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SYSTEM FOR CENTRAL MONITORING, CONTROL, DATA ACQUISITION, AND AUTOMATIC REGULATION FOR ARWQM *

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Abstract. *This paper deals with construction of device for water quality monitoring on open water flows and connection of devices on individual river basins into central system for monitoring and supervision through GPRS modem. The device was tested on the WWTP (Waste Water Treatment Plant) in coal mine Citluk, Sokobanja, and laboratory of the Faculty of Civil Engineering and Architecture Nis.*

Key words: *Central data acquisition, river water quality, river water management, GPRS data transfer.*

1. INTRODUCTION

In order to enable Advance River Water Quality Monitoring (ARWQM) on open water currents, there is a need for: construction of a typical measuring station, acquisition of chosen measuring parameters / Water Quality Parameters/, sending measuring parameters to the Server of Central System using GPRS modem, processing and presenting measuring data. To achieve those goals the following tasks should be accomplished:

– Design, development, producing, and introducing microprocessor programmable controller with software system used for supervision, conversion, acquisition and processing measured parameters for ARWQM /Client of Central System/. (Optionally for automatic regulation of ARWQ in given boundaries in purpose of maintaining given water quality category, data flow regulation from the lake, waste water flow regulation.)

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– Design, development and introduction of communication software, for achieving communication between microcontroller and Central System for supervision and administration (based on PC) through GPRS modem.

– Development of application software on the Central System for supervision, automatic regulation, acquisition, administration, and presentation of measured data given by microprocessor controller through GPRS modem, Server of the Central System. The system can be upgraded for automatic water quality regulation.

As a base in construction of typical measuring station, for measuring and data acquisition, we propose universal regulator INTEGRAF 1008G based on microcontroller Philips 80C552. It is possible to use microcontroller with similar characteristics from other manufacturers (Intel, Atmel, etc.).

2. INTEGRAF 1008G

INTEGRAF 1008G is a compact universal regulator, based on microcontroller Philips 80C552, meant for acquisition, regulation, governing, automatization of processes and production systems and used for supervising and control, simply in any field where is necessary to use microcontroller governing. It is a high performance microcontroller suitable for instrumentation, industrial governing, automatization of industrial, waterworks or agricultural equipment.

Main characteristics of 80552 controllers are:

– 80C51 central processing unit
– max 64Kb of address area for memorizing program
– max 64Kb of address area for memorizing data
– two 16b timers/counters
– one 16b counter with 4 reception registers and 3 comparison registers
– A/D converter with 8 analog inputs and 10b resolution
– two 8b modulated outputs
– six 8b O/I ports and one 8b port that shares pins with analog inputs
– I2C serial I/O port with byte oriented functions
– full duplex UART compatible with standard 80C51
– watchdog timer

In its main configuration INTEGRAF 105, beside controller 80522, contains:
– NVRAM capacity 128x8 for saving working parameters
– EPROM with built-in system and communication software
– Conditioner for accepting analog input values from sensor
– Communication interface RS485 for connecting device with PC – GPRS connection
– Bus connection for connecting different I/O modules
– Set of digital inputs
– Set of digital outputs
– Power source

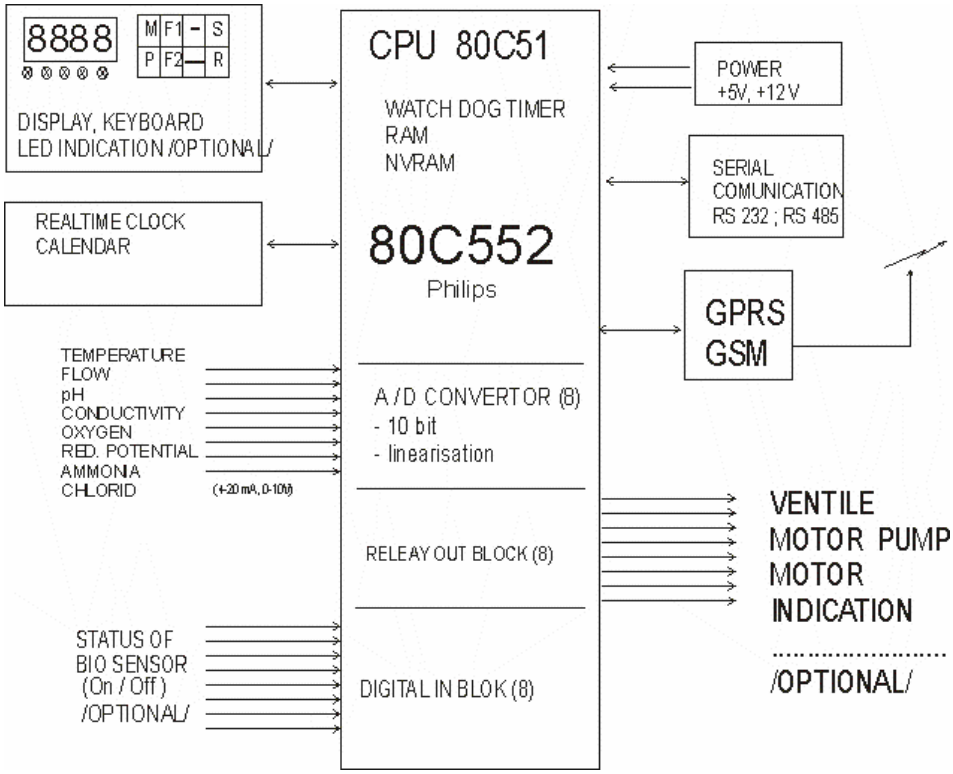

Fig. 1. Structural Block Scheme of INTEGRAF 1008G

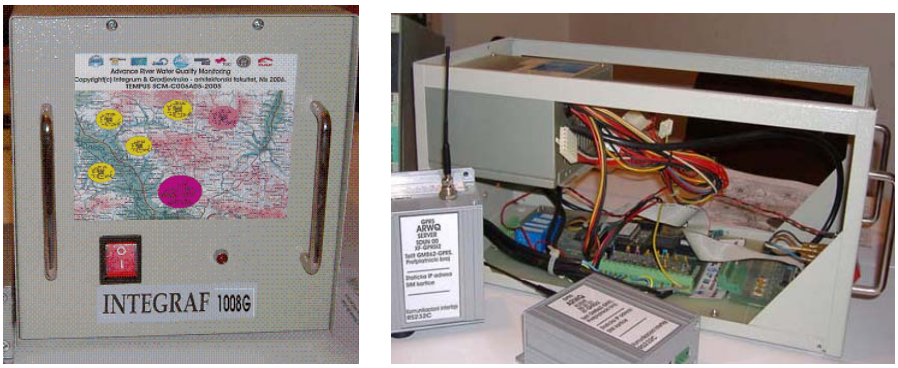

Fig. 2. Device outlook

2.1. Basic functions

On the basis of collected data (input analog and digital signals) and data processing (scaling, calculating technical values with built in algorithms), controller is able to administer outputs completely independently.

Monitoring of measuring values, state of regulation circuits, distant assigning and accessing to regulation parameters is available thanks to real-time connection of controller and PC.

2.2. Technical data

– Power: 220V, +10%, -15%

– Consumption: 5V / 1A, 12V / 0,5A

– Analog inputs: maximal 8
  – Type of input signal: 0/4 ma - 20 ma (Rul <250oma)
    0/2V - 10V
    NTC, PTC, PT 100
  – Type of conversion: successive approximation
  – Resolution: 10 bit

– Digital inputs: maximal 8
  – Type of input signal: no voltage contact

– Digital outputs : maximal 8
  – Type of output signal: relay with no voltage contact

– Communication:
  – Type of communication:
  – GPRS;
  – GSM;
  – RS 232;
  – RS 485

Transmission speed: 19200 bit/sec

Length of communication line: 1200 m without amplifying signal

– NVRAM: (128x8) bit for keeping parameters in case of lost of power supply

– Bus connection for: real time clock
  hand terminal /keyboard with 8 buttons /
  led display - 8 or 16 seven displays
  LCD display 8x16 characters
  LED indicator 8 or 16
  communication controller

3. SERVER APPLICATION SOFTWARE OF THE CENTRAL SYSTEM

Application software for PC written in C programming language for Windows environment /surroundings/ is used for acquisition and processing data received from microprocessor controller. The software can be also used for governing objects in systems, with

certain algorithm, on the basis of processed result of measuring parameters, given by microprocessor controller.

Application software along with microcontroller software, Client of the Central system, INTEGRAF 1008G and communication software, for communication between microcontroller through GPRS modem and PC, Server of the Central System, makes a unique software package of Central System for gathering, processing, and data supervision on purpose of automatization and improvement of system reliability.

The software package allows connecting several systems for tracking and governing, into unique system for Central control, automatic regulation, and data acquisition.

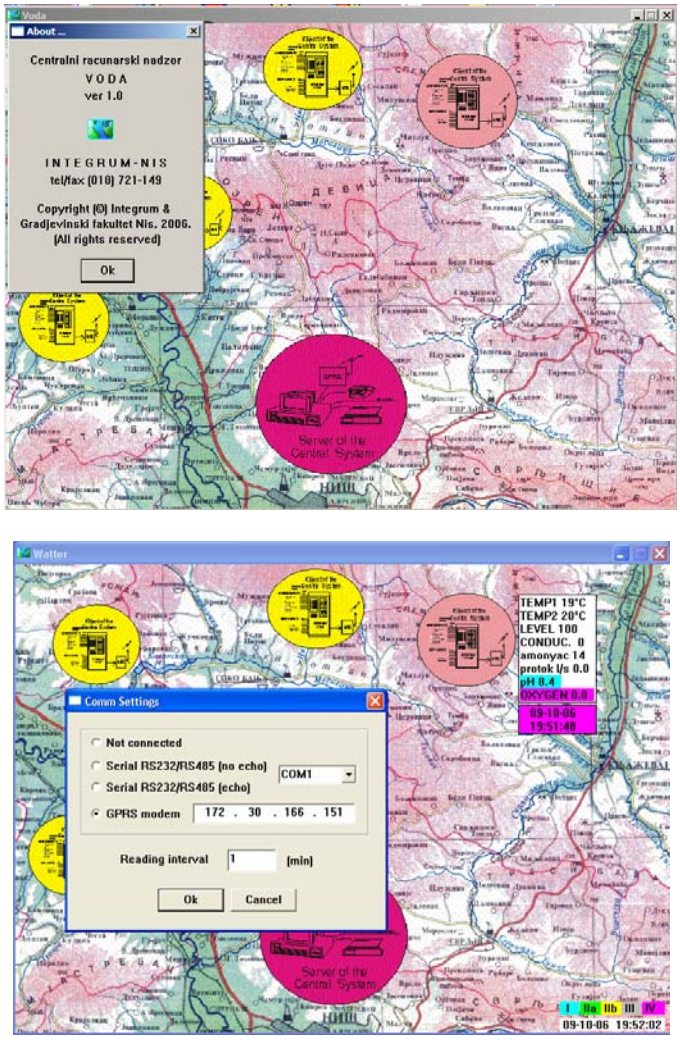

Fig. 3. Outlook of some screens in system during testing

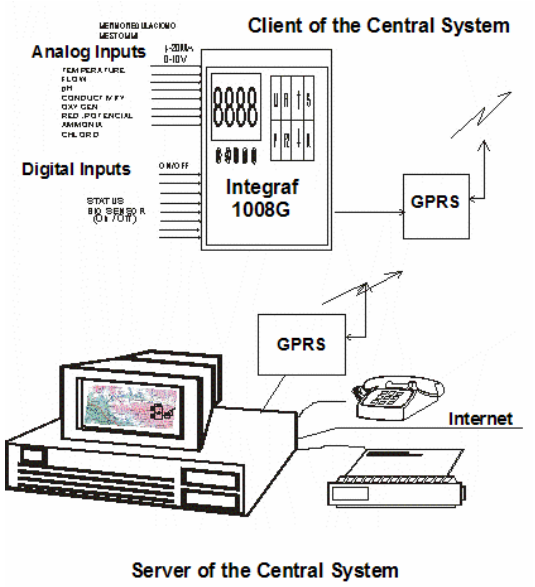

Fig. 4. Server / client system as a part of ARWQM System

For full monitoring of ARWQ and polluters on basin of the river Moravica it is necessary to install five measuring stations on key points. It is possible to use one mobile measuring station, and move it periodically on those five locations.

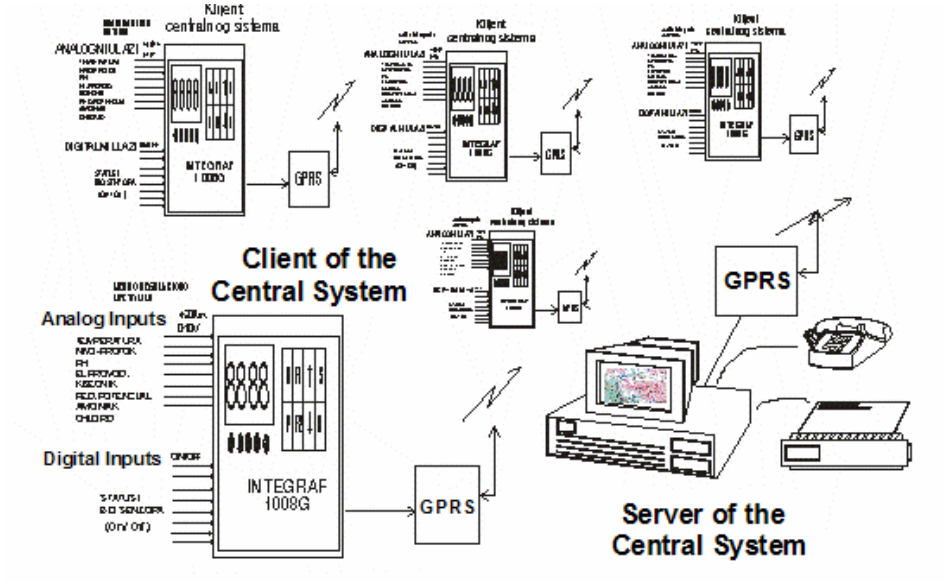

Fig. 5. Block scheme of the Central System elements for Data Acquisition and Monitoring

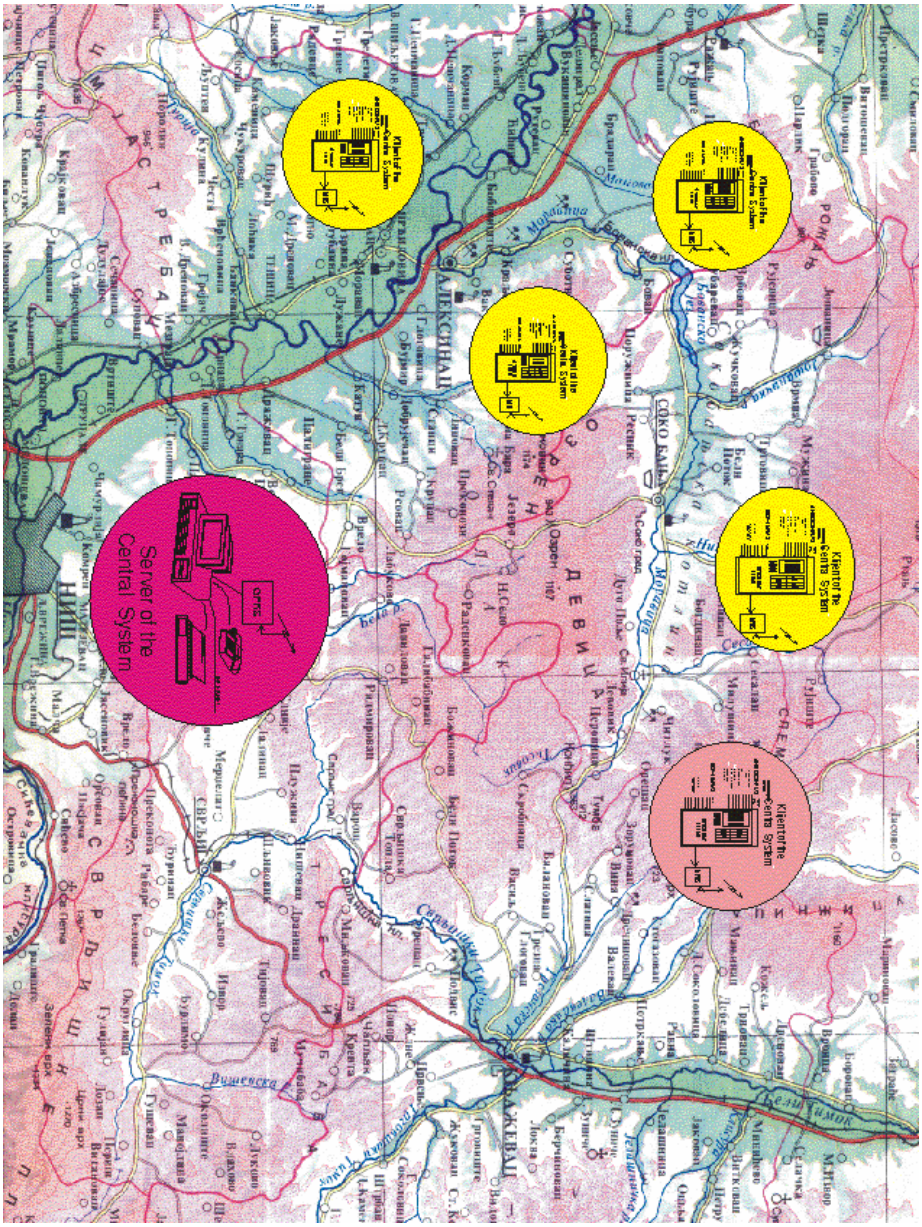

Fig. 6. Disposition of suggested measuring stations of the Central System for Data Acquisition and Monitoring on the river Moravica

Fig.7. Test installation of the system ARWQM on the WWTP Citluk

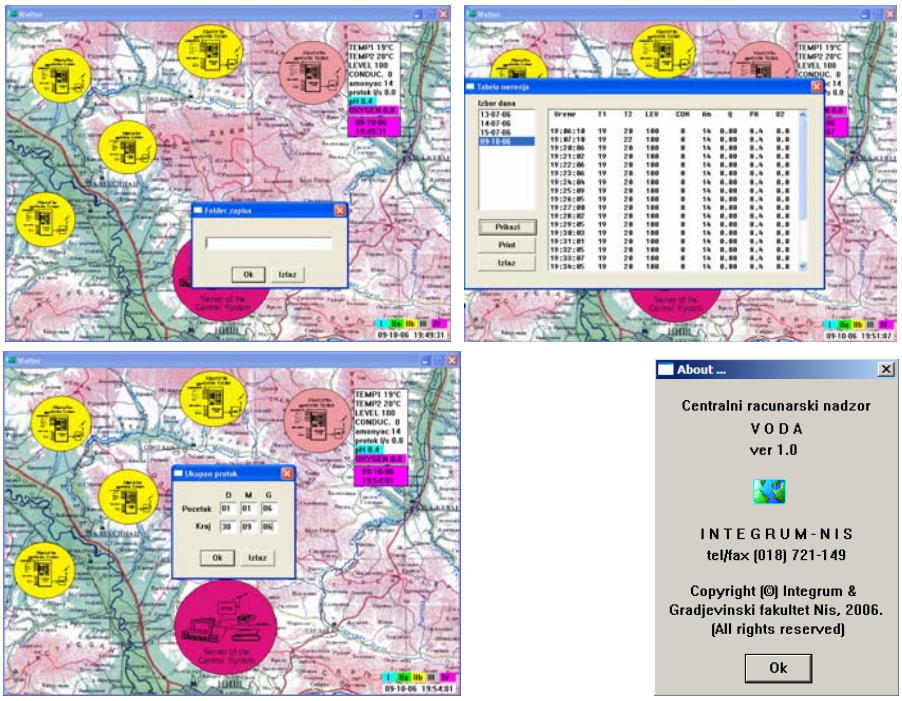

Fig. 8. Some possible functions of program package for ARWQM

4. CONCLUSION

Development of typical mobile station for ARWQ and it's placement on key points of selected river basin would enable complete monitoring of ARWQ in the basin, as well as monitoring of potential polluters. Typical mobile station would enable studying of bio-sensors and defining mathematical models of behavior for some bio-sensors depending on concentration of water quality parameters.

Connecting ARWQ data base, formed on the server, with the data base of spread of certain diseases among people who leave near the river basin, can be useful in determine the influence of water quality on the people's health (as well as on flora and fauna) in the region.

The system can have built-in algorithms for water quality analyses and water categorization on the basis of well known criteria. With lake flow regulation and waste water flow regulation (water released by polluters), keeping water quality in known categories can be achieved. In order to achieve complete ARWQM system it is necessary to track level of water in accumulation, lake, define max and min quantity of water in the lake for given period of the year, use meteorological data base, install best devices on water exhaust valves.

Environment polluted with herbicides and pesticides used in agricultural production, industrialization, increased waste waters in settlements etc., bring us to the fact that from ecological and environmental standpoint monitoring and keeping water quality in the river basin is of great importance.

Communication infrastructure of ARWQM system based on GPRS modem completely solves the problem of connection between the central computer (server) and microprocessor regulators INTEGRAF 1008G (client) within any area covered with the local mobile network. The use of GPRS modem within ARWQM system assures great flexibility of system for data acquisition, central supervision and management, in sense of eased expansion of network or excluding of some parts from the existing network.

The main lack of using GPRS modem within ARWQM system (real-time system), in comparison with cable connection trough 485 communication interface, is the functional dependence of ARWQM system from the quality of mobile service that Telekom Serbia or other local operator of digital GSM network provide. Unreliability of the service and the often traffic blockage would give negative reflection on the work reliability of ARWQM system, mostly in the system with possible managing and maintaining given water quality level. Time of response in ARWQM system with GPRS modems is longer then with using wire connections, and is also dependent on the load of the cellular network.

On account of all said above, in the ARWQM system, as real-time system, is provided possibility of using both GPRS modems and RS232 and RS485 communication interfaces (see Figure 9.).

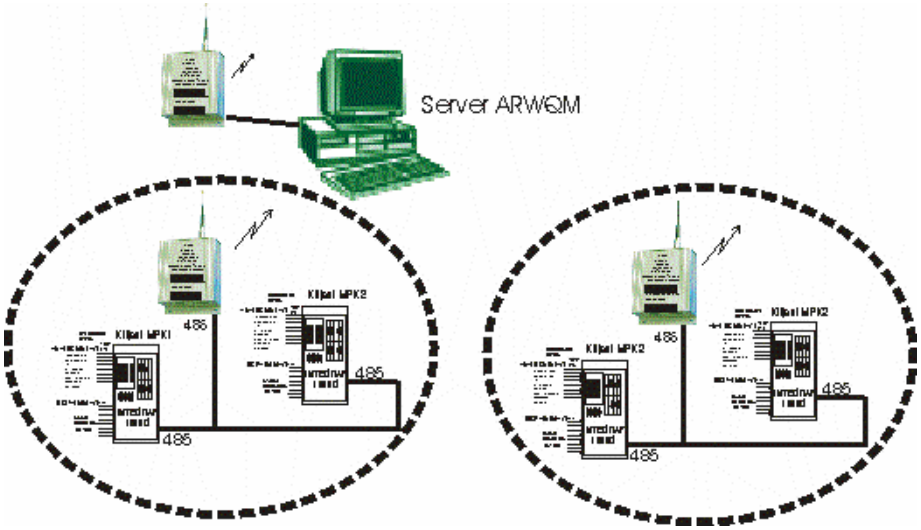

Fig. 9. GPRS modem and RS232 and RS485 communication

The ARWQM system could be used for transferring of meteorological data in stand-alone mode or in combination with the water quality data by expanding input parameters. It is also necessary to enable data buffering within INTEGRAF 1008G in systems where the only connection is trough GPRS, as a mean of prevention of data lost in cases when there is a traffic blockage or connection break.

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SISTEM ZA CENTRALNO OSMATRANJE, KONTROLU, PRIKUPLJANJE PODATAKA I AUTOMATSKU REGULACIJU ZA MODERNO MERENJE KVALITETA REČNE VODE (ARWQM)

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U radu je opisana konstrukcija uredjaja za osmatranje (monitoring) kvaliteta vode na otvorenim rečnim tokovima i povezivanje mreze uredjaja u jedinstveni centralni system za osmatranje i nadgledanje koristeci GPRS modemsku vezu. Uredjaj je testiran na postrojenju za preradu otpadne vode (WWTP) rudnika uglja Čitluk, Sokobanja i laboratoriji Gradjevinsko-arhitektonskog fakulteta u Nišu.