INFLUENCE OF CLIMATE CHANGE ON SURFACE WATER QUALITY IN THE MANECIU – CHEIA AREA

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Abstract

The need for continuous monitoring of surface water quality in order to produce estimations necessary to maintain and provide the sufficiently sources and quality of groundwater is an ongoing concern of the authorities in the protection of water quality. For drinking water sources such studies are required by European legislation. According to the usage degree of surface water for drinking water established by the Romanian Waters Administration, the Buzau-Ialomita basin represents 3.5% of the total water resources. Inside of this basin, the Maneciu-Cheia area has, besides surface waters, an intensively exploited natural lake being an area sensitive to climate change.
This paper aims to analyze the influence of climate change on forest ecosystems and on water quality in the mentioned area. The study having been developed within the European project CC-WARE. The relevant physico-chemical indicators analyzed in the paper are: temperature, organic matter, nutrients, turbidity and pH. As novelty items, tracking the influence of climate change within the CC-WARE project enables the estimation of water resources vulnerability and the prediction of water quality in the studied area for the years 2015 and 2020, based on the monitoring data.

Key words*: climate change, water quality, forest, vulnerability, quality index.*

INTRODUCTION

Globally and nationally, it can be seen that lately, as a result of climate change the frequency of extreme events has increased (heat waves, droughts, storms and heavy rains accompanied by hail, heavy snow, fire), leading to increasing forest area injuries affected by: the drying (and thus the attacks of insects , fire) and tearing wind and snow , landslides , floods etc. The extension, the structure and the health of forest ecosystems threatened by climate change, are vital to ensure a balanced diet of resources and quality of waters. The interaction between the population's growth, urbanization and development with the need for water, the flood control and the way of exploitation/ change of the utilities, requires the restoration of the degraded land and the improvement of water basins in a manner that enables ecosystem services to become more sustainable. Moreover, these engineering activities closely related to forestry, have been and are accepted worldwide as an effective tool to maximize the ecological services and to ensure clean and stable water resources (Giurgiu at al. 2006).

INFLUENCE OF CLIMATE CHANGE ON THE FORESTS

Considering climate and its changes, the analysis of factors / causes that affect forests is particularly important because it allows highlighting a long chain of interactions with harmful effects, interactions generating risks in terms of the environment, of which there emerge:

- acceleration of floods frequency and intensity, due to rapid runoff of rainwater and soil erosion;
- lowering hydropower potential and drinking water resources;
- instability of agricultural production, by disrupting fluid balance and increased droughts;
- reducing the economic and tourism potential of the affected areas.

Other climatic and anthropogenic factors that may lead to the forests deterioration are (Simionescu et al., 2012): the wind and snow causing significant harm (crashes and ruptures) to softwood forests in the mountain, the exacerbated drought in the last decade, which can trigger the growth of the mass of insects, also drying the forests and forest fires diminishing forest area and increasing fragmentation, exacerbated by the political events of 1989, deforestation, grazing in forests, contributing to the deterioration of environmental conditions and the disruption of specific balance of forest ecosystems.

Regarding the hydrological efficiency of the forest, this is the optimal protective shield against erosion, providing a balanced diet of water or snowmelt runoff, helping to stop hydrology modifications and to reduce flooding (*Constandache et al., 2012*). Research has shown that the hydrological efficiency of an ecosystem is dependent on its characteristics and of the soil's, as appreciated by 3 parameters: retention, runoff, erosion amount.

Forests adjacent basin analyzed in this paper are located in most of the mountainous area and the Carpathian hills that guard stepped terraces and plateaus furrowed by deep valleys, with lithological substrate predominantly of sedimentary nature, which increases land vulnerability to erosion, landslide, clogging etc.

The average altitude of the study area is 600 m, and the altitude increases from south to north and it varies between 490 m, at the confluence of Valea Mare with Teleajen, and 1954 m - Ciucas peak.

The vegetation of the area studied, in the Maneciu village, bordering the lake, shows a wide and diverse range. In alpine mountains, over 3000 ha of forests are composed of coniferous forests where spruce and fir tree predominate, while at lower altitudes one can meet mainly hardwood species: ash, hornbeam, elm, birch, alder and so on; the South hills, just as the terraces, are covered with orchards or crops, ponds and meadows.

The hydrographic network consists of Teleajen river, as main stream, flowing from N to S with many tributaries one of which being Telejenel At its confluence with Teleajen it was built a large engineering goal that created a reservoir with an area of 34 square kilometers and a total volume of 60 million cubic meters of water.

The temperate climate of forest specific to this area is cold and wet with long harsh winters. The average annual temperature is 8 degrees C, the average in July is 19 degrees C and in the January 4 degrees C. The average rainfall is 960 liters with the maximum period in May-June and minimum in winter. Precipitation as snow is quite low, the snow is on average 20-30 cm.

The predominant soil types are brown soils and alluvial with profound acidic characteristics. Out of the agricultural land adjacent to forest areas, about 61% are brown acid soils and alkaline soils are about 13%. Note that of the total area of 23643 ha of Maneciu village, 16971 ha (about 72%) are covered by forest.

CLIMATE CHANGE AND THE HYDROLOGICAL EFFICIENCY OF FORESTS IN MANECIU AREA

Previously reported phenomena associated with specific Maneciu habitat (mountains, hills, valleys) preclude to the multifunctional role of forests, given that they suffer continuous changes in size, structure, diversity / quality, age, etc. The structure and stability of forests in the hills can be imbalanced in case of climate change, in the sense of reducing rainfall and increasing temperatures, as well as increasing the awareness of extreme events.

The softwood forests will be affected by the climate changes by increasing of the areas affected by crashes / tearing wind and snow (spruce) and drying (fir, pine and spruce outside the area), phenomena exacerbated lately. The existence of the upper alpine basins of watercourses, the upper limit, the natural forest is an important variable in assessing vulnerability of water resources. This area is

the most active and the most vulnerable in the formation of flash floods, as it has steep slopes, it is completely bare, rocky bed, with significant rainfall and land configuration that allows rapid runoff concentration. Such areas are transiting through the river in the forest, a large influx of water and large quantities of silt, which loads watercourses with solid material and can clog the lake.

INFLUENCE OF CLIMATE CHANGE ON WATER QUALITY IN THE MANECIU-CHEIA AREA

Within Maneciu-Cheia basin, besides surface water, there is a natural lake intensively exploited, as an area sensitive to climate change. Maneciu Dam is located on the confluence of Telejenel with Teleajen, at the foot Ciucas upstream Maneciu town in Prahova County (Hydrografic area Management Plans, 2013, Hydrografic Buzau - Ialomita Management Plans, 2013). The Maneciu dam has a height of 75 feet and a crest length of 750 meters. Lake formed after raising the dam has a volume of 60 million cubic meters and an area of 192 hectares. The dam and lake at Maneciu were thought to have multiple functions. Thus, they play important roles in water supply to settlements of Prahova, irrigation and power generation, but also for flood control (Panaitescu at al., 2008). Tracking of the influence of the climate change within the CC-WARE project was done by estimating the vulnerability of water resources and water quality in the studied area and forecast for 2015 and 2020, based on previously monitored data (EUROSTAT Requirements).

MATERIALS AND METHODS

Physico-chemical indicators chosen in terms of their climate changing influence on surface water quality in the area studied were: temperature, organic matter, nutrients, turbidity and pH. Experimental determinations were carried out in the year 2012 in the laboratory of wastewater treatment and at PGU Ploiesti. Analyses were performed in accordance with applicable standards and using the appropriate equipment, such as: temperature and turbidity were determined using the apparatus HANNA , organic matter content was determined with the VELP device, equipped with sensor BOD, pH was determine with a WTW device, and nitrate and nitrite with Jenway UV-VIS spectrophotometer.

Corresponding concentrations of organic substances were determined by EPA Method 405 and in accordance with standardized methods of Romania STAS 6560-82 and ISO 6060/96, (EPA 821R00003 Analytical Method Guidance, 2002). Nitrogen content was determined according to STAS 8900/1-71, 7890/1-98 ISO STAS 8900/2-71 nitrogen, nitrogen ISO 6777-96. pH was measured with WTW device (ISO 10523-97), turbidity according to STAS 6323/2008. Water sampling was done according to ISO 5667-6:2009 (Panaitescu at al., 2013).

RESULTS AND DISCUSSIONS

Climate change, as seen in the evolution of the water's average temperature within Maneciu-Cheia basin, was in 2012 as follows: during the summer about 21.1º C minimum and maximum of 24.4º C, and in winter the water temperature varied between -1.1º C and 11° C. High temperatures affect water quality due to lower amount of dissolved oxygen and algal population growth. With the increase in atmospheric temperature, the water surface is heated by solar radiation forming two layers of different density.

The winter stagnation occurred and nutrient concentrations decreased significantly due to the reduced intensity of photosynthesis, which is otherwise characteristic of December and January. Water has a relatively constant temperature of 4-6º C, a lower concentration of nutrients, organic and biological substances (algae, bacteria).

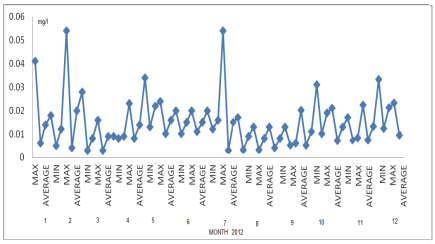

Figure 1. Variation of nitrites concentrations from Maneciu lake in 2012

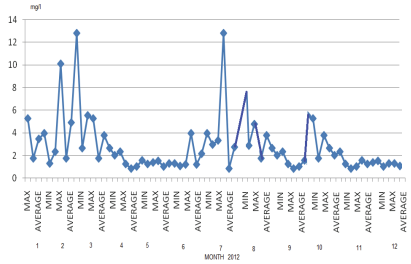

Figure 2. Variation of concentrations of nitrates from Maneciu lake in 2012

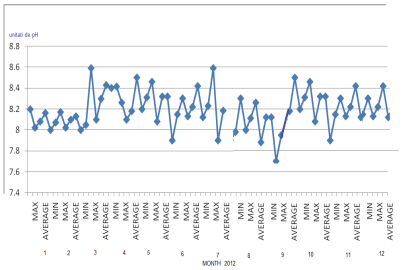

Figure 3. Variation of pH from Maneciu lake in 2012

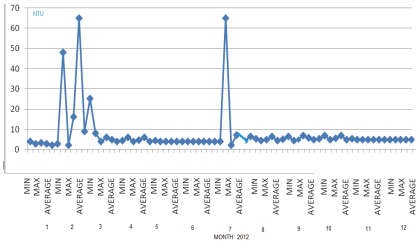

Figure 4. Turbidity from Maneciu lake in 2012

Maximum annual values were recorded when the nitrites were in the range 0.003 mg / L and 0.054 mg / L. Nitrate concentration ranged in 2012 from the value of 0.840 mg/L to the value of 12.82 mg / L. The pH varied between 7.80 and 8.59 pH units, while the turbidity ranged from 2.2 NTU to 65 NTU.

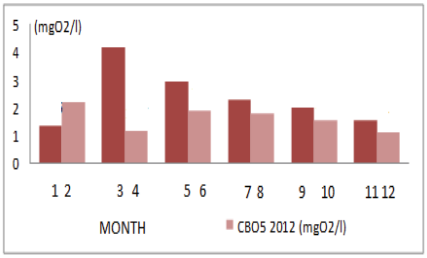

Figure 5. Variation of CBO_5 concentration in 2012

These organic substances in large quantities of about 5 mg / L reduce the concentration of dissolved oxygen, leading to algal population growth due to lower dissolved oxygen concentration. The water quality should be good when BOD5 is maximum 1.9 mg / L.

Estimating the vulnerability of water resources with water quality indices

The quality indicators that may help to estimate the vulnerability of surface waters from Maneciu-Cheia area were chosen WQI (the Water Quality Index) (equation 1, table 1) (Adriano et al. 2006).

$$WQI = \left(\sum_{i=1}^{n} q_i w_i\right)^2 \quad (1)$$

where:
WQI – the Water Quality Index
i – the quality parameter
q_i – the registered value
w_i – the rank of implication of the parameter in the computation formula.

Table 1. Index value intervals and the corresponding quality category

Water quality	Value intervals (percent)
Excellent	95-100
Good	74-94
Moderate	50-74
Marginal	25-49
Poor	0-24

After the calculation of the WQI value, the obtained result of 78% shows that framing water has a good quality. But if we compare this figure with the previous years (Panula Basin Management Buzau-Ialomita, 2012) there may be noticed a degradation of water

quality due to major climate changes in 2012. Water quality class makes it good to be used both for the production of drinking water and for small industry.

Due to climate changes emerged in recent years, the water quality in this area has been classified as good to moderate in 2015 and 2020 (Management Plan). So, based on the data collected by the INS and NARW, there were proposed targets required for the quality of potable water.

Therefore, till 2015, there will be elaborated the drinking water safety plans for urban areas and, till 2020, in all towns with a population higher than 5.000 inhabitants.

CONCLUSIONS

It can be seen that lately, due to climate changes, there has increased the frequency of extreme events (heat waves, droughts , storms and torrential rains, accompanied by hail, heavy snow, fire), factors that determined the growth of forest areas affected by different kind of damage: drying (and henceforth the attacks of insects, fires), crashes and breaks caused by wind and snow, landslides, floods etc.

The analysis of factors-causes that affect the forest is particularly important because it allows highlighting a long chain of interactions with harmful effects, interactions generating environmental risks, in general, and to water quality in the adjacent forest ecosystem, in particular.

For a better performance and a maximum efficiency of the hydrological and ant erosion functions, there are necessary a good proportion, distribution and, especially, a certain structure of the forest in the basin area, and it is required a qualitative analysis of all the utilities in the catchment to assess the vulnerability of the water resources and to establish the management measures and emergency response in terms of climate change.

Forests condition and stability are of major importance in the fulfillment of their environmental, social and economic functions as they are assigned.

REFERENCES

Adriano A., Bordalo Rita, Teixeira W., Wiebe J., 2006, A Water Quality Index Applied to an International Shared River Basin: The Case of the Douro River, Environmental Management, pp. 910-920.

Constandache, C., Bilea, I., C., Vică, P., Bilanici, A., 2012, Monitorizarea bazinelor hidrografice torenţiale - mijloc de prevenire a dezastrelor naturale, în condiţiile schimbărilor climatice, Revista Pădurilor nr. 3, pp. 27-33.

Giurgiu, V., Clinciu, I., 2006, Padurea si regimul apelor, Editura Academiei Române, Bucuresti, pp. 285

http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Water_statistics.

*** Hydrografic area Managent Plans, 2013, Romanian Waters National Administration.

*** Hydrografic Buzau-Ialomita Managent Plans, 2013, Romanian Waters National Administration.

*** http://www.statistica.md/newsview.php, 2009, Activitatea sistemelor de alimentare cu apa.

Panaitescu, Casen, Onutu, I., 2013, Monitoring the quality of the sludge resulted from domestic wastewater treatment plants and the identification of risk factors, Environmental engineering and management journal, Vol. 12, pp. 351-358.

Panaitescu, C., Popescu, C., Dobre, L, Popa, M., 2008, Information management for monitoring surface water quality - case study: Ploiesti, Romania, Information management in the modern organizations: trends & solutions, vols 1 and 2, Conference: 9th International-Business-Information-Management-Association Conference (IBIMA), Marrakech, MOROCCO, pp. 1100-1103.