REMOTE-SENSED MAPPING OF SEAGRASS DISTRIBUTION IN PALK BAY, SRI LANKA, USING HIGH SPATIAL RESOLUTION WORLDVIEW-2 SATELLITE DATA

D.D.G.L. Dahanayaka[1] and V. Pahalawattarachchi [2]
[1]Department of Zoology, Faculty of Natural Sciences, The Open University of Sri Lanka, Nawala, Nugegoda, 10250, Sri Lanka
Email: dddah@ou.ac.lk
[2]National Aquatic Resources Research and Development Agency, Colombo 15, Sri Lanka

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ABSTRACT: This study incorporates field observations and high spatial resolution WV-2 imagery processing techniques to provide an assessment of shallow coastal marine seagrass beds in Palk Bay, North-Western coast of Sri Lanka. The main objective of this study is to influence decision making and coastal planning in Sri Lanka with the increased knowledge on the seagrass habitats in Palk Bay with special reference to Dugong conservation. Field observation were conducted in once a month during 2015 to 2016 and methods included free diving, monitoring transect lines, quantify quadrats, and underwater photography techniques. Common species encountered in study areas were *Enhalus acoroides, Cymodocea rotundata, Cymodocea serrulata* and *Halodule pinifolia*. Cloud free WV-2 satellite imageries of 15th June 2015 and 11th February 2016 were selected as remote sensing data sources. After image pre-processing, supervised image classifications were performed using maximum likelihood, minimum distance to means, and spectral angle mapper methods to compare relative accuracies in mapping seagrass coverage. The maximum likelihood classification produced the highest overall accuracy of 94%. The spectral angle mapper yielded the lowest accuracy due to the predominant influence of water-column optical properties on the apparent spectral characteristics of seagrass and sand bottom. The results achieved by our classification methodology were validated with visual interpretation and field data. The combination of in-situ data and three classification methods resulted in highly accurate classification outcomes that showed the distribution patterns of seagrass of the study area. Based on the results, we conclude that eight-band high resolution multispectral WV-2 satellite imagery has great potential for mapping and monitoring seagrass beds in shallow coastal waters with large-scale coverage. Thus, the primary results of this study provide useful baseline information that is necessary for marine-conservation strategic planning incorporated to protecting feeding grounds of dugongs around the North-Western coast of Sri Lanka.

1. INTRODUCTION

Seagrasses are the most prominent and widespread biotypes found in shallow marine environments, with 72 species found in coastal and estuarine waters around the world (Valiela, 1991; Orth *et al.,* 2006; Short *et al.*, 2011). They are both ecologically and economically important due to their services and functions (Cullen-Unsworth *et al.,* 2013; Dahanayaka, 2009; Dahanayaka *et al.*, 2010), providing extensive spawning grounds and habitats for animals including many endangered species, providing a substrate for epiphytes and additionally providing direct food source for grazing animals such as sea urchins, dugongs, manatees, turtles and some herbivores fishes (Odum, 1974; Nakaoka and Aioi, 1999; Unsworth *et al.*, 2016). In addition to that, their root and rhizome systems trap and stabilize sediments and their roots enable them to exploit the generally high nutrient levels found within these sediments, nutrients which are often unavailable to other primary producers in the ecosystem (West and Larkum, 1983). Moreover, excess organic carbon that is produced is buried within seagrass sediments which are a "sink" for carbon sequestration (Orth *et al.*, 2006). Fourqurean *et al* (2012) highlighted that the estimate of world carbon storage was approximately 27.4Tg Cyr^{-1} while annually storing 19.9 Pg of organic carbon (Pendleton *et al.,* 2012). Therefore, protection of organic carbon stored (blue carbon) in seagrass meadows is considered as an important method for mitigating climate change and that was highlighted by Fourqurean *et al* (2012). Subsequently, Short *et al* (2011) estimated that the value of ecosystem services of seagrasses is US$ 34,000.00 ha^{-1} /year.

Seagrasses are subjected to a magnitude of threats, declining rapidly in the last two decades, with many severe environmental impacts (Dahanayaka, 2009; Dahanayaka *et al.*, 2010). According to the Short *et al* (2011) emphasized that 20% of seagrass population reduction throughout the Indo-Pacific bioregion except for remote islands and areas of low development. With an estimated loss of 110 km^2 a year since 1980 (Serrano *et al.,* 2016; Cullen-Unsworth and Unsworth, 2013), and a loss of 29% of the seagrasses that were believed to have existed at the beginning of the twentieth century (Unsworth and Cullen-Unsworth, 2013), it is clear that seagrasses are still the 'ugly duckling' of the conservation world and greater reignition of their high value is needed. The tropical Indo-Pacific bioregion has the highest percentage of seagrass species globally, where trends in population are generally unknown (Short *et al.*, 2011). Meadows are heavily affected by overexploitation of fisheries resources and deterioration is commonly associated with coastal development and poor land management in many areas (Cullen-Unsworth *et al*., 2013). However, because of the scarcity of historic data, it is difficult to assign such rates of change in South-East Asia and South Asia (Unsworth *et al*., 2016).

Comparing to other coastal ecosystems, minute information, that is restricted to species composition is available for seagrass ecosystems in Sri Lanka (De Silva and Amarasinghe, 2007) . Therefore, Seagrass meadows are still not completely documented and many information gaps exist as a result. The main objective of this study is to influence decision making and coastal planning in Sri Lanka with the increased knowledge on the seagrass habitats in Palk Bay with special reference to Dugong conservation. This will help to understand the current status and development of conservation implication in order to manage seagrass of the area in long term.

2. METHODOLOGY

This study incorporates field observations and high spatial resolution WV-2 imagery processing techniques to provide an assessment of shallow coastal marine seagrass beds in Palk Bay, North-Western coast of Sri Lanka. Field observation were conducted in once a month during 2015 to 2016 and methods included free diving, monitoring transect lines, quantify quadrats, and underwater photography techniques. Locations of sampling transects given in Figure 1. Abundance, species diversity and biomass of the seagrass beds will be assessed in order to quantify the remaining extent of seagrass areas to be managed/ restored. Cloud free WV-2 satellite imageries of 15th June 2015 and 11th February 2016 were selected as remote sensing data sources. After image pre-processing, supervised image classifications were performed using maximum likelihood, minimum distance to means, and spectral angle mapper methods to compare relative accuracies in mapping seagrass coverage.

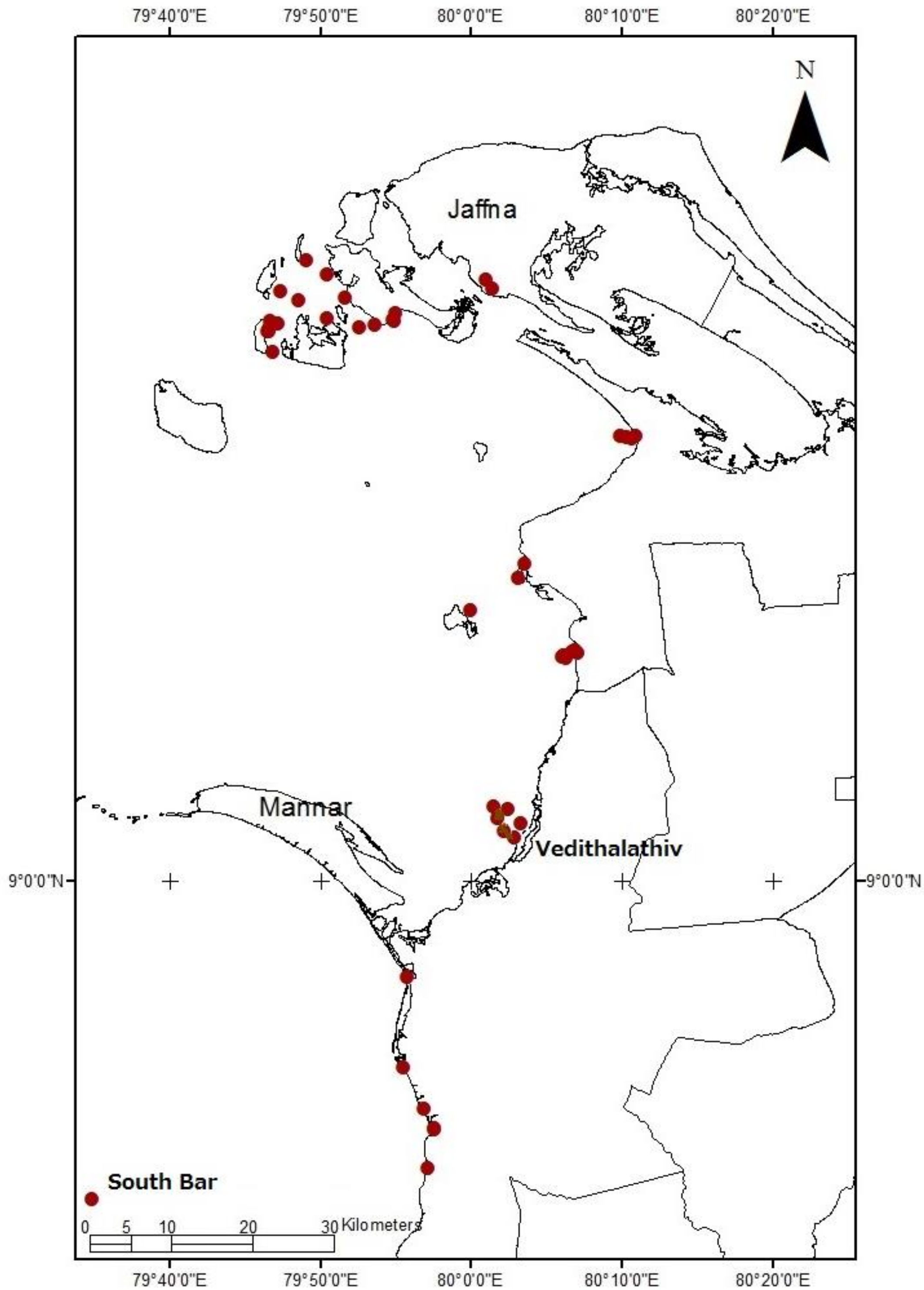

Figure 01: Map of Seagrass bed sampling locations

3. RESULTS & DISCUSSION

Common species encountered in study areas were *Enhalus acoroides*, *Cymodocea rotundata*, *Cymodocea serrulata* and *Halodule pinifolia*. Seagrass distribution along the Iranamatha transect gives as example in Fig 02. The maximum likelihood classification produced the highest overall accuracy of 94%. The spectral angle mapper yielded the lowest accuracy due to the predominant influence of water-column optical properties on the apparent spectral characteristics of seagrass and sand bottom. The results achieved by our classification methodology were validated with visual interpretation and field data. The combination of in-situ data and three classification methods resulted in highly accurate classification outcomes that showed the distribution patterns of seagrass of the study area. Based on the results, we conclude that eight-band high resolution multispectral WV-2 satellite imagery has great potential for mapping and monitoring seagrass beds in shallow coastal waters with large-scale coverage. Fig. 3 shows 0.5 m resolution seagrass distribution map estimated from WV-2 satellite imagery using the in-situ seagrass data with atmospherically corrected WV-2 satellite imageries. Thus, the primary results of this study provide useful baseline information that is necessary for marine-conservation strategic planning incorporated to protecting feeding grounds of dugongs around the North-Western coast of Sri Lanka.

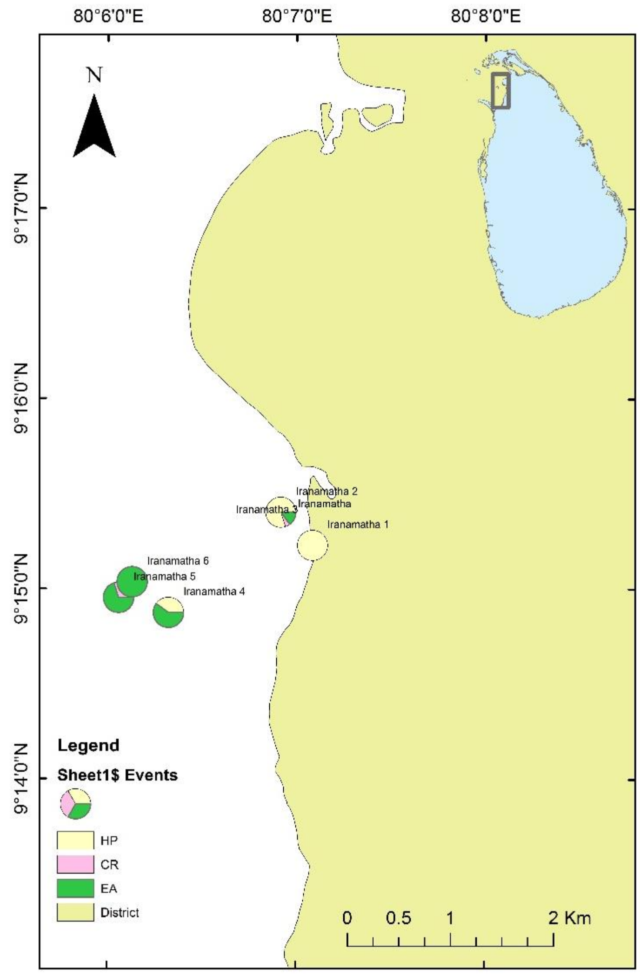

Figure 02: Seagrass distribution along the Iranamatha transect
HP- *Halodule pinifolia*; CR - *Cymodocea rotundata*; EA - *Enhalus acoroides*

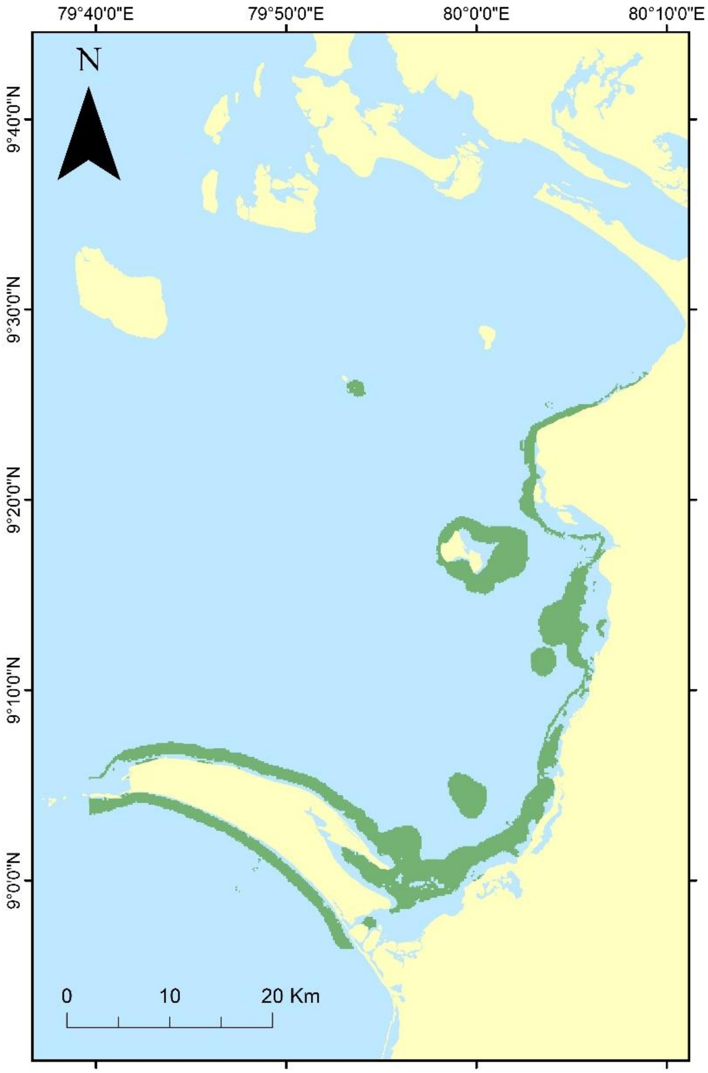

Figure 03: Seagrass distribution maps derived from the satellite data

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