

UNIVERSITY
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SARAJEVO



FACULTY OF
TECHNOLOGY
ZVORNIK

PROCEEDINGS
KNJIGA RADOVA

2ND INTERNATIONAL CONGRESS

ENGINEERING, ECOLOGY AND MATERIALS
IN THE PROCESSING
INDUSTRY

II MEĐUNARODNI KONGRES

INŽENJERSTVO, EKOLOGIJA I MATERIJALI
U PROCESNOJ INDUSTRIJI

JAHRINA, 09.03.-11.03.2011.
BOSNIA AND HERZEGOVINA

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- *THE ACADEMY OF SCIENCE AND ART OF REPUBLIC OF SRPSKA*

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THE INFLUENCE OF THE GLOBAL CLIMATE CHANGES ON THE AMOUNT OF FLOWING WATER IN REPUBLIC MACEDONIA

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Abstract

In this paper there is balance made, of the water flow amounts in Republic of Macedonia, in the period of 45 years, with aim to determine the influence of the global climate changes on the flowing water. It is worked with the data from Hydrological stations of the rivers that are entering Macedonia and leaving Macedonia. Two very important conclusions are made. First is that 85% of the water is domicile, in fact they are welling out in the territory of Macedonia. The second conclusion is that the flowing water amounts in the period from 1961 to 2005 regarding the period from 1961 to 1990 are decreased for 8.8%, which is direct consequence of the global climate changes.

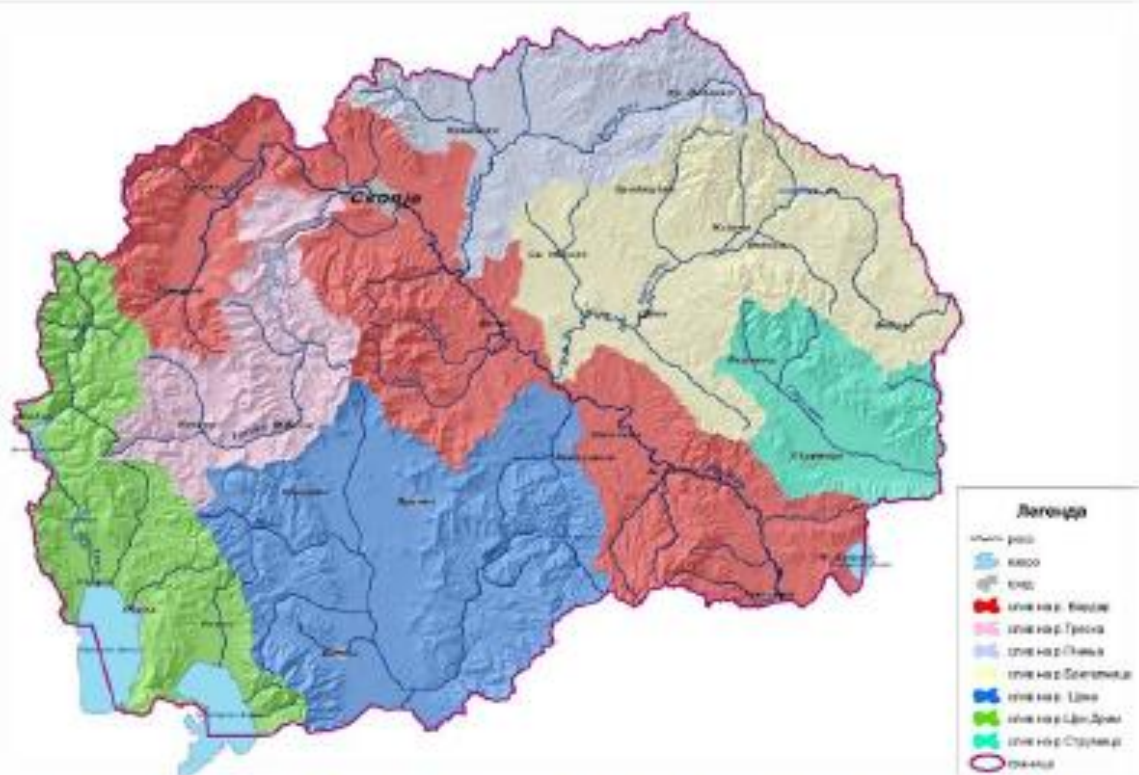
Key words: flowing water, global climate changes, rivers, Macedonia

Introduction

The global climate changes which are already evident and which no serious scientific institution in the world disputes have the most direct impact on the water resources especially on the stocks of drinking water which is alarmingly decreasing. Therefore in this paper the water balance of the running water quantities in Macedonia is made for the period 1961 - 2005, and also a parallel is made with the existing water balance in the Spatial Plan for the period 1961 - 1990 year.

From extraordinary importance is first to define the water resources in Macedonia and their overall balance as a starting point for the functioning of the existing water management systems and the possibility of building a new ones.

The water balance of running water quantities is remarkable significant, because with its help we can precisely define the water wealth that Republic of Macedonia has available, and which can be used for a variety of human needs and goals. It is one of the key factors for deciding on the realization of large hydro-technical infrastructural systems whose need should not be too much spoken for, what is confirmed by recent water management practices in Republic of Macedonia. To have a better overview of rivers, lakes, watersheds and their distribution across the territory of the Republic of Macedonia, they are all shown in Picture 1.



Picture 1. Overview of rivers, lakes, watersheds and their distribution across the territory of the Republic of Macedonia [2]

Balance of the water streaming amounts in Republic Macedonia and analysis of the gained results

The balance equation for definition of streaming waters in the Republic of Macedonia in its simplest form is represented by the expression:

$$W_{exit} - W_{entrance} = W_{personal} \quad (1)$$

W_{exit} - total output surface waters

$W_{entrance}$ - total water input

$W_{personal}$ - Personal surface streaming waters of the territory of Republic of Macedonia

The period for defining the balance equation is 1961-2005, for the considered period of 45 years. The Spatial Plan of the Republic of Macedonia defined the period 1961 - 1990 year. In order to present the impact of the fifteen extremely dry years (1991-2005) on the total balance of the Republic of Macedonia, the table will be presented with both comparative periods due to observations and analysis. The average amount of water output from the Republic of Macedonia's neighboring countries are shown in Table 1.

Table 1. The average water outputs in the Republic of Macedonia

River	Hidrological station	Q_w (1961-1990) (m ³ /s)[2]	Q_w (1961-2005) (m ³ /s)[7][8]
r. Vardar	Gevgelija	144,90	132,85
r. Crn Drim	Špilje	47,70	43,80
r. Strumica	Novo selo	4,18	3,89
r. Cironka r. Levnica	Border with Bulgaria	1.80	1.13
r. Koyedolska r. Lesnicka r. Mala	Border with Serbia	1.60	1.30
r. Binachka Morava	Border with Serbia	0.700	0.275
Σ		200.88	183.25

For the period 1961-1990, the average amount of water output is:

$$Q_w = 200.88 \text{ m}^3/\text{s} \text{ or expressed in volume: } W_w = 6.33 \cdot 10^9 \text{ m}^3.$$

For the extended period of 15 years (1961-2005), the average amount of water outputs are:

$$Q_w = 183.25 \text{ m}^3/\text{s} \text{ or expressed in volume: } W_w = 5.78 \cdot 10^9 \text{ m}^3.$$

For the extended dry period of 15 years (1991-2005), the amount of water output has decreased for $W_{sr} = 0.550 \cdot 10^9 \text{ m}^3$, or percentage for 8.7%. The average water inputs in the Republic of Macedonia are shown in Table 2.

Table 2. The average water inputs in the Republic of Macedonia

River	Hidrological station	Q_w (1961-1990) (m ³ /s) [2]	Q_w (1961-2005) (m ³ /s)[7][8]
r. Lepenec	Border	8,70	7,95
r. Pčinja	v. Pelince	4,85	4,39
r. Elashka	S. Brod	4,90	4,41
Region Prespa	I Crn drim	7.00	6,65
Region Prespa	Tushemishte	3,30	3,135
Σ		28.75	26.535

For the period 1961-1990, the average incoming water is:

$$Q_w = 28.75 \text{ m}^3/\text{s} \text{ or expressed in volume: } W_{sr} = 0.907 \cdot 10^9 \text{ m}^3.$$

For the extended period (1961-2005), the average amount of water output is:

$$Q_w = 26.535 \text{ m}^3/\text{s} \text{ or expressed in volume: } W_{sr} = 0.837 \cdot 10^9 \text{ m}^3.$$

For the reported period of 15 dry years (1991-2005) quantities of inputs of streaming water are decreased for: $\Delta W = 0,070 \cdot 10^9 \text{ m}^3$

Or the percentage of that is: $\Delta W = 7,72\%$

According to the equation (1), for the period (1961-2005) year

$$W_{\text{personal}} = W_{\text{exit}} - W_{\text{entrance}}$$

$$W_{\text{personal}} = 5,78 - 0,837 = 4,943 \cdot 10^9 \text{ m}^3$$

From the total amount of water that leaves Republic of Macedonia, 85.5%, or $4,943 \cdot 10^9 \text{ m}^3$ is domicile or springs on the territory of our country. Regarding the period 1961-1990, for the period 1961-2005, the quantity of water available to the Republic of Macedonia have been reduced approximately for 8.8%.

Conclusion

Based on data obtained from the water balance equation we can express the following conclusions:

- The first major conclusion-which we can extract from the analysis of water balance, is that 85.5% of the running waters originate on our territory or they are domicile. This information is of a great importance to us and suggests that we independently and smoothly to manage and operate with them using them for different needs and goals (water-supplying, irrigation, energy purposes, etc.). Whether and to what extent this potential is used is quite another matter that deserves more attention and more detailed (comprehensive) analysis and whose response may worry us. In any case this fact is going in our use, and it is a great advantage and opportunity that we should maximally use. This water wealth we have on a disposal has contributed to the territory of Macedonia to be built a numerous reservoirs, irrigation systems, regional water supply systems and so on, and should be an additional motive for building new water management systems in the future.
- The comparison with the water balance in the Spatial Plan (1961 - 1990) indicates that only in the last 15 years the running water quantities in Macedonia have been reduced for 8.8%, a figure that should be seriously contemplated and worry because it is going in charge of the actual thesis for the global climate changes on Earth. This alarming reduction of the running water quantities only confirms and reinforces the thesis that the water in the next period should be used as possible rationally and we would not endanger our existence due to lack of water, especially one that we use for drinking.
- In Republic of Macedonia there are still unused water supplies. This suggests the need to build a larger number of reservoirs to be used as reservoirs in scarce times. Water requirements in the future will increase more and more so that the strategic interest is the need to build as many reservoirs and water management systems. It is no longer only "technical issue" but the highest national priority.

References

- [1] Водостопанска Основа на Р.Македонија (1973 година);
- [2] Просторен План на Р.Македонија (1999 година);
- [3] Браните во Р.Македонија (1972 година)
- [4] Проф.д-р Љупчо Петковски, Водостопански Системи
- [5] Проф.д-р Благоја Тодоровски, Проф.д-р А.Ангелов, Хидрологија, (1975 година)
- [6]Проф. Д-р Цветанка Поповска, Проф. д-р Катерина Донева, асистент м-р. Виолета Гошевска, Хидрологија, (2004 година);
- [7]Архива на Управата за хидрометеоролошки податоци (УХМП);
- [8] Атанас Угрински, Студија за влијанието на големите водостопански системи врз расположливите водни ресурси на Р. Македонија, 2010, стр 35-38.