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Studies On Physico-Chemical Characteristics And Biological Diversity Of Ningthoukhong River In Manipur.

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Abstract
Background: *The primary resource that all living things on planet earth require in order to survive and developed is water. River water is the primary source of water for irrigation and domestic uses, hence monitoring it is quite necessary. The main aim of the current study is to evaluate the physico-chemical characteristics, macrophyte diversity and fish diversity of Ningthoukhong River of Bishnupur District of Manipur. The Ningthoukhong River originates in the eastern slope of the northern part of the Thangjing Hill Range flows through the villages of Shantipur and the Central part of Ningthoukhong town and finally falls into Loktak Lake near ITI, Ningthoukhong.*
Materials & Methods: *Two sampling sites were selected along the river and sample were collected on monthly basis from March 2025 to August 2025. The study was carried out through the collection and laboratory analysis of the sample taken from the river. Physico-chemical parameters like temperature, pH, dissolve oxygen, biochemical oxygen demand, free carbon-dioxide, total dissolve solids, calcium, magnesium, total hardness, and chloride were analysed. Macrophytes were collected and identified by using standard method of Curtis (1959) and Mishra (1968). Fishes were collected and identified following Vishwanath (2002).*
Results: *The physico-chemical parameters were higher in the downstream except chloride and calcium. DO value is lower in the downstream. Some of the macrophytes that were obtained during the study were Colocasia cuculata, Digitaria ciliaris, Alternanthera philoxeroides, Eclipta alba, Cynodon dactylon, Persicaria odorata, Ageratum conyzoides, Xanthium strumarium, Paspalum distictum, Phragmites karka, Pistia stratiotes, Salvinia cucullata and Salvinia natans. Fish fauna collected and identified includes 19 species of fishes belonging to 19 genera and 12 families.*
Conclusion: *It concluded that all the values of physico-chemical parameters were found higher in the downstream and the water of Ningthoukhong River is polluted. It shows that both seasonal change and human activities have influence on water quality of Ningthoukhong River.*
Keywords: *Water quality, Macrophytes, fish diversity, Ningthoukhong River, Manipur.*

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I. Introduction

Water is the prime natural resource for the survival of life on earth. It is available widely on the surface of the earth as oceans, surface water bodies, streams, rivers as well as in the form of ground water. The rivers are considered one of the major freshwater sources of water for human consumption, irrigation and industrial uses. These water bodies being exposed to anthropogenic influences and atmospheric deposition of pollutants becomes a very sensitive and critical issue in many countries. has become one of the emerging environmental issue our ecosystems are facing today. Increase in the use of chemical fertilizers and pesticides in agriculture also causes various aquatic environmental pollution and leads to depletion of water quality (Khan et.al, 2012). The quality of water depends on physicochemical properties of water. So, for the prevention of river water pollution, it requires effective and judicious monitoring of physicochemical parameter at regular intervals.

Aquatic macrophytes are an important biological component of an aquatic ecosystem. Aquatic macrophytes are considered photosynthetic organisms of freshwater habitats, comprising vascular plants, aquatic bryophytes and macroalgae growing permanently or temporally in aquatic environments (Jones et al. 2010). They play an important role in the structure and functioning of freshwater ecosystems, their composition, diversity also depends on various environmental factors such as light, water temperature, substrate composition, disturbance, competitive interactions, herbivory, epiphyte loading, water levels, quality of the lake water and sediment nutrients.

Diversity assessment of fishes also plays an important role in gathering information about the habitat ecology and overall health of the ecosystem (Kumar, et. al.,2025). The nature and health of an aquatic ecosystem are an expression of the quality of water and are dependent on the physico-chemical properties of water and its biological diversity. Aquatic ecosystem health directly reflects water quality, determined by the interaction of physico-chemical parameters and biological diversity (Mishra, et. al.,2023).

Objectives of the study

1. To study the water quality of Ningthoukhong River based on various physico-chemical characteristics of water.
2. To study the diversity of macrophytes in and on the bank of the river.
3. To study the diversity of fish found in Ningthoukhong River.

Description of the study sites

Manipur is blessed with numerous rivers and streams of which many are feeding important lakes of the state. Ningthoukhong river is a feeder stream of Loktak Lake which is selected for this study. It originates in the eastern slope of the northern part of the Thangjing Hill Range. The total length of Ningthoukhong river is observed to be 10.67 km and has a catchment area of 9.55 km^2. The catchment boundary of the river encompasses the villages of Shantipur and the Central part of Ningthoukhong town. Two sampling sites were selected for detailed study of the above-mentioned river. Site I is located at the western side of the river with a coordinate of 24° 34' 22.336" N & 93° 44' 27.254" E, called upstream site and Site II is located at the eastern side of the river with a coordinate of 24° 34' 15.349" N, 93° 46' 22.450" E called downstream site and finally falls into Lokatak Lake in Bishnupur District of Manipur State, India. Analysis was carried out from March 2025 – August 2025 for a period of six months as pre-monsson and monsoon.

II. Materials And Methods

This study aims to address the gap of analysing the spatial and temporal variation in the physico-chemical properties of Ningthoukhong River. The present study mainly focuses on the quality of the river water and effects of contamination coming from the human settlements into the river. This study endorses some important limnological parameters. The present study intended to highlight the diversity of flora i.e. variations of macrophytic vegetations and fish diversity in the selected river.

Collection of water sample was done as per standard protocol (APHA,2005). A total of 10 physicochemical parameter i.e. Temperature, pH, electrical conductivity (EC), Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Dissolve Solids (TDS), total alkalinity, Total Hardness (TH), Free CO_2, Chloride (Cl-), Calcium (Ca), Magnesium (Mg), Sodium and Potassium were analysed. Temperature will be determined with the help of thermometer, pH by pH meter, electrical conductivity and TDS through conductivity bridge, DO by Winkler`s titration method, Sodium and Potassium by Flame Photometer and BOD, total alkalinity, total hardness, F-CO2, Calcium and Chloride were determined by following standard methods (Trivedi and Goel, 1984).

Field survey cum documentation were conducted during the study period along the length of the river. The plants were collected, identify and documented using relevant flora literature. The accepted names were verified in websitehttp://www.plantsoftheworldonline.org. while, the various fishes collected from the study sites during the study period were identified following Vishwanath (2002).

III. Results

Table no 1. Physico-chemical parameters of water samples of Ningthoukhong River (Mean ± S.D) during the study period (March 2025 to Aug 2025).

Sl. no	Parameters	Upstream	Min – Max	Downstream	Min – Max	WHO standard
1.	Temp. (˚C)	22.55 ± 0.64	22.1 – 23	22.1 ± 1.13	21.3 – 22.9	25˚C
2.	pH	6.9 ± 0.14	6.8 – 7	6.9 ± 0.14	6.8 – 7	6.5 – 8.5
3.	DO (mg/l)	6.8 ± 0.57	6.4 – 7.2	3.75 ± 1.20	2.9 – 4.6	≥ 5
4.	BOD (mg/l)	5.35 ± 0.64	4.9 – 5.8	2.05 ± 0.50	1.7 – 2.4	<5
5.	Free CO_2 (mg/l)	9.35 ± 0.55	8.8 – 9.9	33 ± 2.2	30.8 – 35.2	<10
6.	TDS (ppm)	64 ± 0	64 – 64	169.5 ± 17.5	152 – 187	500 - 1500
7.	Calcium (mg/l)	44.95 ± 14.49	30.46 – 59.44	29.25 ± 2.80	26.45 – 32.06	≤75 - 200
8.	Magnesium (mg/l)	15.31 ± 14.34	0.97 – 29.66	20.46 ± 3.45	18.02 – 22.90	30 - 150
9.	TH (mg/l)	191 ± 119	72 – 310	157 ± 17	140 – 174	100 - 500
10.	Chloride (mg/l)	14.20 ± 1.42	12.78 – 15.62	26.98 ± 4.26	22.72 – 31.24	≤250

Table no 2. Macrophytes found in Ningthoukhong River during the study period (March 2025 – Aug 2025).

Sl. no.	Macrophytes	Family	Habitat
1.	*Colocasia cuculata* (L.) Schott.	Araceae	Emergent
2.	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	Floating
3.	*Eclipta alba* (L.) Hassk.	Asteraceae	Marginal
4.	*Cynodon dactylon* (L.) Pers.	Poaceae	Marginal

5.	*Ageratum conyzoides* L.	Asteraceae	Marginal
6.	*Xanthium strumarium* L.	Asteraceae	Marginal
7.	*Persicaria odorata* (Lour.) Soják	Polygonaceae	Emergent
8.	*Paspalum distichum* L.	Poaceae	Emergent
9.	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	Marginal
10.	*Phragmites karka* (Retz.) Trin. ex Steud.	poaceae	Emergent
11.	*Pistia stratiotes* L.	Araceae	Free floating
12.	*Salvinia cucullata* Roxb.	Salviniaceae (Pteri)	Free floating
13.	*Salvinia natans* (L.) All	Salviniaceae (Pteri)	Free floating

Table no 3. Fish fauna found in the Ningthoukhong River during the study period (March 2025 – Aug 2025).

Sl. no	species	Family	Order	Genus	Local name
1.	*Amblypharyngodon mola* (Hamilton-Buchanan)	Cyprinidae	Cypriniformes	Amblypharyngodon	Muka nga
2.	*Esomus dnaricus* (Hamilton-Buchanan)	Cyprinidae	Cypriniformes	Esomus	Ngasang
3.	*Lepidocephalicthys guntea* (Hamilton-Buchanan)	Cobitidae	Cypriniformes	Lepidocephalicthys	Ngakijou
4.	*Mystus bleekeri* (Day)	Bagridae	Siluriformes	Mystus	Ngasep
5.	*Heteropneustes fossilis* (Bloch)	Heteropneustidae	Siluriformes	Heteropneustes	Ngachik
6.	*Glossogobius giuris*	Gobiidae	Perciformes	Glossogobius	Nailon ngamu
7.	*Trichogaster fasciata*	Osphronemidae	Anabantiformes	Trichogaster	Ngapemma
8.	*Channa gachua* (Hamilton-Buchanan)	Channidae	Perciformes	Channa	Meitei ngamu
9.	*Puntius ater* (Linthoi and Vishwanath)	Cyprinidae	Cypriniformes	Puntius	Phabounga
10.	*Pethia manipurensis* (Menon, Rema Devi & Vishwanath	Cyprinidae	Cypriniformes	Pethia	Ngakha meingangbi
11.	*Mastacembelus armatus* (Lecepede)	Mastacembelidae	Synbranchiformes	Mastacembelus	Ngarin
12.	*cirrhinus mrigala* (Hamilton-Buchanan)	Cyprinidae	Cypriniformes	Cirrhinus	Mrigal
13.	*Ctenopharyngodon idella (Valenciennes)*	Cyprinidae	Cypriniformes	Ctenopharyngodon	Grass carp
14.	*Cyprinus carpio* Linnaeus	Cyprinidae	Cypriniformes	Cyprinus	Puklaobi
15.	*Monopterus albus* (Zuiew)	Synbranchidae	Synbranchiformes	Monopterus	Ngaproom
16.	*Chanda nama* Hamilton- Buchanan	Cyprinidae	Cypriniformes	Chanda	Ngamhai
17.	*Anabas testudineus* (Bloch)	Anabantidae	Anabantiformes	Anabas	Ukabi
18.	*Tetraodon cutcutia* Hamilton-Buchanan	Tetraodontidae	Tetraodontiformes	Tetradon	Hangoi nga
19.	*Chitala chitala* (Hamilton-Buchanan)	Notopteridae	Osteoglossiformes	Chitala	Ngapai

IV. Discussion

The physico-chemical characteristics of the water sample collected from upstream and downstream of the river under study were presented in table 1.

The water temperature varies from 22.1^{0}C to 23^{0}C with a mean value of 22.55^{0}C and SD of 0.64 in the upstream and 21.3^{0}C to 22.9^{0}C with a mean value of 22.1^{0}C and SD of 1.13 in the downstream.

The pH of natural waters varies around 7. The Ningthoukhong River showed normal temperature and slightly acidic to neutral pH. The pH value varies from 6.8 to 7 with a mean of 6.9 and SD of 0.14 in the upstream and 6.8 to 7 with a mean of 6.9 and SD of 0.14 in the downstream.

Dissolved oxygen is a key parameter reflecting the quality of water and hence used in classifying its quality, particularly of water, which receives waste. Its consumption during decomposition of organic matter reduces its concentration. DO level were moderate but below ideal standards with a value of 6.4 mg/l to 7.2 mg/l and mean value of 6.8 mg/l and SD of 0.57 in the upstream and 2.9 mg/l to 4.6 mg/l with mean value of 3.75 mg/l and SD of 1.20 in the downstream. DO level decreases in the downstream showing decrease in water quality in downstream.

BOD is an parameter to know the presence of biodegradable matter in waste and expresses degree of contamination. Determination of BOD is very useful in identifying an appropriate methodology for wastewater treatment and also to design facilities for disposal. Whenever there is low DO content in water, normally high

BOD is observed, BOD value varies from 1.7 mg/l to 2,4 mg/l with a mean value of 2.05 mg/l and SD of 0.50 in the upstream and 4.9 mg/l to 5.8 mg/l with a mean value of 5.35 mg/l and SD of 0.64 in the downstream. In the upstream it is within the standard limit of less than 5 mg/l but it is slightly higher in downstream. This might be due stagnant of water which reduces oxygen level.

Carbon dioxide constitutes 0.03% of the atmosphere and is formed mainly due to respiration and to some extent contributed by industrial combustion, it is consumed during photosynthesis by plants. Carbonic acid was formed due to dissolution of CO_2, making it slightly acidic in nature. Free CO_2 value varies from 8.8 mg/l to 9.9 mg/l with a mean value of 9.35 mg/l and SD of 0.55 in the upstream and 30.8 mg/l to 35.2 mg/l with a mean value of 33 mg/l and SD of 2.2 in the downstream. The value shows that it is within the limit in upstream but higher than the limit of WHO in the downstream.

TDS is an important parameter to the water quality standards. The higher the concentration of TDS in water, the poorer is its quality. TDS value is 64 ppm with a mean value of 64 ppm and SD of 0.0 in the upstream and 152 ppm to 187 ppm with a mean value of 169.5 ppm and SD of 17.5 in the downstream. Both the values are within the limit but higher value in the downstream shows more human activities in the downstream.

Calcium is found in abundance in all natural waters and its source is limestone from where it is leached. Calcium value varies from 30.46 mg/l to 59.44 mg/l with a mean value of 44.95 mg/l and SD of 14.49 in the upstream and 26.45 mg/l to 32.06 mg/l with a mean value of 29.25 mg/l and SD of 2.80 in the downstream.

Magnesium occurs in all natural waters but its concentration is much less than that of calcium. Magnesium value varies from 0.97 mg/l to 29.66 mg/l with a mean value of 15.31 mg/l and SD of 14.34 in the upstream and 18.02 mg/l to 22.90 mg/l with a mean value of 20.46 mg/l and SD of 3.45 in the downstream.

The total hardness of water is the measure of the capacity of the water to react with soap. Total hardness value is within the limit and varies from 72 mg/l to 310 mg/l with a mean value of 191 mg/l and SD of 119 in the upstream and 140 mg/l to 174 mg/l with a mean value of 157 mg/l and SD of 17 in the downstream.

Chloride is an important ion found in nature in large quantities. Chloride remains within the limit and the value varies from 12.78 mg/l to 15.62 mg/l with a mean value of 14.20 mg/l and SD of 1.42 in the upstream and from 22.72 mg/l to 31.24 mg/l with a mean value of 26.98 mg/l and SD of 4.26 in the downstream.

A total of 13 macrophyte species were recorded during the study period (11 angiosperms & 2 species of pteridophytes) under 12 genera representing 6 families were shown in table 2. The macrophytes are more abundant in the downstream. Most plants recorded were marginal and emergent species.

Fish fauna collected and identified during the present study are shown in Table 3. The collection includes 19 species of fishes belonging to 19 genera and 12 families. Most of the flora and fauna were widely distributed forms, which can thrive well in the polluted waters. Heavy infestation of the macrophytes in the downstream shows that the river is rich in nutrients and they may be considered as nutrient sink.

V. Conclusion

In conclusion, the physico-chemical parameters show higher values in downstream except chloride and calcium. Which shows more anthropogenic activities in the downstream. There is increase in the value of free CO_2, high BOD and less DO level in the downstream shows that Ningthoukhong river is polluted. Proper conservation measures are needed in the Ningthoukhong river for future sustenance. Most of the flora and fauna were widely distributed forms which can thrive well in polluted water which is also an important indicator that the river water is polluted.

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