

Pollution Status of Ashtamudi Lake, Kerala, India and Its Impact on Some Key Stone Mangrove Species - A Case Study

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Abstract: The 'Ashtamudi' as the name implies is a lake with eight prominent arms and is one of the largest wetland ecosystems in Kerala, flourished with immense life varieties. *Sonneratia alba* (Mangrove apple), *Acanthus ilicifolius* (Sea Holly, Shore purslane), etc are a few numbered species that are recently reported as significant phyto-chemical storage apart from their conventional utility as a mangrove. Percentage of foliage cover by these two species was observed for the year 2010-11 and 2014-15. The study report in the year 2014-15, the cumulative foliage cover by these two species fall to 72% (49% and 23% respectively) from 81% in the year 2010-11 (57% and 24% respectively). An overlap of both the species were also found by about 8% in the year 2010-11 and it remains the same for the year 2014-15. The water samples collected from the 20 different zones of the lake in the year 2010-11 represents half of polluted and the another half as of unpolluted, The study was repeated by analysing the water quality by Winkler's method for the estimation of dissolved oxygen from the same representative zones as do above the pollution status was found encroaching three more other areas and leaves only seven unpolluted zones. It was also noted that the least amount of dissolved oxygen reported was 0.6ppm (2014-15) in the place of 0.8ppm (2010-11) clearly questioning the existence of life and its possible impact on biodiversity. Meanwhile a better status (3.2ppm) for the unpolluted water was reported that is on par with the status reported in 2010-11 (3.16ppm)

Keywords: Ashtamudi lake, Pollution, Mangrove.

1. INTRODUCTION

Mangrove forests are particularly found in tropical and subtropical regions within 30° of the equator. These tidal areas, such as estuaries and marine shorelines, are frequently inundated with salt water. Strongly in decline, mangrove forests occupy about 15.2 million hectares of tropical coast worldwide: across Africa, Australia, Asia and America (Spalding *et al.* 2010). They are fragile complex and dynamic ecosystem. The importances of mangroves are innumerable and the habitats formed in those areas are extremely isolated with a unique texture. The faunal aspects in these areas are specific to mangrove ecosystem.

Kerala is well known for brackish water systems, once mangroves were really a part of it and now facing the verge of extinction. Not only the mangroves but also thousands of unique and mutually related faunal aspects may also perish in the nearby feature if not conserved properly. (Ananda Rao *et al.*, 1998) The 'Ashtamudi' is one of the largest wetland ecosystems in Kerala. This estuarine system lies in Kollam district and is the second largest wet land of the state. It is a palm shaped extensive water body with eight prominent arms, adjoining the Kollam Town. The arms converge into a single outlet at Neendakara, to enter the Lakshadweep Sea. This estuary is the deepest among all the estuaries of Kerala with a maximum depth of 6.4 m at the confluence zone. The major river discharging into the Ashtamudi is the Kallada river which originates from the Western Ghats and travels around 120 Km. Ashtamudi lake has been designated as RAMSAR SITE in November 2002.

In this study the most abundant mangrove plants in the lake were taken to study its niche specialties. Plant morphological studies in relation with its ecological significance were considered. The species, *Sonneratia alba* is common throughout its range, although like many mangrove species is less common at the extremities of its range. In India, this species was found in 40% of 100 sampling sites (Kathiresan *et al.*, 2001, 2005). *Acanthus ilicifolius*, commonly known as Holly-leaved Acanthus, Sea Holly, and Holy Mangrove is a species of shrubs or herbs, of the plant family *Acanthaceae*, native

to India, Sri Lanka, Asia, Malesia, Australia and Pacific Islands (Barker, 1986 and Hyland, 2010) It is a small shrub growing along lakes and marshes and sea shores. It is used as medicine in asthma and rheumatism (www.Ethnoleaflets.com and www.Pharmacographica indica.com).

It was estimated that mangrove loss in the last quarter-century report an approximately 20% decline in mangrove areas in countries within this species range since 1980 (FAO 1990, 1997, 2007). Summing up the status of 'Least concerned' in the IUCN-SSC (Species Survival Commission) there were no conservation Actions particular to this species in the world except that this species is planted in mangrove restoration projects in India and Philippines. In the current study the decline in the foliage cover of mangroves in the estuarine coastal areas of *Ashtamudi* lake, Kollam, Kerala, India was scrutinised for the year 2010-11 and in the year 2014-15.

2. MATERIALS AND METHODS

In the current study a prefixed twenty different zones were selected and the major two mangrove species were individually observed for its foliage intensity as a measure along with their overlapping green zones in separate. In the current study the numerical observations were scrutinized statistically for significance using SAS 9.3 statistical software.

2.1. Study Site

Ashtamudi lake located in the Kollam district, is the second largest estuarine system in Kerala with a water spread area of about 32 km² the lake is located between latitude 80 53'-90 2' N and longitude 760 31'- 760 41' E. The main basin is approximately 13 km long and the width varies from a few 100 m to about 3 km. *Kallada* river majorly contribute an annual discharge of 75 X 10⁹ M³ of water into this lake. It is formed by the confluence of three rivers, Viz., the *Kulathoopuzha*, The *Chendurni* and The *Kalthurathy*. The lake opens to the Arabian Sea at *Neendakara*, south west coast of India. This lake is the deepest among all the estuaries of Kerala with a maximum depth of 6.4 m at the confluence zone. Randomly selected 20 locations of 5M X 5M were selected and Mangrove species variances were observed.

2.2. Pollution Status

The lake is under pollution stress on many pockets that are more localised to urbanisation of Kollam town. Several major and minor drainage channels loaded with waste products from municipal and industrial sources join the lake at the southern end. Coconut husk retting for coir fibre manufacture is predominant at several location in the eastern arm of the estuary. Twenty locations half of it representing polluted zones and the next half representing unpolluted zones were selected during the year 2010-11 and the same zones were repeated for scrutiny during the year 2014-15.

2.3. Selected Mangrove Plants

The Mangrove apple (*Sonneratia alba*) is the most widespread of the Mangrove trees (Genus; *Sonneratia*, Family; *Lythraceae*). They are found from East Africa through the Indian subcontinent, Southeast Asia, northern Australia, Borneo and Pacific Islands. Growing up to 15m tall, they have cream, grey to brown bark with slight vertical fissures, with no buttresses or prop roots. Their pneumatophores are cone-shaped. Leaves are rounded, leathery, opposite, with similar upper and undersides of the leaf. Flowers are white and pom-pom-like and open only for one night (Fig. 1A and B). Their fruits are large green, leathery berries with a star-shaped base containing 100-150 tiny seeds. *Sonneratia alba* can tolerate wide fluctuations in salinity and often grow on exposed, soft but stable mud banks low on the tidal mudflats along banks of tidal rivers, creeks and within sheltered bays of offshore islands and reef cays. It is believed that they store excess salt in old leaves which they later shed. They are able to survive inundation by salt water twice a day, and in "soil" which is unstable and poor in oxygen (anaerobic). They also have to deal with swollen rivers carrying silt during the wet season, as well as violent storms that hit the coasts i.e.; they are best species suitable to estuarine habit (Kathiresan *et al.*, 1991; Ramesh *et al.*, 1999). They provide a variety of important ecosystem roles: a refuge and food for a variety of flora and fauna, a natural water filter, and an important stabilizer of coastal and river banks. Their roots prevent mud and sand from being washed away with the tide and river currents. Mangrove trees also slowly regenerate the soil by penetrating and aerating it. As the mud builds up and soil conditions improve, other plants can take root. Mangrove trees also reduce the damage from violent storms.

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Acanthus ilicifolius Linn. (*Acanthaceae*) is a plant of marshy habitat occurring primarily in tropical regions of the world (Fig. 1C and D) (Lakshmi *et.al.*, 1997) relatively lesser-known, yet important medicinal plant of Herbal Materia Medica. The plant is used in traditional systems of medicine, including Traditional Indian Medicine or Ayurveda and Traditional Chinese Medicine. The plant is reported to contain phytochemicals including alkaloid and wide range of glucosides (lignan and phenylethanoid). In traditional medicine, the plant is used in the treatment of diseases ranging from snake bite to skin diseases. Laboratory investigations on extracts of the plant have demonstrated significant pharmacological activities like antioxidant, anticarcinogenic, anti-osteoporotic, hepatoprotective Analgesic and anti-inflammatory properties of this plant have already been reported (Agshikar *et.al.* 1979). The leaves are used in ethnomedical practices to treat rheumatism, snake bite, paralysis and asthma (Subudhi, *et. al.* 1992). 2-Benzoxazolinone, isolated from this plant, showed leishmanicidal activity (Kapil *et. al.*, 1994).



A



B



C



D

Fig1. A, *Sonneratia alba* plant bearing fruit. B, *Sonneratia alba* flower. C, *Acanthus ilicifolius* plant in its habitat. D, *Acanthus ilicifolius* flower

2.4. Biochemical Analysis (Dissolved Oxygen- Do)

The chemical determination of oxygen concentrations in water is based on the method first proposed by Winkler (1888) and modified by Strickland and Parsons (1968). Oxygen in the water sample oxidizes iodide ion (I^-) to iodine (I_2) quantitatively. The amount of iodine generated is then determined by titration with a standard thiosulfate ($S_2O_3^{2-}$) solution. The endpoint is determined by using starch as a visual indicator. The amount of oxygen can then be computed from the titration value one mole of O_2 reacts with four moles of thiosulfate. At the time of sampling, dissolved oxygen is fixed by the addition of Mn (II) under basic conditions, resulting in a brown precipitate, manganic hydroxide ($MnO(OH)_2$). Prior to analysis, the sample is acidified to pH 1.0-2.5. This causes the precipitated hydroxides to dissolve, liberating Mn(III) ions. Mn(III) ions oxidize previously added iodide ions to iodine. Iodine forms a complex (I_3^-) with surplus iodide ions. Iodine and the complex exist in equilibrium; thus, I_3^- serves as a reservoir of I_2 . The iodine is then 239 titrated with thiosulfate; iodine is reduced to iodide and the thiosulfate is oxidized to tetra-thionate.

2.5. Public Survey

A survey regarding ‘Awareness for mangrove to public’ was carried among 100 randomly selected peoples of the age ranging from 18 to 70. And diagrammatic representations were done using Microsoft Excel 2010.

3. RESULT AND DISCUSSION

From the present study, the percentage of foliage cover in the selected 20 locations of the Shore of *Ashtamudi* lake observe significant impact of pollution over the existing mangrove ecosystem. 5M² areas from each of these locations were observed and the plant diversity was noted. It was observed that the lake was covered by *Sonneratia alba* (Mangrove apple) with its foliage by about 57% in the year 2010-11 and it decline to 49% by the year 2014-15. It was also noted that in 2010-11, 24% of the lake margin was covered by *Acanthus ilicifolius* and shows significant niche distinction from *S. alba* by preferring more water shed areas and has a slight shade preference by about 30% (Jithu *et al.*, 2013), but the situation become significantly alarming because the reduction in percentage cover for foliage for these two mangrove species decreases (*A. ilicifolius*, foliage cover decreases to 23% by 2014-15). Though a 9% decline in total foliage cover contributed by these two mangrove species occur by a period of 4-5 years the overlapping mangrove foliage cover remains the same in all the twenty recorded pockets as an 8%. Other species of mangroves and non-mangrove foliage contribute the rest 11% during the year 2010-11 and in the current study that shows a very slight increase of 2%. Percentage distribution of mangrove species in the area of study, *S. alba* dominates in the bar length significantly in comparison with *A. ilicifolius* in both the periods of study (Fig. 2).

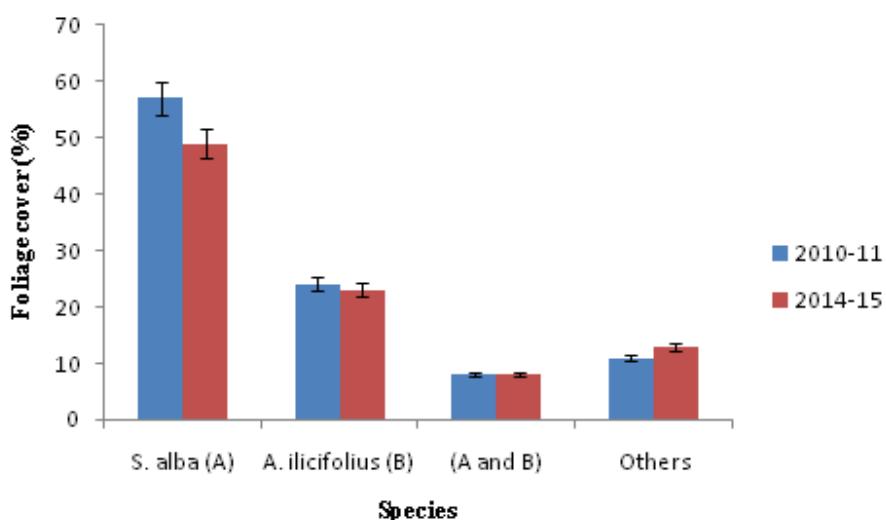


Fig2. Foliage cover of mangroves in Ashtamudi lake

The unscientific disposal of sewage into water bodies cause grave problems to the aquatic environment since this is a global issue the respective was demanding same significance in the *Ashtamudi* lake also. Current study also underlines the issue of pollution by means of DO from selected 10 each locations of seemed to be polluted and unpolluted. It was observed that to an average DO value was very less i.e.; 0.73ppm in polluted water during the study course conducted in the year 2010-11 and by the year 2014-15 the DO value was found significantly much lower as 0.64ppm (P<0.05), the same was in a better status on unpolluted zones. (Table1).

Table1. Dissolved Oxygen from the selected sample sites of Ashtamudilake

2010-11				2014-15			
Un polluted		Polluted		Un polluted		Polluted	
3.13	3.26	0.8	0.91	3.74	4.11	0.8	0.52
4.25	3.79	0.76	1.1	4.17	3.1	0.97	0.81
3.12	3.24	0.84	0.54	3.22	2.9	0.43	0.83
2.75	4.14	0.92	0.32	3.81	4.27	0.31	0.64
4.14	3.75	0.61	0.53	3.28	3.23	0.42	0.71
$\bar{X} = 3.55^a$		$\bar{X} = 0.73^a$		$\bar{X} = 3.58^a$		$\bar{X} = 0.64^b$	

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2010-11 survey in the topic of 'Awareness for mangrove to public' clearly frames the illiteracy of public about the need for conservation of mangroves and its importance (Fig. 3a) while it slightly increased in the survey during the year 2014-15 (Fig. 3b).

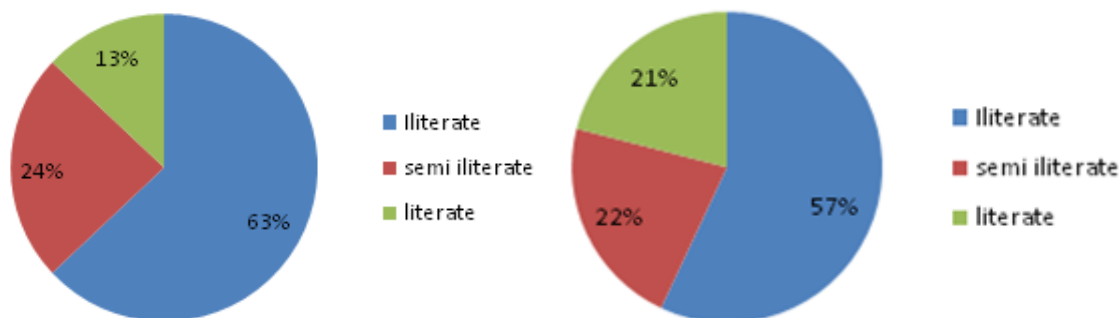


Fig3a. 2010-11

Fig3b. 2014-15

Fig3. Pie diagram showing increased literacy of public towards mangrove conservation for the years (Fig.3a) 2010-11 and (Fig.3b).

4. CONCLUSION

Kollam is the only revenue district in India with the glory of two wetlands declared as RAMSAR sites. The *Ashtamudi* Lake and the freshwater *Sasthamcotta* Lake is the second RAMSAR site in the district, both were designated on the same day. The shores of *Ashtamudi* Estuary are home to thousands of people and become the bio-spots of Kerala by sheltering a large species of flora and fauna. Their future will be significantly affected by decisions made today concerning the estuary's resources and its sustainable management. About 70-80% of the lake shore 240 The *Ashtamudi* mangrove ecosystem is a mere representative of fragile complex and dynamic ecosystem of Kerala. Importances of mangrove are innumerable and the habitats formed in those areas are extremely isolated with a unique texture. The faunal aspects in these areas are specific to mangrove ecosystem. Kerala is well known for brackish water systems, once mangroves were really a part of it and now facing the verge of extinction.

A periodical survey and monitoring agenda must be a mandate concerned for the conservation of mangroves in *Ashtamudi* lake and this study was believed to be a key indicator of pollution hazards on these non-renewable green boundaries. The study encompasses the fact for the need of conservation the lake demands by holding the IUCN red listed least concerned species *S. alba* and *A. ilicifolius*, not only the mangroves but also thousands of unique and mutually related faunal aspects may also perish in the nearby feature if not conserved properly.

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