    "label"=>"First Name", "type"=>"text",
    "maxlen"=>"40", "size"=>"40"),
  array("column"=>"age", "label"=>"Age",
    "type"=>"text", "maxlen"=>"40", "size"=>"40"),
  array("column"=>"gender", "label"=>"Gender",
    "type"=>"text", "maxlen"=>"40", "size"=>"40"),
  array("column"=>"department_id",
    "label"=>"Department ID", "type"=>"to_one",
    "linked_table"=>"departments", "maxlen"=>"40",
    "size"=>"40"),
  array("label"=>"Courses Taken", "type"=>"to_many",
    "linked_table"=>"courses", "maxlen"=>"40",
    "size"=>"40"),
  array("column"=>"other_info",
    "label"=>"Other Information",
    "type"=>"textarea", "rows"=>"4",
    "cols"=>"32",
);
```

Each element in array `$edit_fields` represents a field in an edit form, with options `column`, `label`, `table`, `maxlen`, `size`, and `type`. Option `type` can be `numeric`, `text`, `time`, `date`, `email`, `phone`, `textarea`, `to_one`, or `to_many`.

**textarea:** The input is a string displayed in a text area.

**to_one:** A field of type `to_one` allows a user to view or modify the record related to the current record via a *one-to-one* or *many-to-one* relationship type. In our example, column `department_id` in table `students` is specified as `to_one`. When the `View` button is clicked, the edit form showing the record of the student's department is displayed. Furthermore, a user can search and select a new department record to be linked. Option `linked_table` designates the name of the table storing the associated record. Option `child_column` indicates the column for linking in the associated table. If this option is omitted, the name of the column for linking is identical to that of the foreign key column in the current record.

**to_many:** The purpose of this type is to list the records related to the current record via a *one-to-many* or *many-to-many* relationship type. In our example, the field labelled `Courses Taken` is specified to be `to_many`. When the `Show` button is clicked, all the courses taken by the student are displayed in the select form for courses. This type needs options `linked_table`, `parent_column`, and `child_column`. Option `linked_table` and option `child_column` can be omitted, when the name of the foreign key column of the associated table is identical to that of the primary key column of the current record. Option `parent_column` indicates the *foreign key* column in the current table. If this option is omitted, the foreign key column is the primary key column of the current table.



## Automatic Generation of Map-Layer Configuration Files

We can semi-automatically create a map-layer configuration file by using information in the table `geometry_columns` that stores GIS-related metadata and the layer names in a map file. Figure 7 shows this process for region *xxx*.

1. The default *map-layer meta configuration file* `xxx_maplayers.mconfig`, which lists all the layer groups, can be created by **map_mconfgen**. The map-layer group names are generated from the table names stored in table `geometry_columns` and the map-layer group names defined in the map file.
2. We can customize the default map-layer meta configuration file, whose format is identical to a map-layer configuration file, by selecting and reordering the layer groups. We can also provide customized values for the parameters in each layer group. The meta configuration file needs to keep only the definitions of customized parameters.
3. Finally, map-layer configuration file `xxx_maplayers.config` is generated by **map_confgen**. The information required by this step is



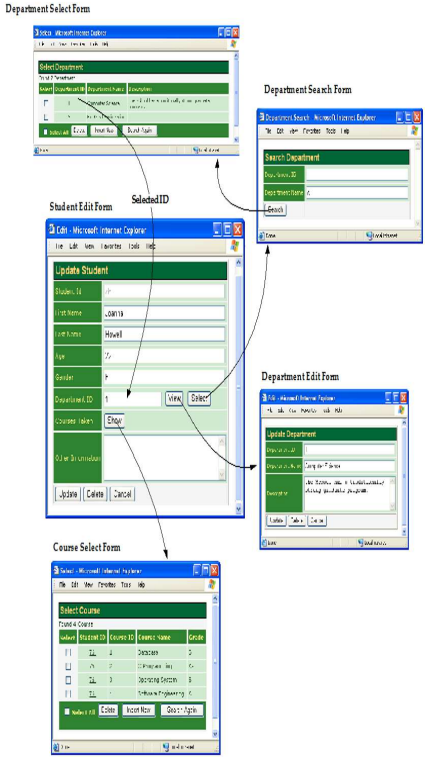


Figure 6: Student Edit Form





retrieved from the meta configuration file, table `geometry_columns`, and the map file. The default values of the parameters determined by the latter two are overwritten if they are customized in the meta configuration file.

A map-layer meta configuration file can define any parameters that are allowed for a map-layer configuration file. However, the default one generated by **map_mconfgen** contains for each map layer group the definitions only for the following parameters:

**layer_selectable** – A boolean option that determines whether the layer can be selected for spatial operations or not.

**legend_label** – The name of the layer that will be displayed on the map legend.

An example of a default map-layer meta configuration file is shown below:

```
$layer_groups = array(
   'grp_eo_py' => array(
      'layer_selectable' => true,
      'legend_label' => 'Eo Py',
),
   'grp_eosrc_' => array(
     'layer_selectable' => true,
     'legend_label' => 'Eosrc Pt',
),
...
```

The user may modify the values of these definitions and add others. For example, the meta configuration file can be customized as follows:

```
$layer_groups = array(
   'grp_eo_py' => array(
      'layer_selectable' => true,
      'legend_label' => 'EO Polygons',
      'search_script' => 'forms/eo/eo_py_eo_search.phtml',
      'select_script' => 'forms/eo/eo_py_eo_select.phtml',
      'edit_script' => 'forms/eo/eo_py_edit.phtml',
      'img_src' => 'images/eo_poly.png',
),
   'grp_eosrc_pt' => array(
      'layer_selectable' => true,
      'legend_label' => 'EOSRC Points',
      'search_script' => 'forms/eo/eosrc_pt_search.phtml',
      'select_script' => 'forms/eo/eosrc_pt_select.phtml',
      'edit_script' => 'forms/eo/eosrc_pt_edit.phtml',
      'img_src' => 'images/eosrc_pt.png',
),
...
```

The following customization was done:

1. `legend_label` was changed to the desired layer name for the map legend.
2. The names and locations of the search form, select form, and edit form are specified in `search_script`, `select_script`, and `edit_script`, respectively.
3. The source file name of the icon in the map legend was specified in `img_src`.

The order of the map-layer groups can also be changed to that desired in the map legend.

Then the map-layer configuration file shown previously can be generated by **map_confgen**.



## WebGD Development History

The WebGD framework and WebGD-Gen were developed *incrementally* and *iteratively* during the last four years. We first implemented in 2000 an application that allowed point features to be inserted on a map by using ASP with ArcIMS and ArcSDE. In 2001, we re-implemented this application with ASP.NET as ASP.NET provides Web controls, which are better building blocks for Web pages. Based on this application, the first version of WebGD framework was created in 2002 in order to support multiple applications.(15)

In early 2003, we re-implemented an application called Motels Oregon with MapServer, PostGIS, and PostgreSQL(9) This version on Linux was more reliable and faster than the old one, as well as being built with free software. While implementing the next MapServer application, which was a germplasm resource management system (GEM-GIS), we created the first version of WebGD framework for MapServer. This framework was then enhanced so that it can handle polygon features as well as point features.

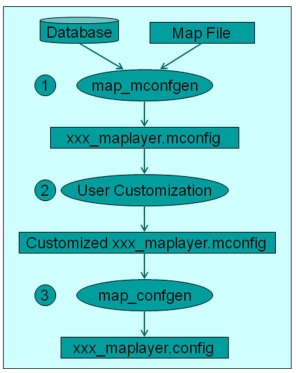


Figure 7: Process of Creating a Map-Layer Configuration File

The two major enhancements made to the WebGD framework in 2004 were *dynamic switching* of `spatial references` for different regions and *automatic generation* of Web forms that can be used to insert, query, and delete geographical features. Compared to an application that simply displays geographical features as points on a map, the current WebGD framework is roughly 20 times more complex in terms of the time we spent implementing the required features.

## Conclusions and Future Work

We have developed the WebGD framework and the WebGD-Gen application generator for rapid development of Web-based GIS/database applications.

1. Geographical features, such as habitats of plants and animals, road-work sites, and waterlines, can be inserted, queried, and deleted with the map interface and Web forms displayed on a standard Web browser.
2. An application can be created without any programming. The map interface and Web scripts for data access can be automatically generated from configuration files, and those configuration files can be generated from the database schema and the GIS metadata, i.e. information stored in the table `geometry_columns`. Automatic generation of a Web-based GIS application not only reduces the development cost significantly, but it also facilitate incremental and iterative development of the application.
3. Dynamic switching of spatial references allows an application to cover different regions with different map files, projections, map legends, and quick-view lists. This is an important feature needed for an application that covers the entire USA or the world.
4. We created the WebGD framework by using only free open-source software. The software tools we use, such as the University of Minnesota MapServer, PostgreSQL DBMS, PostGIS, Apache, and PHP are all available for free. The GIS data used, such as those from USGS, TIGER/LINE, and Digital Chart of the World (DCW), are also in the public domain. Therefore, the framework is available for anyone for free use.
5. The cost of running our applications is extremely low. We could put copies of such large databases as Biotics, SSURGO2 soil data, and a part of National Germplasm Resource Information System on a $800PC.

Automatic code generation of a WebGD application will save a great deal of effort in the development of a spatial decision-support system. Although some manual customization is required, the time needed for customization can be lowered to weeks or months compared to the years required to build a *spatial decision-support system* from scratch.

The WebGD framework and WebGD-Gen are currently available upon request. In order to release them to the public as free and open-source software, we are looking for collaborators. We are also reimplementing the map interface by using OpenLayers to support smooth panning.





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# db4o2D - Object Database Extension for 2D Geospatial Types

*Stefan Keller*

db4o stands for "database for objects". It's a native object oriented database management system (OODBMS) written in Java and .NET and thus targeted towards these two platforms. The software was first released 2001 by db4objects, Inc., and since then it got a major market share among the so called second generation object databases. It is available under two licenses ("dual licensing model"), an open source licence of type GPL for personal and non-commercial use as well as a commercial license.

In this contribution we first introduce db4o. In the chapter *OODBMS and db4o* we discuss the advantages, limitations and differences from a conceptual and a programmer's perspective. Then we report





about a student thesis project called db4o2D. Finally there is a conclusion with an outlook of the project db4o2D.

## First steps in db4o

Let's start with some source code in order to give an idea how easy it is to persist application objects. Our first example demonstrates the four well known steps from database technology: Create, Read, Update and Delete (CRUD). The example is about Person objects which consist of last name, first name and year-of-birth:

```
// 1: Initialize an object container
ObjectContainer db= null;
try {
    // 2: Open db4o database (embedded mode)
    db= Db4o.openFile("addressbook.yap");

    // 3: Create and store some 'Kellers'
    db.set(new Person("Brian", "Keller", 1960));
    db.set(new Person("Clara", "Keller"));
    db.set(new Person("Test"));

    db.commit();

    // 4: Find and read all Kellers
    // with Query by Example
    ObjectSet result= db.get( \
        new Person(null, "Keller", 0));
    while (result.hasNext())
        System.out.println( \
            (Person) result.next());

    // 5: Update Clara's age
    result= db.get(new Person("Clara", "Keller"));
    Person found= (Person) result.next();
    found.setYearOfBirth(1970);
    db.set(found);

    // 6: Delete Test data
    result= db.get(new Person("Test"));
    while (result.hasNext())
        db.delete(result.next());

    // 7: Commit all
    db.commit();
} finally {
    if (db != null)
        db.close();
}
```

*Fig. 1. Code fragment showing CRUD operations on person objects stored in an address book.*

In this example we go though the following steps which show some CRUD operations:

1. The instruction following this comment initializes a container where db4o manages the set of objects to be persisted in a transactional way.
2. The second instruction opens a db4o database file. We propose to use the file extension .yap but this is not normalized. There is an official explanation which says that this is the abbreviation of "yet another protocol". Unofficially it's referring to Yap, a tiny island of Micronesia. As indicated we choose to use db4o in embedded mode. There exists also a client/server mode.
3. With the `set()` method of an `ObjectContainer` three newly created Person objects are stored. With `commit()` all created, changed or deleted objects are forced to be synchronized with the database file.
4. In this step we fetch all objects from the database which are equal to the last name "Keller" and iterate over the result. In this example "Query by Example" is used from the three query languages available from db4o.
5. When creating "Clara Keller" in step 3 we omitted the year-of-birth in the Person's constructor (since it's polite not to reveal the age of a woman beforehand). Now we insist in setting this value, so we have to look for objects like "Clara Keller" and update the first one the query gives back. We use again the set() method assuming that there exists a `setYearOfBirth()` method in the Person class definition.
6. For demonstration purposes we previously inserted also some test data which will be deleted in this code section. This time all objects retrieved by the query will be cleaned up with the `delete()` method of the `ObjectContainer`.
7. Finally we conclude with the `commit()` method and close the database.

The only definitions which are missing in this code fragment are the import statements as well as the Person class consisting of three constructors, the `setYearOfBirth()` method and optionally an overridden `toString()` method in order to print out Person objects nicely.

That's all to demonstrate the simplicity of a db4o enabled application. Next we explain some use cases of OODBMS, some additional features of db4o before an obvious extension is presented which will add geometry types to db4o.





## OODBMS and db4o

### Use Cases and Features

When there is only one application running on top of a database at a time and if it's a mobile application like in location based systems (LBS) or embedded software it's perhaps worthwhile to evaluate one of the so called second generation OODBMS. Because of the easy management of object relationships OODBMS are intrinsically well suited when complex object models, flat object structures or tall object trees are involved – which actually is often the case in Geographic Information Systems (GIS) and LBS.

These are some technical features of db4o:

- Embedded mode and client/server mode.
- No runtime server administration. Database properties are controlled out of the host application.
- Small space requirements of the program library on disk and in memory at runtime.
- Ease of use: db4o is using reflection application programming interfaces (API) from Java and .NET. So there are no extra annotations, no pre- or post-processing (byte code engineering), no sub classing nor interface implementation.
- Methods to control lazy loading of nested object relationships (depth).
- Replication tools as add-on.

Like one would expect from a database, db4o implements ACID (atomicity, consistency, isolation and durability) properties which guarantee reliable transactions: A transaction starts when opening or querying the database and ends with `commit()` and `rollback()` methods. Three approaches for queries are implemented: Query by Example, Simple Object Database Access (SODA Criteria) queries and "Native Queries". The first one was shown above. SODA queries are much like those used in object-relational (O/R) mapping frameworks. Some of the theory behind Native Queries stems from a project from Microsoft (LINQ 2007).

### Advantages

Speaking of O/R mapping frameworks we have to compare OODBMS with this technique too. db4o is very fast according to benchmarks (Polepos 2007). A conceptual argument is that there is no object / relational impedance mismatch: No data types mapping and wrapping (unless wanted), no creation of separate relational schemas, no SQL dialects and no plain SQL query strings.

So it's important to mention that db4o offers decent support of agile software development techniques and refactoring: This is because of queries are written in the host language (Java, .NET) and thus are type safe. There are also nice schema evolution features and no SQL. Software engineers have an easier life than before because they reside in the object world as opposite to database professionals' world.

### Limitations

db4o is probably not well-suited for being used in large data warehouses and in data mining. It's typically not recommended when several application are accessing the database with many views. One can see from the different query languages that there is no single standard and mature query language available compared to the pre-dominant SQL from the relational paradigm. Constraints like referential integrity are not (yet) part of any language except inside a Native Query which basically implements a call back function. Finally, the current lack of standardization was recognized. There are activities from the Object Management Group (OMG) in order to work towards a new release of the ODMG standard version 4.

## Project db4o2D

PlaceLab (Intel 2006) — an Intel project — delivered mobile and desktop applications about a wireless LAN (WiFi) positioning. The database behind this software is a relational open source embedded database. A crucial component there is the management of access points together with their positions. This serves us here as a showcase of an object database which replaces the existing relational database and stores geometries as first class objects.

In a thesis project (db4o2D 2007) there was decided to use db4o and to adapt the broadly used Java Topology Suite library (JTS 2007). JTS follows the "Simple Features" standard (OGC 2006) which defines four 2D (2.5D) geometry attribute types: Point, LineString and Polygon as well as stable operations on it.

So in the following code fragment (c.f. Fig. 2) it is shown how wireless access points are created (2), stored (3) and reread (4). A point contains a coordinate value pair and includes a default coordinate reference system and measurement units.

```
// 1: Open db4o database (embedded mode)
db= Db4o.openFile("poidb.yap");
```

```
// 2: Prepare two JTS points
GeometryFactory factory= new GeometryFactory();
double latitude1= 47.225571, longitude1= 8.822271;
Point pt1= factory.createPoint(new Coordinate(
        longitude1, latitude1));
double latitude2= 47.225582, longitude2= 8.822282;
Point pt2= factory.createPoint(new Coordinate(
        longitude2, latitude2));

// 3: Create and store the access points
db.set(new AccessPoint( \
    1001, "802.11g", "wep", 7, pt1));
db.set(new AccessPoint( \
    1002, "802.11b", "open", 11, pt2));
db.commit();

// 4: Iterate over all access points
ObjectSet result= db.get(new AccessPoint());
while (result.hasNext()) {
    System.out.println( \
    (AccessPoint) result.next());
}
```

*Fig. 2. Code fragment with wireless access points which contain point geometry.*

## Conclusion

The db4o2D project will become an add-on to db4o and is still ongoing. Although that the existing database access layer already was well separated it becomes obvious how smaller, simple and better to maintain the code becomes by using a pure OODBMS.

Future work includes a geospatial index and stress tests for large databases as well as for multithreading client/server mode. Complex SODA queries is another open issue. It's noteworthy to state that this is no obstacle so far because Native Queries can be used in the meantime.

In order to disseminate object database technologies a non-profit group ODBMS.ORG (2007) was created. db4o is one of the leading object database projects and it tries to solve well known problems in embedded software, software engineering, LBS and GIS. Given that these problems have been around for quite some time one could say that second generation OODBMS like this are something like going back to the future.

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# Google Summer of Code for Geoinformatics

*Jan Ježek*


## Abstract

The GeoTools Referencing module has been becoming one of the most powerful tools focused on coordinate reference system transformations in the Java GIS world in recent years. The Referencing module in conjunction with the Coverage module presents a really strong tool for raster operations like reprojecting and transforming.

The aim of this paper is to describe new functionality that has been developed by author during the Google Summer of Code 2006 and 2007 projects. The usability of these new features will be discussed also with relation to the specific needs of reference coordinate systems that are used in the Czech Republic. Google Summer of Code itself will be also mentioned.

New functionality that was and still is being developed is focused on transformation methods based on interpolation. These procedures are usually applied in cases when transformation between coordinate systems is not some kind of exact mathematical relationship (such as cartographic projection or affine transformation for example).

This topic is closely related to rectification of old maps as well as the transformation of coordinate reference systems for those datums, that have been derived before GPS techniques started to rule and so their transformation into the global systems like WGS 84 is problematic and not as accurate as needed.


## Google Summer of Code for Geoinformatics

Google Summer of Code (GSoC) is well known event that brings together students that are interested in open source software with core developers of projects from all branches. Huge projects like KDE, Ubuntu Linux, Apache Software Foundation, etc. participate in this program every year. The aim of GSoC is to get interested students involved in these project. Google plays the sponsor roll (among others) in the whole program and offer stipends for students that successfully participate. For detailed information about GSoC see (4).

The summer of 2007 saw the third volume of this event. The open source geospatial community started to participate in GSoC in 2006 when Refractions Research took the roll of mentoring organization. The projects that had been worked on were focused on the GeoTools library and the uDig desktop GIS. For more information about GSoC 2006 mentored by Refractions Research see (5).

OSGeo joined the program in the summer of 2007 and helped to get sponsorship for 12 students that contributed to a wide range of FOSS4G projects (GRASS, GDAL, GeoTools, Geoserver and uDig). For detailed information see (6).

## Additional functions for coordinate system transformations in GeoTools and uDig

This part describes the work that has been done by the author during Summer of Code 2006 and 2007. The project was mentored by Jesse Eicher and Martin Desruisseaux.

The GeoTools Referencing package presents one of the most powerful tool for re-projecting and transforming in the Java GIS world. The package follows the OGC implementation specification (3). The package also offers a plugin mechanism, that lets users connect to persistent storage of datums and projection parameters such as an EPSG database (2).

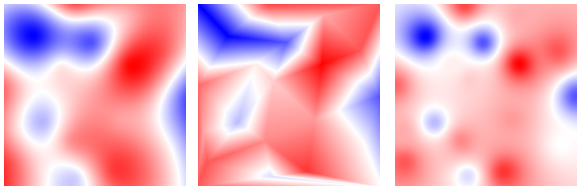
The project that I've been working on during 2006 and 2007 has been focused on new coordinate system transformation algorithms. The aim was to implement tools that helps to solve the opposite transformation task — the task when we know some coordinates in source and target coordinate reference systems (mapped coordinates) and we are searching for the definition of transformation.

### Linear transformations

There are a couple of transformation methods that can be unequally defined from known coordinates in source and target coordinate reference systems (CRS). This methods can be divided into two main







(a) Inverse distance weighted interpolation. (b) Thin plate spline. (c) Rubber sheeting.

Figure 1: Output of three interpolation methods

branches — linear transformation and no residual methods.

New implemented tools can be used to calculate transformation parameters for these linear methods:

- Similar Transformation
- Linear Transformation
- Affine Transformation
- Projective Transformation
- Position vectors (Bursa Wolf) transformation (3D similar 7 parameters)

These methods are unequally defined by different number of mapped position (Similar transformation needs 2, for example). When there are more coordinates than needed the least square method is used to minimize the square of distance between target and transformed source point. Currently there is just Cartesian distance taken into account.

### No Residual algorithms

Another set of algorithms that has been implemented is focused on possibilities to calculate transformations that will exactly fit the source positions to target positions no matter how many mapped positions are defined (this is also called warp transformation). After studying the possibilities to define such methods through EPSG database conventions we choose the following approach.

One of the most general transformation that is defined in the EPSG database is the method based on a regular grid of coordinate offsets. Within this grid simple bi-linear interpolation is used so once you know the grid values you can apply the transformation quite fast. The family of grid-based methods includes:

- NADCON (EPSG dataset coordinate operation method code 9613) which is used by the US National Geodetic Survey for transformation between US systems
- NTv2 (EPSG dataset coordinate operation method code 9615) which originated in the national mapping agency of Canada and was subsequently adopted in Australia and New Zealand
- OSTN (EPSG dataset coordinate operation method code 9633) used in Great Britain

For more information see [(2)].

There have been 3 algorithms implemented that enable users to calculate the grid. These methods are:

**Inverse distance weighted Interpolation:** The offset values are calculated according to the distance from the known mapped positions

**Thin plate spline interpolation:** The name thin plate spline refers to a physical analogy involving the bending of a thin sheet of metal. In the physical setting, the deflection is in the z direction, orthogonal to the plane (1). The offsets in both direction (x and y or easting and northing) are calculated in this manner.

**Rubber Sheeting method:** The surface is divided into particular triangles by applying Delaunay's algorithm on the field mapped positions. Then the affine transformation on each triangle is applied. This method should be applied also as a piece-wise but calculation of the grid makes it more general, reusable an faster.





### Implementation details

Described functions have been designed to become a part of the GeoTools referencing module.

The algorithms let you generate grid files that can be reused also in other software — in all that support EPSG methods explained above.The grid based transformation is designed to be performed using Java Advance Imaging (JAI) warp transform. This greatly helps improve performance especially when transforming raster datasets (JAI is using native library).

Other interesting results are when we try to visualise the calculated grids by converting calculated values to images. In this manner we can nicely see the distribution of the offsets and also the differences between applying particular method. You can see interpolated grids by all three methods using the same set of mapped positions in Figure 1.

All described functionality are currently located online.[5]

Migration into GeoTools 2.5 will take place during upcoming months. Other documentation and code examples can be found on the GeoTools website.[6]

### uDig plugin

Finally, the simple uDig plugin that lets users calculate and apply described methods has been made. The plugin presents a GUI for accessing the described functions. First draft of this plugin is available from the community update site (see (7)) and lets you transform vector data using only a few methods (this was developed during Summer of Code 2006). A plugin that includes all described features has been developed only for trunk version of uDig, that is currently changing a lot so the stable version of plugin will be done after first milestone release of uDig 1.2.

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Topical Interest

# A Generic Approach to Manage Metadata Standards

*Julien Barde, Duane Edgington and Jean-Christophe Desconnets*

## Introduction

Informational Resources[7] (IR) management is a crucial part of environmental resources management. Indeed, the improvement of data processing and decision-making is strongly related to the ability to locate the relevant IR.

However, the exhaustive locating of relevant IR is a challenge for users as they face the following constraints:

- IR are *heterogeneous* (*language*, *semantic*, *syntax/-formats*, *metadata*, *access constraints* because of their *rarity* and *cost*...),
- IR are *distributed* into *heterogeneous Information Systems (IS)* whose interoperability first involves syntactic and semantic/spatial matching issues (answers to a natural language query often require its translation into as many queries as different kinds of IS).

Thus, the key issue to improve data retrieval is a better management of the *{metadata element, value}* pairs, which constitute any metadata sheet. Once aware of existing IS, the priority to locate the relevant IR is the management of the matching between the *heterogeneous metadata elements (syntactic)*, as well as between their *heterogeneous values (semantic)*. The global scale of environmental domains and the multidisciplinary context of related studies strongly increase these constraints and the need of *semantic and spatial referentials* management.

## Metadata management

*Metadata management* is thus a priority before considering any data processing. Nevertheless, metadata management still faces the lack of referentials to homogenize: (i) the terminology of *metadata elements*, (ii) their *relationships* as well as (iii) their *values*. As a consequence, the quality of metadata management tools leans as much on the compliance with the reference standards specifications (syntactic: structure of metadata elements) as on the ability to use values from semantic referentials to edit instances.

The *heterogeneity of standardized metadata elements sets* interferes with *IS syntactic interoperability*:

- standards often use similar *core metadata elements*, designating the same *concepts* by using different *terms*. These elements answer the following questions: *Where*? *What*? *When*? *Who*?... and are essential to retrieve IR,
- moreover, standards with *redundant scopes* generate wider *matching issues* since the same kind of IR could be described with different standards (like *FGDC* and *ISO 19115*),
- setting up new *international metadata standards* makes the previous national/local standards obsolete and brings *archiving issues* (potentially related to the previous *matching issues*),
- the recent use of *XML Schemas* to standardize their implementations decreases the redundancy of standards scopes and prevent wrong interpretations of their implementations (2). Standards can be used as referential types libraries (e.g. the case of *OGC* standards like the update of *ISO 19115* with *ISO 19139*, *SensorML* ...).

The *heterogeneity of metadata element values* interferes with *IS semantic interoperability* if values are not controlled (regardless of the chosen standard): the use of additional referentials is a key issue to improve IR descriptions and their retrieval by managing the *core metadata element values* (which are used in priority in most of the queries). Among them, the management of the following descriptions are crucial as they are the most complicated and ambiguous:

- *terminologic description* management with common (multilingual) controlled vocabularies/semantic referentials to valuate *"keyword" like metadata elements*. Moreover, these referentials help to set up *shared vocabularies* in *pluridisciplinary* contexts,
- *spatial description* management with shared geographic / spatial referentials facilitated by friendly GUIs improves the complex use of geographic information (*GI*) (in particular the use of formats like *GML*, *WKT*...).

The need of multi-standards metadata management tools is increasing. Indeed, even a single institute or project often has to manage more than one kind of IR.

Moreover, by considering users' and software engineers' tasks and needs to manage metadata, it appears that most of them are similar regardless of the standard implemented.

### User's needs and tasks

According to their roles (administrator...), regardless of tools, *users tasks* to manage a metadata standard usually consists of:

[7] An *informational resource* (IR) is the whole of data, information, knowledge produced, needed or treated by users (regardless of their format: hardcopy or digital...). According to the users, this term covers a report, a map, a picture, a video, a dataset, a data series, a database, a model....





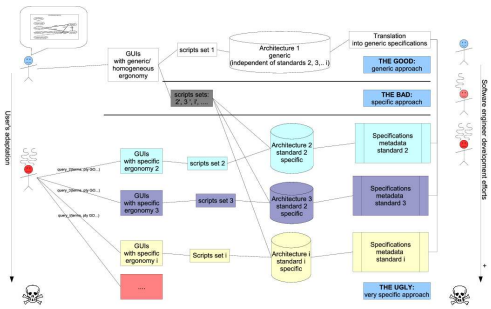


Figure 1: Benefits of a generic approach for multi-standards management





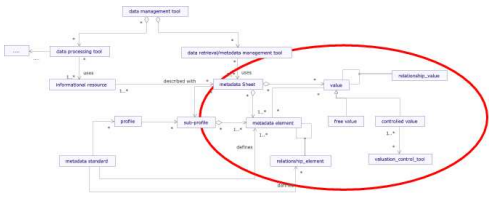


Figure 2: Generic expression of any metadata standard specifications

- *profiling* the metadata standards for their specific uses,
- *editing* standards instances to describe their IR (by relating values to metadata elements of the chosen profile),
- *locating* (and eventually *acquiring* according to access rights) the relevant IR for a given work by using a single *multi-criteria search engine* which allows sophisticated *spatial queries*,
- *import/export* metadata standards instances (usually XML),

*Users need* assistance to perform these tasks easily with friendly tools which are currently lacking. Most of the time, users express the need for single centralized access and tools with GUIs whose ergonomy is friendly and homogeneous from one standard to another (since tasks are similar). Indeed, heterogeneous software/IS implementing different or similar standards strongly increase user's accommodation efforts (as users have first to become familiar with each software to perform these tasks and then consider they are wasting their time). Finally, users need complementary components for any complex valuation process (*Web mapping tool*, *controlled vocabularies*, *calendar*...) with complicated format (like *GML*...). These use cases are illustrated with a UML diagram in the related slideshow (here).[8]

### Software engineer's needs and tasks

In the same way, software engineer's main tasks and needs remain similar from one standard to another.

*Software (engineers) tasks* consist of:

- *satisfying user needs* by *complying with standards*,
- managing the *matching between core metadata elements* of different standards to answer basic queries efficiently,
- integrating and managing existing *semantic and spatial referentials* to warranty the quality of IR descriptions and to manage query expansion process. Indeed, an efficient data retrieval involves the management of as many queries as existing IS. Answers to these queries are all more difficult since terms and geographic objects used are heterogeneous,
- providing a rich *spatial data infrastructure* to manage and eventually process related IR thereafter.

*Software engineers need* to *minimize their development efforts* to implement metadata standards (7). They want to do so by answering similar user needs in the same (automated) way: by reusing a single script set and the same components (WMS...). This requires a generic approach (regardless of implemented standards) (5).

### Generic approach vs. specific approach

Traditional specific implementations lead to heterogeneous data storage systems by translating directly specifications into physical heterogeneous data models and thus require specific scripts sets to process them (see illustration in figure 1).

For example, by using (manually or automatically) generated SQL from UML or XSD standards specifications, the resulting physical data models are going to be highly heterogeneous (as table and column names will match the metadata element names). Scripts to process their contents have therefore to be adapted to these specific terms set to answer similar tasks. Script sets are thus heterogeneous from one standard to another.

According to the previous lists of tasks and needs, the figure 1 illustrates the benefit of a generic approach for both users and software engineers.

So far, existing tools don't cover these different needs as they mainly lean on specific approaches.

[8] See UML diagram in slideshow: http://www.foss4g2007.org/presentations/viewattachment.php?attachment_id=46





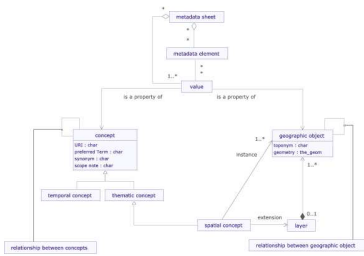


Figure 3: Properties and relationships of spatial and thematic concepts

## Generic models to manage efficiently {metadata element, value} pairs

We present in this section the ongoing generic models we are currently implementing to set up both a multi-standard metadata management tool and additional components which control the values of metadata elements by assisting the users at the same time. In particular these models will focus on the most crucial core metadata element values which are related to thematic and spatial descriptions.

### A generic model to manage heterogeneous metadata standards

The goal is to design a generic pattern (or conceptual model as shown in figure 2) to describe any metadata standard and then set up a generic metadata management system which allows the control of essential values. We suggest expressing a standard as an *inventory of structured metadata elements* with potential additional tools to fill their *content* with controlled *values* (according to standards specifications and/or software engineer's will).

This approach is close to DOM's[9] goal which involves similar concepts to manage *nodes* and their *relationships* as well as their *content* in any kind of document. However, we only focus on the specific case of metadata standards.

Nevertheless, a standard rarely aims to control the potential values of the core metadata elements, and even more rarely relationships between values (in particular terms and geographic objects, date/period...). The control of such values is ruled by other specific standards. It is thus the role of the software engineer to integrate these standards by setting up complementary tools to manage these specific values.

We will thereafter focus on the specific case of the management of spatial and thematic values. We suggest a new model to manage their relationships.

### A generic model to manage heterogeneous (thematic and spatial) values

The different kinds of {Metadata element, value} pairs are more or less crucial for data retrieval. In particular, certain values are especially difficult to control. Among them, *thematic* and *spatial descriptions* are both crucial as they are related to core metadata elements, involved in most of the users queries (re-

[9] Document Object Model

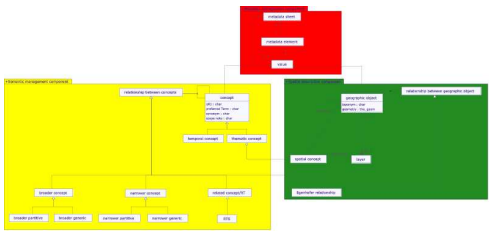

Figure 4: Summarization of the suggested generic approach

lated to *Where*? and *What*? criteria). We aim to manage them in a generic way by focusing on the user's intention: by focusing on the management of underlying *spatial* and *thematic concepts* (by using a formalization of their properties and relationships, see figure 3).

Indeed, the use of terms as values related to core metadata elements is often ambiguous:

- users often formalize their IR descriptions or queries by using such *terms*: *"swordfish, sea temperature, Madagascar, spring"*,
- semantic relationships management allows the system to relate different terms to expand these kinds of queries. For example by collecting other IR described with (*"Xiphias gladius…"*) which is a *synonym* of *"swordfish…"*) as it designates the same *concept* (in the same way as a picture and an image),
- the case of a *toponym* brings a new problematic as this kind of term could be both considered as a keyword or a geographical description. In fact, the geographic object related to the term/-toponym *"Madagascar"* could as well be designated graphically in a Web Mapping tool….

As illustrated in the figure 3, we suggest managing both *semantic and spatial relationships* between *thematic and spatial concepts* as well as *geographic objects* in the following way: *"a spatial concept as a kind of thematic concept whose instances are geographic objects"* (6). However it is important to consider that a *geographic object* is not necessarily related to a *term* or *toponym*.

The figure 4 summarizes the content of the previous generic models and give additional details to improve the management of both metadata elements and their values.

This model has been set up to be compliant with current reference standard implementations, for metadata, semantic and spatial information: standardized implementations of metadata standards (such as *XML Schemas*, *DTD*), (Web) Semantic standards (*SKOS* - related to *ISO 2788* and *5964* standards- /*RDF*/*OWL*) and main GI standard formats. This generic model allows one to set up in a single architecture a *physical link between metadata elements and ontologies* to control their values (including spatial descriptions) and expand the queries efficiently.

In the same way, it is possible to set up additional controls for other crucial values: in particular *temporal* and *contacts descriptions* which answer the questions *When* and *Who*? Such control tools are usually *calendar* or *contacts directory* components (they manage date/period and human resources descriptions related to the IR).

The management of these additional referentials could be done independently of the metadata standards implemented. However, we aim to calculate the values of heterogeneous core metadata elements of the different metadata standards implemented in such a tool by using the same inventories of objects (managed in these referentials) as a basis for any standard. The management of these referentials in the same architecture facilitates the process. Thereafter by keeping track of objects used to describe IR in a dedicated *generic common index table* which duplicates the main descriptions (*What*, *Where*, *Who*, *When*…), it will be possible to answer efficiently most of the users' requests, independently of the metadata standards used, by querying its records using richer values than standardized metadata element values (concepts URI instead of *terms*, 2D/3D geographic objects instead of *bounding boxes*…).





## Model implementation with open source software

We present in this last section an implementation based on open source software.

### Underlying technical choices

*MDWeb* is an open source product which is itself based on other open source software and standards. It implements this kind of architecture to set up a generic metadata management system. MDWeb:

- is a multistandard and multilingual metadata cataloging tool implementing a generic approach (like *M3Cat*, *MetaCat*…),
- is using a *three-tier* (client-server) architecture with:
  1. friendly *GUIs* (in Web browsers) with additional components (pop-ups) to assist metadata editing and searching:
     - *the spatial description* with Web Mapping tools which can be used as well to display the related GI: *Mapserver* / *Mapbuilder*,
     - *the thematic description* with Controlled vocabularies management GUIs to set up and browse of thesaurus / ontology: home made component.
  2. *applications scripts* (PHP/Javascript/XML with Apache Http server),
  3. *data storage*: *RDBMS* to manage metadata standards & spatial IR & related metadata & controlled vocabularies: *Postgres* with *PostGIS* (WMS for remote GI…). Import of *SKOS* files into Postgres by using *JENA* Java API. *XML* repositories.

Additional details on the main characteristics of the suggested three-tier architecture for the physical data infrastructure can be found in the related presentation (here).[10]

[10] See presentation online at: http://www.foss4g2007.org/presentations/viewattachment.php?attachment_id=46

[11] Physical Data Model

### Examples of a possible generic GUIs set

By using *MDWeb* as a basis to implement this approach, it is thus possible to meet users and software engineer's needs, in particular by having a single set of homogeneous GUIs, regardless of the implemented standard (10):

- *Import of any new metadata standard* by translating formal specifications into the PDM[11] (for now only XML Schemas specifications import is automated),
- Set up of *profiles* of imported standards,
- *Metadata sheet edition* with additional GUIs to assist (automation, control…) thematic and spatial descriptions of IR (as shown in figure 5),
- Generic/*multi-standard search engine*,
- *Import/export* of standardized (usually XML) metadata sheet.

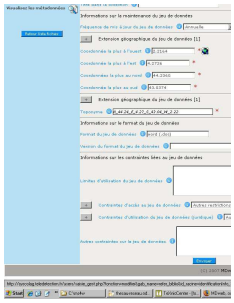

Figure 5: GUI to edit a metadata sheet

## Conclusion and outlook

Data retrieval can be highly improved by managing metadata elements and their values in a better way. By implementing a generic approach (GUIs, scripts set, database) it is possible to manage into a single architecture :

- *heterogeneous metadata standards* (import, profiles, edition…),





- *heterogeneous values*: in particular *controlled terms* and *spatial descriptions* to describe *core metadata elements*,
- a *common index table* duplicating core metadata elements by using homogeneous values which can be used more efficiently by the *search engine* (no wrapper needed), especially to expand queries,
- *spatial IR described by metadata* can then be processed after being retrieved: either locally or remotely by using interoperable protocols or/and rich clients (*WMS*, *QGIS*, *uDig*…).

This kind of architecture is crucial to satisfy both *user's and software engineer's tasks and needs* by *minimizing adaptation and developments efforts* and by integrating the complementary tools to control crucial core metadata elements values.

*Data retrieval* is thus improved. In particular, by managing standardized semantic and spatial descriptions and their relationships in a common architecture, data retrieval can use *queries expansion* processes. It is thus possible to focus on specific use cases involving semantic and spatial relationships management like "find all the IR less than one mile of this geographic object (platform, sensor…) measuring the following physical parameter (temperature…)" by leaning on rich concepts, 2D or 3D geographic objects…. Moreover by using standardized semantic or spatial relationships (*W3C*, *OGC*…) the different kinds of queries can be exported and used in any kind of similar tool.

Generally, this implementation with an extensive use of *OGC standards and open source software* increases its ability to interoperate with external IS.

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# Towards Web Services Dedicated to Thematic Mapping

*Abson Sae-Tang, Olivier Ertz*

## Introduction

Open standards favor interoperability of systems, and Open Geospatial Consortium (OGC) is the group that specifies the standards that allow geographic systems to interoperate. Among most known specifications, OGC defines the Web Map Server (WMS), the Web Feature Server (WFS), the Geographic Markup Language (GML), and the Styled Layer Descriptor (SLD) standards to solve the issue of spatial data sharing and interoperability. The project described in this paper puts the emphasis on the use of SLD to favor interoperability of geographic systems for thematic mapping.

## What is SLD ?

SLD stands for Styled Layer Descriptor, it is an encoding that extends the Web Map Service specification to allow user-defined symbolization of feature data. It allows users (or systems) to determine which features or layers are rendered with which colors or symbols. SLD addresses the important need for users (and software) to be able to control the visual portrayal of the geospatial data. FOSS4G applications highly rely on and respect open standards, and SLD is implemented by Geoserver, Mapserver, deegree among many other software.

Next version of this standard is known as the Symbology Encoding Specification which is still in progress. The ability to define styling rules requires a styling language that the client and server can both understand. Symbology Encoding provides this language, while the SLD profile of WMS enables application of Symbology Encoding to WMS layers using extensions of WMS operations.

## Is SLD ready for thematic mapping ?

Concretely, SLD is a useful and complete specification for styling your maps. For each layer you could say "color all my line features in blue", or "make all polygon borders black, and the insides pale yellow", or even "use little triangles for all my points". But you can also define even more complex styles. You can define the style rules based on attributes of the features in a layer. In a roads data set, you can style highways with a three-pixel red line, style four-lane roads in a two-pixel black line, and style two-lane roads in a one-pixel black line, thanks to an attribute that indicates the type of road.

But is it as good for thematic mapping? That is, for choropleth maps (Figure 1a), proportional symbols (Figure 1b), overlaid symbols (Figure 1c), juxtaposed symbols (Figure 1d), pie charts (Figure 1e), bar/histogram charts (Figure 1f), etc. These charts mainly make use of style rules based on feature attributes to transform statistical data to a graphical representation on the map. So, this project is first a study on how far we can go with SLD for thematic mapping.

With the current specification of SLD, it's more or less possible to describe thematic maps, but there are some drawbacks :

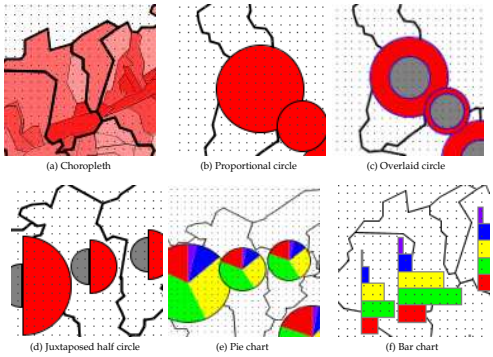
**Choropleth map :** one rule with a filter (class boundaries) per class, each rule having its polygon symbolizer with the fill color to apply.

**Proportional symbols :** a point symbolizer with a built-in graphic mark like circle, a fill color, and its size controlled by a data attribute.

**Bivariate symbols :** a mix of the filter and color of a choropleth map, and the point symbolizer of proportional symbols. Both size of the symbol and fill color are controlled by two data attributes.

**Overlaid symbols :** two rules with a filter for the rendering order (the fact that the smallest symbol has to be in front of the greatest). And two point symbolizers per rule, each with its size controlled by a data attribute.

For juxtaposed symbols, pie chart, and bar/histogram chart maps, it starts to be more complex and even unpleasant to describe them with SLD. Concretely, how do we hang two juxtaposed symbols on a unique point or centroid? Same for slices of a pie chart or bars of a histogram. One solution would be to use InlineFeature (from SLD 1.1) to draw the symbols, bars of the histogram for example. But unfortunately, InlineFeature uses GML to create temporary features, not graphics! So this is not accept-



(a) Choropleth (b) Proportional circle (c) Overlaid circle

(d) Juxtaposed half circle (e) Pie chart (f) Bar chart

Figure 1: Thematic maps

able. The second idea would be to use a kind of third party application for producing pictures of the symbols to represent points with external graphic links. Nonetheless if this is more acceptable, it is too verbose. Because one rule with a filter per symbol is required (given 50 points, SLD will need 50 rules).

## Towards an extension dedicated to thematic mapping

This initial study on how far we can go with SLD lead us to the idea of extending the symbology encoding of SLD. We call it SLD-T (even if it has nothing to do with WFS-T). Such an extension wants to extend the grammar in order to introduce specific terminology the thematic mapper is used to, ease the description of thematic maps, and reduce verbosity and redundancy.

Basically the idea is to create an abstract ThematicSymbolizer (like a PointSymbolizer is) that will be include in the SLD schema by extending the existing Symbolizer element from a Rule, with specializations for each kind of thematic map (Figure 2).

**CategoryThematicSymbolizer :** for maps with classifications (i.e. choropleth and bivariate map). This symbolizer is built-on ThematicCategory elements to describe the classification type (by unique value, by range value, etc.).

**SimpleThematicSymbolizer :** for maps without classification (i.e. proportional symbols). It is a simple wrapper of "standard" symbolizers to let them inherit useful generic elements from the ThematicSymbolizer like symbol priority and placement (see MultiThematicSymbolizer).

**MultiThematicSymbolizer :** to depict several thematic symbols per feature (i.e. overlaid and juxtaposed symbols). A BaseSymbolizer is used to group common rendering element (like Stroke or WellKnownName) and avoid redundancy. For overlaid symbols, the rendering process order is managed by the Priority element which can be controlled by a feature attribute. For juxtaposed symbols, the PointPlacement (inspired from the TextSymbolizer) allow to define an AnchorPoint and a Displacement for each symbol.

**ChartThematicSymbolizer :** for chart symbols (i.e. pie and bar charts). A ThematicMark (following the idea of graphic Mark) is used to specify the chart type (pie or bar). And a ChartParts element to describe the bars and slices composing the complex chart. As all ThematicSymbolizer can be rotated, one can also create an histogram.





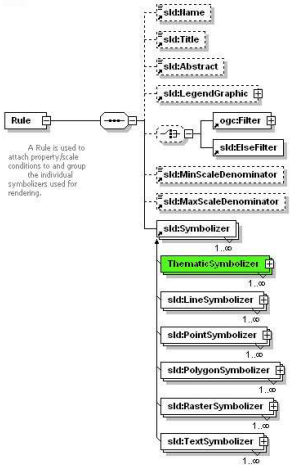



Figure 2: Rule with a new symbolizer

This is a brief summary about the extension. Complete XSD schema and document specification with examples are available online.[12]

SLD specification was originally meant for WMS. The user can define a SLD document and send it to a WMS server, and it returns the layer after applying the style you provided. But it's also useful as part of an OWS compliant desktop application. It could take a SLD file and apply it to a WFS response in GML that it receives. So, it makes sense to use such a styling specification server-side and client-side.

Consider this basic scenario: a cartographer or thematic mapper designing a nice and meaningful map on its SLD compliant desktop application, and as soon as the map is ready, he pushes it on a WMS server to share it. He will push the data and the styling. If interoperability is first about sharing data, it is finally about sharing maps with the appropriate styling for visualization, and the user wants also to share thematic maps.

## Conclusion

The initial study of this project tries to depict how far and how to use the specification for thematic mapping further then just for basic styling. Moreover, to enable SLD for complex thematic mapping, the project describe a solution with an extension of the symbology encoding. The extension has the aim to introduce specific terminology thematic mapper is familiar with, ease the description of thematic maps, and reduce verbosity and redundancy the use of "standard" SLD could produce.

As a proof of concept, a first implementation has been started on GeoTools, only about juxtaposed symbols. It was quite easy, because of an initial strong support of SLD and rendering model. The advantage of using GeoTools is that the library is used server-side for Geoserver but also client-side with uDig. But there are many FOSS platforms on which a complete implementation could be done, and no decision has been made. Future plans include an implementation but also a real use case. Notice, to have a really complete implementation, the rendering of legend graphic is mandatory.

SLD is more then ever a key element for Spatial Data Infrastructure, and its acceptance is probably crossing a step as we see more and more projects building SLD renderer and especially editor to ease user's life to create SLD (GeoServer, Mapbender, OpenLayers, etc.). Finally, at the so called "web thematic mapping"' side, it is good to see MapServer now able to create complex thematic maps with pie and bar charts, and also client-side application like CarThema5 (based on gvSIG), JumpChart (based on JUMP), OrbisGIS (based on GeoTools and GDMS) are ready to go for thematic mapping. This is all good news going the right way.

## Acknowledgements

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# Interoperability for 3D Geodata

**Experiences with CityGML and OGC Web Services**

*Hans Plum and Dr. Markus Lupp*

## Summary

Storage, processing and visualization of 3D geodata are an important subject in the GIS world even before the leading search engine introduced its globe viewer. Usage of standards of the Open Geospatial Consortium (OGC) open up new possibilities for combination and usage of 3D geodata. First practical experiences show promising results.

## Introduction

Processing and visualization of 3D geodata became a common subject during the last years. Some indicators for this are the number of offered software solutions but also the amount of interest for the development of CityGML. CityGML is a GML-based exchange format for three dimensional digital city models, that is already implemented in a number of software products. With the definition of CityGML and application of OGC Web Services for access to and visualization of 3D geodata the areas of 3D geodata processing and Spatial Data Infrastructures (SDI) are converging.

This article is discussing solutions that were realized using technology from the deegree project. The mentioned projects are: "Storage and administration of 3D city models for the cities of Bonn, Berlin and Hamburg", "Visualization of digital terrain models for the Federal Agency for Cartography and Geodesy of Germany", "Realization of a transactional CityGML WFS for the Open Geospatial Consortium" are outlined.





## OGC-Standards with relevance for 3D

A number of discussion papers and specifications of the OGC are of importance for 3D geodata handling. In particular these are CityGML as data model and exchange format, Web Feature Service and Web Coverage Service for data access and Web Terrain Service and Web 3D Service respectively for visualization purposes.

### City Geography Markup Language (CityGML)

CityGML defines a semantic object model for 3D objects in urban areas. It is a GML application schema that is it model objects of an application domain using constructs of the Geography Markup Language. In this aspect CityGML is a semantic model as well as an exchange format.

CityGML is so far mainly developed by a working group of the SDI initiative of Northrhine-Westfalia, although members from all over Germany are part of this group. In version 0.3 CityGML was introduced into the OGC and published as a discussion paper (1). CityGML 1.0 will in short time become an official OGC Best Practice paper.

### Web Feature Service

A Web Feature Service (WFS, (2) allows to query geodata modeled in GML. Filter Encoding (3), an SQL-like language encoded in XML is used to query a WFS. A WFS that allows not only to read, but also write access (create, update and delete) is called a transactional WFS (WFS-T).

WFS is an official OGC-standard in the current version 1.1.0. A WFS implementing this 1.1.0 specification has to support GML 3.1.1 – the same version that is the base for CityGML. It is therefore possible to use a WFS as a data access layer to CityGML.

### Web Coverage Service

A Web Coverage Service (WCS, (4) allows to access all kinds of data that is modeled "field-based", e.g. Raster- or TIN-based. Examples of such data are those created by remote sensing or digital terrain models. In the context of 3D SDI a WCS can be used to access terrain models. WCS is an official OGC standard with the current version 1.1.0.

### Web Terrain Service

A Web Terrain Service (WTS), still in OGC discussion paper status, generates Views of 3D scenes. In contrast to a WMS that creates 2D visualizations, an image depicting 3D data is generated.

Unfortunately, the development of the WTS specification advances rather slow. The current draft version bears the name "Web Perspective View Service" (WPVS) to express that the service is able to depict 3D objects besides "Terrain".

Figure 1 shows the result of a GetView-request. A digital terrain model is depicted that is textured with aerial photographs. On top of the terrain a number of buildings are displayed (one of them transparently).

WPVS creates presentations of 3D objects. The most important operation of this service is GetView which returns static pictures of 3D landscapes. The GetView operation can be seen as an extension to the GetMap operation of WMS. In comparison to GetMap, GetView defines additional parameters allowing to specify a 3D scene. Among these parameters are a rotation angle and the azimuth of the depicted scene. As the result of a GetView operation is a (static) image; it is not possible to navigate directly through the scene. A WPVS client is therefore in comparison with real 3D viewers not very interactive, but can be implemented as a web application using DHTML without the need for browser plugins. Another advantage is that such a simple and web-based 3D client can easily be integrated with other web-client software, like e.g. WMS-based portals.

The challenge when creating a WPVS client is to hide the complexity of a GetView request behind an easy to use graphical user interface, that allows navigation in 3D space.

## Use cases

To support the projects mentioned in the introduction, the following use cases have to be supported.

### Storage of digital city models

Digital city models are often created using CAD systems and stored in CAD file formats. This results in a number of disadvantages. It is not possible to easily select parts of the city model or to organize updates. Because of this reason, organizations who own such city models need homogeneous data that best is stored in a database.

Figure 1: Visualization of terrain and buildings using deegree WTS/WPVS

To support this use case it is necessary to store CityGML in a – most likely relational – database. For access to this database a WFS is the obvious choice, CityGML can then directly be inserted and pulled out of the database.

To control the access to the WFS it is necessary to use an access control mechanism. In the mentioned projects components of deegree iGeoSecurity are used for this.

### Web Visualization

The advantage of 3D geodata is mostly to be found in its possibilities on visualization. Application areas are support of urban planning processes and navigation. In the context of planning processes, 3D geovisualizations allow to display the consequences of planned projects before they are realized.

Tourist information systems can also benefit from 3D visualization. Recognition of landmarks or navigation can be enhanced. Great potential also lies in the coupling of classical 2D maps with 3D scene visualizations.

For marketing purposes of the data itself, terrain and city models are displayed on the Internet. The potential of the data is shown in this way.

## Architecture of a 3D SDI

In the following, the architecture of 3D SDIs realized by deegree will be described (c.f. figure 2).

The building information models will be kept in a spatial enabled database, e.g. PostGIS or Oracle Spatial. A transactional WFS (WFS-T) supports the access for reading and writing of the city models. In order to control the information flow, especially transactions against the WFS, a owsProxy is used to protect the building information against unauthorized access. The editing component – mostly a CAD system – accesses the data via owsProxy and WFS.

Digital elevation data can also be saved in a geodatabase. Especially for TINs or points. Alternatively, raster data can be saved in the filesystem. In order to support a fast access method the mechanisms described above have to be used. Accessing digital terrain data in raster format are provided by a WCS. Getting the according terrain model while rendering a city model is easily done through the Web Coverage Service.

On the right hand side of figure 2 the visualization process is shown. deegree-WPVS accesses the data out of the geodatabase. Furthermore, it is possible to integrate external WFS- or WCS-services. Textures like ortho imagery or maps for navigation are also needed. Via a WMS these kind of data can be integrated. A web-based WPVS-Client provides a graphical user interface that can be used in web browsers.





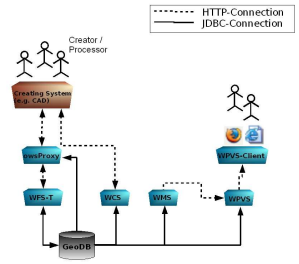


Figure 2: Architecture of a 3D SDI

## Conclusion

The development of CityGML defines an important step towards 3D SDIs. The experiences using deegree components for development of such systems that were made in a number of projects are promising. They show that it is already possible to create 3D SDIs using Open Source software.

The mentioned components are available via www.deegree.org. At the time of writing the RC1 for WPVS (including a client), WFS and WCS are available as easily installable WAR archives.

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# A Model-Driven Web Feature Service for Enhanced Semantic Interoperability

*Peter Staub*

## Introduction

This article addresses current research issues in the field of interoperability of heterogeneous GIS. We focus on heterogeneity at the level of conceptual data models. The presented research project of a model-driven Web Feature Service aims at enhancing semantic interoperability. The approaches of data interoperability such as OGC web services (OWS) are combined with methods of model interoperability. The model-driven approach of conceptual data modelling allows for keeping data models independent from any particular system.

Interoperability is a crucial capability to deal with in the context of geospatial applications and information communities. The use of web services is well-established and useable in a standardised way due to the efforts of the OGC. However, OWS such as the Web Feature Service (WFS) (3) provide data interoperability, but no model interoperability. Conceptual model mappings are a precondition for semantic interoperability but are not supported by OWS.

Among European initiatives for geodata infrastructures – such as INSPIRE[13] – the need for interoperability not only on the data level, but also on the model level, grows. The research project described in this article was initiated in the context of a project in the Lake Constance region[14]. The mentioned project aims at creating a cross-border web-based GIS for applications.

In the presented research project, we introduce a **model-driven WFS** (**mdWFS**) which combines both the advantages of OWS for data interoperability and those of the model-driven approach for conceptual data modelling. Furthermore, formalism for establishing conceptual model mappings is developed and a prototype is implemented. Because of this combination, the mdWFS we introduce is an approach that provides enhanced semantic interoperability.

## Fundamentals of Data Modelling and Semantic Interoperability

### The Model-Driven Approach

The main idea of the model-driven approach is to describe (geo-)data models using a conceptual schema language (CSL). The use of a CSL for modelling allows for keeping data structures independent from any particular system or transfer format such as XML or GML. Virtually any transfer format can be derived from the conceptual schema (syn. model) automatically – given an adequate model compiler.

If you want to reach semantic interoperability, you will have to create conceptual model mappings. A conceptual model mapping is converted into mapping functions $\mathcal{F}_M$ from a source schema $A$ to any target schema $B$:

$$A \xrightarrow{\mathcal{F}_M} B$$

The model-driven approach consists of four steps (see figure 1):

1. Specification of an *application domain* (i. e. "what we are talking about")
2. Specification of a *CSL* with a coherent UML metamodel
3. Description of the application domain with the chosen CSL → *conceptual schema*, platform independent model (PIM)
4. Derivation of any format schema (e. g. a GML Application Schema) → *logical and physical schema*, platform specific model (PSM)

As mentioned above, we assume that the generation of the logical schema is *automatically* carried out by a compiler and the encoding is done by an adequate encoding program.

In the presented research project, the (textual) CSL *Interlis* is applied for data modelling. Interlis is a Swiss standard (8) and is widely applied in cadastral and planning applications. Interlis is based on a UML 2 profile and a compiler[15] generates XML schemas (Interlis format) or GML Application Schemas from any given Interlis data model.

[13] INSPIRE project website: http://www.ec-gis.org/inspire/index.cfm
[14] Bodensee-Geodatenpool (Lake Constance geodata pool) project website: http://www.bodensee-geodatenpool.net
[15] Interlis compiler: see http://www.interlis.ch. The compiler is free and open source.





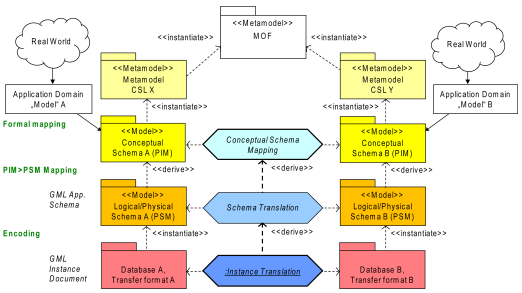


Figure 1: Model-driven approach and semantic interoperability

According to the Model-Driven Architecture (MDA) specified by the Object Management Group (OMG) (4), the generation of a format schema from a conceptual schema is referred to as a PIM–PSM mapping. In terms of mapping directions, the PIM–PSM is also called a "vertical" mapping, whereas model mappings for semantic interoperability are "horizontal" (i. e. PIM–PIM) mappings (see next section).

### Semantic Interoperability

Technically, there are two main aspects characterising "interoperability": 1) *Data interoperability* = the ability of a system or process to exchange datasets using certain data transfer formats. 2) *Model interoperability* = the ability to establish conceptual model mappings in order to execute semantic data transformations.

To achieve semantic interoperability, different data models have to be mapped. A translator then interprets the mapping rules from the conceptual model mapping and executes the instance translation automatically.

Semantic transformation approaches can be classified as follows (1):

- *Level of abstraction:* Semantic transformation can be performed on different levels of abstraction (on the conceptual level, on the logical level and on the physical (i. e. transfer format) level). A semantic transformation on the conceptual level is platform independent, whereas approaches on the logical or physical level are platform specific.
- *Orientation:* Horizontal semantic transformation between different schemas on the same level of abstraction (PIM–PIM; PSM–PSM) vs. vertical semantic transformation between different levels of abstraction (PIM–PSM).
- *Level of automation:* Creating mapping rules by hand vs. automated schema matching which is only partially practicable.

### Shortcomings of Existing Approaches

One possibility is to integrate all data into one central system. This is very costly and requires expert knowledge. In order to integrate the data into the central system, 1:1-format conversions have to be carried out. This is often lossy because a data format which is different from the original one is in general not able to express the entire semantics of the original data format. Besides that, the inevitable redundant data storage possibly causes outdated data.

Existing OWS such as the WFS have some shortcomings with regard to semantic interoperability: OWS allow for syntactic interoperability (i. e. data interoperability) but not for semantic interoperability (i. e. model interoperability). Conceptual models of source systems are hidden from target systems and semantic transformations are not supported. So, the

WFS lacks in the ability to handle conceptual model information aside from data information.

## Concept of the Model-Driven WFS

### Preconditions for a Web-Based Semantic Transformation

If we want to have a web service that allows for data interoperability *and* that is able to store and deliver conceptual schemas, a number of preconditions must be fulfilled. It must be assured that conceptual schemas are described (i. e. modelled) using a textual CSL with its graphic representation in UML 2 (and the respective exchange format XMI). Furthermore, a formal language is needed for expressing schema mapping rules on the conceptual level of abstraction. Finally, we use a standard WFS interface to provide satisfying data interoperability.

### Web Service Requirements

Web-enabling semantic transformations means in our case actually designing a web service. This service has to comply with two main requirements:

1. Provide access to geospatial data based on the data's original conceptual schema (source model) and on any user-defined conceptual schema acting as the target model.
2. Interoperability with existing OWS.

### The mdWFS Interface

We designed a service called "model-driven Web Feature Service" (mdWFS) taking these requirements into account. The mdWFS has the task to store and deliver conceptual schemas and to carry out semantic transformations (PIM–PIM mappings) by means of interpreting transformation models. After a semantic transformation, the mdWFS configures a standard WFS to provide a service for data interoperability. The standard WFS is configured according the target model but delivers transformed feature data from the source model.

### WFS Protocol Extensions

In order to create a WFS that is able to store and deliver conceptual schemas, the OGC WFS specification needs to be extended. In the mdWFS specification, the extensions described below are applied (1):

- To provide a service protocol for the mdWFS, a new request parameter `SERVICE=mdWFS` is implemented.
- The `GetCapabilities` request is extended to provide a `SchemaList`. This list includes each conceptual schema that is available in the service.
- The `DescribeFeatureType` request is extended to provide the `XMI` format for transferring model information.
- Finally, a whole new request `DoTransform` is introduced. This request transfers the conceptual mapping schema to the mdWFS and invokes the semantic transformation.

## UMLT, a Conceptual Schema Mapping Language

### Concept of UMLT

We introduce a conceptual mapping language that can be used to create conceptual mapping schemas (syn. transformation schemas) for semantic transformations. This formal language must comply with several requirements in order to be useable. Transformation schemas must be comprehensible also for non-computer scientists. Therefore, a UML 2 metamodel as well as syntax for a human useable textual notation (HUTN) is developed. Transformation schemas are represented in visual form (UML activity diagrams), in textual form (derived from Interlis CSL) and XML (i. e. XMI), respectively. Common standards in the field of data modelling are taken into account[16]. We also apply an abstraction layer for (geo-)data types.

Two existing approaches from the OMG were examined. First, the Meta Object Facility Query/Views/Transformations formalism (MOF-QVT) (5): this formalism is designed for the transformation of metamodels, e. g. UML→Java. MOF-QVT models are hard to understand and their visual representation helps little. The standard is complex since it actually consists of three languages: Relations, Core and Operational. Furthermore, the MOF-QVT standard is predominantly applied for PIM–PSM implementation mappings.

Another approach that was examined is UML 2 Activities. UML 2 activity diagrams can be used to describe transformations in terms of activity sequences. A clear description of the semantics and of the transfer format (XMI 2.1) is provided in the Superstructure for UML models. UML 2 models are comprehensible and a number of implementations and open source APIs are available.

Because of the above considerations, our conceptual mapping language is based on an independent extension of the UML 2 metamodel. To specify the language elements, a UML 2 model is created and the textual notation of the language is defined by a set of EBNF grammar rules. At project stage, we call our conceptual mapping language "**UMLT**".

[16] Such as standards from OMG, OGC and ISO





### UMLT Language Elements

The language elements of UMLT are an inheritance of UML 2 Activities (7). We introduce the following language elements (see figure 2):

- `StructuredTransformation`
- `SelectionCriteria`: selection of input data through a logical expression.
- `VirtualAssociation`: manage input objects that are not actually associated with an association object. These input objects may have link attributes or foreign key attributes that are evaluated at runtime in order to get calculated relations[17]. During a semantic transformation, such objects can be associated *in a virtual way* if needed. The `VirtualAssociation` is introduced (in contrary to a common "derived association") to provide a means to explicitly specify the join property of the association with the `joinCriteria` expression.
- `TransformationAction`: inheritance from a UML `OpaqueAction` providing an activity element which cannot be structured any further. This is a transformation's elementary action.
- `AssignmentDefinitions`: address primitive types or expressions as value specification.
- `MappingRule`: the actual object mapping. Built as a composition of assignment definitions.
- `AssociationBinding`: selecting associated input objects, one may define how these associations are evaluated during input.
- `JoinType`: an enumeration type to specify the join type of the association binding.

[17] A different example is a geometry/topology relation: a building *on* a parcel

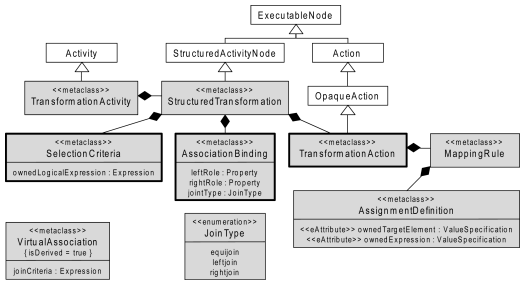


Figure 2: UMLT language elements

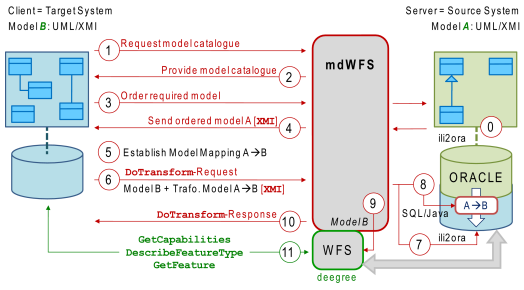


Figure 3: Prototype implementation test bed





## Prototype Implementation

In the context of the presented research project, a proof-of-concept prototype is implemented. Besides the WFS protocol extension and the UMLT language specification, this prototype consists of a model parser, a mapping model editor and a prototype test bed. The model parser and the editor are developed in the Eclipse environment[18]. The model parser creates an XMI file from a UML/Interlis data model and also from a UMLT mapping model.

In the prototype test bed, we use an ORACLE Spatial database and a deegree WFS implementation[19] on which the mdWFS is built upon. Figure 3 shows the steps of a semantic transformation using mdWFS.

We primarily focused on the WFS extension and on the conceptual mapping language UMLT. We consider ORACLE Spatial as a very suitable RDBMS for our needs, providing powerful spatial features. Therefore, we use the RDBMS we already had at hand although it is not a FOSS solution. Principally, an mdWFS can be applied on any RDBMS with a spatial extension.

Before you can start working with mdWFS, you need to configure the database according to the source data model *A*. This can be done using an existing FOSS tool called "ili2ora"[20]. This tool allows to configure an ORACLE Spatial database according an UML/Interlis-data model and to import feature data into this database.

1. Client *B* sends a model-catalogue request to the mdWFS
2. The mdWFS provides a catalogue of available data models
3. Client *B* chooses a source data model (i. e. model *A*) and orders the model information
4. The mdWFS fetches model information *A* and sends the model (XMI) or a model reference to the client *B*
5. Client *B* creates the model mapping $M : A \xrightarrow{\mathcal{F}_M} B$ by specifying adequate UMLT mapping rules
6. The transformation model *and* the target model *B* are parsed and translated into XMI and sent to the mdWFS in a `DoTransform`-request
7. According to the target model *B*, the mdWFS configures an ORACLE Spatial database using ili2ora again

[18] Eclipse: `http://www.eclipse.org`
[19] deegree project page: `http://www.deegree.org`
[20] Source: `http://www.eisenhutinformatik.ch/interlis/ili2ora/`





8. The mapping rules from the transformation model are translated into SQL statements and Java instructions in order to actually transform feature data from source/server model *A* into target/client model *B*
9. The mdWFS configures a standard WFS (deegree) according to the target model *B*. This WFS is connected to the database containing the transformed feature data
10. After finishing the transformation, the mdWFS sends a `DoTransform`-response to the client *B*
11. Client *B* accesses the transformed feature datasets from model/database *A*, transformed into model structure *B*, via standard WFS requests.

## Conclusions

The current evolution of GI systems shows that a conceptual schema language is usually applied for geodata modelling. This is a necessary precondition for semantic transformations on the conceptual level. Any given application domain can be characterised by different data structures. This leads to different data models. Therefore, conceptual model mappings must be established in order to achieve semantic interoperability.

The new *mdWFS* presented in this article implements the methodology of the semantic transformation at the conceptual level of abstraction what allows for a much enhanced semantic interoperability.

Potentially, the mdWFS can be integrated in other (OWS based) infrastructures due to the sound basis of GI standards that are applied.

## Acknowledgements

I would like to thank my colleagues at the ETH Zurich and at the TU Munich for their company and good collaboration in this research project: Dr.-Ing. A. Donaubauer, H. R. Gnägi, A. Morf, F. Straub. I also appreciate the excellent project lead of Prof. Dr. A. Carosio, ETH Zurich and Prof. Dr.-Ing. M. Schilcher, TU Munich.

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# Spatial-Yap: A Spatio-Deductive Database System

*David Vaz and Michel Ferreira*

## Introduction

The paradigm of Deductive Databases extends traditional databases with deduction abilities. Knowledge is not only represented extensionally[21] but also through intensional logic rules. A typical approach in building such deductive database systems is to couple a logic programming system with a relational database system.

The original query language, Datalog (1), restricted attribute data to ground atomic values, such as numbers and strings, which were the typical data stored in databases. However, current databases store much more structured data, such as the geometric attributes of spatial relations.

In this paper we describe the extension of the Yap Prolog (2) compiler, a free, open-source logic programming system, in order to handle spatial data, providing a state-of-the-art solution for its modeling, querying and mining. A proposal of extending Datalog to Spatial Datalog has been described in the literature, in the framework of Constraint Databases (3). The approach followed in Spatial-Yap is different and closer to the spatial databases community, as it is based on spatial terms, rather than on polynomial inequalities. Spatial-Yap can build spatial logic terms from vectorial data in spatial relations, and provides a highly declarative programming environment for its handling, supported, for instance, by the natural specification of recursion, inherent to topological relationships, and by a powerful ADT, as is the logic term. Although the current focus in Spatial-Yap is much more on declarativity than on efficiency, the system is able to explore advanced features of Yap, such as a Prolog to SQL translator and a tabling engine based on tries, to improve performance.

## Logic Programming and Inductive Logic Programming

Logic programming (LP), of which Prolog is the canonical language, is an attempt to implement Colmerauer and Kowalski's idea that computation is controlled inference (4). The motivation for the LP paradigm is to separate the specification of *what* the program should do from *how* it should be done. This was summarized by Kowalski's motto:

$$algorithm = logic + control.$$

Prolog programs use the logic to express the problem and rely on the Prolog system to execute this specification. Prolog implements a subset of first order logic known as Horn clause logic. A Prolog program is a set of relational rules of the form:

`A :- B1, B2, ..., Bn.`

meaning: `A` is `True` if `B1` is `True` and `B2` is `True` ... and `Bn` is `True`. These rules are given a procedural interpretation which reads as:

to solve(execute) `A` solve(execute) `B1` and solve(execute) `B2` ... and solve(execute) `Bn`.

The precise procedural interpretation used in the execution of Prolog programs is a restricted form of SLD-resolution (5).

Deductive database systems are database management systems which are also designed around a logic model of data and whose query language is a set-oriented version of Prolog, known as Datalog. Database relations are naturally thought of as the *value* of a logical predicate and the high expressive power of logic expressions is used to query such relations. The deductive part of such systems comes from the fact that the logic programming engines take *intentions* (or comprehensions), which express properties, and are able to materialize these intentions in *extensional* knowledge (relational tuples or facts).

This process of deduction, which goes from intentions to extensions, is computationally much simpler than the reverse process of going from extensions to intentions. However, being able to derive an intentional representation from extensional data, inferring a general rule from examples, is also crucial. This is the goal of a logic programming paradigm known as Inductive Logic Programming (ILP) (6).

ILP is a research area formed at the intersection of Machine Learning and LP. ILP systems develop predicate descriptions from examples and background knowledge, thus deriving an hypothesized logic program which entails all the positive and none of the negative examples. To derive a theory with the desire properties, many ILP systems follow some kind of *generate-and-test* approach to traverse the *hypotheses space*. An important characteristic of the ILP approach to data mining is that it is multi-relational, being able to formulate theories which involve data in several relations, while many important data mining techniques are only able to look for patterns in a single relation. This is particularly useful for spatial data mining, which is inherently multi-relational (or multi-layered).

[21] Definition of terms: http://en.wikipedia.org/wiki/Extensional_definition





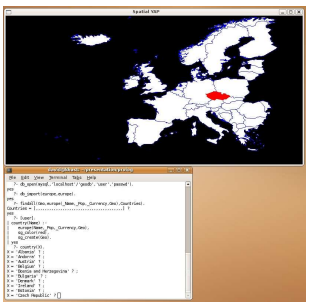

Figure 1: Spatial-Yap example.

## A Spatio-Deductive Database System

Spatial Yap results from a sophisticated interface between several components. The two main components are the Yap Prolog system and MySQL RDBMS, which are coupled through the MYDDAS interface (7) (Mysql/Yap Deductive DAtabase System). This interface is responsible for coupling these two systems, as illustrated in Figure 2. MYDDAS transparently translates logic queries into SQL statements, implements the conversion into Yap terms of MySQL attributes and explores the YapTab tabling engine for solving recursive queries involving database goals. The level of sophistication of this interface is very high, with the fetching of relational tuples being implemented directly in WAM choice-points, supporting pruning operators (8).

To build the spatial deductive database system we extended the MYDDAS interface to support MySQL Geometry Types. Two more components are fundamental to build Spatial Yap: a spatial operators library based on the well known GEOS library and a visualization component.

When dealing with spatial data it is essential to be able to graphically represent such data. Representing a map as a set of Prolog terms is visually unacceptable, from the point of view of a GIS user. Even more important is the representation of a spatial operation, such as the intersection of two polygons, in a graphical way. User-driven spatial analysis and the representation of spatial queries result sets require a visualization component to be added to any spatial database system. Here we could have used one of the existing FOSS, such as MapServer, but we rather needed something simpler that worked as a graphical spatial top-level, tightly coupled to the text top-level of our Prolog system. Interaction between these top-levels was our main goal, rather than sophisticated graphical display. Figure 1 show a screenshot of the interaction between the two top-levels of Spatial-Yap.





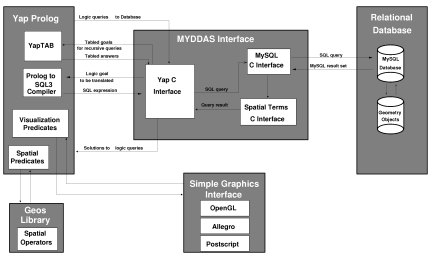


Figure 2: Spatial Yap Blueprint.

## Current Applications

In this section we describe two undergoing projects where we are applying Spatial-Yap.

### Study of Traffic Behaviour in the City of Porto

The aim of this project is to study traffic behavior in the city of Porto, second largest in Portugal, with a road network totaling 965 kms, shown in Fig. 3. We are interested in understanding factors affecting traffic, not only time and day related, but also including intrinsic geographic entities, such as the presence of a school in a street segment and its influence in traffic congestion time-slots. More ambitious goals include the automatic derivation of a road signalization layer, including traffic lights and stop signs locations, based on mobility patterns, or the inference of likely destinations of drivers that can automatically activate navigation systems, based on a background of usual routes.

Figure 3: Road network of Porto.

Routing algorithms and displaying of computed routes are also implemented using Spatial-Yap and its tabling engine. ILP systems provide the support for inference over geospatial data, such as GPS logs.

### Correction of Automatic Classification of Forests based on Spatial Analysis

Another interesting project where we are using Spatial-Yap aims at the global monitoring of biodiversity change (9). Governments have set the ambitious target of reducing biodiversity loss by the year 2010, and scientists now face the challenge of accessing the progress made towards this target. The European Corine Land Cover (CLC) project[22] provides data for two different years (1990 and 2000), using 44 land-cover classes. This data is obtained from satellite images and the vectorization in the polygons of each of the 44 land-cover classes is done automatically, based on color recognition. Unfortunately, the land-cover classes of CLC are not the most appropriate to monitor biodiversity. For instance, currently CLC has only three classes for forest (broad-leaved, coniferous and mixed); therefore, an observed increase in broadleaved forest area could be due to an increase in plantation area of an exotic species, such as Eucalyptus globulus, or an increase in native broad-leaved forest, two phenomena with different implications for biodiversity. The group of biologists with whom we are working has detailed regional maps from the area of Alto Minho, in Portugal (see Fig. 4), also covered by CLC. These regional maps are done based on expensive and slow on-site mapping techniques and on-site identification of forest species, allowing a much higher detail on the list of classes. Our project is trying to use these detailed regional maps to derive a set of spatial logic rules that allow the detailed characterization of CLC data for biodiversity monitoring. We are using Spatial-Yap and the APRIL ILP system over data-sets created based on the intersection of the regional maps and CLC maps. The inducted rules can then be used to improve the categorization of new CLC data, allowing its use for biodiversity monitoring.

[22] The European Corine Land Cover (CLC) project: http://terrestrial.eionet.eu.int/CLC2000





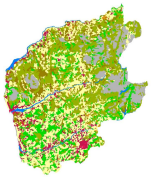

Figure 4: Alto Minho Map.

## Future Work

A migration from MySQL to PostgreSQL is undergoing. Our goal is to extend the Prolog to SQL compiler in order to be able to transfer to the database system conjunctions of logic goals, that can take advantage of spatial indexing that currently is not available in Spatial-Yap.

Spatial-Yap can be downloaded from `myddas.dcc.fc.up.pt`. A users manual and several papers with deeper presentations of Spatial-Yap are also available from the same webpage.

## Acknowledgments

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# Case Studies

# The DIVERT Project: Development of Inter-Vehicular Reliable Telematics

*Hugo Conceição, Luís Damas, Michel Ferreira and João Barros*

## Introduction

The advent of wireless ad-hoc car-to-car (C2C) networks, i.e. groups of spatially-aware vehicles equipped with the ability to communicate over the ether and to self-organize into a collaborative mesh, opens a myriad of possibilities towards sharing and exploiting highly dynamic geospatial information. The CAR 2 CAR Communication Consortium Manifesto (1) describes several scenarios where these networks are used for purposes such as the improvement of driving safety (2), optimization of traffic efficiency or to provide information and entertainment to the driver. Examples of safety applications are *cooperative forward collision warning* (see e.g. (3)), *precrash sensing/warning* or *hazardous location notification*.

Regarding traffic efficiency, applications include *enhanced route guidance and navigation*, where equipped vehicles use information collected either from road infrastructures of from other vehicles about current traffic conditions to calculate optimal routes to destinations. Another application is the *green light optimal speed advisory*, where a traffic sign is able to transmit to vehicles the optimal speed to make their driving smoother and avoid stopping. Similarly, wireless communication between nearby vehicles can provide a *C2C merging assistance* to allow cars to join flowing traffic without disrupting it.

Wireless ad-hoc C2C networks will also enable applications not directly connected to safety or traffic efficiency, such as *point of interest notification* broadcasted to vehicles from local businesses or tourist attractions, or *remote diagnostics* of vehicles. Another application will be *internet access in vehicle* through the C2C network, allowing multi-hop routes to internet access points.

The deployment of a C2C network and its applications face some relevant challenges. It is clear that an inter-vehicular communication technology requires a significant distribution in the market before it can show any effect. The C2C Communication Consortium has estimated a required penetration rate of about 5% to enable traffic information propagation. A reluctant introduction may prevent potential new customers from equipping their vehicles with such communication systems. The scalability of the C2C communication system is another important issue that has to be studied. The system must work in scenarios with very small density of road traffic and in situations with a very high traffic density, which cause different technical challenges. The development of collaborative navigation protocols is another major challenge faced by C2C networks. The goal of propagating traffic information is to allow vehicles to dynamically calculate the fastest route to their destination. Clearly, such dynamic calculation must be based on inter-vehicular collaboration, diverting routes in a global optimization perspective of the road network.

Given these challenges and the complexity in modeling the mobility behavior of large-scale distributed traffic systems (see e.g. (4)), the development of realistic simulation tools is arguably a vital element towards the success of the implementation of a C2C network. Motivated by this need, we present an open-source real-time simulation framework for moving vehicles in different road environments, that includes multiple driving states, inter-vehicle communication and sophisticated visualization. Our simulator provides the basis for a systematic approach towards quantifying the performance trade-offs between relevant metrics such as transmission radius, fraction of communicating vehicles, freshness of data, and network connectivity, thus highlighting the dynamics of cooperative navigation.

## The DIVERT Simulator

From an abstract point of view, the road network can be seen as a large graph, whose topology is static and determined by geography, on top of which we have a random communications graph, whose spatial realization and connectivity pattern at each point in time is determined both by the position of the vehicles moving on the road network and by the transmission aspects of the wireless interface they use to communicate. To obtain a realistic road graph model, we may resort to increasingly available geospatial information, whereas the wireless transmission characteristics have been the object of intense study yielding useful random models with varying complexities (see e.g. (5)). Given these two aspects, we structured our simulation prototype (named DIVERT - Development of Inter-VEhicular Reliable Telematics) in two layers: a traffic simulation layer based on the road network graph; and a wireless telematics layer, based on the random communications graph. We next describe these layers.

### Traffic Layer

The geospatial information over which the traffic simulation layer operates is conveyed to DIVERT using widely used formats, such as shapefiles, which describe the geometry and connectivity of the road network. DIVERT includes a sophisticated user interface which allows editing the basic road segments enriching them with low-level information describing traffic entities. A screenshot of this interface is shown in Fig. 1.

Currently, DIVERT has been setup using geospatial information of the city of Porto, the second largest in Portugal. Its road network covers an area of 62 square kilometers, with 1941 streets summing up to 965 kilometers of total length.

In DIVERT we model two types of vehicles: vehicles which circulate and communicate, called *sensors*; and vehicles which just circulate. Within each type of vehicle, DIVERT further distinguishes in normal and large-sized vehicles, associating appropriate mobility patterns to each. These mobility patterns are also individually influenced by random initialization of attributes such as acceleration, braking, aggressiveness and risk tolerance. Sensors add an attribute of wireless transmission range.

DIVERT uses the following layers of geospatial information about the road network:

1. Two simple layers of the road central axles, representing, through polylines, the geometry of intersection free road segments, and their topological connectivity. These layers can be given to DIVERT as shapefiles. A copy of these layers is present in every sensor, and is used for positioning of GPS readings and for the collaborative propagation of mobility conditions on road segments.
2. Low-level layers describing in detail the road network of Porto, including information of road segment lanes, lane-level connectivity, intersection visibility, traffic lights location, traffic lights inter-relationships, speed limits on segments, and parking. These layers must be edited through the DIVERT interface and are used by the traffic simulator.

A raster layer from satellite images of the simulation area further improves the visualization of traffic in our prototype, which is currently based on 2D data. Work is undergoing on a 3D model, which will not only allow more realistic accelerations parametrized by steepness, but also enable an improved modeling of wireless transmission ranges, which accounts for fading, reflection and shadowing effects based on a 3D layer for buildings.

Regarding vehicle routes, DIVERT currently uses an hybrid model of pre-defined routes and randomly generated routes. For randomly generated routes, our system arbitrarily selects an origin and a destination and calculates the route based on a shortest-path algorithm, either parameterized by distance or by time. Shortest-path based on time uses not only the speed limits of segments, but mainly the dynamic calibration of average mobility derived from previous simulation results. Pre-defined routes have an associated frequency and have been carefully chosen to approximate the simulation to our perception of traffic distribution in our current work case, the city of Porto. Figure 2 shows the DIVERT interface for setting up a pre-defined route.

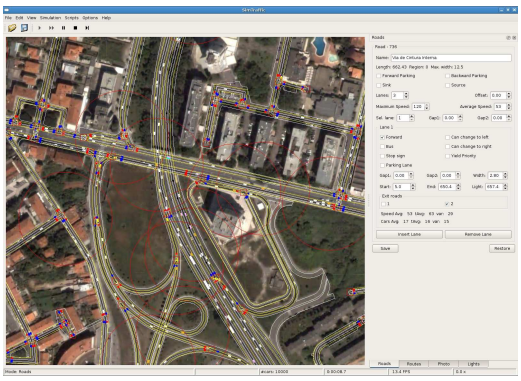

Figure 1: The DIVERT road editing interface

Traffic simulation is parameterized by the number of vehicles and the percentage of these vehicles which are sensors. Simulation is initialized by randomly placing each vehicle in an arbitrary point of its route. Vehicles which arrive at their destination are removed. New vehicles also show up during the simulation, either from entry points in the map, or from parking lanes of segments, as DIVERT tries to maintain the targeted number of vehicles for the simulation.

It should be noted that the simultaneous microsimulation of thousands of vehicles, with the degree of sophistication offered by DIVERT, poses major challenges in term of optimization of algorithms and efficiency of data-structures. In particular, DIVERT implementation is multi-threaded, exploring multi-core architectures of current processors. A geographic partitioning of the simulation region is performed, allowing each partition to be independently simulated in a thread.

### Wireless Telematics Layer

In order to capture the inter-vehicle communication aspects it is necessary to define the level of abstraction with respect to the physical communication channel and the protocol architecture. At the current preliminary stage, we opted for a very simple model, in which vehicles communicate with each other if their distance is below a certain threshold, determined by the transmission radius. The resulting random geometric graph is widely accepted as a simple yet reasonable first-order approximation of the connectivity pattern attained by a mobile ad-hoc network (6). A more elaborate approach would be to consider path loss, multi-path and shadowing effects, however this would incur in a high penalty in terms of simulation complexity. Another alternative would be to consider collisions and packet losses over the wireless medium. We are currently considering the possibility of integrating these aspects in our simulation in order to obtain a richer connectivity profile.

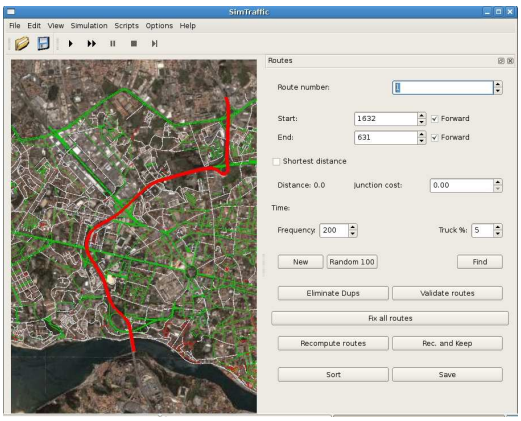


Figure 2: Setting up pre-defined routes in DIVERT

The wireless telematics layer simulates the communication between vehicles. Several inter-vehicular protocols can be implemented in this layer, such as protocols for safety applications or for traffic conditions propagation and collaborative navigation. The implementation of this wireless telematics layer is supported by the traffic simulation layer, which acts as a global positioning server, emulating a GPS receiver in each of the sensors. The interface between the two layers is thus done through GPS-like sentences, where the traffic simulator generates the position of each sensor, in terms of latitude and longitude, and its velocity vector, together with a global timestamp which provides the time-synchronization among the inter-vehicle data exchange. It is a task of the wireless telematics layer to calculate the vehicles in the (parameterized) transmission range of a given sensor, to implement the message exchange protocols between vehicles, and to trigger actions based on the information collected, such as a route modification. The architecture of the two layers in DIVERT allows that a triggered action such as route modification can be conveyed back to the traffic simulation layer, affecting the behaviour of the vehicle.

Currently, the protocols we have implemented using DIVERT aim at the collaborative propagation of mobility information about road segments. Each sensor stores a common data structure, where the pair $(AverageSpeed, Freshness)$ describes the average speed attained by sensors traversing each of the road segments, together with a quantification of the timeliness of average speed estimate. These pairs are updated either by each sensor based on the road it is traversing and its GPS information, or by aggregated information collected from the wireless communications broadcasted by other sensors. Typically, sensors only transmit information about road segments for which the freshness value is above a predefined

threshold. DIVERT is able to simulate the propagation of this mobility information using different wireless transmission radii. Our results show that there exists a critical value for the transmission radius after which the dissemination of traffic information is sufficient for a large number of vehicles to be able to compute a comprehensive and accurate congestion map. This observation is strikingly related to the physical phenomenon of percolation, which is well known to govern the connectivity of large classes of wireless networks (7). Once the transmission radius is above the critical threshold, the graph representing wireless connectivity has a giant component on which traffic information flows very fast and over long distances.

## Future Developments

DIVERT is under constant development. Currently the implementation lists 50000 lines of C++ code, including the graphical interface and visualization component. The DIVERT interface also allows launching simple programs written in Python, which are very useful to make the simulator produce several types of reports, generate videos of a simulation or help in the edition of maps. A redefinition of the simulator architecture in several independent modules is undergoing. Our goal is to have a larger number of independent modules which will make it simpler for a large community of users to modify the simulator to their specific needs.

A particular effort is being put on the development of a specification language that will allow making easier the setting up of DIVERT with different geospatial data. The geographic layers underpinning the simulation are already based on open standards, but there are still a number of areas where the lack of automation constitutes an obstacle to the wide use of DIVERT. In particular, the realistic calibration of routes and their frequency is a crucial problem. We are trying to approach such automation through the analysis and processing of cellular phone logs, a technique known as *floating car data*, which in urban environments are able to provide high-precision descriptions of travels in the road network. The automation of the construction of realistic origin/destination matrices, together with geospatial data defining the road network based on widely used standards, would provide the necessary data to test DIVERT in different scenarios.

We will continue designing, implementing and testing different protocols for inter-vehicular communications through DIVERT. Our focus will continue to center in traffic efficiency, where we have been able to find challenging problems related to collaborative optimization of traffic flow. We hope to see alternative protocols developed worldwide using the DIVERT framework, in all areas of C2C communication.

For those who missed the FOSS4G2007 DIVERT demonstration, a video of a simulation is available online.[23]

## Acknowledgments

We would like to thank the Porto City Council for providing us with the maps of the road network. This work has been partially supported by the Portuguese Foundation for Science and Technology (FCT) under project MYDDAS (POSC/EIA/59154/2004) and by funds granted to LIACC and IT through the Programa de Financiamento Plurianual and POSC.

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# GRASS GIS and Modelling of Natural Hazards

**An Integrated Approach for Debris Flow Simulation — First results of an application in the Central Andes**

*Martin Mergili and Wolfgang Fellin*

## Background

Debris flows are rapid mass movements of water and debris, constituting a considerable hazard when interfering with people, buildings, or infrastructure. They are often triggered by heavy or prolonged rainfall or by extreme snow melt. Mobilization of the material occurs due to translational or rotational failure of saturated or undercut slopes, or by detachment due to surface runoff or the debris flow itself. Various models do exist for simulating sub-processes included into debris flows, for example for detachment (*r.sim.sediment* within the GRASS GIS environment), for soil hydrology and slope stability (14), or for debris flow runout (9; 7). More integrated GIS-based approaches as attempted for example by (1) or (11) are scarce. Such approaches would be valuable for a quick assessment of hydrological thresholds for potential debris flow hazard regarding specified features at risk. This paper describes and discusses the development of such a model as GRASS GIS raster module. The model is designed for small catchments (few square kms) and is tested at the moment with seven study areas along the international road corridor from Mendoza (Western Argentina) to Central Chile, crossing the highest section of the Andes (figure 1). The preliminary results for the study area *Guido A* are presented.

## Model

### Implementation and model design

The simulation model is implemented as a GRASS GIS raster module called *r.debrisflow*, based on the C programming language. Data management is facilitated using shell scripts. The model is in an intermediate stage of development right now, with major technical and methodical enhancements prospected for the near future. Additionally, a GUI for data management shall be created. By now, the latest development version can be downloaded from the homepage of the first author. *r.debrisflow* constitutes of a framework of a number of sub-modules described in more detail below, the general model design is illustrated in figure 2. The sub-modules can be combined in two different ways, depending on the availability of input information:

**Simulation mode 1:** The entire hydrological, stability, detachment and runout modelling is executed for a defined number of time steps during a rainfall or snowmelt event, requiring an extensive set of information as input, including






Figure 1: Study areas. The preliminary results for Guido A are presented.

meteorological data, an elevation model, soil mechanical and hydrological parameters and surface hydrological characteristics (including land cover).

**Simulation mode 2:** The zones of debris flow initiation are defined manually (e.g. from mapping in the field or from orthophotos), and only runout is computed. The advantage of this mode is that it requires much less input than the others, but, on the other hand, it is not suitable for predicting future events.

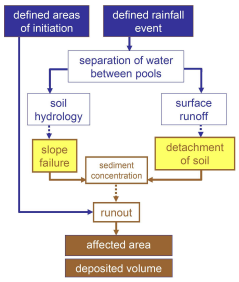


Figure 2: General model design.

### Water input

Rainfall is read from the input file and added to the system by increasing the surface water table of each cell, reduced by interception. If a snow cover exists, snowmelt is computed for each cell with a user defined degree-day-factor and added to the surface water table.

### Soil hydrology and slope stability

For this sub-module, a three-dimensional raster approach is used, down to the depth of bedrock (if known), or to a user-defined maximum soil depth. The soil is assumed to be homogeneous over its entire depth regarding its physical, hydrological and mechanical properties. Vertical flow between cells is computed with the Darcy-Equation. If the water content of a cell exceeds 90 % of the maximum content, groundwater flow is assumed to be parallel to the slope and it is tested whether the cell is stable or not, using an infinite slope stability approach (14). For each pixel, the bottom of the deepest cell with a factor of safety lower than 1 is considered as failure plane (figure 3). It has to be pointed out that this approach constitutes a rough approximation to the reality with the character of a worst-case assumption: the stabilizing role of vertical water movement is neglected, and the destabilizing role of the assumed slope-parallel component is fully included in case of saturation. In the real world, both components are combined, resulting in more stable conditions than in the model.





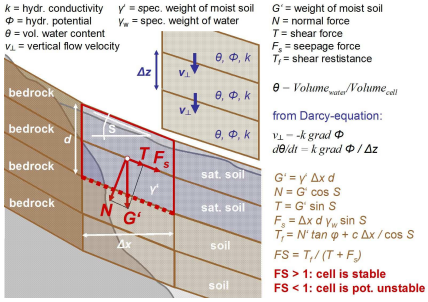


Figure 3: Subsurface hydrology and slope stability model.

### Surface runoff and detachment

All the water which is not infiltrated into the soil is added to the surface water table of the corresponding cell. Flow velocity from one cell to the other is computed using the Manning equation. If no flow channel is defined for any downward cell, flow takes place to all downward cells, weighted for slope angle. If a channel is defined, the entire flow moves there. Transport capacity is computed using the (15) equation, which it is supposed to suit best for the conditions in the study areas (6). Rates of detachment are derived from the transport capacity. The model design is illustrated in figure 4.

### Debris flow runout and deposition

Debris flows are here understood in a strict sense, with a non-hydraulic flow regime and excluding heavily sediment-loaded water discharge. For this reason, the sediment concentration is computed for the mobilized soil volume of each cell:

1. If the sediment concentration exceeds a threshold value (6), the entire mobilized volume is considered to develop into a debris flow. If mobilization occurred due to slope failure, the cell is marked and runout of all the failed cells is computed at the end of the event. If mobilization occurred due to detachment, runout is calculated immediately at the end of the time step. This is a first approximation as the empirical runout models used (compare below) neglect the time required for runout.
2. If the sediment concentration is too low for the development of a debris flow, the material is removed with surface runoff and either deposited downslope or removed from the system, following the (15) equation (compare figure 4). Though deposition from surface runoff does not fall into the concept of debris flow, it can provide valuable complementary information and is therefore regarded, too.

Debris flow runout itself can be simulated using physically-based models (9; 7), but they are complex and hard to be integrated into a GIS environment. Therefore it was decided to use a combination of empirical approaches first for estimating the runout distance and the distribution of the deposited volume (figure 5). (10) developed an approach enabling the distinction between scouring and deposition areas, using threshold slope angles and the ratio between vertical distance of scouring and horizontal distance of deposition. (2) and (8) used mobilized volume, angles, and runout distances for estimating the reach of the debris flow. These approaches, however, have the disadvantage that they don't allow distinguish-

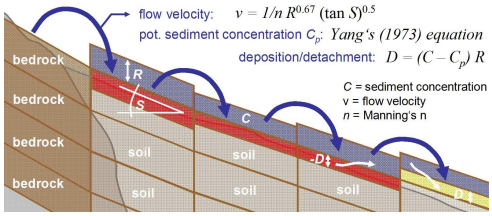


Figure 4: Surface runoff and detachment model.

ing between areas of scouring and deposition, and therefore the distribution of the deposited material. The approach was included into the model as follows:

1. The Vandre approach was applied with user-defined parameters for estimating distributed scoured and deposited volumes.
2. The Corominas et al. and the Rickenmann approach were applied independently and then combined to an index.

The debris flow is routed downwards separately for each unstable cell, following a random walk (3) weighted for slope angle and the existence of a defined channel, until the stop criteria for all of the three approaches is fulfilled. Though each cell is treated separately, the mobilized volume required for runout distance is calculated for each patch of debris flow initiation. In the area of scouring, the entire saturated soil column is considered to be removed, but never exceeding the depth of initiation. The initiated and scoured volumes are considered to distribute over the area of deposition as wedge shape rising towards the front.

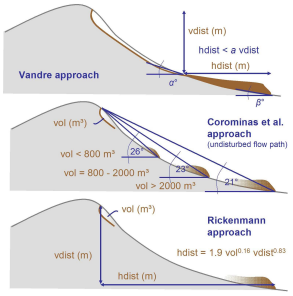


Figure 5: Runout models.

## First results

The model was tested within the study area Guido A (compare figure 1). Mainly consisting of granite residuals, the soils of the catchment (area: 2 km²) are relatively homogeneous. Therefore it was decided to use one single set of soil parameters for the entire area:

| texture | $\rho_d$ kg/m³ | $c_s$ N/m² | $\varphi$ deg. | $\Theta_s$ | $k_f$ cm/h |
|---|---|---|---|---|---|
| Sand | 1850 | 0 | 40.0 | 0.43 | 29.7 |





$\rho_d$ is the dried bulk density of the soil, $c_s$ is soil cohesion, $\varphi$ stands for the angle of internal friction, $\Theta_s$ is the maximum (saturated) water content, and $k_f$ is the saturated hydraulic conductivity.

The figures 6 and 7 illustrate the mapped areas of debris flow initiation in the study area Guido A, and the patterns of surface change due to a debris flow event, based on the mapped areas of initiation and the computed patterns of scouring and deposition (simulation mode 2). The white line crossing the right part of the maps represents the international road, roughly coinciding with the distal part of the observed debris flow depositions. The figures 8 to 11 show some of the simulation results for a hypothetical 100 mm rainfall event, corresponding to the maximum daily sum ever recorded at the nearby meteorological station, and therefore constituting a worst-case assumption (simulation mode 1). All maps show plausible patterns when compared to field observations. The areas of debris flow initiation and deposition are located correctly, but are overestimated compared to the patterns observed in the field (what is not surprising for a worst-case assumption). The calculated sediment volumes deposited on the international road are within the same magnitude as those reported by the road authorities. When simulating the impacts of smaller rainfall events, the model results correspond well to the findings of (5) that debris flows in the Mendoza valley usually occur at daily rainfall sums exceeding 6.6 to 12.9 mm.

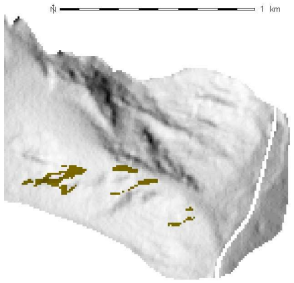


Figure 6: Mapped areas of clearly identifiable previous debris flow initiation, depth of initiation assumed as 0.75 m according to field evidence.

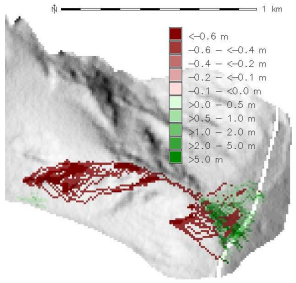


Figure 7: Simulated change of terrain height due to debris flow, using mapped areas of initiation.

## Discussion and Preview

Though the preliminary results for Guido A appear plausible, the simulation model still shows a number of shortcomings that have to be reworked.

1. Infiltration of water into the soil is not yet modelled in a satisfactory way, so that the approach will have to be refined (Green-Ampt model). Slope-parallel groundwater flow will be included, too, for enabling a closer approximation to the reality of soil hydrology.
2. The slope stability model as applied at the moment is only valid for plane, infinite, cohesionless slopes. For very shallow failures, this assumption is sufficiently close to reality, but for more deep-seated rotational failures, it is unsatisfactory and slope curvature has to be taken into account. (12) and (13) could serve as examples for such an approach.
3. The empirical approaches for debris flow runout shall be complemented by the implementation of a physically-based runout model according to (9) and (7), or at least of an interface to a non GIS-based runout model.
4. An interesting extension would be to introduce some probabilistic elements into the slope stability model (regarding the SINMAP model as an example) and into the distinction rules between debris flow and other types of movements.





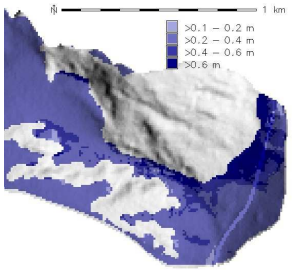


Figure 8: Maximum depth of saturation computed for 100 mm rainfall event.

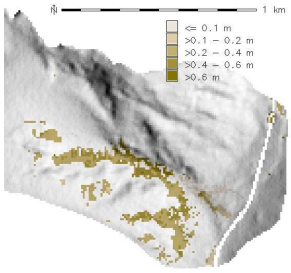


Figure 9: Simulated areas of potential debris flow initiation computed for 100 mm rainfall event.

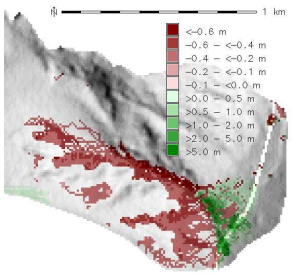


Figure 10: Simulated change of terrain height due to debris flow caused by 100 mm rainfall event.

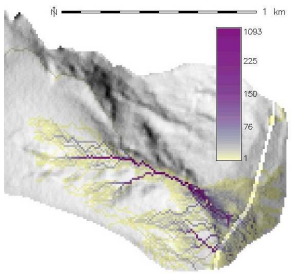


Figure 11: Debris flow index for 100 mm rainfall event, denoting number of cells the mobilized material of which hits the pixel.





5. Finally, the model has to be applied to the remaining study areas (compare figure 1), and the results have to be tested carefully against the field observations and the validation data (reports about volumes of material deposited on the international road).

With the mentioned optimizations, r.debrisflow shall be a valuable tool for evaluating the potential magnitude of debris flows as a response to defined rainfall or snow melt events, including the possibility to determine meteorological thresholds for debris flow hazard. However, it has to be pointed out that all the results only denote potential occurrences with the character of worst case scenarios or probabilities - it will probably never be possible to predict the actual response of a slope to a meteorological event in the real world, as nature is too complex to be fully understood in all details.

## Acknowledgements

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# A Spatial Database to Integrate Information of the Rondonia Natural Resource Management Project

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***Keywords:*** *Spatial Database, ZSEE-RO, PLANAFLORO, Data Integration*

## Abstract

This paper presents the construction of a spatial database for the integration information from Social-Economic Ecological Zoning of Rondonia State (ZSEE/RO). The project's objective consists of modeling a new database for ZSEE/RO, making it possible to access the data and information for use in varied projects. So all the evaluation was performed based on the quantity of ZSEE-RO data and information. File conversions were carried out, aimed at making the files accessible in standard formats. Later the consistency of converted data was verified, to insure quality control at different scales. Some applications had to be reconfigured and installed which were developed exclusively for the ZSEE/RO. The main results so far relate to the recognition of ZSEE/RO data quantity and establishment of the necessary requirements for accessing the original data. Diverse files have been converted to universal formats. Moreover, the problems with regard to the data quality which have been detected include non geoencoded data, inconsistencies at different scales, and inconsistency in printed matter versus stored digital files.

## Introduction

This article covers spatial database construction for the integration of Social-Economic Ecological Zoning of Rondonia State (ZSEE/RO), which is being developed in partnership with Secretariat of Planning and General Coordination of the State of Rondonia. The ZSEE/RO is originally the Rondonia Natural Resource Management - PLANAFLORO.

The general objective of the project consists of modeling a new database of the ZSEE/RO, making it possible for various project to access the data. Specifically, it is intended with the elaboration of this work: to evaluate the content of diverse source databases for ZSEE/RO, to shape and construct a spatial database for storage of data and information, and to convert the data to a new internet based format.

## The PlanaFloro Project

Through the State Decree No. 3782 of 14 June of 1988 the Social-Economic Ecological Zoning of Rondonia State - ZSEE/RO - was established, dividing the State into zones of ambient protection and zones for farming and agroforestry activities (4). Rondonia was the first Brazilian state to have policies of preservation of nature with the Rondonia Natural Resource Management Project - PLANAFLORO, directed to the question and of granting land for the aboriginal peoples, executed between 1992 and 1999 growing into the Social-Economic Ecological Zoning of Rondonia state.

As one of the components of PLANAFLORO the second approach of the ZSEE/RO supported a field survey at 1:250,000 scale, elaborating diverse fields of the knowledge such as: vegetation, geology, pedology, geomorphology, fauna, land use and occupation etc. The partnership responsible for execution of this mission consisted of distinct teams, one for each area of the knowledge. Consequently, The thematic data had been stored using different solutions in accordance with the necessities of the diverse teams. Its implementation was an ArcINFO geographic database, however it was very poor in attributes (Dall'Igna, 2005). The completed thematic studies became the basis for diagnosis of the State of Rondônia and, using its results, Approach of Ecological the Partner-Economic Zoning of the State was elaborated.

## Initial Procedures

To define the work methodology the great volume of data concerning the ZSEE/RO was taken into account, Original data were available in heterogeneous formats, many of them unknown to the technician of the state agencies and potential researchers. Technological obsolescence was also considered, even though PLANAFLORO was initiated in 1992. Thus the project proceeded to evaluate and collect data and information for ZSEE-RO, composing archives in digital media, customizing software for PLANAFLORO and producing printed material as maps, letters and reports. The principal files formats found included:

- ADF: ArcINFO 7.x Coverage files. In this format were themes covered by ZSEE, vector and descriptive data, airport points, curve-level, law protected areas, etc.
- LAN: Raster files. Landsat satellite images, with a 30 meters resolution, covering the entire state of Rondonia.
- GRA: Plot files. Maps generated by ZSEE for printing.
- RTL: Plot files. All themes covered by ZSEE as hydrology, geology, hydrogeology, geomorphology, vegetation, among others, and all maps prepared in scales ranging from 1:250.000 to 1:1.000.000

In addition to the formats listed above reports, pictures and spreadsheets in .DOC .XLS .TIFF .JPG and .EPS were identified.

Conversions of archives has been carried out, aiming to become accessible and standardized, converting them from proprietary files which need specific software, into universally accessible files for diverse technologies. The files that were in .ADF vectorial format were converted to the ESRI Shapefile format. The satellite images .LAN format were converted to GeoTiff and the plot files .RTL and .GRA were converted to .PDF format. The reports and pictures originally in .DOC, .TIF, .JPG and .EPS were also converted to the .PDF. All spreadsheets, database and some TXT format files were uploaded to tables on PostgreSQL. Some applications adopted and developed exclusively for the ZSEE/RO, have been reconfigured and installed. In the future, its functions will be tested to determine if they will be used, substituted or brought up to date.

Also TerraView, ArcView, ArcInfo and IDRISI are software being used. The geographic database of the ZSEE/RO was structured with ArcInfo, extensions were developed for ArcView for use in visualizations and consultations. The pedology team used IDRISI in its analyses giving the possibility of working with the data of SIGTERON as well as with the ArcInfo and ArcView.

TerraView was chosen as an alternative, being free software capable of importing shapefiles and images in GeoTIFF format, and universal formats for vector and raster files respectively. The permission for its redistribution and/or modifications is under the terms of the GNU General Public License (GPL), as published by the Free Foundation Software. TerraView is an application based on the geo library TerraLib. It manipulates vector and raster data, both stored in relational or geo-relational DBMS on the market such as ACCESS, PostgreSQL, MySQL and Oracle (7). Figure 1 demonstrates the TerraView interface.

Later the consistency of the converted data was verified, with the intention to check the quality of the information at different scales. The procedures for checking consistency of data involved georeferencing available data points, the overlap of raster files among themselves, and the verification of the geocoded data, with the links between the geometry of objects and their descriptive attribute.

## ZSEE/RO Spatial Database

An infrastructure for storage and distribution of spatial data was implemented, based on free software: PostgreSQL (5), with the PostGIS extension (6), the web map servers MapServer and GeoServer (2) as well as the catalog server GeoNetwork (3).

Vector layers were converted and stored into a PostgreSQL database through the functionality provided by the spatial extension PostGIS. The descriptive data of spatial objects, contained in heterogeneous format files, such as database files in format .DBF and electronic spread sheets, were converted for PostgreSQL tables and properly linked with its geometric representation. The vector data stored included information on various topics covered by the project ZSEE/RO: geology, soils, land use and occupation, socio-economics, transmission lines, flora, fauna, climatology, and so on. Furthermore, the data refer to basically raster images from the Landsat satellite with a resolution of 30 meters and cover the entire state of Rondonia. Furthermore, descriptive data of spatial objects, contained in heterogeneous format files, such as database files in format .DBF and electronic spread sheets, are being converted to PostgreSQL tables and properly linked with the layer's geometry.

All the thematic documentation of the ZSEE/RO was organized and stored in the GeoNetwork Open-







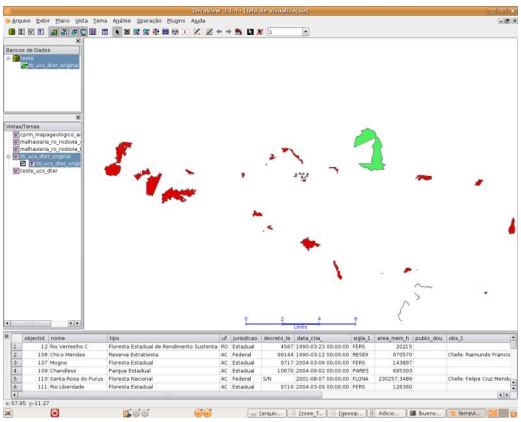

Figure 1: The Terraview interface

source. The functionality of a literal search in GeoNetwork allows easy access to a great amount of information. For each subject encompassed by ZSEE/RO, a corresponding metadata was created, where all the documentation related with the subject is posted through the resources of distribution of the GeoNetwork.

The visualization tool for spatial data chosen was I3Geo. I3Geo (Integrated Interface for Internet of Geoprocessing tools) is an application developed for access and analysis of geographic data. Based on free software, especially MapServer, it uses as its platform standard internet browsers, Internet Explorer and Firefox. I3Geo is licensed under GPL and can be used and incorporated by any interested institution with no costs. Adopting international standards of interoperability, I3Geo incorporates functions that facilitate the remote access of data, allowing for the establishment of cooperative networks. Operations that normally are found only in programs for personal computers, which operate in local installations, are available in I3Geo, such as generation of graphs, tabular data analysis, spatial operations, etc. (8).

## Results

The main result achieved so far is the recognition of the content of ZSEE/RO and establishment of the necessary requirements for the access to the original data. In addition, many files have been converted to universal formats, totaling more than 500 (five hundred) converted files, and stored in the spatial database and available for consultants. Moreover, problems with regard to quality of the data have been detected, such as non-geocoded data, inconsistency of the data in different scales, and inconsistency of the available data in printed maps in rela-





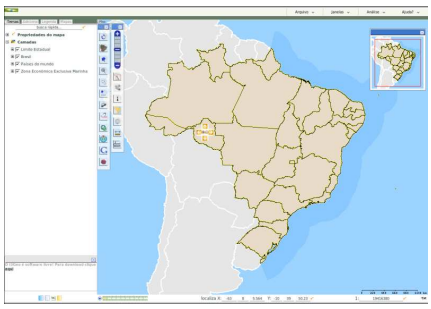

Figure 2: The I3Geo interface

tion to the stored ones in digital files.

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# GeoSIPAM

**Free and Open Source Software Applied to the Protection of the Brazilian Amazon**

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***Keywords:*** *Spatial Data, Brazilian Amazon, SIPAM, Infrastructure, GeoSIPAM*

## Abstract

This paper presents the infrastructure implemented and maintained by the System of Protection of Amazon - SIPAM for storage and distribution of spatial data called GeoSIPAM. The use of free and open source applications for the storage and distribution of the spatial data was chosen. The relational database PostgreSQL was chosen, with the PostGIS extension for spatial data storage and manipulation. Several applications (GeoServer, GeoNetwork and InterMap) have been customized for use by SIPAM. The implemented customizations involved procedure development which enhanced the tools used in daily tasks played by the collaborators. The application interface of the GeoNetwork and InterMap were altered aiming at making them accessible and adding features. Care was taken that the infrastructure was adjusted to spatial data storage, manipulation and distribution. The customizations allowed the applications to be merged into SIPAMś organizational environment. It was also verified that the use of OGC standards were complied with for interoperability on diverse systems.

## Introduction

The database of the System of Protection of Amazon - SIPAM integrates information brought up to date on the Brazilian Legal Amazon. The use of these information in projects developed for the SIPAM and agency partners provides the generation of knowledge that assists the planning and coordination of global actions of government, aiming at the protection, social inclusion and sustainable development of the region.

This work presents the infrastructure implemented and maintained for SIPAM for storage and distribution of spatial data called GeoSIPAM. GeoSIPAM aims at providing integration and evaluation of data to aid the planning and the coordination of the actions of the developed public politics in the Brazilian Legal Amazon. Specifically, the objectives of GeoSIPAM are: to display through Internet or Intranet the metadata referring to the projects carried through for SIPAM; to make available Internet maps, geocoded images and related literal information; to visualize maps, images and relevant information for other institutions, through the use of standard compliant Open Geospatial Consortium - OGC (1) protocols

## Free and Open Source Software in GeoSIPAM

The development and use of free software for geoinformatics has made available an increasing number of software tools. In the designing of GeoSIPAM it was opted to use free and open source software for the storage and distribution of the spatial data. The tools chosen include:

- PostgreSQL Object-relational database management system
- PostGIS Spatial database extension for PostgreSQL
- GeoServer OpenGIS Transactional Web Feature Server
- GeoNetwork Catalog application to manage spatially referenced resources through the web
- InterMap Map viewer, generally configured to operate of form integrated to the GeoNetwork

## Infrastructure for Spatial Analysis

The chosen software architecture was organized in layers involving

- a Database Management System (DBMS) for data storage, management and manipulation
- maps and catalogues servers for data distribution and information
- as well as interfaces for data access based on the standards established for the OGC.

The PostgreSQL DBMS was chosen, with the PostGIS extension for storage and manipulation of





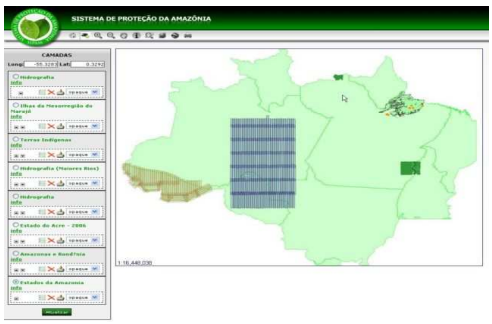


Figure 1: Interactive map visualization, usage of the customized InterMap software interface

spatial data. The GeoNetwork and InterMap applications interface had undergone alterations aiming to make them accessible and unique.

Figure 1 presents the visualization of an interactive map in the customized interface of InterMap software.

The GeoServer, GeoNetwork and InterMap, applications are tools developed in Java and implement the Web Map Services (WMS), Web Feature Services (WFS) and Catalogue Service Web (CSW) standards. These were customized for use at SIPAM. The implemented customizations involved development of procedures that enabled collaborators to carry out daily played tasks. Following are some customizations implemented by the GeoSIPAM team.

Originally InterMap Open Source used to attend the requirements of the standard WMS / OGC, but did not attend to the standard WFS / OGC, both offered by GeoServer. In InterMap Open Source a service was created to carry through WFS service solicitations to GeoServer, making it possible to download raster files. In this way, an option for the WFS GetFeature service call was developed, in the SHAPE - ZIP format and the service services.map.DownloadService was implemented. Also a corresponding button in the layer toolbar was created, as demonstrated in figure 2. This functionality was implemented by source code changes, involving JavaScript, XSL and Java programming.

```
public Element exec(Element params,
       ServiceContext context) throws Exception
{
// Get request parameters
int id = Integer.parseInt(
    params.getChildText(
        Constants.MAP_SERVICE_ID
    ));

// Get the MapMerger object from the user session
MapMerger mm = MapUtil.getMapMerger(context);

// Get the layer name
String nome = mm.getService(id).getName();
// Get the WMS server url
String serverUrl = mm.getService(id).getServerURL();

// Declare and set the WFS server url
int pos = serverUrl.indexOf("/wms")+1;
String WfsFeatureInfoUrl = serverUrl.substring(0, pos) +
Element el = WmsGetCapClient.getCapabilities(serverUrl);

// Return the necessary information for
// the service execution
return new Element("response")
.addContent(WmsGetCapClient.getCapabilities(serverUrl))
.addContent(new Element("serviceName").setText(nome))
.addContent(
  new Element(
```





```
    Constants.URL).setText(
      WfsFeatureInfoUrl));
}
```

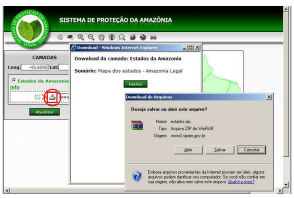


Figure 2: Customized InterMap interface for the download of layers

The option to offer the layer for download is configured through service WFS. The WFS GetFeature service allows download indiscriminately all the available layers in the server. The option was created to allow/deny the layer download in the cadastre screen of the FeatureType in the GeoServer. This information is also sent to WMS customer through the service getCapabilities. The Download button will be shown in the InterMap whenever the corresponding option is qualified in the GeoServer, as demonstrated in figure 3. The functionality was implemented through changes in the GeoServer source code, which is written in Java.

Another implemented functionality allows the visualization of the data together with images provided by Google Earth API. An inserted button in the InterMap toolbar sets in motion a floating window that shows the spatial data, synchronizing the GeoServerś raster data with the Googleś API images. The position and zoom are kept synchronized even after changes in the Google API window or InterMap maps' window. The InterMap layers are displayed in the Googleś API window in transparent shades, allowing simultaneous viewing of Googleś images. Figure 4 presents the Google API window implemented in InterMap. This functionality was implemented by the inclusion of JavaScript code in the file im_main.xsl. The code line below shows the reference to the Google API, in the file im_main.xsl:

```
<script
 src="http://maps.google.com/maps? \
    file=api&v=2&key=GOOGLE_API_KEY"
 type="text/javascript">
</script>
```

The term GOOGLE_API_KEY should be replaced by the key obtained on the Google API site[24]. To obtain the key you should access the site and provide the server URL where InterMap is installed. The key is sent to the email address of the applicant, who must have a GMail account. The functions "addWMS" and "montaMapa" were coded and added to the file im_main.xsl. The function "addWMS" is used to rebuild the list of layers to show the Google API, always when a new layer is added in InterMap. The function "montaMapa", is used to construct the Google map. Below is shown the source code of the functions "addWMS" and "montaMapa".

```
// Add WMS servers and layers types
function addWMS(servidor, camada){
 achou = false;
//Check if the server exists.
// If it does, add a new layer.
// If it does not register a new
// server and layer
for (contador = 0; wmsurl.length>contador; contador++){
if( wmsurl[contador] == servidor) {
// server found.. add layer
layersG[contador] = layersG[contador] + ',' + camada
achou = true;
}
}
if(!achou) {
// server not found, register in the vector
pos = wmsurl.length;
wmsurl[pos] = servidor;
layersG[pos] = camada;
}
listalayers = listalayers + camada
}

// Set up the google map on the screen
function montaMapa() {
var camadaWMS = new Array();
if( visivelG ) {
mapG = new GMap2(document.getElementById("mapaG"));

// A handler is called when a
// map movement break event is called
GEvent.addListener(mapG, "moveend", function() {
// If the movement was done at the Google map,
// the Intermap map changes too
if( actOrigem == '' ){
var center = mapG.getCenter();
// Obtain the center
main.map.zMapCenLat = center.lat();
// in LatLong
```

[24]Google API site: http://www.google.com/apis/maps/





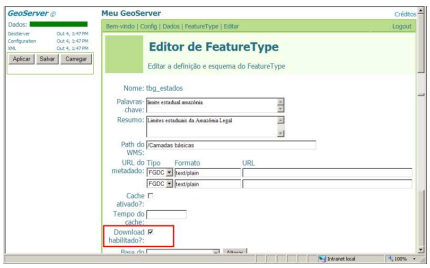


Figure 3: Customized GeoServer interface for enabling download

```
main.map.zMapCenLng = center.lng();
main.map.moveIntermap();
// moves the Intermap map
}
actOrigem = '';
if(navm){setTimeout("pngfix()",1000); }
});
// Handler is called
// when a drag action event is called
GEvent.addListener(mapG, "dragstart", function() {
actOrigem=''
});

// Handler is called
// when a zoom event is called
GEvent.addListener(mapG, "zoomend",  \
    function(zoomant, zoomatu) {
if( actOrigem == '') {
var bbox = mapG.getBounds();
// Obtain the center
main.map.zmapminlat = bbox.getSouthWest().lat();
// em latitude e longitude
main.map.zmapminlng = bbox.getSouthWest().lng();
// e move o mapa
main.map.zmapmaxlat = bbox.getNorthEast().lat();
main.map.zmapmaxlng = bbox.getNorthEast().lng();
main.map.zoomIntermap(zoomant, zoomatu);
// no intermap
}
if (actOrigem != 'X'){actOrigem = '';}
});

// Handler is called
// when a drag action event is called
```

```
var layer1=[G_SATELLITE_MAP.getTileLayers()[0], \
    G_HYBRID_MAP.getTileLayers()[1]];
var custommap1 = new GMapType(layer1, \
    G_SATELLITE_MAP.getProjection(), \
    "Google", G_SATELLITE_MAP);

var layer3=[G_SATELLITE_MAP.getTileLayers()[0], \
    G_HYBRID_MAP.getTileLayers()[1]];
for( contador=0; wmsurl.length > contador; \
contador++){
// create tile layers
camadaWMS[contador]= new GTileLayer( \
    new GCopyrightCollection(""),1,17);
if( wmsurl[contador] != '' )
{ if( layersG[contador] != '') {
camadaWMS[contador].myLayers=layersG[contador];
camadaWMS[contador].myBaseURL=wmsurl[contador];
camadaWMS[contador].getTileUrl=CustomGetTileUrl;
if(navm) {camadaWMS[contador].myFormat='image/png'}
} }
layer3[contador+2] = camadaWMS[contador];
}

var custommap3 = new GMapType(layer3, \
    G_SATELLITE_MAP.getProjection(), \
    "Intermap", G_SATELLITE_MAP);

mapG.getMapTypes().length = 0;
mapG.addMapType(custommap3);
mapG.addMapType(custommap1);
SWLatLng = new GLatLng(SWLat, SWLng)
NELatLng = new GLatLng(NELat, NELng)
bbox     = new GLatLngBounds(SWLatLng, NELatLng)
zoom     = mapG.getBoundsZoomLevel(bbox)
gmapt = mapG.getMapTypes()
```

```
zoomMax = \
    gmapt[1].getMaximumResolution(mapG.getCenter())
if( zoom > zoomMax) {zoom = zoomMax;}
actOrigem = 'X'
mapG.setCenter(bbox.getCenter(),zoom);
mapG.addControl(new GLargeMapControl());
mapG.addControl(new GMapTypeControl());
with(document.getElementById( \
    "google").style){top = "113px";left = "239px";}
actOrigem = '' } }
```

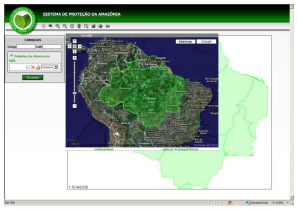

Figure 4: Customized InterMap software interface with Google API

Because of the great number of layers available in WMS servers, the list layers visualization, when shown as a flat list, becomes inadequate. The display of layers was modified to be loaded in tree form with options of "collapse" and "expand". The functionality was implemented by the inclusion of JavaScript code in the file im_get_services.xsl. It employed the dTree API, a free JavaScript tree menu. dTree JavaScript can be obtained online.[25]. In this case, the strategy adopted was entering the WMS server layers in an array. Thus, the layers tree is mounted by dTree from this array. Figure 5 demonstrates the layers visualization organized in tree form.

## Results

An infrastructure was chosen and implemented that insured the capabilities for spatial data storage, manipulation and distribution. The database was populated with spatial data regarding the Legal Brazilian Amazonia, including topics such as hydrography, geology, use and occupation of land, mineral resources, administrative boundaries, roads, soil, etc. Spatial data from SIPAMś other partners, such as the National Agency of Water (ANA) and Brazilian Geological Service (CPRM), Brazilian Institute of Geography and Statistics, IBGE was also stored in GeoSIPAM. The volume of data stored grows every day. Local customizations to available FOSS GIS packages allowed implementing some features into SIPAM which were particular to organizational environment. It was also verified that the use of OGC standards ensures interoperability with diverse systems. The spatial data and products elaborated for the operational team of the SIPAM are being registered in a cadastre and stored in the GeoSIPAM system. This information is being distributed in the internal net and also for the public in general, through the SIPAMś web portal over the Internet. Among the main partners which constantly access the site are the Environment Secretaries of the State Governments of Amazonia, the Environmental Police, regional universities and others. Implemented statistics controls have logged more than 100,000 hits to GeoSIPAM.

[25] dTree JavaScript API: http://www.destroydrop.com/javascripts/tree/

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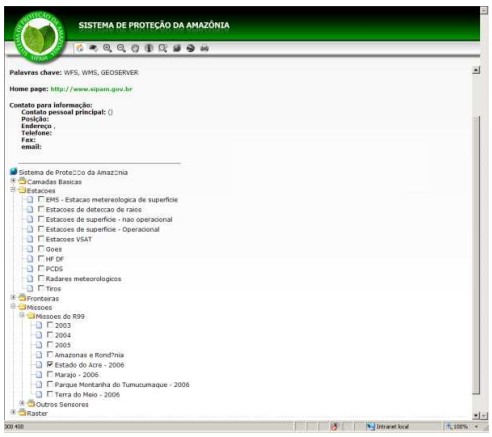


Figure 5: Customized InterMap interface with list layers vizualization





# The Amazon Deforestation Monitoring System

**A Large Environmental Database Developed on TerraLib and PostgreSQL**

*Freitas, U. M., Ribeiro, V. O., Queiroz, G. R., Petinatti, M. R. and Abreu, E. S.*


## Abstract

Brazil's National Institute for Space Research and the Foundation for Space Science, Technology and Applications developed a complete monitoring system, based on TerraLib open source technology[26] (Camara, G., et al., 2000), in order to map and calculate the annual deforestation rates in the Brazilian Amazon. TerraLib implements the archiving of geographic vector and raster data, on a variety of proprietary and non-proprietary DBMS, including PostgreSQL. TerraLib supports methods for image and vector data processing and analysis. A client application, named TerraAmazon, was developed using C++ and the free graphic user interface toolkit QT (version 3), which runs on LINUX or Windows machines. The data is managed by PostgreSQL version 8.2, running on a LINUX Server. The application manages all data work flow, gathering around 600 satellite images, pre-processing, segmenting and classifying these images, for further human interpretation and edition, on a concurrent multi-user environment. The database stores approximately 2 million complex polygons and 20 gigabytes of full resolution satellite images are added every year, using TerraLib pyramidal resolution schema. A Web site is provided for visualization and analysis of full resolution data, using the TerraLib PHP extension and TerraLib OGC WMS server.


## Introduction

Brazil conducts a large environmental project to monitor deforestation in the Amazon biome using satellite data. Every year a deforestation map and the rate of yearly deforestation are produced and made public over the Internet by Brazil's National Institute for Space Research ("Instituto Nacional de Pesquisas Espaciais" – INPE). The Brazilian Amazon biome covers an area of 4.7 million square kilometers. Given this huge area, the task is very demanding. At every year a complete coverage of the region by satellite images, with 20 to 30 meters resolution, are acquired, automatically processed and analyzed by remote sensing specialists.

The final deforestation data product has cartographic precision suitable for a 1:250,000 scale. This project is named PRODES – short for Legal Amazon Deforestation Project - started at the end of the 1980s, and has evolved from an analog interpretation process to a fully digital procedure. The current methodology was implemented in 2005 and its technical features are presented in this paper.

Before the new system became operational, deforestation maps were produced using SPRING, a free desktop image processing and geographic information system developed by INPE.[27] In order to produce the complete deforestation map, 229 independent databases, each one covering the area of one LANDSAT 5 satellite image were required. This methodology created a complex environment for management since each database was transferred from one workstation to another to be submitted to a specific process, involving dozens of specialists.

In addition to the complexity of the previous methodology, new requirements forced the Brazilian government in 2005 to improve the former methodology. The first new requirement was the need to introduce multi-satellite source, in order to guarantee data availability, even under a satellite operational interruption. Images from the 20 meter resolution CBERS (China Brazil Earth Resources Satellite) CCD sensor, 30 meter LANDSAT 5 images and 32 meter DMC (Disaster Monitoring Constellation) satellites images are now used. Figure 1 shows the satellite images used for 2005 deforestation mapping. The second requirement was the need for a fast data delivery, in order to create conditions to implement government policies to be applied earlier, before the next period of deforestation.

The use of CBERS images as the primary data source increases the number of images to 570 and the use of the previous methodology with independent databases would have created a yet more complex environment for data management. The solution was to create a unique corporate database which is suitable for management of all data operations, in a distributed and concurrent environment.

[26] TerraLib Library: http://terralib.org/
[27] INPE SPRING project: http://www.dpi.inpe.br/spring





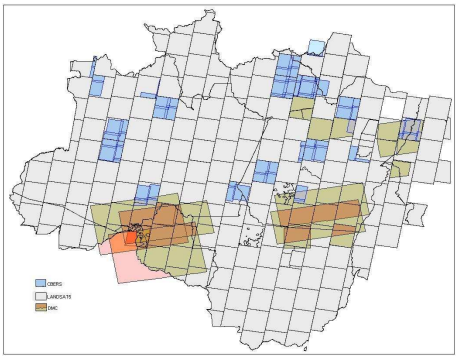


Figure 1: The 221 CBERS, 223 LANDSAT, and 18 DMC satellite images used in 2005

The technology selected to achieve the project goals was TerraLib. TerraLib is an Open Source Library developed by INPE and distributed under GNU LGPL license.[28] TerraLib implements the storage of geographic vector and raster data, on a variety of proprietary and non-proprietary Database Management System (DBMS), including PostgreSQL. TerraLib implements methods for image and vector data processing and analysis. FUNCATE under contract with INPE developed the complete suite of computer programs to process all data and deliver the deforestation maps and annual rate, on a full open source environment. This suite of programs was named TerraAmazon.

## Methodology

Deforestation and subsequent burnings occur in Amazon during a short period: the dry season, from July to September. After this season, it is virtually impossible to deforest, due to the high rates of precipitation. Based on this fact, the annual deforestation rate is calculated for the period between August 1st of the previous year and July 31st of the current year. The later date coincides with the end of the dry season for most part of the Amazon. In order to obtain the deforestation rate, images acquired during the dry season period are analyzed. The annual deforestation rate is estimated by interpolation, considering that deforestation occurs linearly during the dry season. In addition, deforested areas are estimated under regions covered by clouds, considering that the ratio of deforestation is the same in areas with and without clouds coverage. Detailed information of this method can be found at INPE's site.[29]

TerraAmazon manages all operations required by the deforestation project, in an interactive, distributed and concurrent environment using a corporate database. In order to take full advantage of TerraAmazon, the whole Amazon region is divided into cells and each cell is manipulated by only one remote sensing specialist at a given time.

Cells are created by partitioning the project extents using a geographic grid with 0.25 degrees dis-

[28] TerraLib Library: http://www.terralib.org
[29] Detailed information available online: http://www.inpe.br/prodes

tance between grid lines. Each remote sensing specialist can lock one or more cells to process using a long transactions schema. The expert manipulates one of these cells using image processing and vector edition tools available in TerraAmazon. The following steps are applied to each of these cells.

1. Import a TIFF image
2. Register image with reference image and save used control points
3. Audit image using reference image, and
4. If image is not approved then repeat from step 2
5. Create shade and ground images
6. If image has cloud coverage above a given threshold then
   (a) Classify image to extract regions with clouds
   (b) Convert regions to cloud polygons
7. Segment shade and ground images
8. Combine ancillary vectors (previous years deforestation, non forest, and hydrography polygons), segmentation polygons, and cloud polygons (if any)
9. Interpret and edit combined vectors to create new deforestation and cloud polygons
10. Audit resulting polygons. If not approved then return to 8; and
11. Disseminate results.

The image processing tools available in TerraAmazon are: TIFF format image file import, georeferencing based on control points, color composition and enhancement, mixing model analysis, segmentation, and classification.

For vector edition, TerraAmazon include: raster to vector and vector to raster conversion, vector elements edition that considers snap and topology, and set operations (union, difference, intersection, and overlay) operations on geographical features.

Other TerraAmazon tools include visualization and database check{}-in and check{}-out procedures.

## TerraAmazon Implementation Details

TerraAmazon is a database client application, developed on top of TerraLib geographic components library, using Standard C++ programming language and graphical interface implemented using the free graphic user interface library QT.[30] TerraAmazon can be executed on LINUX or MS-Windows environments. All data is managed by the PostgreSQL DBMS[31], running on a LINUX server.

Each of the 0.25 degrees cell is blocked by the remote sensing specialist in a long term transaction schema, bounded by check-in and check-out operations. The cell field is used to clip all available geographic representations in order to reduce the amount of geographic elements, guaranteeing manageability of graphic features. For fast visualization these graphic features are cached in memory and indexed by a linear R-Tree (Guttman, 1984). Figure 2 shows a region of Amazon with cell edges highlighted in green.

TerraAmazon topological restriction operations are used during the edition of new deforestation areas and clouds. Before a new deforestation or cloud polygon is stored in the database, TerraAmazon subtracts from the polygon previous deforestation polygons. Figure 3 shows these steps for a new cloud polygon.

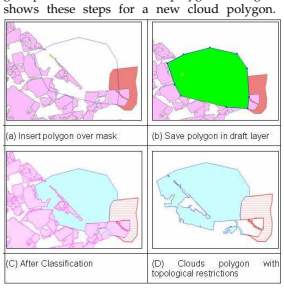


Figure 3: TerraAmazon topological restriction applied to a new cloud polygon. The polygon stored in the database is the one presented in (D).

The complete set of TerraAmazon tools is composed by:

1. Import of TIFF image;
2. Georeference using polynomial model calculated from control points;

[30] QT Library: http://trolltech.com
[31] PostgreSQL DBMS: http//:www.postgresql.org





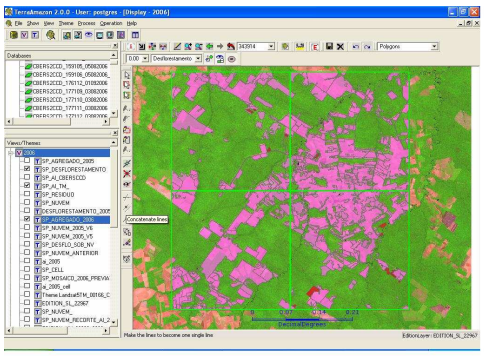

Figure 2: Cells (highlighted in green) selected for edition in a small part of Amazon.

3. Image enhancement and color composition;
4. Mixing model analysis; (Shimabukuro,1987); (Shimabukuro;Smith,1991)
5. Image segmentation using region growing algorithm; (Bins et al., 1996)
6. Labeling of regions;
7. Clustering classification;
8. K-means classification;
9. Raster to vector and vector to raster conversion;
10. Graphic interface for vector edition with snap and topological control;
11. Union, difference, intersection, and overlay set operations on graphical features;
12. Check-in and check-out procedures using cells index.

An Internet distribution site is provided, based on a PHP application running on a LINUX Web Server, powered by Apache. The Web application was created on top of TerraLib library, using the TerraPHP extension.

The Internet site feature includes:

1. Seamless visualization of full resolution data;
2. Image visualization, using pyramidal resolution;
3. Export of full resolution features, defined by user;
4. Web Map Server - WMS - access to data;
5. User queries, including deforestation by municipalities and inside protected areas;
6. Deforestation ranking by municipality;
7. Deforestation indices by cell grid;

Figure 4 shows the Internet dissemination site[32].

## Deforestation Project Figures

The following figures demonstrate the huge task made possible by TerraAmazon:

- To create the deforestation map for the period 2004-2005, 221 CBERS images, 223 LANDSAT images and 18 DMC images was used, for 2005-2006, 70 CBERS images and 211 LANDSAT images
- During the interpretation phase, in 2006, the system was accessed by up to 20 concurrent

[32] Internet dissemination site: http://www3.funcate.org.br/prodes2





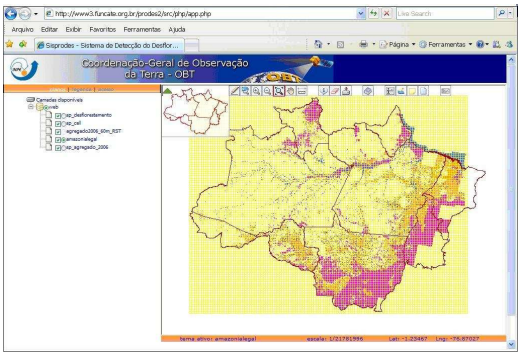


Figure 4: TerraAmazon Internet deforestation data dissemination site.

users. These users added 213,693 new deforested polygons and 595,575 new cloud polygons to the database

- The final database stores 2,380,880 polygons, classified in different categories. These polygons are complex - the largest one has 69,925 vertices, the average number of vertices is 59 and the average number of holes per polygon is 7
- The current volume of data stored in database is 237GB and includes full resolution images using a multi-resolution pyramidal RLZ compressed schema

## Conclusion

TerraAmazon fulfilled the requirements imposed by the Brazilian Government and has been used since 2005. TerraLib technology is an option to create a complex GIS system, using only open source software and made feasible the implementation of TerraAmazon. In addition, TerraAmazon has been proving to be robust, easy to manage and reliable in a high demand production multi-user environment.





## Acknowledgments

This work was supported by INPE - National Institute for Space Research. The authors wish to thank the development and user groups at FUNCATE for their efforts. Their collaboration is really greatly appreciated. We are grateful to Dr. Laercio Massaru Namikawa for his support and suggestions.

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The Open Source Geospatial Foundation, or OSGeo, is a not-for-profit organization whose mission is to support and promote the collaborative development of open geospatial technologies and data. The foundation provides financial, organizational and legal support to the broader open source geospatial community. It also serves as an independent legal entity to which community members can contribute code, funding and other resources, secure in the knowledge that their contributions will be maintained for public benefit. OSGeo also serves as an outreach and advocacy organization for the open source geospatial community, and provides a common forum and shared infrastructure for improving cross-project collaboration.

Published by OSGeo, the OSGeo Journal is focused on presenting discussion papers, case studies and introductions and concepts relating to open source and geospatial software topics.



The *OSGeo Journal* is a publication of the *OSGeo Foundation*. The base of this journal, the LaTeX $2_\varepsilon$-style source has been kindly provided by the GRASS and R News editorial board.




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# *Question 10.a - Sponsors*

*a. Describe in detail your relationship, if any, with your sponsors.*

OSGeo has several types of sponsors, described below.

Foundation Sponsors
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These are sponsors who provide funds for the general purposes of the foundation as a whole. Foundation sponsors are recognized on the OSGeo website and in publications, for example the OSGeo Journal. Full details for the sponsorship program and sponsor benefits are defined our on our sponsorship page (http://www.osgeo.org/sponsorship):

"""
OSGeo is a not-for-profit organization dedicated to providing a reliable home for open source geospatial software. It also serves as a vehicle for promoting open source software and is a place where the community can gather to drive ahead innovations and maturation of the technologies we collectively share.

Although we have a tremendous volunteer community -- including corporations as well as individuals -- involved in the advancement of open source technologies, some things still have hard costs. To cover these costs we need your help. Your support will help ensure that OSGeo will be a sustainable and healthy organization representing open source geospatial technologies long into the future.

Why Sponsor OSGeo

* Your Organization Depends on OSGeo Software - Your company or government agency uses OSGeo technologies in its day-to-day work, allowing you to compete effectively and deliver services in an efficient manner. By helping sustain OSGeo you also support your current operations into the future knowing that a strong OSGeo is behind your business activities.
* You represent a Community of Practice that has Adopted OSGeo Software - Communities representing a wide range of domains, from professional associations to non-government organizations, leverage OSGeo software as a critical component of their end-user applications. Your community has an interest in ensuring the software can be sustained into the future. By sponsoring OSGeo you demonstrate support for your members' software selection.
* Your Goals are aligned with OSGeo's Support for Open Standards and Other Priorities - Help achieve your own organization's objectives by sponsoring OSGeo as a like-minded organization and benefit from the volunteer efforts of a rapidly growing world-wide community.
* Demonstrate Your Leadership in Open Source Geospatial Technologies - By sponsoring OSGeo you will help align your business with the activities of thousands of adopters of OSGeo software around the world. As a sponsor of OSGeo, you will align your business growth with the momentum behind OSGeo in the marketplace.
* Benefit from Sponsor Networking Opportunities - As a sponsor of OSGeo, you will benefit from unique opportunities to meet and share ideas with key members of OSGeo, other OSGeo sponsors and affiliated like-minded individuals and organizations.

Sponsorship Levels

Foundation sponsorships are available on an annual basis and offered to organizations at four different funding levels.

OSGeo Sponsorship Levels Level $USD

| | |
|---|---|
| Sustaining Sponsor | $50,000 |
| Principal Sponsor | $20,000 |
| Supporting Sponsor | $10,000 |
| Associate Sponsor | $3,000 |

Sponsorship Benefits

A critical part of the success of OSGeo, is the success of organizations that partner with OSGeo. One strength of OSGeo is its ability to operate at arm's length from any single organization and, therefore, from any individual sponsor. Every sponsor is an important part of OSGeo, no matter what funding level they commit to. For this reason the benefits offered to sponsors do not compromise impartiality.

In recognition of the various levels of sponsor contributions, each sponsor receives particular benefits. The benefits are outlined below and are cumulative as the amounts increase (higher levels include lower level benefits as well).

Sustaining Sponsor

* Top Visibility on the OSGeo Sponsors web page
* Key OSGeo marketing materials feature your organization's logo
* At promotion events, your organization's logo is displayed as part of the OSGeo Booth
* Right to First Sponsorship Selection for the Annual OSGeo International Conference
* Full-page Promotional Space on a personalized OSGeo Sponsor Page
* Promotional Space on an OSGeo Sustaining Sponsor Page
* Joint Press Release with OSGeo to announce Sponsorship
* Invitation to Sponsor Information Exchange Event with Board of Directors following annual OSGeo International Conference
* Invitation to Sponsor Networking Event with OSGeo Board of Directors and other invited guests following annual OSGeo International Conference
* Right to use OSGeo Sponsor logo and promote named sponsorship level

Principal Sponsor

* Promotional Space on an OSGeo Principal Sponsor Page
* Right to Sponsorship Selection for the Annual OSGeo International Conference (after Sustaining Sponsors)
* Joint Press Release with OSGeo to announce Sponsorship
* Invitation to Sponsor Information Exchange Event with Board of Directors following annual OSGeo International Conference
* Invitation to Sponsor Networking Event with OSGeo Board of Directors and other invited guests following annual OSGeo International Conference
* Right to use OSGeo Sponsor logo and promote named sponsorship level
* Sponsor is promoted on the OSGeo Sponsors web page, with link to sponsor's Web site

Supporting Sponsor

* Joint Press Release with OSGeo to announce Sponsorship
* Invitation to Sponsor Information Exchange Event with Board of Directors following annual OSGeo International Conference
* Invitation to Sponsor Networking Event with OSGeo Board of Directors and other invited guests following annual OSGeo International Conference
* Right to use OSGeo Sponsor logo and promote named sponsorship level
* Sponsor is promoted on the OSGeo Sponsors web page, with link to sponsor's Web site

Associate Sponsor

* Right to use OSGeo Sponsor logo and promote named sponsorship level
* Sponsor is promoted on the OSGeo Sponsors web page, with link to sponsor's Web site

How to Sponsor

To sponsor OSGeo or discuss sponsorship opportunities further, please contact:

    * Tyler Mitchell, Executive Director, Open Source Geospatial Foundation (OSGeo)
        o Email: tmitchell at osgeo.org
        o Phone: +1-250-303-1831
"""

While foundation sponsors are invoiced, there is no legal agreement in place with sponsors, and the above sponsorship guidelines defines the relationship.

Project Sponsors
---

These are sponsors who provide funds for the specific purposes of supporting one of our software development projects. The funds are used by the project steering committee of the project to support development and promotion of the project in question. Uses have included paying for software maintance, supporting software development events (ie. Code Sprints), promotional/team building items like t-shirts, and funding internet hosting, for instance for build machines. Each project may have slightly different guidelines for their project sponsors, but they work within the general project sponsorship guidelines. Sponsors receive promotional acknowledgement. Sponsors do not control how their sponsorship funds are spent, this is decided by the project steering committees. No legal agreements are signed with project sponsors.

"""
Organizations will be given the opportunity to sponsor specific foundation projects through a process of Project Sponsorship. Project sponsorship is intended as a mechanism for organizations that depend on a project, or who otherwise wish to support it to provide financial support to support and sustain the project.

Such project targetted funding may be used by the project steering committee of that project for a variety of activities. These include funding new features, documentation, testing, maintenance, meetings or promotion.

Sponsorship Levels

Organizations may provide sponsorship support in any amount of at least $500USD. Any organization providing such funding will be known as a "Sponsor" of that project. At particular levels of funding the organizations will be additionally identified with a sponsorship level.

1. Silver: $3000 USD
2. Gold: $9000 USD
3. Platinum: $27000 USD

Sponsorship is considered to be an annual contribution. To remain a Gold sponsor an organization would need to continue to provide an addition $9000 USD each year. Organizations who have made a contribution in the past, but not within the last year will be known as past sponsors.

Project Reponsibilities

To participate in the project sponsorship program, projects must opt-in. That is the project PSC must pass a motion to participate in the program, with the understanding they will have the following responsibilities.

* To maintain a prominent Sponsorship page off the main project web page listing all sponsors. The page should prioritize current sponsors by level, and clearly identify Platinum, Gold and Silver sponsors. Past sponsors should also be listed at the bottom of the page titled as Past Sponsors (at the sponsors option). Sponsors listed should include a sponsor logo or organization name with a link to the organizations web page.
* To pass well documented motions for any expenditure of funds from the project sponsorship fund.
* To provide clear direction (via the project chair/VP) to the OSGeo Treasurer for any payments to be made from the project sponsorship fund.
* To produce a detailed annual report of activities based on the sponsorship funding to be posted on the web site, and for distribution to sponsors.

As an unofficial addendum, it is required that projects either have completed incubation or receive a special exemption from the OSGeo board before entering the sponsorship program.

## OSGeo Finance Management

Project sponsorship amounts will be held by OSGeo on behalf of the projects by the foundation treasurer (or delegate). One quarter of the sponsorship amount will be put into the general OSGeo account for any OSGeo use (such as paying hosting costs, general promotion, etc). The remaining three quarters will be put kept track of as funds only for the use of the project.

OSGeo responsibilities (via the treasurer or delegate) include:

* Keep clear records of sponsorship payments collected (date, sponsor, amount, special conditions).
* Keep clear records of all payments out of project sponsorship funds.
* Provide income, and payment details to project PSC chair/VP on request.
* Make payments as requested by project PSCs when given clear directions.

The treasurer also has the right to defer any payment until it can be discussed by the foundation board if there is a concern that it is improper in some way. If the board decides the proposed payment is improper it may, by motion, stop the payment. Generally speaking this is to be used in the event a payment does not appear to be properly approved by the project PSC or if the payment is one that is likely to bring the foundation into disrepute. However, the treasurer isn't responsible for a detailed review of project directed payments.

## Earmarked Sponsorships

Projects PSCs may optionally designate special projects for which they are seeking funding. For example, development of a particular feature, or contracting for limited term maintenance services.

These special projects will be listed on the project web site, with details of what would be done, and how much money is required, as well as how much has been collected so far. Project sponsors can indicate that some or all of their sponsorship will be earmarked for a particular activity.

Once sufficient earmarked funds are collected for it, the project PSC will launch the activity.

## Sponsor Benefits

* Sponsors help ensure a project on which they depend is better maintained and sustained.
* Sponsors will be listed on a prominent sponsors page on the project web site.
* Sponsors may call themselves sponsors of the project, and use the project logo in such an indication on their web site or promotional materials.

    * Sponsors will gain some goodwill from the project, which may help get bugs fixed, or answers to usage questions.
    * Sponsoring efforts are made public through project web pages, and possibly other project related mechanisms (Example: http://www.gdal.org/credits.html).

Who Might Be a Project Sponsor?

    * End user organizations using the foundation packages, such as governments, NGOs and service organizations. These organizations are already saving money using free software, and have a stake in the successful future improvements to the packages and the health of the open source geospatial ecosystem.
    * Consultants and integrators are building solutions for their clients based on foundation projects. The continued success of the packages is important to their commercial leverage. The PR benefit of sponsorship helps raise their stature when with potential clients.
    * Proprietary software vendors using the libraries in their packages are good candidates. These companies depend on the quality of the libraries.

Who Solicits Project Sponsors?

Project sponsorships are primarily beneficial to the project being sponsored, so it is anticipated that members of the project community will be primarily responsible for soliciting project sponsorships. The fundraising committee of OSGeo will also be explaining the project sponsorship option to organizations it reaches out to, but will generally be encouraging Foundation Sponsorship.

"""

Currently there are four projects which have joined the OSGeo Project Sponsorship program: GDAL/OGR, MapGuide, OpenLayers and QGIS.

Event Sponsors
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The FOSS4G conference, and to some extent other specialized events like some code sprints, solicit sponsors to support costs of the events.  The sponsors are provided with various promotional benefits (logo placement, mention during programs, and some complimentary conference registrations). The most recent FOSS4G conference in 2009 the prospectus offered the following benefits for the Premier sponsor.  Other sponsors received a subset of these benefits.

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***Question 19 – License Samples***

# Open Source Initiative

Home

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# Open Source Initiative

Home

## Open Source Initiative OSI - The GPL:Licensing

## The GNU General Public License (GPL)
## Version 2, June 1991



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# Open Source Initiative

Home

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Version 2.1, February 1999



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d) If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

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This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

**4.** You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

**5.** A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

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|---|---|---|---|---|---|---|---|
| Christl, Arnulf | Siemensstr. 8 | Bonn | NW | 53121 | Germany | **Director**, President | None |
| Butler, Howard | 1528 Ranier Dr. | Iowa City | IA | 55246 | USA | **Director**, VP Systems Com. | None |
| Jolma, Ari | Skinnarintie 12 H 20 | Vantaa | | 1630 | Finland | **Director** | None |
| Neteler, Markus | Via Anne Frank, 5 | Trento | TN | 38100 | Italy | **Director**, VP GRASS Project | None |
| Ravi Kumar | 11/8 Nu-Tec Satyam Villa Lakshmi Colony, North Crecent Road | Chennai | AP | 600017 | India | **Director** | None |
| McKenna, Jeff | PO Box 448 | Lunenburg | NS | B0J 2C0 | Canada | **Director**, VP Conferences | None |
| Schmidt, Chris | 236 Allston St. | Cambridge | MA | 213 | United States | **Director**, VP Website Committee | None |
| Warmerdam, Frank | 3594 Foymount Rd. | Eganville | ON | K0J 1T0 | Canada | **Director**, VP Incubation Committee | None |
| Zeiss, Geoff | Apt #612, 124 Springfield Rd | Ottawa | ON | K1M 2C8 | Canada | **Director** | None |
| Mitchell, Tyler | PO Box 4844 | Williams Lake | BC | V2G 2V8 | Canada | **Executive Director** Secretary, VP Marketing | USD $90,000 |
| Chen, Rongguo | Bldg.917,Datun Road,Anwai | Beijing | 11 | 100101 | China | VP, China Chapter | None |
| Schweik, Charlie | Univ. of Massachusetts | Amherst | MA | 01003 | USA | VP, Education and Curriculum Project | None |
| Bitner, David | 300 E 48th St. | Minneapolis | MN | 55419 | USA | VP, Geospatial Data Project | None |
| Roy, P. S. | Dept. of Space, Gov't of India | Hyderabad | | 500 037 | India | VP, India Chapter | None |
| Mori, Toru | 6F JA-Kyosai Yokohama Building | Yokohama | 14 | 231-0002 | Japan | VP, Japan Chapter | None |
| Rothstein, Uli | Siemensstr. 8 | Bonn | BW | 53121 | Germany | VP, Mapbender Project | None |
| Shorter, Cameron | Suite 112 The Lower Deck | Pyrmont | NSW | 2009 | Australia | VP, Mapbuilder Project | None |
| Uzureau, Erik | c/o Familia Lopez-Sol | Mexico | MEX | 01900 | Mexico | VP, OpenLayers Project | None |
| Bray, Robert | 2100, 645 - 7th Ave SW | Calgary | AB | T2P 4G8 | Canada | VP, MapGuide Project | None |
| Ticheler, Jeroen | Grotenhuisweg 61 | Wilp | GL | 7384 | Netherlands | VP, GeoNetwork Project | None |
| Boone, Greg | 2100, 645-7th Ave SW | Calgary | AB | T2P 4G8 | Canada | VP, FDO Project | None |

# *Question 27 – Part IX – Updated Financial Data*

## Financial Data

| | Current budget 2010 | 2009 | 2008 | 2007 | Total |
|---|---|---|---|---|---|
| | | | | | |
| 1. Gifts, grants, and contributions received | 200,000 | 142,605 | 194,839 | 185,446 | **722,890** |
| 2. Membership fees received | 0 | 0 | 0 | 0 | **0** |
| 3. Gross investment income | 0 | 0 | 0 | 0 | **0** |
| 4. Net unrelated business income | 0 | 0 | 0 | 0 | **0** |
| 5. Taxes levied for your benefit | 0 | 0 | 0 | 0 | **0** |
| 6. Value of services or facilities furnished by a governmental unit with charge | 0 | 0 | 0 | 0 | **0** |
| 7. Any revenue not otherwise listed above or in lines 9-12 below (attach itemized list) | 0 | 0 | 0 | 0 | **0** |
| **8. Total of lines 1 through 7** | **200,000** | **142,605** | **194,839** | **185,446** | **722,890** |
| 9. Gross receipts from admissions, merchandise sold or services performed, or furnishing of facilities in any activity this is related to your exempt purposes | 400,000 | 428,358 | 327,284 | 437,385 | **1,593,027** |
| **10. Total of lines 8 and 9** | **600,000** | **570,963** | **522,123** | **622,831** | **2,315,917** |
| 11. Net gain or loss on sale of capital assets | 0 | 0 | 0 | 0 | **0** |
| 12. Unusual grants | 0 | 0 | 0 | 0 | **0** |
| **13. Total Revenue add lines 10 through 12** | **600,000** | **570,963** | **522,123** | **622,831** | **2,315,917** |
| 14. Fundraising expenses | 0 | 0 | 0 | 0 | **0** |
| 15. Contributions, gifts, grants, and similar amounts paid out | 0 | 450 | 2,120 | | **2,570** |
| 16. Disbursements to or for the benefit of members | 0 | 0 | 0 | 0 | **0** |
| 17. Compensation of officers, directors, and trustees | 0 | 0 | 0 | 0 | **0** |
| 18. Other salaries and wages | 96,000 | 97,153 | 105,723 | 99,779 | **398,655** |
| 19. Interest expense | 0 | 0 | 0 | 0 | **0** |
| 20. Occupancy (rent, utilities, etc.) | 0 | 0 | 0 | 0 | **0** |
| 21. Depreciation and depletion | 0 | 0 | 0 | 0 | **0** |
| 22. Professional fees | 0 | 271 | 969 | 1,000 | **2,240** |
| 23. Any expense not otherwise classified, such as program services (attach itemized list) | 443,000 | 491,753 | 373,490 | 387,715 | **1,695,958** |
| **24. Total Expenses. Add lines 14 through 23.** | **539,000** | **589,627** | **482,302** | **488,494** | **2,099,423** |

# PART IX Financial Data (Continued)

## B. Balance Sheet

| | | | Year End: 2009 |
|---|---|---|---|
| **ASSETS** | 1. Cash | **1** | 142476.23 |
| | 2. Accounts receivable, net | **2** | 149042.01 |
| | 3. Inventories | **3** | |
| | 4. Bonds and notes receivable | **4** | |
| | 5. Corporate stocks | **5** | |
| | 6. Loans receivable | **6** | |
| | 7. Other investments | **7** | |
| | 8. Depreciable and depletable assets | **8** | |
| | 9. Land | **9** | |
| | 10. Other assets | **10** | |
| | **11. Total assets (add lines 1 through 10)** | **11** | **291518.24** |
| **LIABILITIES** | 12. Accounts payable | **12** | 2825.47 |
| | 13. Contributions, gifts, grants, etc. payable | **13** | |
| | 14. Mortgages and notes payable | **14** | |
| | 15. Other liabilities (attach an itemized list) | **15** | |
| | **16. Total Liabilities (add lines 12 through 15)** | **16** | 2825.47 |
| | **17. Total fund balances or net assets** | **17** | **0** |
| | **18. Total Liabilities and Fund Balances or Net Assets (add lines 16 and 17)** | **18** | **2825.47** |
| | 19. Have there been any substantial changes in your assets or liabilities since the end of the period shown above? | **19** | NO |

# *Question 31 – Line 23 Expenses*

| 23. Any expense not otherwise classified, such as program services (attach itemized list) | 443,000 | 491,753 | 373,490 | 387,715 |
|---|---|---|---|---|
| | | | | |
| | **2010** | **2009** | **2008** | **2007** |
| Bank Service Charges | 1,500 | 597 | 1,383 | 356 |
| Conference Expense | 350,000 | 437,495 | 320,273 | 331,963 |
| Promotion & Visibility | 25,000 | 11,780 | 17,282 | 5,925 |
| Equipment Rental | 0 | 827 | | 148 |
| Incorporation costs | 0 | 1,283 | 1,047 | 274 |
| Insurance | 4,000 | 618 | | |
| Office Supplies | 5,000 | 3,038 | 4,082 | 4,859 |
| Postage and Delivery | 0 | 184 | | 446 |
| Project Disbursements | 22,500 | 6,330 | 3,698 | 12,551 |
| Supplies | 0 | 269 | | |
| Systems | 15,000 | 13,152 | 15,496 | 15,517 |
| Travel & Ent | 20,000 | 16,180 | 10,229 | 15,676 |