A simple wireless system for remote water quality monitoring in rural area rivers.

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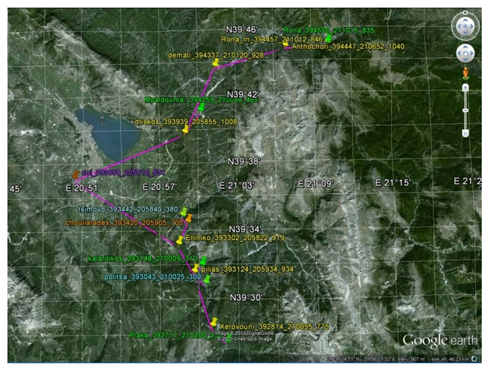
wwqm_avr project

The objective of the **Wireless Water Quality Monitoring of Arachthos and Vjosë Rivers (wwqm_avr)** project [1] is the development of an in-situ wireless river water quality monitoring sensor system equipped with a web server, based on a microcontroller, storing the data locally and transmitting them on demand through a WiFi point to point local network to a remote internet endpoint (personal computer) station. The later includes a wireless transceiver with directional antennas and gateway between the local network and the University networks as well as web services, user interface etc. Each p2p connection comprises a number of repeater nodes including directional antennas, access points and switches. All systems are solar energy self powered. The energy is stored in supercapacitors. All parts of the system are fixed on the upper section of a small antenna tower including a conical tank filled with fresh river water in fixed predefined times (4) during the day by a sling/rife pub (modern application of Archimedes snail or screw pump) operating by the river water flow. Eight sensors measuring Temperature, PH, conductivity, DO, ORP, Ammonium, Nitrate and Chloride ions are used. Due to the limited sunshine presence in the river gorges the system is active periodically and the data are calibrated locally using lab measurements. In order the stations to be synchronized for its periodical operation they are equipped by a GPS receiver in order to calibrate their local Real time clocks.

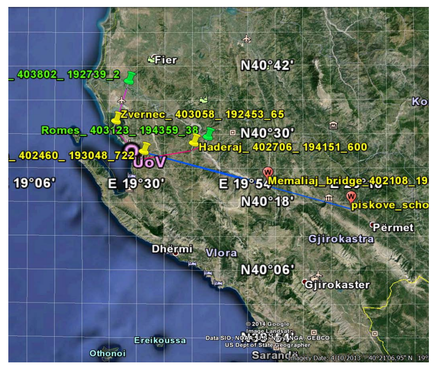
Target area

Arachthos area
Greece (rough river)



4 double and one single water quality monitoring station are foreseen in combination of eight repeater nodes. In addition a river flow online measurement station are foreseen.

Vjosë area
Albania, (smooth river)

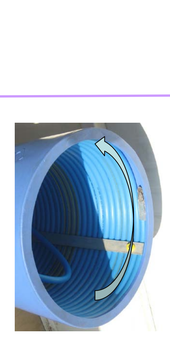


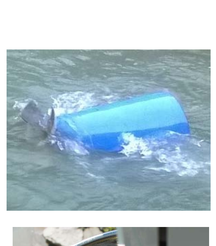
4 single water quality monitoring station are foreseen in combination of three repeater nodes. Two of them were foreseen to interconnect via the Albanian education school network.

Sampling system

Pumping river water to a conical tank using a sling pump based on the Archimedes snail pump [2]. The water must have the same physicochemical properties as in the river. The conical tank includes:

- 8 sensors (Temperature, PH, conductivity, DO, ORP, Ammonium, Nitrate and Chloride ions)
- 2 float switches one at the cylindrical bottom tank line and the other bellow the top cylindrical line of the tank
- 2 drain holes, one at the conical bottom connected to an electric valve and an water overflow bellow the top cylindrical tank line
- 1(or 2) fill hole bellow the top cylindrical line connected to 1(or 2) 3-way electro valve.



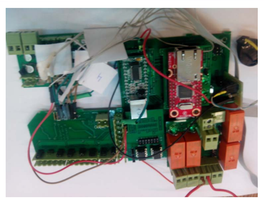


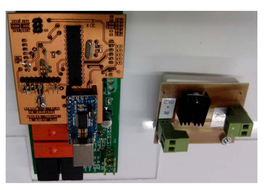
Beer conical tank

Sampling control and water quality measured system

Station electronics hardware

- web server in a ATmega2560 [3] μcontroller
- Real time clock (RTC), reset circuit
- Serial to SPI(Ethernet), Serial to USB,
- SD memory card,
- 4-20 mA to 1-5V sensor card,
- signal conditioning board for the ion selective sensors,
- sampling DAQ card, power supply card (3.3V)



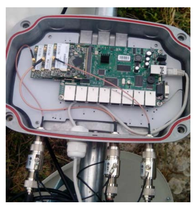


Station and repeater node power system

- Photovoltaic panels (2x20W)
- Power control system
  - Wake up power control card (based on ATmega328p and a GPS receiver)
  - Low voltage Power Supply (12V, 5V)
- Power storage system (based on supercapacitors [4])

Communication System

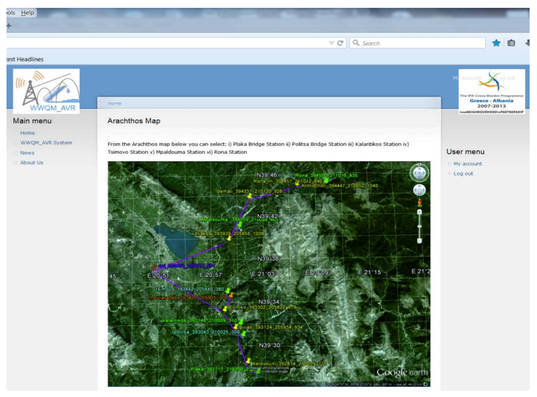
• River stations and repeaters (no line of sight between Universities and stations). Each station has two interfaces: one wired Ethernet to connect to the microcontroller of the station and one wireless to connect to the repeater (client) using a directional antenna (SXT at 5MHz, MikroTik Ltd).
• A MS Windows application called Winbox provides a graphical user interface for the RouterOS configuration and monitoring, RouterOS also allows access via FTP, telnet, and secure shell (SSH). An application programming interface is available for direct access from applications for management and monitoring.
• For the repeater nodes two options [5] are used:a) two directional antennas (SXT)), b) more directional antennas connected to wireless cards (R52H, Mikrotik up to 3) hosted in a routerboard (RB493, MiktoTik Ltd)



Sampling measuring procedure

- Every 6 hours starting on 06:00 GMT/UTC+2 time the system is powered for 10-20 min using the stored energy.
- The drain electro-valve is open and when the water tank is emptied (activation by the empty tank float switch), the water Input electro-valve is opened to fill the tank with fresh water . For 2 min the tank is cleaned, followed by the closure of the drain electro-valve to fill up the tank (full tank float switch).
- The input electro-valve is closed, and the sensors are activated, the water physico-chemical parameters are measured and stored in the μSD. The water remains in the tank until the next period for sensor protection
- At 18:10 all WiFi Wireless Water Quality Monitoring system stations are activated for 10 min in order to transfer the daily measurement files to the Universities.
- Parameter history plots updated.
- Calibration constants are calculated once a year using lab measurements. Using the same procedure the error on the measured.

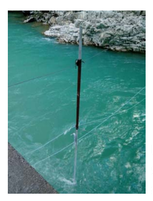
wwqm_avr site and monitoring end point site: www.wwqm-avr.info



Clickable areas in the map:
Links to daughter pages

Physicochemical parameters time evolution

wwqm_avr status – discharge (streamflow) measuring station.



Using a sliding rod in a hollow section having fixed at its end a propeller type current meter.

The hollow section is moving vertical to the river by a steel wire cable on tackle blocks

- River water velocity at a riverbed cross section (0.5 x0.5 m grid, in ~ 30x5 =150 points). Measurements for each (at least 3) water level ⇒ river discharge as a function of water level.
- The station measures-stores-sends the water level and calculates the discharge from a look up table.

Example of the water velocity for a specific water level (4 m) in ft/sec

6.05	6.475	6.75	6.4	6.625	6.45	6.5	6.125	5.625	5.4	5.275	5.075	2.225
5.7	6.1	6.5	5.8	5.15	5.05	5.1	5.75	5.35	5.25	4.8	4.4	2.8
rock	rock	0.2	0.6	3	1.8	3.6	2.25	3.2	3.1	2.9	2.4	rock
rock	rock	rock	rock	rock	rock	rock	rock	0.2	1.4	2.25	2.1	rock
rock	rock	rock	rock	rock	rock	rock	rock	rock	rock	rock	rock	rock

1x1 m grid

References

[1] Water Quality Monitoring of Arachthos and Vjosë Rivers (wwqm_avr-A.1-2.1-83-2.1), http://www.greece-albania.eu/index.php/projects.html?view=item&id=14, http://www.wwqm-avr.info ,
[2] Rife or sling river pump, http://www.riferam.com
[3] Atmel ATmega2560, http://www.atmel.com/devices/atmega2560.aspx
[4] Maxwell BCAP3000 P270, http://www.maxwell.com/products/ultracapacitors/k2-series
[5] Mikrotik SXT, R52H, RB493, http://www.mikrotik.com

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