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RESEARCH ARTICLE

MONITORING AND WATER QUALITY ASSESSMENT OF LAKE MANDRA (LAKE MANDRENSKO) IN CITY OF BURGAS (BLACK SEA) REGION OF REPUBLIC OF BULGARIA

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ABSTRACT

***Background*:**For a purpose of water quality and assessment of the major sides west and east of lake Mandra(area of 38.84 km²) located in city of Burgas in the Black Sea, region of Republic of Bulgariawas investigated. and compared. Lake MandraTrends of the water quality parameters were collected, analysed and investigated in different seasons a year from year 2014 to 2018. Several water samples were collected from two regions of the lake (west and east point). The samples were taken approximately 10-20 meters from the lake line, where the depth was 0.5-1.0 meter. Several tests were conducted using high standard methods to identify the levels of inorganic substances and physico-chemical parameters. The purpose of this research is to identify the changes in the ecological state of the lake, to identify trends in water quality, to specify the influence degree of the pollutants (chemical and biological) over the biodiversity of the lake and eventual use for recreational purposes.

***Results*:**Based on the analysed data, the pH was relatively basic, where it ranged between 7.9 and 9.2 with respect to both points of sampling (west and east) of the lake. Highest conductivity value recordedfor the eastern point of the lake was28,000.00 µs/cm (fall 2017) while the minimum recorded conductivity was 149.00µs/cm for westernpoint of the lake in the spring time (2018). Total Nitrogen concentration ranged between 1.32 – 3.85 mg/l (most analysis data, spring time) and lower than1.32 mg/l in winter time.

***Conclusions*:** Based on results and study, several substances involving Cl, P, Fe, Mn, SO_4^{2-} and others were at normal level. BOD, COD, Nitrogen with its different state as well as saturated Oxygen were also analysed to determine the impact of human, industrial activities on water quality during four seasons of the year. Some of the data collected for such parameters have showed low concentrations which is an indicator for desirable level of pollutiondespite the fact that the studied area is managed well so that for controlled part of the lake as well; indicating a non-polluted site for the lake.

INTRODUCTION

Background

Lake Mandraor Lake Mandrenskois a lake located in city of Burgas in the region of Black Sea in Bulgaria (figure 1-3). This lake isthe southernmost of the Burgas Lakes and close to Black Sea. It is 8 km long and 1.3 km wide at maximum with an area of 38.84 km². it was a saline natural lake until 1963, when it was turned into a reservoir with the construction in order to be a source of fresh water [1-3].

Rivers such as Izvorska, Fakiyska, Sredetska and Rusokastrenska are flow directly into this lake Mandra.Parts of Lake Mandra are designated protected areas, Poda and Uzungeren, inhabited by a number of locally and globally endangered species of fish and birds.The study area and analysis of this present work spotted at west "West Point' and east "East Point" of the lake (figure 2, 3). Water analysis and data collected were at multipletimes a year (four seasons) from 2014to 2018.Lake Mandra has a strategic location in Bulgria, furthermore it has a protected area called "Mndra-Poda". This area has geographical features and strategically important. The lake "Mandra" and the water basins in the protected area 'Poda' are the most important features for the biodiversity of the

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protected area so that, Mandra-Poda complex is integrated in the Burgas wetlands that include also Atanassovsko Lake and Vaya Lake. 'Mandra' was formed by building a dam in the eastern part. The breeding ponds and unluckily the oxidizing lakes of 'Lukoil Bourgas' also comprise parts of the complex. Another part of it is the protected area 'UstienarekaIzvorska'. All these unique components make the protected area very unique and varied. Moreover, continues monitoring and water quality assessment of lake Mandra is a key factor to maintain the quality of water because any change in parameters has direct and indirect impacts or inhibit or even eliminate the natural exchange with the black sea since the lake Mandra is connected with the black sea [4-8].

MATERIALS AND METHODS

Chemicals, reagents used for water analysis experiment were of analytical grade.

Data analysis, all water samples analysis data were obtained from accredited testing laboratory with aaccreditation certificate no 135 li, Issued by EA BCAA, according to the requirements of BDS EN ISO/IEC 17025. Ministry of Environment and WaterExecutive Agency for EnvironmentDg L– Analytical WorkRegional Laboratory Burgas-03.

Methods and standard, the following number of standardized/validated methods were used for water samples analysis:

BDS 17.1.4.01:1977; BDSENISO 10523:2012; BDSEN 27888:2000; BDSENISO 5814:2012; BDSEN 872:2006; BDSISO 6059:2002; VVLM 1023/2010; BDSENISO 11732:2006; BDSENISO 13395:2001; BDSISO 7890-3:1998; BDSEN 12260:2004; BDSENISO 6878:2005 ; BDSEN 25663:2000; ISO 9297:1989; VVLM 1009/2010; VVLM 1004/2010; BDSENISO 17294-2:2005; VVLM 1007/2010; VVLM 1019/2010; ISO 6060:1989; BDSEN 1899-2:2004; BDSEN 1484:2001; VVLM 1013/2010; BDS 17.1.4.25:1980.

Sample collection, lake water samples were collected from two points: West Point (western point) and East Point (eastern point) in the lake Mandra (Lake Mandrensko), figure 4. Samples were collected at different times/months of the year representing four seasons spring, summer, fall and winter.The presented data in this study, water analysis, were collected and analyzedthrough the year 2014 - 2018. All samples were taken 8m away from the shore at a depth of 1.0 m. Samples were then analyzed within short period of time (one-two week) from the time of collection. Water samples collected were subjected to:

1. Physico-Chemical test: pH, electrical conductivity, Temperature.
2. Chemical (Inorganic substances/elements) analysis: Total Phosphorus (P), Ortho Phosphate (Ort-PO_4^{3-}), Dissolved Iron (Fe), Manganese (Mn), Chlorine (Cl) and Sulfate (SO_4^{2-}).
3. Pollution indicators such as BOD and COD, total Nitrogenconcentration, Ammonia, and Dissolved Oxygen concentration.

RESULTS AND DISCUSSIONS

The present study deals with data analysis from year 2014 to the end of year 2018.At the beginning, general overviewof water samples for 2014 are considered in order to have an idea about the quality of water at that time and data analysisare shown inTable 1. These data represent water analysis collected from the lake Mandra in May/June (Spring time) for the western side of the lake.Further investigation was considered for the year 2015. Water samples were collected in four seasons of the year 2015 assessment and quality of water at western side (west point) of the lake Mandra were also investigated and table 2 lists the physical and chemical properties of water samples with concentrations of inorganic substances in mg/l and in μg/l for dissolved Iron and Manganese in water. Water sample collection and analysis were done and tabulated according to the following order: Spring season (March/April), Summer (August/September), Fall (late September) and at the beginning of winter time (November).

Referred to table 2, a comparative analysis and water quality assessment were started, and data are shown in graphs for correlation purpose so that, figures 5-10 representing western side (west point) of Lake Mandra (Lake Mandrensko) of the year 2015.Monitoring and water quality assessment of lake Mandra were continued to satisfy the current study so that more data and analysis were obtained for the western side (west point) and eastern side (east point) of the lakefor the year 2016, 2017 and 2018. Study areas are shown in figures and satellite view in figure 4.Consequences are shown in tables 3-5.Finally, a comparative and average concentration values are considered and written in table 6 (among years 2014-2018) [9-11].

Results show that the lowest temperature recorded was in year 2016 which was 12.00 °C in 2016 (western side) and 22.30 °C in 2014 for the entire lake (western side). With respect to electrical conductivity, in general, it is found to be higher in summer time with max value reached at 28,000 μS/cm.This was recorded in year 2017 for the western point of the lake while the lowest was seen in 2018 at west side of the lake (146.00 μS/cm); this trend is noticed for the other years too. Beside measuring other parameters, measuring electrical conductivity reflects a good indication of existing of excess species in water in fact informing us a vibrant correlation outcome for both quantitative and qualitative knowledge of the water and elements existence [12].

The average BOD value in 2015 was found to be the highest among other years (2014-2018), 6.10 mg/l (west point) and this might be due to extensive activities during the summer time while is found to be low in winter 2018 (Av. 2.48 mg/l). COD analysis has a regular trend in which the average values show high (west point in 2016), low (west point 2015) and very low (east point 2018) 31.30, 25.27, 11.65 mg/l respectively. The trend is considered logic and normal for the chemical process since it is representing the organic compounds that are oxidized at high temperature and in the presence of a strong oxidizing agent. Dissolved Oxygen of the entire lake ranges between 6.93 – 9.70 mg/l (2016, 215 respectively. The pH value has an average between 8.34 and 8.83 which indicates a basic environment that might be one of the reasons that may lead to higher ammonia and other fragments[13].

The analysis of total nitrogen, nitrogen as N-NH_4 and Ammonia are also analyzed and average concentration are presented in table 6. In general, the average value of total nitrogen concentration varied from 0.80 mg/l (recorded at east point year 2018) to 5.12 mg/lthat is seen in 2015 for the west point of collection. In 2018, at west point of the lake, N-NH_4 concentration found to be 0.17 mg/l (max recorded) and lowest value was 0.04 mg/l in 2017 (east point) that indicates level of human activities is higher for recent year. Ammonia concentration, NH_3 reached the max value of 0.27 mg/l (2015, west point) and low was recorded in 2017 at east point (0.03 mg/l); full behavior is shown in this study for both west and east point for years 2014-2018 (tables 6). Phosphorus concentration average value (as Ortho-PO_4), ranges between 0.012 - 0.27 mg/l and seen at low level for all years (2014-2018). Average total phosphorus concentration was low too (2014-2018) at level between 0.06 – 0.40 mg/l.Additionally, Table 6 show that Iron and Manganese remain at low level 12.30 – 136.00 µg/l and 0.9 – 19.08 µg/l respectively. Sulphate (SO_4^{2-}) concentration found to be high in fall time 2016 for east point (1,087.00 mg/l) and low with value 29.20 mg/l in fall 2018 (east point). Chloride concentration has similar behavior, highest recorded at the beginning of fall with value 5, 984.00 mg/l (east point 2016) and low at east point 2018 equal to 24.30 mg/l (beginning of fall). The trends of those two parameters considered normal especially in summer time periods, low flow, when evaporation exceeds precipitation other factors might also be a reason such as road salt, sewage contamination and water softeners. Overall, data indicating a non-polluted place. This is a good sign of well-regulated and managed sites facilities leading to desirable level of pollutants in fact, the lake water quality in general is desirable and the study gives a general overview of the water quality for those two points (western and eastern side) of the lake Mandra [14].

CONCLUSION

The aim of this project was to investigate the water quality and assessment ofthe major sides west and east of lake Mandra located in city of Burgasin the Black Sea, region of Republic of Bulgaria. This study was based on data collected from yea 2014 to 2018. Many Physico-Chemical parameters, pollution indicator tests such as BOD, COD, Ammoniaand others for water samples taken at depth 1.0 m and analyzed using accredited standard method in the lab. Overall, we have found that the pH values were basic, electrical conductivity, BOD, COD values were slightly high especially in Summer time Dissolved Oxygen was relatively same for the entire lake in four seasons while total other inorganic substances such as manganese, iron phosphate values were within normal range [16]. Many inorganic and chemical parameters were at low concentrations despite the fact that the studied area is managed well so that for controlled part of the lake as well; indicating a non-polluted site for the lake. It seems to us (authors), this project is one of the first and latest studies to give a general assessment and of the water quality of Lake Mandrain the Black Sea Region of Republic of Bulgaria.

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