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Paradox of the Plankton and the Algae Importance in Modern Lakes Preservation Projects Written by Ms. Aizhan Angelina Ussenaliyeva Save Lake Balkhash International

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"Nothing is more precious to us, more essential than water. Yet, paradoxically we treat this resource with disdain and lack of care" - these brave words were said by my Auntie Gulya who lived in Balkhash city on the shore of lake Balkhash. I interviewed her in 2019 when the risk of lake Balkhash disappearance was as high as never before due to the accelerated desertification process multiplied by climate change factor. In 2020 she died due to Covid-19. In the same year social boiling point in the Balkhash region has reached its historical apogee. The pandemic crisis interfering with water scarcity and economic challenges triggered both political power and social need for a change. People started to question environmental justice in the Balkhash region and the great task of saving lake Balkhash began.

The 600 km-long lake Balkhash became a talk of the country, by getting shallower and more saline since 1970s, when the first Oil & Gas crisis hit the global market prompting the first shift towards energy-saving technologies, [3] the construction of Qapshaghay Bogeni Reservoir to the southeast of lake Balkhash by the state order became one of the main reasons of the Balkhash's current desertification. The 140 km-long Qapshaghay was created by a dam on the Ili River which flows from the mountains in the east from China towards Lake Balkhash to the northwest [5]. In 1967, an extension of newly irrigated crop areas began, and in 1970, the Kapchagay Reservoir, the largest reservoir in the region, began to fill [4]. The reservoir was created with the aim of regulating river flow and meeting growing economic demands of Almaty region. A dam and hydroelectric power plant were constructed on the River Ili, creating the Kapchagay reservoir [3]. However, the project took years to complete on account of the inadequacy of the water sources. Balkhash lake's faith was put on a limnological gamble game table [2].

It was projected that the reservoir would become a major water feeder for the dry arid soil in the Almaty region to increase crop production; however, the complete filling of the Kapchagay reservoir started to affect the water level in lake Balkhash. Filling of the reservoir discontinued in 1982. By 1986, Kapchagay reservoir was still only half full [3]. It was the year when my generation was born. The competition not only for the country's water, but for the country's attention and budget raised ecological rates from north to south. The economic war of the regions has started mixed with tribal conflicts and nepotism.

While advocating lake Balkhash in Kazakhstan I learnt more about limnology and hy- drology which aspect economic development of the regions. The importance of the morphology in determining a lake's basic level of productivity I find to be a fundamental concept in hydroeconomy. According to my independent research which I have been providing since 2017 there is a critical depth which shows the changes of Balkhash algae number. Significant changes of that bio-indicator at critical depth of 580 cm and - 280 cm prove rapid drop of lake water level and increase in salinity of lake Balkhash [6].

According to my international research and analysis of the Ili-Balkhash basin, the lake holds the largest underground water reserves in Kazakhstan and the lake's surface has a second highest thermal inertia index in the country which is enough to save Kazakhstani climate from advancing deserts [6].

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In 1961 the father of modern ecology, George Evelyn Hutchinson [2] described a paradox of the plankton when a limited range of nutritious resources supports an unexpectedly wide range of plankton species, apparently refuting the competitive exclusion principle described by Hardin in 1960, which holds that when two species compete for the same resource, one will be driven to extinction [1] Hutchinson proposed that the paradox could be resolved by factors such as vertical gradients of light, turbulence, differential predation, symbiosis, commensalism or constantly changing environmental conditions. More recent works of international teams of researchers have proposed that the paradox can be resolved by factors, such as chaotic fluid motion, spatiotemporal heterogeneity, size- selective grazing and periodic environmental changes [2]. More generally, researchers suggest that ecological and environmental factors continually interact such that planktonic habitat never reaches equilibrium for which a single species is favoured. In 2020 during my research study of lake Balkhash I found out that diatom algae can be a valid indicator of the water level quality as the type and number of Balkhash algae highly depend on water depth and salinity and can be used as a sustainable and climate change friendly tool to monitor local morphological changes. In Kazakhstan it is expensive to use industrial methods to monitor water level changes. According to my above mentioned research data significant changes at critical depth of 580 and 280 cm range always show a rapid drop of the water level and increase in salinity [6].

While working in the governmental project management office as an invited expert I met several hydrologists in Kazakhstan from the local Ministry of Ecology and we discussed the ways to restore water volume in the lake Balkhash [6]. During the course of my work I found out that it is the lack of environmental conscious- ness and ineffective water management that add additional risks to the country's energy system and I have developed my understanding of the risk mitigation plan to avoid climate change threats related to the desertification process of lake Balkhash [6].

Several technical innovative ideas and solutions were also discovered by me while implementing the research of Save Lake Balkhash International Project and they are based on the in-water tides management, Lake Bottom dredging and perforation, as well as the possible construction of the well systems around the lake to help sustain the sufficient water volume and decrease the overall salinity [6].

When scientists, ecologists specifically, consider the relationships between species in- habiting one ecosystem, they usually underestimate the mathematical justice of the Lotka - Volterra equation, which can be generalised to any number of species competing against each other [1]. My idea is that among any number of considered species there should be a prioritisation factor included and additional species interaction parameters (besides competition) such as symbiosis, to be considered during the evaluation or reevaluation stage of the monitoring status of the ecosystem balance. Paradox of the plankton here plays a significant role as it describes a theoretically endless list of the factors that can influence the competition environment and ecosystem balance [2].

As per my professional opinion there should be a clearer understanding of the critical and highly critical environmental factors based on the priority and certainty in qualitative and quantitative parameters, influencing the ecological competition process [6].

As the basis for the food supply chain inside the "ecosystem bubble" as I call it, the im portance of the algae (plankton) functions and its original conditions should become the primary data. In my case based on the Save Lake Balkhash International Project research, the algae factor became critical in defining water level changes as well as the increase in salinity of the lake Balkhash during 2005-2022 period proving that the desertification process of the lake Balkhash is real and climate change is negatively effecting the lake's ecosystem [6].

Using the community matrix based on lake Balkhash case (Figure 1) and the Lotka-Volterra equation principle (Figure 2) I proposed to create a list of the most endangered species and their interactions with a precise definition of all concomitant quantitative and qualitative environmental factors within the observed ecosystem, including the food chain relationships and intersection points on the population - time graph in order to integrate and scale up the prey / predator model. This research-based innovation will add extra variables to prioritise limited resources that can be allocated to preserve a lake ecosystem and optimise budget distribution among competing projects within green portfolios.

Algae factor is not mentioned in the formula but it remains a fundamental one as it represents the basis of the lake's ecosystem food supply chain. The quality and quantity of algae species within the lake's water should become a focus area for the future research studies and included in the local administrative budgets across country's regions to be monitored [6].

Finally, lakes moderate temperature and affect climate of the surrounding land. They store water, helping people and nature to survive climate change. The UN called the death of Aral Sea the greatest environmental disaster of the 20th century, but I call it a human tragedy. The importance of being able to speak up and share the ecological awareness regarding lakes' problems and risks is crucial. Based on my research and international studies I can suggest that the best available approach to save the lake is an activity-based approach and it requires a lot of international collaboration.

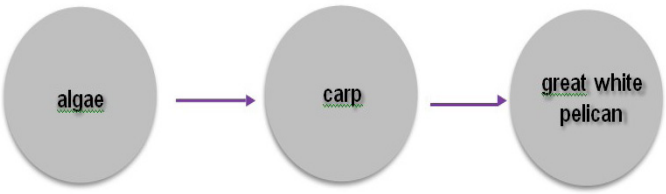

Figure 1: Community Matrix of the lake Balkhash.

	algae	carp	great white pelican
abundance (healthy status quo)	x	y	z
Alpha diversity (water conditions 2022)	αx	αy	αz
Beta diversity (morphological changes of the water conditions 2024)	βx	βy	βz

Figure 2: Lotka - Volterra equation for the carp (prey example) and pelican (predator example) relationship model.
dx / dt = x (1 - x/K) - y x / 1+x dy / dt = δy x/1+x - γy
Where x - the carp's density y - the pelican's density K - the carp population carrying capacity δ - pelican's rate of decay and γ - pelican's benefits of consumption. The term x (1 - x/K) represents the carp's logistic growth and x / 1+x - pelican's functional response.

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