Change detection of mangrove cover in Puttalam lagoon using Remote Sensing and GIS technology

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Abstract

Mangrove ecosystems dominate the coastal wetlands along the North West Coast of Sri Lanka and they are among some of the most threatened and vulnerable ecosystems. Information on the distribution pattern and extent of such valuable coastal resources is a main requirement for managing and conserving them. The study was conducted to assess the mangrove cover changes in Puttalam lagoon over the past six decades and how shrimp farming industry has contributed to the changes in mangrove coverage. Aerial photographs of years 1956, 1981, 1992, IKONOS satellite image for year 2005 and Google Earth images of year 2014 were utilized as data sources. Tone, texture, shape and association were used to identify mangroves, shrimp farms and salt pans from the images. On screen digitizing was performed to extract data from the above sources. Results shows that mangrove cover presently exists at the Puttalam lagoon is about 1642.3 ha. It is a 1.45% reduction compared to the year 1956. Shrimp farms established in 1992 were drastically increased by 21.40% until 2005. However, it could be observed that 880.32 ha of abandoned shrimp farms exist presently all over the lagoon. Statistically it shows that there is no any significant impact to the mangrove ecosystems due to shrimp farm establishments in the lagoon. However, the study found that 11 Gramasewa Niladari Divisions can be identified as the possible mangrove restoration areas for future management and conservation.

Keywords: Mangrove, Remote sensing, Geographic Information System, Shrimp farms, Restoration

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Introduction

Mangroves are dicotyledonous woody shrubs or trees that are dominantly found in coastal tropics. They provide many ecological benefits to associating floral and faunal community and many economical benefits to human. At the same time mangroves are among the most threatened ecosystems as they undergo many anthropogenic and natural threats. Lack of monitoring and management has been a problem to the proper assessment of the status of the mangrove cover in the area. Remote sensing and GIS

techniques can be used efficiently in resource monitoring and management as demonstrated by Ramachandran (2005). Many of the studies like mangrove mapping, mangrove species identification and mangrove change detection have performed using these techniques. The main aim of this study was to identify the mangrove cover changes occurred in Puttalam lagoon over the past six decades. Many environmentalists claim that establishment of salterns and shrimp farms led to a vast destruction of mangrove resources in Puttalam lagoon. This study attempts to determine the significance of the impact of this change on the lagoonal environment. Viral outbreaks that occurred in North Western province have left with many abandoned shrimp farms in this area. Restoring those areas again with mangroves is a good way of conserving the resources.

Materials and Methods

Aerial photos which depict the Puttalam lagoon in year 1956, 1981 and 1992 were scanned and imported into ArcGIS interface for the geo-referencing. Before data extraction, IKONOS satellite images were subjected to pre-processing steps such as layer stacking, pan-sharpening, and atmospheric corrections using ERDAS Imagine software. Present Mangrove coverage was obtained by Google Earth images without any pre-processing steps. According to the tone, texture, size and association like visual interpretation characteristics mangroves, shrimp farms and salt pans were identified clearly from the images. When identifying shrimp farms in year 2014, they were identified as active or abandoned accordingly. Data extraction was performed using on screen digitizing methods and finally extent calculations were performed using ArcGIS software. An overlay analysis was conducted by combining Gramaseva Niladari Division (GND) layer with mangrove coverage layer to calculate change as GND wise. One-wayANOVA test was conducted to assess the significance of impact occurred on mangrove ecosystems due to shrimp farm establishment. Abandoned shrimp farms with naturally grown mangrove patches nearby, were selected as possible restoration sites. A map was prepared based on the sites selected and also recommendations were given to accelerate the restoration activities.

Results and Discussion

Mangroves, shrimp farms and salt pan extents in the Puttalam lagoon during the period from 1956 to 2014were as follows.

Total extent in Hectares (ha)					
	1956	1981	1992	2005	2014
Mangrove	1666.54	1808.55	1524.81	1594.09	1642.3
Salt pan	802.69	755.08	848.99	1036.38	1531.98
Active Shrimp farm	NA	NA	120.26	1465.39	146.02
Abandoned Shrimp farm	NA	NA	NA	NA	880.32

The mangrove covers in Puttalam lagoon has gone up by 142.01 ha from 1956 to 1981. Natural growth of the ecosystem is the main reason for such observation. In 1992 initiation of the shrimp farms in the lagoon can be noticed, and at the same time extent of mangrove has gone down by 283.74 ha. That mangrove cover reduction was occurred mostly in areas of Manalthivu, Parana Eluwankulama, Samagipura, Uchchamunai, Vattakandal but the shrimp farms were started in Daluwa, Musalpitiya, Palaviya, Pothuvilluwa, and Puludiviyal which are not mangrove areas. It is a evident that mangrove cover was not destructed due to initiation of shrimp farms in that year (1992), but may be a cause which the study has not focused on. When it comes to 2005, Manalthivu, Puludiviyal, Thethapola, andVattakandal GN divisions experienced a significant increase of shrimp farms while at the expense of mangrove stands, but this reduction was overcome by the growth of mangrove in Parana Eluwankuma, Uchchamunai GN Divisions as well as in mangrove islands.

Compared to year 2005, in year 2014 mangrove cover has increased by 48.21ha. Anandakanniya, Karadipuwal, Karamba, Karathivu South, Musalpitiya, Puludiviyal, Samagipura, Thethapola, and Vattakandal are the major GN Divisions which have increased the mangrove extent. At the same time those are the main GN Divisions which records the highest extent of abandoned shrimp farms in the year 2014. So it can be estimated that natural reforestation of mangroves where there are abandoned shrimp farms is the reason for the increment of mangrove extent for the year 2014.

As to the statistical analysis, it does not indicate that mangrove cover in Puttalam lagoon has significantly impacted by shrimp farm establishments (p value 0.584). Karathivu South, Vattakandal, Manalthivu, Karamba, Thethapola, Daluwa, Nawakkadu, Mudallapaliya, Musalapitiya, Kurinjipitiya North, and Vanni Mundalama GN Divisions were identified as possible restoration sites.

Conclusion

Presently the mangrove extent of Puttalam lagoon is about 1642.3 ha. Statistically it proves that there is no significant impact from shrimp farms for the distribution of mangroves in Puttalam lagoon.

Reference

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