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Lake Water Ecological Simulation for a Typical Alpine Lake on the Tibetan Plateau

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Abstract: Lakes on the Tibetan Plateau (TP) serve as both indicators of and safeguards against climate change, playing a crucial role in the aquatic ecosystems of the TP. While considerable attention has been devoted to studying the thermal and dynamic processes of TP lakes, research focusing on their ecological variations has been limited. In this study, we selected Namco, a representative lake on the TP, to investigate its water ecological processes using the AQUATOX lake ecological model. Long-term ecological variations spanning from 1980 to 2020 were analyzed based on lake observations. Our results revealed a consistent increase in water nutrients, particularly total nitrogen (WTN), and total phosphorus (WTP), over the study period. Additionally, the concentrations of chlorophyll-a (Chl-a) and water gross and net primary production (WGPP and WNPP) exhibited a significant upward trend. Despite the persistent state of poor nutrition in the lake, the ecological conditions improved. Multiple linear regression analysis indicated that the concentrations of WGPP, WNPP, and Chl-a were more sensitive to the local climate and hydrology compared to WTN and WTP. A continuously warming climate would heat up the lake water body, further enhancing primary production and improving water quality in the future. This study provides insights for lake limnological and ecological research and can be used to inform water management strategies in high-altitude alpine regions.

Keywords: lake ecology; AQUATOX; water nutrients; primary productivity; Tibetan Plateau

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1. Introduction

Lakes are invaluable natural resources and comprise approximately 1.8% of the global land surface area [1,2]. Distinguished by their unique characteristics, including their substantial heat capacity, robust evaporation rates, and expansive level surfaces, lakes play a pivotal role in shaping local climates. These attributes foster increased precipitation in surrounding areas, mitigate temperature fluctuations, and elevate wind speed and humidity levels [3–5]. Furthermore, lakes offer a multitude of benefits, including the provision of aquatic resources and freshwater provision, facilitation of power generation, support for transportation networks, and the promotion of tourism. Consequently, they significantly contribute to the sustainable development of both the economy and the environment in their respective regions [6,7].

In the context of global warming, lakes assume a critical role as indicators of and safeguards against climate change, and exhibit sensitive responses [8,9]. The Tibetan Plateau (TP) stands out as one of the world's most vulnerable regions to climate change [10]. This plateau harbors a cluster of lakes, boasting the highest, most numerous and largest inland lake area globally, encompassing 57.2% of China's total lake area and exhibiting a high distribution density [11]. TP lakes have a profound influence on local hydrology [12], climate [13] and ecosystems [14]. Amidst climate change on the TP, the thermal and dynamic processes of these lakes have undergone substantial transformations [15]. Utilizing in situ data, remote sensing data, and numerical modeling, extensive research has revealed a consistent trend of increasing lake water temperatures [16], heightened evaporation rates [12], diminished lake ice coverage and shortened ice duration [17], and expansions in water levels [18] with spatial heterogeneity. These alterations in lake processes consequently impact local climate patterns and ecosystems [19].

In addition to their thermal and dynamic aspects, the ecological status of lakes plays a significant role [20–22]. Lake ecological processes have garnered increasing attention, particularly for lakes in low-altitude and plain areas, where observation monitoring is easily carried out [23–26]. The rapidly warming climate has triggered widespread changes in lake ecological processes, as demonstrated by ecological indicators such as water clarity [27], methane production [28], lake water gross primary production [29], and lake thermal habitat [30]. However, due to the TP's harsh environmental conditions and high altitude of the TP, studies focusing on long-term lake ecological processes are scarce. In situ water ecological observations within lake interiors are insufficient to support long-term research on lake ecological processes. Additionally, remote sensing observations suffer from discontinuity and require validation. Consequently, the current variations in key water ecological indicators for TP lakes, especially those with minimal human activities, remain unclear.

Lake water ecology models serve as valuable tools for investigating lake ecosystems. Presently, there are several lake water ecological models available, each with distinct advantages [31–33]. These models help assess changes in water nutrients and pollutants [34], eutrophication and risk assessments [35], and the identification of direct or indirect impact factors on lake ecology [36]. Among these models, AQUATOX, which was developed by the United States Environmental Protection Agency (US EPA), stands out as highly effective and features a flexible structure and user-friendly interface [37]. The AQUATOX model has been widely utilized for nutrient content analysis [38], studying the effects of climate change on water ecosystems [39], and conducting natural resource damage assessments [40].

In this study, we employed this lake ecological model, AQUATOX, to simulate long-term variations in the lake water ecology in Tibetan Plateau (TP) lakes, focusing on Lake Namco, a representative alpine lake in this cold region. We extracted water nutrient data, including total nitrogen (WTN) and total phosphorus (WTP), as well as chlorophyll-a content (Chl-a), and water gross and net primary production (WGPP and WNPP) for analysis. Our objective was to examine variations in these water ecological indicators and identify the main influencing factors, particularly those related to local climate and hydrology, over the past 40 years, i.e., from 1980 to 2020. This paper is structured as follows: Section 2 introduces Lake Namco, the lake ecological model, and the data sources used in this study. Section 3 presents the simulation results and analysis. The discussion and conclusions are provided in Sections 4 and 5, respectively.

2. Study Area, Lake Model, and Data

2.1. Study Area

Lake Namco, a brackish lake, is situated in the central region of the Tibetan Plateau, spanning approximately 30.5~30.95° N, 90.2~91.05° E. It is the largest and highest lake in the central plateau. Characterized by a semi-arid cold climate, Namco has an elevation of around 4718 m and covered an area of approximately 1998 km^2 in 2019. The lake's maximum and mean depths are 90 and 40 m, respectively [41]. The primary water sources for Namco are precipitation and glacier melting, with evaporation being the primary mode of water loss [42]. Typically, the lake begins freezing in late November and thaws in late March or early April, with the ice cover lasting for approximately 5 to 6 months [43]. Thermal and dynamic processes within Namco are predominantly influenced by the local climate and environmental factors. With a high altitude and cold climate, Lake Namco is often regarded as an oligotrophic lake. With minimal human activities, Namco serves as an ideal and representative alpine lake for exploring natural lake processes [44–46].

2.2. Lake Model

In our study, we utilized AQUATOX, an open-source and widely utilized aquatic system model, to simulate the ecological processes of Lake Namco. AQUATOX has been extensively employed in research pertaining to various water bodies, including lakes, estuaries, and reservoirs. This model operates by simulating changes in the concentrations of organisms, nutrients, chemicals, and sediments within the aquatic ecosystem. AQUATOX employs differential equations to represent the changing values of state variables, which necessitate initial conditions at the onset of the simulation. The time resolution for simulations can be tailored to any desired length, offering flexibility in modeling. It can be utilized as a simple model or configured as a complex food-web model, accommodating diverse research needs. The main variables outputs by this model are water nutrients, CO_2 and O_2 content, water clarity, primary productivity, and biomass within the lake.

In our study, simulations were conducted for the period from 1979 to 2020 for Lake Namco, with a daily time resolution. Initial conditions were set based on lake observations, ensuring the accuracy and reliability of the model outputs. The first year, 1979, was set as the spin-up time. The model output for the period from 1980 to 2020 was analyzed in this study.

2.3. Data

In this study, in situ observation data were utilized for both model input and evaluation, as presented in Table 1 and Figure 1. The lake characteristics, including depth, length, and area, were incorporated into the model. Additionally, datasets concerning various lake ecological processes, such as water nutrients, phytoplankton, and water quality, were gathered from the academic literature [16,41,47–54], as shown in Table S1.

Table 1. Main input parameters and setting values for the AQUATOX model.

Type	Parameter	Value	Reference
Lake characteristics	Surface area	1997.55 km^2	[47]
	Mean depth	40 m	[41]
	Maximum depth	95 m	[41]
Local climate	Shortwave radiation	Figure 2a	[48,49]
	Wind speed	Figure 2b	[48,49]
Lake thermodynamics	Water temperature	Figure 2d	[50,51]
	Water volume	Figure 2c	[47]
	Water evaporation	27.52 int	[16]

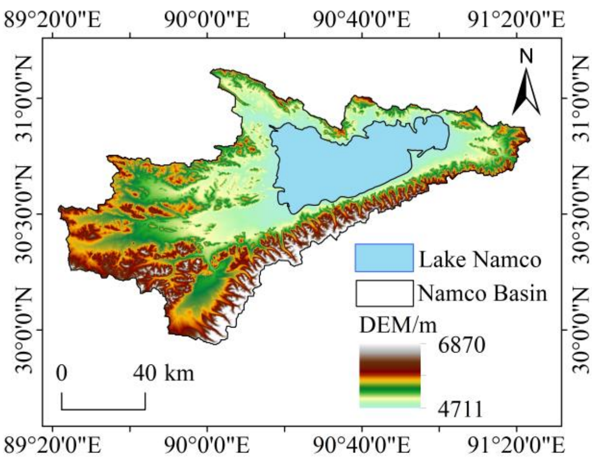

Figure 1. Geophysical location map of Lake Namco.

The meteorological data used in our study encompassed downward shortwave radiation and wind speed, which exhibited a slight decreasing trend over the study period. Furthermore, lake thermodynamic data, comprising lake water temperature (WT), evaporation, lake water volume (WL), and lake water area (WA), were considered. Notably, both the lake volume and area of the lake exhibited rapid increases after the 2000s, as depicted in Figure 2.

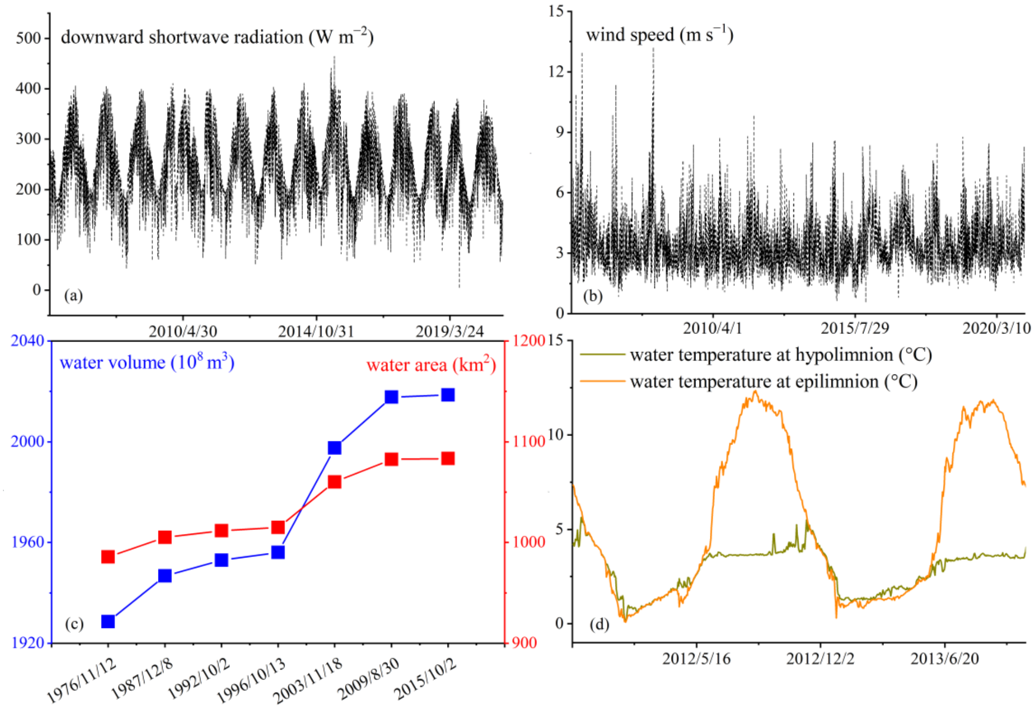

Figure 2. Variations in meteorological and lake thermal and dynamic elements of (**a**) downward shortwave radiation, (**b**) wind speed, (**c**) lake water volume, and (**d**) lake water temperature for Lake Namco.

In our study, simulations were conducted for the period from 1980 to 2020, with a daily temporal resolution. To mitigate the effects of interannual fluctuations, the simulation results for each decade (1981–1990, 1991–2000, 2001–2010, and 2011–2020) were analyzed. In this paper, the main variables used to represent lake ecology are WTP, WTN, and Chl-a), and primary production (WGPP and WNPP).

To elucidate the factors influencing lake ecological processes, long-term series data for meteorological and lake thermodynamic elements were employed to assess their respective impacts on lake ecological variations. Meteorological data were sourced from the multi-circle comprehensive observation and research station around Lake Namco [48,49] and included downward shortwave radiation (DSR), air temperature (AT), specific humidity (SH), wind speed (WD), air pressure (AP), and precipitation (PC).

To delineate the influence of meteorological elements on lake ecological indicators, including WTN, WTP, Chl-a, WGPP, and WNPP, a multiple linear regression model was employed using the SPSS software version 25. Generally, the relationship between the dependent and independent variables is expressed as shown in Equation (1):

$$y = a_1x_1 + a_2x_2 + a_3x_3 + \cdots + a_ix_i + b \quad (1)$$

where y is the dependent variable, x_i (i = 0, 1,. . ., n) is the independent variable, a_i (i = 0, 1,. . ., n) is the regression coefficient, and b is the constant term. The relative contribution of the changes in lake water ecological indicators was estimated using multiple regression coefficients as shown in Equation (2):

$$n_i = a_i / (|a_1| + |a_2| + |a_3| + \cdots + |a_i|) \quad (2)$$

where n_i is the relative contribution coefficient. The larger this value, the greater the contribution from the independent variable to the dependent variable.

3. Results

3.1. Model Calibration and Validation

To ensure the accurate simulation of lake ecological processes and obtain reasonable results, uncertainty and sensitivity analyses were conducted in this study using the lake ecology model. By combining uncertainty and sensitivity analyses, we identified and controlled the parameters affecting lake water ecological processes. To evaluate the performance of the parameter settings in the model, we compared the simulated results with limited observed data, which included water clarity (SD), WTP, and WTN. Water clarity, i.e., water transparency, serves as a relatively intuitive indicator for monitoring and assessing lake water quality, which plays a crucial role in water thermodynamic and ecological processes.

Through calibration processes, the mineralization parameters were found to be crucial for simulating lake water ecological processes. The optimal temperature was set to 15 °C. The extinction coefficient for water and sediment were set to 0.12 and 0.17 m^{-1}, respectively. The maximum decomposition rate was 0.14 g $(g\ d)^{-1}$. The maximum rate of denitrification was set to 0.005 d^{-1}. In addition, the physiological parameters of phytoplankton were the most critical in terms of reflecting the reasonable ecological conditions of the lake. The main parameters, with adjustment, included the optimal temperature, photorespiration coefficient, mortality coefficient, sedimentation rate, and saturation intensity. On the basis of the default settings in the model and the literature, the final values used in the model are shown in Table 2.

With the well-configured model, we assessed the simulated relative errors of these three variables and found them to be within 20%, as shown in Table 3. Consequently, despite the limited water ecological observations for Namco, the lake ecology model was deemed capable of capturing the variations in key indicators in the lake ecosystems.

Table 2. The physiological parameters of phytoplankton set in the model.

Parameter	Value Set for Diatom Algae	Value Set for Green Algae
Optimal temperature	18 °C	20 °C
Photorespiration coefficient	0.05 d^{-1}	0.08 d^{-1}
Mortality coefficient	0.001 g $(g\ d)^{-1}$	0.001 g $(g\ d)^{-1}$
Sedimentation rate	0.015 m d^{-1}	0.005 m d^{-1}
Saturation intensity	300 Ly d^{-1}	110 Ly d^{-1}

Table 3. Simulated relative errors compared to observations.

Variable	Simulated Relative Error (%)
SD	12
WTP	17
WTN	15

3.2. Simulation Analysis

3.2.1. Water Nutrients

Water nutrients, particularly WTN and WTP, serve as valuable indicators that reflect lake ecological processes within lake water ecosystems. Variations in WTP and WTN concentrations can significantly influence lake nutrient levels. The WTN and WTP simulations were analyzed, as depicted in Figure 3. Both the WTN and WTP concentrations exhibited a noticeable increasing trend over the past 40 years. WTN levels rose from 0.135 mg L^{-1} during the 1980s to 0.245 mg L^{-1} during the 2010s, with an increasing trend of 0.0369 mg L^{-1}

per decade. Similarly, WTP concentrations increased from 0.0321 mg L^{-1} during the 1980s to 0.0395 mg L^{-1} during the 2010s with an increasing trend of 0.00245 mg L^{-1} per decade. The regression coefficients R^2 for WTN and WTP were found to be 0.99 and 0.97, respectively. Despite Namco Lake on the Tibetan Plateau being characterized as an oligotrophic alpine lake [55,56], it demonstrated an improving trend in terms of its nutritional condition. However, it is worth noting that the lake remains in a state of lower nutrient levels.

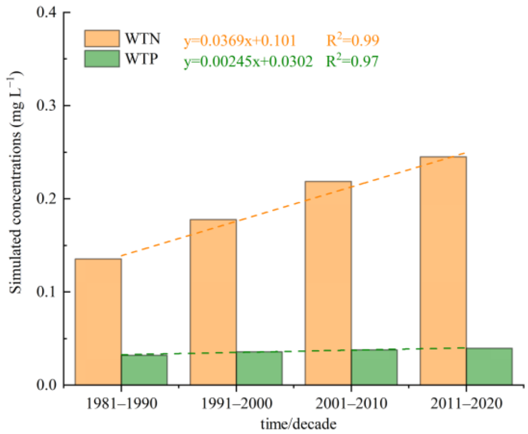

Figure 3. Simulated concentrations of WTN and WTP for the periods of 1981–1990, 1991–2000, 2001–2010, and 2011–2020.

3.2.2. Concentrations of WGPP, WNPP, and Chl-a

Primary productivity and Chl-a concentrations are the fundamental attributes of inland aquatic ecosystems and are influenced by complex environmental factors. These properties of lake water ecosystems are also often used to evaluate water quality. Simulations of WGPP, WNPP, and Chl-a were conducted (Figure 4). WGPP, WNPP, and Chl-a concentrations all exhibited a significant increasing trend over the past 40 years. WGPP increased from 0.00186 g O_2 m^{-2} d^{-1} during the 1980s to 0.208 g O_2 m^{-2} d^{-1} during the 2010s with an increasing trend of 0.0651 g O_2 m^{-2} d^{-1} per decade. WNPP increased from 0.0147 g O_2 m^{-2} d^{-1} during the 1980s to 0.162 g O_2 m^{-2} d^{-1} during the 2010s with an increasing trend of 0.0509 g O_2 m^{-2} d^{-1} per decade. Chl-a increased from 0.00569 µg L^{-1} during the 1980s to 0.643 µg L^{-1} during the 2010s with an increasing trend of 0.2 µg L^{-1} per decade. The regression coefficients R^2 for GPP, NPP, and Chl-a were found to be 0.97, 0.97, and 0.96, respectively. These results indicated that aquatic phytoplankton in the lakes have flourished, and the productivity of lake water ecosystems has increased over the years.

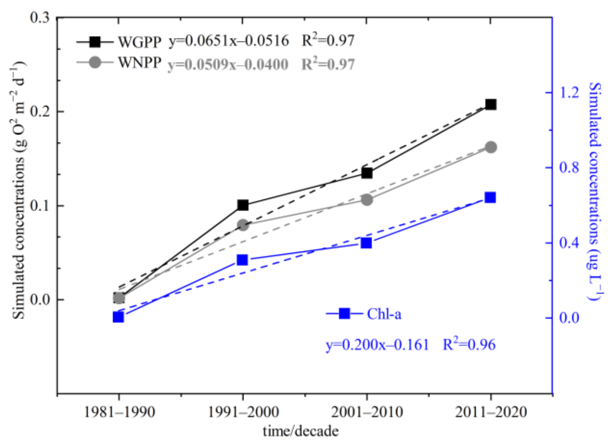

Figure 4. Simulated concentrations of WGPP, WNPP, and Chl-a for the periods of 1981–1990, 1991–2000, 2001–2010, and 2011–2020.

3.2.3. The Impact of Meteorological and Hydrological Factors

The relative contributions of climatic and hydrological elements to variations in lake ecological variables were extracted, as shown in Figure 5. Lake water temperature exhibited a significant effect on WGPP, WNPP, and Chl-a, with the relative contributions of WT for WGPP and WNPP surpassing 0.4. Increases in WT have the potential to enhance the water environment and stimulate the growth of aquatic vegetation growth. Furthermore, specific humidity and water volume also contributed to these three lake ecological indicators. The combined contribution from the local climate and hydrology on these indicators exceeded 0.5, indicating the substantial influence of local climate and lake hydrology on lake ecological changes. In contrast, WTN and WTP exhibited relatively small contributions from climatic and hydrological elements, with all relative contributions being less than 0.1. This suggests that WTP and WTN may be more sensitive to lake ecological interaction processes. Additionally, concentrations of CO_2 and O_2 within the lake were found to correlate with WTN and WTP. Biological processes (e.g., nutrient uptake by phytoplankton) and sediment nutrient release play crucial roles in regulating water nutrient concentrations within the lake. Changes in these processes would influence WTP and WTN dynamics over time. In summary, WGPP, WNPP, and Chl-a appear to be more susceptible to changes in the local climate and hydrology compared to water nutrients.

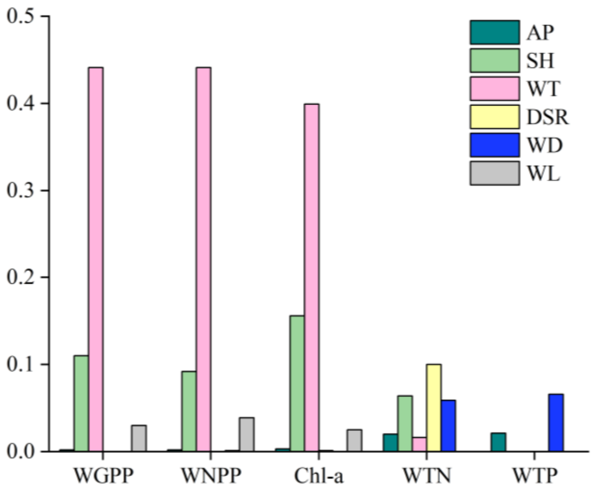

Figure 5. Contribution of climate and hydrology elements to variations in the lake ecological indicators.

4. Discussion

4.1. The Ecological Status of This Lake

In this study, lake ecology simulations were conducted with limited water ecological observations. Through these simulations, we aimed to deepen our preliminary understanding of the ecological status and changes of lakes on the TP. Despite experiencing minimal human activities and being oligotrophic over the long term, the results indicated that the lake exhibited a clear trend toward improvement in terms of its ecological condition. With WTN and WTP concentrations less than 0.4 and 0.02, respectively, Lake Namco was generally classified as an oligotrophic lake, according to the trophic type classification standards for Chinese lakes [56,57]. In addition, the content of Chl-a in this lake was lower than the threshold of Chl-a content for eutrophication according to most standards for eutrophication. The ecological condition of Lake Namco derived from this study was consistent with the conclusions drawn in previous research [56].

In the simulation, Lake Namco, i.e., a typical alpine lake on the TP, was in a state of poor nutrient content and developed towards improvement. For the other TP lakes, the mean Chl-a content was in the range 4.46 ± 3.64 μg L^{-1} with heterogeneity [29]. The spatial Chl-a distribution in this lake was found to be 0~1 μg L^{-1} in 1995 and 0~2 μg L^{-1} in 1999 [58]. In addition, the Chl-a content in most lakes on the southern TP increased significantly [59]. In summary, the results from this study were consistent with those from previous research. In addition, geographical features, lake characteristics, and the local climate should be considered when carrying out similar research on water ecological processes for the other TP lakes [60].

4.2. The Factors Influencing Changes in Water Ecology

Primary productivity is affected by phytoplankton growth, which, in turn, affects the Chl-a content and water quality. In this study, lake water temperature was found to be the most critical factor influencing WGPP, WNPP, and Chl-a. Due to the harsh environment, high altitude, and low air temperature surrounding this lake, WT was one of the most important factors restricting the phytoplankton growth in Namco. According to the linear regression model analysis, with a 1 °C increase in water temperature in the epilimnion, WGPP and WNPP would increase 0.047 and 0.034 g O_2 m^{-2} d^{-1}, respectively. With increasing air temperatures and melting glaciers, this lake expanded as a result of the dilution effect. Lake volume had a negative effect on the increase in the WGPP, WNPP, and Chl-a. It is worth noting that atmospheric humidity also played an adverse role in the variations in primary productivity. This may be because a wetter climate leads to more precipitation and, thus, an increased lake water volume. Using the regression equation based on meteorological and hydrological factors, the regression coefficients were 0.58, 0.57, and 0.58 for WGPP, WNPP, and Chl-a, respectively. Therefore, primary productivity in such an alpine lake was shown to be sensitive to changes in local climate and lake evolution.

Water nutrients were not closely related to meteorological and hydrological factors. Even though the concentrations of water nutrients within this lake exhibited a significant upward trend, WTN and WTP exhibited no significant correlations with local climatic or hydrological elements, all producing a correlation coefficient R^2 lower than 0.1. WTN and WTP may be easily affected by initial conditions, source loadings from the surrounding environment, and biochemical processes within the lake. Since this paper focuses on long-term variations in water quality and primary productivity, local climatic and hydrological elements were considered principally as factors influencing lake ecosystems. Thus, attention should also be paid to the biochemical processes affecting water nutrients and the differences between TP lakes and other lakes on the plain.

4.3. Possible Changes in the Ecological Conditions for This Lake

A decrease in CO_2 emissions was noted in the TP lakes, which was likely induced by lake expansion due to climate change [61]. Such a reduction in CO_2 emissions may cause continuous lake water warming and accelerated phytoplankton growth. Primary productivity in the inland water bodies is an important indicator of phytoplankton growth, which is closely related to the terrestrial carbon cycle.

As informed from above analysis, lake water temperature had the most prominent impact on primary productivity within the lake body. According to the WT projections from ISIMIP2b simulations conducted with the Community Land Model version 4.5 (CLM4.5) [62], the bias-corrected WT output from four global climate models (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR and MIROC5) for future periods indicated that, from 2021 to 2099, lake temperatures in the epilimnion and hypolimnion will exhibit almost no obvious changing trends under RCP2.6. However, with the high CO_2 emissions under RCP6.0 and RCP8.5, lake temperatures increased at 0.41 and 0.70 °C per decade in epilimnion and at 0.17 and 0.32 °C per decade in hypolimnion, respectively. Such a warming water environment as a result of the warmer climate in the future would benefit the phytoplankton growth status and further drive primary productivity.

Water nutrients (WTN and WTP) could be the limiting factors of phytoplankton photosynthesis and growth [29]. To better understand changes in water nutrients under different climate change scenarios, the external inputs from the surrounding rivers and possible human impacts need to be incorporated. Thereafter, we can attempt to predict possible changes in primary productivity and water quality in the lake water bodies under different climate change scenarios for fragile ecological lake ecosystems in high-altitude regions.

4.4. Limitations of This Study

There exist certain limitations in our study. Firstly, the parameters related to plant growth were established based on the existing research literature alongside uncertainty and sensitivity tests. In the future, more refined observational data will be necessary to verify and calibrate this model. Secondly, the contribution of water nutrients from surrounding rivers to the lake was not considered in this study, potentially leading to an underestimation of water nutrient concentrations. Additionally, lake ecological interaction processes were not thoroughly explored; however, they were not the focus of this paper. Our attention was primarily directed towards the construction and application of an ecological modeling of TP lakes by aggregating observations and analyzing interannual variations in key ecological indicators of lakes. Possible factors influencing these indicators were also discussed to explore the effects of climate and hydrology on lake ecosystems on the TP.

To thoroughly understand the lake water ecological processes on the TP as related to global climate change, obtaining long-term variations in lake ecological parameters, such as WTP, WTN, and WGPP, is crucial [29,63,64]. With the availability of satellite remote sensing data, some important parameters for lake water ecology, such as water clarity, can be obtained in areas with abundant observations [65,66]. However, in regions with minimal human activity, particularly in high-altitude and high-latitude areas, actual observations are still necessary to validate remote sensing inversion datasets. Thus, establishing a long-term observation network for lake ecosystems in these regions is imperative.

5. Conclusions

This study employed the AQUATOX lake ecological model to simulate the ecological variations in a typical alpine lake, Namco, on the TP, using the available lake observation data. Through uncertainty and sensitivity modules, the key parameters affecting the ecological indicator simulations were tested and calibrated. The model demonstrated acceptable performance in modeling the concentrations of water nutrients, specifically WTP and WTN, within the lake. Long-term simulations revealed an upward trend in the concentrations of water nutrients, WGPP, WNPP, and Chl-a over the period from 1980 to 2020, even though this lake was in an oligotrophic state. The WTN and WTP concentrations increased to 0.0369 mg L^{-1} and 0.00245 mg L^{-1} per decade, respectively. The regression coefficients R^2 for WTN and WTP of lake ecology were found to be 0.99 and 0.97, respectively. Moreover, the WGPP, WNPP, and Chl-a concentrations increased at 0.0651 g O_2 m^{-2} d^{-1}, 0.0509 g O_2 m^{-2} d^{-1}, and 0.2 μg L^{-1} per decade, respectively. For WGPP, WNPP, and Chl-a, the regression coefficients R^2 were 0.97, 0.97, and 0.96, respectively. Furthermore, utilizing multiple regression analysis, it was determined that WGPP, WNPP, and Chl-a were largely influenced by the local climate and hydrology. The lake's thermodynamic status, including lake water temperature and volume, was found to be an important factor. In addition, water nutrients, i.e., WTP and WTN, exhibited insensitivity to local environmental changes. With continuous lake warming in the future, water primary productivity would maintain an increasing trend, especially under high-emission scenarios. Future research should focus on integrating datasets for lake water ecology and enhancing the accuracy of lake ecological simulations, particularly for lakes situated in high-altitude and high-latitude regions.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/w16141982/s1, Table S1: Data used for initialization and modeling the ecological indicators in the AQUATOX model.

Author Contributions: Conceptualization—Q.Z.; formal analysis—Q.Z., L.C. and X.G.; methodology—Q.Z., L.C., X.G., R.D. and M.M.; writing—original draft, Q.Z.; review and editing—Q.Z., L.C., X.G., R.D. and M.M. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Data are contained within the article and Supplementary Material.

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Conflicts of Interest: The authors declare no conflicts of interest.

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