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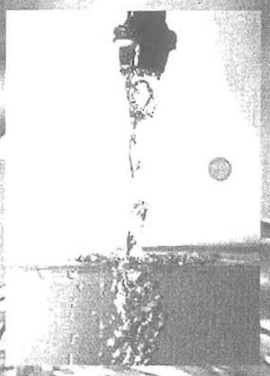
ROMANIAN WATER ASSOCIATION

1st Danube – Black Sea Regional Young Water Professionals Conference

INNOVATIONS IN THE FIELD OF WATER SUPPLY, SANITATION AND WATER QUALITY

14-15 June 2011



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The monitoring of water quality intended for human consumption

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Abstract
In Romania, the water intended for human consumption is obtained from surface water resources (90-92%) and underground water resources, and the existent systems of water supply cover only 65% of population consumption (97% for urban population).
Under the EEA Financial Mechanism, INCD ECOIND and STIFTELSEN SINTEF (Norwegian Company) will develop in partnership a project for monitoring potable water quality (from catching until production and distribution) supplied by two Romanian companies, which have, at regional level, monopoly on services of potable water production and distribution for at least 100,000 inhabitants.
The potable water quality monitoring duration was 12 months, over 1400 samples were taken from 185 sampling points, captation (raw water), technological flow, the plant exit, from storage tanks and from networks distribution – final consumers. For each sample physical and chemical determinations were performed according to national and European regulations. From the analytical results we constantly observed, for some water treatment plants - at the exit and at consumers - high concentrations of free chloride, trihalomethanes, aluminium, iron, zinc, sulfur and ammonium and sporadically we detected turbidity, nitrate, organic matters and manganese. Regarding microbiological quality, we observed the presence of *Clostridium perfringens*, *Pseudomonas aeruginosa* bacteria and mesophile bacteria which grow at 22°C and 37°C.
The expected results of the project are: adequate and representative monitoring programme of the quality of drinking water and measures and recommendations to protect human health from the adverse effects of any contamination of drinking water.

Keyword
Monitoring system; microbiological quality; drinking water; water treatment plant

INTRODUCTION

Nowadays, it is unanimously recognized that water resources (ground and surface water) are limited enough against water requirements and the water resources are not always of proper quality imposed to surface water used for potabilization.

In Romania, water intended for human consumption is obtained 90-92% from surface and underground water, and the existent systems of water supply cover only 65% of population consumption, of which 97% is for urban population.

The treatment systems applied in Romania for potable water obtained from natural sources are, in general, classic: pre-chlorination, coagulation/flocculation with aluminium sulphate, decantation/filtration on sand and disinfection with chlorine. The quality of water supplied by approx. 1400 treatment & distribution plants of potable water existent on the Romanian territory do

not always fulfil the requirements of the regulations in force for chemical and microbiological parameters, leading to potential risks for public health.
Under the EEA Financial Mechanism, INCD ECOIND (Romania) and STIFTELSEN SINTEF (Norway) developed in partnership, a project for monitoring potable water quality (from caching until production and distribution) supplied by two Romanian companies, which have, at regional level, monopoly on services of potable water production and distribution for at least 100,000 inhabitants.

The overall goal of the project is to protect the public health from the adverse effects of any contamination of water intended for human consumption, by ensuring that potable water produced and supplied by the Romanian companies meets quality conditions imposed by the national and European regulations [1, 2, 3, 4] and can be safely consumed.

The present paper has the intention to present the actual situation of drinking water quality supplied by 2 national companies, after a monitoring program implementation, to ensure the quality indicators for safe human consumption.

MONITORING PLAN

In the first step we selected the water treatment and distribution system from the South-Eastern part of Romania and we assesses the current operation status and analysis of the existent situation in the WWTP and distribution system of drinking water in order to identify: raw water sources and technological process; the control system of treatment process and water quality monitoring plan on treatment flow; the technical situation of water storage reservoirs and distribution system.

In the second step we assessed the current monitoring system of water quality from caching until to distribution, based upon the documents offered by the selected Romanian company. There we emphasized the control points, the number and types of water samples, sampling frequency/samples analysis, physical-chemical and microbiological indicators and the methods of analysis applied. Also, we assessed the water quality control laboratories (organization and personnel structure, facilities and environmental conditions, endowment and ways of registering /verifying /reporting of results) [5, 6].

After some working meetings with the project partners we have established the design of sampling and monitoring plan of the physical-chemical and bacteriological indicators according to the national and European regulations in force (EU Directive 98/83/EC)[7].

To develop and implement an adequate and representative monitoring program of the quality of potable water we have selected 2 companies located in the S-E part of Romania - SC CUP Dunarea SA Braila with 7 treatment plants (Braila, Chiscani, Gropeni, Ianca, Movila Miresii, Victoria and Rosiori) and SC ECOAQUA SA Calarasi with 6 treatment plants (Chiciu, Oltenita, Urziceni, Lehliu Gara, Budesti, Fundulea). The raw water sources of these water distribution companies are surface water from Dunarea River and groundwater from deep wells.

Depending of water sources, these companies apply different treatments to obtain potable water: for ground water – chlorination, oxidation – aeration, chemical oxidation and filtration; and for surface water – coagulation/flocculation with aluminium sulphate, decantation/filtration and pre-chlorination.

The water distribution companies have facilities and laboratory equipment for assessment of periodic monitoring of potable water produced and distributed and also for control of efficiency treatment procedure (especially for chlorination), for organoleptic characteristics and microbiological quality. They routinely perform physical measurements (temperature, pH and conductivity), volumetric determinations (water hardness, chloride, alkalinity and oxidability), spectrometric determinations (turbidity, free and total residual chlorine, ammonia, nitrite and nitrate) and metals (aluminum, iron, manganese) and microbiological determinations. Their laboratories perform outdated analytical and microbiological methods and don't have a quality management system implemented according to SR EN ISO 17025, but interest and preoccupation exist to obtain Health Ministry Authorisation and RENAR accreditation [8].

Sampling

The water quality monitoring has been developed in the period of October 2009 - September 2010, on a monthly basis in sampling campaigns and samples were analysed in order to evaluate the quality of raw water, the treated water and the potable water distributed to consumers.

The monitoring implementation plan required elaboration of a sampling guideline according to Drinking Water Directive for each selected water suppliers, which included information useful for the company staff, concerning the controlling points from treatment plants, critical points at consumers, routine and periodical monitoring parameters, list of physical – chemical and bacteriological analyses according to national and European regulation (Law no. 458/2002 concerning drinking water quality, modified/completed by Law no.311/2004, G.D. no. 100/2002 (NTPA 013) concerning the norms for surface waters quality intended for human consumption modified by G.D. no. 662/2005, Directive 98/83/EC for water quality intended for human use, Directive 75/440/EC for surface water quality used for drinking).

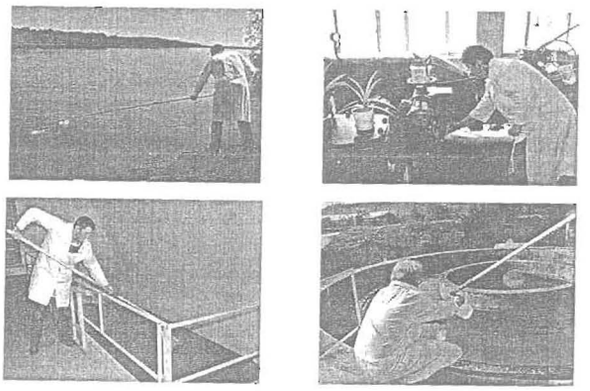

Figure no. 1 Sampling of drinking water (treatment plant)

During monitoring programme of 12 months over 1400 samples were taken from 185 control points at: caption – raw water sources; tehnological flow of the 13 treatment plants of the two selected companies; outpout of plants and from stock reservoires and distribution network – final consumers.

RESULTS AND DISCUTIONS

The physical – chemical and bacteriological analyses (about 55,000 analyses) were performed by INCD-ECOIND Bucharest, with acredited laboratories in conformity with ISO 17025:2005. For all analyses we used standardized methods at national /international level

In the next graphics (**figure no. 1- 17**) are presented the statistical results of analytical and microbiological determination for water quality distributed by Calarasi and Braila treatment plants.

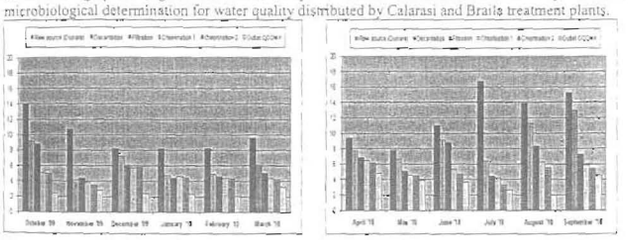

Figure no. 2 Variation of oxidability indicators for Calarasi treatment plant (october'09 – september'10)

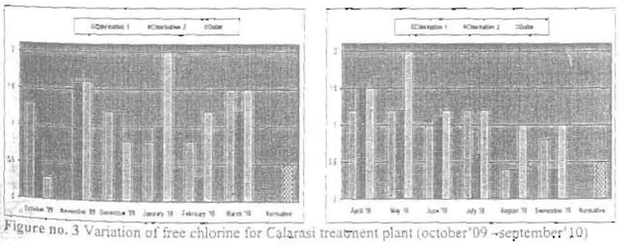

Figure no. 3 Variation of free chlorine for Calarasi treatment plant (october'09 -september'10)

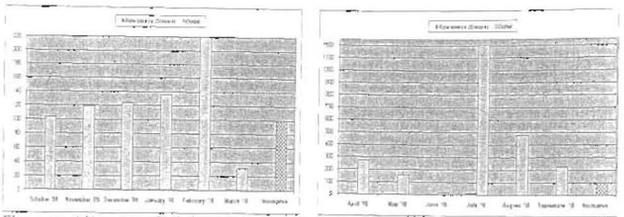

Figure no. 4 Variation of trihalomethanes for Calarasi treatment plant (october'09 –september'10)

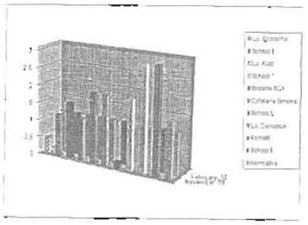

Figure no. 5 Variation of free chlorine at Calarasi consumers (november'09 –february'10)

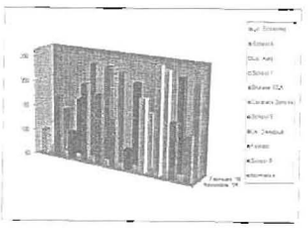

Figure no. 6 Variation of trihalomethanes at Calarasi consumers (november'09 –february'10)

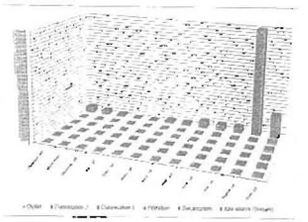

Figure no. 7 Variation of mesophile bacteria at 22°C for Calarasi treatment plant (october'09 – september'10)

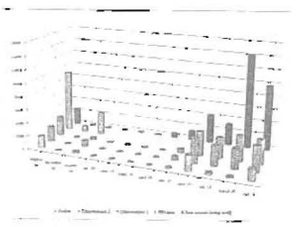

Figure. no. 8 Variation of mesophile bacteria at 22°C for Urziceni treatment plant (october'09 – september'10) (Br 1-20 – consumers)

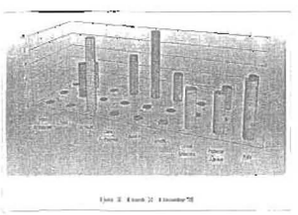

Figure no. 9 Variation of mesophile bacteria at 22 °C for Calarasi consumers

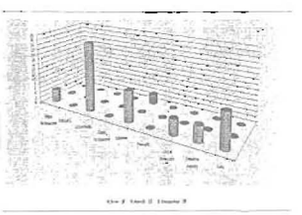

Figure no. 10 Variation of mesophile bacteria at 37 °C for Calarasi consumers

Table no. 1 Overtaking indicators for raw water sources, outlet plants and distributed water-consumers (SC ECOAQUA SA Calarasi)

TREATMENT PLANT	OVERTAKING INDICATORS
SC ECOAQUA SA Calarasi	
CHICIU Calarasi	*Raw source (Dunarea River):* Kjeldahl nitrogen (3.21-7.80 mg/L), dissolved hydrocarbons (0.09-0.6 mg/L), CBO_5 (3.21 -7.80 mg/L) and anionic surfactants (0.051 -0.211 mg/L) *Outlet:* free chlorine and trihalomethanes, *Clostridium perfringens* *Consumers:* free chlorine and trihalomethanes
OLTENITA	*Raw source (Dunarea River):* Kjeldahl nitrogen (3.36-6.54 mg/L), dissolved hydrocarbons (<0.05-0.81 mg/L) and anionic surfactants (0.063 -0.707 mg/L) *Outlet:* free chlorine and trihalomethanes *Consumers:* free chlorine, trihalomethanes, mesophile bacteria at 22°C and 37°C, *Enterococcus* sp. and *Pseudomonas aeruginosa*
URZICENI	*Raw source (deep well):* sodium (260-309 mg/L), manganese (165-298µg/L), bor (1009-1406 µg/L) *Outlet:* manganese, sodium, bor *Consumers:* manganese, sodium, bor, mesophile bacteria at 22°C and 37°C
LEHLIU-Gara	*Raw source (deep well):* ammonia (2.09-5.02 mg/L), sulphides (2551 -7717 µg/L), turbidity (1-7 UNT), oxidability (1.6-8.1 mgO2/L, 4.58-17.25 mgO2/L), sodium (150-202 mg/L, 149-210 mg/L) *Outlet:* sulphides, ammonium *Consumers:* sulphides and ammonium, mesophile bacteria at 22°C and 37°C
BUDESTI	*Raw source (deep well):* manganese (39-156µg/L), ammonia (0.41-0.79 mg/L) *Outlet:* manganese, nitrate, mesophile bacteria at 22°C and 37°C *Consumers:* maganese, mesophile bacteria at 22°C and 37°C
FUNDULEA	*Raw source (deep well):* nitrate (23.56 -42.8 mg/L), bor (231-282 mg/L) *Outlet:* mesophile bacteria at 22°C and 37°C *Consumers:* mesophile bacteria at 22°C and 37°C

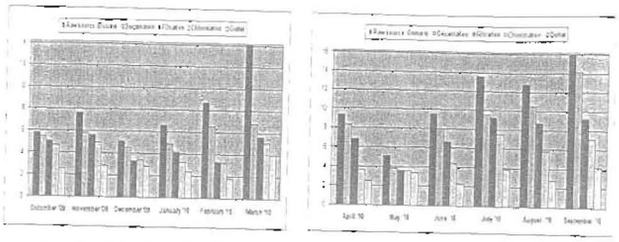

Figure no. 11 Variation of oxidability indicators for Braila treatment plant (october'09 – september'10)

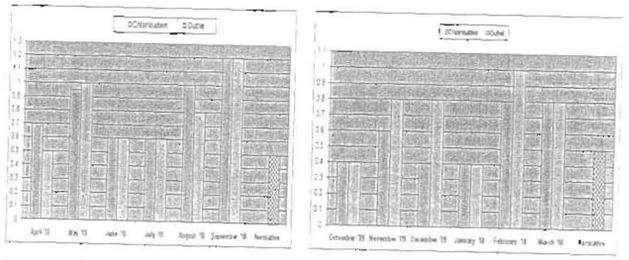

Figure no. 12 Variation of free chlorine for Braila treatment plant (october'09 –september'10)

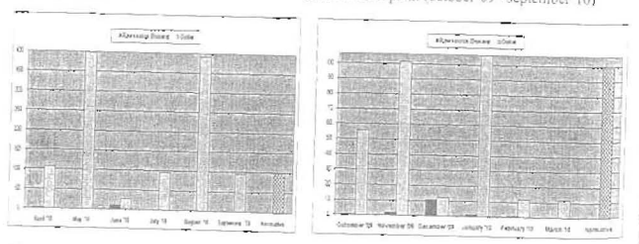

Figure no. 13 Variation of trihalomethanes for Braila treatment plant (october'09 –september'10)

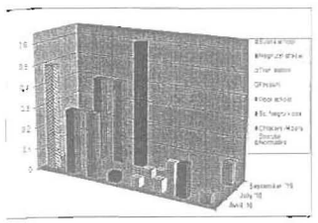

Figure no. 14 Variation of free chlorine at Braila consumers (april'09 – september'10)

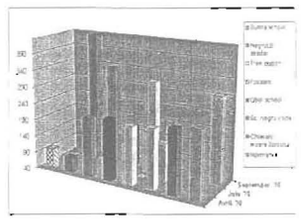

Figure no. 15 Variation of trihalomethanes at Braila consumers (april'09 – september'10)

Table no. 2 Overtaking indicators for raw water sources, outlet plants and distributed water-consumers (SC CUP „Dunarea" SA Braila)

TREATMENT PLANT	OVERTAKING INDICATORS
SC CUP „Dunarea" SA Braila	
BRAILA	*Raw source (Dunarea River)*: Kjeldahl nitrogen (3.16-6.98 mg/L), dissolved hydrocarbons (<0.05-1.09 mg/L) and anionic surfactants (0.103 -0.698 mg/L) *Outlet* : free chlorine şi trihalomethanes *Consumers*: aluminium, free chlorine si trihalomethanes
CHISCANI	*Raw source (Dunarea River)*: is within the limits *Outlet* : trihalomethanes, free chlorine (in summer time) *Consumers*: trihalomethanes (in summer time)
GROPENI	*Raw source (Dunarea River)*: Kjeldahl nitrogen (3.11-6.23 mg/L), dissolved hydrocarbons (<0.05-1.36 mg/L) and anionic surfactants (0.103 -0.68 mg/L) *Outlet* : trihalomethanes and free chlorine (in summer time) *Consumers*: trihalomethanes and free chlorine (in summer time), mesophile bacteria at 22°C and 37°C
IANCA	*Raw source (Dunarea River)*: Kjeldahl nitrogen (3,08-6,01 mg/L), dissolved hydrocarbons (<0.05-1.28 mg/L) and anionic surfactants (0.191 -0.59 mg/L) *Outlet*: trihalomethanes and free chlorine (in summer time), mesophile bacteria at 22°C and 37°C *Consumers*: trihalomethanes and free chlorine (in summer time)
MOVILA MIRESII	*Raw source (Dunarea River)*: Kjeldahl nitrogen (3.16-6.48 mg/L), dissolved hydrocarbons <0.05-0.79 mg/L) and anionic surfactants (0.09 -0.414 mg/L) *Outlet*: trihalomethanes and free chlorine (august), *Clostridium perfringens* *Consumers*: trihalomethanes and free chlorine (august), mesophile bacteria at 22°C and 37°C

VICTORIA	*Raw source (deep well):* sodium (202-240 mg/L), manganese (84-120 µg/L), bor (630-1030 µg/L), turbidity (3-7 UNT), ammonia (0.21-1.87 mg/L), iron (100-350 µg/L) *Outlet:* is within the limits *Consumers:* is within the limits
ROSIORI	*Raw source (deep well):* sodium (390-470 mg/L), manganese (37-55 µg/L), chloride (220-260 mg/L), nitrate (23-62 mg/L), iron (200-306 µg/L), water hardness (47-52 German grades) *Outlet:* is within the limits *Consumers:* iron and zinc

The evaluation of analytical results emphasized high concentrations of free chloride, trihalomethane, aluminum, iron, zinc, sulphide and ammonium at outlet, for some treatment plants and at consumers. Turbidity, nitrate, organic matter and manganese exceeding were sporadically detected. Regarding microbiological quality, we observed the presence of *Clostridium perfringens, Pseudomonas aeruginosa* and mesophile bacteria growing at 22°C and 37°C.

In conclusion we have observed that in all monitored treatment plants (Calarasi and Braila) and consumers, most physical - chemical and microbiological indicators are in acceptable limits. High concentrations of free chlorine, trihalomethanes and aluminium were constantly identified at consumers.

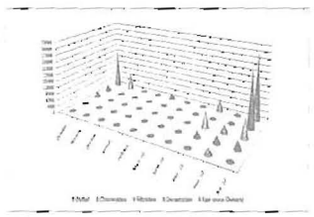

Figure no. 16 Variation of mesophile bacteria at 37°C for Braila consumers

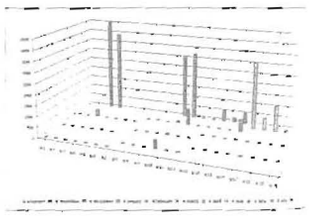

Figure no. 17 Variation of mesophile bacteria 22°C for Braila consumers

CONCLUSIONS

The monitoring activity of drinking water quality, from source to consumers, has revealed the following aspects:

- it is necessary for some treatment plants to adopt some improvement measures for treatment processes,
- cleaning and replacement of water network distribution, where is appropriate;

assessment of a strict analytical control of water quality through constant analysis of pollutants for raw water and drinking water on network distribution - trihalomethanes, aluminum, manganese, iron, zinc, bacteriological indicators.

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