ON-LINE SUPPORT SYSTEM FOR NUTRIENT POLLUTION IN BISTRITA BASIN

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ABSTRACT
An important objective of the DIMINISH Project is the development of a dedicated on-line system based on GIS technology, in order to improve the water quality management and implementation of mitigation programs, in the mentioned area. The DIMINISH on-line system is web-based with a distributed architecture and consists in a core server, which handles the interactions between the various modules, the end-users management, the display and manipulation of data

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1. INTRODUCTION

This paper is the presentation of the Diminish Project (LIFE03 ENV/ RO/000539) on-line managemnt system, accomplished in the framework of the Life Environment Program. The project aims to develop an integrated system for water basin environmental management for managing the water quality in relation with water resources, using socio-economical analysis, at the scale of the Bistrita drainage basin. Based on modeling approache the developed decisional system allows to combat the nutrients pollution and to predict which strategy will lead to the reduction of nutrient concentrations within the Bistrita basin and respectively to the reduction of nutrient loads transported by the Siret River into the Danube. The implementation of the Water Framework Directive demands a good knowledge of the many complex interactions between natural processes and human activities and the accomplishment of a sustainable and integrated management of waters.

2. STUDY AREA

Bistrita River (283 km length) had proven to be specifically sensitive to human activities and it is one of the main tributaries of the Siret River, which is the second affluent of the Danube River in terms of discharge and basin surface. The Bistrita River Basin has an area of 7039 km2 and its contribution to the Siret discharge represents more than 30% (Qmean = 65 m3/s). The mean altitude of the basin is 919 m. Besides pollution, the Bistrita basin is influenced by hydraulic management. Residence time in the hydraulic system represents hydrological constraint, influencing biological processes and water quality.

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Within the basin there are eight reservoirs and three hydraulic channels with role for the sustenance of low summer flow during summer time and for reducing flood intensity along Bistrita River. The investigated area is covered by 9 hydrogeological stations, formed by 4-8 observations wells located normal on the river direction. The permeability ranging between 50 and 500 m/day and the specific debits are above 10l/s/m. The aquifer recharge is due mainly to the infiltration from precipitation. According to the results of the chemical analyses, the groundwater water quality is not good in the middle and the south area of the basin, were was lined out overflow for concentrations of ammonium, nitrates, CCOMn , phosphates. The surface water quality monitoring of Bistrita River is accomplished by twenty control stations concerning monthly measurements.

3. GIS DATABASE

The Diminish project allowed the accomplishment of a complex database developed in the GIS environment and provided the possibility to bring together in the same reference system different type of information. The structure of the dedicated GIS database has been planned for the study, evaluation and management of information (related to water quality management), as well as for the assessment of damages inflicted by pollution effects. In this regard the database represented by the spatial geo-referential information ensemble (satellite images, thematic maps, series of the meteorological and hydrological parameters, other exogenous data) is structured as a set of file-distributed quantitative and qualitative data focused on the relational structure between the info-layers. It has been decided to develop a GIS database for the whole study area of the Bistrita basin using different cartographic documents at the scales 1: 25 000, 1: 50 000, 1:200 000. Most of the thematic layers have been extracted from this classical mapping support. Due to the fact that, in most of the cases, the information on the maps is old-fashioned, it is imposed to update it on the basis of the recent satellite images (e.g. the hydrographic network, land cover/land use) or by field measurements (it was necessary to organize several measurements campaigns and to use the GPS technology). One of the purposes of the “Data collection and surveying” task was the improving and updating of the existing database concerning water quality. Besides experimental investigations set up the points-sources and wells location, several campaigns for validation have been carried out 6 months in 2005 year, specially for phytoplankton biomass and silica concentrations at the outlet of the main sub-basins, within the reservoirs and in control sections from the main axis.

The GIS database contains the following info-layers (Figure 1):

- sub-basin and basin limits;
- land topography (15 meters cell size DEM);
- hydrographic network and canals network;
- communication ways network (roads, railways);
- localities;
- administrative boundaries;
- weather stations network, hydrometric stations network ;
- different point of interest (pollution sources, water quality control sections etc.)
- land cover/land use, updated from satellite images.

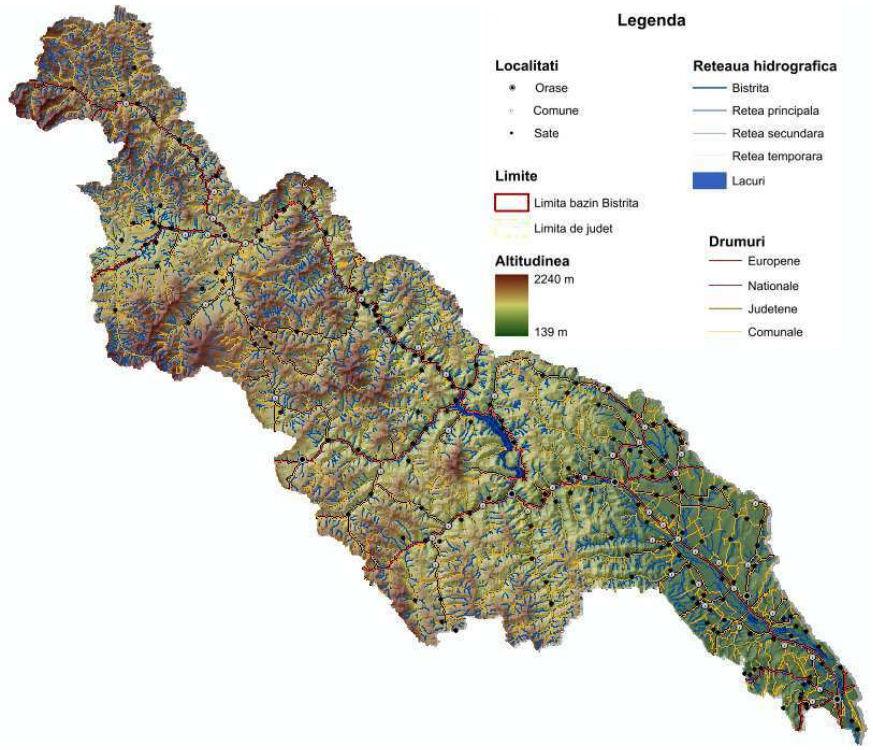

Fig. 1. ***GIS info-layers for the Bistrita basin.***

4. MODELLING APPROACH

The developed basin management system integrates in GIS environment, by using an open WEB-based interrogation and analysis informatics tool, the identification of sources pollution (e.g. agriculture, industry, waste water disposal), the monitoring data and mathematical modeling tools that are enabling to analyze the impact of human activities due to their complexity and due to the fact that they are developed to specific purposes. The ecological model for surface water was developed for studying eutrophication problems in large rivers (namely the Seine River). The model consists in coupling a hydrological model (Hydrostrahler) with an ecological model (Rive). The surface water model takes into account the whole drainage network according to the concept of stream order and calculates the seasonal and geographical variations of the main water variables for the entire network, taking into consideration the constrains related to the morphology, hydro-meteorology and point and non point pollutions. Together with the GIS environment the modeling approach facilitate the identification and quantification of the effect of possible measures for achieving the environmental objectives. These will be used to analyze for instance the effect of change in land use, water abstraction or point and diffuse pollution, measures linked on the functionality of the wastewater treatment plants or the use of the chemical fertilizers.

The mathematical models are easy to use by the local authority due to the developed web interface, which is able to connect in an automated mode the input originating from the

users of the system, to interactively extract data and requests from the users. Due to the designed visualization interface several actions such as the display of the GIS information or the selection of the zoom display of the data will be performed by the user before sending the request to the system.

5. DIMINISH ON-LINE SYSTEM

An important objective of the DIMINISH Project is the development of a dedicated on-line system based on GIS technology, in order to improve the water quality management and implementation of mitigation programs, in the mentioned area. The DIMINISH on-line system is web-based with a distributed architecture and consists in a core server, which handles the interactions between the various modules, the end-users management, the display and manipulation of data. The main functions of the on-line system are the following: acquisition, storage, analysis, management and exchange of raster and vector graphic information and related attribute data for the water quality management activities, as well as updating the information, data restoring, elaboration of thematic documents and generation of value-added information. The distribution of the spatial and tabular attribute data over an Internet Web-based network represents a powerful and effective communication method that overcomes the disadvantages of the classical approach. All the partners and end-users are able to access the system using a simple web browser (like Internet Explorer or Mozilla Firefox) to store, display, query, analyze and retrieve information's. The system flow-chart is presented in Figure 2.

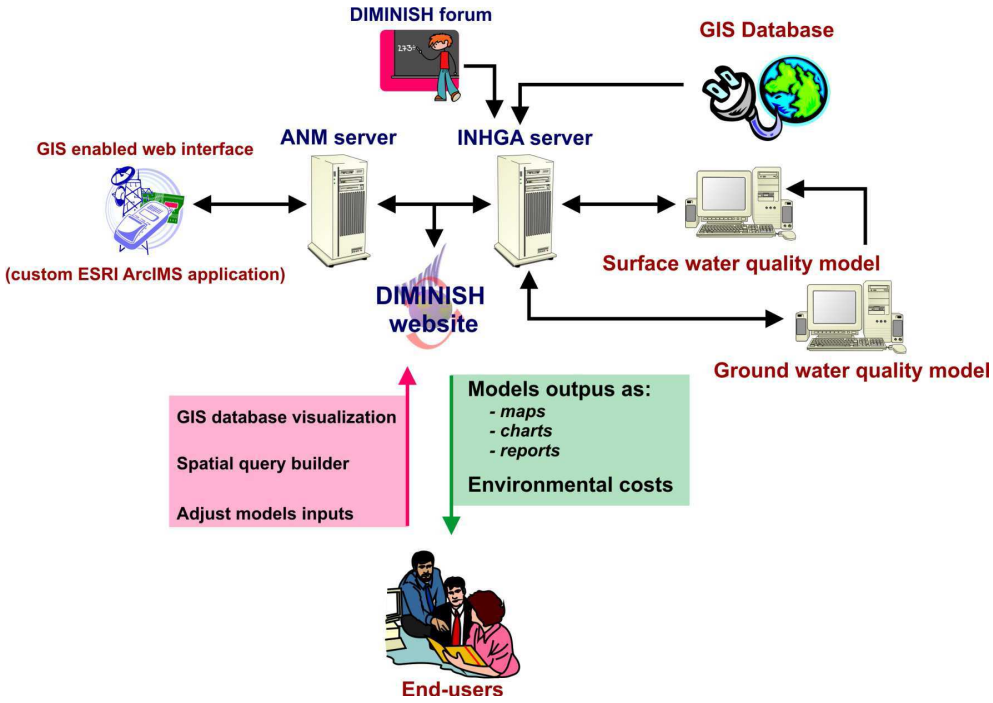

Fig. 2. ***DIMINISH on-line system flow-chart***

Viewing GIS data on the Web, generally involves a three-tiered architecture:

- a spatial server that can efficiently communicate with a Web server and is capable of sending and receiving requests for different types of data from a Web browser environment;
- a mapping file format that can be embedded into a Web page;
- a Web-based application in which maps can be viewed, download and queried by an end-user/client via a Web browser.

Publishing the data on the Web (webmapping) using this approach would not change the existing data workflow– how the data are created, maintained, and used by desktop applications. This means that the mapserver dynamically generates maps from the files stored in a certain folder every time a user sends a request, without changing the initial data files.

Users with appropriate privileges can access the DIMINISH through the web browser and perform queries, and retrieve different products useful in order to:

- process these data for specific computations;
- change the inputs for the mathematical models;
- browse the mathematical models outputs in a GIS environment;
- integrate the multi-source processed information in Decision-Analysis-Matrixes in order to better understand the impact of the pollution on humans and environment; upgrade the result in a Decision-Analysis common access space of the GIS Server;
- provide the right, both short and long term, decisions.

ESRI ArcIMS was chosen as core software for webmapping. ArcIMS is on of the most important application in the field. The native formats can include those used by different commercial vendors. Other nonproprietary formats can be used as well, including the OGC standards for Geography Markup Language (GML), Web Map Server (WMS), Web Feature Server (WFS) and relational databases. The ability to have simultaneous access to diverse data formats on the fly without conversion makes ArcIMS one of the top applications available. The use of ArcIMS as webmapping platform ensured the compatibility between all the DIMINISH participants as they all use ESRI products for GIS activities. The basic structure of ArcIMS is presented in Figure 3.

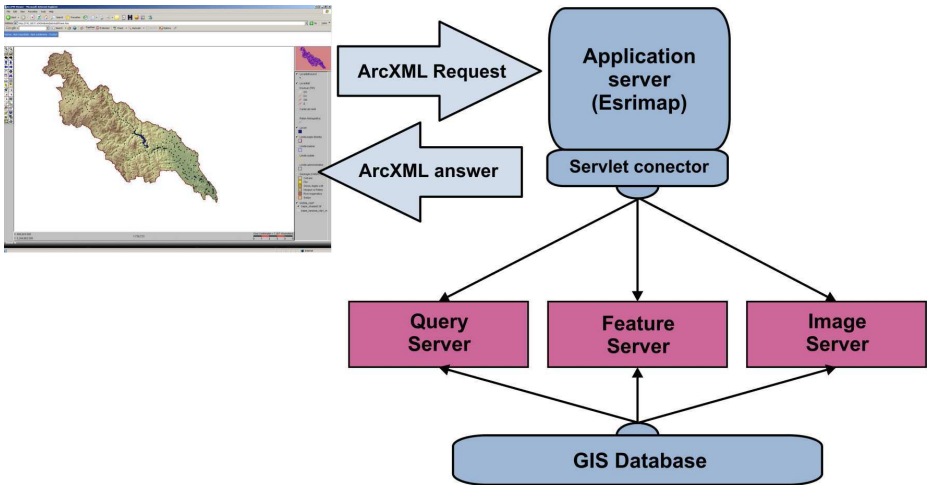

Fig. 3. ***ArcIMS structure***

The web interface was designed according with end-users needs. The goal is to obtain a simple and friendly environment for spatial data management and scenario creation. A screenshot from the main page of the web interface is presented in Figure 4.

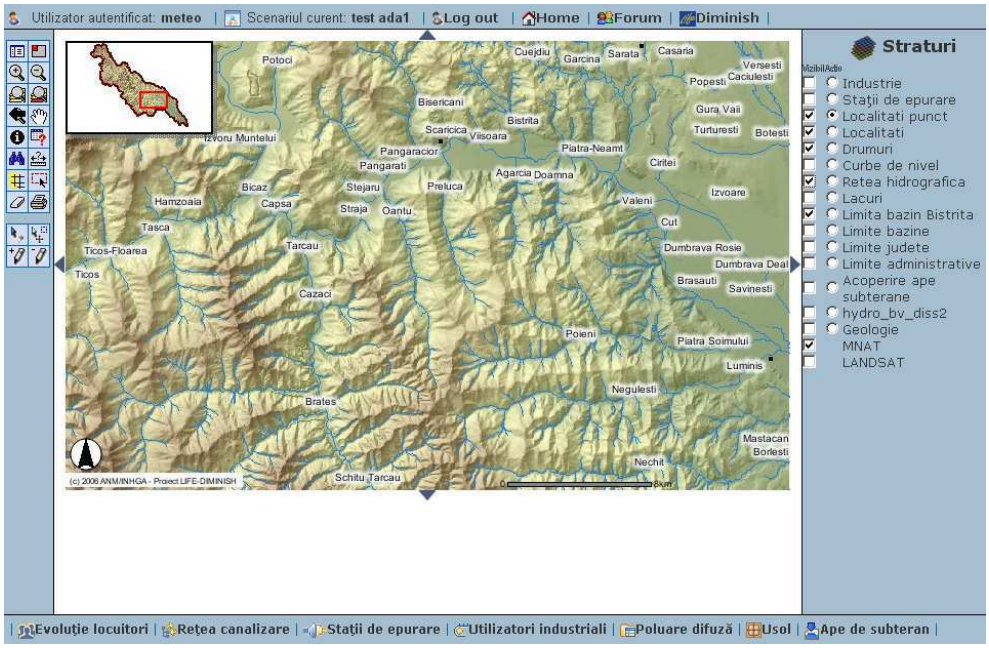

Fig. 4. ***Web interface structure***

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