Use of OGC compatible GIS for monitoring and planning in the IWRM-project

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ABSTRACT

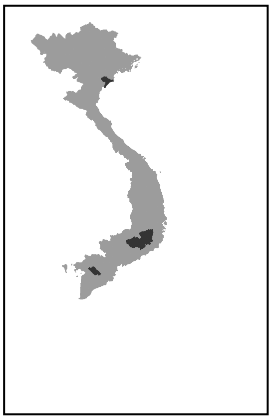
The IWRM-project is a joint project for the management of water resources in Vietnam. The project is located in 3 provinces (Lam Dong, Nam Dinh, Can Tho). As part of this project, the company Moskito creates GIS-solutions for monitoring of water. Within this project, it became obvious, that a tool for planning of water resources is very necessary.

All GIS-Tools are presented to the internet using OGC-protocols. The solution is a server-oriented architecture using a lightweight client. This results in a simple, effective, reusable solution. The server offers its services to the client including functions, not only data.

To overcome the limits of current OGC-protocols without violating them was one of the important results. We want to share our experiences in programming for the advantage of other projects.

1. INTRODUCTION

1.1 What does IWRM do?



This project sets up an integrated concept for water management in Vietnam, founded by German BMBF and Vietnamese government. It does this by evaluating 3 situations at 3 reference provinces.

- Nam Dinh province, industrial regions.
  - Structures for cleaning of industrial waste water.
  - Structures for cleaning of household waste water in urban region.

- Lam Dong province, highlands with rural structures.
  - Creating a supply system for drinking water.
  - Creating a water cleaning system.
- Can Tho province with Mekong river delta.
  - Reducing the pollutant discharge into the river.
  - Creating a monitoring system for surface water quality.

Moskito is responsible for the GIS and monitoring system in Can Tho and Nam Dinh. The results will be working prototype systems that can be used by the project partners from Vietnam and Germany. Now the monitoring system is nearly finished and active.

Monitoring systems capture data of any kind and then presents an analysis to is users. In this case it captures water quality data and collects all data in a website. The user is presented with maps of water quality, warnings for violations of allowed values and reports.

Vietnam is a fast growing country. All structures need to be tested and planned with changes in mind. In this case we care for waste water amount and quality. In 5 – 10 years, the population has grown and the industry changed. This results in new requirements on sewage treatment plants. To know these requirements we need computer systems doing simulations and predictions for changing situations. It will solve questions like: How much waste water will be produced, if the town has twice the population and three times the income counted from now? Here an automated planning system is very helpful.

2. MONITORING WITH GIS

2.1 Situation

The project area is located in the Mekong delta. It consists of about 30 positions in 5 provinces along the Hau river. Every province does 4 measurements at each location. They will be done twice a year (spring and autumn) at low and high tide. We have about 6 parameters that will be measured (COD, NH4, NO2, NO3, PO4, P tot, …). Can Tho city has 2 additional campaigns with continuous measurement values. A ship equipped with a ?? produces continuous measurement values traveling up the Hau river from the sea to the border line of Vietnam.

2.2 System requirements

The first requirement was to have a system that can make the monitoring results available for all connected provinces. It has to give some features:

- Present a view of the project area in your browser.
- View, enter and change the measurement values online.
- User interface in local (Vietnamese) language

The next requirement was “make it simple”. Every user of the monitoring system must be able to use it without a long education. No installations on the client machine need to be done. If these requirements are fulfilled, the advanced wishes should be solved:

- Very informative and impressive presentation.
- Automatic reporting for the annual water quality situation.

2.2 Technical requirements

Additional to the requirements for the functionality we had to fulfill requirements for the internal functions. One goal of this research project was, to find out how far the official standards can be used for such system.

- Which standards can be used, if you create a really interoperable system, where your results can be used in alien environments.
- How to create multi language sytems (with multi language maps) using OGC.
- How to manage a distributed GIS-Database for monitoring using OGC.

2.3 Solution

First we defined the map layers. They are mainly for reference. Only one layer is available for the real data. The reference layer where Satellite map and borders and rivers. At the first practical test we got an unexpected result. The preferred satellite map was to slow, as the data cannot be compressed as much as the border lines. The first tested decision was:

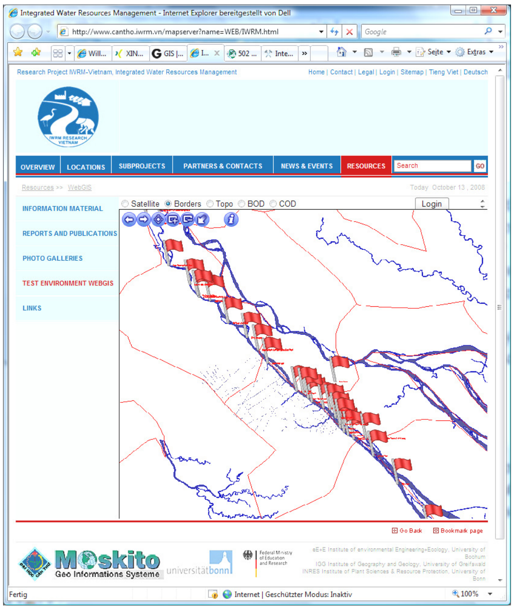
- Use the simple, but fast Border map as background, the user can switch to the better manually.

The real measurement positions are presented as flags, on which a user can do queries. We have required the system to integrate into alien environments, but the results of the query are complex. They include a picture of the position, measurement values and detail information on the place. If every client system, that needs to use out data, has to implement the presentation itself, out data would never be used. Our solution was, to serve the client system with the ready formatted data. This way an alien client does not need to know the contents of the maps and we can change the response without conflict on the client side.

On the next step we needed a security system. The requirements where common to many other systems, but the solution is not used very often. It had to be

- Simple and foolproof
- Easy administration
- medium security level
- useable in an alien environment

The solution was the well-known “basic authentication”. This is standard to every browser and has very easy administration. We use a database with user-groups and rights. Every request is checked against this and the response shows, what the user is allowed.



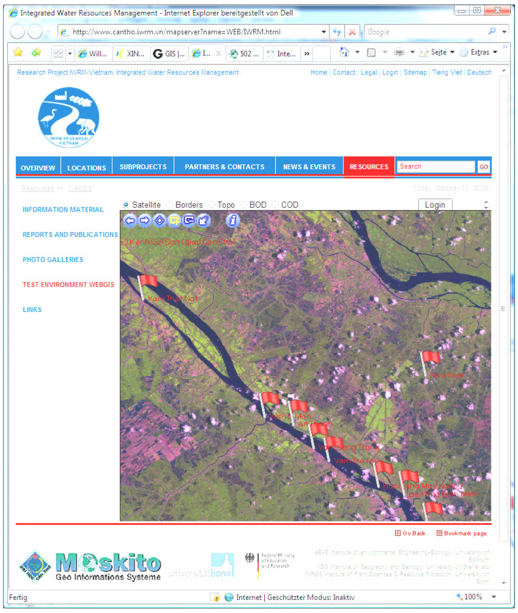


Fig. 1: Basic map (fast transfer) Fig.2: with sat image (slow transfer)

2.3 Current development

Even is this seem to be simple and easy developments, the big advantage is just this simplicity. We don't need license server, client programming or JS-code for diagrams. The next step will lead to a distributed system. The reason is internet speed. We cannot serve Vietnamese user from Germany and we cannot serve German user from Vietnamese server. We need 2 servers, that can do the same maps and queries at the same time. Now that you have 2 servers, they need to keep in sync with changing data. We do this by exchange of WFS-queries and SOS-queries, both standard OGC-protocols. This is a type of distribution, not present yet in OGC-servers. It results in the faster server to resolve the query. This phase of the project will be available start of 2009.

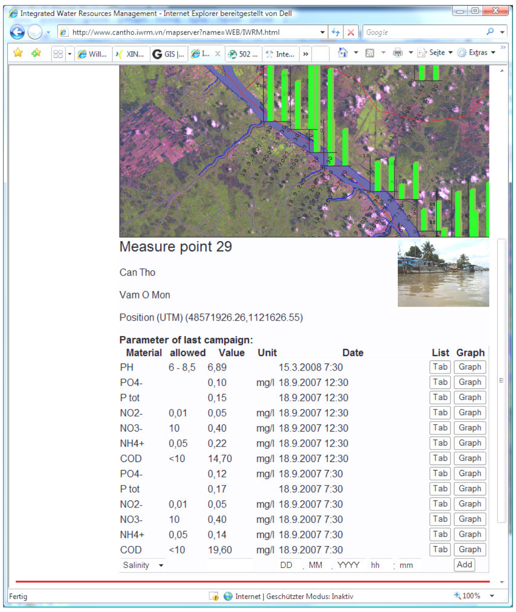


Fig. 3: Info query (not logged in) Fig.4: Info query (logged in)

The current monitoring system is open for the public and it is available from Europe at www.cantho.iwrm.vn . From Vietnam this link is too slow, we have another server running at http://ctgis.ctu.edu.vn/IWRM-CanTho/mapserver?name=WEB/VN/IWRM.html .

3. GIS AS PLANING SYSTEM

The second location of the IWRM-project with Moskito GIS involved will create components for a waste water planning system. In the recent 2 years we have collected all necessary data and explored the structures. This has been done mainly by the University of Greifswald. The next step now is to implement this knowledge into the GIS. The area of interest is Tong Xa for the first step and Nam Dinh for the next bigger step. Now we have our concepts ready to implement.

3.1 Planning with GIS for waste water management

First we had to decide the structure of the planning tool. The possible decisions where

- Use a statistic program like SPSS
- Use a spreadsheet like Excel
- Do everything inside the GIS

We have chosen the last one, because we need a close connection between location (GIS) and features. This resulted in two directions. First the GIS needs be able to do simulations and this way needs active objects. This extension to Moskito is in progress now and is explained later. Second we need a flow model for waste water planning. The decision was to simplify this model resulting in a fast time schedule until the total solution can be tested the first time.

3.1.1 *Simple waste water model*

We need the following object classes for a waste water model: Building, House connection, housing pipe, sleeve, main pipe, sewage pit, sewage treatment plants.

3.1.1 Planning and *Simulation extension for Moskito GIS*

In the design phase of this extension we have chosen the concepts of well-known simulation languages. This leads to the following fundamental concepts:

- Every GIS object can be an active simulation object.
- Simulation objects consist of input parameters, output parameters and a calculation function.
- The Planning GIS executes the objects, when an input value changes and on a regular time schedule depending on the object type.
- A parameter database is used for customizing of the behavior of the objects.

The behavior can be modeled the following way:

Buildings

Input: from a database with social parameters like number of people, income, kind of water supply, kind of building.
Output: Amount of waste water, kind of pollution
Parameter: water use per normal person depending on income and house type.
Function: Calculate waste water amount.

Main pipe

Input: all waste water input of collecting sewer.
Output: Amount of waste water, kind of pollution.
Action: Show overflow situation in the map.

Parameter: water use per normal person depending on income and house type.
Function: calculate sum of waste water.

All other objects are treated similar. The planning system does handle complex and dynamic situations. It separates the task into 2 phases. The expert phase includes the modeling and basic configuration. Now the decision makers use the planning system to view the results. They can change parameter values to view results of different decisions. At this time no expert is necessary any more.

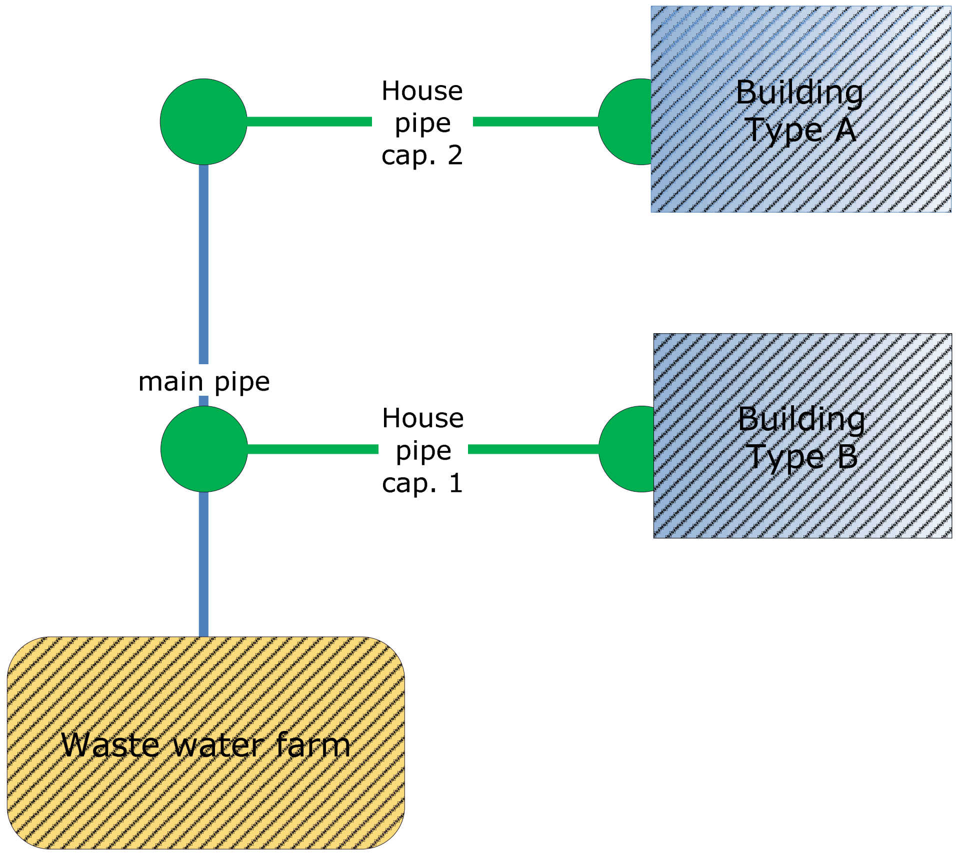


Fig. 5: Simulation schema of an example waste water network

3.2 Future plans

Waste water was the first topic, where the Moskito GIS planning tool is used. We can extend this to every network based topic. This can be done by Moskito or by any customer itself. We will release all tools for creating new models soon. Possible examples as drinking water and traffic as well as quality for surface (river) water. The only part that has to be changed is the object class definition and the behavior of the objects.

- Create objects classes of interest.
- Define object behavior.
- Define a parameter set in the parameter database.
- Build the network data itself and
- Run the system