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Impact of cultural stresses on lentic water bodies of Imphal, Manipur

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Abstract

In Manipur (longitude 93°03′E to 94°78′E and latitude 23°83′N to 25°86′N), India, lentic water bodies have served for food, nutrition and environmental security since centuries. In a study conducted on few lentic water bodies at Imphal, Manipur the biotic and abiotic variables were studied. The vegetational analysis revealed presence of 3 communities; community co-efficient, similarity indices, diversity indices, distribution pattern of vegetation were analysed. The various physico-chemical parameters of water and sediment were assessed. The study revealed that the economic activities of human beings viz. utilization of water for agriculture, domestic purposes, aqua culture including over exploitation of aquatic plants have resulted in cultural stresses affecting the characteristics of water bodies. The paper advocates for integrated management of these water bodies involving the communities.

INTRODUCTION

The aquatic habitats present a great contrast to the terrestrial habitat and the aquatic organisms display a wide range of adaptations that they continue to attract the attention of biologist even today. The studies of Mobius (1877), Forbes (1887), Gause (1934) and Odum (1957) in the aquatic ecosystem represent most important mile-stones in the development of ecology. Few important contribution from India are Kaul, Handoo and Raina (1980), Sankhla and Vyas (1982), Singh (1980), Singhal and Singh (1978), Munshi and Munshi (1996).

Manipur ((longitude 93°03′E to 94°78′E and latitude 23°83′N to 25°86′N), India (Fig 1) constitute the wet land area of 52,959 ha. And has a large number of lentic water bodies to which the local communities are traditional linked. They have sustained their livelihood for generation upon the resources from these lintic water bodies for food, nutrition and environmental security. As we know that human intervention hastens the process of degradation when resources are exploited commercially.

So, there is a need to study the lentic water bodies of local significance which may provide an important clue for managing them. Hence the present study is undertaken to assess few lentic water bodies at Imphal, Manipur.

CLIMATE

The study area has sub-tropical monsoon type of climate. The minimum temperature is 4.5°C (January) and maximum temperature is 31°C (May). The annual average being

28°C. The annual rainfall is 1488.2 mm. The ombrothermic diagram is represented in Fig. 2.

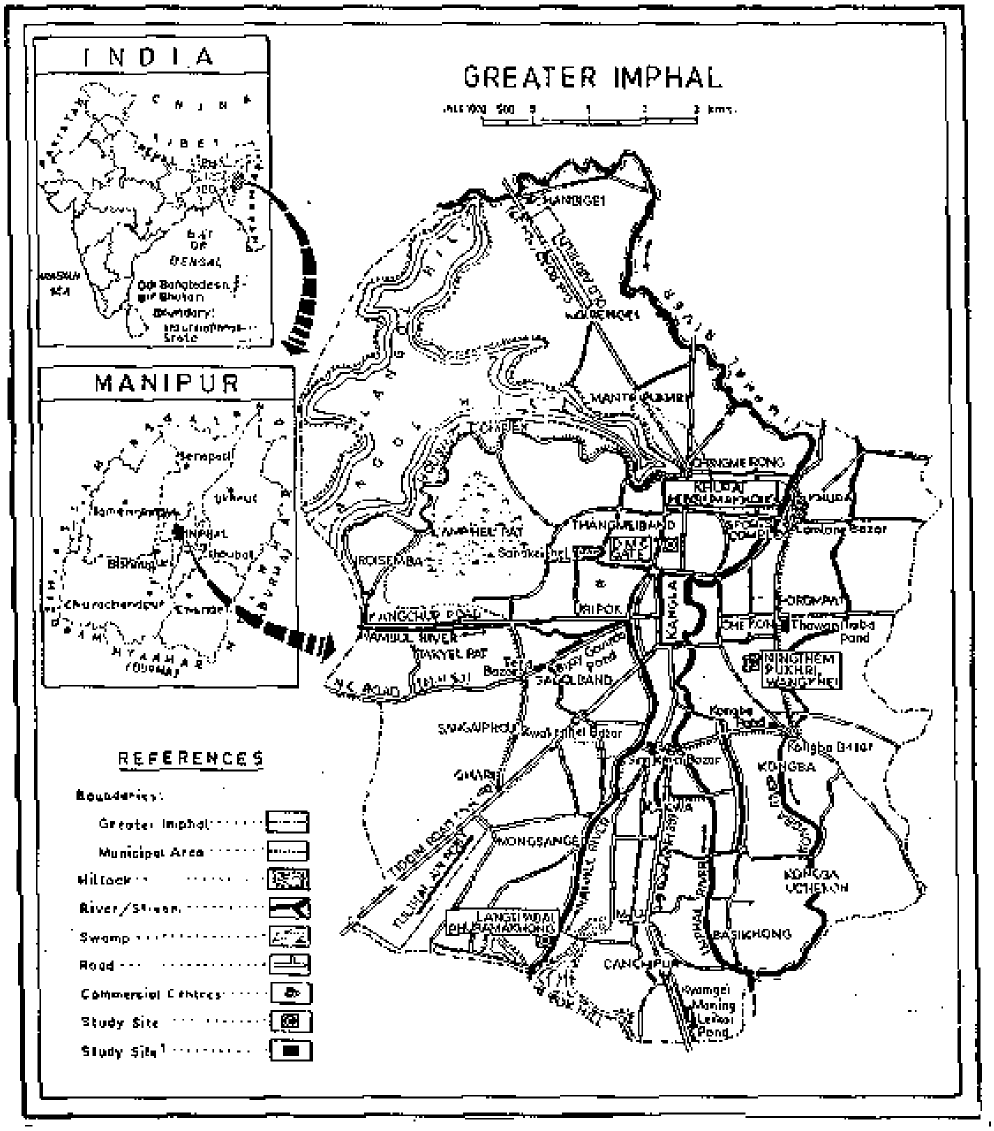

Figure 1. Location of the study sites.

SELECTION OF SITES

Four community ponds were selected from the urban and rural Imphal, capital of Manipur viz. Site-I Wangkhei Ayangpalli Thawanthaba pond, Site-II Sagolband Bijoygovinda pond, Site-II Kongba pond and Site-IV Kyamgei Maning Leikai pond. Morphometry of the sites are given in Table 1 and micro relief features of four ponds are reflected in Fig 3 (a, b, c, d). All the ponds are utilised for washing and bathing purpose except for

Site-IV which is also utilised for drinking and agricultural purposes Site-II Sagolband Bijoy Govinda Pond's history can be traced back to 1779 A.D. The Heikru Hidongba a festival of Manipur is celebrated in every year, which signifies the traditional boat race in Manipur.

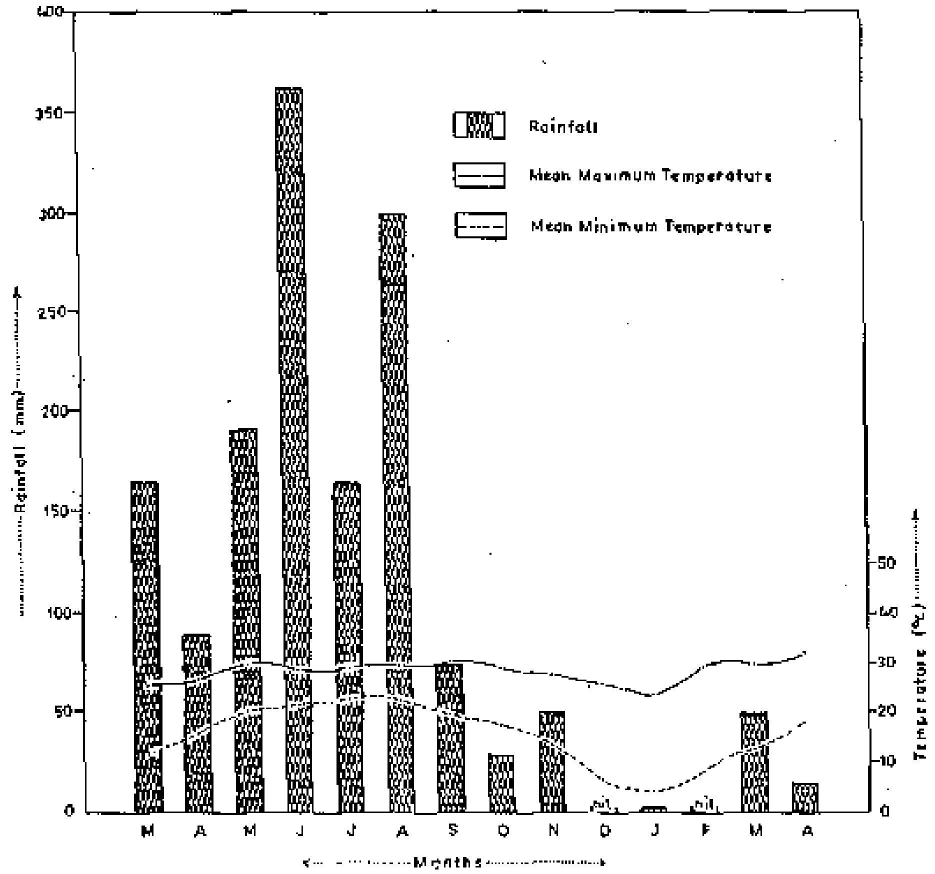

Figure 2. Ombrothermic diagram of Imphal (March 1998 to April 1999).

Table 1. Morphometry of sites.

	SITES			
	I	II	III	IV
Maximum length (m)	100	480	95	72
Maximum breadth (m)	80	20	70	20
Surface area (Sq.m)	8000	9600	6650	1440
Maximum depth (m)	2.30	3.2	2.8	1.95
Minimum depth (m)	0.53	0.68	0.81	1.2
Mean depth (m)	1.4	1.94	1.805	1.5
Mean depth/max.depth ratio	0.608	0.606	0.64	0.78
Volume of the pond (cum)	16400	26880	9975	2160
Surface area/ volume ratio	0.48	0.357	0.66	0.66

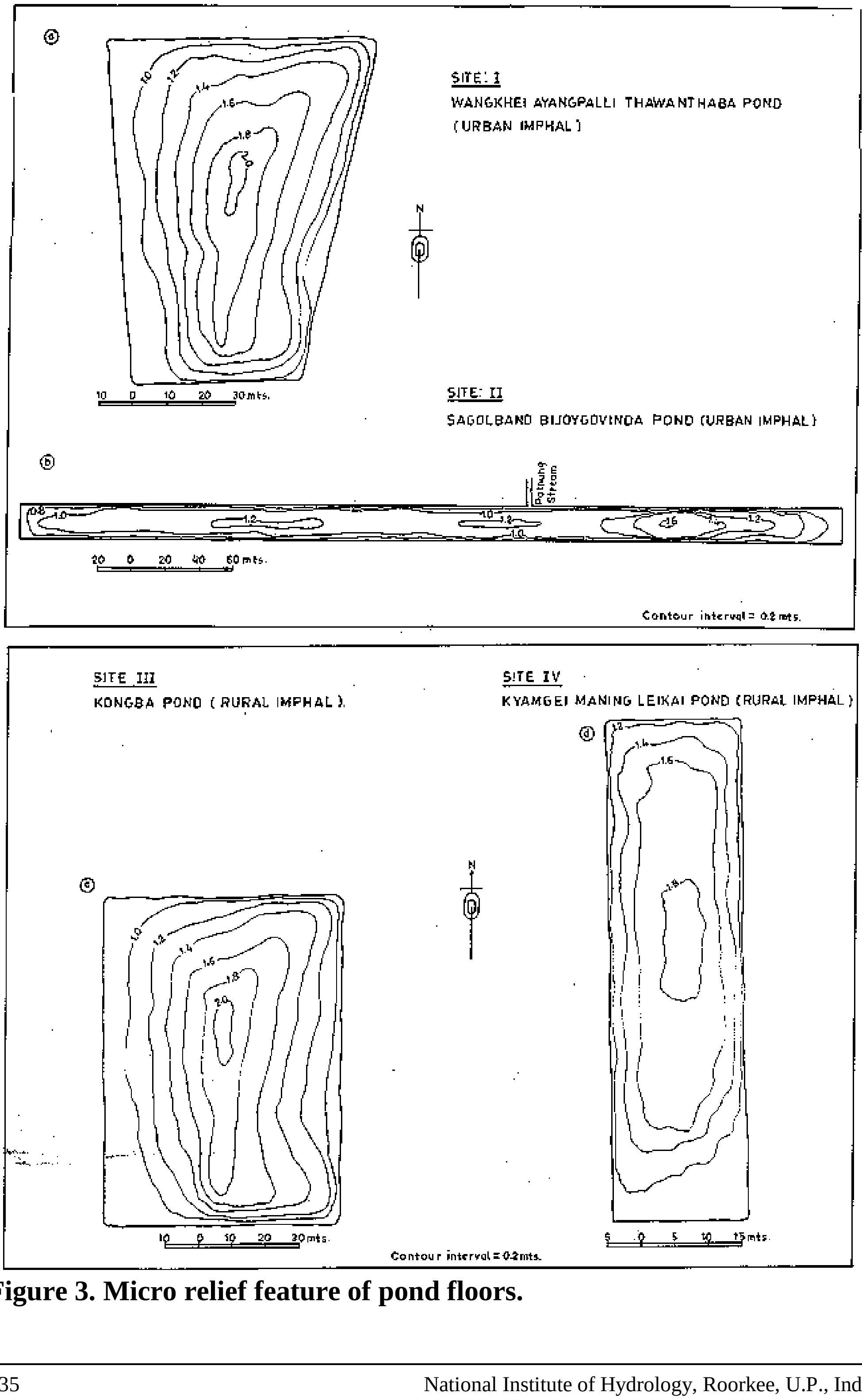

Figure 3. Micro relief feature of pond floors.

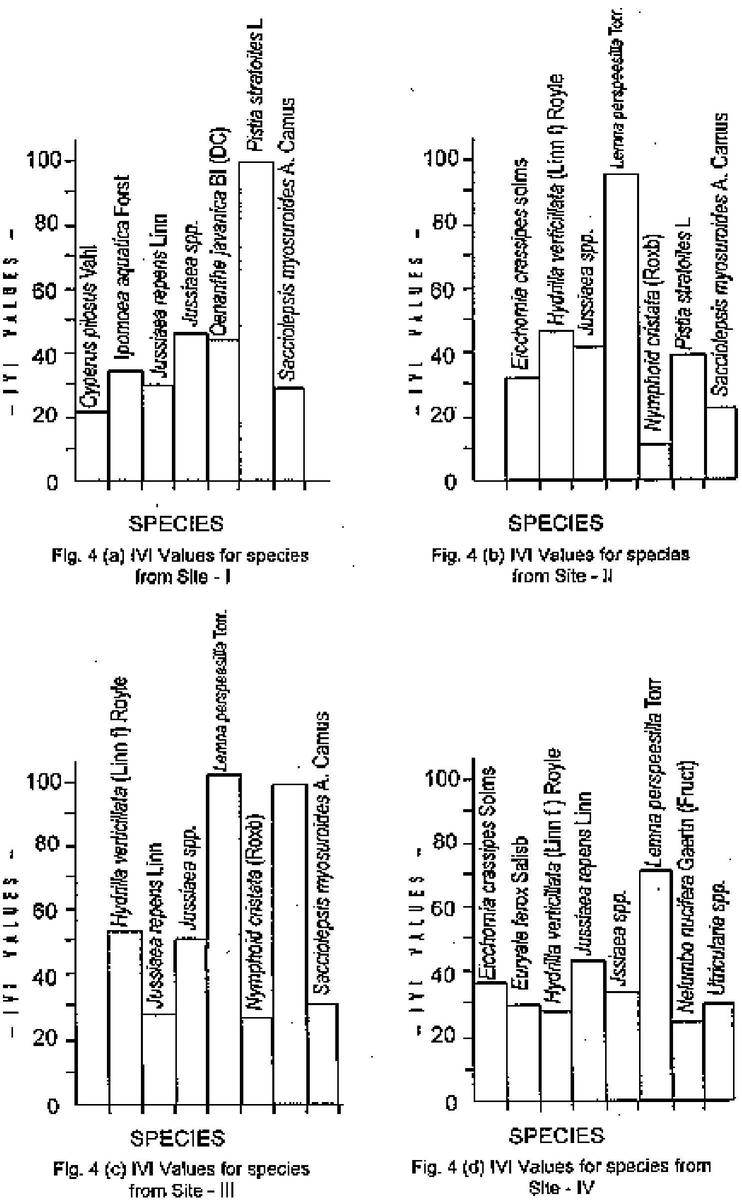

Figure 4a,b,c,d. IVI values for species from site I,II,III and IV.

MATERIAL AND METHODS

The sampling of vegetation, water and collection of sediments were done. The phytosociological characters were studied by transect method. The water and sediment parameters were analysed by following the procedures as given by APHA 1985.

RESULTS AND DISCUSSIONS

Wetlands are generally eutrophic system i.e. they are rich in nutrients which support their high growth rates. The nutrients are received primarily from the surrounding catchment with water. As usual the nutrients are absorbed by the plants for their growth and are returned to the system after their death and decay. The input and output of nutrients from the wetland vegetation ecosystem are directly related to the flow characteristics of water entering. The absorption, precipitation and accumulation in sediment is also affected by the water regime indirectly. As the structure and dynamics of vegetation provide and indication of the whole environment, hence analysis of phytosociological character, water and sediment parameters were done.

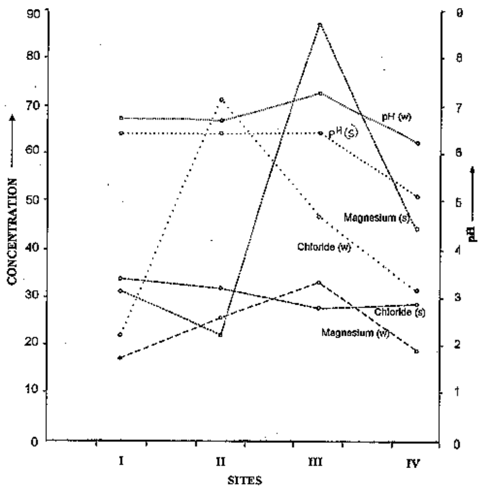

Figure 5a. Comparison of variables Magnesium, Chloride, pH for water and soil from the study sites.

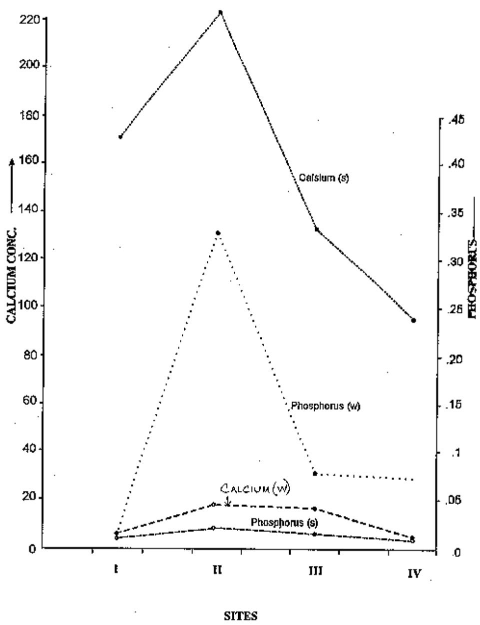

Figure 5b Comparison of variable concentration Phosphorus, calcium for water and soil from the study sites.

PHYTOSOCIOLOGICAL CHARACTERS

Maximum frequency was recorded for *Pistia stratoites* (100%) and *Jussiaea spp.* (90%) from Site-I. *Lemna perspeesilla* and *Pistia stratoites* (90% each) from Site-II and again *Lemna perspeesilla* (100%) for Site-III and IV. The values of density ranged from 0.9 to 24.1 plants per transect. The maximum abundance was contributed by *Pistia stratoites* (21.9) from Site-I and *Lemna perspeesilla* from Site-II, III and IV revealing the values of 22.33, 24.1 and 10.2.

Table 2. Similarity indices for the study sites.

SITES	II	III	IV
I	0.42 (0.58)	0.46 (0.54)	0.26 (0.74)
II	-	0.76 (0.24)	0.53 (0.47)
III	-	-	0.57 (0.43)

Table 3. Community co-efficient for the study sites.

SITES	II	III	IV
I	0.93	0.705	0.494
II	-	1.65	1.3
III	-	-	1.402

The highest IVI was recorded by Pistia stratoites at Site-I and Lemna perspeesilla in Site-II, III and IV (Fig. 4 a, b, c, d). The 3 communities of the dominant and codominant species were Pistia-Oenanthe in Site-I, Lemna-Hydrilla in Site-II and Lemna-Jussiaea in Site-III and IV. The highest value of similarity indices (0.76) was obtained between Sites (II-III) as shown in Table 2, Community co-efficient (Table 3) shows the same trend of similarity indices. Shannon index (H′) showed the highest value in Site-IV (Table 4). Distribution pattern of all species were found to be contagious.

Table 4. Richness and diversity indices of acrophytes in four study sites.

SITES	RICHNESS	DIVERSITY INDICES	
		SIMPSON'S (λ)	SHANNON'S (H′)
I	7	0.19	1.79
II	7	0.19	1.53
III	6	0.22	1.33
IV	8	0.12	2.O3

In general the macrophytes of the four ponds were categorised into 4 classes :

Submerged eg. – Hydrilla, Utricularia spp.
Rooted floating leave eg. – Nelumboo,Euryale ferox, Nymphoid cristata.
Free floating eg. – Lemna, Pistia.
Emergent eg. – Cyperus, Ipomoea, Oenanthe etc.

They occupied different niche in the different shallow water ponds. Jussiaea spp. is found at all the four sites. For comparing the communities from four sites the values of similarity indices were taken into account and the highest similarity was found among sites II and III (0.76) whereas the least similarity was reflected between sites I and IV (0.26). The same trend of community co-efficient was reflected between the study sites.

H′ reflected the species diversity of the site giving the highest value for site IV which also shows maximum richness. The minimum value of H′ is found in site III, whereas just opposite trend was noticed for Simpson's index.

Table 5. Physico-chemical characteristics of surface water samples from the four study sites.

Sl. No.	VARIABLES	SITES I	II	III	IV	RANGE
1.	Temperature (°C)	22	20.4	23	21	20.4 – 23
2.	Light penetration (cm)	17.8	56	59.5	43	17.8 – 59.5
3.	PH	6.7	6.6	7.2	6.3	6.3 – 7.2
4. *	Free CO2	5	13.2	22	11	5 – 22
5. *	Dissolved Oxygen	4.86	8.5	0.405	5.67	0.405 - 8.5
6. *	Total hardness	86	148	176	88	86 – 176
7. *	Calcium	6.41	17.23	15.6	4.8	4.8 – 17.23
8. *	Magnesium	17.04	25.56	33.35	18.5	17.04-33.35
9. *	Chloride	22.72	71	46.86	31.95	22.72 – 71
10 *	Fluoride	0.001	0.13	0.03	0.01	0.001-0.13
11 *	Phosphorus	0.16	0.65	0.15	0.14	0.14 – 0.65

* mg/l

Spatial pattern (A/F ratio > 0.05) revealed the contagious distribution pattern (Curtis and Cottam 1956) which suggested that individual are aggregated in more favourable part of the habitat which may be due to among several factors the reproductive mode of species (Pamberton and Frey 1984). Species like Pistia, Lemna, Hydrilla, Eicchornia are heavily propagating by vegetative means.

Table 6. Physico-chemical characteristics of sediments for the four study sites.

Sl. No.	PARAMETERS	SITES I	II	III	IV	RANGE
1.	PH	6.4	6.4	6.5	5.1	5.1 – 6.5
2.	Electrical conductivity (μ mhos).	26	210	31	190	26 – 210
3.	Total nitrogen (%)	16.8	14	19.6	25.5	14 – 25.5
4. *	Calcium	192.38	228.45	132.26	96.19	96.19-228.45
5. *	Magnesium	131.49	21.91	87.66	43.83	21.91-131.49
6. *	Chloride	34.08	31.24	28.4	29.82	28.4 – 34.08
7. *	Phosphorus	0.013	0.034	0.0235	0.012	0.012-0.034

*mg/g

There are some cultural stresses which are caused by the community due to their intentional or unintentional activities. These stresses result in major changes in the physical, chemical and biotic aspect of the lentic water bodies. As a result these may be unfavourable alteration in the system.

PHYSICO – CHEMICAL CHARACTERISTICS OF WATER AND SEDIMENTS

Tables 5 and 6 reveal the Physico – chemical characteristics of surface water and sediment samples from the four study sites. Temperature of surface water was found to between 20.4 °C to 23 °C and was in confirmity with the ambient air temperature. Minimum light penetration was found in site I (17.8 cm) which might be due to enhanced turbidity resulting from the commencement of rains before study and maximum in site III (59.5 cm). pH was found to be acidic in all sites except site III (7.2) which is tended to be alkaline. However more acidic condition was observed in sediments. The minimum value of DO was found in site III (0.405 mg/l) accompanied by maximum value of free CO_2 (22 mg/l). This site has recorded fish "kill" due to enhanced decomposition processes in summer, BOD may be increasing which might be responsible for quick conversion of organic matter into biogas resulting in heating up process in deoxygenated area causing fish "kill" accompanied by release of harmful and odourous chemicals. Water of the four study sites was found to be not hard (86-176 mg/l) which was supported by lower values of Calcium (4.8-17.23 mg/l) and Magnesium (17.04 to 33.35 mg/l). Calcium and Magnesium are the cations for which sediments acted as sink. Input of cations Ca & Mg mainly takes place with the import of water in the concerned site. Site II received input from the stream Patnung that resulted in the highest value of Ca in the sediment. However, the water bodies which are not receiving any input have low Ca and Mg concentration. Chloride is the commonest anion in fresh water and in our study was found in the range of (22.72 to 71 mg/l) whereas it revealed lower values in sediment (28.4 – 34.08 mg/l). Fluoride concentration in water sample was found to be low (0.001 to 0.13 mg/l). Phosphorus is an essential element for all organisms and rich phosphorus in water column (0.14 to 0.65 mg/l) was noted in all the study sites as compared to sediments (0.012 to 0.034 mg/g). In summer O_2 content comparatively gets lowered resulting in movement of phosphorus in the water column. Enrichment of phosphorus in site II might owe to enhanced addition of it with soap and detergents while bathing, washing, the input through Patnung stream, connected to the Nambul river recorded as polluted where the domestic sewage of Imphal city is dumped; also resulted in the increased value of phosphorus.

Table 7. Analysis of waste.

Sl. No.	Kinds of waste	% weight (Wet)
1.	Biodegradable (vegetable/organic)	40
2.	Paper	20
3.	Plastics	20
4.	Glass and crockery	5
5.	Metals	1
6.	Bioresistant (leather, rubber)	1
7.	Others	4

Source : Imphal Municipal Council.

The total nitrogen content in the sediment ranged between 14% to 25.5%. High nitrogen value was reported at Site IV (25.5%) with its proximity to agricultural field indicating that fertilizers applied to agro-ecosystem must be reaching with run off in the site. Highest conductivity was reflected in site II (21 μmhos), site IV which received agricultural run off also reflected high conductivity (190 μ mhos).

Table 8 recorded the ethnobotanical notes for 14 species reported from the sites indicating the dependence of community for food, fodder, nutrition, medicinal purposes including, socio-cultural linkages and resulting environmental security.

Table 8. Ethnobotanical notes.

Sl. No	Scientific Name	Local Name	Family	Classification	Ethnobotanical Notes
1	Cyperus pilosus Vahl	Napi maru	Cyperaceae	Marginal emergent	Fodder
2	Eicchornia crassipes	Kabokang	Pontederiaceae	Free floating leave emergent	Feed for poultry, forage, eraser, catching fishes
3	Euryale ferox salish	Thangjing	Nymphaeceae	Rooted floating leave	Vegetable
4	Hydrilla verticillata (Linnf) Royle	Charang	Hydrocharita-ceae	Submerged	Covering fishes & other vegeta-bles during transport
5	Ipomoea aquatica Forst	Kalamni	Convolvula-ceae	Rooted emergent	Vegetable, medicinal
6	Jussiaea repens Linn	Ishing Kundo	Oniagraceae	Rooted emergent	Vegetable
7	Jussiaea spp.	Ishing Touth-ra	Oniagraceae	Rooted emergent	Vegetable, feed for domestic livestock
8	Lemna perspeesilla Torr.	Kangmacha	Lemnaceae	Free floating	Feed for poultry, manure, medi-cinal use
9	Nymphoid cristate (Roxb)	Tharo	Nympheaceae	Rooted floating leave	Rhizomes are eaten, medicinal
10	Nelumbo nucifera Gaertn (Fruct)	Thambal	Nympheaceae	Rooted floating leave	Rhizomes & fruits are deible, leaves used for wrapping pur-posed, flowers used in religious ceremonies
11	Oenanthe javanica BI (DC)	Komprek	Umbelliferae	Rooted emergent	Vegetable
12	Pistia stratoites Linn	Kangjao	Araceae	Free floating	Feed for poultry
13	Sacciolepsis myosuroides A Camus	Hup	Poaceae	Rooted emergent	Used for fodder, shoots are used in religious ceremony
14	Utricularia spp.	Eshang	Utriculariaceae	Submerged	

CONCLUSION

On the basis of present study it is concluded that various economic activities by local community have resulted in cultural stresses on the lentic water bodies which in turn results in changes in the characteristics of biotic and abiotic variables. In our study it was observed that various activities of the local community have resulted in cultural stresses on the lentic water bodies viz. creation of fish pond on the bank, uncontrolled fishing activities, draining of water for irrigation to agricultural field, physical manipulation of sediments from the bank in order to harvest edible rhizomes of some aquatic plants, shoreline restructuring etc. For the city Imphal (29.57 sq. km. area) comprising population of 2.45 lacs the solid waste generated per head per day is 250 gm which comes to a total of 61MT of which domestic solid waste comprises 20 MT. The solid waste collected by Municipal corporation by employing 7 trucks is only of the value of 38 MT, and which reflected that 23 MT of solid waste generated per day are even not collected by Municipal corporation (Table-7). As fresh water is essential for sustainable development. It is essential to safeguard the quality of water so that it remains available for various uses. Different competing water uses from the community ponds of Imphal reflect poor water management practices at present resulting in changes in physico-chemical characteristics of water and cultural stresses on the water bodies. It is very much essential to manage the lentic water bodies in relation to the land resources, as it is observed that the agricultural run off from the Site-IV is altering the characteristics of water. Hence it is of prime importance for harmonious development of lentic water bodies which serve as important but vulnerable source of water to the community management with an integrated approach to address both scientific and societal issues at the interface of land and surface water, surface water and ground water.

Local community have understood the importance of the aquatic resources and macrophytes and have used as food (including poultry feed), fodder, medicine, wrapper etc. and ensured for them environmental security opting for sustainable harvest of resources in the past (Table-8). However in Manipur the expansion of trade and commerce relating with wetland product (Angom & Gupta 1999) have diverse impact over the status of lentic water bodies causing over-exploitation of resources. Hence proper management of living resources and the ecosystem that support them is very much necessary. The rehabilitation of degraded aquatic system has been a major limnological issue all over the world (Peter Biro 1999). Therefore it is essential that integrated management system by involving community may be followed so that further degradation of the fresh water habitats may not occurred.

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