AN APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM TO EVALUATE THE WATER QUALITY OF ERGENE RIVER (TÜRKIYE)

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ABSTRACT

Ergene River is the most significant watershed for the Thrace Region. However, it is one of the most polluted lotic ecosystems of Türkiye and known that exposed to an intensive domestic, agricultural and industrial pollution almost from its source region. The aim of this research was to determine the water quality of Ergene River by measuring a total of 15 significant water quality assessment parameters including dissolved oxygen (DO), oxygen saturation (%O2), pH, electrical conductivity (EC), total dissolved solids (TDS), salinity, turbidity, suspended solids (SS), nitrate (NO3), nitrite (NO2), ammonium (NH4), phosphate (PO4), sulphate (SO4), biological oxygen demand (BOD) and chemical oxygen demand (COD) and (2) to assess the water quality by using Geographic Information System (GIS). For this purpose, surface water samples were collected from 5 stations (from upstream to downstream; E1 – E5) located on the Ergene River in winter season (December) of 2020. As a result of this study, the mean recorded values of investigated water quality parameters in Ergene River were found as: 5.30 mg/L for DO, 46.50 % for %O2, 9.16 for pH, 743 µS/cm for EC, 502 mg/L for TDS, 0.50 ‰ for salinity, 186 NTU for turbidity, 136 mg/L for SS; 11.79 mg/L for NO3, 1.08 mg/L for NO2, 2.34 mg/L for NH4, 1.69 for PO4, 93.66 mg/L for SO4, 10.80 mg/L for BOD and 41. 16 mg/L for COD.

Keywords: Ergene River, Water quality, Geographic Information System

INTRODUCTION

In especially recent years, environmental pollution has become a global concern and contamination of freshwater ecosystems is top of attention for all over the world. Anthropogenic pressure on the freshwater resources is increasing day by day and accessing the clean water for many people in the world is also getting harder day by day [1 – 4]. Contamination by nutrients because of agrogenic and domestic discharges and also salinization of freshwater ecosystems because of industrial discharges are among the most significant problems for the freshwater ecosystems for all over the globe [5 – 7].
Ergene River Basin is knowns as the lifeblood of Thrace Region and known as one of the most contaminated freshwater habitats of Türkiye. It is adversely affected by the agricultural, industrial and domestic runoff caused from especially intensive paddy and sunflower cultivation and lots of settlements and dense industrial facilities located around the watershed [8 – 10]. The Ergene River is one of the main fluvial ecosystems located in the Thrace Region of Türkiye and it is the main sub - basin of Meriç River a significant cross boundary riverine ecosystem for the Europe. The length of the Ergene River is approximately 285 km from the source in the Yıldız Mountains to the point where it joins the Meriç River [11 – 13].

The main objectives of this investigation were (1) to assess the water quality of Ergene River by determining a total of 15 significant limnological parameters (dissolved oxygen, oxygen saturation, pH, electrical conductivity, total dissolved solids, salinity, turbidity, suspended solids, nitrate, nitrite, ammonium, phosphate, sulphate, biological oxygen demand and chemical oxygen demand) and (2) to evaluate the water quality by using Geographic Information System (GIS)

MATERIAL AND METHODS

Sample collection

In the present research, freshwater samples were collected from 5 locations selected on the Ergene River in rainy (winter) season of 2020. The topographic map of study area with the selected sampling points are given in Figure 1.

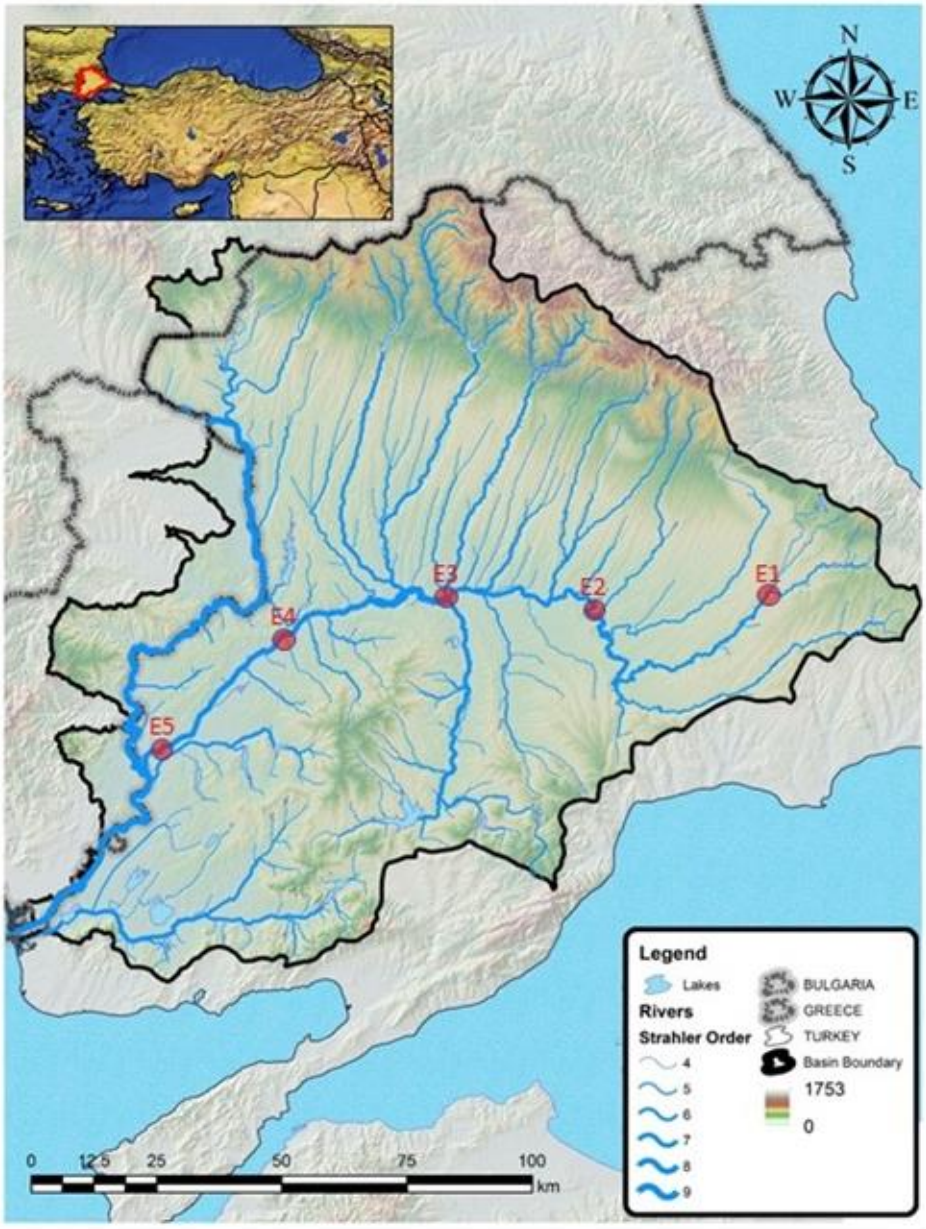

Figure 1. Ergene River Basin and selected stations

Psychochemical Analysis

Dissolved oxygen (DO), oxygen saturation (%O2), pH, electrical conductivity (EC), total dissolved solids (TDS) and salinity variables were determined by using a multi – parameter device (Hach Lange – HQ40D) in the field studies; turbidity variable was determined by using a portable turbidimeter device (Hach Lange – 2100Q) in the field studies; suspended solids (SS) variable was determined by using gravimetric method in the laboratory studies; biological oxygen demand (BOD) variable was using a BOD device (Hach Lange – BOD Trak II) in the laboratory studies; nitrate (NO3), nitrite (NO2), ammonium (NH4), phosphate (PO4), sulphate (SO4) and chemical oxygen demand (COD) variables were determined by using a spectrophotometer device (Hach Lange – DR3900) in the laboratory studies.

RESULTS AND DISCUSSION

Significant spatial differences were detected for all of the investigated water quality parameters in the water of Ergene River. The results of measuring 15 limnological parameters in water of Ergene River are given in Table 1 and the GIS based distribution maps of investigated all of the parameters are given in Figure 2 – 5.

Table 1. Results of investigated variables

	E1	**E2**	**E3**	**E4**	**E5**
DO (mg/L)	7.96	1.90	2.27	6.71	7.67
%O_2	70.8	16.7	20.0	58.2	66.8
pH	9.75	8.83	8.96	9.20	9.07
EC (µS/cm)	287	1503	910	514	505
TDS (mg/L)	189	1038	596	345	344
Salinity (‰)	0.19	1.05	0.60	0.35	0.34
Turbidity (NTU)	32	54	187	333	327
SS (mg/L)	46	57	84	238	257
NO_3 (mg/L)	4.50	9.16	15.50	18.60	11.20
NO_2 (mg/L)	0.318	1.010	2.060	1.200	0.812
NH_4 (mg/L)	0.436	3.500	2.750	2.680	2.360
PO_4 (mg/L)	0.746	1.650	2.760	1.590	1.730
SO_4 (mg/L)	38	114	113	98	105
BOD (mg/L)	3.9	23.0	18.7	4.3	4.1
COD (mg/L)	25.1	69.1	52.8	30.9	27.9

The lowest dissolved oxygen and oxygen saturation values were measured at the E2 and E3 stations (1.90 – 2.27 mg/L for DO; 16.7 – 20.0 for %O2 respectively), while the highest dissolved oxygen and oxygen saturation values were measured at the E1 station (7.96 mg/L for DO; 70.8 for %O2). Similarly, the highest electrical conductivity, total dissolved solids, salinity, biological oxygen demand and chemical oxygen demand data were recorded at the E2 and E3 stations (1503 – 910 µS/cm for EC; 1038 – 596 mg/L for TDS; 1.05 – 0.60 ‰ for salinity; 23.0 – 18.7 mg/L for BOD; 69.1 – 52.8 mg/L for COD respectively), while the lowest data of these parameters were recorded at the E1 station (287 µS/cm for EC; 189 mg/L for TDS; 0.19 ‰ for salinity; 3.9 mg/L for BOD; 25.1 mg/L for COD) (Table 1).

A gradual increase in turbidity and suspended solids parameters from the upstream to the downstream of the Ergene River was detected. It was also noted that the values of nitrogen and phosphorus compound recorded in the middle and lower basin (excluding only the source region – E1) were at very high levels (Table 1).

In general, it has been determined that the upper basin of Ergene River has 1st class water quality, the middle basin of Ergene River has 3rd class water quality, and the lower basin of Ergene River has 2nd class water quality in terms of investigated water quality parameters [14].

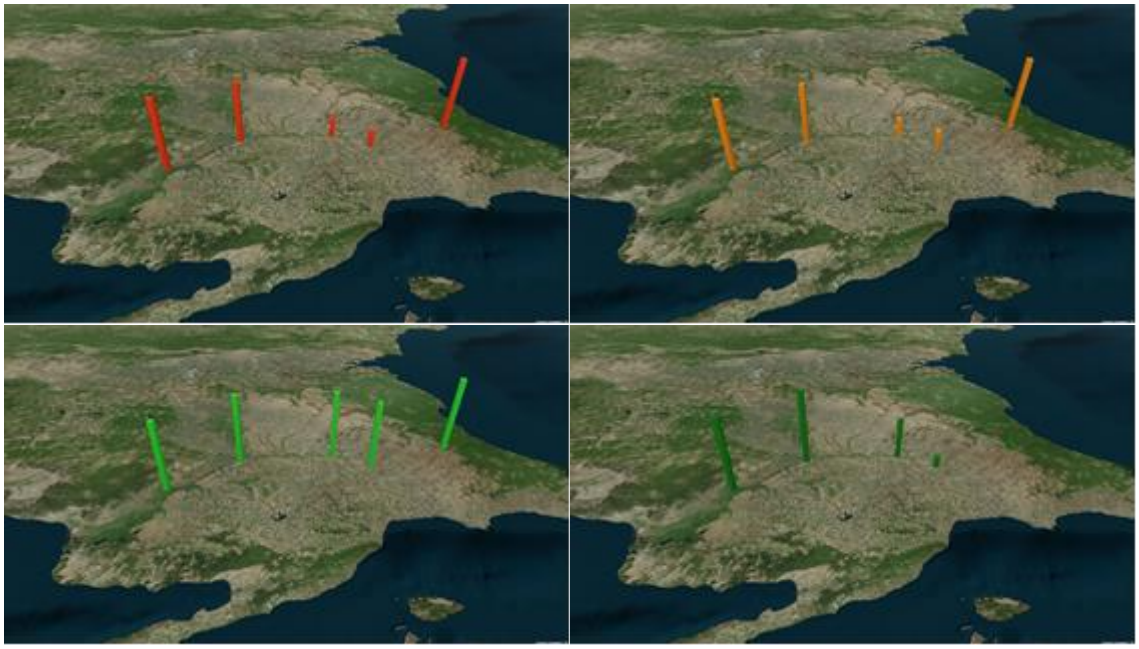

Figure 2. DO (up-left – mg/L), %O2 (up-right – %),
pH (down-left – pH), turbidity (down-right – NTU) levels

Figure 3. EC (up-left – µS/cm), TDS (up-right – mg/L),
Salinity (down-left – ‰), SS (down-right – mg/L) levels

The organic pollutant contents of the Ergene River, especially the phosphate and ammonium contents, were recorded as at very high levels in the whole basin waters. It has been noted that all the investigated stations from upstream to downstream have 3rd class water quality in terms of phosphate and ammonium values [14]. It is clearly

documented that agricultural applications may significantly raise the concentrations of nitrogen and phosphorus compounds in soil and water [15 – 18]. There are many agricultural lands and industrial establishments in the Ergene River Basin. It is thought that the very high levels of organic pollutants and high salinization rates detected in the waters are caused by the agricultural and industrial activities carried out in the watershed.

Figure 4. NO3 (up-left – mg/L), NO2 (up-right – mg/L),
NH4 (down-left – mg/L), PO4 (down-right – mg/L) levels

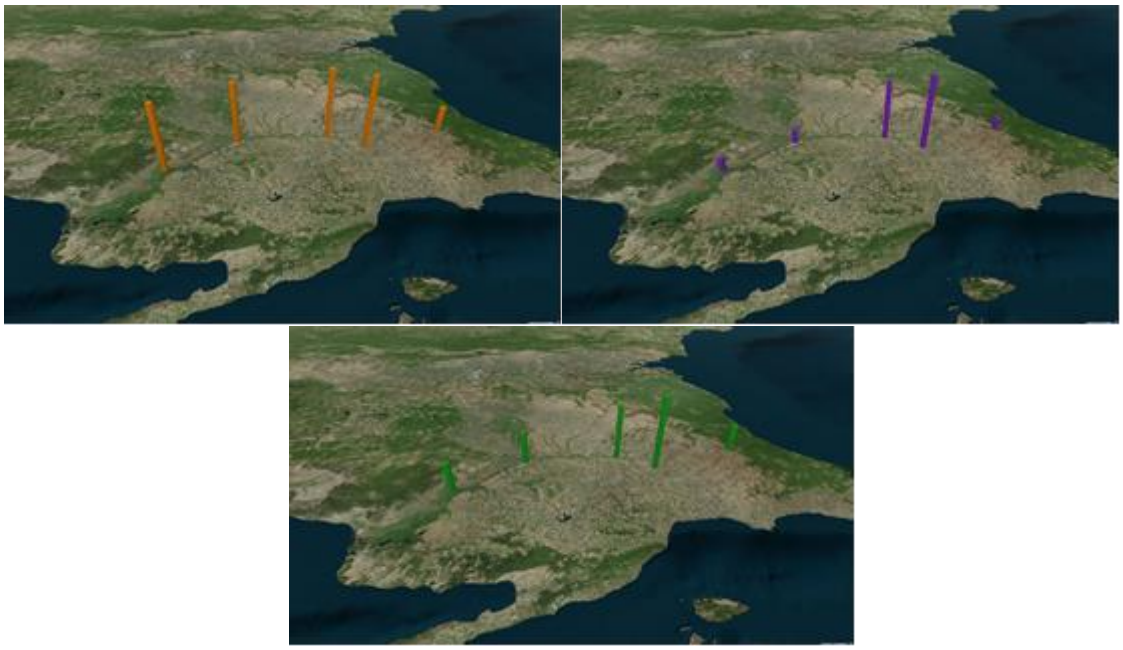

Figure 5. SO4 (up-left – mg/L), BOD (up-right– mg/L),
COD (down-middle – mg/L) levels

In order to assess the pollution status of the investigated parameters in waters of the Ergene River, the levels of water quality parameters obtained from the current research were compared with those reported by previous investigations in Türkiye (Table 2).

The average levels of measured dissolved oxygen values in the water of Ergene River in the current research were lower than those in water of Tunca and Meriç Rivers and Emet, Seydisuyu and Havsa Streams. It was also determined that the average levels of measured EC, salinity, turbidity, nitrate, nitrite and phosphate values in the water of Ergene River in the current research were significantly higher than those in water of Tunca and Meriç Rivers and Emet, Seydisuyu and Havsa Streams [19 – 22].
These findings revealed that the concentrations of organic pollution parameters like nitrate, nitrite and phosphate and salinity parameters like EC and salinity of different lotic habitats varied significantly as a result of anthropogenic activities and natural sources. The current research was also clearly revealed that Ergene River is adversely affected by human-induced activities.

Table 2. Comparison of parameters in current study with other fluvial habitats

	DO mg/L	**pH**	**EC** µS/cm	**Sal** ‰	**Tur** NTU	**NO_3** mg/L	**NO_2** mg/L	**PO_4** mg/L	**Reference**
Ergene River	5.30	9.16	744	0.50	186	11.79	1.08	1.69	Current Research
Tunca River	8.44	8.25	679	0.37	7.99	1.47	0.04	0.27	[19]
Meriç River	8.67	8.22	327	0.18	6.17	1.90	0.02	0.16	[19]
Emet Stream	9.32	7.92	652	0.39	-	1.23	0.03	0.68	[20]
Seydisuyu Stream	8.13	7.92	543	0.29	-	11.31	0.02	0.57	[21]
Havsa Stream	-	8.19	402	0.19	35.30	0.93	0.02	0.62	[22]

DO: Dissolved oxygen; Sal: Salinity; Tur: Turbidity

CONCLUSION

In the present research, the water quality of Ergene River was investigated by measuring some significant limnological parameters. According to the result of this study, water of Ergene River was found as significantly contaminated by the organic pollutants mainly phosphate and ammonium.
In conclusion, it can be recommended that consequently, special measures should be taken to control the input of organic pollutants into the Ergene River and polyculture agricultural applications have to be supported to avoid using overly chemical fertilizers and pesticides around the region. Also discharges of industrial wastewaters without any treatment must be prevented in order to improve the quality and provide the sustainability of aquatic life in the Ergene River.
The data of the present research also reflects the applicability and necessity of GIS technology on evaluation the qualities of surface water ecosystems.

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