

# CALCULATION OF SEDIMENT REDUCTION AT THE OUTLET OF NESTOS RIVER BASIN, DUE TO THE DAMS

**M. Andredaki<sup>1</sup>,  
V. Hrisanthou<sup>1</sup>,  
N. Kotsovinos<sup>1</sup>**

*<sup>1</sup>Department of Civil Engineering, Democritus University of Thrace, 67100 Xanthi, Greece*

E-mail: mandreda@civil.duth.gr

Nestos River flows through two European countries, Bulgaria and Greece, and discharges its water into the Aegean Sea. The basin area of Nestos River, considered in this study, is about 5100 km<sup>2</sup>. In the Greek part of Nestos River, two dams, Thisavros Dam and Platanovrysi Dam, were already constructed. The construction of the dams implies the reduction of sediment yield at the outlet of Nestos River basin and, generally, the alteration of the sediment balance of the basin, which results in coast erosion. Thus, the main aim of this study is to calculate sediment yield at the outlet of Nestos River basin, before and after the dams construction.

In order to reduce sedimentation in Thisavros Reservoir, measures against soil erosion should be taken in both parts of Thisavros Reservoir basin, namely in the Greek and the Bulgarian parts. It means that, apart from the issues regarding water quantity and quality of Nestos River in both countries, sediment transport issues should also be confronted in common by both countries.

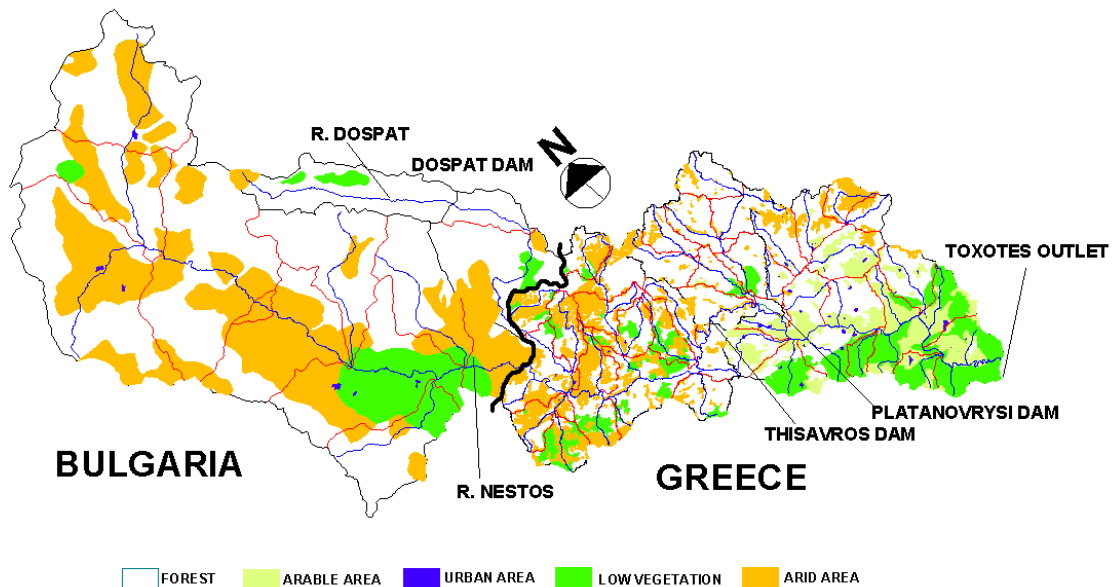
The mathematical model RUNERSET (**RUN**off – **ER**osion – **SE**diment Transport) was applied to Nestos River basin for the calculation of a mean annual value of sediment yield, due to rainfall and runoff, at certain locations. The above mathematical model consists of three submodels: a rainfall-runoff submodel, a soil erosion submodel and a sediment transport submodel for streams.

For more precise calculations, Nestos River basin was divided into 60 sub-basins (Figure 1). Specifically, the basin of Thisavros Dam (Bulgarian and Greek parts) was divided into 31 sub-basins, the basin of Platanovrysi Dam (Greece) into 9 sub-basins and the basin downstream of Platanovrysi Dam into 20 sub-basins. The outlet of the last basin is named Toxotes.

Meteorological data (mainly rainfall and temperature) from 22 meteorological stations in Greece and Bulgaria were used as input data for the mathematical model. The following thematic maps were constructed for the accurate computation of sub-basin parameters:

- Altitude contours map with sub-basins
- Main streams map (Figure 1)
- Thiessen polygons map
- Soil cover map (Figure 1)
- Geological map

The values of the sub-basin parameters (e.g. area of the sub-basins, mean slope gradient of soil surface, mean slope gradient of the main stream of the sub-basins, percentage of Thiessen polygons, percentage of soil cover etc.) were used also as input data for the model. The calculations were performed on a monthly time basis.



**Figure 1:** Main streams and soil cover map of Nestos River basin divided into sub-basins

Sediment measurements (suspended load) of 53 years (1937 – 1989) were available for the location “Momina Koula”, in the Bulgarian part of Nestos River. The mean annual suspended sediment yield for the time period given above is  $202 \text{ tn/km}^2$ , according to the measurements. RUNERSET was applied to the basin corresponding to this location for the same time period. The basin area is  $1511 \text{ km}^2$ , about 30% of the entire basin area of Nestos River. Bed load measurements were not available; therefore, the following assumption was made: the ratio of bed load to suspended load amounts to 0.25. According to this assumption, the measured mean annual sediment yield at M. Koula is  $252.5 \text{ tn/km}^2$ . As a final result, the mathematical model used underestimates the measured mean annual sediment yield by about 18%. The relatively low deviation between computation and measurement results for the mean annual sediment yield at the location “Momina Koula” is an encouraging indication for the further application of the mathematical model to other parts of Nestos River basin.

So, the following calculations were performed for a time period of 11 years (1980 – 1990):

- Calculation of mean annual sediment amount inflowing into Thisavros Reservoir from the Bulgarian part ( $3052 \text{ km}^2$ ) and from the Greek part ( $804 \text{ km}^2$ ) of Nestos River basin.
- Calculation of mean annual sediment amount inflowing into Platanovrysi Reservoir from the corresponding basin ( $405 \text{ km}^2$ , Greece).
- In a previous study, the mean annual value of sediment yield at the outlet of Nestos River basin (Toxotes) was calculated. This sediment yield originates mainly from that part of Nestos River basin which lies downstream of Platanovrysi Dam ( $840 \text{ km}^2$ , Greece).

The arithmetic results for the annual sediment yield, for different years, at certain locations of Nestos River basin (Thisavros Reservoir, Platanovrysi Reservoir, Toxotes) are summarized in Table 1.

**Table 1:** Computational results of sediment yield at various locations of Nestos River basin

YEAR	HYDROLOGIC BASIN: THISAVROS RES.			HYDROLOGIC BASIN: PLATANOVRYSI RESERVOIR (tn)	HYDROLOGIC BASIN: DOWNSTREAM OF PLATANOVRYSI DAM (BASIN AFTER THE CONSTRUCTION OF THE DAMS) (tn)	ENTIRE HYDROLOGIC BASIN OF NESTOS RIVER (tn)
	BULGARIAN PART OF THE BASIN (tn)	GREEK PART OF THE BASIN (tn)	BASIN DOWNSTR. OF DOSPAT DAM (tn)			
1980	1 083 882	184 000	154 577	366 000	278 000	2 066 459
1981	968 013	127 800	128 426	344 000	588 000	2 156 239
1982	850 246	312 500	112 484	409 000	426 000	2 110 230
1983	309 348	114 000	32 612	99 500	73 000	628 460
1984	678 675	360 500	107 329	277 000	494 000	1 917 504
1985	991 120	94 500	127 561	54 500	131 000	1 398 681
1986	1 495 731	613 000	162 198	303 500	198 000	2 772 429
1987	1 020 871	875 500	131 478	761 500	673 000	3 462 349
1988	884 022	357 600	130 120	241 000	383 000	1 995 742
1989	73 527	121 000	XX	192 500	207 000	XX
1990	545 250	552 400	46 541	289 500	64 000	1 497 691
<b>MEAN (tn)</b>	<b>809 153</b>	<b>337 527</b>	<b>113 333</b>	<b>314 550</b>	<b>330 800</b>	<b>2 000 578</b>
<b>MAX (tn)</b>	1 495 731	875 500	162 198	409 000	673 000	3 462 349
<b>MIN (tn)</b>	73 527	94 500	32 612	54 500	64 000	628 460
<b>ST. DEV.</b>	391 785	252 288	42 353	186 329	208 229	765 792
<b>ST. DEV./MEAN</b>	0.48	0.75	0.37	0.59	0.63	0.38

\*XX: No results due to very low values

According to Table 1, the mean annual value of sediment yield at the outlet of Nestos River basin, before the construction of the dams, is about  $2 \times 10^6$  tn, while, after the construction of the dams, the mean annual value of sediment yield at the basin outlet amounts to  $0.33 \times 10^6$  tn. It means that the construction of the dams implies a dramatic decrease (about 84%) of the sediments supplied directly to the basin outlet and indirectly to the neighbouring coast. This fact influences the seashore sediment balance resulting in an obvious erosion of Nestos River mouth and the adjacent coastline.