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Research Article

ASSESSMENT OF NUTRIENT CONCENTRATION IN DOMINANT MACROPHYTIC PLANT TISSUES AND THEIR ACCUMULATION DURING PRE AND POST MONSOONS PERIODS FROM KONGBA RIVER, MANIPUR

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ABSTRACT
The present paper highlights the nutrient accumulation in dominant macrophytes during pre and post monsoon periods from Kongba River, Manipur (latitude 23.80^o N to 25.68^o N and longitude 93.03^o E to 94.78^o E) during the study period (2006-2007). The higher value of standing state (nutrient accumulation) of N, P, K of macrophytes from different sites may be mainly due to its accretion of the maximum standing crop biomass in the study period. The nutient accumulation in pre-monsoon and post-monsoon period were found in the order N>K>P. The range in shoot and root of N accumulation from five sites of Konga River among macrophytes was found to be between 549.003 to 2153.95 mg m^{-2}, 4.48 to 159.05 mg m^{-2}. Similarly, the range in shoot and root of P and K accumulation in macrophytes from Kongba River varied between 29.37 to231 mg m^{-2}, 0.3888 to 21.09 mg m^{-2} and 1.939 to 1576.30 mg m^{-2}, 2.6 to 77.95 mg m^{-2} respectively. Thus, the study revealed that macrophytes store nutrient during the growth period and release after the senescence. Also, it plays a very significant role in reducing the absorption rate of N and P in the water and thus, improving the water quality of the river. Removal of aquatic plant biomass with its accumulated nutrient is an alternative technique for reducing nutrient lower and may help the system to minimize abuses of biological and chemical effect.

Keywords: *Nutrient Accumulation, Macrophytes, Water Quality, Aquatic Plant Biomass*

INTRODUCTION
A key resource that is often limiting in aquatic systems is the availability of nutrients for macrophyte growth. In recent years, the amount of nutrients of anthropogenic origin are increasingly finding their way into water bodies worldwide, which has resulted in declines of macrophyte diversity and changes in community structure (Phillips *et al.*, 1978; Vitousek *et al.*, 1997; Bedford *et al.*, 1999; Tracy *et al.*, 2003). Some invasive species are all to increase in nutrient availability and out-compete native species that cannot respond in a similar fashion (Burke & Grime, 1996; Vitosek *et al.*, 1997; Kennedy *et al.*, 2009). Most of the existing studies of river show an increase in nutrient loading and concentration until the 80's and an ulterior stabilization or decrease due to an improvement in water management (Radach & Patsch, 2007; Littlewood & Marsh, 2005). Macrophytes are considered to be the main biological component of constructed wetlands and play an important role in wetland succession (Wu *et al.*, 2011). Helophytes mainly take up nutrients from the sediment, floating and submerged aquatic macrophytes, such as Azolla spp. or Myriophyllum spp., can also take up nutrients from the water layer (Best and Mantai, 1978; Van Kempen *et al.*, 2012). By regularly harvesting these plants, nutrients may be removed from the system. The aquatic biomass can then be used in various bio-based applications, for instance, as a bio-fertilizer or as fodder for livestock (Hauck, 1978; Biswas and Sarkar, 2013). Tang *et al.*, (2017) reported that aquatic macrophytes can be used for waste water polishing Macrophytes can be important transient storage with high nutrient turnover, and by providing quiescent conditions for the setting of seston. However, given wide range of influences upon macrophytes in rivers it is possible that, for many species, sediment characteristics are of minor importance providing macrophytes are able to anchor firmly and there are no phototoxic effects (Clarke, 2002). This preliminary analysis of the correlations between nutrient and macrophyte and between nutrient in sediment and status of rivers is complex one, partly because of the

effects of a wide range of environmental variables and partly because rooted macrophytes can absorb nutrients from the riverbed sediment and the water column (Clarke and Wharton, 2001).
The present investigation is based to understand the nutrients concentration in dominant macrophytic plant tissues and their accumulation in pre and post monsoon periods from various sites of Kongba River.

Description of the Study Sites

The present work was carried out on Kongba river of Manipur (Latitude 23.80^{0}N to 25.68^{0}N and 93.03^0 E to 94.78^0 E Longitude) which has about 120kms^2 catchment areas. It rises from Kongba Maru and it meets at Kongba Meilombi with Imphal River and finally reaches Myanmar and joins Chindwin River. Five sampling sites were selected during the study period 2006 (Nov) to 2007 (Nov) on the Kongba River viz., Site I- Khundrakpam Village, Site II-Kongpal, Site III- Kongba Bazaar, Site IV- Kongba Ucheckon and Site V- Kiyamgei (Figure 1).

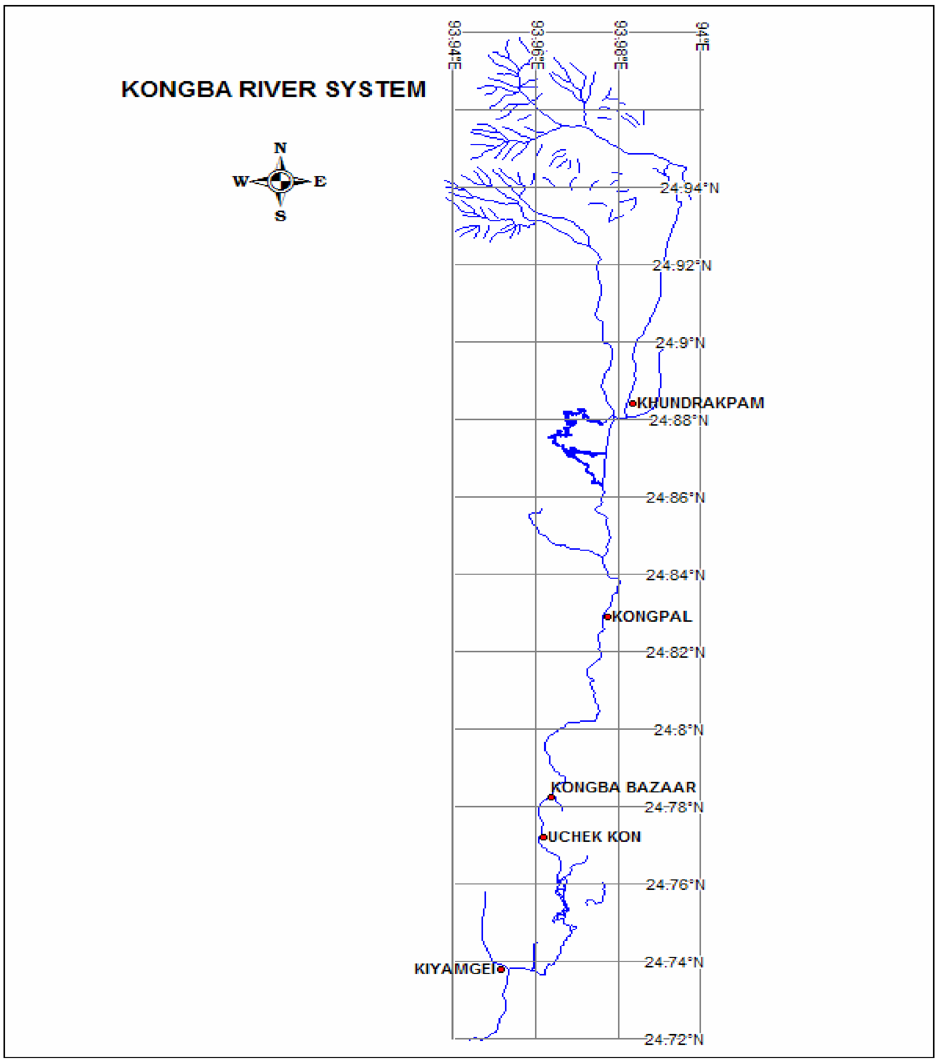


Fig 1: Location map and study area

MATERIALS AND METHODS

The concentration of the nutrients like Nitrogen (N), Phiosphorus (P), and Potassium (K) in the macrophytes were analysed periodically by using standard methods as described by Jackson (1973), Misra (1968), Wilde *et al.,* (1974). Carbon accumulation was calculated on biomass dry weight multiply by concentration of the nutrients.

RESULTS AND DISCUSSION

Nutrient concentrations of N, P and K in macrophytes from five sites of Kongba River during the pre-monsoon and post-monsoon periods are depicted in Figures 2 to 4. Nutrient concentration of Nitrogen, Phosphorous and Potassium in dominant macrophytes viz. *Polygonum lapathifolium*, *Hydrilla verticillata, Jussiaea repens, Polygonum hydropiper* were assessed from site I. The highest nutrient concentration of N in shoot was exhibited by *Hvrdilla verticillata* (2.03%) during post-monsoon period and lowest nutrient concentration was found in *Polygonum lapathifolium* (1.4%) during the post-monsoon and pre-monsoon periods respectively. In root, maximum nutrient concentration of N was found in *Jussiaea repens* (0.56%) and minimum (0.07%) was found in *Polygonum lapathifolium* during the post-monsoon and pre-monsoon periods respectively. The maximum nutrient concentration of P in shoot was contributed by *Hydrilla verticillata* (0.30%) and least concentration of P in shoot was exhibited from *Jussiaea repens* (0.17%) during the post-monsoon and pre-monsoon periods respectively. In root, highest nutrient concentration of P was recorded from *Jussiaea repens* (0.04%) and the lowest nutrient concentration of P was found in *Polygonum hydropiper* (0.001%) during the post-monsoon and pre-monsoon periods respectively.

In shoot, the highest nutrient concentration of K was found in *Hydrilla verticillata* (1.18%) and lowest was found in *Polygonum lapathifolium* (0.02%) during post-monsoon and pre-monsoon periods respectively.

In root, the maximum nutrient concentration of K was exhibited by *Jussiaea repens* (0.20%) and the minimum nutrient concentration was found in *Polygonum hydropiper* (0.02%) during post-monsoon and pre-monsoon periods respectively.

Nutrient concentration of N, P and K in dominant macrophytes viz., *Alternanthera philoxeroides, Ceratophyhllum demmersum, Monochoria hastata* and *Polygonum hydropiper* were analysed from site - II. In shoot, the maximum nutrient concentration of N was exhibited from *Ceratophyllum demersum* (2.73%) during the pre-monsoon period and the minimum was found in *Alternanthera philoxeroides* (1.6%) during the pre-monsoon period.

In root the maximum nutrient concentration of N was exhibited from *Polygonum hydropiper* (0.49%) and the minimum was found in *Monochoria hastate* (0.003%) during post-monsoon and pre-monsoon periods respectively.

The highest nutrient concentration of P in shoot was contributed by *Ceratophyllum demersum* (0.29%) during the pre-monsoon period and the lowest nutrient concentration of P in shoot was exhibited by *Polygonum hvdropiper* (0.15%) during the pre-monsoon period. The maximum nutrient concentration of P in root was found in *Alternanthera philoxeroides* (0.09%) and the lowest was found in the same species (0.002%) during the post-monsoon and pre-monsoon periods respectively.

In shoot, the highest nutrient concentration of K was found in *Ceratophyllum demersum* (1.82%) during the pre-monsoon period and the lowest was found in *Monochoria hastata* (1.20%) during the pre-monsoon period. In root, the maximum nutrient concentration of K occurred in *Monochoria hastata* (0.38%) and minimum in *Alternanthera philoxeroides* (0.22%) during post-monsoon and pre-monsoon periods respectively.

The dominant macrophytes viz., *Alternanthera philoxeroides, Jussiaea repens, Polygonum lapathifoluim* and *Pistia stratiotes* from site-III were assessed for nutrient concentration (N, P and K). In shoot, the maximum nutrient concentration of N was found in *Pistia stratiotes* (3.01%) and minimum in *Alternanthera philoxeroides* (1.68%) during the pre-monsoon periods. In roots, the maximum nutrient concentration, of N was contributed in *Pistia stratiotes* (0.42%) during pre-monsoon period and the minimum was exhibited by *Jussiaea repens* (0.003%) in the same period. The highest nutrient concentration of P in shoot was shown by *Alternanthera philoxeroides* (0.27%) during post-monsoon and lowest by *Polygonum lapathifoluim* (0.02%) during the pre-monsoon period.

The highest nutrient concentration of P in root was found in *Pistia stratiotes* (0.11%) and lowest was found in *Polygonum lapathifoliurn* (0.004%) during the pre-monsoon period. In K, the highest nutrient concentration of shoot was reflected by *Pistia stratiotes* (2.14%) and lowest by *Jussiaea repens* (1.42%)

from pre-monsoon periods. The maximum and minimum nutrient concentrations of root were contributed by *Pistia stratiotes* as 0.58% and 0.40% from pre-monsoon and post monsoon periods respectively.

The dominant macrophytes viz., *Alternanthera philoxeroides, Ceratophyllum demersum, Jussiaea repens* and *Polygonum hydropiper* from site-IV were analysed for nutrient concentration of N, P and K. In shoot, the highest concentration of N was found in *Ceratophyllum demersum* (2.80%) and the lowest in *Jussiaea repens* (2.17%) during the pre-monsoon periods.

In root, the maximum nutrient concentration of N was shown by *Polygonum hydropiper* (0.56%) by *Alternanthera philoxeroides* (0.2 1 %) in post-monsoon and pre-monsoon periods respectively. The maximum nutrient concentration of P in shoot was found in *Ceratophyllum demersum* (0.27%) and lowest in *Polygonum hydropiper* (0.15%) during the pre-monsoon periods.

The highest nutrient concentration of P in root was shown by *Jussiaea repens* (0.09%) and the lowest was reflected by *Alternanthera philoxeroides* (0.002%) during post-monsoon and the premonsoon periods respectively.

In K, the highest nutrient concentration of shoot was exhibited by *Ceratophyllum demersum* (1.88%) and lowest was reflected by *Alternanthera philoxeroide* (1.60%) during the pre-monsoon periods. The maximum nutrient concentration in root was shown by *Polygonum hydropiper* (0.018%) and lowest was exhibited by *Alternanthera philoxeroides* (0.002%) during the post-monsoon periods.

Nutrient concentration of N, P an K in dominant macrophytes viz. *Alternanthera philoxeroides, Eichhornia crassipes, Polygonum hydropiper* and *Polygonum lapathifolium* were assessed from site-V. The maximum nutrient concentration of N in shoot was found in *Eichhornia crassipes* (2.80%) and least in *Alternanthera philoxeroides* (2.03%) during postmonsoon and pre-monsoon periods respectively. The highest nutrient concentration of N in root was found in *Eichhornia crassipes* (0.98%) and lowest (0.28%) in *Alternanthera philoxeroides* during post-monsoon and pre-monsoon periods respectively. In shoot, the maximum nutrient concentration of P was exhibited by *Eichhornia crassipes* (0.33%) and least by *Alternanthera philoxeroides* (0.19%) during post-monsoon and pre-monsoon periods respectively.

In root, the highest nutrient concentration of P was reflected by *Eichhornia crassipes* (0.33%) and the lowest by *Alternanthera philoxeroides* (0.001%) during postmonsoon and pre-monsoon periods respectively.

The maximum nutrient concentration of K in shoot was found in *Eichhornia crassipes* (2.60%) and the minimum in *Alternanthera philoxeroides* (1.82%) from post-monsoon and pre-monsoon periods respectively. The highest nutrient concentration of K in root was shown by *Polygonum lapathifoluim* (0.40%) and the lowest by *Eichhornia crassipes* (0.04%) from post-monsoon and pre-monsoon periods respectively.

The nutrients accumulation (N, P, K) have been estimated in dominant macrophytes from the different study sites of Kongba River and have been given in table 1 to 6. Of the dominant macrophytes from site-I, *Polygonum lapathifolium* contributed the highest value of accumulation of Nitrogen in shoot (574 to 696.23 mg m^{-2}), of Phosphorous (82 to 117.54 mgm^{-2}) and of K (418.2 to 515.3 mg m^{-2}). In root, the maximum values of standing state (Nutrient accumulation) of N (69.93 to 109.11 mg m-2), of Phosphorus (0.499 to 6.928 mgm-2) and of K (13.32 to 27.71 mg m^{-2}) were recorded in *Jussiaea repens.* In site-II, *Monochoria hastata* exhibited the maximum value of standing state of N and K in shoots (819.39 to 1624.35 mg m^{-2} and 453.12 to 888.42 mg m^{-2}) respectively. Phosphorous was maximum in *Alternanthera philoxeroides* shoots (73.92 to 57.76 mg $m^{-2)}$.

In roots, maximum accumulation of N was exhibited by *Alternanthera philoxeroides* (4.48 to 10.75 mg m^{-2}), whereas Phosphorous and Potassium in *Polygonum hydropiper* (0.388 to 0.40 mg m^{-2}) and 2.6 to 38.88 mg m^{-2} respectively.

The dominant macrophyte species from site-III, *Pistia stratiotes* contributed the highest nutrient value of standing state in shoots of Nitrogen (549.003 to 817.72 mg m^{-2}) of Phosphorous (34.18 to 59.84 mg m^{-2}) and of Potassium (422.31 to 582.08 mg m^{-2}) and also in roots as 637 to 56.44 mg m^{-2}, 8.19 to 14.78 mg m^{-2} and 36.4 to 77.95 mg m^{-2} of Nitrogen, Phosphorous and Potassium respectively. From site-IV, the highest standing state (Nutrient accumulation) of Nitrogen in shoot was exhibited by *Alternanthera* *philoxeroides* (896 to 2153.95 mg m^{-2}), of Phosphorous in *Jussiaea repens* (29.37 to 112.32 mg m^{-2}), of Potassium in *Polygonum hydropiper* (1.939 to 2.56 mg m^{-2}). In root, the maximum value of standing state of nutrients was contributed by *Polygonum hydropiper* viz. for N (56.56 mg m^{-2}), for P (.8.544 mg m^{-2}) and for K (2.56 mg m^{-2}).

The maximum value of standing state (nutrient accumulation) of Nitrogen and Phosphorous in shoot from site-V was contributed by *Eichhornia crassipes* as 1823.08 to 1940.4 mg m^{-2} and 214.86 to 231 mg m^{-2} respectively, and of Potassium in *Alternanthera philoxeroides* as 1154.30 to 1576.30 mg m^{-2}. In root, the maximum value of standing state of Nitrogen and Phosphorous was recorded from *Eichhornia crassipes* as 139.35 to 159.05 mg m^{-2}, and 1.327 to 21.09 mg m^{-2} respectively, whereas, that of Potassium in *Polygonum lapathifolium* (36.92 to 55.17 mg m^{-2}).

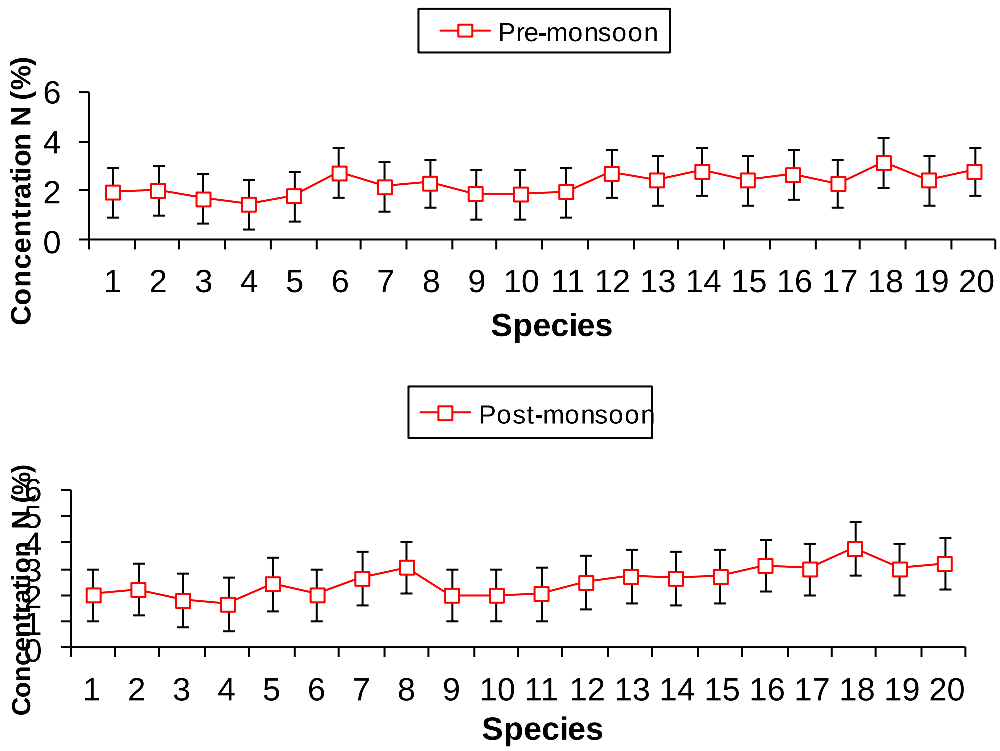


Figure 2: Concentration of Nitrogen (%) in Macrophytes from 5 Sites of Kongba River During Pre-Monsoon and Post-Monsoon Periods

	Site-I		Site-II		Site-III		Site-IV		Site-V
1	*Hydrilla verticillata*	5	*Alternanthera philoxeroides*	9	*Alternanthera philoxeroides*	13	*Alternanthera philoxeroides*	17	*Alternanthera philoxeroides*
2	*Jussiaea repens*	6	*Ceratophyllum demersum*	10	*Jussiaea repens*	14	*Ceratophyllum demersum*	18	*Eichhornia crassipes*
3	*Polygonum hydropiper*	7	*Monochoria hastate*	11	*Pistia stratiotes*	15	*Jussiaea repens*	19	*Polygonum hydropiper*
4	*Polygonum lapathifolium*	8	*Polygonum hydropiper*	12	*Polygonum lapathifolium*	16	*Polygonum hydropiper*	20	*Polygonum lapathifolium*

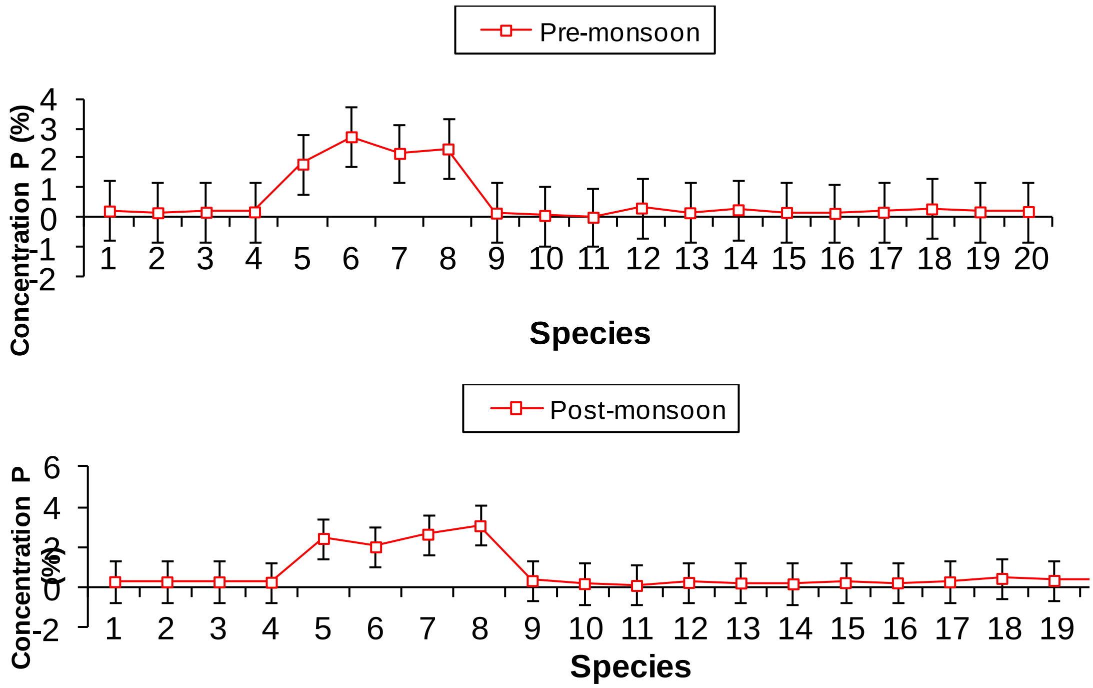
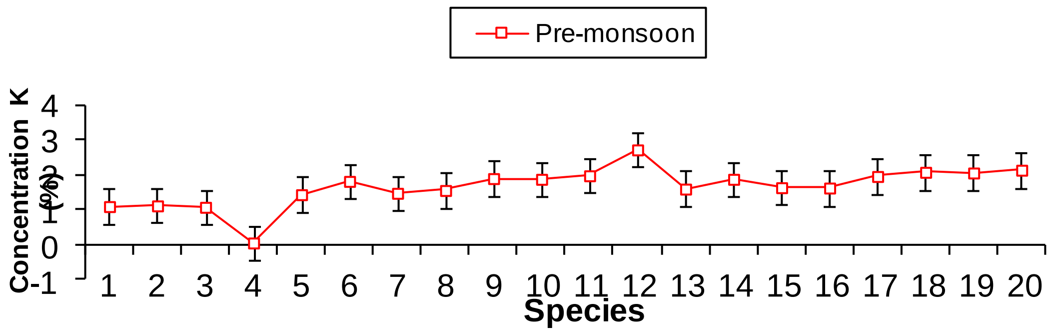


Figure 3: Concentration of Phosphorous (%) in Macrophytes from 5 Sites of Kongba River during Pre-Monsoon and Post-Monsoon Periods

	Site-I		Site-II		Site-III		Site-IV		Site-V
1	*Hydrilla verticillata*	5	*Alternanthera philoxeroides*	9	*Alternanthera philoxeroides*	13	*Alternanthera philoxeroides*	17	*Alternanthera philoxeroides*
2	*Jussiaea repens*	6	*Ceratophyllum demersum*	10	*Jussiaea repens*	14	*Ceratophyllum demersum*	18	*Eichhornia crassipes*
3	*Polygonum hydropiper*	7	*Monochoria hastate*	11	*Pistia stratiotes*	15	*Jussiaea repens*	19	*Polygonum hydropiper*
4	*Polygonum lapathifolium*	8	*Polygonum hydropiper*	12	*Polygonum lapathifolium*	16	*Polygonum hydropiper*	20	*Polygonum lapathifolium*

Table 1: Anova of N (Pre-Monsoon) for Nutrient Accumulation of the Dominant Macrophytic Species from Kongba River

Shoot:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	2574084.1	4	643521.030	7.112	2.7
Within months	1354244.1	15	90482.941		
Root:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	6739.101	4	1684.775	4.247	2.7
Within months	5950.670	15	396.711		
Total					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	2918271.000	4	729567.760	7.449	2.7
Within months	14691287.700	15	97941.911		



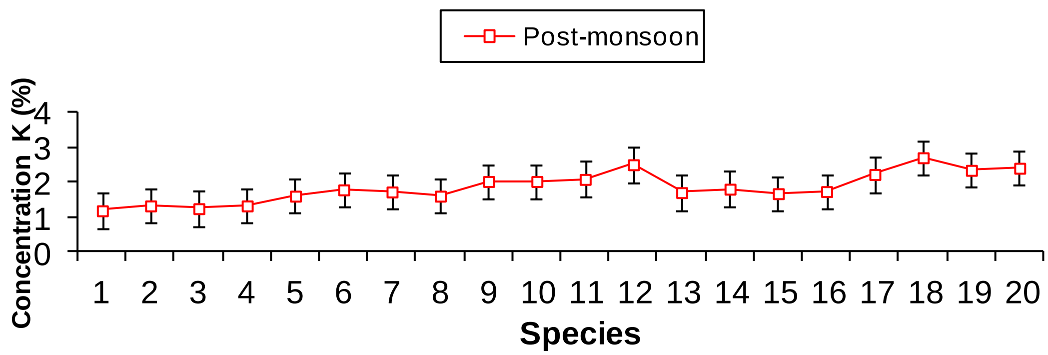


Figure 4: Concentration of Potassium (%) in Macrophytes from 5 Sites of Kongba River during Pre-Monsoon and Post-Monsoon Periods

	Site-I		Site-II		Site-III		Site-IV		Site-V
1	*Hydrilla verticillata*	5	*Alternanthera philoxeroides*	9	*Alternanthera philoxeroides*	13	*Alternanthera philoxeroides*	17	*Alternanthera philoxeroides*
2	*Jussiaea repens*	6	*Ceratophyllum demersum*	10	*Jussiaea repens*	14	*Ceratophyllum demersum*	18	*Eichhornia crassipes*
3	*Polygonum hydropiper*	7	*Monochoria hastate*	11	*Pistia stratiotes*	15	*Jussiaea repens*	19	*Polygonum hydropiper*
4	*Polygonum lapathifolium*	8	*Polygonum hydropiper*	12	*Polygonum lapathifolium*	16	*Polygonum hydropiper*	20	*Polygonum lapathifolium*

Table 2: Anova of P (Pre-Monsoon) for Nutrient Accumulation of the Dominant Macrophytic Species from Kongba River

Shoot:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	29260.431	4	7315.108	5.885	2.7
Within months	18645.321	15	1243.021		
Root:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	59.774	4	14.944	6.349	2.7
Within months	35.304	15	2.354		
Total					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	31415.431	4	7853.858	5.707	2.7
Within months	2643.899	15	1376.260		

Table 3: Anova of K (Pre-Monsoon) for Nutrient Accumulation of the Dominant Macrophytic Species from Kongba River

Shoot:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	2258044.200	4	564511.050	9.738	2.7
Within months	869532.340	15			
Root:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	6760.076	4	1690.019	6.566	2.7
Within months	3861.131	15	257.409		
Total					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	2436872.900	4	609218.217	10.061	2.7
Within months	908301.420	15	60553.428		

Table 4: Anova of N (Post-Monsoon) for Nutrient Accumulation of the Dominant Macrophytic Species from Kongba River

Shoot:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	0.030	4	0.007	4.174	2.7
Within months	0.027	15	0.002		
Root:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	7843.254	4	1960.813		2.7
Within months	8628.105	15	575.207		
Total					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	159432.000	4	387358.012	5.583	2.7
Within months	1040674	15	69378.300		

Table 5: Anova of P (Pre-Monsoon) for Nutrient Accumulation of the Dominant Macrophytic Species from Kongba River

Shoot:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	0.030	4	0.007	4.174	
Within months	0.027	15	0.002		
Root:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	0.014	4	0.004	3.286	
Within months	0.016	15	0.001		
Total					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	0.053	4	0.013	4.205	
Within months	0.047	15	0.003		

Table 6: Anova of K (Post-Monsoon) for Nutrient Accumulation of the Dominant Macrophytic Species from Kongba River

Sources of Variation	SS	df	MSS	F	P-value
Shoot:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	13380.000	4	334514.504	5.845	
Within months	858404.72	15	57226.981		
Root:					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	3149.801	4	787.450	4.217	
Within months	2800.983	15	186.732		
Total					
Sources of Variation	**SS**	**df**	**MSS**	**F**	**P-value**
Between months	1361872.000	4	34068.090	6.529	
Within months	782194.700	15	52146.316		

In the aquatic ecosystem, nutrient concentrations are continuously affected by a wide range of physical, chemical and biological processes resulting in a dynamic water quality status. Macrophytes growing in the river induce substantial changes in the river ecosystem. Tissue nutrient contents changed from upstream to downstream sites in the river. Several attempts have been made to relate the extent of nutrient uptake to concentration in the environment by measuring concentrations of nutrients in plant tissue (Royle and King, 1991, Robach *et al.*, 1996). The concentration of nutrients in the dominant macrophytes from the five study sites were found in order: shoot>root. The highest concentrations of nutrients are found in the submerged and free floating macrophytic plants than the emergent plants. The nutrient concentration differed slightly for Nitrogen, Phosphorous and Potassium in different plants components i.e. shoot and root in different macrophytic species. In the Kongba River, nutrient in the plant tissue was highest in aquatic plants growing in downstream sites than in those of growing upstream. High tissue nutrients were measured in sites having nutrient-rich environment. The higher value of standing state of N, P, K of macrophytes from different sites may be mainly due to accretion of the maximum standing crop biomass in the study period. Nutrient content depends upon absorption capacity of particular nutrient. In the present work nutrient concentration in shoot and root followed the trend as N>P>K sequence in all the five sites. In site-I Nutrient concentration (N, P and K) of root and shoot of the dominant macrophytes viz. *Jussiaea repens, Polygonum lapathifolium* and *Polygonum hydropiper* were found to be highest in post-monsoon period. The shoot and root of free floating species i.e. *Eichhornia crassipes* are found to have the highest concentration among the emergent species except the concentration of K that was noted in roots of *Jussiaea repens.* The probable reason for the occurrence of more nutrient concentration during the post-monsoon period which happens to be the flowering and fruiting period in winter and it might be also due to the luxuriant uptake of nutrient (Reddy & Tucker, 1983; Vymazal, 2005; Vymazal, 2007; Wu *et al.*, 2011). In site-II, the nutrient concentration (N, P and K) in dominant macrophytes viz. *Alternanthera philoxeroides, Ceratophyllum demersum, Monochoria hastata* and *Polygonum hydropiper* varied considerably during the study period. Nutrient concentration of N, P and K was found to be highest in submerged species i.e. *Ceratophyllum demersum* during the pre-monsoon that may be attributed to its prolific growth whereas emergent species viz. *Allernanthera philoxeroides, Monochoria hastata* and *Polygonum hydropiper* were found to have maximum concentration in post-monsoon period. In site-III, the nutrient concentration N, P and K in emergent species i.e. *Altenranthera hydropiper* was found to have highest concentration in postmonsoon period, whereas free floating species viz. *Pistia stratiotes* had maximum concentration in pre-monsoon period which might be due to its flowering and fruiting period in pre-monsoon period. In site-IV, N, P and K concentration was highest in *Ceratophyllum demersum* in pre-monsoon period which was the period for flowering and fruiting while the emergent macrophytes were found to have high concentration in post-monsoon period (Khan and Shah Manzoor, 2010). When the plants are young generally the nutrient content are found to be low. In site-V, the dominant macrophytes viz. *Alternanthera philoxeroides, Eichhornia crassipes, Polygonum hydropiper* and *Polygonum lapathifolium* were assessed for N, P and K. The macrophytic species viz. *Alternanthera philoxeroides, Eichhornia crassipes, Polygonum hydropiper* and *Polygonum lapathifolium* were found to have highest concentration in post-monsoon period for N, P and K. The free floating species i.e. *Eichhornia crassipes* are found to be highest in N, P and K concentration than the emergent species like Alternanthera *philoxeroides*, *Polygonum hydropiper* and *Polygonum lapathifolium.* The high concentration of these elements (N, P and K) in *Eichhornia crassipes* reduced the absorption rate of N and P in the water (Petrucio and Esteves, 2000). It was concluded that aquatic macrophytes can be effectively used in reducing the N and P levels of nutrient enriched waters and can play a very significant role in removing N and P from water and improve the water quality of river. Soils and sediments are often the primary source of nutrients (other than $_{CO2)}$ for rooted macrophytic vegetation, from which by subsequent decay a nutrient pump, can operate from sediment to water as illustrated in relation to macrophytes stands of Africa by Howard-William and Lenton (1975) and in Denny (1985), analysis of floating tropical macrophytes have particular relevance in relation to water-borne nutrient supply and uptake as demonstrated by invasive water fern *Salvinia molesta* in a series of freshwaters from Papua New Guinea to Northern Australia (Room and Thomas, 1986, a, b). Low nitrogen content was often linked to reduced growth rates, expressed seasonally or latitudinally. Stocks of nutrients in biomass per unit area can be particularly large in floating papyrus mats, floating grasses and in rooted reedswamps. The chemical composition study of tropical macrophytes has received considerable attention in four regions: East Africa (Gaudet 1975, 1977b) Central Southern Africa (Howard –Williams 1972, 1979 a; Howard Williams and Lenton, 1975; Ittis and Limcolle, 1983), Amazonia (Junk, 1970; Howard- Williams and Junk, 1976; Junk and Howard –Williams, 1984; Junk and Furch, 1991; Furch and Junk, 1992; Piedade *et al.*, 1997) and Southern Brajil (Esteves and Barbieri, 1983; Barbieri and Esteves, 1991). Piedade *et al.*, (1997) also referred to the issues of macrophyte nutrient interception and release in Amazonia. It is perhaps not generally appreciated that these plant stocks contain potassium in similar quantities (often about 1-4% dry weight) to nitrogen. Work on floating macrophytes, especially *Salvinia molesta* in Papua New Guinea and Northern Australia (Room and Thomas, 1986a), support this view. There is also conclusive evidence for N-limitation of *Eichhornia crassipes*, in the subtropical Parana flood plain (Carignan *et al.*, 1994). According to Carr (2002), macrophytes increased linearly with increasing sediment P concentration in the artificial streams, and tissue P concentration peaked at 400μg g^{-1}. Biomass did not respond to increasing sediment N concentration, and only a weak relationship was observed between tissue N and sediment N, with maximum tissue N corresponding to ≈140 μg sediment exchangeable N. Accumulation of nutrients in tissue depends upon the absorption rates in various macrophytes from both the water and sediment. However, Carpenter and Lodge (1986) proposed that sediments are the main source of both prosphous and nitrogen in Pampean streams. Water has been found to be the main source of nutrient in Egeria deasa (Feizzo *et al.*, 2002). The study reveals the mechanism for the uptake and retention where more efficient for P than for N in F. densa. Pelton *et al.*, (1998), contended that the water may be a main source of' Phosphorous in lotic environment. Phosphorous concentration is generally higher in flowing than in quiescent waters, sediments are aerobic and diffusive boundary levels around plant shoots are thinner. Water was found to be the main source of P in Potamegeton species and *Vallisneria americana* (Pelton *et al.*, 1998, Carigan, 1982).The source of N may be sediment or water in *Myriophyllum* species (Best and Mantai, 1978, Wersal and Madsun, 2011).

The accumulations of various nutrients in different species were assessed separately for pre-monsoon and post-monsoon periods.

The accumulation value varied considerably in different species and for all the nutrients the maximum accumulation of' nitrogen was revealed in *Alternanthera philoxeroides* during post-monsoon period at site IV. The nutrient accumulation in various species in shoots and root part varied in pre-monsoon and post-monsoon periods.

In order to understand the relation between macrophytes and stream nutrients, Statistics was applied to establish the spatial and temporal variability in macrophytes and its link to water column and to specify the nutrients in sediment, water and macrophyte species (Accumulation/concentration). The efficiency of macrophyte harvesting as eutrophication counted strategy depends upon on the water column of the plants (Biomass, morphology and reproductive strategy), nutrient concentration flowing / still water, mineralization and on sediment type. Macrophytes store nutrient during the growth period and release after the senescence. Removal of aquatic plant biomass with its accumulated nutrient is an alternative technique for reducing nutrient lower and may help the system to minimize abuses of biological and chemical effect.

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