GEOGRAPHICAL SCIENCES

SUBJECT: QUALITY OF THE STRUMA RIVER

Assistant-Professor, PhD Ivanova Svetla

South-West University, Faculty of Mathematics and Natural Sciences, Blagoevgrad, Bulgaria

Abstract. *Struma is one of the main rivers in the Republic of Bulgaria with certain hydrologic characteristics. The size of its catchment area is 10,797 km. It flows through southwestern Bulgaria and northern Greece and flows into the Aegean Strymonian Gulf of the Aegean Sea. Its length is 415 km, of which 290 kilometers are within the Republic of Bulgaria.*

For the survey, the section between the points of Razhdavitsa village and the village of Krupnik has been selected. The selected area has the best informative value, which makes the survey representative. There are active hydrometric stations supporting hydrometric network of the National Institute of Meteorology and Hydrology at the Bulgarian Academy of Sciences and points for surface water monitoring by the National System for Environmental Monitoring of the Ministry of Environment and Water. The area is representative for conducting research on the quality and quantity of water.An analysis and evaluation of water quality of the Struma River in the selected area between Razhdavitsa and Krupnik for the period 1981 -2005 have been made.The research presented is part of my PhD dissertation: "Use of information on water quality in making management decisions".

Keywords: *Struma River, monitoring, monitoring programs, monitoring station, physico-chemical indicators, water quality.*

Introduction. The determination of the water quality of the receiving water is a basic procedure in relation to the collection of information for evaluation of water status and management decisions concerning the use and conservation. This is the task of the network for monitoring surface waters of the National System for Environmental Monitoring (NEMS) of the Ministry of Environment and Water (MoEW).

The stations of surface waters from NEMS along the Struma River during the survey period are 17, 7 of which are of the main river and 10 of the major tributaries.

After an initial comprehensive analysis of the information from existing monitoring stations of surface water along Struma and representativeness of the data obtained by them for the purpose of the study the paper focuses on the section of the Struma River between the points of Razhdavitsa and Krupnik. Both points are part of the current hydrometric network of the National Institute of Meteorology and Hydrology at the Bulgarian Academy of Sciences (NIMH-BAS) and NEMS to MoEW. The have collected data from observations carried out over a long period of time on both quantitative status (measured water quantities) and the qualitative (chemical) status of waters.

Data and Methods. For both points of the Struma River in the village of Razhdavica and the village of Krupnik, measurement data have been collected and processed for the period 1981-2005 of the following indicators: active reaction (pH), dissolved oxygen, oxygen saturation, biological oxygen demand on the fifth day (BOD5), permanganate oxidation, dissolved and suspended solids, chloride and sulphate ions, nitrogen (ammonium), nitrates and nitrites, phosphates, hydrogen sulfide, iron, manganese, calcium and magnesium. In one of the stations interruptions in measurements of some of the indicators have been established, which reduces the comparability of the data series for the period.

Results and Discussion

1.**The Struma river at the village of Razhdavitsa** - during the survey period the checkpoint has the second category of water [6]. To this point there have been examined data collected for the period 1981–2005 on individual indicators, a length of string for each one of them has been given and their average concentration for the period has been calculated (Table 1).

Table 1. Investigated indicators for the period 1981-2005 at the point of the village of Razhdavitsa

Indicator	Period	Lengthofsequence	Average concentration
pH	1981-2005 г.	239	8,059
Oxygen saturation	1981-2005 г.	230	95,89
Dissolved oxygen	1981-2005 г.	235	10,019
Dissolved solids	1981-05.2005 г.	236	346,394
Suspended solids	1981-2005 г.	239	32,075
NH^{4+}	1981-2005 г.	232	0,342
NO_3	1981-2005 г.	237	5,743
NO_2	09.1989-2005 г.	115	0,028
PO_4	07.1997-2005 г.	89	0,331
Iron (total)	1981-2005 г.	181	0,576
BOD_5	1981-2005 г.	231	3,816
permanganate oxidation	1981-2005 г.	229	4,821
Chlorine ions	1981-2005 г.	120	19,286
Sulphate ions	1981-2005 г.	114	64,596
Hydrogen sulfide (free)	03.1981-06.1997г.	56	0,029
Mn (total)	03.1981-2005 г.	84	0,029
Calcium	03.1981-2005 г.	With many interruptions Data-59	65,125
Magnesium	03.1981-2005 г.	With many interruptions Data-59	23,513

Source: MoEW, West Aegean Basin Directorate (WABD), my own calculations

After processing and data analysis the following conclusions can be drawn:

• No excess of the norm for the second category indicators of permanganate oxidation, dissolved solids, chloride and sulfate ions and manganese have been found.

• A single exceedance has been registered by the indicator BOD_5.

• A double exceedance has been found in phosphates (in November 2003 and March 2004).

• Multiple excesses of the norm have been considered for the following indicators: -Active Reaction (pH) - for the period: January and March, 1982; March, 1997; September, 1998; multiple exceedances in 1999, 2000, 2001, 2002, 2003, 2004 and in April and July, 2005 (Figure 1).

The tendency is towards the increasing of the values of pH indicator, especially after 1998.

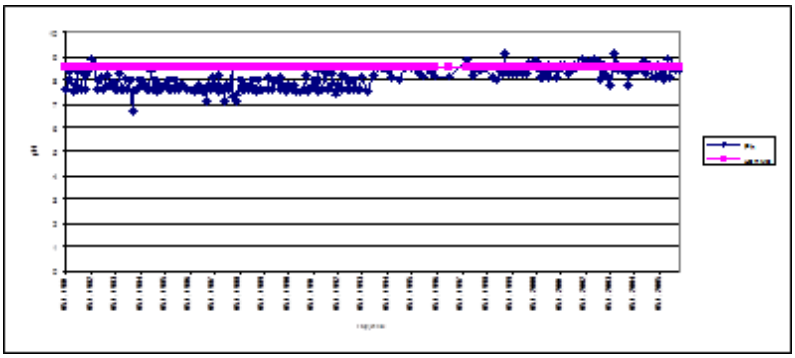

Fig.1. Results of measurementsand pH at the point of the Struma River in the village of Razhdavitsa from January, 1981 to November, 2005.

Suspended solids - this indicator has detected multipleexcesses during the years 1981, 1982, 1983, 1984, 1986, and in September,1985; in December,1990; in July1991; in Januaryand August,1992; in December,1995; in June, 1999; in April,2001; in October, 2002 (Figure 2). There has been detected adownward tendency of the pressureafter1987and especially after1992.

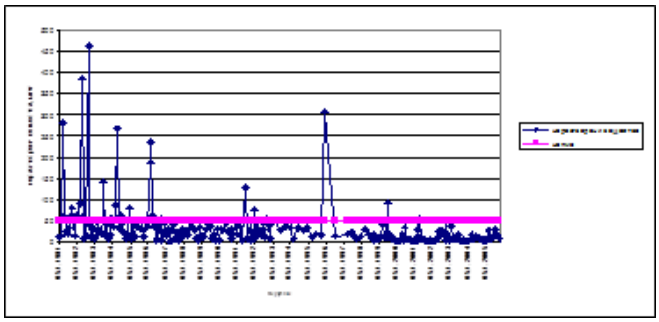

Fig. 2. Results of measurement of the suspended solids at the pointof the Struma River in the village of Razhdavitsa from January, 1981to November, 2005.

Nitrogen (ammonium) - this indicator has exceeded the normin June,1984; in March, 1985; in March and September, 1986 (Figure 3). There has been areduction of this indicator since1993and especially after1997. Exceedances have not been registered since 1987.

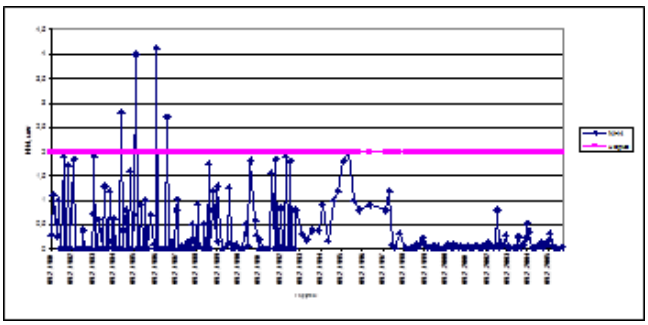

Fig. 3. Results of measurement of the nitrogen (ammonium) at the point of the Struma River in the village of Razhdavitsa from January, 1981 to November, 2005.

Nitrite Nitrogen (NO2) –the data covers the period from September,1989 until October, 2005. There areexcessesin the following periods: in June and August,1992; in December,1997; in October,1998; and multipleexcesses over the years: 1999, 2000, 2002, 2003, 2004 and 2005 (Figure 4). The indicator's measurement resultsshow a tendecy of increasing the values after 1991 and especially after 1996.

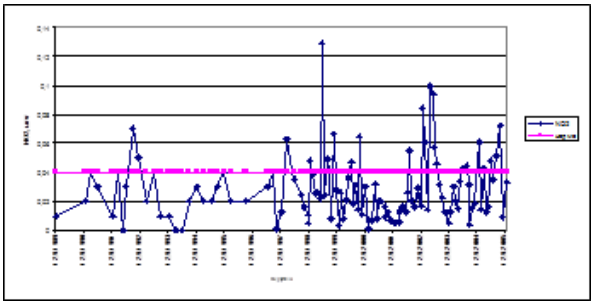

Fig. 4. Results of measurements of nitrate nitrogen indicators at the point of the Struma River in the village of Razhdavitsa from January,1981 to November, 2005

Nitrate Nitrogen (NO3) - multiple exceedances of the limit value have been attested for the periods 1981-1988 and 1990-1992 (Figure 5). The trend is towards a reduction of the measured values of the indicator after 1993 and their entry into the rules under Regulation 7/1986 [5].

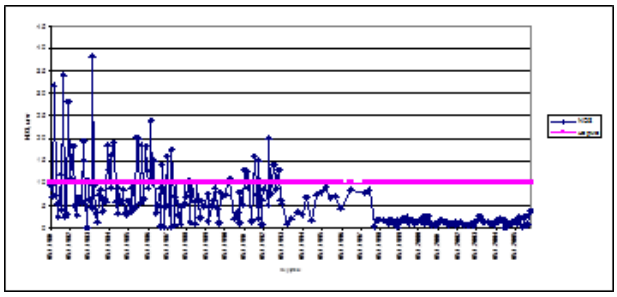

Fig. 5. Results of measurement of the nitrate nitrogen at the point of the Struma River in the village of Razhdavitsa from January, 1981 to November, 2005.

Iron (total)–it has exceeded the norm during the periods: June, September and December,1981; August,1982; June and September1983; March, May and June1984; February and March, 1986; June, 1988; May and August, 1989; August, 1991 (Figure 6).

In the indicator of iron there has been a downward tendency since 1992 (with a fewexceptionsin 1999), but not exceeding the norms.

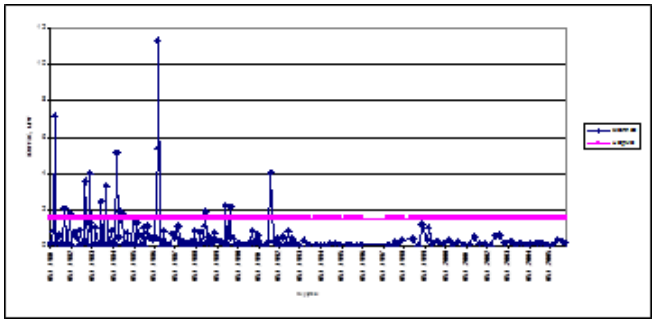

Fig. 6. Results of measurements of the indicator of iron at the point of the Struma River in the village of Razhdavitsa from January,1981 to November, 2005.

Hydrogen sulfide (H_2S) –the gathered data is for the period March 1981-June 1997. For the second category of water this indicatoris not allowed .Values others than zero were measured during the periods: April, June and September,1983; June,1984; March and September,1985; December, 1986.

There have been downwards since 1986, since when there have been noreported exceedings of the norm, which is zero.

2. **The Struma river at the village of Krupnik** – during the investigated period the checkpoint is of the third category of water [6]. It examines the data for the period from January, 1981 to November, 2005. The following indicators are presented in Table 2.

Biological oxygen demand on the fifth day (BOD_5)- Exceedance of the norm in July1985. (Figure 7). The trend has been towards a decrease in this indicator since 1988 and especially since 1998.

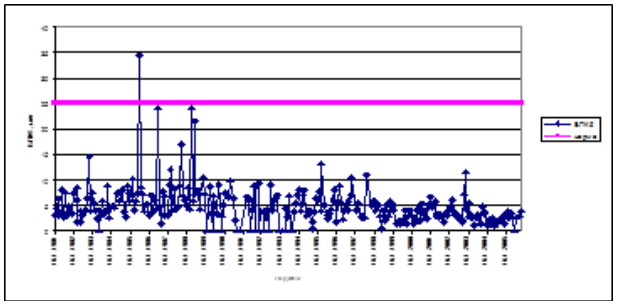

Fig. 7. Results of measurements of the indicator BOD_5 at the poin of the Struma River in the village of Krupnik from January, 1981 to November, 2005

Table 2. Investigated indicators for the period 1981-2005 year in the point of the village of Krupnik

Indicator	Period	Length of sequence	Average concentration
pH	1981-2005	277	7,818
Oxygen saturation	02.1981-2005	Interruption from December, 1992 to November, 1997-215	91,766
Dissolved oxygen	1981-2005	277	9,508
Dissolved solids	1981-06.2005	273	246,078
Suspended solids	1981-2005	276	80,532
NH^{4+}	02.1981-2005	Interruption from December, 1992 to September,1998 -205	0,736
NO_3	1981-2005	Interruption from September,1993 to January,1995 -257	4,777
NO_2	04.1989-2005	156	0,09
PO_4	06.1989-2005	interruptionduring the period1989-1992 - 149	0,62
Iron (total)	1981-2005	199	1,014
BOD_5	1981-2005	259	5,1
Permanganate oxidation	1981-2005	268	7,986
Chlorine ions	03.1981-2005	202	31,423
Sulphate ions	03.1981-2005	162	59,241
Hydrogen sulfide (free)	03.1981-11.2002	WithmanyinterruptionsData-121	0,025
Mn(total)	03.1981-2005	WithmanyinterruptionsData-80	0,033
Calcium	03.1981-02.1998 and one measurement in 08.2005	WithmanyinterruptionsData-116	56,434
Magnesium	03.1981-02.1998 year and one measurement in08.2005	WithmanyinterruptionsData-116	18,616

Source: MoEW,WABD, my own calculations.

After analyzing the data on this point, the following conclusions can be made:

• Occasionalexcesses of the norm (typical emergencies) have been established for the following indicators:

Permanganate oxidation–asingleemergencexcess was attested in April 1995. (Figure 8). The tendency has been to decrease the measured values of the indicator since1992 and especially since 1997.

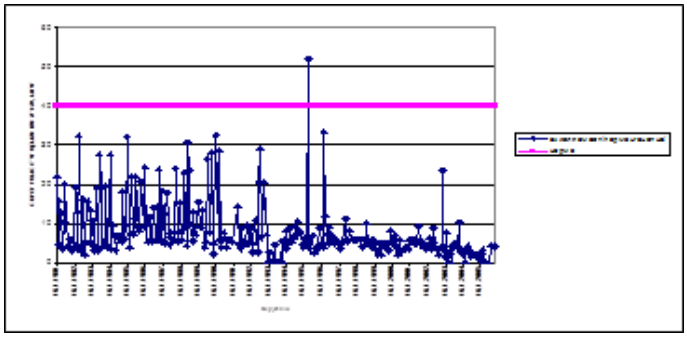

Fig. 8. Results of measurement of the permanganate oxidationat the point of the Struma River in the village of Krupnik from January, 1981 to November, 2005.

For this point the exceedances of the limit value for the third category have been detected only for the indicator of suspended solids (DS). Multipleexcesses have been attested over the years: 1981-1987, 1992, 1993, and in July, 1994. As well as in April, 1995; April and May, 1996; May, 1997; May and October,1999; in February, 2003 (Figure 9). Exceedances are most likely due to high waters.

There has been a downward trend in this indicator since 1987. Violations of the norm are missing from 1988 to 1992 and from 2000 to 2005, with one small exception in 2003. During these periods there were no major high waters.

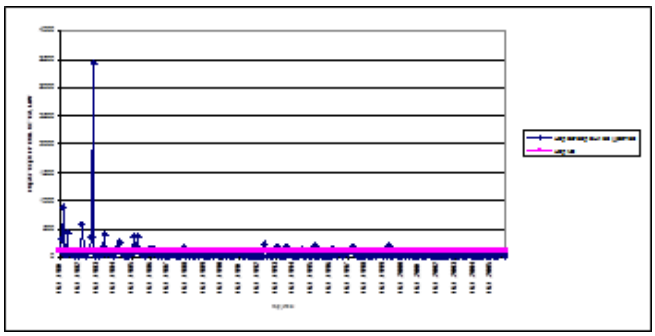

Fig. 9.Results of the measurement of the suspended solids at the point of the Struma River in the village of Krupnik from January, 1981 to November, 2005

Other indicators meet the standards of a third category of water.

Conclusions. The main pollutants of the Struma River in the selected area aresettlements, industrial and agricultural activities. The problematic spots in the valley of the Struma river are of a local nature.

A significant improvement of water quality is seen in the results of chemical analysis for the period after 1990-1992.

The relative improvement in the river water quality is due to:

• Reducing the volume of production of most of the industrial enterprises, and hence the amount of discharged wastewater into rivers;

• commissioning of treatment plants (WWTP);

• reducing the amount of fertilizers imported into farmland and plant protection products (mainly for economic reasons);

• closure of some livestock complexes.

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