Study of the impact of various supplies on the quality of surface water

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Abstract:

Introduction purpose: As population growth and industrial expansion continue, surface freshwater reservoirs such as dams have become increasingly vital due to their accessibility and ease of treatment. However, the quality of these water sources has significantly deteriorated, primarily due to the discharge of domestic and industrial wastewater. The proliferation of extensive algal blooms has led to significant challenges in maintaining drinking water quality and raised concerns about public health. This study investigates the impact of various water sources on the physicochemical quality of an Algerian dam over four seasons (December 2020 – October 2021) and explores the factors influencing the occurrence of cyanobacterial blooms to better understand and manage this excessive growth.

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Methods: Physicochemical properties and algal composition of the dam water were analyzed monthly to determine nutrient sources and environmental factors affecting cyanobacterial proliferation.

Results: The analysis revealed that the Timgad stream and Reboua valley are notable sources of nutrient enrichment. Elevated temperatures and high nutrient loads, particularly total phosphorus (TP), in Timgad dam water facilitate the proliferation of blue-green algae. Additionally, limited nitrogen content favors the dominance of nitrogen-fixing cyanobacteria such as Aphanizomenon and Oscillatoria. The study also highlights that the low flow rate and high nutrient load of the Timgad stream create favorable conditions for cyanobacterial growth.

Conclusions: Nutrient inputs, temperature, and hydrological conditions significantly influence cyanobacterial blooms. Understanding these factors is crucial for implementing effective water management strategies to reduce algal proliferation and protect freshwater quality.

Key words: Koudiet Medouar water dam, blue-green algae, cyanobacteria, nutrient pollution, Timgad.

Introduction

The availability of fresh water is one of the necessities of life. Although it represents 2.5% of all the water on our planet, less than 1.2% is in lakes, rivers, and dams, while 68.7% is in form of glaciers and ice caps, and 30.1% is under ground (Gleick, 1993).

With demographic growth and industrial development, surface fresh water such as that from dams has become more and more important because of its ease of access and treatment (Berga et al, 2006; Loucks et al, 2017). However, the quality of such water resources has suffered serious deterioration, principally because of domestic and industrial wastewater effluents (Quesada et al, 2019; Segerson & Walker, 2002; Walker et al, 2019).

Surface water pollution has been made the principal objective of several studies during the last years, indeed because of their serious health and environmental risks. Pollutants such as heavy metals, nitrates, phosphorus, dissolved organic matter (DOM) and others are well-studied (Adimalla et al, 2020; Karaouzas et al, 2021; Pivokonsky et al, 2016; Qu & Fan, 2010), but in fact, they still make a real challenge for water producers. Nutrient pollution which includes nitrogen (N) and phosphorus (P) is the leading type of contamination in water sources such as dams (Segerson & Walker, 2002). While plants and animals need these nutrients to grow, they have become a major pollutant due to fertilizer runoffs and effluents of domestic and industrial wastewater. Nutrient pollution typically stimulates phytoplankton growth in dams (Dzialowski et al, 2005; Marra et al, 1990). Unfortunately, some genera of phytoplankton named cyanobacteria or blue-green algae (B-G Algae) usually break out and stand stably, leading to problems with hypoxia, toxins, and changes in the structure of biological communities (Carmichael, 2008; Havens, 2008; Dobricic et al, 2016)

The excessive proliferation of blue-green algae not only creates ecological problems but can also affect the ability of water treatment plants (Gitis & Hankins, 2018; Wurtsbaugh et al, 2019). This includes poor settling, clogging sand filters, and breakthrough of small-size algae through sand filters, the fouling of membranes, and ion-exchange resins (Cheng & Chi, 2003; Hoeger et al, 2005). In addition, algae can also serve as precursors to form disinfection by-products (DBPs) during chlorination (Richardson & Postigo, 2011).

The Koudiet Medouar dam (Timgad, Batna, NE Algeria) is one of the most important freshwater resources in the area; it is used mainly to produce drinking water for one million inhabitants of the cities of Batna and Khenchla as well as for irrigation (Amrane & Bouhidel, 2019). Timgad's water dam receives water from three principal supplies: Reboua valley, the Timgad stream, and the water transfer from the Bni Haron water dam (Mila/Algeria).

The plant of this dam uses a conventional treatment based on the use of the coagulation/flocculation CF technique since it has been widely used for the treatment of surface water due to its several advantages such as the removal of organic, suspended, and colloidal matters. It can also be effective in removing many protozoa, bacteria, and viruses; it has been also found to be cost-effective, easy to operate and it is an energy-saving treatment alternative (Feihrmann et al, 2017; Mhamdi et al, 2016).

Recently, the treatment plant in the Timgad dam has faced serious problems with water quality caused by cyanobacteria blooms. Based on the reports, algae concentration reached 600×10^3 cells cm^{-3} in the summer which causes an increase in the chemicals during water treatment and affects the organoleptic quality of the produced drinking water. While the dam plant uses chlorination as a pretreatment, a lot of concerns have been raised about DBPs formation and its risks to public health.

Since this dam is of recent origin and little research has been carried out about it, except for a few studies (Bouslah et al, 2017; Labed, 2015; Smatti-Hamza et al, 2020; Tiri et al, 2017) on the water quality and water pollution, this research work aimed to study the impact of different water supplies on the physicochemical quality of the dam water, as well as the factors affecting the presence of cyanobacterial blooms in this important Algerian reservoir for better environmental monitoring.

In this work, the physicochemical parameters (especially nutrients), blue-green algae count, and identification have been followed during four seasons in the water reservoir and its water supplies. To the best of our knowledge, no study has so far been reported on the nutrient pollution, blue green algae presence and their effect on the Timgad dam water quality.

Study materials and methods

Study area

The Koudiet Medouar watershed is located northeast of the city of Batna in the eastern part of Algeria (Figure 1). The water from its reservoir is used for drinking and irrigation supply with a 69 million m^3 total capacity, 44 m depth, and 59.000 m^2 surface area (Amrane & Bouhidel, 2019). The flow goes from south to north, and it is supplied by rainwaters that come through Reboua valley by purified sewage of bordering cities and villages that come through the Timgad stream, and by water transfer that comes from the Bni Haroun watershed. The area lies between the longitude of 35°30′57″ N and the latitude of 6°30′48″ E (Figure 1).

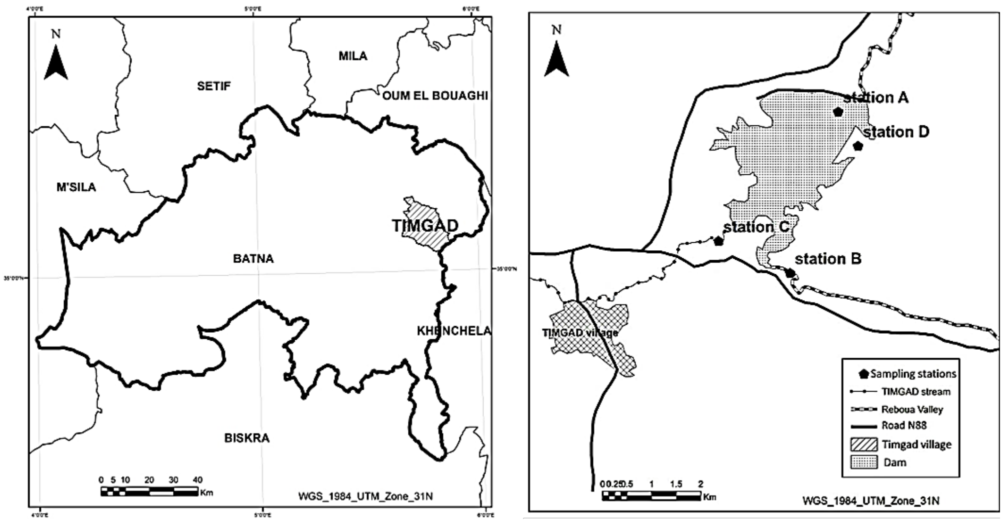

Figure 1 – Geographic map for the study area. The Koudiet Medouar dam, Timgad-Batna-Algeria (software used ArcGIS 10.3.1)

The Koudiat Medouar watershed is characterized by a semi-arid climate, characterized by cold and wet winters, warm and dry summers, and the rainfall between 300 and 450 mm per year. The extreme is marked by a climate known as a mountain climate with abundant rainfall (over 600 mm per year), especially in spring and late fall. It is sometimes characterized by violent storms. Generally, the regional rainfall exhibits three maxima during the year: January, May, and November. The annual average temperature is between 12 and 13 °C, with January as the coldest month and August as the hottest month (average between 26 and 34 °C) (Bouslah et al, 2017).

Sampling

Four sampling sites were chosen, each one from the dam and its supplies:

- Station A - The intake tower of the dam: the samples in this station were collected from different depths using a Niskin bottle attached to an electric hoist winch.
- Station B - Reboua valley (a source of rainwater that comes from the mountains).
- Station C – The Timgad stream (a source of purified wastewater that comes from the purification stations of the bordering cities).
- Station D - The water transfer comes from the Bni Haroun dam water (Mila-Algeria) which was put into service in 2013 (this supply was out of service during the period of study).

Samples were collected monthly from December 2020 to October 2021. They were collected at about 30 cm in depth and 1m away from the shore (APHA, 1999). For physicochemical analysis, Polyethylene bottles (1 dm^3) were used to collect water samples. The measurement of the pH, turbidity, temperature, and conductivity was performed on-site. Afterwards, samples were immediately transported to the laboratory and maintained at 4 °C in darkness for no more than 48 h before analysis.

The samples of the algae were collected. These samplings were carried out using a 20 to 100 µm mesh plankton net; the samples were fixed in a LUGOL solution and stored in glass jars (1 dm^3).

Analytical methods

Chemicals and materials

All chemicals used in this work, such as $K_2Cr_2O_7$ (≥99.5%), HCl (36.5–38%), NaOH (≥98%), H_2SO_4 (95–98%), potassium hydrogen phthalate

(KHP) (≥99.95%), ammonium persulfate (≥98%), potassium antimonyl tartrate (≥99%), ammonium molybdate (99.98%) and ascorbic acid (99%), anhydrous sodium tetra borat $Na_2B_4O_7$ (≥99.5%), phenol (≥99%), disodium ethylenediamine-tetraacetic acid EDTA (≥97%), and others, were purchased from Sigma-Aldrich, Algeria.

Analysis of the physicochemical parameters

Temperature, pH, and conductivity were measured in situ using a Hanna Instrument (Portable pH/EC/TDS/ Temperature) Model No. H1991300. Also, the dissolved oxygen (DO) was measured in situ using a portable oxygen meter (Hanna HI 9142). Turbidity was measured in the laboratory using a HACH 2100N turbid meter. Calcium (Ca^{2+}), and total hardness were determined by the volumetric method using ethylene diamine tetraacetic acid (EDTA) while orthophosphates (PO_4^{3-}) and nitrate (NO^{3-}) were determined by colorimetric assay using a Shimadzu UV-1601 spectrophotometer (Rodier et al, 2009).

Organic matter analysis

The COD of the dam water and deferent supplies was measured following the chemical oxygen demand index small scale sealed-tube method (ST-COD) (Rodier et al, 2009). Standards of 0, 5, 10, 15, 20, and 25 mg dm^{-3} of dissolved oxygen were prepared with potassium hydrogen phthalate (KHP) using ultra-pure water for all dilutions. After 2 h in a normalized thermo-reactor (WTW) at 150 °C, the dichromate excess absorbance of samples and standards was measured using a UV-visible spectrophotometer (Shimadzu, PharmaSpec 1700 UV/Vis) at 444 nm with a quartz cell of a 1 cm path length. The instrument was calibrated using ultrapure water as a blank.

Total phosphorus (TP) analysis

In a typical procedure for neutral digestion, 1 cm^3 of sulfuric acid solution and 0.4 g of ammonium persulfate were added to a 125 cm^3 Erlenmeyer flask containing 50 cm^3 of the aqueous sample (or the standard), and mixed. Then these flasks were placed on a pre-heated hot plate for approximately 30-40 min. After digestion, the samples were cooled and diluted to 50 cm^3 and 8 cm^3 of a combined reagent (H_2SO_4 solution, potassium antimonyl tartrate solution, ammonium molybdate solution, and ascorbic acid solution) was added and mixed thoroughly.

The characteristic blue color fully developed within 10 min at room temperature. The absorbance of the formed compound was measured at

880 nm with a spectrophotometer using a 1 cm quartz cuvette (APHA, 1992).

Total nitrogen (TN) analysis

The TN is analyzed following the Kjeldahl digestion method using an automated system of digestion/distillation/titration (U.S. Environmental Protection Agency, 2001).

Algae analysis

The collected samples of algae were fixed using a LUGOL solution of 15%, and the species were counted and identified using an inverted microscope OPTIKA IM-2 Trinocular according to the method of UTERMÖL (British Standards Institute, 2006).

Results and discussion

Physico-chemical quality of the studied water

Samples were taken from 3 different locations, at about 30 cm in depth. Table 1 shows that most physicochemical parameters are in normal values except for Reboua Valley which gives high levels of turbidity reaching 60.4 NTU during the rainy season due to the high flow rate.

Figure 2 shows that the TP concentration is extremely high ranging between 0.92 and 15.76 mg dm^{-3} in the Timgad stream (throughout the study period). These results are unexpected for the Timgad stream, which is considered purified wastewater. And on the contrary, the results of TN ranged between 150 and 300 µg dm^{-3} laid as to confirm that the purification plan used needs improvement.

Reboua valley has also shown high levels of TP ranging between 0.59 and 15.77 mg dm^{-3} during the rainy season; this may be due to an erosion of agricultural lands. The TN values ranged between 500 and 625 µg dm^{-3}.

On the other hand, the TP concentration in the dam water varies between 0.59 and 6.48 mg dm^{-3} (below the Algerian standards of 10 mg of P dm^{-3}), which shows a clear impact of the Timgad stream and Reboua valley on the dam water quality. The TN results ranged between 105 and 223 µg dm^{-3}.

The organic matter concentration in the water between summer and winter has also been investigated in this study. The maximum value of 25 mg O_2 dm^{-3} was recorded during May in the dam water and 27 mg O_2 dm^{-3} in the Timgad stream. A good stratification and aeration in the dam water was shown by the DO analysis; the mean average is 6.54 and 6.30 mg dm^{-3} at the top and bottom, respectively.

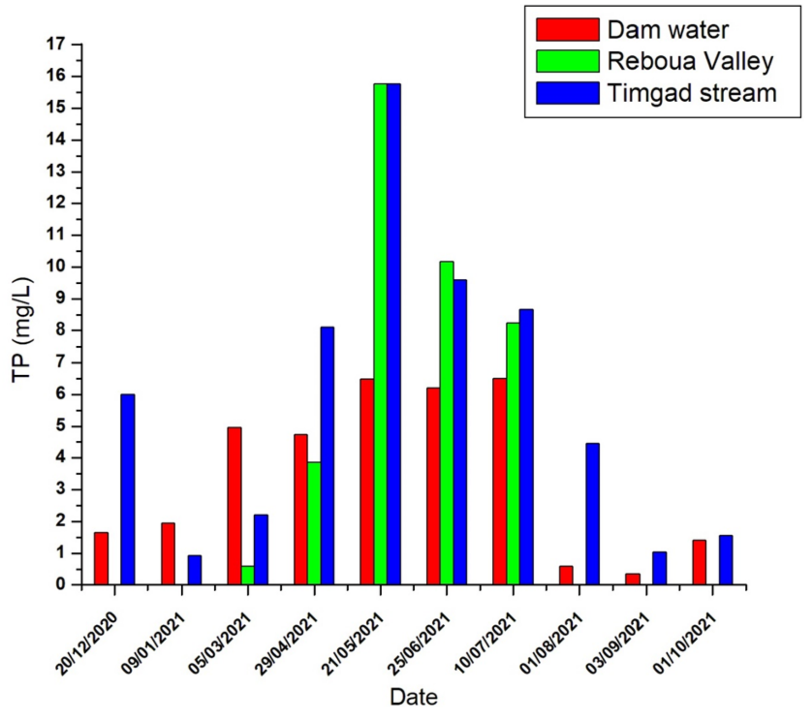

Figure 2 – Results of total phosphorus between December 2020 and October 2021

Algae analysis

In this study, two water supplies have been investigated and compared with the dam water. The maximum values of the total algae concentration were 428.5×10^3 cells cm^{-3} (recorded during October 2021) and 344×10^3 cells cm^{-3} (recorded during July 2021) in the Timgad stream and the dam water, respectively, as shown in Figure 3 and Figure 4.

It seems that the low flow rate, the high load of nutrients (TP especially), and the lighting conditions in the Timgad stream give the perfect conditions for algae proliferation (Lv et al, 2011; Mitrovic et al, 2011). Since the maximum values of the blue-green algae (B-G Algae) concentration were recorded in July 2021 (360×10^3 cells cm^{-3}) and May 2021 (217×10^3 cells cm^{-3}) in the Timgad stream and the dam water respectively, a probable reason was the ideal conditions of temperature, light, and nutrients (Giannuzzi, 2018). The percentage of blue-green algae shows values superior to 50% between March and August 2021 (spring and summer). The possible explanation for these results is the nutrients load (TP in particular) as well as the temperature that can control the domination of algae species (Journey et al, 2013; Lv et al, 2011). During the period of study, no algae proliferation is found in Reboua valley, probably due to the high flow rate.

Table 1 – Results of physicochemical analysis between December 2020 and Ocobert 2021

Location	T (°C)		pH		EC (µs cm^{-3})		DO (mg dm^{-3})		TP (mg dm^{-3})		TN (µg dm^{-3})		DCO (mg O_2 dm^{-3})	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Station A (The dam water)	8.4	26.2	7.44	8.58	919	1432	4.7	8.61	0.59	6.48	105	223	12	25
	Dec	Jul	Apr	Dec	Dec	Apr	Apr	Mar	Sep	May	Aug	Jan	Sep	May
Station B (Reboua valley)	-	-	7.47	7.83	703	1542	-	-	0.59	15.7	500	625	8	9.44
	-	-	May	Apr	Jun	Mar	-	-	Dec	Apr	Jun	Dec	Mar	Apr
Station C (Timgad stream)	9.5	27.3	7.38	8.69	1182	1508	-	-	0.92	15.7	150	300	14	27
	Dec	Jul	Apr	Dec	Jun	Apr	-	-	Sep	May	May	Jan	Oct	May

The dominant algal species identified in the dam water and the Timgad stream between March and August 2021 were Planktothrix (Cyanobacteria), and Aphanizomenon flos-aquae (Cyanobacteria). Cylindrospermopsis (Cyanobacteria), Euglena sp (Cyanobacteria), Nodularia spumigena (Cyanobacteria). These species are often considered a type of "nuisance algae" because they can form dense blooms that can affect the appearance, odor, and taste of the water, as well as interfere with the growth of other aquatic plants and animals (Havens, 2008). They can also produce potent toxins that are harmful to humans and animals (Codd et al, 2005). For this reason, monitoring and management strategies are necessary to control the proliferation of these species.

The dominance of some cyanobacteria like Aphanizomenon and Oscillatoria is possible due to the low nitrogen content in the dam water and the Timgad stream, whereas in a similar situation this genera of cyanobacteria called N2-fixing can fix atmospheric nitrogen, which can lead to a lack of nitrates or ammonia (Issa et al, 2014).

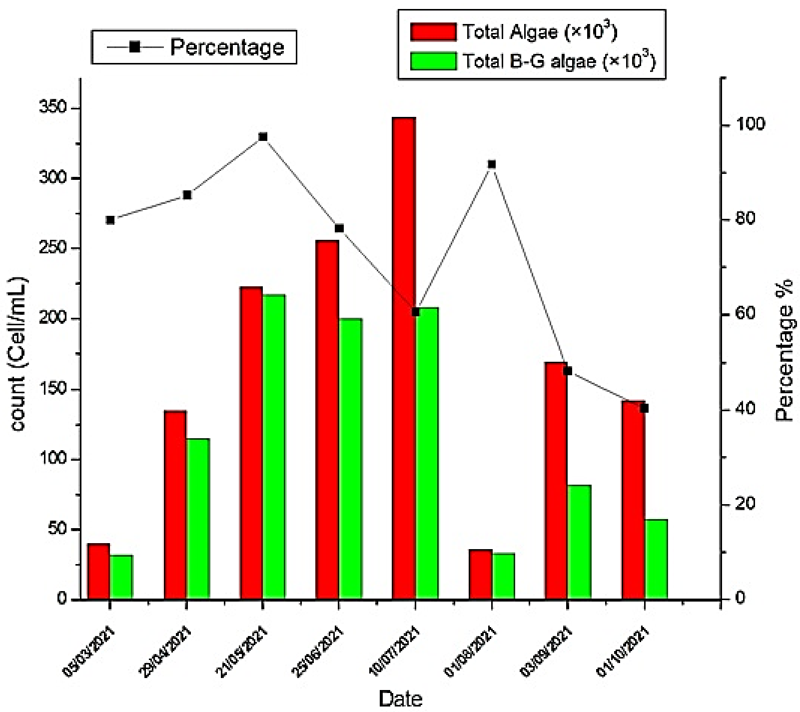

Figure 3 – Count of Algae and B-G algae in the dam water (Station A)

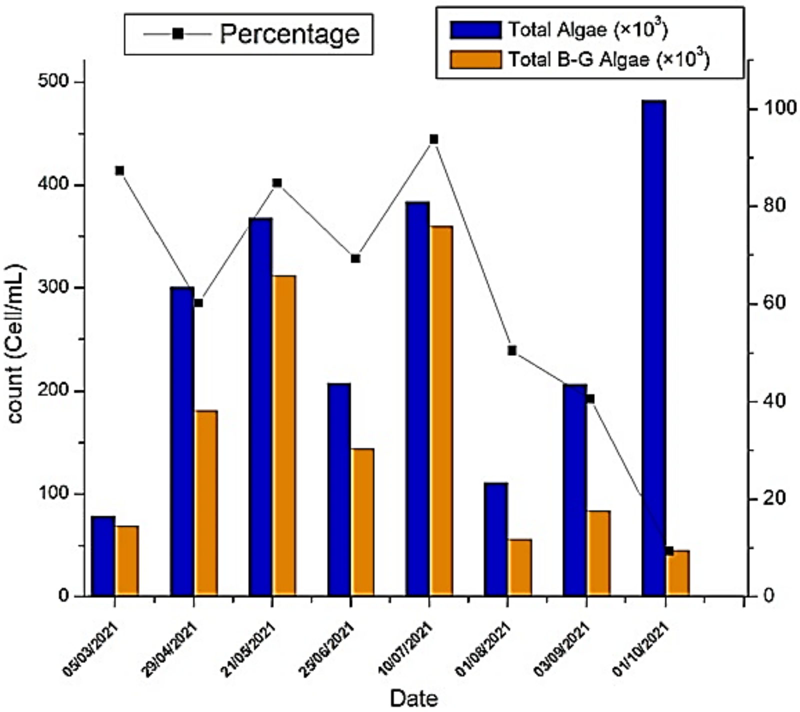

Figure 4 – Count of Algae and B-G algae in the Timgad stream (Station C)

Effects of TP on blue-green algae dominance

The combined results of the physicochemical analysis and the algae analysis show a positive correlation between the TP and blue-green algae concentration in the dam water (R^2=0.85) (Figure 5), and in the Timgad stream (R^2=0.48) (Figure 6).

The strong positive correlation in the dam water compared with the Timgad stream is possibly due to the difference in homogeneity and mixing conditions (Whitton, 2012).

However, in general, these results have been in agreement with the conclusion of a recent study that considered the TP to be the limiting nutrient in freshwater ecosystems (Li et al, 2018; O'Neil et al, 2012).

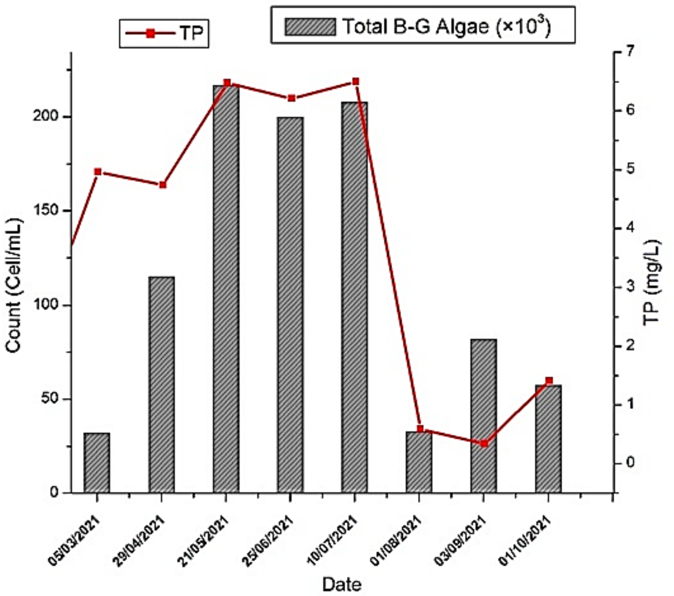

Figure 5 – Correlation between the TP and Cyanobacteria count in the dam water between March 2021 and October 2021

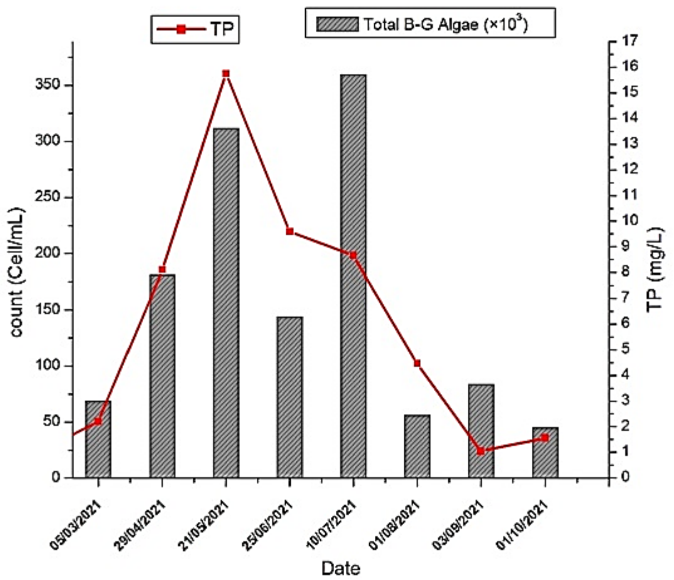

Figure 6 – Correlation between the TP and Cyanobacteria count in the Timgad stream between March 2021 and October 2021

Effects of temperature on blue-green algae dominance

A positive correlation has been recorded between temperature and blue-green algae concentration in the dam water (R^2=0.83) (Figure 7), and in the Timgad stream (R^2=0.84) (Figure 8) in the period between March and August 2021. These results show that temperature is an important factor that controls blue-green algae dominance in freshwater ecosystems (Beaulieu et al, 2013; Konopka & Brock, 1978).

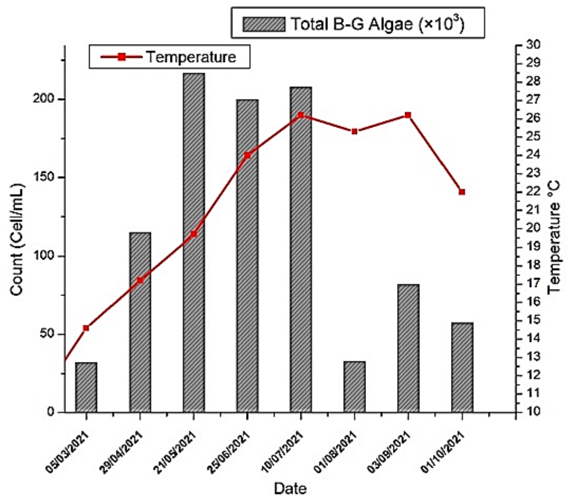

Figure 7 – Correlation between temperature and the Cyanobacteria count in the dam water between March 2021 and October 2021

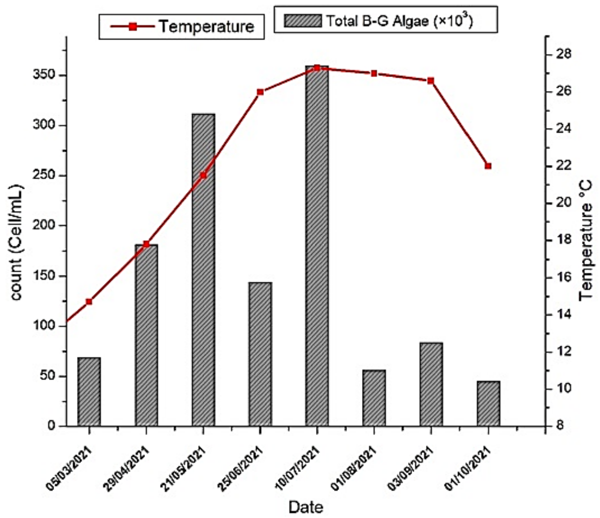

Figure 8 – Correlation between temperature and the Cyanobacteria count in the Timgad stream between March 2021 and October 2021

Effects of blue-green algae on DO

The DO results negatively correlated with the blue-green algae concentration in the dam water (Figure 9). The excessive proliferation of algae leads to oxygen depletion (Dobricic et al, 2016). However, the results show that the eutrophication phenomenon has not yet been reached.

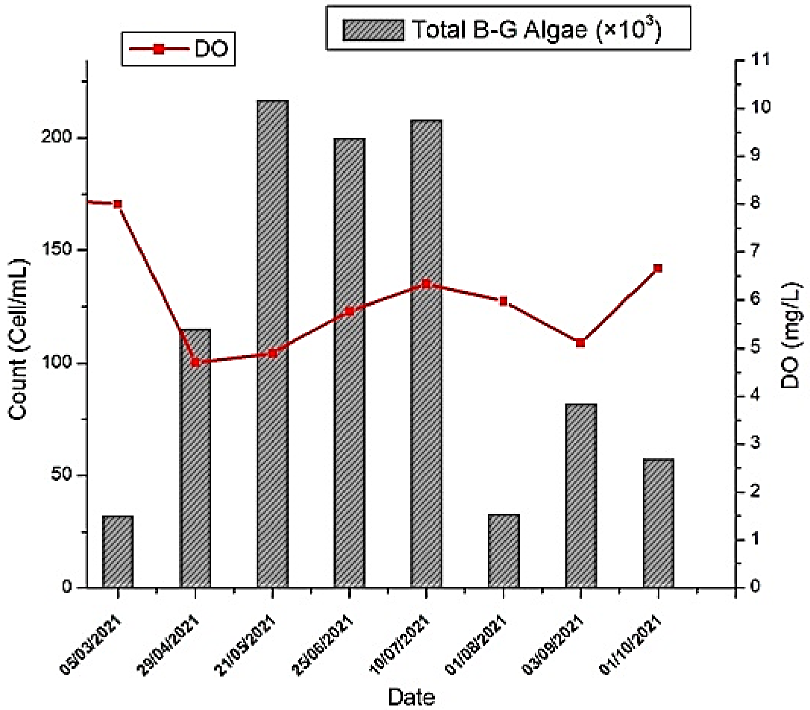

Figure 9 – Correlation between DO and the cyanobacteria count in the dam water between March 2021 and October 2021

Conclusion

This paper delves into the impact of various water supplies on the physicochemical quality of the Timgad dam water and the factors influencing the presence of cyanobacteria blooms. The findings reveal that the Timgad stream and Reboua valley contribute significantly to nutrient levels. Elevated temperatures and nutrient loads, particularly those of total phosphorus (TP), in the Timgad dam water facilitate the growth of blue-green algae. Conversely, the limited nitrogen content favors the predominance of nitrogen-fixing cyanobacteria such as Aphanizomenon and Oscillatoria. Moreover, the study highlights that the low flow rate and high nutrient load of the Timgad stream create favorable conditions for cyanobacterial growth. Importantly, the study confirms that eutrophication has not yet occurred, underscoring the critical need for controlling nutrient levels to enhance the efficiency of water treatment plants, maintain potable water quality, and safeguard the aquatic ecosystem from further deterioration.

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Estudio del impacto de diversos suministros sobre la calidad de las aguas superficiales

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CAMPO: química ambiental
TIPO DE ARTÍCULO: artículo científico original

Resumen:

Introducción/objetivo: Con el continuo crecimiento poblacional y la expansión industrial, los reservorios superficiales de agua dulce, como las presas, se han vuelto cada vez más vitales debido a su accesibilidad y facilidad de tratamiento. Sin embargo, la calidad de estas fuentes de agua se ha deteriorado significativamente, principalmente debido al vertido de aguas residuales domésticas e industriales. La proliferación de floraciones extensas de algas ha generado importantes desafíos para mantener la calidad del agua potable y ha suscitado preocupación por la salud pública. Este estudio investiga el impacto de diversas fuentes de agua en la calidad fisicoquímica de una presa argelina durante cuatro temporadas (diciembre de 2020 a octubre de 2021) y explora los factores que influyen en la aparición de floraciones de cianobacterias para comprender mejor y gestionar este crecimiento excesivo.

Métodos: Se analizaron mensualmente las propiedades fisicoquímicas y la composición algal del agua de la presa para determinar las fuentes de nutrientes y los factores ambientales que afectan la proliferación de cianobacterias.

Resultados: El análisis reveló que el arroyo Timgad y el valle de Reboua son fuentes importantes de enriquecimiento de nutrientes. Las temperaturas elevadas y las altas cargas de nutrientes, en particular el fósforo total (PT) en el agua de la presa de Timgad facilitan la proliferación *de algas verdeazuladas. Además, el contenido limitado de nitrógeno favorece el predominio de cianobacterias fijadoras de nitrógeno, como Aphanizomenon y Oscillatoria. El estudio también destaca que el bajo caudal y la alta carga de nutrientes del arroyo Timgad crean condiciones favorables para el crecimiento de cianobacterias.*

Conclusión: El aporte de nutrientes, la temperatura y las condiciones hidrológicas influyen significativamente en las floraciones de cianobacterias. Comprender estos factores es crucial para implementar estrategias eficaces de gestión del agua que reduzcan la proliferación de algas y protejan la calidad del agua dulce.

Palabras claves: presa de agua Koudiet Medouar, algas verdeazuladas, cianobacterias, contaminación por nutrientes, Timgad.

Изучение влияния различных форм водоснабжения на качество поверхностных вод

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РУБРИКА ГРНТИ: 61.01.94 Охрана окружающей среды
ВИД СТАТЬИ: оригинальная научная статья

Резюме:

Введение/цель: В связи с ростом населения и развитием промышленности поверхностные водоемы с пресной водой, такие как плотины, приобретают все большее значение из-за простоты эксплуатации и очистки. Однако качество этих источников водоснабжения значительно ухудшилось, в первую очередь из-за сброса бытовых и промышленных сточных вод. Распространение бурного цветения водорослей привело к серьезным проблемам в сохранении качества питьевой воды и вызвало обеспокоенность по поводу общественного здравоохранения. В данном исследовании изучается влияние различных источников воды на физико-химическое качество воды в одной алжирской плотине в течение четырех времен года (декабрь 2020 г. - октябрь 2021 г.). В статье также исследуются факторы, влияющие на возникновение цветения цианобактерий, *с целью лучшего понимания и предотвращения их чрезмерного роста.*

Методы: В ходе исследования ежемесячно анализировались физико-химические свойства и водорослевый состав воды плотины для определения источников питательных веществ и факторов окружающей среды, влияющих на размножение цианобактерий.

Результаты: Анализ показал, что водоем Тимгад и долина Румбура являются важными источниками питательных веществ. Повышенные температуры и высокая концентрация питательных веществ, особенно общего фосфора в воде плотины Тимгад способствуют размножению сине-зеленых водорослей. Помимо того, ограниченное содержание азота способствует преобладанию азотфиксирующих цианобактерий, таких как афанизоменон и осциллатория. Исследование также показало, что медленное, богатое питательными веществами течение реки Тимгад создает подходящую среду для роста цианобактерий.

Выводы: Поступление питательных веществ, температура и гидрологические условия существенно влияют на цветение цианобактерий. Понимание этих факторов имеет ключевое значение в применении эффективных стратегий управления водными ресурсами, направленных на предотвращение распространения водорослей и защиту качества пресной воды.

Ключевые слова: плотина Кудиат-Медуар, сине-зеленые водоросли, цианобактерии, биогенное загрязнение, Тимгад.

Испитивање утицаја различитих облика снабдевања на квалитет површинских вода

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ОБЛАСТ: хемија животне средине
КАТЕГОРИЈА (ТИП) ЧЛАНКА: оригинални научни рад

Сажетак:

Увод/циљ: С растом популације и ширењем индустрије резервоари површинских слатких вода, као што су бране, постају све значајнији због своје приступачности и лакоће прераде. Међутим, квалитет ових водоизворишта постаје све лошији, пре свега због испуштања комуналних и индустријских отпадних вода. Пролиферација екстензивног цветања алги довела је до значајних проблема у одржавању квалитета пијаће воде, као и до забринутости за јавно здравље. Ова студија бави се утицајем различитих извора воде на физичко-хемијски квалитет воде у једној брани у Алжиру током четири годишња доба (децембар 2020 – октобар 2021), а испитује и факторе који утичу на појаву цветања цијанобактерија како би се боље разумео и контролисао њихов прекомерни раст.

Методе: Физичко-хемијска својства воде у брани, као и састав алги у њој, анализирани су на месечном нивоу како би се одредили извори нутријената и фактори животне средине који утичу на ширење цијанобактерија.

Резултати: Анализа је показала да су водоток Тимгада и долина Ребоуа значајни извори обогаћивања хранљивим материјама. Високе температуре и висока засићеност воде хранљивим материјама (нарочито укупним фосфором) у брани Тимгад олакшавају ширење плавозелених алги. При томе, ограничени садржај азота подстиче доминацију азотофиксирајућих цијанобактерија као што су Aphanizomenon и Oscillatoria. Такође, у студија се истиче да спори ток Тимгада богатог хранљивим материјама представља погодну средину за раст цијанобактерија.

Закључак: Доток хранљивих материја, температура и хидролошки услови знатно утичу на цветање цијанобактерија. Познавање ових фактора од суштинске је важности за примену ефикасних стратегија управљања водом како би се смањила пролиферација алги и заштитио квалитет слатких вода.

Кључне речи: водена брана Коудиет Медоуар, плавозелене алге, цијанобактерије, загађење нутријентима, Тимгад.

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