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Point and nonpoint sources of nutrients to lakes – ecotechnological measures and mitigation methodologies – case study

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ARTICLE INFO

Article history:
Received 24 January 2008
Received in revised form 3 July 2008
Accepted 5 July 2008

Keywords:
Agricultural runoff
Nonpoint source pollution
Lake Egirdir
Nutrient transport
Wastewater management
Basin management

ABSTRACT

Although Lake Egirdir is Turkey's second largest freshwater lake and the drinking and irrigation water resource for 350,000 people around the reservoir, it does not have a management plan. This study covers the nutrient influx from point and nonpoint sources, based on data that were obtained from a project that was performed in the reservoir of Lake Egirdir between 2000 and 2007. The impact of the point sources on the lake was determined, and appropriate sustainable treatment systems were designed to minimize the impact, whereby treatment technologies were developed for five select pilot settlement areas for testing purposes. Other studies attempted to assess the impact of pollution from point and nonpoint sources. The collective data suggest that several precautions can be taken to reduce nutrient input into the lake's reservoir.

Presently, 1514.4 and 150.5 t/year of total nitrogen and phosphorus, respectively, enter Lake Egirdir from point and nonpoint sources. The successful implementation of projects that have been prepared for point sources may reduce total nitrogen pollution by 79% and total phosphorus by 30–50%. The nutrients that come from nonpoint sources, except from atmospheric deposition, can decrease by a minimum of 50% through effective control techniques.

1. Introduction

It is possible to find the studies that have been previously carried out in the reservoir of Lake Egirdir relating to the changes in lake water level, lake water quality, and water products farming in lakes (Kesici and Kesici, 2006; Bostancı et al., 2007; Ugurlu et al., 1999). In particular, the monitoring of the changes in the level of water of the lake and the regulation of the water level are very important in terms of the use of water for drinking and irrigation purposes. The fact that the lake acts as drinking and irrigation water for the settlement areas inside and outside the reservoir ensures that attention is paid to the lake's water level. However, we have not come across any studies that concern the minimization of pollution in the lake's reservoir that results from point and nonpoint sources. With projects that have been completed between 2000 and 2007, comprehensive studies that relate to point and nonpoint sources were initiated and data that might form the basis for the preparation of a sustainable management plan for the lake were generated. Minimization of not only the point but also the nonpoint sources in the lake's reservoir is the main goal of this study. As a matter of fact, in general, studies that have been carried out with respect to nonpoint sources are quite limited in number in Turkey, while point sources are put

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doi:10.1016/j.ecoleng.2008.07.004

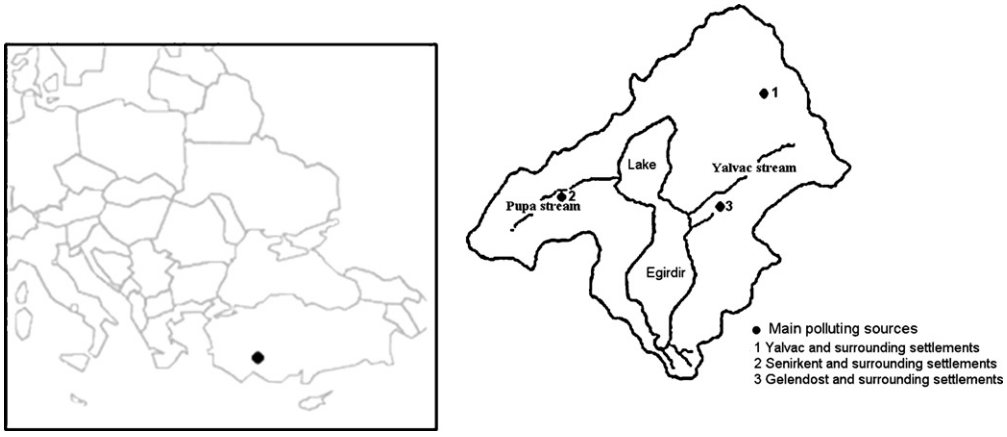

Fig. 1 – Lake Egirdir and its basin.

more to the foreground. It is difficult to find data on the most sensitive issues. On the other hand, discharge from nonpoint sources to receiving environments is not always less than that from point sources. For example, according to Khaleel et al. (1980), one-third of the pollution that comes to receiving environments in the USA is from nonpoint sources. Similarly, in research that was conducted for Lake Champlain in the USA, it was found that one-third of the phosphorus that poured into the lake was from agricultural sources (Meals, 1996). These values change from country to country. For example, in some areas, it is observed that nitrogen transportation is particularly high. A study carried out in Poland revealed that 60% of the total nitrogen discharge from this country into the Baltic Sea originated from agricultural areas (Maciej, 2000).

According to Todd et al. (1989), NPS pollution has been linked to agricultural activities, atmospheric deposition, and runoff from urban and developing areas. In addition to them, there exists especially nitrogen input from underground waters to receiving water bodies (Rast and Lee, 1983). When the leakage to underground water is ignored, phosphorus transportation from underground sources essentially takes place through erosion (Droc and Zagorc Koncan, 2002). It is obvious that in many cases, the exact boundaries of point and nonpoint sources are indistinct (Mander and Forsberg, 2000). Although these are classified separately, the formation of runoff and its resultant effects are considerably complex. In order to achieve an effective result in the control of nonpoint sources, effective agricultural management must be implemented. Nonetheless, while taking the necessary control measures, the periods when heavy precipitation occurs must be taken into consideration, and the measures that can best tolerate precipitation in these periods must be especially considered. According to Sharpley et al. (1999), more than 75% of the annual flow that stems from watersheds in Ohio and Oklahoma occurs as a result of the heavy precipitation that takes place once or twice a year. More than 90% of the annual phosphorus that flows to water annually comes from such precipitation.

2. Materials and methods

2.1. *Description of the study area*

Lake Egirdir, located in the Mediterranean region, is the second largest freshwater lake in Turkey and is a tectonic lake that lies in the north–south direction in the north of Egirdir district (Fig. 1). The lake narrows in its middle, in the east–west direction. The width of this narrow region is 2 km. Part of the reservoir that is located to the north of the shrunken part is called the Hoyran part, and the one located to the south is called the Egirdir part. Its total length in the north–south direction is 50 km (Ugurlu et al., 1999). Although the water level of Lake Egirdir varies by years and seasons, its maximum depth remains around 13.5–15 m (Gunay et al., 1985; Ugurlu et al., 1999). Because the final flow direction of the lake water is north to south, a water exit gate (regulator), where the extra water in the lake is discharged in a controlled way, is located at the southern end of the lake. Water that is discharged from the regulator is discharged into the Kovada channel. Areas to the left and right of the Pupa sthat are located in the Hoyran section of the lake act as bumpers for contaminants that result from runoff in the lower water elevations of the lake. However, those areas that act as bumper regions at lake water level elevations of 918 m and greater are now losing such nature by being flooded by water. This shall apply to some areas in the eastern part of the lake.

The water input into Lake Egirdir comes from small creeks that pour into the lake and the small sources inside the lake, and through precipitation. The major creeks are: the Pupa stream, which comes from the Uluborlu and Senirkent settlements; the Degirmen stream, which comes from the same region of the lake; and the Akcay stream, which comes from the Yalvac district. The water outflows of Lake Egirdir are: more than 20 chasms, among which the Kovada channel exists; waters that are given out for irrigation through Bedre, Gencali, Gelendost, and pumping sites; and water loss that results from vaporization.