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Precipitation and Soil Quality in a Small Watershed

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Abstract. Anthropogenic sources began to adversely impact the environment especially after the industrial revolution. With the increasing use of water by domestic, industrial and agricultural activities, the importance of keeping water resources in unpolluted shape has grown. To abate pollution of water resources knowledge about the pollutants arriving from the atmosphere and other sources is of prime importance. In this study, pollutants which are deposed by precipitation and from the soil are determined for the Borabey Pond, Eskişehir, in Inner Anatolia of Turkey. The pond's surface covers 0.16 km2 has volume 1.4 Mm3. Precipitation contains many pollutants, also from agricultural activities which find their way to the atmosphere principal among them are nitrogen and phosphorus species. The maximum total nitrogen concentration in precipitation was found to be 9.7 mg/L and total phosphorus concentration 1.97 mg/L. Besides, the soil has a total nitrogen concentration 50 mg/kg and total phosphorus concentration of 3.5 mg/kg. Strategies must be developed to protect the water source and improve water quality.

Keywords: Water Pollution, Precipitation Quality, Nutrients in Soil

1. Introduction

Water resources are used for drinking water, irrigation, industrial use, energy production and it is being excessively polluted due to rapid growth of population and human activities. Because of these activities, eutrophication of many lakes is a global problem which reduces water quality [1]. Once a lake is eutrophic, it will lose its functions and this will reflect negatively in the economy and society [2]. Besides, precipitation can be one of the major source of pollutants for a lake because it contains atmospheric pollutants [3]. Moreover, agricultural activities are a major source of eutrophication, because excessive amounts of nutrients such as nitrogen and phosphorus enter water bodies with the precipitation and cause algal blooms, eroded soil is another source of pollutants [4]. Algal blooms can lead to decreases in clarity and dissolved oxygen levels so this has negative effects on organisms living in the lake.

In addition, decomposition of organic matter can cause deterioration of the ecosystem [5]. Besides, physicochemical properties of water such as turbidity, odor, taste are negatively affected with eutrophication. As a result, eutrophic water sources can contain dead zone [6].

Eutrophication of a lake is combined with two major nutrients; nitrogen and phosphorus. Phosphorus is usually known as the growth-limiting nutrient for the growth of algae [4]. If the N:P weight ratio is larger than 7,2N:1P, the limiting element is phosphorus; smaller than 7,2N:1P, nitrogen becomes the limiting element [7]. It has been determined that nitrogen is responsible for controlling phytoplankton production in olgotrophic marine regions, while phosphorus controls continental water bodies [6].

Monitoring the environmental factors is essential to manage and maintain water quality of lakes and also nutrient sources coming to the lake must be investigated [8]. In this study, the nitrogen and phosphorus

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concentration are determined which are brought by precipitation to the Borabey Pond and N-P concentrations of the watershed's soil are established. Soil is unable to keep nitrate, so excess nitrate above the needs of plants, move to around water. Because of being responsible for creating conditions of producing algal blooms, the critical concentrations of nitrogen and phosphorus (including total phosphorus, orthophosphates, total nitrogen, ammonium, nitrite and nitrate) are important.

2. Study Area

The study area is the Borabey Pond which is located in Eskişehir, Turkey. Eskişehir is a large city in northwestern part of Inner Anatolia. There have been many of agricultural products in the region are principally wheat, barley, rye, corn, sugar beet. Industrial activities include brick and tile, food and textiles production. There are also mining activities, especially for chromium and coal in Eskişehir.

The pond lies in a hilly region at an elevation of 900 meters above mean sea level and covers 0.16 km^2 and its main usage is for irrigation of farmlands to the downstream. The watershed area is 8.6 km^2. Eskişehir has continental climate due to geographical area, altitude and land forms. The summers are hot and arid, the winters are cold and wet.

The water body serves as a habitat to waterbirds and fish, but the pond obtains runoff from farmlands which brings nitrogen and phosphorus. Agricultural areas are nonpoint pollution sources so run off from these areas cause pollution unless precautions are taken.

3. Material and Methods

In this study, a meteorological station established in the watershed close to the pond was used and to collect the pollutants coming with precipitation to the watershed (Fig. 1-b). The samples were brought to the laboratory and analyses were made with Hach DR2400 spectrophotometer. For measuring ammonia nitrogen the Nessler Process, for nitrate-N the Cadmium Reduction method; for nitrite-N the Diazotization method; for total N the Persulphate Digestion method were used and for phosphorus species; for total phosphorus the Persulphate Digestion method and for orthophosphate the Ascorbic Acid method were used. Soil samples were taken from two sides (Fig. 1-a). Then, they were brought to the laboratory and analyzed with Hach DR2400 spectrophotometer. The soil's pollutants are determined with spectrophotometer after extraction.

Fig. 1.a: Borabey Pond with soil sampling sites

Fig. 1.b: Precipitation collection device

4. Results and Discussion

Precipitation analysis were carried out on a monthly basis at a station situated at the shore of the pond. Precipitation is collected and analyzed later in the laboratory. The values at a particular date reflect the concentrations in the collected water in the period beginning with the last date. They also represent total atmospheric deposition. This is not the case for the analysis in December 2014 which begins after a long period. While this does not affect phosphorus concentrations to a significant degree, nitrogen concentration must be viewed with care. Especially after waiting ammonia can escape from the samples and decrease total nitrogen levels.

As seen in Fig. 2 total nitrogen in precipitation has a maximum value of 9.7 mg/L in March 2013. At the same time, ammonia nitrogen takes a maximum value of 3.21 mg/L. Increasing total nitrogen concentrations were observed in the spring 2013. The average of nitrate concentration is 0.47 mg/L. Besides, nitrite concentrations generally have low values of which the maximum is 0.006 mg/L.

Total phosphorus concentration is another important parameter which creates eutrophication. Kaya (2013) determined the eutrophication status of the pond as mesotrophic and the limiting nutrient as phosphorus [9]. Total phosphorus maximum concentration which comes from precipitation is 1.97 mg/L and also orthophosphate concentration has a maximum value 1.92 mg/L in precipitation in March 2013 (Fig. 3). The reason of increased nitrogen and phosphorus concentration (Fig. 2 and 3) is thought to be dust particles from the Sahara Desert reaching Turkey in the period of sampling [9].

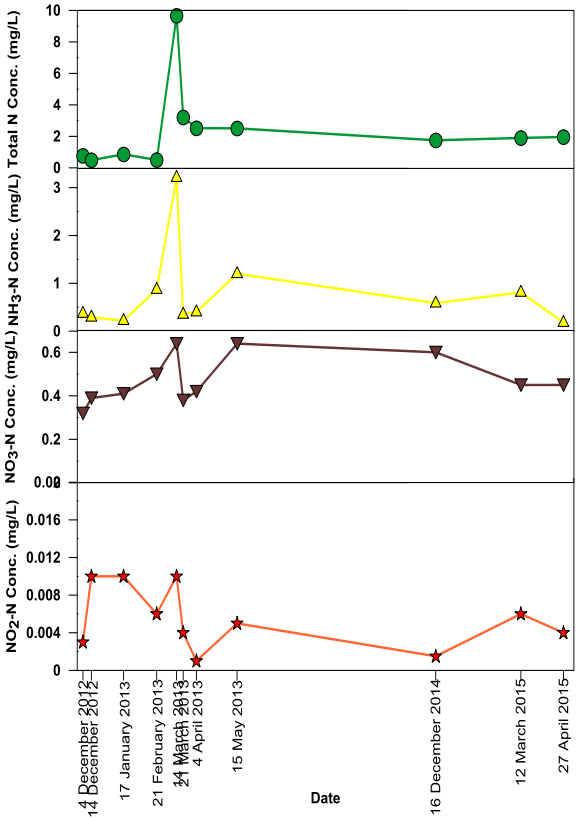

Fig. 2: Nitrogen concentrations in precipitation

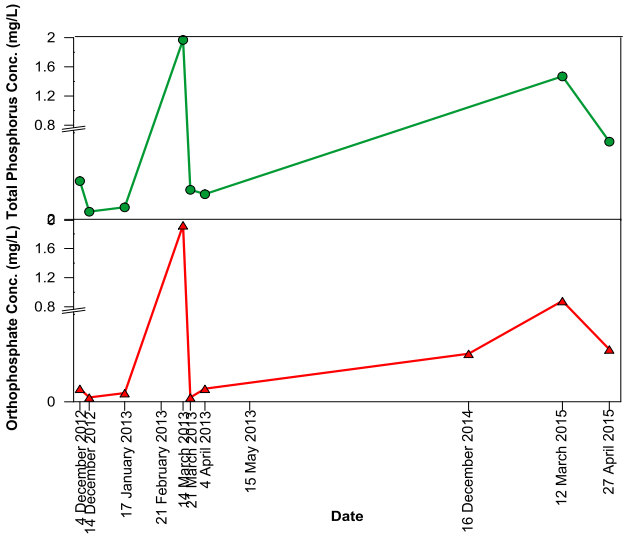

Fig. 3: Phosphorus concentrations in precipitation

The soil is another important source of pollutants carried to the lake. In 2015, two analysis were made about nitrogen and phosphorus concentration in the soil and the results are shown in the Table 2. Total nitrogen concentrations in diffrent soils change between 20-200 mg/kg [10]. Besides, the phosphorus concentrations in a variety of soils lie in a range of 1-50 mg/kg in the soil [11]. Measured concentrations in the Borabey Pond have been found to lie within these ranges.

Table 1: Pollutant concentrations on soil

	Total N (mg/kg)	NH_3-N (mg/kg)	NO_3-N (mg/kg)	NO_2-N (mg/kg)	Total P (mg/kg)	Orthophosphate (mg/kg)
12 March 2015	23	4,5	0,035	1,5	3,5	1
27 April 2015	50	1	0,035	1	3,5	0,5

5. Conclusion

In this study, pollutants contained in precipitation reaching the Borabey Pond were measured and the nitrogen and phosphorus content of the watershed soil was determined. As in the case of the high loads in precipitation in March 2013, atmospheric sources can be an important pathway of pollutants to the pond and its watershed can carry loads of nitrogen and phosphorus from the soils which receive their loads from agricultural activities.

In this study, total nitrogen in precipitation has a maximum value of 9.7 mg/L. Besides, ammonia nitrogen takes a value of 3.21 mg/L. The average nitrate concentration is 0.47 mg/L. Moreover, nitrite concentrations generally have low values of which the maximum is 0.006 mg/L.

Total phosphorus maximum concentration of precipitation is 1.97 mg/L and also orthophosphate concentration has a maximum value 1.92 mg/L. Soil analysis values are within ranges found in literature.

6. Acknowledgements

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