World Wide Journal of Multidisciplinary Research and Development

WWJMRD 2017; 3(7): 376-380
www.wwjmrd.com
Impact Factor MJIF: 4.25
e-ISSN: 2454-6615

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Effect of edaphic factors and chemical properties of water on floristic composition in Kalipoika and Kudilthodu wetlands of Kozhikode district, Kerala, India

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Abstract
The present study on selected wet lands of Kozhikode district reveals that, Kalipoika wetland area was very peculiar with several macrophytes, *Acrostichum aureum* L. was found as the dominant species of the area, similarly in Kudilthodu wetland also dominated with the species like *Acanthus ilicifolius* L. The water pH was alkaline in Kalipoika wetland area (9.60) and almost neutral pH (6.92) was observed in Kudilthodu wetland area. There was much difference in term of dissolved solids (625.0mg/l and 4380 mg/l), Chloride (189.89mg/l and 2136.08mg/l), Sulphate (12.72 mg/l and 9.4 mg/l) and Magnesium (4.77mg/l and 104.84 mg/l) between Kalipoika and Kudilthodu wet land areas. Soil in Kalipoika wetland area was found to be less acidic (4.6) than Kudilthodu wetland area (4.3). Variations were also observed in terms of quantity of Carbon (3.1 & 5.8 %), Sulphur (0.9 & 0.7 %), Phosphorus (17.6 & 177 kg/ha) and Potassium (38.0 and 95 kg/ha). The present observation also highlights the direct influence of various factors in wet land ecosystem determines floristic composition and its distribution.

Keywords: Edaphic factors, Flora, Wetlands, Kozhikode, Kerala

Introduction
Wetlands, often referred to as the "kidneys" of the earth are ecotones that occupy an intermediate position between dry land and open water. Wetlands show characteristics of both terrestrial and aquatic ecosystems and properties that are uniquely of their own. Wetlands support variety of organisms and deliver many ecological, climatic and societal functions [1].

Wetland systems provides goods and services to the people. They helps to check floods and prevent the coastal erosion. They store water for long periods. Wetlands preserve water quality and increase biological productivity for both aquatic life as well as human communities of the region [2]. Inundated wetlands are very effective in storing rainwater and are the primary source for recharging ground water covers. More over wetlands may have provided a green barrier to protect coastlines and the coastal communities that live there. There were reports from around the Indian ocean region in which the damaging impact of the *Tsunami* was reduced behind mangrove stands and coral reefs [3, 4].

Wetlands also provide food and shelter for mammals. They act as natural filters and help remove a wide range of pollutants from water, including harmful viruses from sewage and heavy metals from industries. Moreover mangrove forests are valued for production of fish and shell-fish, live-stock fodder, fuel and building materials, local medicine, honey and bees-wax etc., part from that, they also provides durable timber, fuel wood, and protein rich fodder for cattle etc. [5, 6].

Materials and methods
Sampling sites of the present study
Both plants, soil samples and water were collected from Kalipoikka and Kudilthodu wetland areas of Kozhikode district, Kerala

Kalipoika wetland area: It **is** one of the prominent wet land area in Kozhikode district, it consist of wetlands associated with mangrove plants, in which they offer habitats for many organisms especially birds. This area is a protected place to conserve mangrove species and other floristic and faunastic elements (Fig.1)

Fig. 1: Kalipoika wetland area with dominant distribution of *Acrostichum aureum* L.

Kudilthodu wetland area - It is an another well-known wet land area in Kozhikode district, This also serve as habitats for various flora and fauna (Fig.2).

Fig. 2: Kudilthodu wetland area with dominant distribution of *Acanthus ilicifolius* L.

Soil analysis

Soil samples were collected from each site from a rooting depth of 10 cm in polythene bags and brought to the laboratory. The soils were air-dried, crushed before analysis. The soil analysis was completed within one week after collection. Macronutrients (C, N, S, P, and K) and micronutrients (Zn, Fe, Cu and Mn) were determined by standard methods [7]. The present soil analysis was performed at department of Soil Science and Sustainable Forest Management division, Kerala Forest Research Institute, Peechi, Thrissur, Kerala

Analysis of chemical parameters of water

The quality of water in wetland areas were analysed to characterize it with major components and physico - chemical characteristics. The physical and chemical properties of a water body are also depends the climatic, geochemical, geomorphological and pollution conditions which are prevailing in the area. Water samples were collected in a sampling bottle avoiding floating materials. The stoppers of the sample containers were closed properly to prevent outside contamination. Then they are labelled properly with following informations such as name of the water bodies, date, time, and locality. The present water analysis was performed at Water quality division, Centre for Water Resources Development and Management (CWRDM), Kunnamangalam, Kozhikode, Kerala.

Analysis of Floristic Composition

Sample plots of size of 100 m^2 were selected to cover the wetland area and floristic composition of each plot was studied and recorded, the collected specimens were identified properly with the help of Floras and literature for documentation.

Results and Discussion

Floristic composition

The present study reveals that, Kalipoika wetland area was very peculiar with several macrophytes like *Acrostichum*

aureum L. (Pteridaceae), *Derris trifoliata* Lour. (Fabaceae), *Premna serratifolia* L. (Verbenaceae), *Sauropus bacciformis* L. (Euphorbiaceae) and *Ipomoea sp.* (Convolvulaceae). Among these *Acrostichum aureum* L. was found as the dominant species of the area (28 Nos.), followed by *Derris trifoliata* Lour. (13 Nos.) (Table 1).

Table 1: Floristic composition of Kalipoika wetland with respect to the no. of species

Sl. No.	Botnical Name	Family	No. of plants
1.	*Acrostichum aureum* L.	Pteridaceae	28
2.	*Derris trifoliata* Lour.	Fabaceae	13
3.	*Premna serratifolia* L.	Verbenaceae	03
4.	*Sauropus bacciformis* L.	Euphorbiaceae	02
5.	*Ipomoea cairica* (L.) Sweet	Convolvulaceae	08

Similarly in Kudilthodu wetland also having macrophytes like *Acanthus ilicifolius* L.(Acanthaceae), *Acrostichum aureum* L. (Pteridaceae), *Bruguiera cylindrica* (L.) Blume (Rhizophoraceae), *Carallia brachiata* (Lour) Merr. (Rhizophoraceae), *Cerbera odollam* Gaertn. (Apocynaceae) and *Derris trifoliata* Lour. (Fabaceae). Out of these, *Acanthus ilicifolius* L. is the dominant species of the area (110 Nos.), followed by *Acrostichum aureum* L. (38 Nos.), *Bruguiera cylindrica* (L.) Blume (18 Nos.), and *Carallia brachiata* (Lour) Merr. (15 Nos.) (Table 2). *Acanthus ilicifolius* L.(Acanthaceae) has received considerable attention due to its wide range of secondary metabolites and its traditional usage in Indian system of medicine.

The dominance of *Acrostichum aureum* L (Pteridaceae) at Kalipoika wetland area and *Acanthus ilicifolius* L (Acanthaceae), at Kudilthodu wetland area may be due to the qualitative and quantitative variations in the soil and water quality parameters. When compared to Kalipoika wetland, Kudilthodu wetland area was found in a state of degradation due to various human anthropogenic activities.

Table 2: Floristic composition of Kudilthodu Wetland with respect to the no. of species

Sl. No.	Botnical Name	Family	No. of plants
1.	*Acanthus ilicifolius* L.	Acanthaceae	110
2.	*Acrostichum aureum* L.	Pteridaceae	38
3.	*Bruguiera cylindrica* (L.) Blume	Rhizophoraceae	18
4.	*Carallia brachiata* (Lour) Merr.	Rhizophoraceae	15
5.	*Cerbera odollam* Gaertn.	Apocynaceae	05
6.	*Derris trifoliata* Lour.	Fabaceae	36

Hydrological characters

Quality of water was found as an important factor in determining floristic composition in wetlands. Factors affecting water quality in wetlands includes type of soil, vegetation, topography, water quantity, climate, groundwater and surface water chemistry. The result of the water quality analysis of these two important wetland areas is given in **Table 3**.

Total hardness

Sum of calcium and magnesium concentrations is regarded as total hardness of the area, both expressed as $CaCO_3$ in mg/L. Hardness is predominantly caused by divalent cations such as calcium, magnesium, alkaline earth metal such as iron, manganese, strontium, etc.

Calcium hardness

Calcium is an important macro-nutrient and it contributes to the total hardness of water and in aquatic environment. The presence of calcium in water results from passage through or over deposits of limestone, dolomite, gypsum and such other calcium bearing rocks.

Magnesium hardness

All natural waters generally contain Magnesium and its source lies in rocks, generally present in lower concentration than calcium. Magnesium also an important element contributing to hardness of water and a necessary constituent of chlorophyll.

Sulphates

Sulphur is soluble in water, it imparts hardness with other cations. Sulphates are found in all natural waters, particularly those with high salt content. Industrial pollution, domestic sewage and biological oxidation of reduced sulphur species add to sulphate content.

Chlorides

Chlorine is the major form of inorganic anions in water for aquatic life. The presence of chlorides in natural waters can mainly be attributed to dissolution of salt deposits in the form of ions (Cl^-). Otherwise, high concentrations may indicate pollution by sewage, industrial wastes, intrusion of seawater or other saline water.

Water pH was alkaline in Kalipoika wetland area (9.60) and almost neutral pH (6.92)was observed in Kudilthodu wetland area. There was much difference in term of dissolved solids (625.0mg/l and 4380 mg/l), Chloride (189.89mg/l and 2136.08mg/l), Sulphate (12.72 mg/l and 9.4 mg/l) and Magnesium (4.77mg/l and 104.84 mg/l) between Kalipoika and Kudilthodu wet land areas.

Table 3: Water quality analysis of selected wetlands of the Kozhikode district, Kerala

Sl. No.	Parameters	Test Method	Sample taken from Kalipoika wetland area	Sample taken from Kudilthodu wetland area
1.	pH	APHA, 2012	9.60	6.92
2.	Colour, Hazen	APHA, 2012	5.0	60.0
3.	Turbidity, NTU	APHA, 2012	7.0	90.0
4.	Total Dissolved solids (mg/l)	APHA, 2012	625.0	4380.0
5.	Total hardness (mg/l)	APHA, 2012	90.21	588.0

6.	Total Alkalinity, (mg/l)	APHA, 2012	72.0	432.0
7.	Chloride (mg/l)	APHA, 2012	189.89	2136.08
8.	Sulphate (mg/l)	APHA, 2012	12.72	9.40
9.	Calcium (mg/l)	APHA, 2012		62.75
10.	Magnesium (mg/l)	APHA, 2012		104.84
11.	Iron (mg/l)	APHA, 2012		238.60

Soil characteristics

Soil is a mixture of mineral elements, soil air, soil water and soil organic matter and is an independent body (soil type) having specific properties and morphological characteristics that can be used to differentiate it from adjacent soil types. The properties and characteristics of each soil type are influenced by climate, parent material, time and living organisms. The key soil properties of wetland soils include horizonation, organic matter content, texture, permeability, drainage, and color. These properties and associated morphological characteristics are unique to each soil type. The details of the soil analysis report taken from these wetland areas are given in Table 4.

Soil Ph –Soil pH is an indicator of the soil's acidity which is a primary factor controlling nutrient availability, microbial processes, and plant growth. A pH of 7.0 is neutral, less than 7.0 is acidic, and greater than 7.0 is alkaline. Maintaining proper soil pH is one of the most important aspects of soil fertility management. Most plants grow best with a soil pH between 6 (somewhat acidic) and 7.5 (slightly alkaline).

Micronutrients – Elements required in trace quantities are called micronutrients. Iron, manganese, zinc, and copper are the microelements tested routinely. Micronutrient availability influences distribution of plant species in the area.

Carbon – Availability of soil organic carbon is an important factor which influences distribution plant species in the area. Soil organic carbon releases nutrients for plant growth, promotes the structure, biological and physical health of soil, and is a buffer against harmful substances.

Nitrogen - Nitrogen is the element which is commonly found deficient in soils. Nitrogen is the most abundant micro element in plants and is an important constituent of proteins, amino acids or amino sugars etc.

Sulfur – Sulfur is a structural constituent of several enzymes, proteins, vitamins etc. Plants obtain nitrogen from soil in the form of inorganic ions.

Potassium – Pottassium is an important critical element for plants. It is involved in opening and closing of stomata, turgidity of cells etc. Potassium also activates some enzymes.

Phosphorus –Phosphorus is a constituent of ATP, plasma membrane etc. It is also involved in all phophorylation reactions.

Soil in Kalipoika wetland area was found to be less acidic (4.6) than Kudilthodu wetland area (4.3). Variations were also observed in terms of quantity of Carbon (3.1 & 5.8 %), Sulphur (0.9 & 0.7 %), Phosphorus (17.6 & 177 kg/ha) and Potassium (38.0 and 95 kg/ha).

Various abiotic and biotic factors influence floristic composition of wetland areas. Unfortunately, relatively little research has been directed towards analysis of soil and water parameters in comparison with plant diversity and dominance. The wetlands of Kerala are rich in floristic diversity. There were only few studies on the ecological and life history requirements of many species. The present study was an attempt towards exploring the floristic wealth of wetlands in comparison with the soil and water quality parameters.

Table 4: Soil parameters of selected wetlands of the Kozhikode district, Kerala

Locality	pH	Total carbon (%)	Total nitrogen (%)	Total sulphur (%)	Available Phosphorous (kg/ ha)	Available potassium (kg/ ha)	Micronutrients			
							Zn	Fe	Cu	Mn
Locality	**pH**									
Sample taken from Kalipoika wetland area	4.6	3.1	1.4	0.9	17.6	38.0	0.6	2.9	0.5	4.6
Sample taken from Kudilthodu wetland area	4.3	5.8	1.5	0.7	177.0	95.0	4.7	5.2	1.0	2.6

Conclusion

Wetlands are one of the most threatened ecosystems in the world. Wetland ecosystems are the most affected ones throughout the coastal reaches of Kerala from south to north. Loss of the world's wetlands poses an increasing problem because it may result in extinction of specific species perhaps irreversibly, when natural wetland is transformed or degraded. Services offered by many wetland systems to human society are extremely important. Although difficult to estimate, the total ecosystem services of wetlands may be particularly significant, as wetland comprises a diverse range of marine, coastal, estuarine and freshwater habitats. There is a great need for inventorying the aquatic and wetland taxa in Kerala, especially in the face of the widespread habitat destruction and pollution that is taking place.

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