IMPACT OF SHRIMP FARMING ON DEGRADATION OF DIVERSITY, SOIL AND WATER QUALITY OF MANGROVE ECOSYSTEM IN ANAWILUNDAWA RAMSAR WETLAND SANCTUARY

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INTRODUCTION

Mangroves are among the most productive ecosystems in the world. Mangroves are coastal equivalent of tropical forests and hence are of ecological and environmental significance, in Sri Lanka. It is estimated that mangroves in Sri Lanka cover only 160 km^2 which amounts to around 0.24% of total land area of the country (Priyashantha and Taufikurahman, 2020). In Sri Lanka mangroves occur along the sheltered inertial coastline associated with estuaries and lagoons. The largest tracts of mangrove habitats in Sri Lanka are found in the Puttlam lagoon, Kala Oya basin and Trincomalee. Mangroves provide many ecosystem products and services. They provide habitats, feeding grounds, nursery, and hunting grounds for animals, protect the lagoons and the estuaries from erosion, and reduce pollution of near shore coastal waters by trapping pollutions, promote ecotourism, and supply field laboratories for researchers. Further they provide food and fodder for animals, medicines, pigments, fuel wood, and timber for constructions, furniture and as boat building materials.

The Anawilundawa Ramsar Wetland Sanctuary is situated in the Puttalam district in the North western Province of the country, between Chilaw and Puttalam to be more specific, it is situated between the coast and the Chilaw- Puttalam railway line. The uniqueness of Anawilundawa is its immediate proximity to three vastly different ecosystems, the coast, the mangroves, and the freshwater tanks; making it one of the six Ramsar wetlands in Sri Lanka. This ecological setting has made it a favourable nesting and breeding ground for hundreds of species of birds.

Shrimp farming is no traditional aquaculture in Sri Lanka, but there is in China and India (Jayasekara, 1993). In the beginning of commercial shrimp culture in Sri Lanka, most of the large-scale shrimp farms adopted intensive culture practices, which depend on hatchery bred post larvae, high stocking density, use of formulated feeds, application of aeration and intensive water management. However, in the late 1980s outbreaks of diseases made many farmers change to semi-intensive systems, in which the stocking density is 15–20 post larvae per square meter (Dayaratne et al., 1997).

The mangrove forests in the Puttlam district have suffered the highest level of degradation arising from human activities, particularly shrimp farming. Conversion of mangroves to aquaculture ponds is responsible for about 38% of the total mangrove loss that has occurred in the country (Valietel et al., 2001). In addition to the direct destruction of mangroves, shrimp farming has also caused the degradation of water quality and the loss of soil characteristics. According to this experiment we can identify the impact of shrimp farming on mangrove ecosystem and determine how to minimize loss in mangrove ecosystem. The objectives are to determine the soil composition of mangroves in Anawilundawa International Ramsar Wetland Sanctuary, to determine the water quality parameters in the *Olandaela* and identify the true mangrove species in Anawilundawa Ramsar Wetland Sanctuary.

METHODOLOGY

This study was carried out in the mangroves of Anawilundawa Ramsar Wetland Sanctuary. In experiment one three mangrove sites were selected in this area. Pinkattiya area, Anawilundawa area and Sengaloya area were selected as mangrove sites. Impacts were monitored in 3 mangrove sites located adjacent to shrimp farms that were currently in operation while 3 sites away from shrimp farm served as reference sites. Soil and water samples were taken from the shrimp farm at those 3 locations and above samples were taken from 2 km places away from the shrimp farm. Soil and Water sample were collected from each sampling place and the parameters, namely soil and water pH, soil and water temperature, soil and water salinity, soil and water nitrate, soil and water phosphate were measured. The pH was measured using a portable pH meter. Soil and water Temperature were measured by inserting a glass mercury thermometer into the soil after making a hole with a wire and soil and water salinity was measured by a salinity refractometer. Soil nitrate was measured by nitrogen kjeldahl method, soil phosphate was measured by using spectrophotometer. Each experiment was repeated four times for replication. Experiment two is the survey that was conducted to identify the true mangrove species in Anawilundawa Ramar Wetland Sanctuary. In this survey that was conducted according to the guide book "mangroves of Sri Lanka" related to the morphological characters of the species found in the respective sections by using a rope 20m by 20m along the Dutch canal.

The experiment was set up as two factor-factorial Randomized Complete Block Design (RCBD) with four replicates. Each parameter data was analyzed using ANOVA procedures of SAS. Means were compared using Tukey's test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Water parameters

Water temperature measured from close and distant locations of shrimp farm in Sengal oya ($F_{4,5}$=12.25, P=0.0249) and Anawilundawa ($F_{4,5}$=25.00, P=0.0075) significantly varied but in the water temperature of Pinkatiya ($F_{4,5}$=6.25, P=0.0668) there is a no significant difference between away and near sites of shrimp farm. Highest water temperature recorded in Anawilundawa site was 32.3 ^{0}C (Figure 1).

pH level of water of Olanda ela was measured from close and distant locations of shrimp farm. Highest water pH level was recorded from near the shrimp farm of Anawilundawa site (8.6) as well as lowest pH level showed in a location distant from the shrimp farm of Sengal oya site (6.4). In all three sites pH level varied significantly between close and distant locations of Sengal oya ($F_{4,5}$=400.00, P<.0001), Anawilundawa ($F_{4,5}$=29.51,P=0.0056) and Pinkatiya ($F_{4,5}$=33.03,P=0.0045).

Water salinity levels of all sites varied significantly.. In Sengal oya ($F_{4,5}$=28.90, P=0.0058), Anawilundawa ($F_{4,5}$=37.50, P=0.0036) and Pinkatiya ($F_{4,5}$=108.00, P=0.0005). Highest in near to shrimp farm in Sengal oya (32ppt) and lowest water salinity level (24ppt) a location away from shrimp farm in Pinkattiya site (Figure 1).

There was a significant difference between the total nitrogen percentages of water in Sengal oya ($F_{4,5}$=13.14, P=0.0223) and Anawilundawa ($F_{4,5}$=12.81, P=0.0232) but no difference in Pinkatiya ($F_{4,5}$=3.49, P=0.1350) site (Figure 1). Highest water nitrogen level shown in place of near the shrimp farm in Anawilundawa site (1.56mg/L). However, the lowest water phosphorus level shown is away from the shrimp farm in Sengal oya site (0.11mg/L). There was a significant difference of total phosphorus percentage of water in Sengal oya ($F_{4,5}$=35.71, P=0.0039) and Anawilundawa ($F_{4,5}$=201.64, P<0.0001) but not in Pinkatiya ($F_{4,5}$=637.00, P= <0.0001) site. Highest water phosphorus level shown in place near the shrimp farm in Pinkattiya site (0.36mg/L). As well as the

lowest water phosphorus level was shown away from the shrimp farm in Pinkattiya site (0.056mg/L).

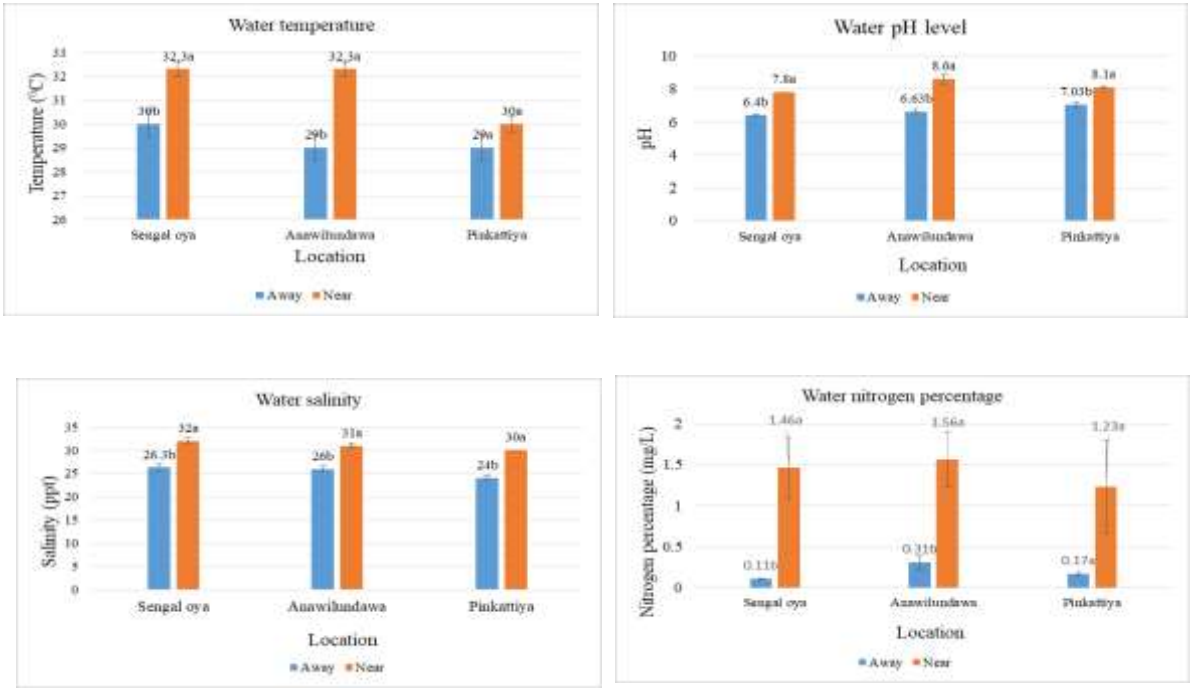


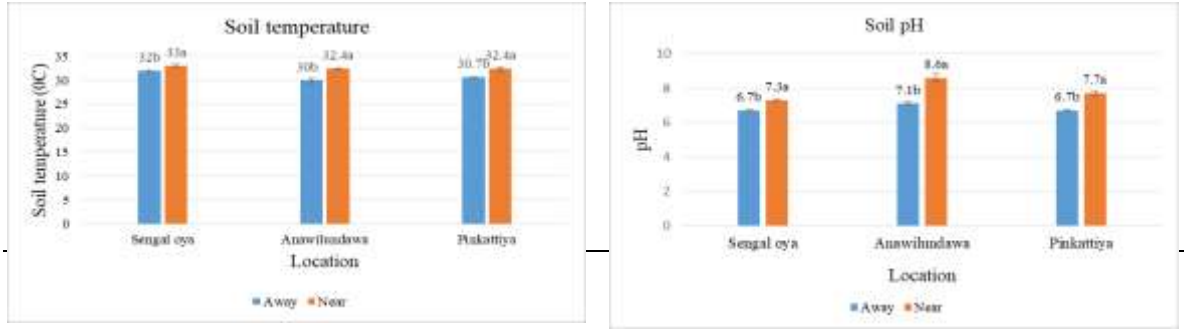
Figure 1: Water parameters in Sengal Oya, Anawilundawa and Pinkattiya

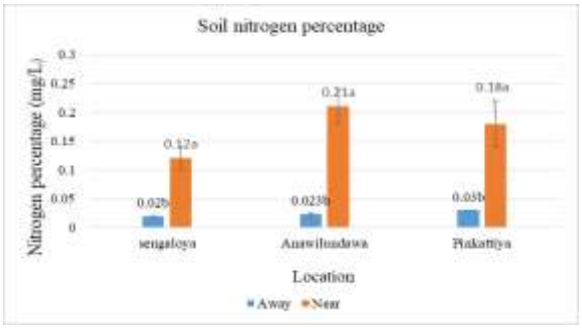
Soil parameters

Soil temperature was significantly varied from far and close locations of shrimp farm in Sengal oya ($F_{4,5}$=25.00, P=0.0075) and Anawilundawa ($F_{4,5}$=16.98,P=0.0146) Pinkatiya ($F_{4,5}$=12.64, P=0.0237). Highest soil temperature was recorded near the shrimp farm in Anawilundawa site (33.0^{0}C) and lowest soil temperature was (30.0^{0}C) Away from the shrimp farm in Anawilundawa site (Figure 2).

The highest soil pH level (8.6 pH) was shown in a place near the shrimp farm in Anawilundawa site as well as a distant place from the shrimp farm at pH level (7.1 pH) was recorded and it was significantly different. The lowest pH level (6.7 pH) was shown in both places away from the shrimp farm in Sengal oya and Pinkattiya sites. pH levels of both places was significantly different as follows, Sengal oya ($F_{4,5}$=51.57, P=0.0020), Anawilundawa ($F_{4,5}$=33.06, P=0.0045) and Pinkatiya ($F_{4,5}$=60.00, P=0.0015).

Soil salinity levels of all sites were significantly different as in the case of water salinity level. In Sengal oya ($F_{4,5}$=52.55, P=0.0019) and Anawilundawa ($F_{4,5}$=75.00, P=0.0010) Pinkatiya ($F_{4,5}$=64.29, P=0.0013). The highest soil salinity level (34.0ppt) was recorded near the shrimp farm in Sengal oya site and the lowest soil salinity level (21.0ppt) was recorded away from the shrimp farm in Pinkattiya site (Figure 2).





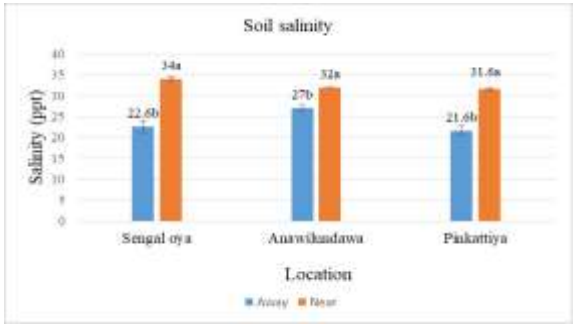
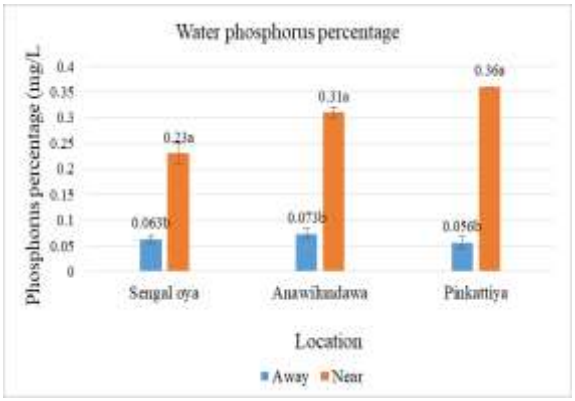


Figure 2: Soil parameters in Sengal Oya, Anawilundawa and Pinkattiya

The total nitrogen percentage of soil was significantly changed between two places of samples collected (away and near the shrimp farm) in all sites as follows Sengal oya ($F_{4,5}$=18.75, P=0.0123) and Anawilundawa ($F_{4,5}$=25.38, P=0.0073) and as well as Pinkatiya ($F_{4,5}$=10.62, P= 0.0311) site(Figure 2). Highest soil total nitrogen level was shown in places near the shrimp farm in Anawilundawa site (0.21mg/L). However, the lowest water phosphorus levels were shown away from the shrimp farm in Sengal oya site (0.02mg/L). There was a significant difference of total phosphorus percentage of water in Sengal oya ($F_{4,5}$=75.67,P=0.0010) and Anawilundawa ($F_{4,5}$=262.55,P<.0001) but not different in Pinkatiya ($F_{4,5}$=22.56,P=0.0090) site. Highest soil phosphorus level was shown in place near the shrimp farm in Anawilundawa site (0.31mg/L) as well as the lowest soil phosphorus level was shown away from the shrimp farm in Sengal oya site (0.03mg/L).



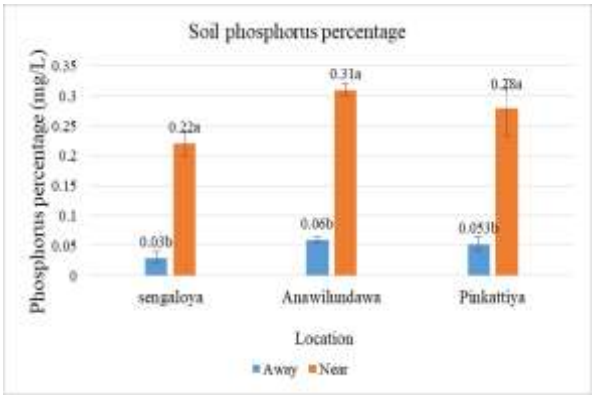


Figure 2: Water and soil phosphorus levels in Sengal Oya, Anawilundawa and Pinkattiya

Identification of mangrove species

A survey was conducted to identify the true mangrove species in Anawilundawa Ramsar Wetland Sanctuary. The national red list 2012 completed by biodiversity secretariat, 22 species of true mangrove in Sri Lanka. Of the 22 mangrove species in Sri Lanka, but only 8 true mangrove species and 4 species are mangrove associates found in the Anawilundawa Ramsar Wetland Sanctuary (Table 1).

Mangroves in Sri Lanka are seriously threatened due to shrimp farming and human development activities (Kumarasinghe, 1999). This research proved that statement because most of the water and soil parameters were significantly changed near shrimp areas. Both water and soil temperature were increased in shrimp farms. According to this research water and soil pH levels and salinity levels were significantly increased near shrimp farm areas compared with distant locations from the shrimp farm. Also, both soil and water total nitrogen percentage as well as total phosphorus percentage were significantly increased near the shrimp farms. Furthermore, research needed to define what are the reasons for increased total nitrogen levels and phosphorus level in soil and water near the shrimp farm because farmers are using various type of chemicals and feeds.

Table 1. True mangrove species in the Anawilundawa Ramsar wetland sanctuary.

General name	Scientific name
Mutti kadol	*Xylocarpus granatum*
Mal kadol	*Bruguiera sexangula*
Heen kadol	*Aegriceras corniculatum*
Maha kadol	*Rhizophora mucronata*
Telakiriya	*Excoecaria agallocha*
Atuna	*Heritiera littoralis*
Beriya	*Lumintzera racemosa*
Madagas	*Avicennia marina*

Table 2. Mangrove associate species in the Anawilundawa Ramsar wetland sanctuary.

General name	Scientific name
Kadolpichcha	*Clerodendrum inerme*
Gansuriya	*Thespesia populnea*
Belipatta	*Hibiscus tiliaceus*
Walmidi	*Premna seratifolia*

CONCLUSION

The present study showes that rapid growth of shrimp farms in this area has serious negative impacts on the mangrove ecosystem in Anawilundawa Ramsar Wetland sanctuary. This was evident through its impacts on both soil and water in this area. The composition of soil and water were seriously altered in the vicinity of shrimp farms in comparison to that of the far and distant sites. Despite the constant flushing water Quality of the Olanda ela has deteriorated as apparent by the greater levels of nutrients implying risks of eutrophication and the potential toxicity to mangroves.

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