MONITORING OF SUCEAVA RIVER UPSTREAM AND DOWNSTREAM OF THE HOMONYMOUS CITY IN 2018 AND 2019

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ABSTRACT

Water level, electrical conductivity, dissolved oxygen, oxidation-reduction potential and pH of Suceava River were monitored in 2018 and 2019 in order to assess the upstream-downstream evolution of these parameters and the impact of Suceava City on this river that divides its built area. The measurements were done automatically every hour with two AquaTROLL 500 instruments. This study focuses on analyzing distinct time intervals with typical and atypical fluctuations of the selected parameters as well as on identifying some periods when the upstream and downstream time intervals have different behaviors. Streamwater pollution events were detected by some parameters, e.g. by peaks in specific conductivity recorded only downstream, where higher than upstream values are constantly recorded. Our study shows that Suceava city has a measurable impact on Suceava River. The downstream monitoring point indicates that, after passing through the urban area, Suceava River has more polluted waters, as revealed by the increased values of specific conductivity and the lowered values of dissolved oxygen, oxidation-reduction potential and pH. Causes and effects of the observed values are also discussed.

Keywords: monitoring system, water quality, streamwater evolution

INTRODUCTION

Streamwater monitoring is a necessity today for forecasts and for a better assessment of river water behaviours under different natural and anthropogenic conditions. Water quality of rivers in urban areas is of high interest for those aiming to investigate changes induced by various human activities and buildings specific to cities. Land use in urbanised watersheds have a measurable effect on river water quality [1] and water specific conductance (SC), pH and oxidation-reduction potential (ORP) are useful parameters for an overall view [2-3]. The water level, dissolved oxygen (DO), SC and pH are frequently used parameters in various monitoring systems around the world, some of them with real-time data [4]. Water parameters such as pH, DO and electrical conductivity are often used to calculate water quality indices for various rivers [5]. The significance of data obtained in the field increases with the increase in the sampling frequency due to the modern equipment.

The aim of our research was to implement a streamwater monitoring system on Suceava River. We obtained real-time data and used that data to provide a meaningful analysis of the measured water level, SC, DO, ORP and pH.

STUDY AREA

Suceava metropolitan area has a population of approximately 150000 people and is located in Suceava Plateau, part of the Moldavian Plateau, in the north-eastern Romania. Climate is temperate continental, with hot and wet summers. Rivers in the study area have important discharges in the early-mid spring, after the snowmelt, and during summer, when the heavy rainfalls occur. There are studies dealing with the physical and chemical properties of rivers in Suceava Plateau [6], some of them describing the self-purification of Suceava River [7]. This river has an average flow rate of approximately 17 m^3/s and passes through the middle of Suceava city (Fig. 1). Inside the city, this river receives waters from its urban tributaries, which drain some of the urban stormwaters and wastewaters. At the exit from the administrative area of Suceava city, Suceava River receives the discharge of the urban wastewater treatment plant. The monitoring points used in this study are located on Suceava River at Mihoveni Dam (used for run-of-the-river hydroelectricity), upstream of Suceava city, and at Tişăuţi, downstream of the city (Fig. 2). The distance between the two points is 14.5 km along the river.

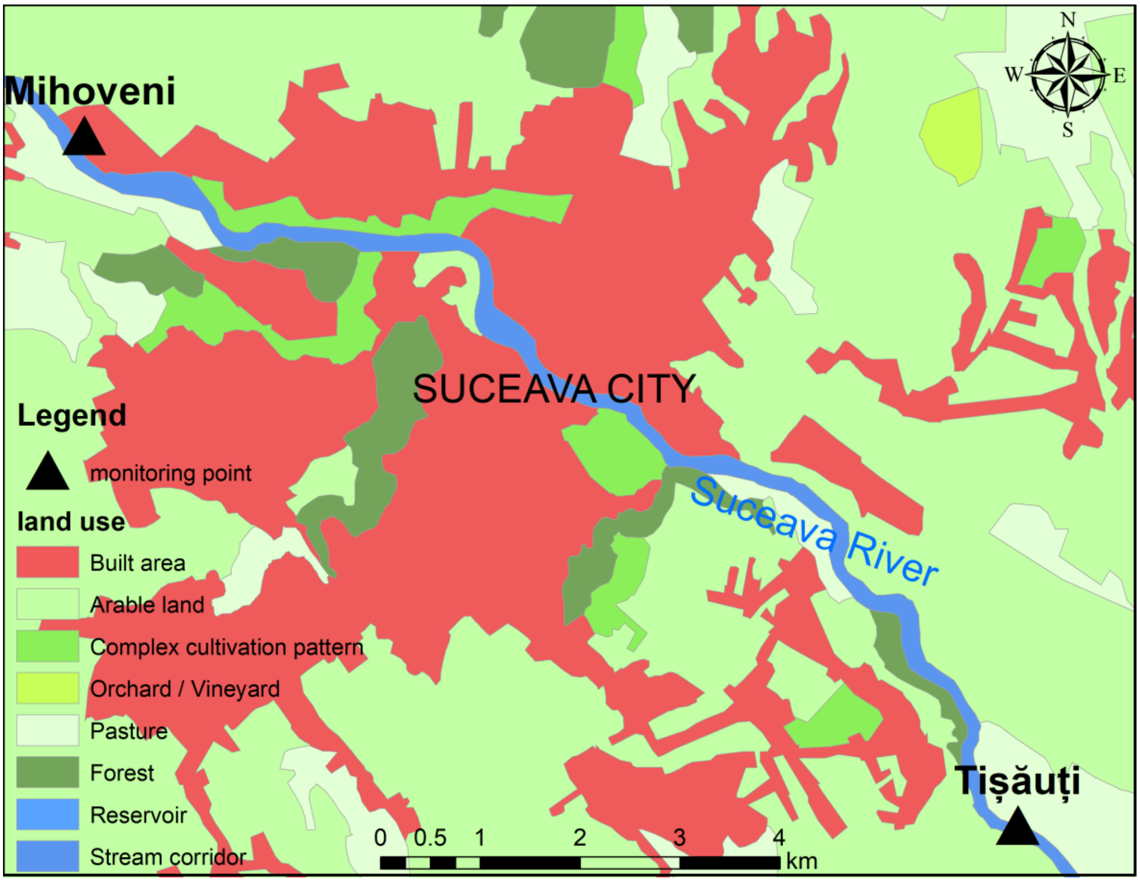


Fig. 1. Overview of Suceava city and its surroundings, where the two monitoring points are located (simplified land use extracted from CLC 2018 [8]).

a b

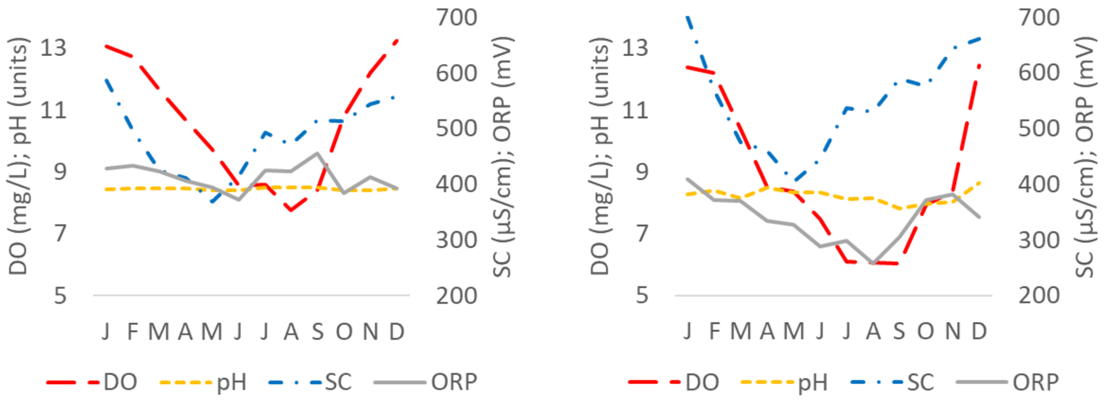
Fig. 2. Site details of the selected monitoring points: a. Mihoveni (upstream); b. Tişăuţi (downstream).

DATA AND METHODS

Data was obtained within a research project that provides real-time data about Suceava River upstream and downstream of Suceava city. At both monitoring points, AquaTROLL 500 multiparameter instruments were used for measuring water properties every hour during October 10^{th}, 2018 - October 9^{th}, 2019 (this is the time interval used for the analyses in this study only). Each instrument was equipped with sensors for measuring water level, SC, DO, ORP and pH. All data used the local standard time (EET) and the database was corrected by removing erroneous or missing values. Data can be viewed and downloaded at http://water.usv.ro, the project website where other details about sensors, sites and data can be found.

RESULTS AND DISCUSSION

The annual regimes of the monitored parameters indicate that there is an annual variation for most of them (Fig. 3). Due to discharge/temperature increase, SC/DO have the annual minimum in May/August. ORP and pH are less sensitive to climate.



a b

Fig. 3. The annual regime of DO, pH, SC and ORP at the upstream (a) and downstream (b) monitoring points.

A typical temporal evolution for a few consecutive days (days or weeks scale) of the monitored parameters indicates a similar upstream-downstream evolution consisting of successive diurnal cycles (Fig. 4). Cycles in water level are less obvious and frequent than in the time series of the other parameters. The diurnal cycles are unphased, the general trend being to have a variation later downstream due to the time needed for a water volume to travel from Mihoveni to Tişăuţi (variable time depending on water level/velocity). At high waters, peaks propagate downward within 2-3 hours, in general. During baseflow, diurnal maxima can be found downstream after 4-5 h from the moment of occurrence at Mihoveni. Valleys in SC, caused by high waters, can propagate downward in 4 h (as for pH), while the diurnal maximum, caused mainly by evapotranspiration, occurs downstream after a highly variable delay of approximately 12-16 h. The diurnal cycles of pH in our points are almost continuously in antiphase.

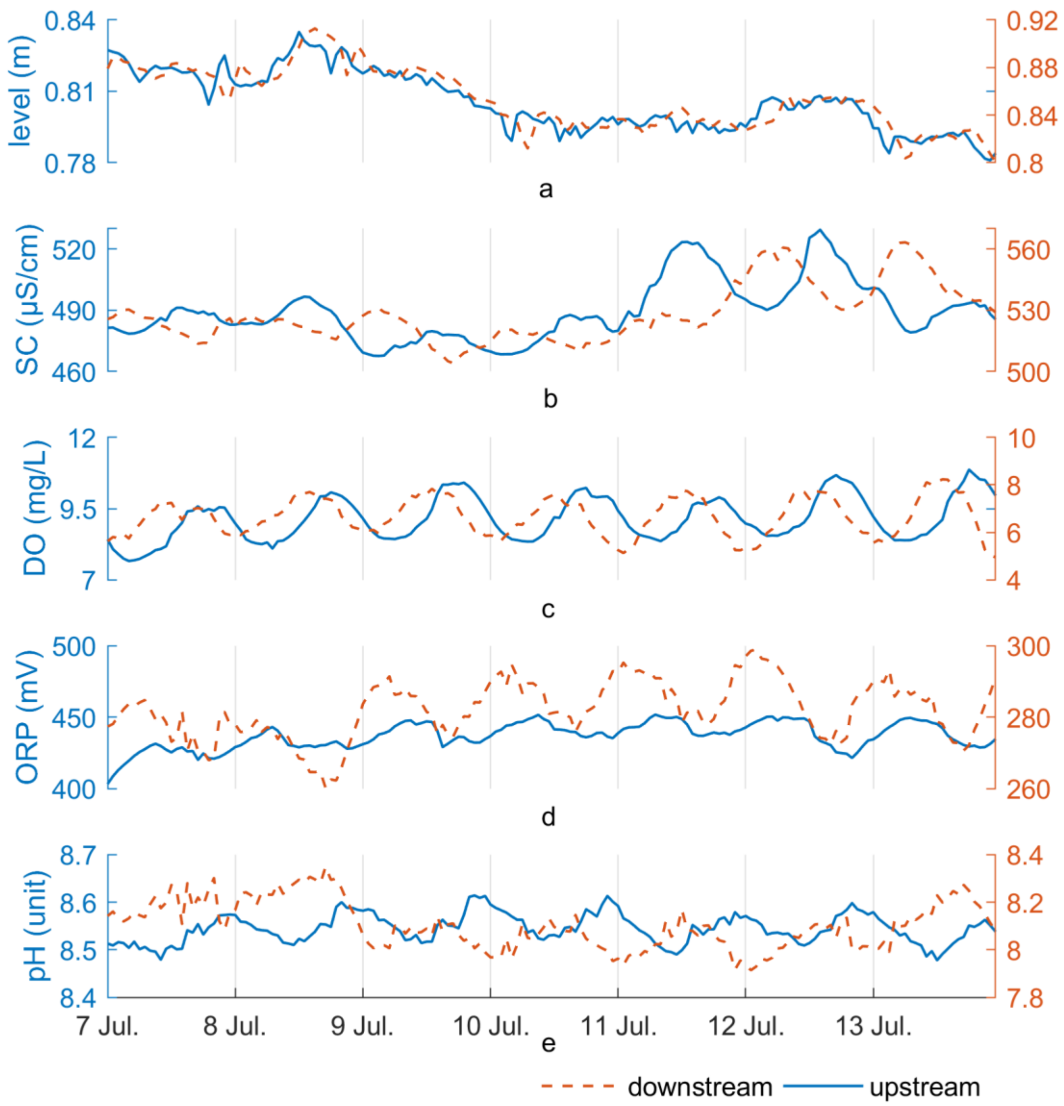
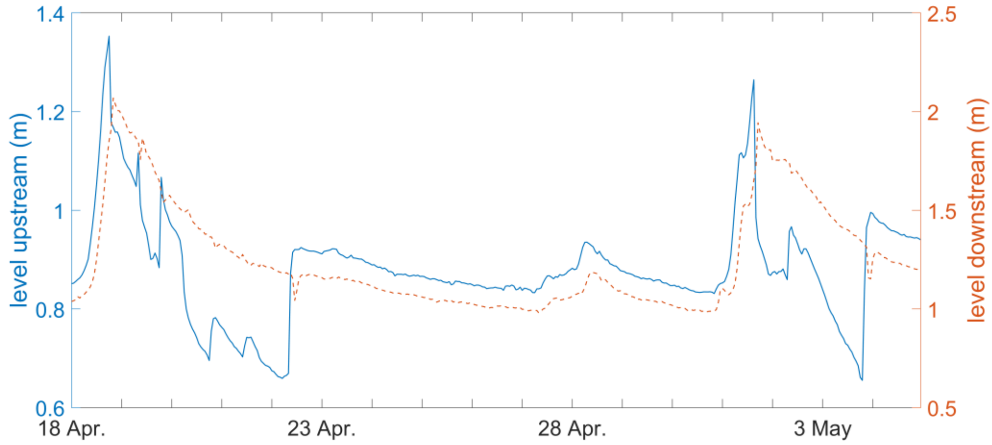


Fig. 4. Typical temporal evolutions of the studied streamwater parameters at the upstream and downstream monitoring points: a. level; b. SC; c. DO; d. ORP; e. pH.

Being dependent on air and water temperature, the DO parameter should, in theory, exhibit simultaneous diurnal cycles at both monitoring points. Simultaneous and in-phase variations of the diurnal cycles occur only in some cases. The dominant pattern, revealed by the shape analysis of consecutive diurnal cycles, has the diurnal maximum/minimum occurring approximately 6 h earlier at the downstream monitoring point. ORP diurnal cycles at Mihoveni and Tişăuţi tend to be in antiphase or out of phase.

Atypical temporal evolutions of the studied parameters occur in various cases. These behaviours refer to time intervals when only the macro trends are still preserved. For example, during high water events, the diurnal cycles are perturbed or absent. There are also cases when, at a monitoring point, diurnal cycles occur for one parameter, whilst, at the other monitoring point, the same parameter has fluctuations with a pattern similar to that of the white noise. The selected atypical upstream-downstream temporal evolutions are displayed in Figs. 5-7. Water level records rare and abrupt increases and decreases due to maneuvers at the Mihoveni Dam (during high waters), which caused water level increases at Mihoveni during April 22nd and May 3rd, 2019 (and decreases at Tişăuţi).



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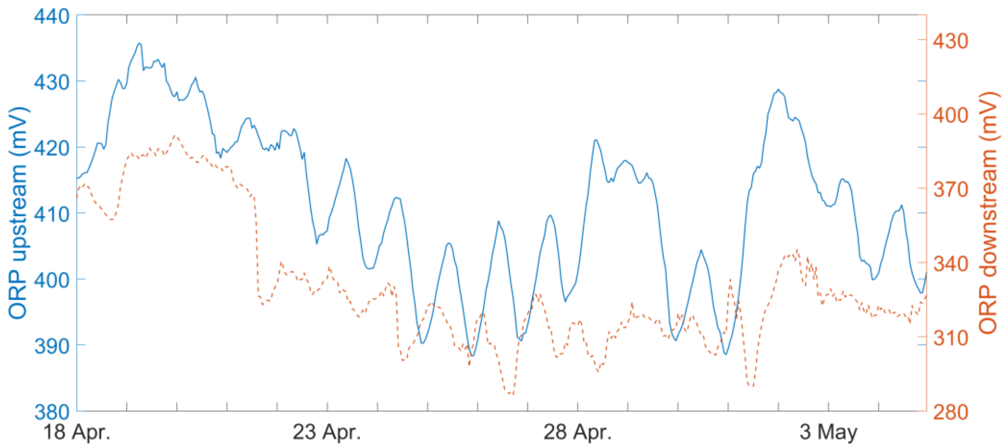


b

Fig. 5. Atypical temporal evolutions of streamwater level (a) and ORP (b) in 2019.

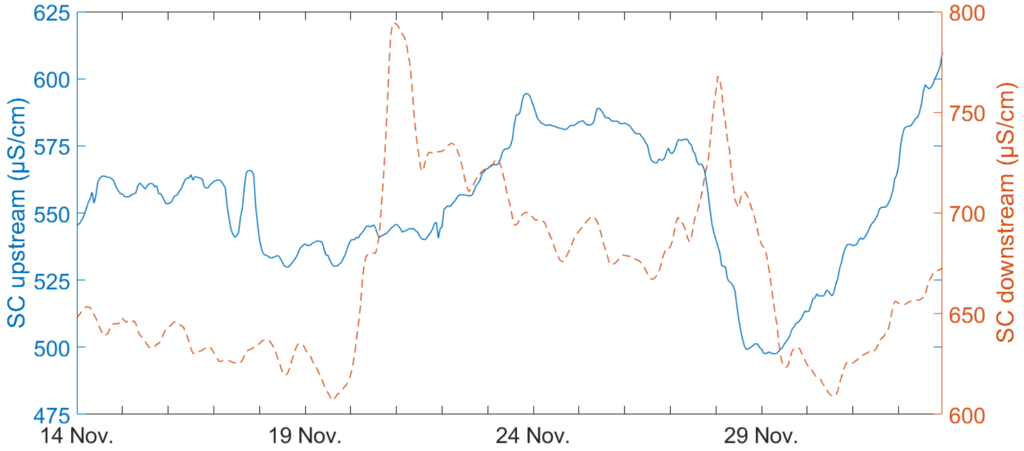
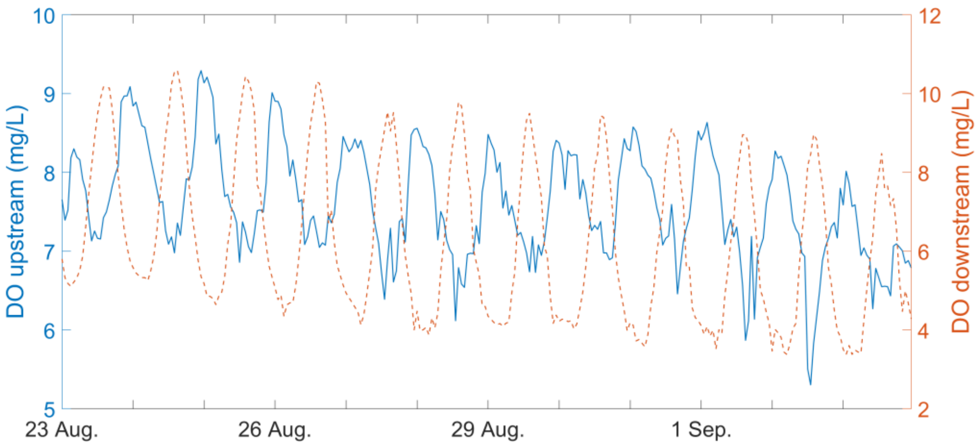


Fig. 6. Atypical temporal evolution of streamwater SC in 2018.



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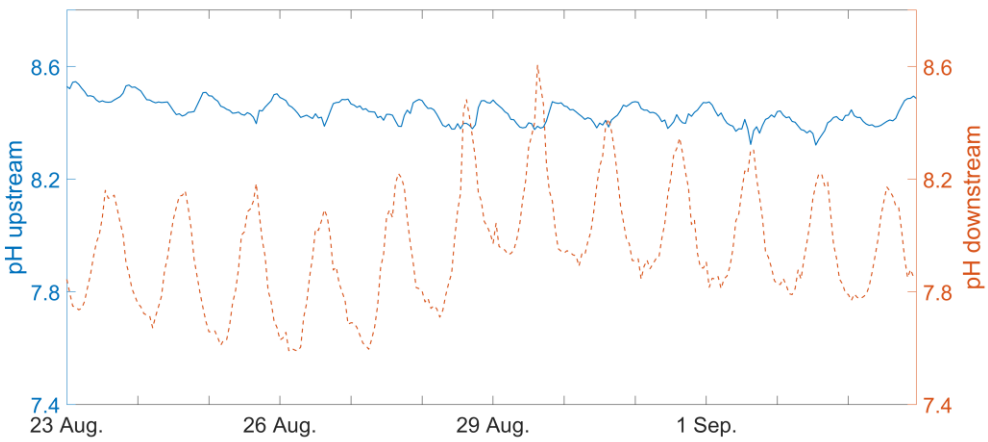

b

Fig. 7. Atypical temporal evolutions of streamwater DO (a) and pH (b) in 2019.

During the time interval depicted in Fig. 5, ORP recorded increased values due to natural increases in flow rate (caused by rainfalls in the catchment), but remained insensitive to the short-term changes induced by man (at the dam).

There are cases when important peaks of a parameter occur only downstream, due to the impact of the urban areas. This is the case for SC in the late of November 2018 (Fig. 6). After important snowfalls, de-icing measures were applied in Suceava city and lead to an increase of salt concentration in Suceava River downstream of the city – as result, peaks in SC were recorded during November 20^{th}-21^{st} and 27^{th}-28^{th}. Salts as de-icing agents in cities have a measurable impact on urban rivers and riparian ecosystems and originate from roads and wastewaters [9-10].

As observed in the figures of this study, SC has constantly higher values downstream than upstream. An inverse relationship between the values of the studied monitoring points applies to DO, ORP and pH. Sometimes, the minimum diurnal value of a parameter in one point is equal to or greater than the maximum diurnal value of the same parameter in the other monitoring point. These big differences are caused by Suceava metropolitan area through its stormwaters, urban heat island and wastewaters. Also, the variability of the studied parameters is greater downstream than upstream.

There are cases when the amplitude of the diurnal cycle recorded downstream is so big that the maximum diurnal value is greater than its counterpart from Mihoveni. This occurred for DO in August - September 2019 (Fig. 7). During this time interval, the diurnal cycles were in antiphase. Also, the diurnal minima downstream reached values that are critical to native fish species in Suceava River. In the same time interval, pH recorded a similar behaviour, but had less important diurnal amplitudes, during August 28^{th}-29^{th}.

CONCLUSION

Strong annual cycles were observed in the SC and DO time series. Significant diurnal cycles were measured in the temporal evolution of SC, DO, ORP and pH, but these cycles have different shapes and positions at Mihoveni and Tişăuţi. The low DO values recorded downstream have a negative ecological impact. A relevant atypical upstream-downstream temporal evolution of SC occurs when de-icing solutions are applied in Suceava City and salts enter Suceava River, leading to high SC only at the downstream monitoring point. Changes in Suceava River water properties from the upstream monitoring point to the downstream point indicate an overall decrease in water quality.

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