Influence Of Mild Winters On Groundwater In Bulgaria

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Abstract

We have presented in this paper the role of the meteorological conditions during the mild winters for the period 1961-2003 in the cases of the groundwater regimes. For these purpose we used the received classification of the winters by the surface data and the statistical criteria for the territory of Bulgaria. Besides we have analysed the precipitation and its relation with thermal regimes by five synoptical stations in the mountain regions of Bulgaria. The basic result is that the mild winters had negative impact on the groundwater and this water resource in Bulgaria is influenced by climatic variability.

Key words: mild winter; precipitation; groundwater levels and spring discharges

Introduction

The territory of Bulgaria is reach in “water towers” - mountains. Water resources in Bulgaria are influenced by climatic variability. In this paper the attention was paid to winter processes.

Utilized data: time-series (1961-2003) of the monthly mean, temperatures and precipitation, discharge for karstic springs and water level for observational wells were utilized. Three representative hydrogeological stations were chosen to present basic features of the groundwater regime:

(a) karstic spring N 396 at the village of Musina from the north Bulgaria; it refers to drainage basin of the river Rositza, the affluent of the Yantra;
(b) karstic spring N 39a at the village of Beden from the south Bulgaria; it is situated in the Rhodopes mountain;
(c) observational well N 526 at the village of Trakia; it refers to drainage basin of Maritza river and is situated 70 km east from station Plovdiv within the Upper Tracian kettle.

Seasonal variability

Atmospheric circulation

We used the classification of the winters by [1]. The warm winters have been prevailing since 1961 till now. By reason of this we have analyzed the precipitation and its relation with thermal regimes for the winters of Bulgaria.

It is known for a long time that the significant changes both of the climate system and its local regimes reflect the atmospheric circulation dynamics.

The zonal atmospheric circulation was prevailing mainly during the mild winters. The activity of the Mediterranean cyclones was not so frequent and well manifested.

The analyses of the synoptic processes over European region and the determination of the blocking processes are of significant importance for the definition of the periods of extreme processes over Balkans and particularly for Bulgaria [2, 3].

Precipitation and temperature anomalies for:

Flat country. During the last decade a well defined trend dominates towards the temperature increase in the country. In the whole country during the mild winters the precipitation anomalies averaged for the season are generally lower than norm.

For the period 1986 - 2003 the months of the winter are periods of positive [6] anomalies (see Figs 3 - 6). Strongly expressed maximums of the temperature are observed in 1988, 1994 (for January dT is 4.4 and 5.9^{o}C), 1995, 2002 (for February dT is 6.3 and 6.9^{o}C), 2000 (for December dT is 2.8^{o}C). The

winter is the season of climate warming in the country in the long period. The averaged temperatures were for the most part of the years above the norm in northern and south Bulgaria (see Figs 1 and 2).

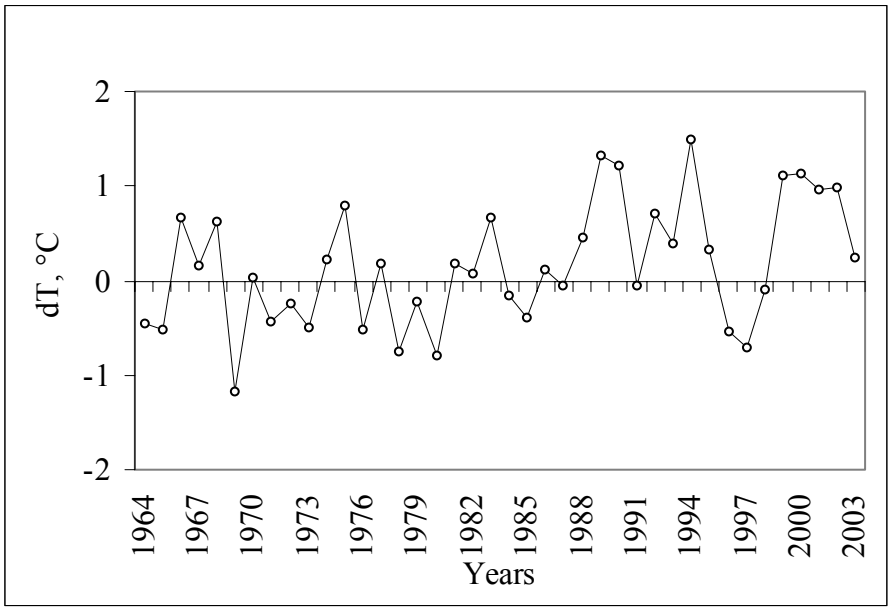

Figure 1. Annual mean temperatures difference from 1961-1990 normal for station Pleven

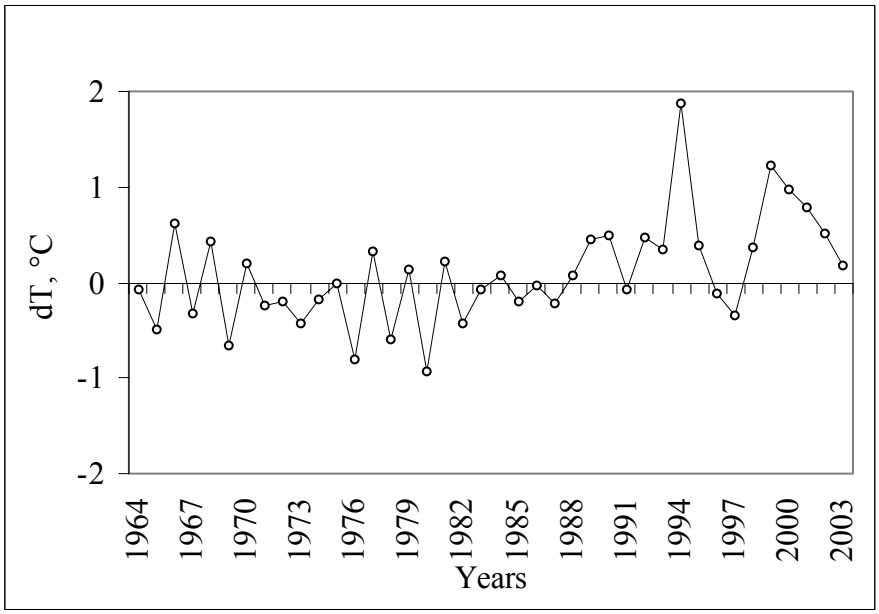

Figure 2 Annual mean temperatures difference from 1961-1990 normal for station Plovdiv

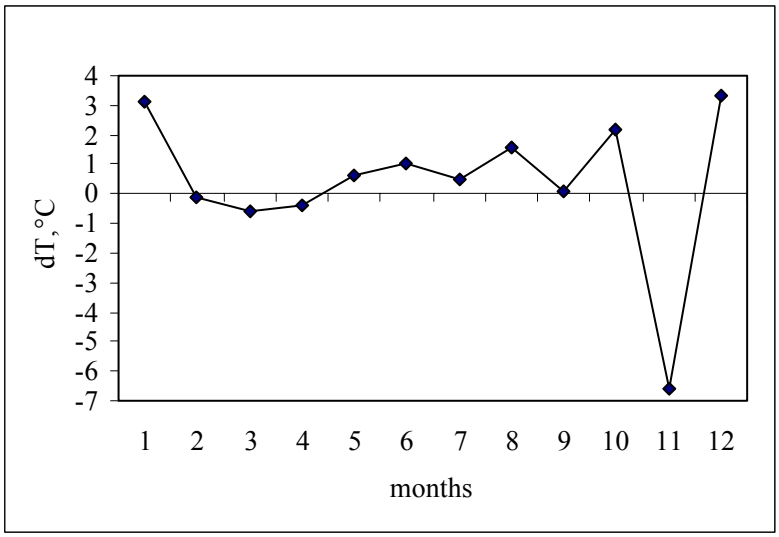

Figure 3 Monthly temperature deviations in 1993 for station Pleven

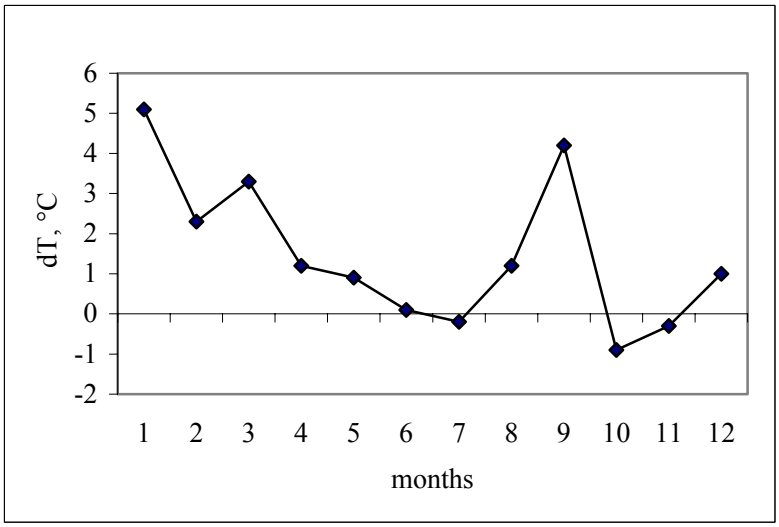

Figure 4 Monthly temperature deviations in 1994 for station Pleven

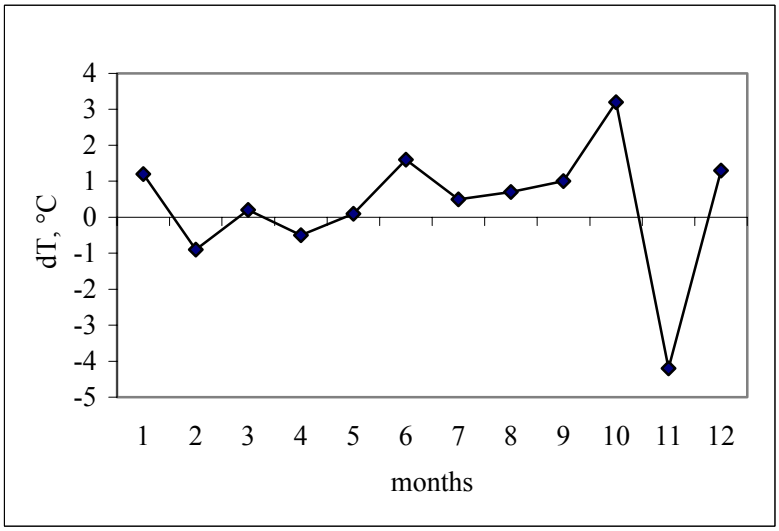

Figure 5 Monthly temperature deviations in 1993 for station Plovdiv

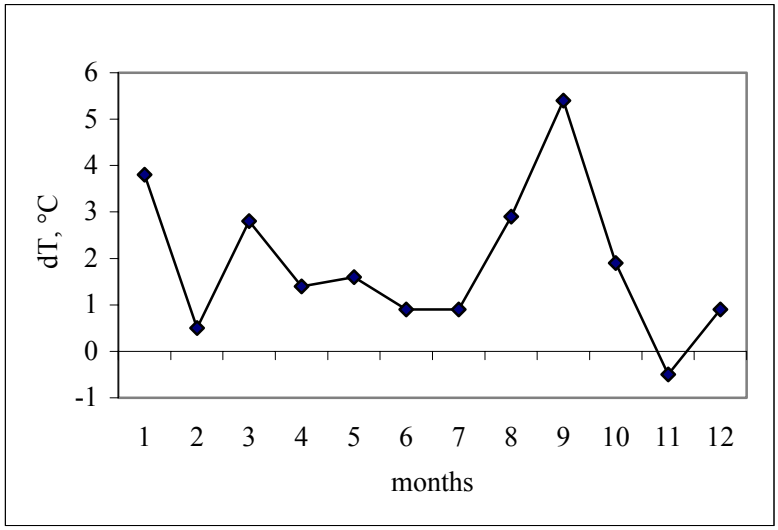

Figure 6 Monthly temperature deviations in 1994 for station Plovdiv

In the whole country in the period 1961 -2003 more than 70% of the precipitation anomalies are lower and equal than the estimated norm. For extremely 1994 rainfall totals were below normal almost everywhere only. July was a wet month in the north part of Bulgaria, both April and October – for south part of the country (see Figs 7 and 8).

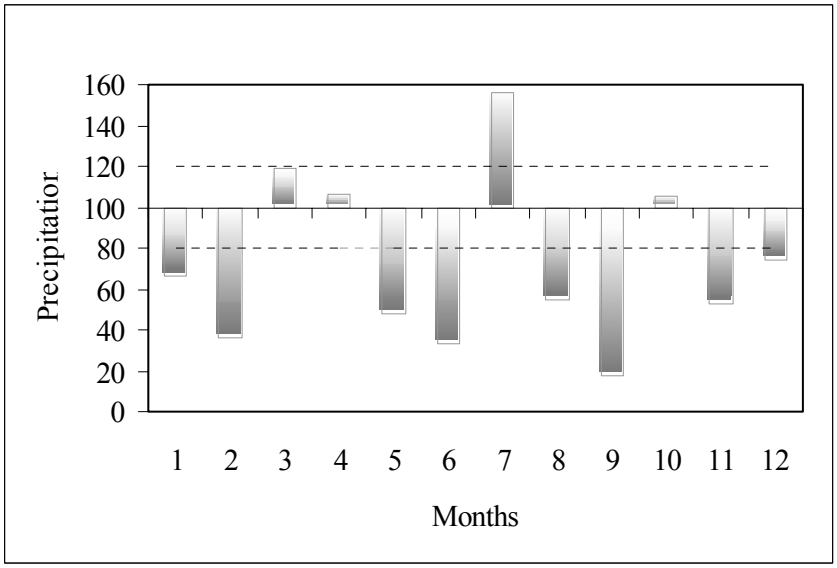

Figure 7 Percentage of 1961-1990 normal for January to December 1994 for station Pleven

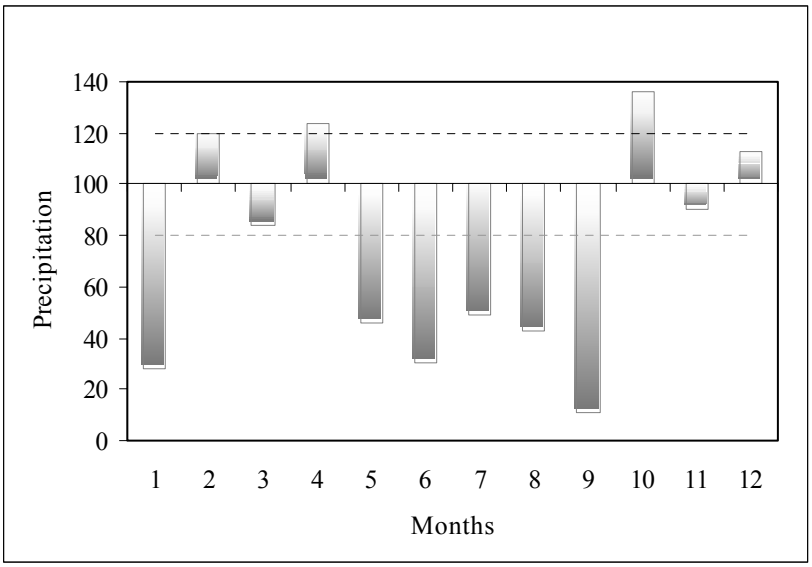

Figure 8 Percentage of 1961-1990 normal for January to December 1994 for station Plovdiv

The mountain regions. In the whole country during the mild winters the precipitation anomalies averaged for the season are generally lower than norm. The mild winter period is favourable to assign the impact of climatic variability on the mountains regions [5] (see Table 1 and Fig. 9). The deviations of temperature are between 1.2 and 1.8°C (for the Rhodopes) above normal, the precipitation is between 59 and 89% below normal.

Table 1 Deviations of winter temperature and precipitation during the last decade

Station	High, m	Geopotential level, hPa	dT, °C	Precipitation, %	Years
Mussala	2925	700	1.2	59	1994 -1998, 2001
Botev	2376	700	1.2	58	1994 -1998, 2001
Cherni vrah	2286	700	1.3	54	1994 -1998, 2001
Rojen	1750	850	1.8	89	1994,1995, 1997,1998, 2001
Murgash	1687	850	1.6	66	1994,1995, 1997,1998, 2001

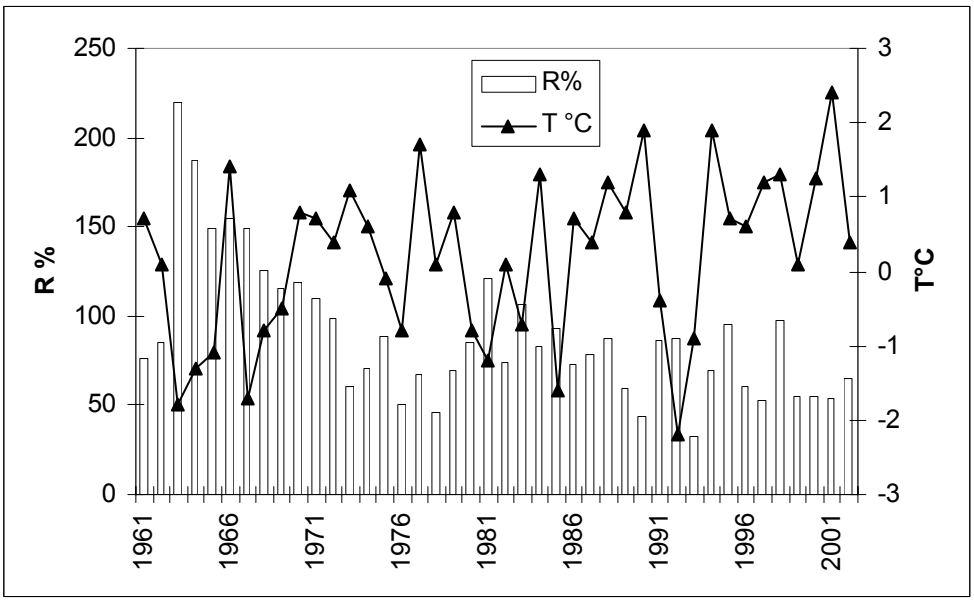

Figure 9 Deviations of winter temperature and precipitation for station Botev from mountain Stara Planina in Bulgaria

During the winter the predominant precipitation was in the form of a snow, but for some cases of mild winter the precipitation was rain. The mild winters lead to early snowmelt and the conditions for spring charge again that the rivers are changed during them [4].

Impact on groundwater regime

Climate variability in Bulgaria shows strong impact on groundwater regime. Some basic results are presented in Table 2. For each karstic spring and observational well are presented average winter discharge (water level) for the reference period 1961-1990 and for some chosen mild winters. It is evident that spring discharges during mild winters show reduced values and they are affected by drought periods (see Figs 10 - 12). Increased drought periods were succeeded by reduction of spring discharges and extremely low water levels in observational wells.

Table 2 Values of spring discharge and water level during selected Water Years

Station N	Season	Dimen-sion	average 1961-1990	1988	1994	2000	2001
396	Winter	m3 s-1	0.435	0.232	0.085	0.365	0.105
396	Spring	m3 s-1	0.690	0.612	0.102	0.694	0.187
39a	Winter	m3 s-1	0.657	0.517	0.314	0.508	0.331
39a	Spring	m3 s-1	1.063	1.195	0.587	0.944	0.767
526	Winter	m	7.75	7.97	8.26	7.93	8.17
526	Spring	m	7.47	7.83	8.08	7.72	7.93

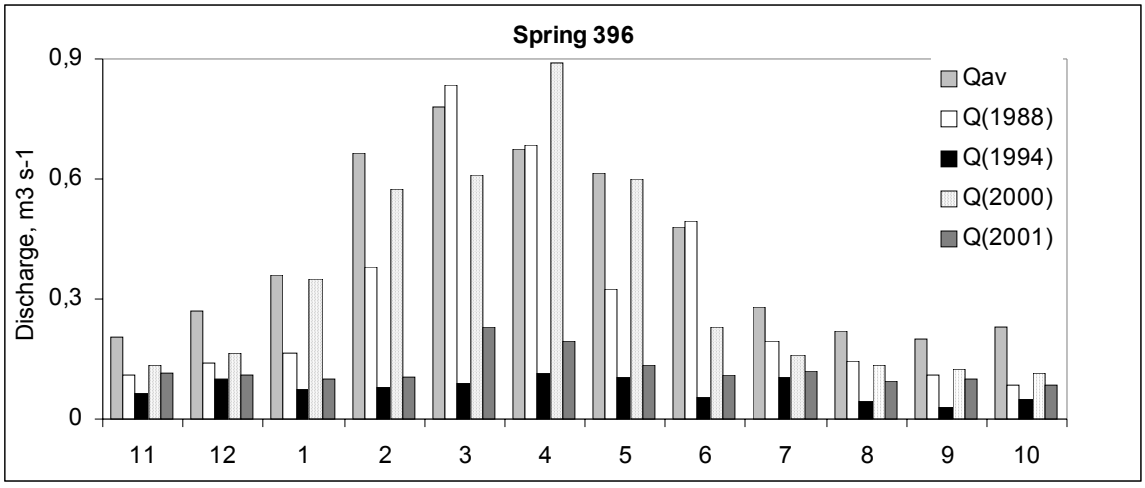

Figure 10 Discharge of spring 396 for selected Water Years

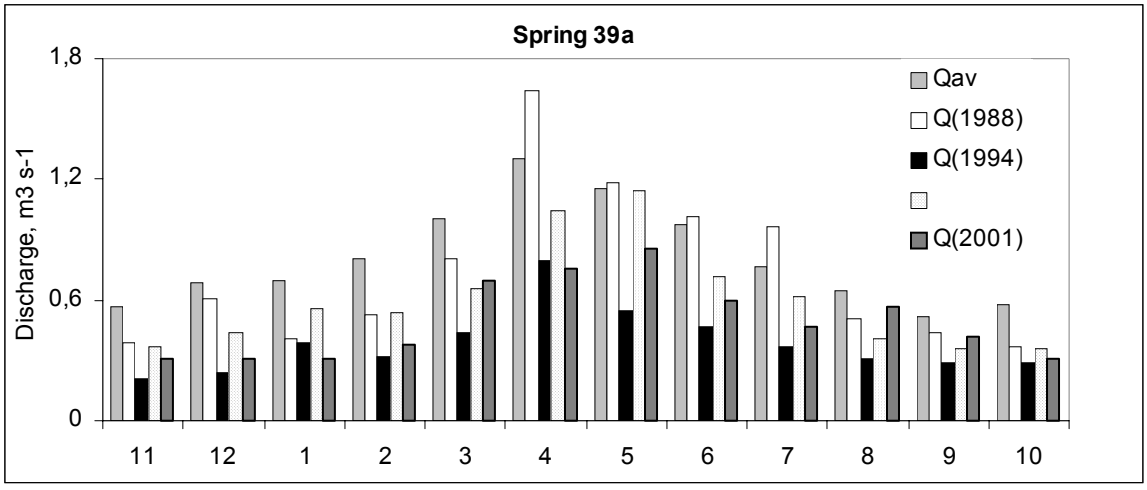

Figure 11 Discharge of spring 39a for selected Water Years.

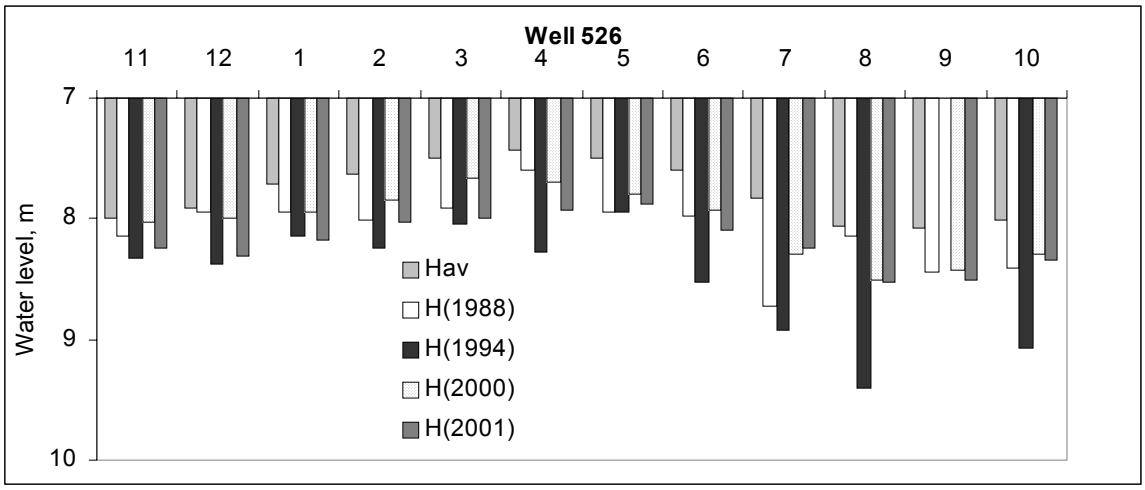

Figure 12 Discharge of well 526 for selected Water Years

Similar results were obtained for other stations from different regions of Bulgaria.

Basic results

- The frequency of mild winters is increased. The precipitation below norm is observed usually during the periods with positive anomalies of air temperature.
- There is the tendency for positive anomalies of air temperature to increase during winter.
- There is the tendency for decreasing in winter precipitation during the 1961-2003 period in Bulgaria.
-The values of the deviations of air temperature are smaller on the higher geopotential levels and vice versa.
-The climate variability during the drought period influenced considerably on the groundwater regime in Bulgaria. Most karstic springs had reduced discharge and observational wells showed lowering of the water table due to decrease in recharge to groundwater.
- The reduction in winter precipitation during the drought period in Bulgaria had strong negative influence on groundwater recharge.

Reference

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