

VJETRENICE

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In the same climatic type, canyon and cliff valleys show some significant deviations of certain climatic parameters, especially air temperatures and humidity relative to the same values at the same time of measurement on open surfaces. These changes in a very small area are salient in the warmer period of the year, especially during summertime, when the thermal differences measured in the said river valleys in relation to the open valleys and the temperature, difference in temperatures can be up to 10°C, while the air humidity is around 40 %.

Daily thermal and hygrometric oscillations increase if the river valley is rather deep and narrow and oriented south-north and covered with dense forest vegetation. They are less warm during the day compared to surrounding open areas, resulting in lower temperatures, higher air humidity and slightly higher air pressure. In such circumstances there will be different baric state within these valleys compared to the surrounding open terrains, primarily as a result of uneven heating. The more compacted isobars of higher air pressure in the cooler closed canyon-cliff valleys will direct the isobaric system towards the thinner isobars of the warmer air at the end of these valleys. In this way, the advection of cold (fresher) air will be established, towards the warmer environment where the canyon or cliff valley are ending.

Advection of the air conditioned by unequal baric conditions is actually a vapor wind that constantly blows from a cooler river valley to its end. This aeration places them within special valley type that carries refreshment and is called vjetrenice.

Key words: narrow river valleys, cliff-canyon river valleys, thermal differences, air humidity, isobaric states, advection, vjetrenice.

INTRODUCTION

During field research works of different themes, primarily hydrographic in diversified natural geographic environments, thermal differences within the narrow river valleys (canyon and cliff ones) in relation to the open area were observed. Refreshment is felt in those valleys, and at their end, an intensive advection somewhat with colder air towards the warmer surroundings.

Winds of fresh air occur during thermal differences that are established as a result of unequal heating of the air conditioned by vertical and horizontal relief breakdown. Their basic expression is very narrow and relatively deep river valleys. These processes are enhanced if those valleys are covered with high and dense forests.

The consequence of a somewhat lower temperature in these valleys is caused by increased humidity and slightly higher air pressure. From these valleys isobaric conditions are directed towards the valley ends so there is constant stream of fresh wind which defines such valleys as Vjetrenice

MATERIAL AND METHODS

Research object

The study of these weather conditions was carried out during the summer in the year of publication of this number of scientific journal. For this purpose, we used a small river valley of Dzamijski potok, the tributary of the Solunska River, which in the place of Solun is ending up in Krivaja River. Apart from this, comparative research was carried out in the Orliji valley, with more diverse relief, which ends in Hoćeonica, the left tributary of Krivaje in its upper stream.

Therefore, the object of the research is the upper river basin of the river Krivaja, whose stream is created by the juncture of Bištica and Stupčanica in Olovo, and ends in Zavidovići in the Bosnia river. It is the most important tributary of the Bosnia River.

The Krivaje River Basin belongs to the moderately warm and humid climate of the continental variant with an average isotherm of 8,4°C and a isohyet of 1215 mm. This type

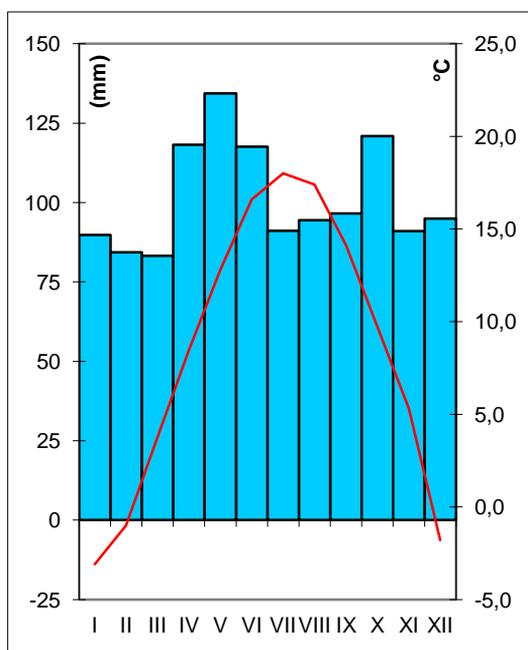


Fig.1. Air temperature and precipitation diagram in the Krivaja valley

of climate defines four seasons in which transitions are somewhat shorter and phenologically less pronounced in relation to summer and winter. Therefore, in this climate and in the indicated geographical environment, the average year is divided in a warmer and colder period. In such circumstances, long-term weather conditions, which generally define the climate, during the warmer period of the year can be quite warm with a slightly longer period of hot days accompanied by drought, and the winters are sometimes moderately cold and less snowy. The situation can be reversed, so the summers are fresh, and the winters are sharp, snowy and cold.

The definition of this climate is also influenced by topoclimatic characteristics. In the horizontal indented relief morphological depressions, be it basins, valleys, and combinations thereof, during the colder period of the year can occur thermally crafts, known as a temperature inversion, while in the warmer periods of

the year in narrow valleys, due to the closure of relief, and thus shortened duration of the sun's shine, a slightly fresher weather conditions can be formed, i.e. lower temperatures, increased humidity and air pressure in relation to open and less diversified relief spaces. Such weather conditions are particularly pronounced in the deep canyons-cliff valleys of the northern exposures and primarily in those covered by dense forest vegetation.

Research methodology

In order to obtain relevant indicators that document this phenomenon, the mobile instrumental monitoring was used that consisted of: precise (referent) mercury thermometer, aspiration thermometer, hygrometer and barometer (aneroid). All these instruments were removable from one place to another, which was required by research methodology.

Measurements in the shadow of the trees included an open space at the entrance of the narrow valley of the Dzamijska creek where the strongest air flow was felt. Thus, at the end of a narrow valley we carried out operational measurements and the measurements in open spaces served as a comparative ones.

During the work, the methods of weather measurements of both the temporal and meteorological one were applied. The collected data was analyzed and with the comparison method checked at several more locations. After the analysis of the obtained indicators, they were also synthesized in general, which is an opportunity for discussion and a conclusion about the mentioned problem.

RESULTS AND DISCUSSION

During the summer of 2017, there was a longer drought with temperatures during the day, especially around the afternoon when it was over 30°C , although it cannot be defined as tropical days, as the temperature during the other days of measurements was lower than the temperature threshold to be called tropical. Under such conditions the air was almost dry, and the air pressure was quite high.

When entering the very deep and narrow valley of northern expositions with the vegetation of the site of the Dzamijski creek, the tributary of Solun stream, the flow of fresh air was noticed. Its freshness and velocity of flow increases from the morning and is maximally high during the fastest period of the day, ie, 2 hours after the upper culmination of the sun above the horizon. After that period airing becomes weaker and in the evening it stops and continues until the morning the next day. The flow of air is a one way process from valley towards the open surface.



Fig.2 . In the canyon river valleys in the Krivaja basin, the topoclimate with modified climatic elements in relation to the basic climate type is formed.
Explanation in text

The results of open field measurements in the shadow of trees, two hours after the upper culmination of the sun, showed a temperature of 32.8°C , humidity 28% and air pressure of 999, 3 hPa. At the valley's entrance of Dzamijska creek, the measured temperature was 24.2°C , humidity 67%, and the air pressure was increased to 1000 hPa. The low warming of the deep and wooded valley of the northern exposition showed a lower temperature of 8.6°C , so the air humidity increased by 39% and the air pressure was 0.7 hPa.

All this caused special baric state

with an orientation from the valley of Dzamijski creek towards its completion on the open area. In such conditions the advection of cooled air occurs for about 8,6° C and more humid for 39% from the narrow valley to the open surface. The current air is much fresher due to the occurrence of thermal differences, which caused the change of other meteorological parameters, especially humidity and air pressure.

During night, morning and evening when warming is weaker, and the substrate radiation is increased, an equilibrium state of the mentioned weather parameters is established, so the airflow from the narrow valley towards the open surface is absent and vice versa. The advection of the air from the narrow valley towards the open surface occurs and in other days and seasons when there are no significant thermal amplitudes between valleys and open surfaces.

The valleys of these morphological features are more common in the basin of Krivaja, as well as the entire Dinaric basin of Bosnia and Herzegovina. The intensity of these phenomena is greater if greater amplitude differences occur, and directly depend on the depth of the valley, the afforestation, the exposure, and the sudden opening at their end.

Comparative studies were conducted in the valley Orlje, right tributary of Hocevisa, which in Križevići ends in Krivaja from its left side. Orlja is quite deep, along the longitudinal profile of the staggered valley with the basic direction south-north. At its estuary it is still closed but shows no significant deviations of thermal regime in relation to more open areas. Because of such morphological conditions the stronger advective streams of fresh air directed from the south to the north are not generally felt. The measurements in its lowest floors show lower temperatures by about 5°C, higher humidity by about 20% and air pressure by about 0.5 hPa in relation to the farther adjacent open surfaces. Therefore, this valley is completely fresh in its whole length, and its temperatures almost never exceeds 26°C.

The third valley below the Boganjska / Ponjerka cave at its end, in which the same meteorological parameters are measured, shows almost identical values to those listed in the Dzamijski creek. Differences in the measured meteorological parameters in this valley are conditioned, besides its valley closure, even with the flow of cold air from the cave down its valley in the direction of the Krivaja river.

CONCLUDING CONSIDERATIONS

The narrow, afforested deep valleys of the northern exposures, due to the short warming of their surface during the day, have cooler air compared to the open spaces. The difference in the temperature of the ground air is evident, due to which the inclined isobaric state is formed from the valley to the open, and thus the warmer surfaces. Because of this, the air flows from the valley towards its end and brings a lot of freshness and coolness. This condition is established only during the warmer period of the year during hot summer days. Valleys from which a cool air flows are named Vjetrenice.

Vjetrenice have an evident role in lowering the summer temperatures in the main river valleys of Bosnia and Herzegovina in which the narrow canyon-cliff valleys end. Because of this, the air temperatures in them during the summer are considerably lower in relation to the broad valley areas. Thermal differences can be higher than 8 ° C.

During the summer precipitation, due to the slightly lower air temperature in the vjetrenica, there is a local increased amount of precipitation due to a slightly moist air in them. In addition, during the summer they have a pronounced advection of air in the case



Fig. 3. Source of the Orlja river. At its source the water temperature averages at 4.5 C and of the air it's 7 C. During the summer, fresh air blows from it.

when horizontally from the warmed substrate air flows through vjetrenice, where it cools down and thus condensates.

Vjetrenice, during the summer are the refreshments that the inhabitants use for this purpose. During the winter, vjetrenice are places of accumulation of cold air as a result of temperature inversions of lowering air masses. In them, snow is kept for at least 15 days longer than the open areas. The participation of temperature inversions in the lowering of air masses when cold air is settled in them also shows vegetation that

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