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CHANGES IN SPECIFIC DISCHARGE IN THE WATERSHED OF VIT RIVER

Abstract: The report is aimed at the changes in the specific discharge occurring in the watershed of Vit River from the middle of the last century to the present day. It treats two periods, for which are published maps of specific discharge (1935/36-1954/55 hydrologic year and 1951-1965 year) and average values at hydrometrical stations for the periods 1961-1998 year and 1961-2002 year. At graphic way are compared the location of the contours with the same value of specific discharge during different periods. Since the middle of last century to the present day module runoff in the catchment area of Vit River is constantly changing. In its vast territories, the period 1935/36-1954/55 hydrologic year is with increased water abstraction compared to the period 1951-1965 year. In other parts the water abstraction does not show large differences during the two periods or is larger in the period 1951-1965. Four of the five hydrometrical stations in the region observed reduction of the outflow module at the end of the 20th and the beginning of the 21st century. It is between 1.9% and 14.3%. Only one HMS shows no change of the specific discharge.

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INTRODUCTION

The Vit River is located in Basin Directorate "Danube Region" of Bulgaria. The length of the river is 189 km and the average slope is 9,6 ‰. Its water catchment area is 3220 sq.km. It is heavily elongated with a small average width (25 km), which does not allow the development of a dense river network. Its density is only 0,5 km/km^2 . The number of tributaries is small. Vit River has about 10 tributaries, the largest being Kamenka River, Kalnik River and Tuchenitsa River. The report is aimed at the changes in the specific discharge occurring in the watershed of Vit River from the middle of the last century to the present day. It treats two periods, for which are published maps of specific discharge (1935/36-1954/55 hydrologic year and 1951-1965 year) and average values at hydrometrical stations for the periods 1961-1998 year and 1961-2002 year.

MATERIALS AND METHODS

The "Annual Flow Outflow Module" map, located in the Hydrological Atlas of the Republic of Bulgaria, is based on data for the 1935/36-1954/55 hydrological year (first period). The data from 186 hydrometer stations were used in its compilation. The authors of the map I. Marinov, T. Panayotov and D. Pecinov state that they have applied the method of linear interpolation. In the mountainous parts of the country, the graphical connections between the annual flow outflow module and the average altitude are used for the individual river basins or regions. Extrapolation is also allowed in high-mountain areas. After the isolines are drawn, a check is made on the convergence between the values of the annual flow outflow module calculated on the card and obtained on the actual data. Accordingly, map corrections have been made so that the deviations do not exceed 10% [10]. It displays isolines for specific discharges of 0.5, 1, 2, 3, 5, 7.5, 10, 12.5 and 15 l/s/sq.km (Figure 1).

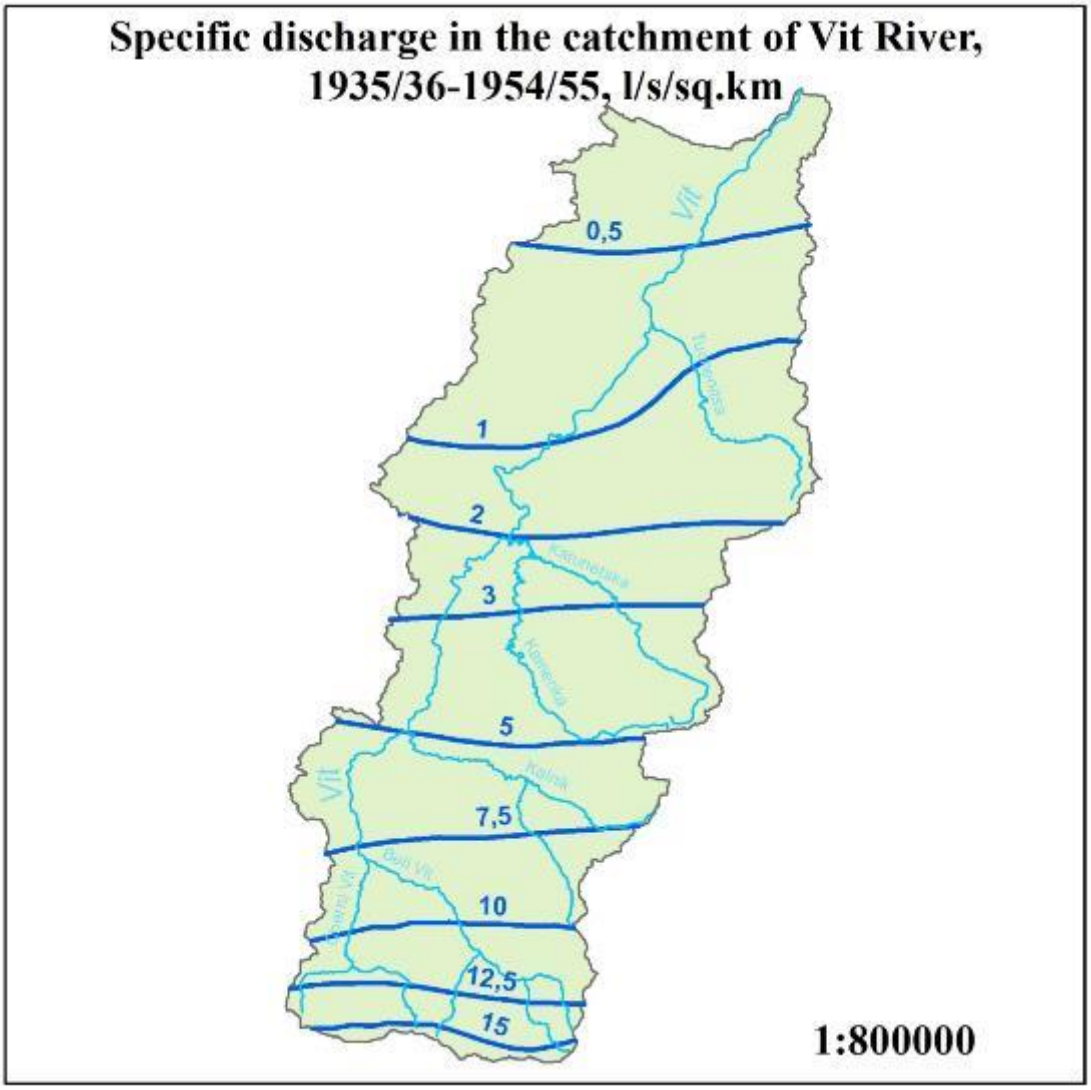

Fig. 1 Specific discharge in the catchment of Vit River 1935/36-1954/55 hydrological year, l/s/km^2

The "Outflow Module" map, published in the Atlas of the Republic of Bulgaria, is based on data for the period 1951-1965 (second period). Its author is R. Rusev. Hydrometric data of 230 HMS (hydrometrical stations) were used to calculate the mean multiannual values. The connection between the specific discharge and the average altitude of the river basins is used to draw the isolines. The same author has identified 23 regional connections of this type across the country [1]. On the map are shown isolines for specific discharges for 0.5, 1, 2, 4, 6, 8, 10, 15, 20, 25 and 30 l/s/sq.km (Figure 2).

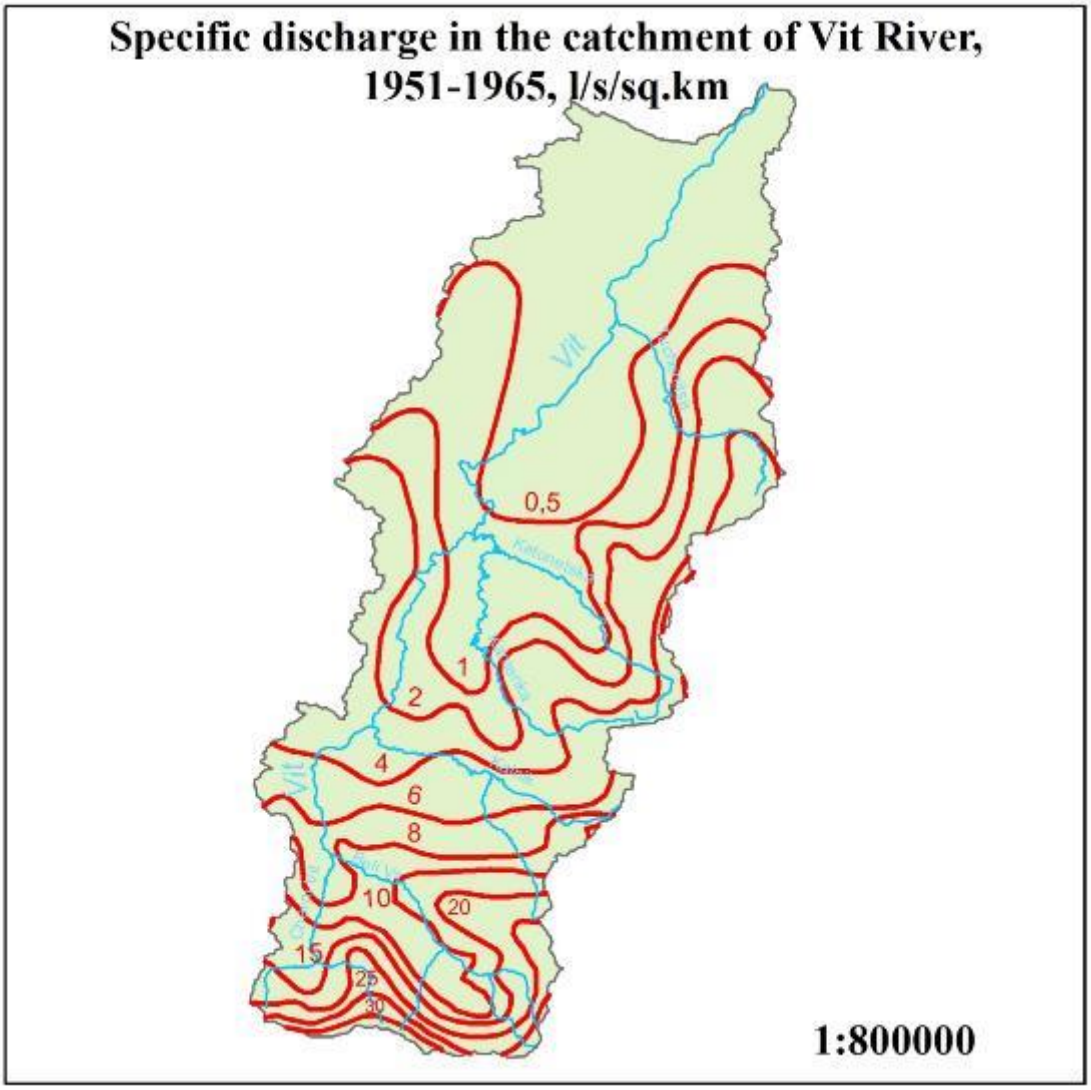

Fig. 2 Specific discharge in the catchment of Vit River 1951-1965 year, l/s/km^2

For the purpose of the study, average values for the specific discharge at 5 HMS in the basin of the Vit River for two periods are also used (Figure 3). These are the average annual runoff values for registered and restored natural river runoff for the period 1961-2002, presented in the research "Determination of mean, minimum and maximum runoff values with different repeatability". It introduces the concept of spatial interpolation based on regional empirical dependences of the flow with basic hydrographic characteristics.

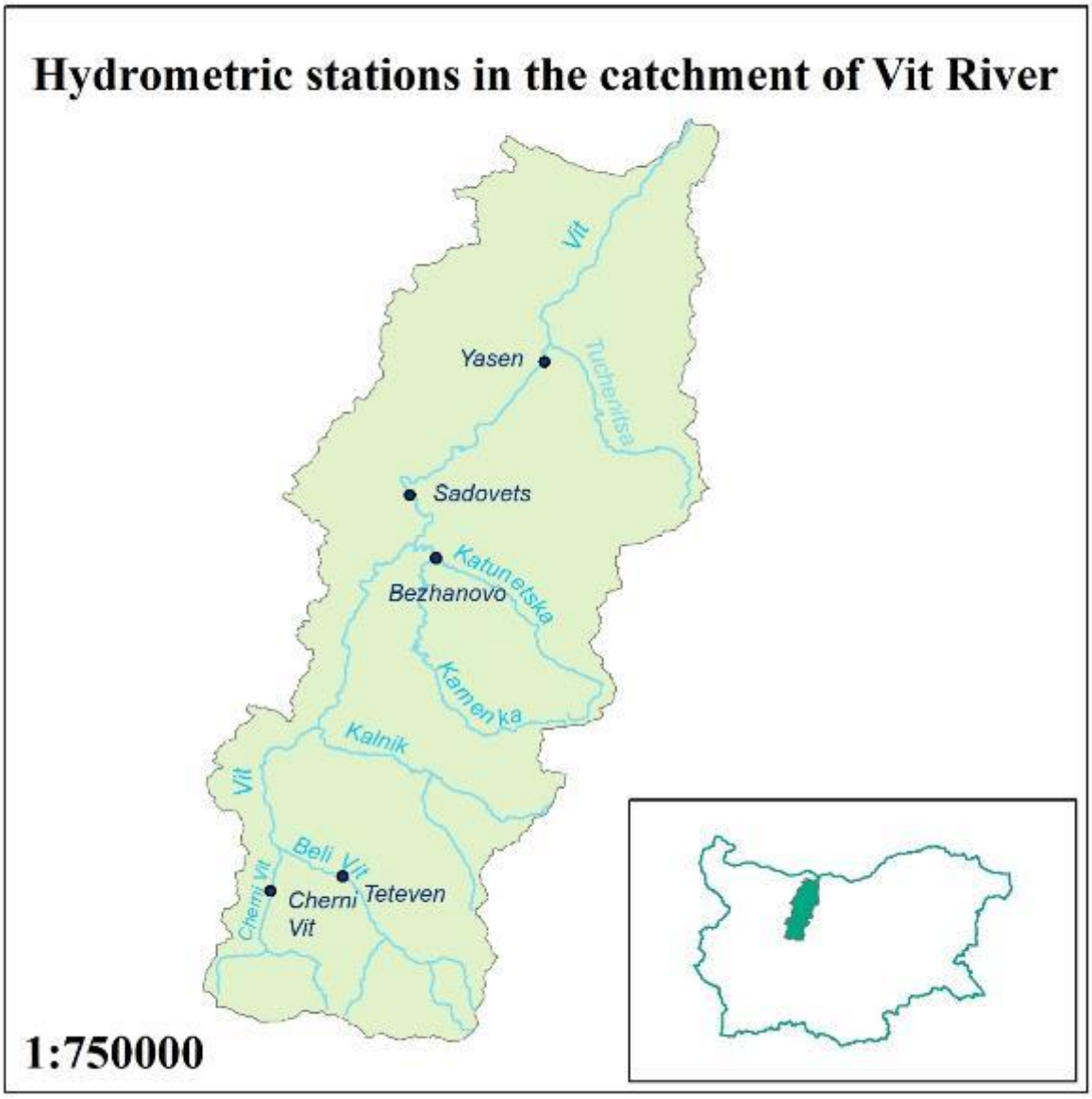

Fig. 3 Hydrometric stations in the catchment of Vit River

In the spatial interpolation, the regional empirical dependencies between the runoff and the area of the respective catchment basins as well as between the outflow modules and the average altitude of the basins are most widely used. The period 1961-2002 is characterized by intensive hydro-technical construction and exploitation of water supply systems, which disturb the natural river flow. The restoration of natural data rows has been done by two methods, depending on the information available: through water supply balances - if water consumption data are available; by analogy with undisturbed runoff data and, in some cases, rainfall [9].

RESULTS AND DISCUSSION

The two maps, for the period 1935/36-1954/55 hydrological year and for the period 1951-1965, were placed over one another in GIS (Geographical Information Systems). (Figure 4). In order to correctly study the changes in the specific discharge, it is necessary to compare the location of only the isolines with the same values on the two maps (Table 1). These are isolines of 0.5, 1, 2, 10 and 15 l/s/sq.km.

Table 1. Isolines with outflow module

	Hydrological Atlas of the Republic of Bulgaria (1935/36-1954/55)	**Atlas of the Republic of Bulgaria (1951-1965)**
Values of isolines, l/s/sq.km		30
		25
		20
	15	**15**
	12.5	
	10	**10**
		8
	7.5	
		6
	5	
		4
	3	
	2	**2**
	1	**1**
	0,5	**0,5**
		less than 0,5

All five pairs of isolines have different configurations in both periods. With regard to the 0.5, 1 and 2 l/s/sq.km specific discharges, the first period is more abudant in water than the second period.

With regard to the isoline of 10 l/s/sq.km, abudance of water is the same in both periods in the Cherni Vit river basin. It is larger during the second period in the Beli Vit river basin.

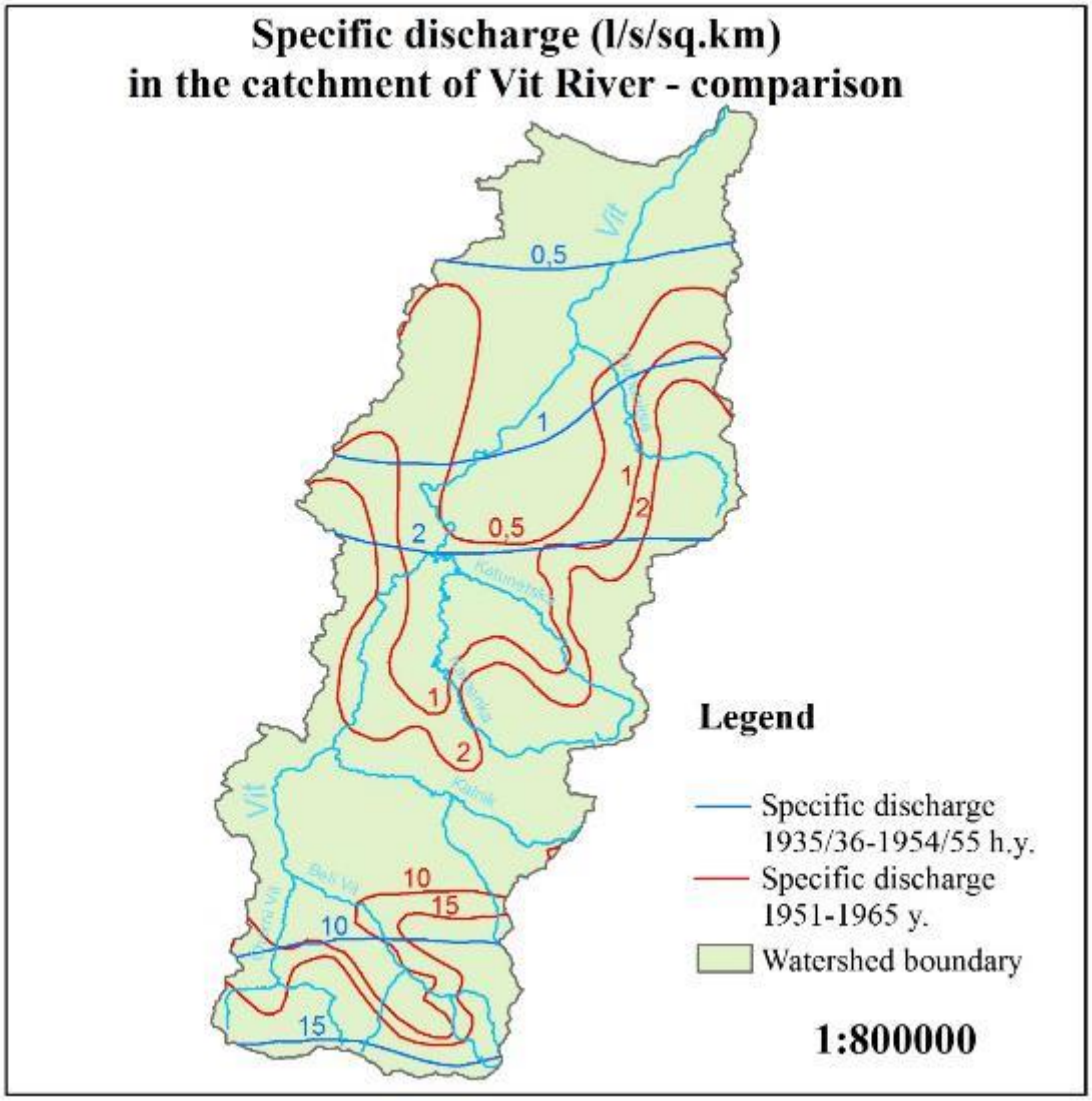

Fig. 4 Specific discharge in the catchment of Vit River - comparison, l/s/km^2

The location of isoline 15 l/s/sq.km indicates that the abudance of water during the second period is greater than during the first period.

Changes in the outflow module at the end of the 20th and early 21st century can be ascertained when comparing its average values for the periods 1961-1998 [2] and 1961-2002 [9]. For most HMS, there is a decrease of the specific discharge during the second period. It is between 1.9% and 14.3%. Only Vit River - Sadovets shows no change of the specific discharge during the second period (Table 2, Figure 4).

Table 2. Modification of the specific discharge in the watershed of the Vit River in 1961-2002 compared to 1961-1998

No. of HMS	River, HMS	Area, sq.km	1961-1998 year	1961-2002 year	Modification, %
21350	Cherni Vit river- Cherni Vit	155,4	19,7	19,1	- 3,0
21650	Beli Vit river - Teteven	306,0	15,9	15,6	- 1,9
21750	Vit river - Sadovets	1750,0	7,5	7,5	0
21800	Vit river - Yasen	2407,0	6,3	5,4	- 14,3
21500	Kamenka river - Bezhanovo	486,0	5,3	5,1	- 3,8

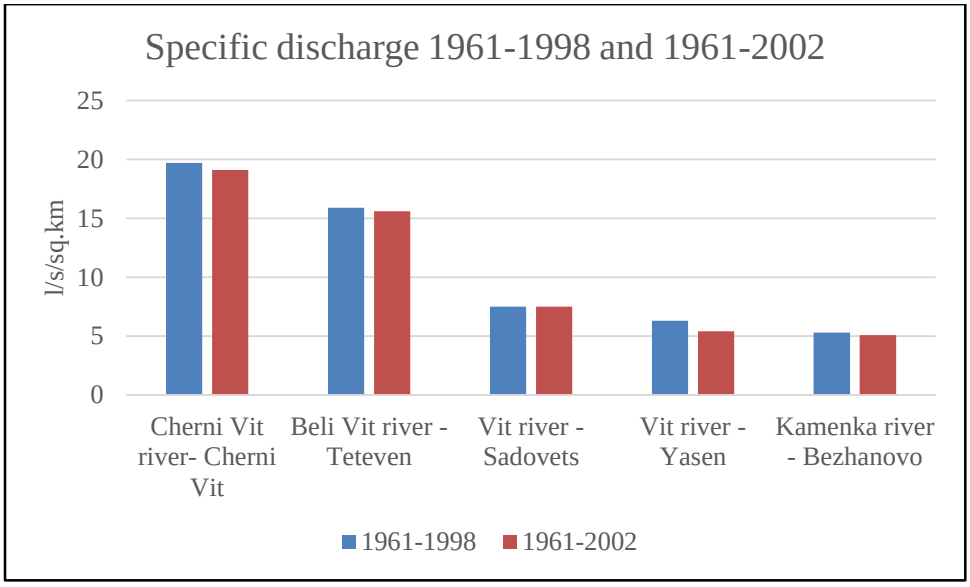

Fig. 5 Modification of the specific discharge in the water catchment area of the Vit River in 1961-2002 compared to 1961-1998

Similar studies have been carried out for other river basins in Bulgaria. Most of them show a decrease of the specific discharge during the period 1998-2002. The exception is the Kamchiya River where the outflow module increases [7]. In the catchment area of the Provadiyska River for the same period a slight reduction of the specific discharge from 2% to 6% [3] was established. In the watersheds of the Dobrudzha rivers for these five years a certain reduction of the outflow module has been established [4]. There it is even less and ranges between 0.47-1.85%. Most of the HMS from the Tundzha River catchment also show some decrease in the specific discharge during this period. It occupies values in the range of 0.5-6.7% [5]. The same analysis was also made for the watersheds of the Donau tributaries west from the Ogosta River, where a decrease in the drainage module was also observed. There it is more noticeable and amounts to 2.6-9% [6].

The reasons for the changes are varied and numerous, with different direction and degree of impact. They can be searched in changes in the multi-annual rainfall, changes in the land cover and drainage conditions, the regulating role of the dams, etc.

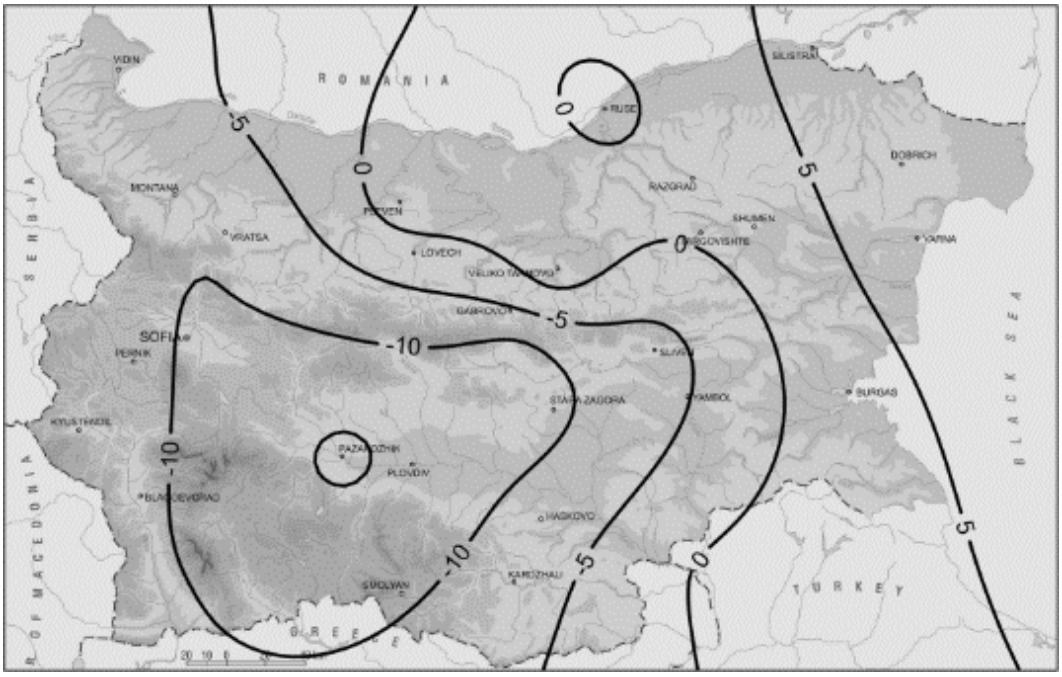

Fig.6 Spatial distribution of trends (mm/decade) of annual precipitation amounts in Bulgaria for the period 1950–2012 (Nojarov, P., 2015)

The main reason is probably the specific changes in the annual rainfall during the period 1950-2012. The annual rainfall decreases at all HMS from the Vit's catchment area by 5 mm/decade, except at HMS Sadovets, where it remains unchanged [8].

CONCLUSION

From the middle of the last century to the present day the specific discharge in the catchment area of the Vit River is constantly changing. In its vast territories, the period 1935/36-1954/55 hydrologic year is with increased water abstraction compared to the period 1951-1965 year. In other (predominantly mountain and spring) parts the water abstraction does not show large differences during the two periods or is larger in the period 1951-1965. Four of the five hydrometrical stations in the region observed reduction of the outflow module at the end of the 20th and the beginning of the 21st century.

Changes could be more accurately analyzed by following the multi-annual flow of river runoff where the cycles with increased and decreased water abstraction are separated and on this basis averaged over periods covering an equal number of such cycles.

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