E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2021; 9(4): 223-229

www.fisheriesjournal.com
Received: 13-05-2021
Accepted: 15-06-2021

Velda Syifa Septiningsih
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang, Jatinangor, Indonesia

Zahidah
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang, Jatinangor, Indonesia

Heti Herawati
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang, Jatinangor, Indonesia

Dan Herman Hamdani
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang, Jatinangor, Indonesia

Corresponding Author:
Velda Syifa Septiningsih
Department of Fisheries, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Bandung-Sumedang, Jatinangor, Indonesia

Distribution of phosphate concentration and its impact on fertility of Jatigede reservoir Sumedang, West Java

Velda Syifa Septiningsih, Zahidah, Heti Herawati and Dan Herman Hamdani

Abstract
Jatigede Reservoir is located in Sumedang Regency by damming the flow of the Cimanuk River, which carries a pollutant load in the form of domestic waste and agricultural waste. The waste resulted in a high concentration of phosphate in the Jatigede Reservoir. This research aim is to determine the level of water fertility based on the distribution of phosphate concentration on Jatigede Reservoir, Sumedang. The research was conducted from August 2020 to March 2021 using the survey method. Sampling was carried out at six stations at three water depths, surface, half-compensated depth, and compensated depth. The water parameters observed included physical parameters (temperature) and chemical parameters (pH, dissolved oxygen, nitrate, and phosphate). Spatial analysis to describe the distribution pattern of phosphate concentration in Jatigede Reservoir using ArcGIS 10.3.

Keywords: phosphate, water quality, fertility, Jatigede reservoir

1. Introduction
Jatigede Reservoir is located in Sumedang Regency, West Java. This reservoir was built to stem the flow of the Cimanuk River with a total area of 4122 hectares and accommodat3 a total of 980,57 million m^3 [1]. The flow of the Cimanuk River carries several wastes in the form of domestic waste and agricultural waste, which will worsen the condition of reservoir deposits [2]. Based on the Decree of the Minister of Public Works Number 267/KPTS/M/2010, water quality in the Cimanuk-Cisanggarung River area is included in the category with poor water quality in all rivers with high concentrations of dissolved solids. The condition will result in eutrophication of the waters of the Jatigede Reservoir.
Eutrophication is the enrichment of nutrients, especially nitrogen and phosphate, caused by anthropogenic activity [3]. Anthropogenic activity in waters, especially settlements and agriculture, will waste domestic waste and agricultural waste [4]. Domestic waste and agricultural waste are sources of water pollution that contain nutrients in the form of nitrogen and phosphate [5]. Waste originating from households, such as detergents and agricultural waste in the form of residual fertilizer, contains many nutrients (nitrogen and phosphate) [6]. Phosphate (PO_4) is a nutrient used as an indicator of the level of fertility of the waters [7]. The amount of phosphate content will affect the population of fishery biota [8]. According to Government Regulation (Indonesia) Number 22 of 2021, phosphate concentration in waters for class III and III is 0,03 mg/L and 0,1 mg/L. Meanwhile, according to the Regulation of the Minister of the Environment (Indonesia) Number 28 of 2009, the trophic status category based on phosphate concentration is divided into 4, namely oligotrophic (≤ 0,65 mg/L), mesotrophic (≤ 0,75 mg/L), eutrophic (≤ 1,0 mg/L), and hypertrophic (> 1,0 mg/L).
Water fertility is the level of high and low nutrients (nitrogen and phosphate) in the waters. High levels of nutrients can increase the growth of phytoplankton and can result in the poor ecological status of the waters [9]. The form of phosphate in the waters can be utilized by phytoplankton, thus affecting the productivity of the waters [10]. The distribution of phosphate in water can be used to determine the fertility level of the waters. So it is necessary to research the distribution of phosphate concentration and its impact on the fertility level of Jatigede Reservoir, Sumedang. This research aims to determine the level of water fertility based on the distribution of phosphate concentration on Jatigede Reservoir, Sumedang.

2. Materials and Methods

The research was conducted from August 2020 to March 2021. The method used in this research is a descriptive method and the determination of the sampling location using the purposive sampling technique. The sampling station was selected based on the input of river water flowing into the water body of the Jatigede Reservoir and representing the entire waters (Table 1). Sampling was carried out at six-station points (Fig. 1) with three depths: surface, half-compensated depth, and compensated depth.

Table 1: Research Location

Location	Coordinates	Description
Station 1	6°55'52,59"S 108°5'46,97"E	Inlet primary sources are from Cimanuk River, Cialing River, and Cibuntu River. This station is a zone riverine.
Station 2	6°55'19,54"S 108°5'45,07"E	The water comes from two small rivers, namely the Cimuja River and the Cijajaway River, and the Cimanuk River as the main river.
Station 3	6°54'46,1"S 108°5'46,4"E	A transition zone with the water supply coming from the Cihonje River, Cimuja River, and Cacaban River. In addition, at station 3, there is capture fishery activity.
Station 4	6°55'16,02"S 108°6'50,69"E	This location gets its water supply from the Cacaban River Stream and includes a transition zone. There are fishing activities using gill nets.
Station 5	6°53'31,06"S 108°6'13,52"E	It is a flooded zone. Station 5 has no fishing activity due to strong winds.
Station 6	6°51'45,96"S 108°6'10,9"E	Locations representing outlet zones. Station 6 has no fishing activity due to strong winds, deep seabed, and high currents.

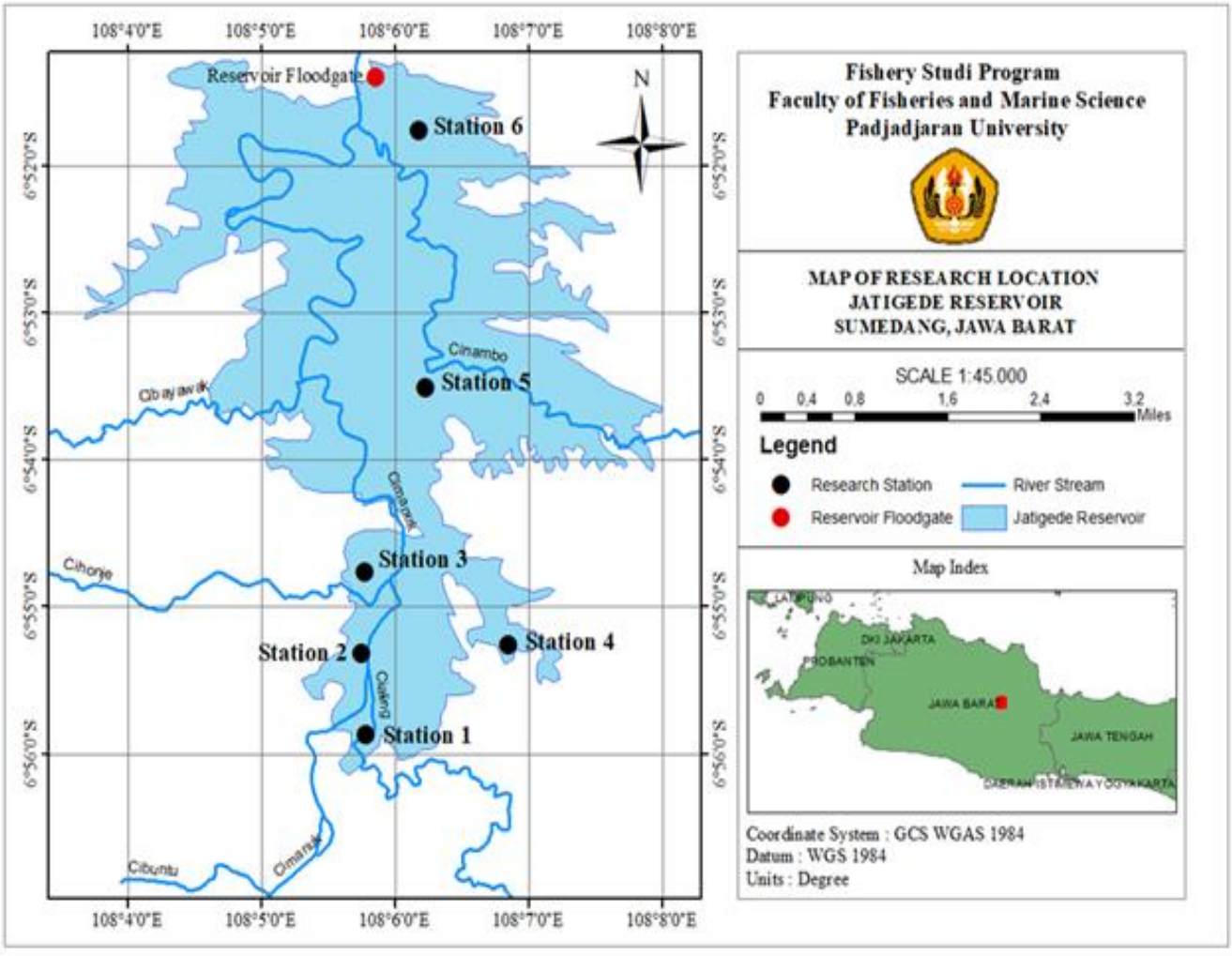

Fig 1: Research Location Map

3.1 3. Research Procedure

Measurement of physical and chemistry variables

Water samples were taken from three depths (surface, half-compensated depth, and compensated depth). Physical parameter measurement was carried out in situ, including temperature and chemical parameters, including dissolved oxygen and pH. Meanwhile, the analysis of chemical parameters, including nitrate and phosphate, was carried out ex-situ at the Laboratory of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

3.2 Spatial Analysis
Spatial analysis in describing the distribution of phosphate concentrations in the Jatigede Reservoir is divided into three stages, namely the interpolation stage, the classification stage, and the layout stage. The data from the measurement of the phosphate concentration corresponds to the coordinates and has been averaged and then converted into a form of spatial data extension so that interpolation can be carried out. The interpolation stage is the stage of estimating the value of the phosphate concentration in the entire waters of the Jatigede Reservoir with six sampling points. The interpolation technique used is IDW (Inverse Distance Weighting) to see the distribution of phosphate concentration in the Jatigede Reservoir.

3.3 Data Analysis
The research data were analyzed using comparative descriptive, which includes physical and chemical parameters and compared with the quality standards of Government Regulation Number 22 of 2021 Class II and III to determine the water quality in Jatigede Reservoir, its designation in the field of fisheries. Based on the distribution of phosphate concentration, the fertility level of Jatigede Reservoir waters can be described with the Regulation of the Minister of the Environment Number 28 of 2009. To produce the distribution patterns of phosphate concentration and abundance of phytoplankton in the Jatigede Reservoir, ArcGIS 10.3 was used.

4. Results and Discussion
4.1 Physical and Chemistry Parameters of Water
In general, the water quality in Jatigede Reservoir is based on physical parameters (temperature) and chemical parameters (dissolved oxygen, pH, Nitrate, and Phosphate) and has met the quality standards of Government Regulation Number 22 of 2021 Class II and III.

The result of temperature measurement in the Jatigede Reservoir conducted in situ ranged from 26,6-29,7ºC. The water temperature in the range of 20-30ºC was suitable for the growth of aquatic biota [11]. Temperature measurements carried out at three depths showed that the temperature value decreased with increasing water depth. It was influenced by the intensity of light entering the waters. The upper layer of water has a higher temperature and lower density in the lower layer because light entering the waters is absorbed and turned into heat energy intensively in the upper layer [12].

The degree of acidity (pH) in the Jatigede Reservoir ranges from 6,6-8,7. Based on Government Regulation Number 22 of 2021, the pH value in the Jatigede Reservoir has met the class II and III quality standards, which is 6-9. The research location with the highest pH value was at station 2 (surface 7,45±0,57; half-compensated depth 7,27±0,46; and compensation depth 7,31±0,68). This is because it gets water supply from the Cimanuk River, Cimuja River, and Cijajaway River, which results in high organic matter and causes the activity of decomposers to carry out the decomposition process. Higher pH value in the waters is due to the activity of decomposers who carry out the decomposition of organic matter into organic and inorganic compounds [13].

Dissolved oxygen concentration during research in Jatigede Reservoir ranged from 3 to 6, 7 mg/L. The dissolved oxygen concentration at all stations decreased with increasing depth. This is because oxygen is used by decomposers to decompose organic matter and results in high nutrient content (nitrogen and phosphate) in the waters [14]. The vertical distribution of dissolved oxygen at all stations in the Jatigede Reservoir belongs to the type clinograde. Goldman and Horne [15] divide the four types of dissolved oxygen distribution that the type clinograde occurs in productive (eutrophic) lakes or reservoirs with high nutrient and organic matter content.

The concentration of nitrate in the waters of Jatigede Reservoir ranges from 0,007-0,044 mg/L. Station 2 has the highest nitrate concentration at each depth (surface 0,028±0,008 mg/L; half-compensated depth 0,026±0,007 mg/L; and compensation depth 0,028±0,008 mg/L), and the highest concentration of nitrate at half-compensated depth is at the station 3 of 0,026±0,005 mg/L. Nutrients cause the highest nitrate concentration at station 2 from the Cimanuk River, Cimuja River, and Cijajaway River, which carries domestic waste and agricultural waste. High concentration in stagnant waters (reservoirs and lakes) stems from human activities, namely nitrogen fertilizers and human organic waste [16].

4.2 Map of Phosphate Distribution
Based on research conducted in Jatigede Reservoir, phosphate concentration ranged from 0,054-0,137 mg/L. In general, the phosphate concentration in the waters of the Jatigede Reservoir has met the quality standard of Government Regulation Number 22 0f 2021 class III, which is 0,03-0,1 mg/L. According to the Regulation of the Minister of the Environment No. 28 of 2009, classify fertility levels based on phosphate concentration into four, namely <0,01 mg/L oligotrophic waters, 0,02-0,3 mesotrophic waters, 0,04-0,1 mg/L eutrophic waters, and 0,1 mg/L hypertrophic water. Based on the Regulation of the Minister of Environment Number 28 of 2009, in general, the waters of the Jatigede Reservoir are included in the eutrophic fertility level.

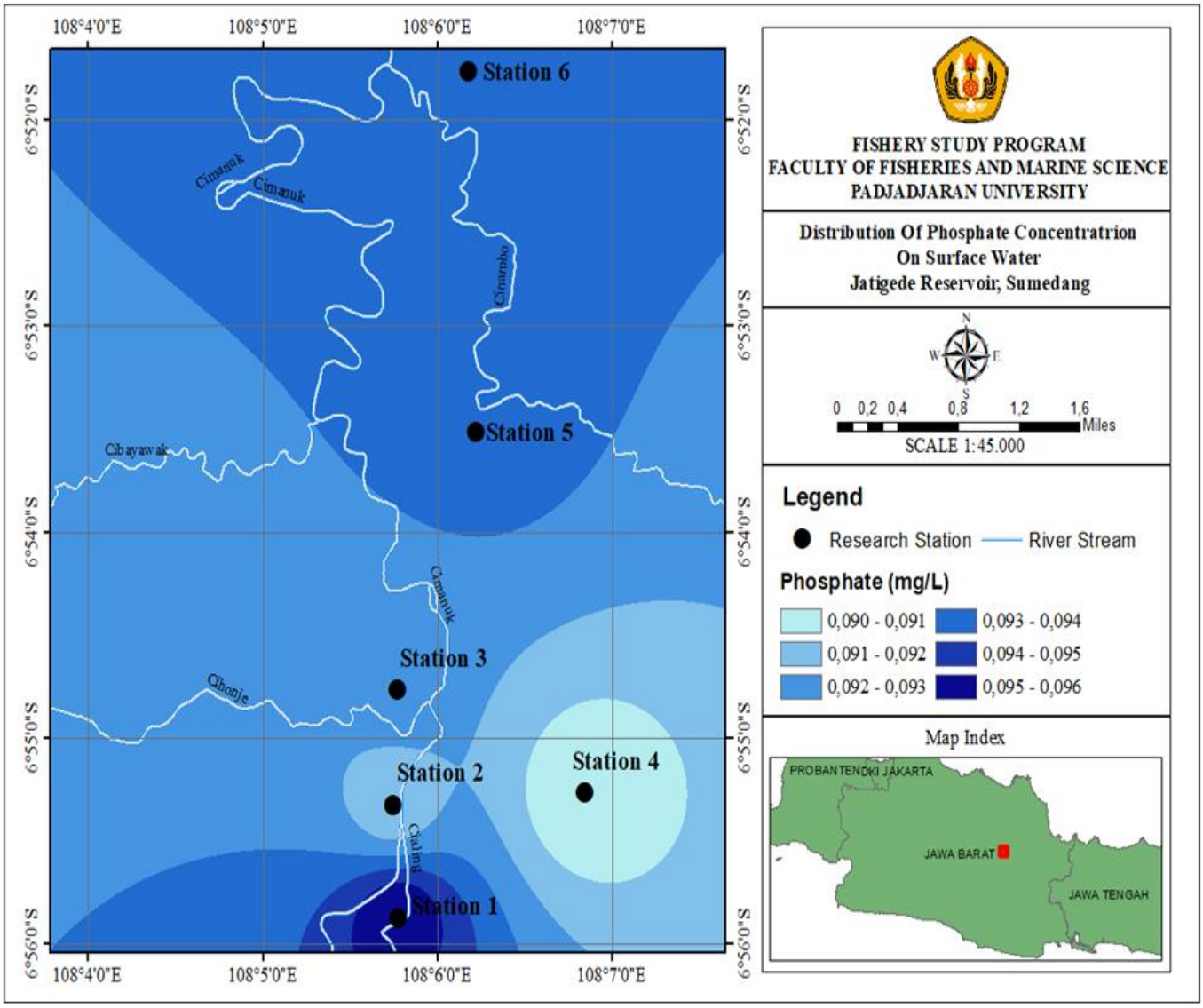

Fig 2: Distribution Map of Surface Phosphate Concentration

The result of data processing on the distribution of surface phosphate concentrations is shown in Figure 2. Station 1 has a dark blue color, indicating that the phosphate concentration at that location is high, namely 0,095-0,096 mg/L. The phosphate concentration is shown in light blue at station 4 of 0,090-0,091 mg/L. The high concentration of phosphate at station 1 is caused by the flow of water that enters the water body and originates from the Cimanuk River, Cialing River, and Cibuntu River and carries domestic and agricultural waste. The higher concentration of phosphate in stagnant waters such as lakes or reservoirs can be caused by the flow of rivers that empties these waters [17]. The high concentration of phosphate in the waters will impact the explosive growth of phytoplankton (blooming), which will result in a lack of light penetration into the waters and the availability of dissolved oxygen decreases [18].

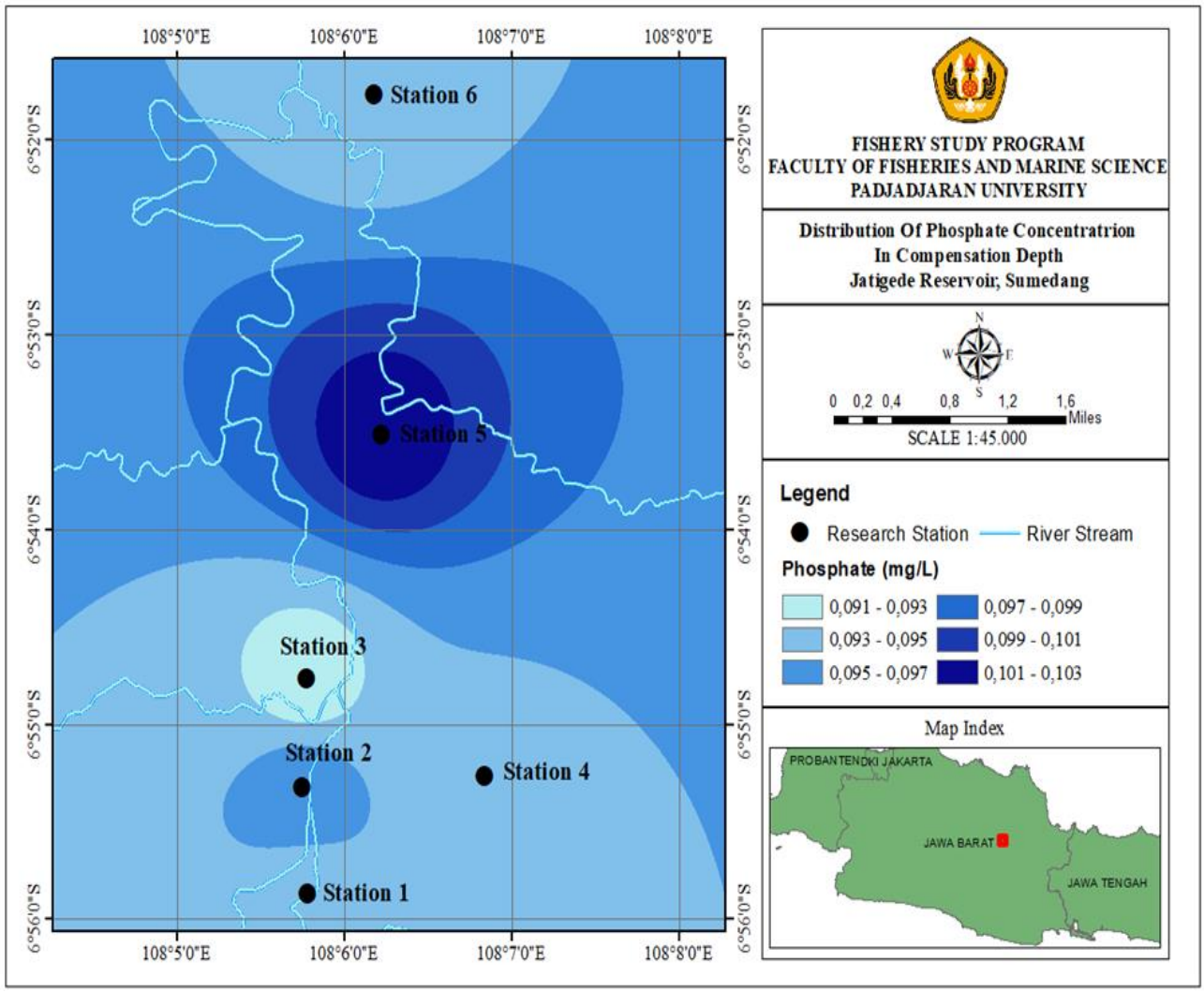

Fig 3: Distribution Map of Phosphate Concentration at Half-Compensation Depth

Fig. 3 is a map of the distribution of phosphate concentrations at half-compensated depth, illustrating that the highest phosphate concentration is shown in dark blue and the lowest phosphate concentration is in light blue. Station 2 is the research location with the highest phosphate concentration of 0,104-0,106 mg/L and the lowest concentration is at station 6 of 0,091-0,093 mg/L. The highest phosphate concentration at station 2 is due to household and agricultural activities around rivers and reservoirs. Station 2 gets its water supply from the Cimanuk River, Cimuja River, and Cijajaway River. In the watershed, there are settlements and agricultural activities that cause waste to enter the waters of the Jatigede Reservoir. The presence of phosphate in nature comes from natural processes, but phosphate concentration will increase due to agricultural activities that use fertilizers and contain high phosphate [19]. The fertilizers used are not entirely absorbed by the plants, but the residue will be carried through rivers and into water bodies of lake reservoirs [20].

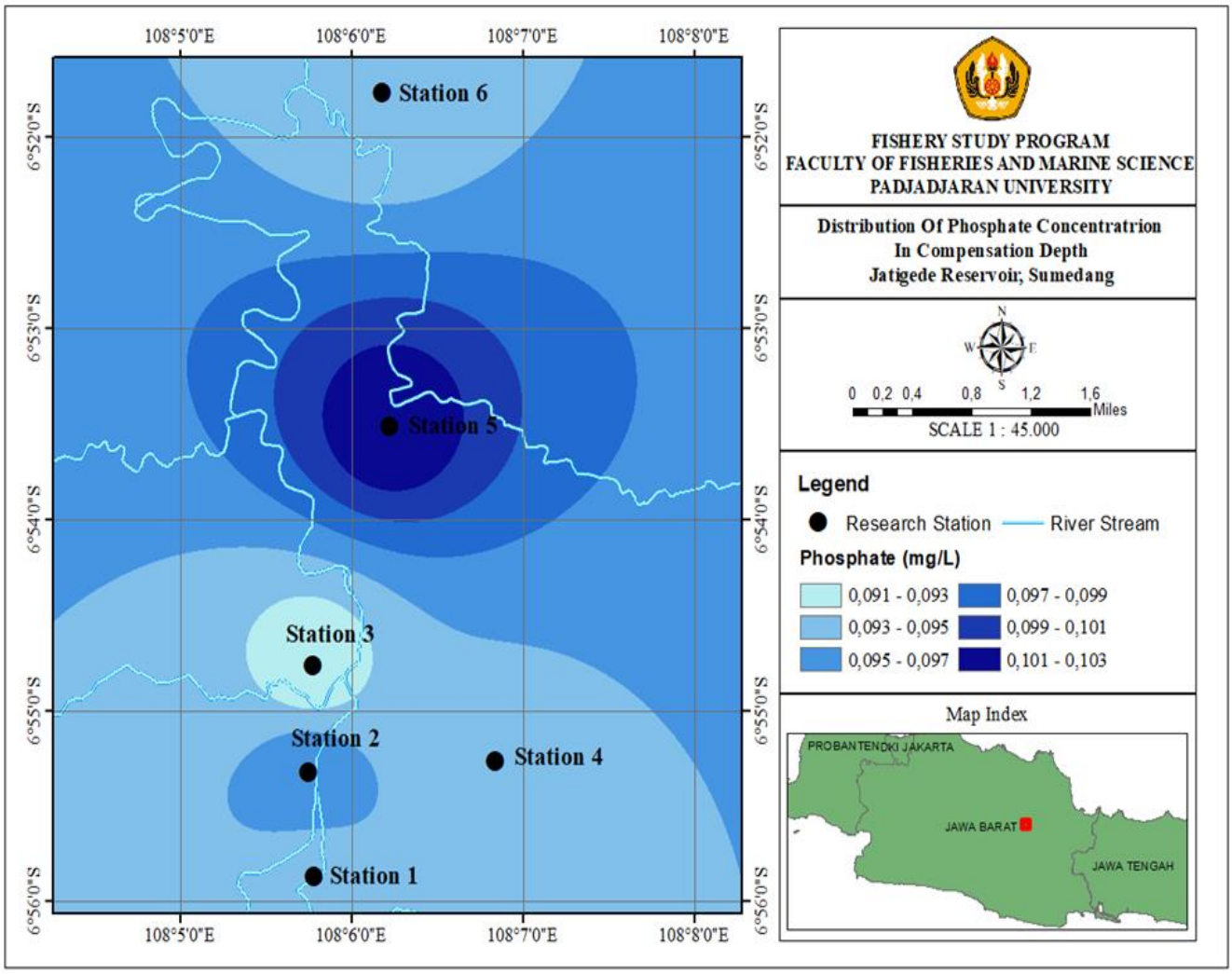

Fig 4: Distribution Map of Phosphate Concentration at Compensation Depth

The distribution of phosphate concentration at compensation depth (Fig. 4) shows that station 5 has the highest concentration of 0,101-0,103 mg/L, shown in dark blue. The lowest concentration of phosphate is found at station 3, which is 0,091-0,093 mg/L. The highest concentration of phosphate at station 5 is that the organic matter that settles at the bottom of the waters will decompose and produce phosphate. In addition, station 5 is a research location that represents a flooded zone and is close to the outlets. The high concentration of phosphate in waters close to the outlet zone is since at the location of these waters, and there are water inputs from various reservoir water flows so that there are indications of the accumulation of organic and inorganic material [21].

5. Conclusion

The distribution of phosphate concentration in Jatigede Reservoir ranges from 0,054-0,137 mg/L. In general, phosphate concentration in the Jatigede Reservoir has met the quality standard requirements of Government Regulation Number 22 of 2021 class III, which is 0,03-0,1 mg/L. The fertility level of Jatigede Reservoir is classified as Eutrophic fertility level according to the Regulation of the Minister of the Environment Number 28 of 2009, which is <0,1 mg/L.

6. References

1. Haifa RN, Hasan Z, Herawati H, Nurruhwati I, Sahidin A. Spatial Distribution of Phytoplankton in Jatigede Reservoir, West Java, Indonesia. Asian Journal of Fisheries and Aquatic Research 2020;6(1):39–48.
2. Harsono E. Kajian Hubungan Antara Fitoplankton dengan Kecepatan Arus Air Akibat Operasi Waduk Jatiluhut. Jurnal Biologi Indonesia 2011;7(1):99-120.
3. Piranti A, Soedirman. Pengendalian Eutrofikasi Danau Rawa Pening. Universitas Jenderal Soedirman 2011.
4. Mardianto D. Faridah, Sunarno, Najib, Widyaningsih, Setiawan. Tata Kelola Rawa Pening Berdasarkan Tingkat Resiko Bencana Lingkungan di Sub DAS Rawa Pening 2020;1:22-40.
5. Brahmana S, Achamd F. Potensi Beban Pencemaran Nitrogen, Fosfat, Kualitas Air, Status Trofik dan Stratifikasi Waduk Riam Kanan. Jurnal Sumberdaya Air 2012;8(1):53-66.
6. Simanjuntak M. Kualitas Air Laut ditinjau dari Aspek Zat Hara, Oksigen Terlarut dan pH di Perairan Banggai, Sulawesi Tengah. Jurnal Ilmu dan Teknologi Kelautan Tropis 2012;4(2):290-303
7. Indriani W, Hutabarat S, A'in C. Status Trofik Perairan berdasarkan Nitrat, Fosfat, dan Klorofil-a di Waduk Jatibarang, Kota Semarang. Management of Aquatic 2016;5(4):258-264.
8. Permanasari SW, Kustiani, Widjanarko. Tingkat Kesuburan Perairan di Waduk Wonorejo dalam Kaitannya dengan Potensi Ikan. Journal of Fisheries and Marine Research 2017;1(2):88-94
9. Nopem I, Arthana I, Putu A, Krisna. Keterkaitan Tingkat

Kesuburan Perairan Karamba Jaring Apung dengan Fitoplankton di Desa Terunyan, Danau Batur, Bali. Jurnal aquatic Science 2020;3(1);54-61.
10. Zulti, Sugiarti, Fluktuasi PH, Oksigen Terlarut dan Nutrien di Danau Towuti. Jurnal Limnotek 2015;22(2):170-177.
11. Zulfia N, Aisyah. Status Trofik Perairan Rawa Pening ditinjau dari Kandungan Unsur Hara (NO_3 dan PO_4) serta Klorofil-a. Jurnal Bawal 2013;5(3):189-199.
12. Sinaga, Muhtadi, Bakti. Profil Suhu, Oksigen Terlarut, dan pH Secara Vertikal Selama 24 Jam di Danau Kelapa Gading Kabupaten Asahan Sumatera Utara. Jurnal Akuatika Indonesia 2016;12(2):114-124.
13. Hamiedah, Hasan, Zahidah, Herawati, Heti. Primary Productivity of Jatigede Reservoir in Sumedang, West Java. Asian Journal of Fisheries and Aquatic Research 2020;8(4):20-27.
14. Artauli, Siagian, Sitohang. The Vertical Profile of Phosphate in Pinang Dalam Lake Buluh China Village Siak Hulu Sub District Kampar Riau Province. Journal Of Maquares 2014;3:1-10.
15. Goldman G, Horne. Limnology (International). McGraw Hill Book Company 1983.
16. Kayame M, Indrawati E, Mulyani. Analisis Fisika Kimia Air Danau Paniai-Papua Untuk Pengembangan Budidaya Ikan. Journal Of Aquaculture and Environmental Management 2017;7(3):260-266.
17. Lihawa F, Mahmud. Evaluasi Karakteristik Air Danau Limboto. Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan 2017;7(3):260-266.
18. Kayame MM, Indrawati, Mulyani. Analisis Fisika Kimia Air Danau Pinai-Papua Untuk Pengembangan Budidaya Ikan. Journal of Aquaculture and Environment 2021;3(2):23-28.
19. Yunita, Agam B, Maryonoc, Merdekawati. Analisa Parameter Kimia Perairan di Danau Kurapan dan Sungai Sambas Desa Sepantai, Kabupaten Sambas. Berkala Perikanan Terubuk 2021;4(1):742-747.
20. Alfionita, Patang, Kaseng E. Pengaruh Eutrofikasi Terhadap Kualitas Air di Sungai Jenebarang. Jurnal Pendidikan Teknologi Pertanian 2019;5(1):9-23.
21. Heriyanto, Hasan, Zahida, Yustiati, Nurruhwati. Dampak Budidaya Karamba Jaring Apung Terhadap Produktivitas Primer di Perairan Waduk Darma Kabupaten Kuningan Jawa Barat. Jurnal Perikanan dan Kelautan 2018;9(2):27-33.