AUTOMATIC SYSTEM FOR WATER QUALITY MONITORING, FLOOD PREDICTING AND ENVIRONMENT PROTECTION IN HYDROGRAPHIC AREAS

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Abstract: Phreatic and surface waters can provide a lot of useful data concerning flood predicting, water quality and environment protection, therefore some parameters are periodically monitored in hydrographic areas. Remote automatic measurements can be performed in order both to facilitate the overall activities in this matter and to avoid human error. The paper describes a such kind of system, proposing an architecture based on equipment like PC, PLC's, microcontrollers, transducers, and remote data transferring methods.

Keywords: automatic system, distributed open architecture, phreatic and surface water parameters

1. INTRODUCTION

Surface waters and groundwater reserves are tapped for in-house and industrial use, as well as for major construction projects and heating-related purposes. Numerous instances of soil and water contamination are known in populated areas, which can only be rehabilitated on the basis of exact knowledge of hydrographic areas' conditions.

Until now many hydrological measurements were performed manually by people who had little knowledge and who couldn't sometimes deliver data on time. The automatic measuring and data centralizing system for hydrographic areas supervising intends to achieve an easier, faster and more reliable way to monitor several surface and phreatic water parameters useful in activities like flood predicting and water quality controlling. The targeted area is the Somesul Mic hydrographic area (part of the Somes-Tisa hydrographic area), but the open architecture leaves the possibility of extending the system to national scale.

2. THE SYSTEM PRESENTATION

2.1. General description

The system processes and centralizes different type of measurements (water level, temperature, pH, dissolved oxygen etc.) acquired in the field from pluviometric posts, drilling wells and stations.

The automatic system is three main levels structured:

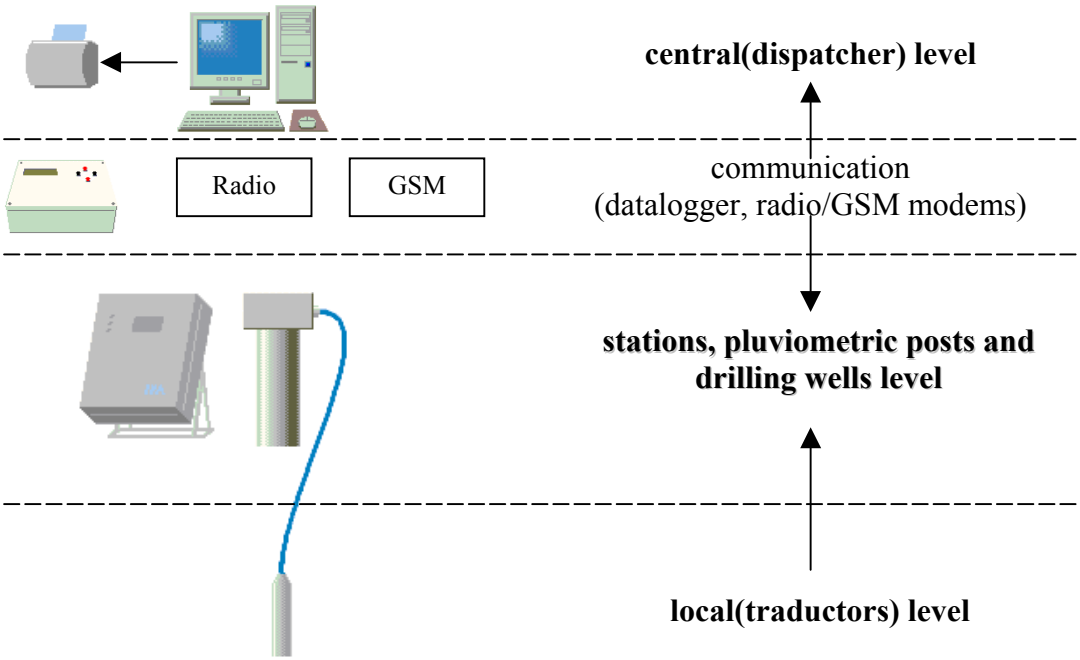

Figure 1: System structure

The architecture is open and distributed within the targeted hydrographic area, therefore it has an additional level of communication representing the important link between the dispatcher and the stations level.

2.2 Central level (dispatcher)

The dispatcher consists of a Windows application and is made for running on an IBM PC compatible computer, under Microsoft Windows NT/2000 Server operating system, having network-related facilities.

The program package was developed under the National Instruments LabWindows/CVI 5.5 environment, which is specialized in data acquisition and has SQL relational database interaction capabilities through its additional LabWindows/CVI SQL Toolkit 2.0 module. Because of this the user benefits both the available graphic interfaces (screens) and the possibility of using objects implemented with other Windows instruments.

The operator exchanges messages with the system: inserts the data and parameters the application needs and receives both results (on screen or/and printed) and abnormal functioning information (through warning messages along with specific sound alarms).

"HIDROSIS" is a tree-like structured application that allows step-by-step navigation through different screens in order to achieve better monitoring performances concerning system functioning and acquired parameters' evolution.

Figure 2 presents application's main screen representing the Somesul Mic hydrographic map with the measurement points within that area. Information about a certain point can be found easily with only a few mouse clicks on the map.

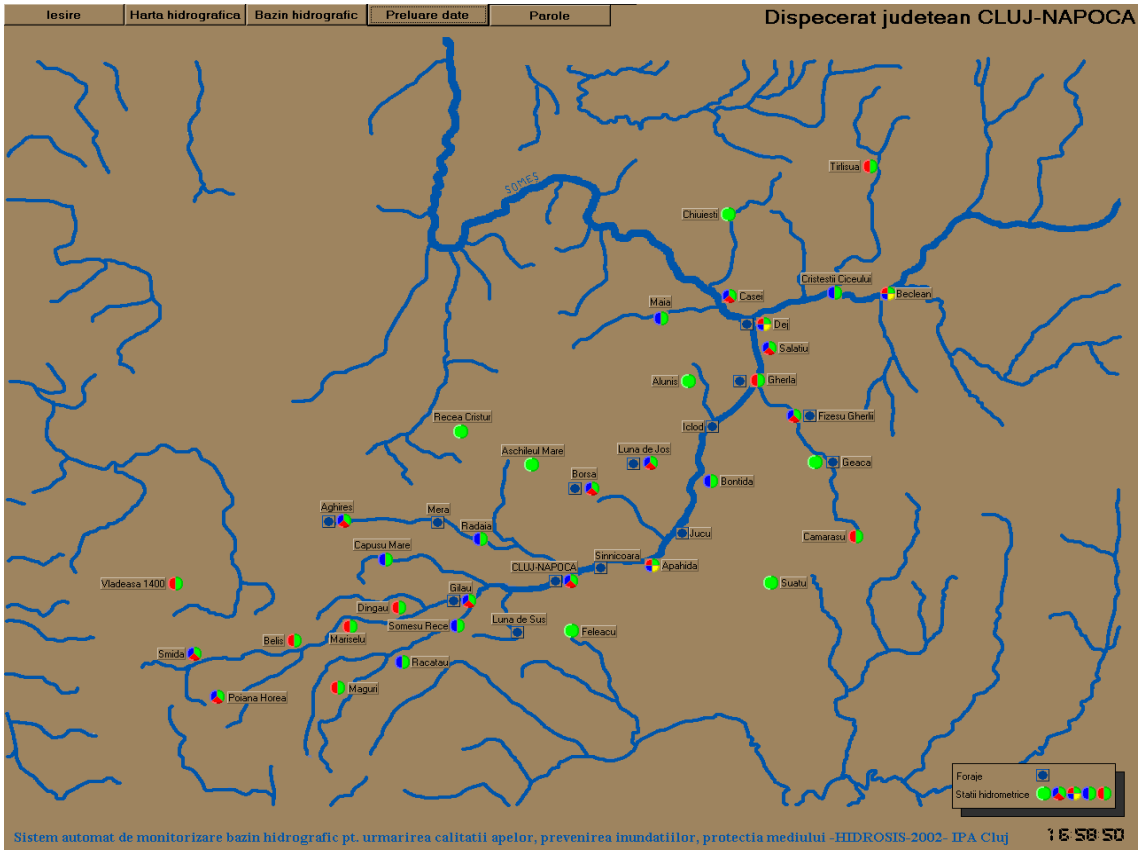

Figure 2: Main screen representing Somesul Mic - hydrographic area

The application performs the following main tasks:

- hydrographic areas of the country and relevant area dispatchers map generating;
- area to be analyzed selecting;
- selected hydrographic area and relevant district dispatchers map generating;
- map placing of all acquisition points relevant for the district dispatcher selected;
- acquisition point configuring: locality name, measurement points (hydrometric stations, pluviometric posts and drilling wells);
- measurement point configuring: geographical coordinates (hydrographic area, location river, ground height etc.), technical data, acquisition mode (automatic/manual), automatic acquisition station type, data transmitting mode (communication or portable datalogger), measured parameters ;
- measurement point selecting and relevant information viewing: configuration, acquired data etc.;
- measurement point selecting and manual acquired data inserting;
- database generating for hydrologic parameters based on automatic acquired and manual inserted data ;
- communication assuring on existing support between dispatcher and measurement points;
- periodic data transfer from stations level to dispatcher;

- gathering data from portable dataloggers and storing them into the database ;
- on-line displaying of read data (correct or along with error messages, if the case), which enhances acquisition process monitoring;
- table-like and graphic displaying of time variations for monitored hydrological parameters on user request;
- database stored information displaying on user request, sorted by different criterions (working point, time interval, parameter type etc.);
- generating, displaying and printing reports.

The image below presents two of the application's screens (level evolution graphic and some chemical analysis data).

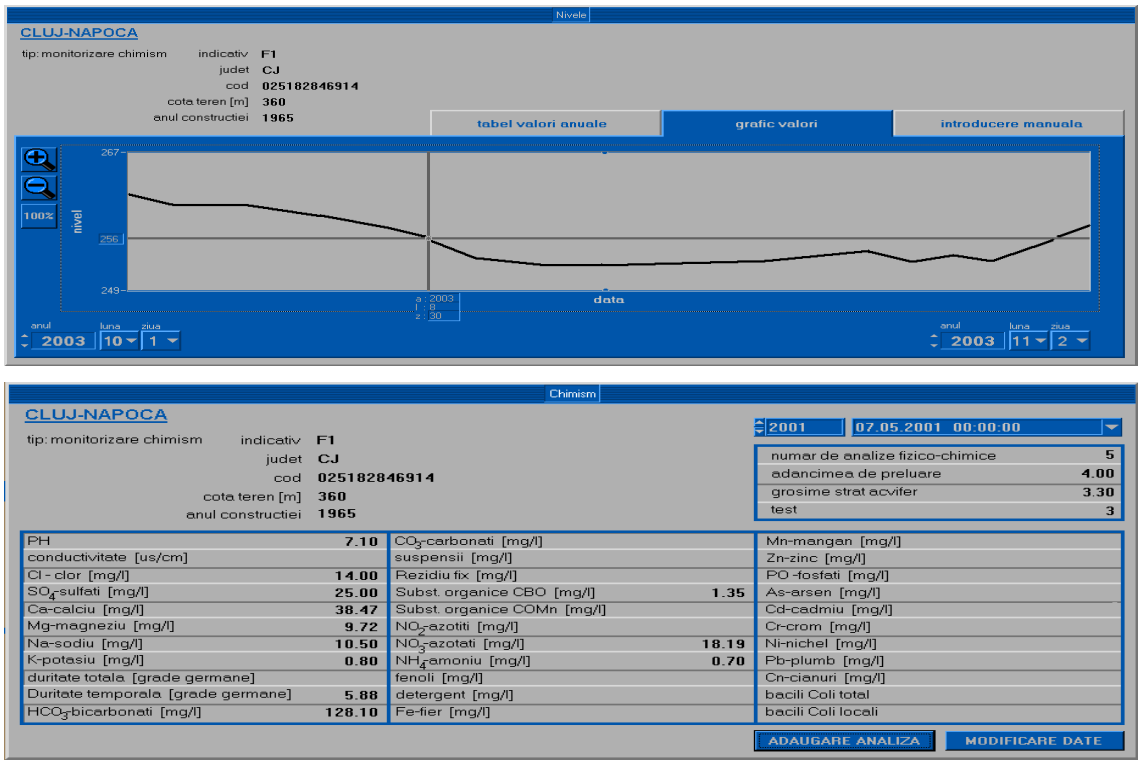

Figure 3 Detailed screen information

Certain operations are password restricted in order to protect data to unauthorized access. The parameters for a hydrographic area (flow capacities, river beds and phreatic water levels, rainfall and water quality indicators for surface waters and drilling wells) are structured as electronic data in a relational database implemented under Microsoft SQL Server 2000. The database is structured on tables containing information related to hydrographic areas, hydrographic sub-areas, rivers, acquisition points, stations, drilling well groups, measured water levels, chemical analysis

2.3. Stations level

The stations level is represented by 4 types of stations:

- Hydrometric station 1
- Hydrometric station 2
- Drilling well acquisition station
- Configuring/data downloading device

The hardware structure of the hydrometric stations includes the following components: PLC, power source, user interface and GSM communication modem (radio modem). In case the power source runs down, the station has the possibility of running on solar supplied batteries.

The program implemented in the PLC's memory for both types of hydrometric stations is written in assembly language and performs acquisition and automatic measurements of hydrologic parameters at the pluviometric posts and hydrometric stations located within the hydrographic area (river bed level, rainfall, air temperature, water quality indicators). Some additional functions are:

- local configuring
- transducer gauging for every analogue channel
- local displaying of measured values

The hardware architecture of the drilling well acquisition station includes the following components: station block, batteries and connectors for transducers and communication. The program for this type of station is written in assembly language for microcontroller and performs data gathering regarding levels and quality of phreatic waters as well as configuring, gauging, storing and resources managing functions.

The configuring/data downloading device consists of four main blocks: central unit, display, configuring block and power supply. Its program, stored in the EEPROM memory, is written in C for microcontrollers language and performs the following main tasks:

- store downloaded data stations identifiers;
- read/download acquisition buffers;
- read/download event report buffers;
- reset datalogger memory for further data downloading.

2.4. Local level

The local level represents the transducers needed, which include different kinds of devices for specific measurements:

- water level transducer
- pH transducer
- conductivity transducer
- dissolved oxygen transducer
- ORP/Redox transducer
- barometric pressure transducer
- humidity transducer
- temperature transducer
- rainfall transducer

2.5. Communication

The communication functions can be performed in two different ways: using on-line transmission (using either modems, radio stations, GSM devices) or using the mobile station for data gathering, storing and transmission. The software consists of the dedicated program for the mobile device and the inter-communication functions, implemented into the dispatcher software as well to the stations application software.

3. CONCLUSIONS

The project proposes modern and efficient real time monitoring of hydrographic areas through precise continuing measurements regardless of the atmospheric conditions. This enhances the overall knowledge upon water level evolution and toxic waste contributing to environment protection. It also increases the time available for intervention in case of major threats. In terms of human resources the system reduces expenses and human error by eliminating the necessity of using untrained available people for manual measurements.

The open architecture leaves the possibility for further improvement in case new devices or sensors need to be used in hydrographic areas.

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4. REFERENCES

1. The Rio Declaratio of Environment and Development, Agenda 21, 1992, The United Nations Conference on Environment and Development-Earth Summit, Rio de Janeiro
2. Sofronie C., 2000, "Amenajari hidrotehnice in bazinul Somes-Tisa", Casa de Editura Gloria, Cluj-Napoca
3. Meteorological Service of Canada - Atmospheric Monitoring and Water Survey Directorate, 2001, "National Radar Project",
4. Ungureanu G., Covaciu F., Balaj A., 2001, "HIDROSIS-Sistem automat de monitorizare a unui bazin hidrografic pentru urmarirea calitatii apelor, prevenirea inundatiilor si protectia mediului", Program MENER
5. Advanced Design Corporation, 2001, "Doppler Weather Radar and Weather Data Display Systems", Indiana
6. Ungureanu G., Covaciu F., Balaj A., Calarasu A., Posteuca C., 2002, "Informatic System for Flood Prevent in Somesul Mic Cascade", AQTR Theta 13, Cluj Napoca