

Monitoring Water Quality Parameters of the Transboundary River Nestos

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Abstract: The Nestos/Mesta river, shared by Greece and Bulgaria, needs monitoring system along its course for sustainable management and environmental preservation. Such a system, known as R.E.MO.S., was installed in the year 2000 and operates since then on a 24 h basis at a station in the river deltas channel. It records water level, water and air temperature, conductivity, redox potential and dissolved oxygen. The so far recorded data indicate that the R.E.MO.S. A station in the final course of Nestos, reveal the quantitative and qualitative water parameters in the river regime. Furthermore, it can be used to evaluate their environmental role as well as to clarify possible effects on the ecology of the river at the broader deltaic plain. So far, R.E.MO.S. Networks have been established in the areas of Thesavros dam-lake and Potamoi Village close to the borders between Greece and Bulgaria, by the Public Power Corporation of Greece (DEH) and the PERSEAS research group. Following the Nestos/Mesta bilateral agreement of 1995, such R.E.MO.S. Networks should be extended in the Bulgarian territory of the Mesta drainage basin.

Key words: Monitoring system, water quality, ecology, nestos/mesta transboundary river

INTRODUCTION

The river Nestos/Mesta occupies an intermountain basin of the western part of the Rhodope^[1, 2]. It drains 3317 km² of the Bulgarian territory as Mesta (North) and 2097 km² of the Hellenic territory as Nestos (South). At the coastal zone of the North Aegean sea Nestos forms an extensive (453 km²) deltaic plain, which is included in the Ramsar Treaty as an internationally important wetland complex^[3, 4].

Geographically, Nestos/Mesta considered the borderline between two historical areas. Thraki to the east and Macedonia to the west.

The river itself is considerably important for the relations of both the sharing countries, Bulgaria and Greece. The bilateral agreement, signed in 1995, reflects their common effort to contribute to the water management and environmental protection to the river and its drainage basin.

Monitoring of quantitative and qualitative parameters of the river water at its 240 km course, is a basic term for both the sustainable management and future collaboration.

In the main course of Nestos in the Hellenic territory the Public Power Corporation-Directory of Hydroelectricity Works-of Greece (DEH/DAYE) have constructed and now operates two dams. The upper dam of Thesavros (at highest level +380 m, lake area 18 km², lake volume 750*10⁶ m³) and the lower dam of Platanovrysi (at highest level +227.5 m, lake area 3 km², lake volume 73*10⁶ m³).

These multipurpose dams satisfied the needs for anti flooding control, for power production and irrigation of the deltaic platform, as well as for the environment. Another low dam was constructed three decades ago, in the main course of Nestos at the head of the deltaic platform, known as Toxotes dam. It provides water for the irrigation networks of the plain.

In the Bulgarian territory there is also a dam-lake on the main course of Dospat river, a major branch of the Mesta/Nestos network.

MATERIALS AND METHODS

The Management Issue: The so far known human works and other activities in both the drainage basin and the deltaic platform of the Mesta/ Nestos river during the last 50 years^[5] brought serious changes in the river regime and the natural environment. To clarify these changes as well as their effects on the natural life of the area requires further research in the times to come.

Meanwhile, the river system requires a management plan for water use as well as for the environment. Such a plan for the Hellenic territory of Nestos was scheduled by the Public Power Corporation (DEH) of Greece^[6] and approved by the Ministry of Environment (KYA 18492/19-09-1996). The management plan was also based on the terms of the bilateral agreement of 1995 between Bulgaria and Greece, as well as on the requirements of the Ramsar Treaty of the deltaic wetland of Nestos.

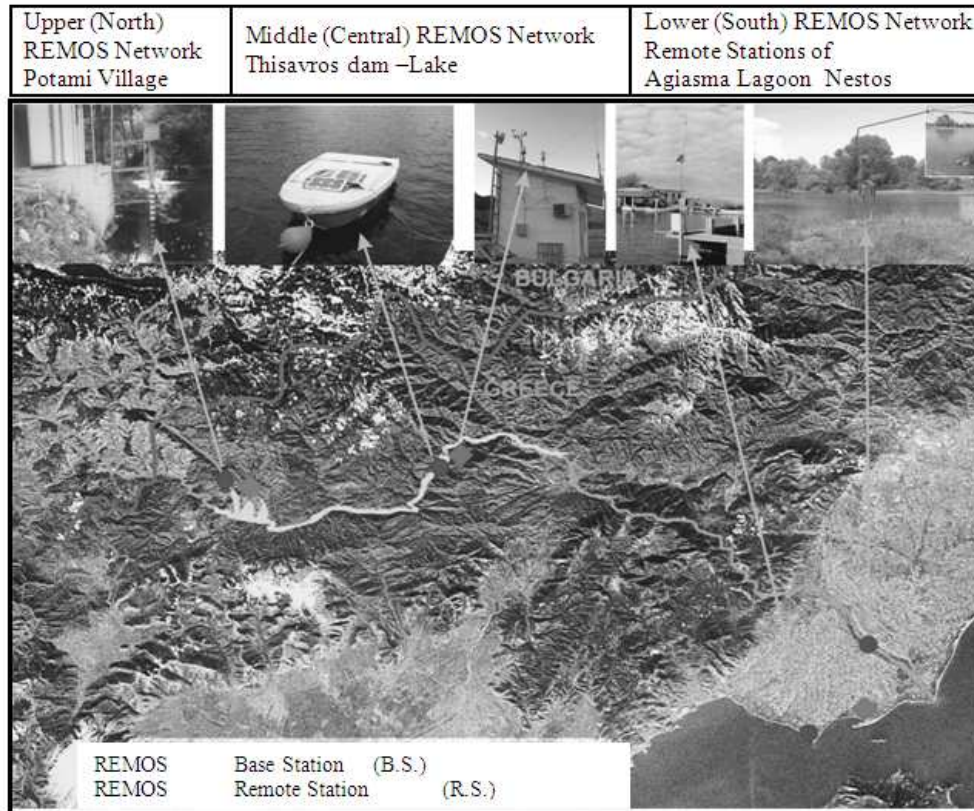


Fig.1: Stations of REMOS Network in the River Nestos

Furthermore, DEH proceeded in the monitoring of Nestos water and the environment, following the requirements of the Ministry of Environment^[7]. The

A PERSEAS research group of the Aristotle University of Thessaloniki constructed, installed and now operates on DEH three monitoring networks of REMOS (Fig. 1):

- * The Lower network in Nestos deltaic plain
- * The Middle network of Thesavros dam area
- * The Upper network of Potami area close to the Bulgarian borders.

The REMOS (Remote Environmental Monitoring System) has the following characteristics^[8]:

- * It is a prototype electronic system for automated measurements of water and air parameters
- * It forms a network of remote telemetry stations, which continuously monitor electronically the values of various parameters in environmentally sensitive ecosystems.
- * It has advanced capabilities, which is implementing the approach of "Integrated Environmental Monitoring" that is the integration of many different kinds of environmental measurements to a common computerized structure.

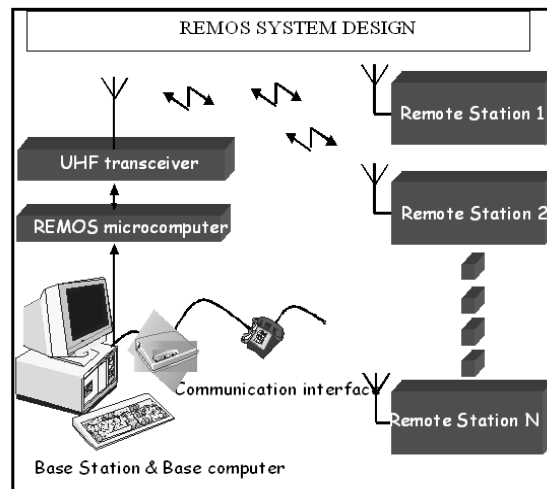


Fig. 2: REMOS System Design

Each of the three networks of REMOS consists of a Base Station (B.S.), equipped with a base computer, a communication interface and a UHF transceiver to communicate, as well as to a number of Remote Station (R.S.) (Fig. 2), equipped with a microcontroller unit, a communication interface, a UHF transceiver, a solar panel and a battery and several measuring units (sensors).

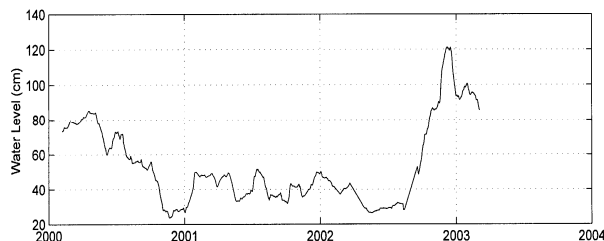


Fig. 3: The Hydroperiod of Nestos/Mesta River the Last Three Years of Measurements (2000-2003)

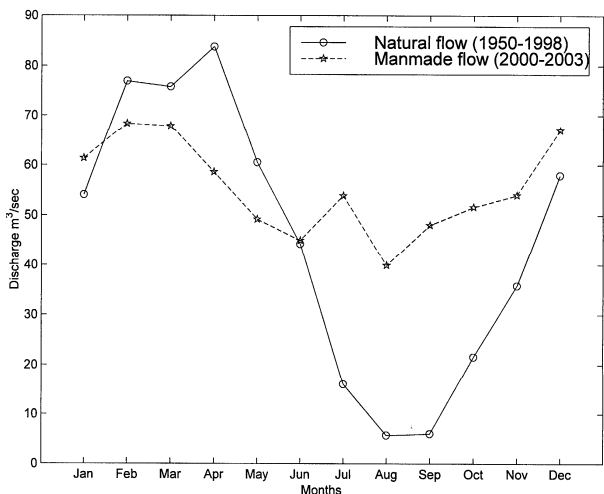


Fig. 4: Comparison between the Natural Hydroperiod of Nestos, Prior to the Dam Construction and the Man-made Hydroperiod

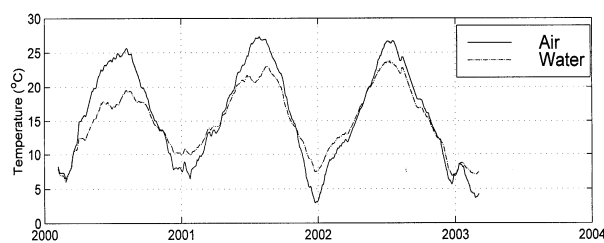


Fig. 5: The Water and Air Temperature Annual Curves of Nestos

The Lower Network of Nestos deltaic platform includes a R.S in the deltaic channel of the river. It works on a continuous (24 h) base, monitoring six parameters, such as water level, water and air temperature, water conductivity, water redox potential and water dissolved oxygen.

The recorded data are presented as daily averages for the entire measuring time 2000-2003 (three full years).

The above measured parameters are considered as the basic and important ones for in the river water, for the natural processes, as well as for the ecology of the river and its broader area of the deltaic wetland.

Although the operation time of the three years is inadequate to reveal river natural processes, the so far collected data seems to contribute in the clarification of the river annual fluctuations, after the dam construction and operation.

The Data from Nestos Remote Station: The so far collected data for three years can be briefly summarized as follows:

- * The hydroperiod of the river (Fig. 3) have not yet been normalized. The annual curves present several fluctuations through the year. Their forms are also different from year to year.
- * During the year 2000 the maximum water level obtained in April and the minimum one in November. In the summer months July and August were much higher than expected.
- * During the year 2001 the water level remains low all through the year with maximum values in February-April, July and December. Low values appear in May and September-October.
- * During the year 2002 the maximum values reached in December, a period of successive flooding episodes, while the minimum values reached in the period May-August.

The natural hydroperiod of Nestos, prior to the dam construction, had maximum values at the end of April and minimum values at the end of August (Fig. 4). It is therefore clear that the present river Nestos have not yet established its new hydroperiod.

- * The water temperature annual curves of Nestos (Fig. 5) follows similar forms with the air temperature annual curves. Maximum values appear in early August, while minimum values appear in December-January, of each year for both air and water on the deltaic platform of Nestos. In natural conditions the water temperature has also higher values in winter time and lower values in summertime, in relation to the air values. The difference is normally 3-5°C of the daily temperature values. The recorded data indicate a daily average of water temperature 2-5°C higher in the wintertime, as well as 5-7°C lower in summertime, compared to the air temperature of the area. In April and November the temperature values of the air and water of Nestos are similar.
- * The water conductivity of Nestos has generally low values 200-300 $\mu\text{S cm}^{-1}$ all through the year. Within this range the conductivity curves have certain fluctuations. Usually, low values seem to coincide with high values of water level and discharge. The water conductivity of Nestos on its deltaic platform, just before the river mouth, indicates its good quality in terms of dissolved material.
- * The Redox potential annual curves for Nestos water are highly irregular, show no periodical changes within the year and in several cases follow sharp

fluctuations. The so far collected data do not allow an accurate scientific approach to the matter of redox potential in Nestos water.

- * The dissolved oxygen in the water was satisfactory all through the measured period in Nestos water. The usual range of values is between 8 and 12 mg L⁻¹. In certain cases were recorded low values 5-6 mg L⁻¹, or high values over 12 mg L⁻¹. Even in periods of low water level the dissolved oxygen in Nestos water remains satisfactory.

RESULTS

The daily average data, recorded in the Nestos deltaic channel by the Remote Station of REMOS network, for a three-year period, allow the following results:

- * There is a continuous water flow in the deltaic channel of Nestos all through the year.
- * The natural hydroperiod of the river have been changed. The curve has not yet been normalized and presents several fluctuations through the year. The important change occurred in summertime by the increase of water level in the channel.
- * The water temperature follows similar annual curves with that of the air temperature. The two curves coincide in April and November. In wintertime they differ 2-5°C in favor of water, while in summer time they differ 5-7°C in favor of the air.
- * The quality of water in terms of conductivity and dissolved oxygen seems to be very good.
- * It is difficult to evaluate and clarify the Redox potential data that need further study.

DISCUSSION

The construction and operation of the multipurpose dams of Thesavros and Platanovrysi in the intermountain valley of Nestos, as well as of the irrigation dam Toxotes at the deltaic head, seems to have influenced certain quantitative and qualitative parameters of its water in the deltaic channel.

This can be attributed to the management practices applied by the DEH in the hydroelectric stations, as well as by the Agricultural Services in the irrigation dam of Toxotes.

Among the changes of particular interest is the increase of water level and discharge in summer time, which is related to the increase in power production to satisfy the energy needs of air conditioners of the broader area. This is a new phenomenon in Greece, of the last decade, that shows how the change of life conditions influence the river flow in case of regulated rivers (Nestos, Aliakmon, Acheloos etc.). The daily fluctuations of the water level are also an interesting parameter for further analysis because it seems to influence the ecological conditions of the deltaic platform.

The temperature differences between water and air on the Nestos deltaic channel during the summer period, seems to be also important. The explanation comes through the measurements of water temperatures in the dams^{18, 91}. The water released from the dams has very low temperatures (6-12°C) and it is not able to reach normal values in its 65 km downriver flow, up to the REMOS Station of the deltaic platform. Particularly in summer time when the natural water temperature exceeds 20-25°C.

The construction of the lowest lower dam of Temenos as it was originally scheduled by the DEH of Greece, might have positive effects in the future in normalizing both the water flow and temperature up to the deltaic platform.

The so far applied river management seems to have positive effects also in the water quality, which in turn influences the river and the deltaic ecological conditions, up to the Thracian sea.

The so far obtained data indicate changes in the river regime, due to anthropogenic activities. In order to clarify these changes and evaluate their role in the ecology of the river and the deltaic system, two conditions required:

- * More monitoring stations along the river course up to the drainage basin in the Bulgarian territory and
- * More continuous monitoring time.

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