Full Length Research Paper

Mapping the extend of seagrass meadows of Gulf of Mannar Biosphere Reserve, India using IRS ID satellite imagery

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Gulf of mannar marine biosphere reserve is the first of its kind in India and also in south east Asia. It extends from Rameswaram in the north to Tuticorin in the south. GOM is having a chain of 21 islands running almost parallel to the mainland. These areas are endowed with a combination of ecosystems including mangroves, seagrasses and coral reefs. Remote sensing techniques offer a wide range of possibilities in the study of various ocean related parameters. During the present survey, the occurrence of 12 seagrass species in the islands was verified and is mapped using satellite imagery. The study reported a total of 85.5 sqkm area covered by seagrass beds in Gulf of mannar (GOM) based on IRS- 1D 1998 satellite data and there is a need for the continuous monitoring of the seagrass resources because of its importance to the marine environment.

Key words: Gulf of mannar, remote sensing, seagrass, mapping, IRS-ID.

INTRODUCTION

Seagrasses are commonly found in shallow coastal marine locations, salt marshes and estuaries. Seagrass ecosystem provides habitats for a wide variety of marine organisms, the relatively high rate of primary productions of seagrass and its contributions to detritus based food chains help support many of these organisms. Seagrass are effective in removing nutrients from marine waters and surface sediments and are therefore, important in the control of water quality of coastal waters. The importance of seagrass as they are often correlated to the fish breeding ground can assists in identifying both fish breeding and fishing grounds (Patriquin, 1972).

Seagrass ecosystems are sensitive to impacts linked with human activities and are undergoing substantial declines (Jagtap et al., 2003). Hence, the management of seagrasses becomes a major issue and accurate information on seagrass distribution plays a vital role for the management of seagrass resources. For the management and monitoring of seagrass beds, a large scale mapping programmes were undertaken in recent years (Barsanti et al., 2007; Thangaradjou et al., 2008).

Seagrasses are the only marine flowering plants, capable of completing their life cycles when they are submerged in the sea water (Kannan and Thangaradjou, 2006). Of the 13 genera and 58 species of seagrasses reported all over the world, 14 species belonging to 6 genera are in India, out of which 13 species are found in the Gulf of mannar biosphere Reserve (Kannan et al., 1999). Seagrasses ecosystems are considered to be very productive and seen as nursery and breeding ground for many marine organisms. Seagrasses also acts as sediment stabilizers, provide a suitable substratum for epiphytes and a good source of food for marine herbivores, as well as fodder and manure.

Remote sensing techniques offer a wide range of possibilities in the study of various ocean related parameters. The unique capabilities of satellite based sensors in providing a wide spectrum of information available through the electro magnetic spectrum in repetitive and synoptic coverage over in accessible and larger areas in frequent intervals made the remote sensing technology an effective tool in the sustainable development and management of our environment and resources (Kasturirangan et al., 1996). Monitoring the extension of

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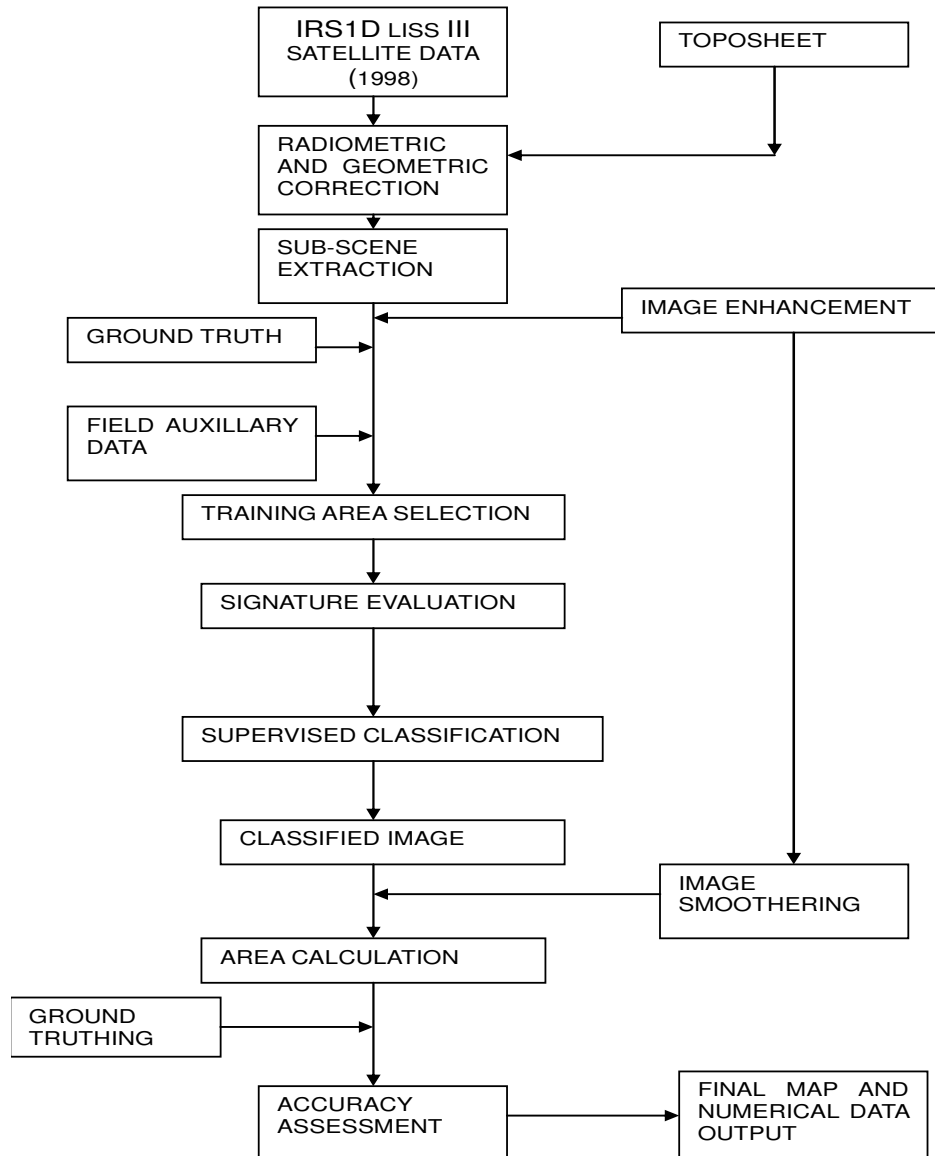
Figure 1. Flowchart showing the methodology.

seagrass meadows over time is of primarily importance for the surveillance of marine coastal diversity. Applications of remote sensing techniques for mapping seagrass resources were investigated by several peoples over a period at different locations, mapping of *Cymodocea nodosa* in Gulf of Tigullio (Barsanti et al., 2007), spatial and temporal variations of submerged aquatic vegetations of Chwaka Bay (Gullstrom et al., 2006) and impact of Indian ocean tsunami on coastal ecosystems including seagrass ecosystem (Chatenoux and Peduzzi, 2007) are the some recent reports.

Thangaradjou et al. (2008) mapped the seagrass resources of the Mandapam group of islands and found large scale seagrass loss due to man made activities. Though few studies on seagrass mapping are available for Gulf of mannar, they are not completely covering the whole study area. In this paper an attempt is made to map and monitor the seagrass beds in Gulf of mannar biosphere reserve for the conservation and management of these resources using remote sensing and GIS.

Study area

Gulf of Mannar extends from Tuticorin to Rameswaram Island in the SW- NE direction, lies between 78°5' and 79°30' E longitudes and 8°47' and 9°15' N latitudes to a length of about 140 km. There are 21 Islands (Figure 1) situated at an average distance of about 8 km from the coast and running almost parallel to the coast line. These
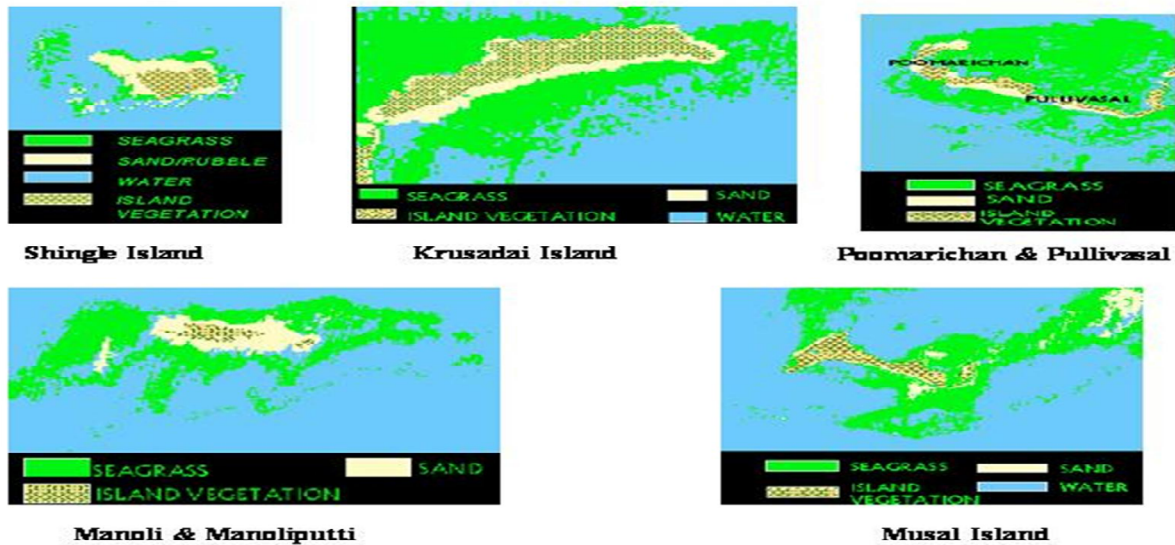
Figure 2. Seagrass map of Mandapam group.

islands are broadly grouped into Mandapam, Keelakarai, Vembar and Tuticorin group of islands. These areas are endowed with a combination of ecosystems including mangroves, seagrass and coral reefs.

MATERIALS AND METHODS

The base map of the study area was prepared using survey of India (SOI) 1975 toposheets (58 0/7 and 8, 0/3 and 4, 58 K/16, 58 K/12, 58 K/8 and 4, 58 L/1 and 5). Remote sensing data [IRS-1D, LISS III (Path 101/Row 68 and Path 102/ Row 67)] of 1998 was loaded in ERDAS imagine. Ground control points were identified both in remote sensing data and corresponding rectified SOI toposheet for features such as intersection of roads, road- rail, road- canal etc. Using the ground control points and their statistics the image was rectified.

   Using the rectified imagery supervised classification was carried out in ERDAS Imagine. The island was classified with respect to the coral reef ecosystem, mangroves and seagrass beds by using the corresponding reflectance values and field knowledge. An image interpretation key is the inherent element within an image that can provide clues towards the detection, identification and measure-ment of various features base on the tone, texture, shape, location and associated features.

Ground truth verification

In this study seagrass map was prepared after incorporating the necessary corrections that are observed during the ground truth check. 70 random points were selected with reference to survey of India toposheet and plotted on the interpreted maps. DGPS was used to correctly locate the points in the field and was fed into the base map after necessary corrections. Species identification was carried out after verifying the seagrass beds using the base map derived from satellite imageries. The validation work has been combined with field work in order to verify more categories apart from the random points selected for estimation of classification accuracy.

RESULTS AND DISCUSSION

Seagrasses are the widely dispersed group of plants comprising relatively few species and are often overlooked due their submerged environment (Short et al., 2007). Seagrass play an important ecological role in coastal ecosystems due to their habitat value for many organisms. Even though Gulf of mannar is blessed with coral reefs, mangroves and seagrasses, the literature on seagrasses were not appreciable. Seagrass mapping and the island wise details of the seagrass resources were undertaken only in the recent decades (Thangaradjou et al., 2008). Previous work related to seagrass of the Gulf of mannar is limited to primary productivity in the seagrass beds and its growth (Kannan et al., 1998; Kannan et al., 1999).

   The potential of using satellite remote sensing tech-nology for detection and assessment of submerged aquatic vegetation has been demonstrated in numerous studies including mapping of spatial change, spectral distinction between seagrass and other aquatic habitats and cost effectiveness (Mumby et al., 1999). Our study supports the use of satellite image analysis (IRS 1D LISS III) to map the distribution pattern of seagrass in the islands of Gulf of mannar.

   During the present study seagrass areas around the Islands of Gulf of mannar was estimated to be 85.5 sqkm based on IRS- 1D 1998 satellite data. Out of 14 species reported from Indian coast, 13 species belongs to Gulf of mannar (Kannan et al., 1999). During the present survey 12 seagrass species are identified following the keys of Ramamurthy et al. (1992) and the seagrass meadows of each island is mapped using satellite imagery (Figure 2, 3, 4 and 5). Distribution of seagrasses along the Indian coast varied with varying species diversity. The island wise classifications and the mapping of the seagrass
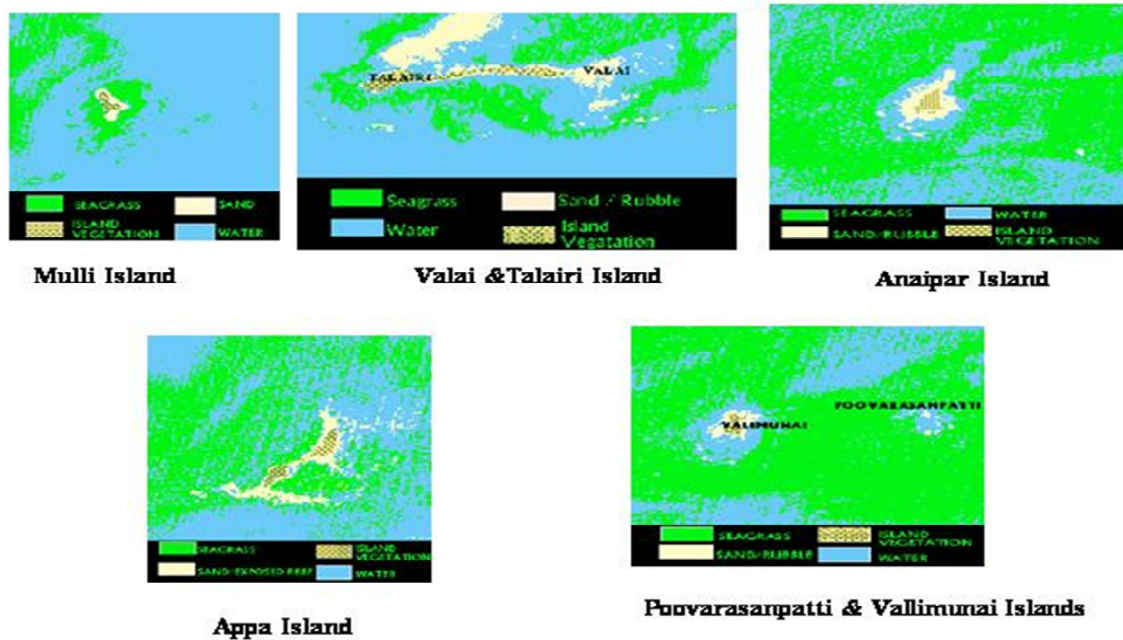
Figure 3. Seagrass map of Keezhakkarai.
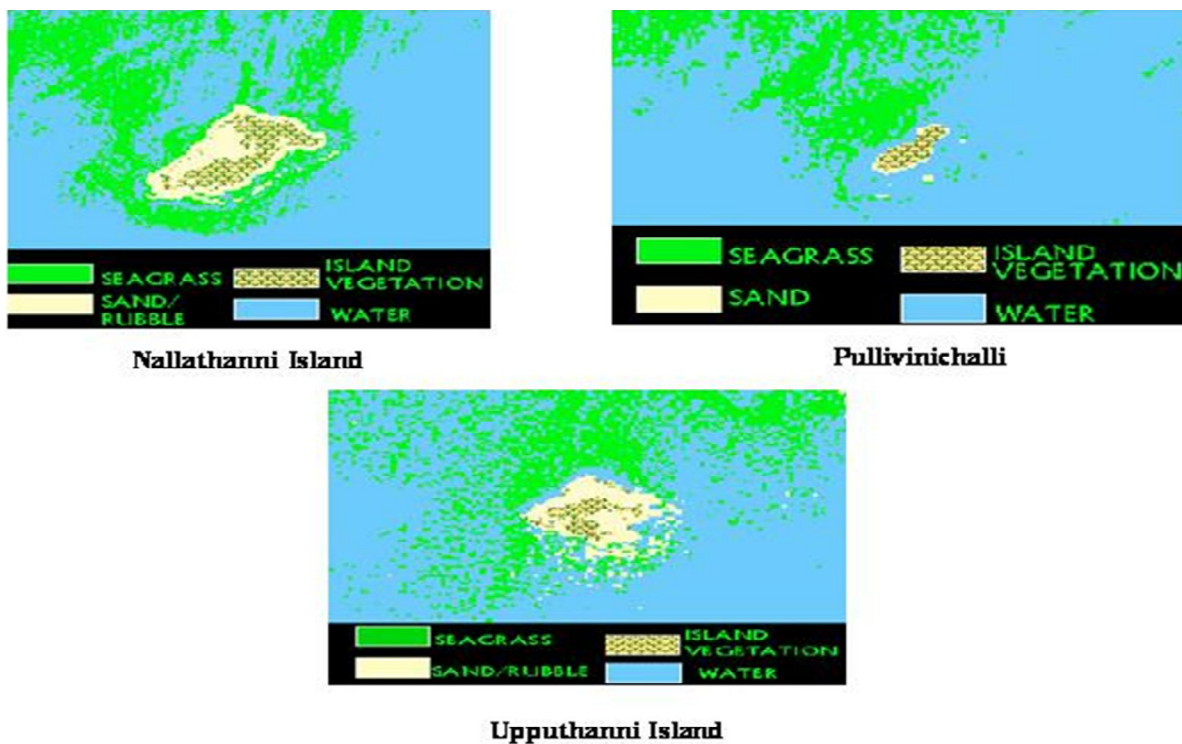
Figure 4. Seagrass map of Vembar group.

were not undertaken in the past in Gulf of Mannar.

During the present survey, the species diversity of the 21 islands (Table 1) were undertaken and the aerial extend of the seagrasses were mapped using satellite data (Table 2). Anaipar Islands in the Keezhakkarai group showed the maximum seagrass cover of about 14 sqkm. A total of 11 species were recorded from this station where as the islands which reported 12 species of sea-

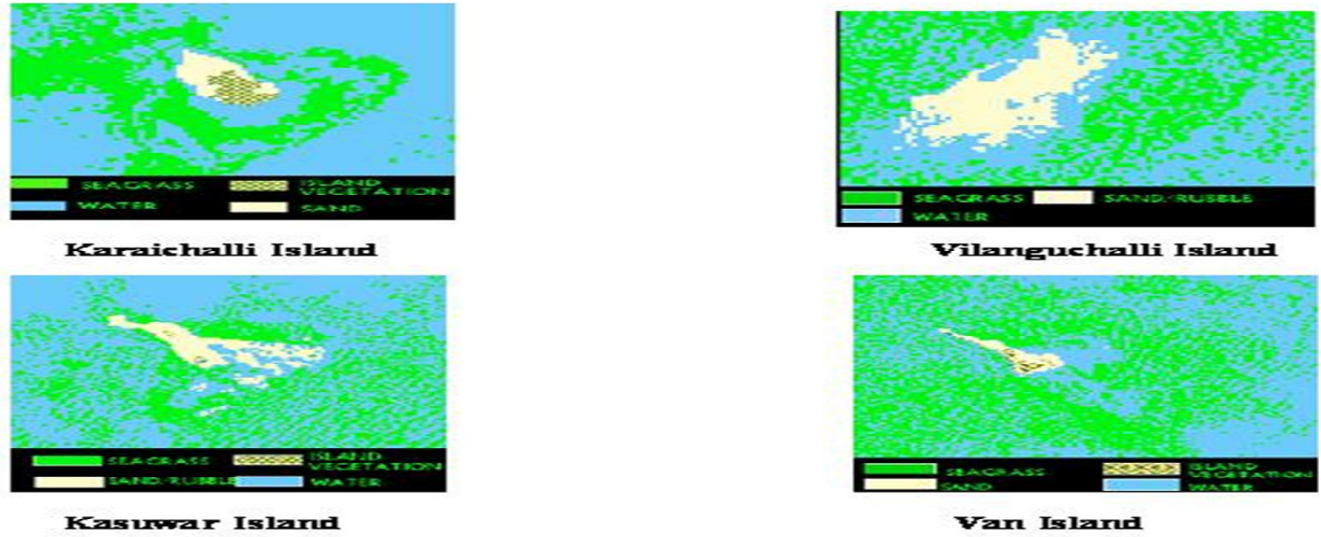**Figure 5.** Seagrass map of Tuticorin group.

Table 1. Seagrass species diversity in the islands of Gulf of Mannar

Species	Shingle	Krusudai	Pullivasal	poomarichan	Manoliputti	Manoli	Musal	Mulli	Valai	Taliri	Appa	Poovarasanpatti	Valimunai	Anaipar	Nallathanni	Pulivinichalli	Upputhanni	Karaichalli	Vilanguchalli	Kasuwar	Van
Enhalus acoroides	-	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thalassia hemprichii	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Halophila beccarii	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Halophila decipiens	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Halophila ovalis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
Halophila ovata	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Halophila stipulacea	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Syringodium isoetifolium	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cymodocea rotundata	+	+	+	+	+	+	+	+	+	+	-	-	-	+	+	+	-	+	+	+	-
Cymodocea serrulata	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
Halodule pinifolia	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Halodule uninervis	+	+	+	+	+	+	+	+	+	-	-	-	-	+	+	+	+	+	+	-	-
Total no. Species	12	12	12	12	12	12	12	11	11	10	9	9	9	11	11	11	10	11	11	8	9

Table 2. Area coverage of seagrass in Islands of Gulf of mannar.

Island Group	Island Name	Area(sq.km)
Mandapam	Shingle	0.21
	Krusadai	3
	Pullivasal and Poomarichan	5
	Manoli and Manoliputti	5
	Musai	9.5
	Mulli	2
	Valai and Talairi	8
Keezhakkarai	Appa	8
	Poovarasanpatti and Vallimunai	11.5
	Anaipar	14
	Nallathani	5
Vembar	Pulivinichalli	1.5
	Upputhanni	2.5
	Karaichalli	1
Tuticorin	Vilanguchalli	1.5
	Kasuwar	3
	Van	5

grass shows less than 3 sqkm area cover only. Mandapam group of islands reported the maximum species diversity with 12 species when compared to other island groups, this results supports the earlier findings (Ramamurthy et al., 1992). Sridhar (2005) used standard FCCs of IRS LISS III of 1996, 2000, 2002 and 2004 for mapping the seagrass of Palk Bay and noticed that there are similarities in tonal variations of coral reefs, reef vegetation, and seagrasses. These similarities in tonal characters would have made it difficult to map the seagrass resources as a separate entity by several workers (Thanikachalam and Ramachandran, 2003; Bahuguna and Nayak, 1998) and so they have included seagrasses in reef vegetation class.

Conclusion

Mapping of seagrass beds using remote sensing and GIS has demonstrated that these tools can be excellently used for determining the extend of seagrass coverage in the islands of Gulf of mannar and for the future monitoring and policy implementation. Aerial surveys and remote sensing is widely used as a tool to monitor the changes in seagrass meadows. The overlay facility of GIS can be utilized to understand the distribution of seagrasses with reference to depths. This can be used for demarcation of boundaries for conservation and management and protection. The present survey found 12 seagrass species of seagrass and are mapped in island wise category using remote sensing and GIS technology. An area of 85.5 sqkm was reported with the presence of seagrass beds in Gulf of mannar.

Current sectoral approaches to the management of marine and coastal resources have generally not proven capable of conserving the biological diversity. The present Indian remote sensing satellite series like IRS P6 LISS III and LISS IVMX may also be used for the real time monitoring of the coastal resources in future because of its better resolution. New models are needed to move planners towards multiple uses, systems oriented and community based management approach. We can no longer continue to take seagrasses granted or assume that they can support unlimited resource exploitation or unmanaged global trade.

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