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Water quality and biological diversity of Budhoholi Wetland, Jhapa, East Nepal

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Abstract

The present study deals with the physico-chemical parameters and biological diversity of Budhoholi at Sani-Arjun Municipality -7 Jhapa, from July to October, 2015. The physico-chemical properties of water were within the maximum permissible limit with slight variation in some parameters. The biological diversity was found to be rich. Riparian vegetation consisted of 21 herbs 13 shrubs, 11 trees and 4 climbers, 9 aquatic macrophytes and 21 species of fishes. The overall result of the lake indicated that the lake is not disturbed and is not polluted.

Kew words: Aquatic macrophytes, Fish diversity, Macrophytes, Physico-chemical parameters, Riparian vegetation

Introduction

According to the 2003 National Wetlands Policy of Nepal, "Wetlands denote perennial water bodies that originate from underground sources of water or rain. It means swampy areas with flowing or stagnant fresh or salt water that are natural or man-made, or permanent or temporary. Wetlands also mean marshy lands, riverine floodplains, lakes, ponds, water storage areas and agricultural lands" (HMGN, 2003). Nepal's wetland habitat is created through varied water bodies that range from permanent flowing rivers to seasonal streams, lowland ox-bow lakes, high altitude glacial lakes, swamps, marshes, paddy fields, reservoirs and ponds (Bhandari, 1992). Lowlands of Nepal exhibit most extensive wetland systems which are playing important role in maintaining the ecology and economy of the regions but the people are not always aware of the economic value of the wetlands. Budho holi wetland is being set aside for park and recreational purpose, attracting large number of visitors which may alter the overall environmental condition of the entire lake ecosystem. Moreover wetlands of Nepal are in critical state and Budho Holi may not be far from it therefore regular monitoring of such virgin lake ecosystem is needed so as to conserve its biodiversity for its sustainable development.

Materials and Methods

Study area

A wetland, locally called Budhoholi is located about 6 km north from Birtamod Municipality, Jhapa. It is included in Sani-Arjun Municipality ward No. 7. It is under "Sukhani Shahid pratisthan Nepal" occupying an area of 22.4 ha. Previously this forested area was under the domain of "Namuna Samudaik Ban Samuha" having an area of 100 ha. Former HMG had provided this sector of forested land from a community forest group and declared to establish "Sahid Smarak Park". The wetland is surrounded by Bhimsen Ghat, lying on the way to Sanichare-Charali road on the north, Sarki Khola with a small Salbari

village on the east and cultivated land on the west and south separated by Adua Khola respectively. Amidst it, a square park is located at a narrowing middle part of it. Regarding its origination, it is belived as an old course of Aduwa River.

The wetland is irregular in shape extended from northwest (inlet) to southeast (outlet). It is located from N 26º40'37.4" to N 26º40'24.7" latitude and E 88º00'37.6" to E 88º00'53.3" longitude. Its diagonal length is 620 m and average breadth reaches to 98 m, having an area of 3.45 ha (Oli, 2005). First part of the inlet is narrower whereas middle part broader and then the outlet slightly narrow down (Map 1). Depth of the wetland varies from outlet to inlet but at the center the average depth is 5 m (Rai & Bhattarai, 2005). The wetland is covered with many shrubs and weeds, especially bryophytes and pteridophytes and surrounded by regenerated Sal forest.

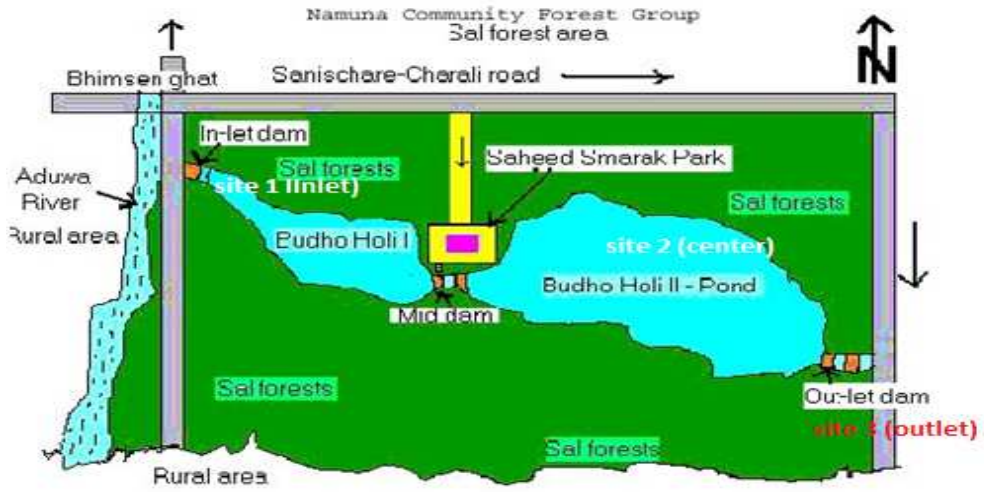

Figure 1. Diagrammatic Sketch of Bhudo Holi Wetland (Rai, 2003)

Experimental design

The study was carried out for three months from July to October 2015, in their respective first week. Depending upon the strata layout, three sampling site viz. inlet, center and outlet of the lake were selected to carry out the sampling of phyisco-chemical parameter of water. Aquatic macrophytes were also enumerated by fixing quadrat of 1m x 1m from inlet and outlet. Both sampling of aquatic macrophytes and lake water were taken for three months of monsoon season (first week of July, August and September). The sampling of fish community and riparian vegetation were also carried out during same period. All the sampling was done between 9 AM to 11 AM in each sampling day.

Site selection

Based on the strata and feasibility of the Bhudo Holi Lake three sites were selected for the sampling purpose i.e.,

- Inlet : This site is at the inner mouth to the west ward of the lake at an elevation of about 135m (26º40’607’’ and 88º00’638’’) having water level of nearly 1 ft. It is fed by water from old course of the adjoining Adhuwa Khola. Two different samples were taken from the two corners of inlet portion for the sampling purpose.

- Center: This is the main water body of the wetland ecosystem (26º40'536'' and 88º00'759'') where five samples were taken from the four corners and the central part of the water body for sampling purpose respectively. The depth variation was from 3ft to 9ft in this part of the wetland.
- Outlet: This site is below the dam which is boggy area (26º40'516'' and 88º00'788'') with abundant vegetation. Two samples were taken from the outlet of two corners for the sampling purpose of research.

The physico-chemical parameters like temperature, pH, transparency, DO, free carbondioxide was measured immediately on the site at the time of sampling. Parameters like alkalinity, chloride, acidity, Nitrate, Phosphate TDS, TSS, TS and hardness were done in the laboratory of Mechi Multiple Campus and laboratory of SEAM-Nepal, Biratnagar in the same day within 4 to 6 hours as per the methods described in Trivedy and Goel (1984).

Results and Discussion

Physico-chemical parameters

The pH range (6.7-7.4) of the water samples were found within the range defined by WHO guidelines of 6.5-8.5 (WHO, 2004). It indicates good, favorable and suitable conditions for the optimal survival conditions for aquatic life. In the present study water transparency values ranged from 18 to 32 cm which indicates productive nature of this water on the basis of clarity values. Free carbon dioxide plays an ambient role in photosynthesis for chlorophyll bearing organism. High average value of free carbon dioxide i.e., 21.02 mg/l than that of WHO permissible level 10mg/l (WHO, 2004) was recorded in this study. High value of free carbon dioxide in the monsoon may be due to the diffusion of carbon dioxide from atmosphere with rain water and by the decomposition of organic matter. Alkalinity represents the buffering capacity of the water. The present value of our research showed an average of 17.7 mg/l of total alkalinity which is lower than that of WHO standard i.e. 200mg/l (WHO, 2004). The lower value indicates that the lake is not eutrophic, more over it may be due to high water level in monsoon (Table 1).

Table 1. Variation of different physico-chemical parameters.

SN	Parameters	Months (2015)									Mean
		July			August			September			
		Inlet	Center	outlet	Inlet	Center	outlet	Inlet	Center	outlet	
1	Water temp. (ºC)	28	30	30	29	30	30	30	30	30	30
2	pH	6.7	7.2	6.8	6.9	7.4	7.4	6.8	7.3.	7.4	7.1
3	Total alkalinity (mg/l)	15	10	15	25	20	20	20	20	15	17.8
4	Total hardness (mg/l)	24	22	24	22	20	22	24	20	20	21.8
5	Ca hardness(mg/l)	8.8	7.2	7.2	5.6	4.8	4.0	5.6	4.8	4.0	5.7
6	Chloride (mg/l)	11	3.5	3.6	10	3.5	3.5	11	3.8	3.6	5.9
7	Free CO_2 (mg/l)	22	17.6	22	26.4	22	17.6	22	17.6	22	21.0
8	Tot. phosphorus (mg/l)	0.07	0.1	0.07	0.07	0.1	0.07	0.08	0.1	0.07	0.08
9	Nitrate (mg/l)v	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
10	Total acidity (mg/l)	7.5	7.5	7.5	12.5	15	12.5	15	17.5	15	12.2
11	Transparency (cm)	27	20	30	21	18	32	20	18	30	24
13	Dissolved solid (mg/l)	201	146	201	222	123	234	221	146	223	190.7
14	Total solid (mg/l)	423	298	414	435	250	467	452	330	435	389.3
15	Dissolved O_2 (mg/l)	6.0	5.6	5.6	6.0	6.0	5.6	6.0	5.6	5.2	5.8

Total hardness is the sum of soluble Ca and Mg salts present in water. It also includes the sulphates and chlorides of calcium and magnesium. In the present investigation the average value of total hardness was found to be 21.7 mg/l which is well below the permissible limit of WHO i.e., 80-120 mg/l (WHO, 2004). High dilution of water during monsoon season and presence of lower amount of soluble salts might be the reason behind the lower concentration of total hardness present. Chloride ranged from 3.5 to 11 mg/l with a mean value of 6 mg/l. The maximum value found in the inlet may be due to the contamination of sewage at the entrance point. Usually high concentration of chloride together with ammonia indicates sewage pollution. All the value of chloride was well below the permissible limit of WHO standards. This low value of chloride suggests, it is less likely that the water is contaminated with sewage in the wetland. Dissolved oxygen is an important aquatic parameter, whose presence is vital to aquatic fauna and flora. It plays crucial role in life processes of animals in water. In average 5.8 mg/l was the dissolved oxygen in the present result at different sites during different months. The lower value of dissolved oxygen may be due to higher rate of decomposition of organic matter during summer and rainy seasons. Total dissolved solids are simply the sum of cation and anion concentration expressed in mg/l. A high content of dissolved solid influence osmo regulation of fresh water organisms reduces solubility of gases like oxygen and result into eutrophication of the aquatic ecosystem. TDS in this lake fluctuated between 120 to 225 mg/l with average value of about 190 mg/l which suggest that the lake is not eutrophic. Phosphate has been considered as the main nutrient for the productivity of aquatic ecosystem. It occurs in both organic and inorganic form. It is the important nutrient essential to all the lentic community presents in an aquatic ecosystem (Lind, 1974).our findings revealed the lower value of the phosphate content. The lower value of phosphate might be due to rapid biological up take and the formation of water insoluble calcium carbonate. The result of nitrate was well below the permissible limit of WHO standard guidelines i.e. less than 0.05. Generally nitrate comes directly from fertilizer application or from biological oxidation of ammonia (Acharya & Rajbhandari, 2014). The low value of nitrate indicates that there is no risk for eutrophication of the lake. Low value of nitrate also supports less plankton growth. Low value may be due to the inactiveness of microbes or when decomposition rate becomes low or may also be due to the dilution of water bodies during monsoon season.

Biodiversity

The present study documented riparian vegetation with 4 species of climbers, 21 herbs, 13 shrubs, and 11 trees (Table 2).

Table 2. Plant species of Riperian vegetation in Bhudho holi wetland

S.N.	Scientific name	Nepali name	Family	Habit
1	*Schima wallichii* (D.C.) Korth.	Chilaune	Theaceae	Tree
2	*Semicarpus anacordium* L.f.	Bhayalo	Anacardiaceae	Tree
3	*Orozylum indicum* (L.) Kurz	Tatelo	Bignoniaceae	Tree
4	*Woodfordia fruticosa* (L.) Kurz	Botdhayero	Lythraceae	Tree
5	*Dillenia pentagyna* Roxb.	Gineri	Dilleniaceae	Tree
6	*Sizygium cumini* (L.) Skeels	Jamun	Myrtaceae	Tree
7	*Bauhinia purpurea* L.	Takhi	Leguminosae	Tree
8	*Careya arborea* Roxb.	Kumbi	Lecythidaceae	Tree
9	*Shorea robusta* Gaertn.	Sal	Dipterocarpaceae	Tree

10	*Azadidachta indica* A. Juss.	Neem patti	Meliaceae	Tree
11	*Alstonia scholaris* (L.) R. Br.	Chattiwan	Apocynaceae	Tree
12	*Eupatorium adenophorum* (Spreng) [I]	Banmara	Asteraceae	Shrub
13	*Antedesma diandrum* L.	Archale	Asclepiadaceae	Shrub
14	*Adhatoda vasica* L.	Asuro	Acanthaceae	Shrub
15	*Solanum surattense* L.	Bihi	Solanaceae	Shrub
16	*Datura metal* L.	Dhatura	Solanaceae	Shrub
17	*Smilax macrophyla* Blume	Kukurdaina	Smilaceae	Shrub
18	*Clerodendron viscosun* Vent.	Bhatte	Verbenaceae	Shrub
19	*Calotropis gigantea* (L.) Dryand.	Aank	Asclepiadaceae	Shrub
20	*Raodia spinosa* L.	Maidal	Rubiaceae	Shrub
21	*Colebrookea oppositifolia* Sm.	Dhusre	Lamiaceae	Shrub
22	*Solanum torvum* Sw.	Bhemsenpatti	Solanaceae	Shrub
23	*Lyonia ovalifolia* (Wall.) Drude	Angeri	Ericaceae	Shrub
24	*Lagerstromia speciosa* (L.) Pers.	Asare	Lythraceae	Shrub
25	*Commelina bengalensis* L.	Kane jhar	Commelinaceae	Herb
26	*Ageratum conyzoides* L.	Bantil	Asteraceae	Herb
27	*Acorus calamus* L.	Bhojo	Araceae	Herb
28	*Phyllanthus parvifolius* Buch.-Ham. ex D.Don	Khareto	Euphorbiaceae	Herb
29	*Lilium nepalensis* D.Don	Ban lasun	Liliaceae	Herb
30	*Saccharum officinarum* L.	Kash	Poaceae	Herb
31	*Mimosa pudica* L.	Lajawati	Leguminosae	Herb
32	*Tinosporia cordifolia* (Lour.) Mers.	Burjo	Menispermaceae	Climbers
33	*Phyllanthus niruri* L.	Bhui amala	Phyllanthaceae	Herb
34	*Dioscorea bulbifera* L.	Bhayukar	Dioscoreaceae	Herb
35	*Centella asiatica* (L.) Urban.	Ghod tappre	Apiaceae	Herb
36	*Rawolfia serpentine* (L.) Benth. ex Kurz	Sarpagandha	Apocynaceae	Herb
37	*Murraya kaenigii* (L.) Spreng.	Mitha neem	Rutaceae	Herb
38	*Lycopodium lucidulum* Michx.	Nagbeli	Lycopodiaceae	Herb
39	*Crysopogan asiculatus* L.	Kuro	Poaceae	Herb
40	*Leea aspera* L.	Galena	Leeaceae	Herb
41	*Eclipta prostrate* L.	Bhumihraj	Asteraceae	Herb
42	*Oxalis corniculata* L.	Chariamilo	Oxalidaceae	Herb
43	*Ocimum gratissimum* L.	bantulashi	Lamiaceae	Herb
44	*Cynodon dactylon* (L.) Pers.	Dhubo	Poaceae	Herb
45	*Imperata cylindrica* (L.) P. Beauv.	Siru	Poaceae	Herb
46	*Bauhinia vahlii* Wight & Arn.	Bhorlo	Leguminosae	Climber
47	*Mikania micrantha* Kunth[I]	Banmaro laharo	Apocynaceae	Climber
48	*Spatholobus parviflorus* (Roxb.)Kuntze	Debre laharo	Leguminosae	Climber
49	*Trachelosspermum lucidum* (D.Don) K. Schum.	Dudh laharo	Apocynaceae	Climber

[I]Invasive plant species

Wetlands are the natural habitats which harbors a large number of endemic wildlife species both flora and fauna. Macrophytes contribute to maintain key functions and related biodiversity in fresh water ecosystem and to provide the needs of human society. Budhoholi wetland is rich in biodiversity with unique landscape. It has Sal dominated forest along the periphery and is characterized by the presence of some high altitude species like Chilaune, *Lycopodium* etc. and some invasive plant species like Banmara, *Mikania* etc. The tree

species found here were all in the sapling stage except Sal. It can be concluded that after restoration of Bhudo Holi as park human activities were checked which favors the growth of other secondary species.

Aquatic macrophytes

Aquatic macrophytes were found less in number (Table 3). It was present only in the inlet and outlet of the wetland. Throughout the main water body i.e., the center, no aquatic macrophytes were found; it may be due to clearing of the wetland in regular interval and clearing of the dead trees from the shore line area by park management few months before our research period.

Table 3. List of macrophytes

S.N.	Scientific name	Local names	Family	Habit
50	*Cyperus rotundus* L.	Mothe	Cyperaceae	Emergent
51	*Eichornia crassipes*[I] (Mart.) Solms	Jalkumbhi	Pontederiaceae	Floating
52	*Hydrilla verticelata* (L.f.) Royle	Khasi	Hydrocharitaceae	Floating
53	*Ludwigia hyssopifolia* (G.Don) Exell	Khorsani jhar	Onagraceae	Emergent
54	*Najas graminea Delile*	-	Najadaceae	Submerged
55	*Nelumbo nucifera* Gaertn.	Kamal	Nymphaeaceae	Emergent
56	*Polygonum barbatum* L.	Pire jhar	Polygonaceae	Emergent
57	*Potamogeton natans* L.	Nil-kamal	Potamogetonaceae	Submerged
58	*Rotala rotundifolia* (Buch-Ham ex Roxb) Koehne	-	Lythraceae	Emergent

[I]Invasive plant species

Fish diversity

Fishes found in our study shows that there is decline in a number of species than reported in earlier literatures. Some larvivorous fishes dominate this wetland (Table 4). Local fishes were found only from the inlet and outlet sites but Aplochelius and Puntius species were present throughout the lake. It can be said that due to high water table of the lake and draining of the lake few months before as reported by the management committee the local species may have moved to downstream in the boggy area decreasing the number of species of fishes in the main water body of the wetland and also due to the heavy stocking of exotic species of carps for farming the local species may have been decreased and may lead to extinction in future if the trends continue.

Table 4. Wild and cultured fish species of Budho Holi wetland

Family	Zoological name	Nepali name	Remark
Wild fishes			
Mastacembelidae	*Macrognathus aculatus* (Bloch)	Gaichi	Carnivorous
Channidae	*Channa striatus* (Bloch)	Saur	Larvivorous
Channidae	*Channa gachua* (Hamilton)	Hile	Larvivorous
Nandidae	*Badis badis* (Hamilton)	-	Larvivorous
Belontidae	*Colisa fasciatus* (Bloch & Schneider)	Katare	Omnivorous
Cpprinodontidae	*Aplocheilus panchax* (Hamilton)	Tikuli	Larvivorous
Cyprinidae	*Puntius chola* (Hamilton)	Sidre	Larvivorous
Cyprinidae	*Puntius sophore* (Hamilton)	Pothi	Larvivorous
Cyprinidae	*Puntius terio* (Hamilton)	Ek thople pothi	Larvivorous
Cyprinidae	*Denio rerio* (Hamilton)	Zebra macha	Larvivorous
Cobitidae	*Lepidocephalichthys guntea* (Hamilton)	Painya	Larvivorous

Cobitidae	*Noemacheilus botia* (Hamilton)	Gadela	Carnivorous
Claridae	*Clarius batrachus* (Linneus)	Mungri	Carnivorous
Saccobranchidae	*Heteropneustes fossilis* (Bloch)	Singhi	Carnivorous
Bagaridae	*Mystus cavasius* (Hamilton)	Tengra	Planktonivorous
Belonidae	*Xenontodon cancila* (Hamilton)	Chuche bam	Carnijvorous
Anabantidae	*Anabus testudineus* (Bloch)	Kabai	Larvivorous
Amphipnoidea	*Amphipnous cuchia* (Hamilton)	Bam	Carnivorous
Cultured fishes			
Cyprinidae	*Labeo rohita(Hamilton)*	Rohu	Detritivorous
Cyprinidae	*Catla catla* (Hamilton)	Bhakur	Planktonivorous
Cyprinidae	*Cirrhinus mrigala* (Hamilton)	Naini	Planktonivorous
Cyprinidae	*Cyprinus carpio* (Linneus)	Common carp	Omnivorous
Cyprinidae	*Hypothalamichthys molitrix* (Valencinneus)	Silver carp	Planktonivorous
Cyprinidae	*Aristichthys nobilis* (Richardson)	Big head	Planktonivorous
Cyprinidae	*Ctenopharyngodon idella* (Valencinneus)	Grass carp	Herbivorous

Conclusions

Bhudo holi wetland was studied for three months period which falls in the rainy season. The present study exhibits the status of the wetland to be ecologically balanced. The vegetation around the wetland is well conserved and it's dense. The overall productivity of the wetland is low. Hence all the fishes cultured were found to be under proper growth. The water was clear and less turbid. Almost all the results of physico-chemical parameters were within the standard permissible limits.

The physical aspect of the study showed the area to have warm humid climatic condition. The chemical parameters were found to be under permissible limits. Macrophytes diversity was found to be low due to low level of nutrients as the amount of phosphate and nitrate was low. Vegetation studied around 10 m periphery of the wetland was rich in composition comprising of 21 species of herbs most of which are of medicinal importance, 13 species of shrubs , 11 species of trees dominated by hard-wood, 4 species of climbers. Fish diversity reached to 21 species which includes some ornamental fishes like zebra fish and colisa. Most of the fish species were larvivorous in nature.

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