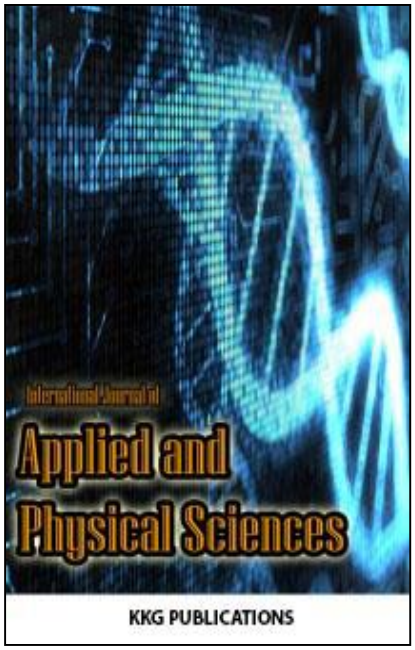


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[1] Eastern University, Sri Lanka
[2, 3] University of Peradeniya, Sri Lanka

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# VERTICAL VARIATION OF SALINITY, ELECTRICAL CONDUCTIVITY, TEMPERATURE AND pH OF BATTICALOA LAGOON

SUGIRTHARAN MUTHUCUMARAN [1*], SELVARAJAH PATHMARAJAH [2], M.I.M. MOWJOOD [3]

[1] Eastern University, Sri Lanka
[2, 3] University of Peradeniya, Sri Lanka

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**Abstract.** This study was conducted at 21 different locations in the Batticaloa lagoon of Sri Lanka to determine the variations of salinity, EC, water temperature, and pH at different depths of the lagoon during the month of May 2013 (early dry period). The locations were grouped into four, based on the distance from bar mouth and geographic locations. Vertical profiles of salinity were tested using Salinity Refractometer. Temperature, pH, and Electrical Conductivity (EC) were measured using a portable pH/EC/TDS meter. Results were statistically analyzed using the Minitab 14 software. Results revealed that pH varied from 7.87 to 8.89 and 7.98 and 8.79 at the surface and bottom layer of the lagoon, respectively. The result of pH indicated slightly alkaline in nature. Further, observations indicate that the surface layer of lagoon water had a higher temperature (mean 32 oC) than the bottom layer (mean 31ºC) of the lagoon. Furthermore, a positive correlation (r=0.146, *p*=0.168) was found between lagoon depth and salinity.



## INTRODUCTION

Coastal lagoons are separated or partially isolated from oceans or seas and are saline [1]. The system of lagoon is likely to consist various elements such as catchment area, ocean conditions and lagoon mouth characteristics. The effects of these various factors surrounding a lagoon would influence mixing processes. Those various phenomena occurring in the lagoon affect the social and economic activities around it [2]. Further, salinity and temperature of the water column plays an essential role in lagoon hydraulics which relates in lagoon productivity [3]. Saline water intrusion is one of the important factors determining various physical, chemical, and ecological processes occurring in the water body. Depending on local climatic conditions, lagoons which exhibit salinities may be changed from completely fresh to hypersaline. This is particularly true for the type of coastal lagoon, where the lagoon is connected to the coastal sea, at least intermittently, via a single channel and the tidal variability is largely filtered out during propagation of the tidal wave into the lagoon [4].

Batticaloa lagoon is one of the estuarine lagoons situated at the east coast of Sri Lanka. It is the largest coastal water body in the Batticaloa District and it is a long and narrow lagoon occupies an area of 168 km2 [5]. Most of the fishing community is depending on this lagoon for their livelihood.

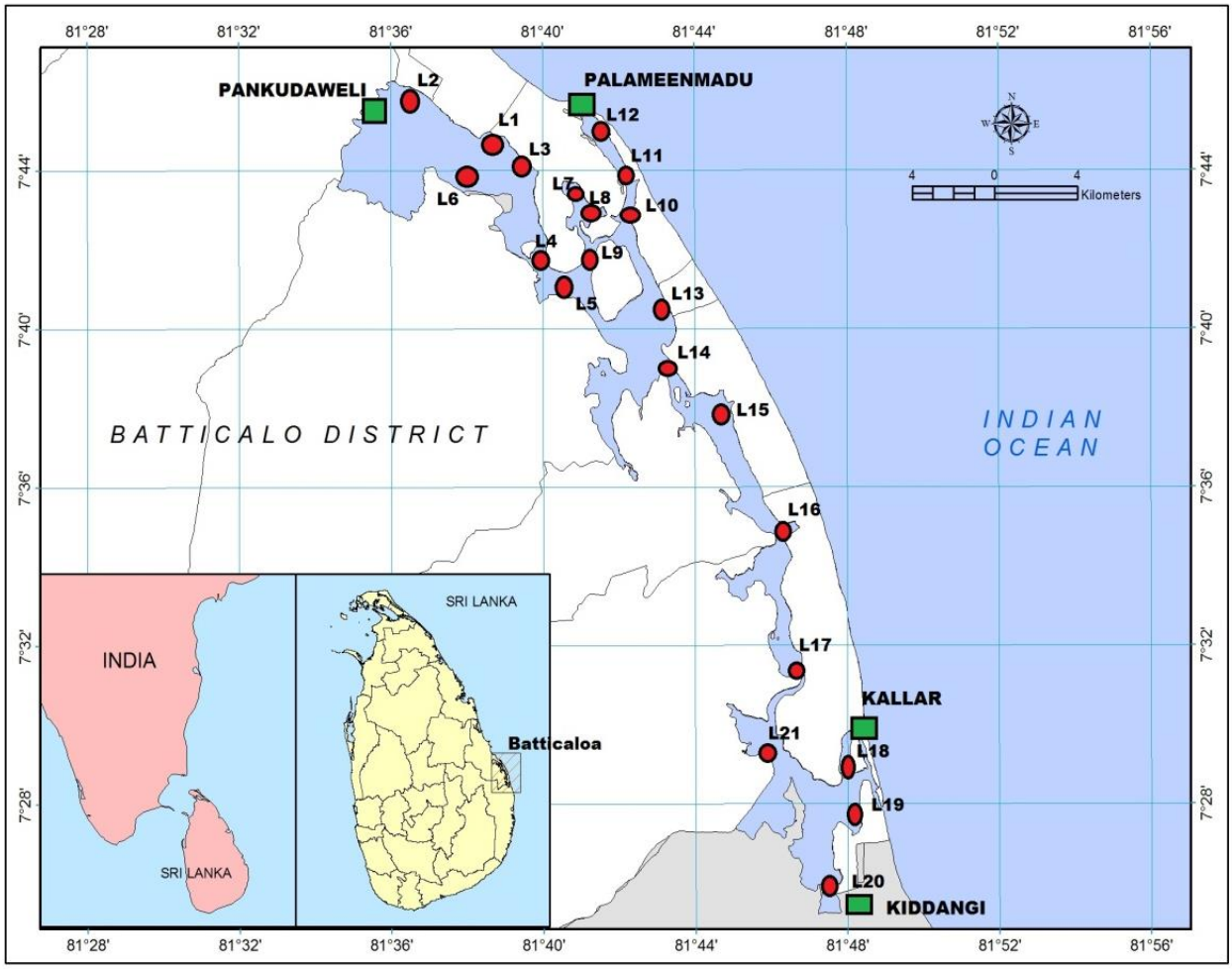
Batticaloa lagoon opens in to the sea at two points. One in the southern end of the lagoon at Kallar and the other is midway of the lagoon at Palameenmadu which is close to the Batticaloa town. Palameenmadu mouth is open most of the time while the bar mouth at Kallar is open only during rainy seasons. Saline water intrusion is the major event happening in the Batticaloa lagoon environment through the bar mouth opening during later part of the rainy season causing changes in lagoon water salinity. Mainly, it influences the type of fish catch and the ground water quality at wells of the adjacent areas. [3] stated that in coastal lagoons, density stratification which refers to layering of water on the basis of vertical variation in the salinity or temperature of the water column plays an essential role in lagoon hydraulics which directly relates to lagoon's productivity. Hence studying the salinity stratification phenomena of lagoons is very important. In this view, the present study was carried out during the mid of dry season to find the vertical variation of salinity of the Batticaloa lagoon as it is important for the management of coastal lagoons.

## METHODOLOGY

Batticaloa lagoon located between 7° 24’ - 7° 46’N, and 81° 35’ - 81° 49’E, is one of the most productive brackish water bodies in Sri Lanka. More than 90% of the lagoon is located in Batticaloa District and the rest lies in Ampara District. Batticaloa lagoon is 56 km long and extends from Kittangi/ Kalmunai in Ampara District in the south to Pankudaweli in Batticaloa District in the north [6]. Lagoon area receives about 1500 mm of rainfall per annum, primarily (about 60%) from the Northeast monsoons during October to February. Winds are generally moderate,

*Corresponding author: Sugirtharan Muthucumaran
E-mail: sugirtharan818@yahoo.com

ranging from 7–15 km per hour with the evening winds being stronger [7]. The maximum depth of the lagoon is about four meters [8] and the average water depth is around 1.5 m [9].




**L1 - Thannamunai, L2 - Eravur, L3 - Sathurukondan, L4 - Valaiyravu, L5 - Kannankudah, L6 - Eachchanthivu, L7 - Urani, L8 - Puliyanthivu, L9 - Puthur, L10 - Kallady, L11 - Periyauppodai, L12 - Navalady, L13 - Kattankudy, L14 - Manmunai, L15 - Puthukudiyruppu, L16 - Chettipalayam, L17 - Paddiruppu, L18 - Koddaikallar, L19 - Periyakallar, L20 - Kiddangi, L21 - Mandur**

Fig. 1. Location of study area and the monitoring points.

Vertical profiles of salinity (at surface, 0.5 m, 1.0 m, 1.5 m and 2.0 m depths) were tested using Salinity Refractrometer. Temperature, pH and Electrical Conductivity (E.C.) of the Batticaloa lagoon were also measured using Portable pH/EC/TDS meter at 21 different locations (Figure 1) along the lagoon during the month of May 2013 (i.e. during the early dry period). Measurements were taken at 50-100 m distance away from the shore during morning time (between 9.00 a.m to 10.00a.m).

The locations were grouped into four (P1, P2, P3 and P4) based on the distance from bar mouth and geographic locations. Second bar mouth at Kallar was closed during the measurement. Distance between these two bar mouth is about 32km.

P1 (West part of lagoon) - L1, L2, L3, L4, L5, L6
P2 (Bar mouth and closer area) - L7, L8, L9, L10, L11, L12, L13
P3 (Mid part of lagoon) - L14, L15, L16, L17
P4 (Southern part of lagoon) - L18, L19, L20, L21
Results were statistically analysed using the Minitab 14 software.

## RESULTS AND DISCUSSION

### Variation of pH with the lagoon depth

The pH of water is an important environmental factor. The fluctuation of pH is linked with chemical changes, species

composition and life processes. It is generally considered as an index for suitability of the environment [10].

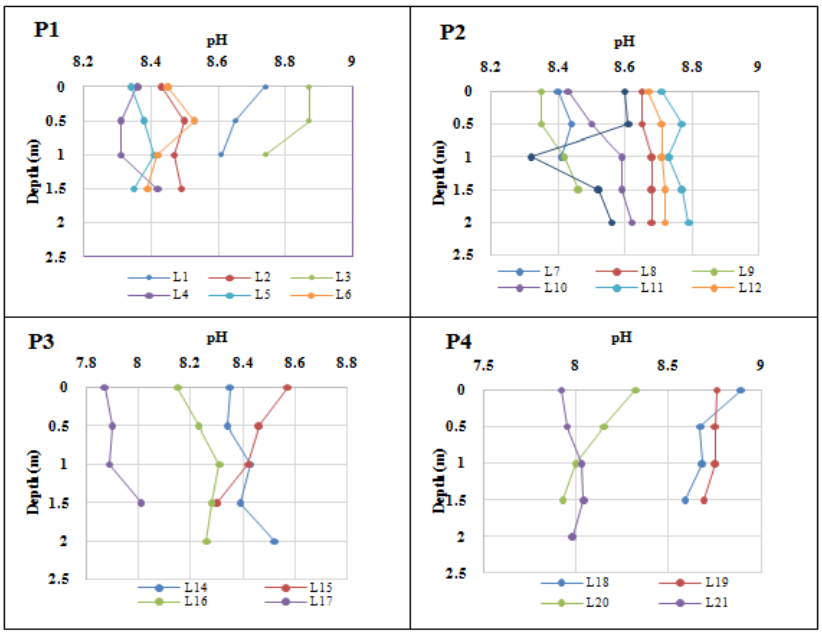



Fig. 2. Vertical variation of pH at different locations of batticaloa lagoon.

Figure 2 shows the spatial and vertical variation of pH in the Batticaloa lagoon. pH varied from 7.87 to 8.89 at the surface of the lagoon whereas, it varied between 7.98 and 8.79 at the bottom layer of the lagoon. From the present study, the values of pH indicate slightly alkaline in nature. [11] reported that, the degradation of plants, living organism and organic waste in the lagoon might increase the carbonate and bicarbonate levels, thus increase the pH value. This might also be the reason for the increased pH value of lagoon water in the present study. There was no significant relationship (r=-0.009, *p*=0.933) found in between the depth of the lagoon and the pH value.

**Variation of Temperature with the Lagoon Depth**

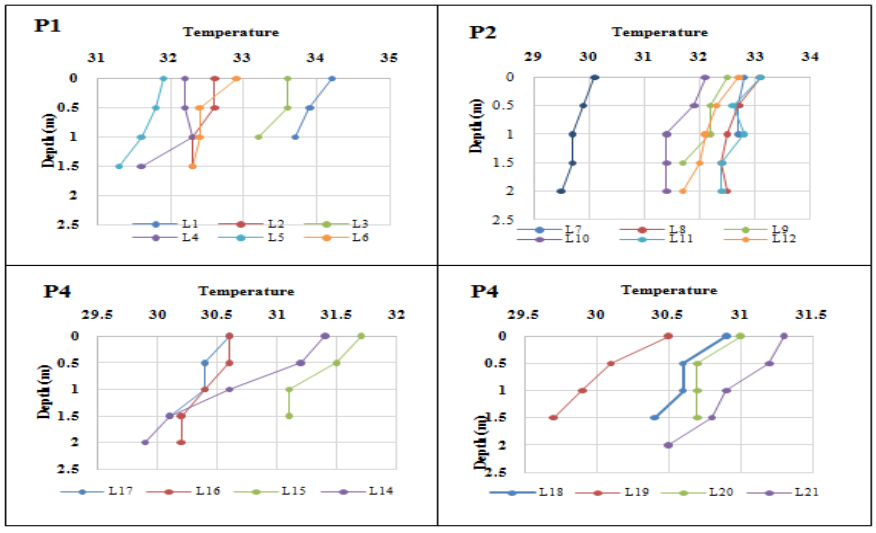



Fig. 3. Vertical variation of temperature of lagoon at different locations.

Temperature is a critical factor influencing several aspects of the lagoon ecosystem. It influences biological activity and many chemical variables in the lagoon [12]. In the present study, temperature of the lagoon water varied in between 29.5 $^{o}$C

and 34.2 ºC. Generally, it was found that the surface layer of lagoon water had higher temperature (mean 32 ºC) than the bottom layer (mean 31 ºC) of lagoon water (Figure 3). The rise in water temperature and water level in the lagoons is due to changes in the air temperature and atmospheric circulation. Therefore, atmospheric temperature above the surface of this lagoon might also be the reason for the higher temperature values at the surface layer. Further, there was a significant negative correlation (r=-0.303, *p*= 0.004) found between depth of lagoon and the temperature.

**Variation of E.C. and Salinity with the lagoon depth**

The E.C. values of the Batticaloa lagoon varied from 0.170 dS/m to 37.5 dS/m. Bottom layer of the lagoon water exhibited higher E.C. values (0.950 dS/m - 37.5 dS/m) compared to the other layers of lagoon. There was no significant correlation (r=0.147, *p*= 0. 168) found between depth of lagoon and the E.C. values.

Figure 4 shows the vertical profiles of salinity between surface and bottom layers (P1, P2, P3 and P4) of the lagoon. As these measurements were made at the early dry periods, the salinity level in the mouth area was high compared to that of the other areas. Southern part of the lagoon (P4) shows lower salinity than other locations as it is far away from the barmouth. Further, it should be noted that the second barmouth at Kallar was closed during the measurement.

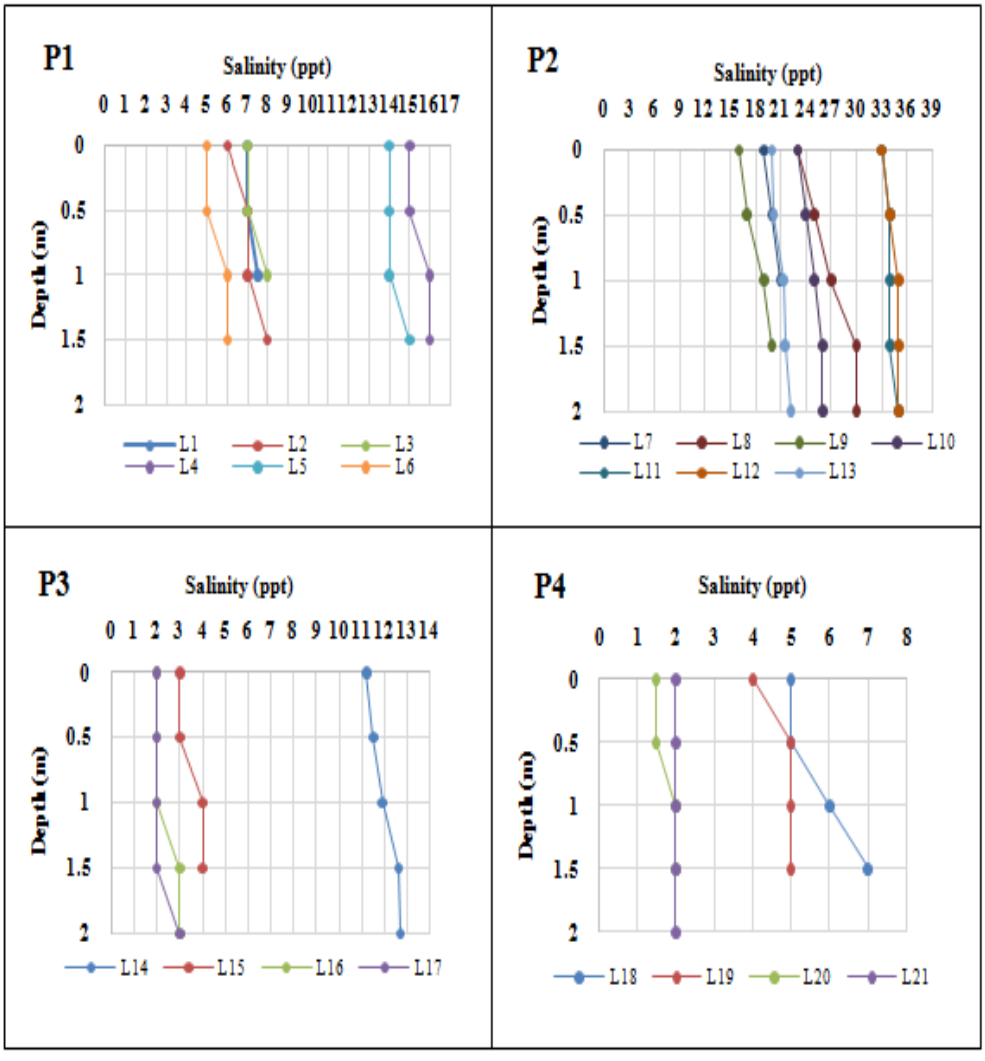



Fig. 4. Vertical variation of salinity of lagoon at different locations.

The salinity values of the Batticaloa lagoon at 21 locations varied between 1.5 ppt and 35 ppt. [2] Reported that, generally vertical density stratification of the lagoon differs depending not only on temporal conditions but also on spatial

conditions. In addition, river inflow and intrusion of saline water through the lagoon mouth from sea affects the stratification. Similar observation is made in the present study as well.

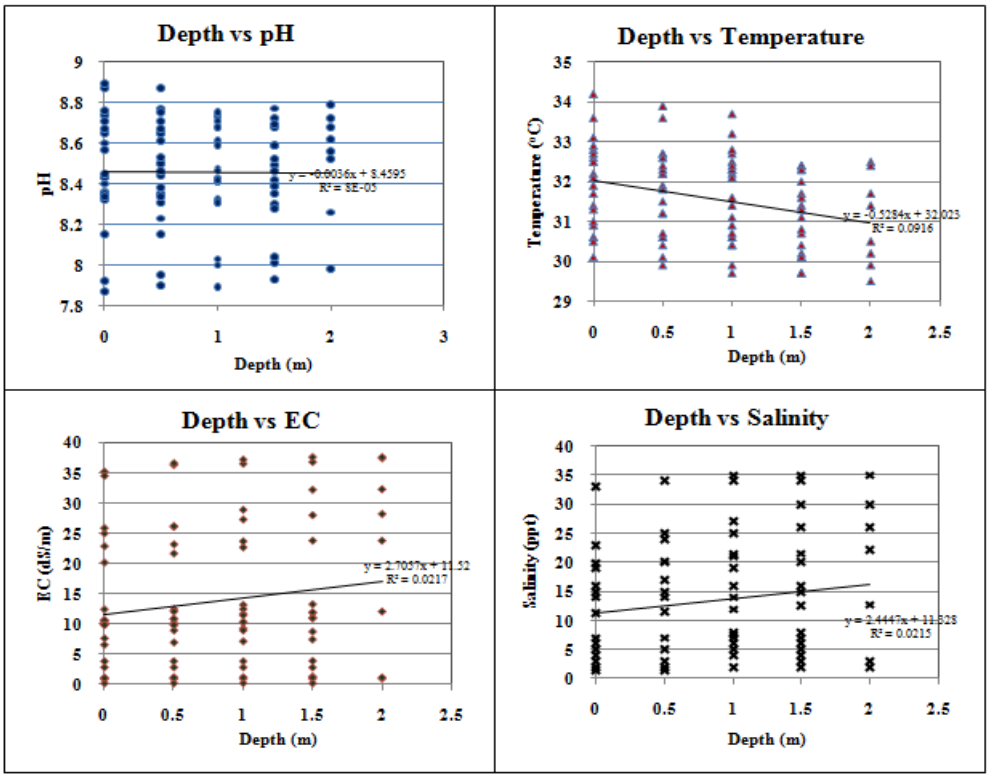



Fig. 5. Relationship of water quality parameters with lagoon depth.

Salinity and E.C. of lagoon water exhibits similar vertical trend (Figure 5). There was no significant correlation (r=0.146, *p*=0.168) found between lagoon depth and salinity. Comparatively, bottom layer of water found with more salt content than surface of the lagoon water. It shows, salt settled at bottom layer of lagoon remain without strong mixing with surface layer thus no dilution occur at bottom compare with surface water. Further, most stations showed only weak, or no salinity stratification. [13] also reported that the salinity is largely controlled by the tidal action.

## CONCLUSION

Salinity and E.C. values were high at the bottom layer of the lagoon but no significant relationship found with the lagoon depth. However, significant vertical temperature stratification was found in this study. Tidal action and atmospheric temperature might influence on the degree of vertical variation of the salinity, E.C. and temperature of the lagoon. Temporal variation of density stratification needs to be study at different locations from the barmouth opening and closing conditions that will give more valuable information for the sustainable development of this lagoon against the salinity.

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