**The Drava River through miles and seasons**

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**1. Research questions / hypotheses**

Drava is the longest European river. It enters Croatia at Ormoz, and flows into the Danube near Aljmas. The entire length of the flow is 720 km. Annual average flow rate of Drava is 1- 1.5 m/s, which indicates a relatively fast flow and high mechanical strength, which erodes the coast. For the Drava river is characteristic glacial water regime which means maximum water draft from May to July, lowest draft of water from December to February.

Drava is of great importance for two very distant cities - Varazdin and Belisce. This distance attracted us to do joint project. Drava dictates development, location and climate of the cities, which is why we were very interested in research.

Our research questions:

1. What is the annual mean temperature of the river Drava in Varazdin and Belisce?

1. What are the most differ properties of Drava on the two stations during the year?

2. How water level affects the temperature and water clarity at these stations?

**Our hypotheses**:

Annual mean temperature of the water will be balanced without major deviations on both the station with minimum temperatures in winter and peaking during the summer months.

2. Small differences are expected in water temperature, the greater the difference on the two stations is expected in the transparency of the water.

3. Water level affects the properties of the Drava river. A higher water level of the water causes less transparency and a lower temperature at both stations.

**2. Research methods**

At stations, we were measuring water and air temperature and transparency of Drava.

Measurements were conducted according to GLOBE Hydrology protocols. The temperature of the water and the air we measured with alcohol thermometers. The transparency of the water was measured by Secchi disk. National Meteorological and Hydrological Service provided us with data for water level.

In order to compare the data, we took measurements the same days of the week at the same time.

The data obtained by measurement we presented graphically.

**3. Data**

The research lasted one year (from 4th October 2014 to 4th October 2015). Measurements were conducted on Saturdays from 13 to 14 hours at stations Varazdin and Belisce.

The collected data we presented graphically.

Chart 1. Graphic view of transparency of the Drava river at stations Varazdin and Belisce

From the chart we see that the transparency of water is much higher at the station Varazdin. The measured values ​​are in the range of 10 cm up to 250 cm. The highest values ​​of transparency were measured at the end of December and in January. Transparency was the lowest in October and November.

Chart 2. Graphic view of temperature of the Drava river at stations Varazdin and Belisce

Analyzing data from Chart 2, we see that the water temperature at both stations match. The temperature maxima were achieved in July and August (Belisce - 27˚C, and Varazdin - 25 ° C). The minimum temperature was achieved in December and February.

Chart 3. Graphic view of water level of the river Drava at stations Varazdin and Belisce

Data from Chart 3. shows that the annual mean water level at the station Varazdin is uniform while at the station Belisce there are leaps in the winter and summer months. At the station Belisce we can see two minima, in the period from December to February and in September and two maximums in late May, on the beginning of June and in late autumn (November). The highest measured value at Belise is 412 cm and in Varazdin 250 cm. The lowest values ​​are 95 cm in Belisce and 76 cm in Varazdin.

Chart 4. Graphic view of impact of water levels (Blue line) on transparency (Red line) at the station Varazdin

Chart 5. Graphic view of impact of water levels (Blue line) on transparency (Red line) at the station Belisce

From charts 4 and 5. we can see how water level affects the transparency of the water on both stations: the greater the water level the less transparency of water is and vice versa.

Chart 6. The dynamics of the water level (red line) and water temperature (blue line) at the station Varazdin

Chart 7. The dynamics of the water level (red line) and water temperature (blue line) at the station Belisce

From both charts is visible inverse proportionality of the water temperature and water level through the year. During the high water level the water temperature decreases and vice versa.

**4. Conclusions**

1. The results showed the correspondence to the measured temperatures at both stations. Annual mean temperature is uniform with no major deviation and has a distinctive seasonal travel. The increase in water temperature is associated with an increase in solar radiation and thus temperature of air.In summer and autumn months, the water temperature was slightly higher at the station Belisce while in spring and winter temperatures were the same. Cause of slightly higher temperatures at the station Belisce in the summer and autumn months can be a lower altitude (Varazdin-169-173n / m; Belisce- 91-93n / m), higher air temperature at the station, and increased water levels of water which led the slower cooling of water (specific heat of water).

2. Water transparency data agree with our assumptions, because they show a much greater transparency of the water at the station Varazdin. This may be because of sandy and muddy ground on the station Belisce, location of the town which is 234 river km farther than Varazdin, higher water level in Belisce and greater erosion of the surrounding soil. Low transparency (less than 1 m) at the stations are indicative of the larger amounts of suspended solids and high productivity of water in autumn. The highest values ​​of transparency were recorded in December and January when the water level and productivity decreased.

3. From the results of research we found that the water level affects the temperature and water clarity at both stations. A high quantity of water causes lower temperatures and lower water clarity. At the station Varazdin stable water level can be linked to hydro powers in the area that regulate the amount of water, but also reduce amount of sediment (Bonacci, 2006).

Higher water levels were recorded at Belisce with two maximums in the late spring and summer (snow melting) and late fall due to heavy rainfall. Minima are in winter and in September when there is no melting of ice in the Alps. At stations Belisce there is less transparency due to high water levels and muddy and sandy substrates.

**5. Literature**

1. GLOBE Hydrology protocol

2. Bonacci O, Oskoruš D. 2006. The influence of three croatian hydroelectric power

plants operation on the river drava hydrological and sediment regime, Faculty of Civil Engineering and Architecture, Split University

3. <http://www.obz.hr/hr/pdf/zastitaokolisa/Osnova%20obiljezja.pdf>

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