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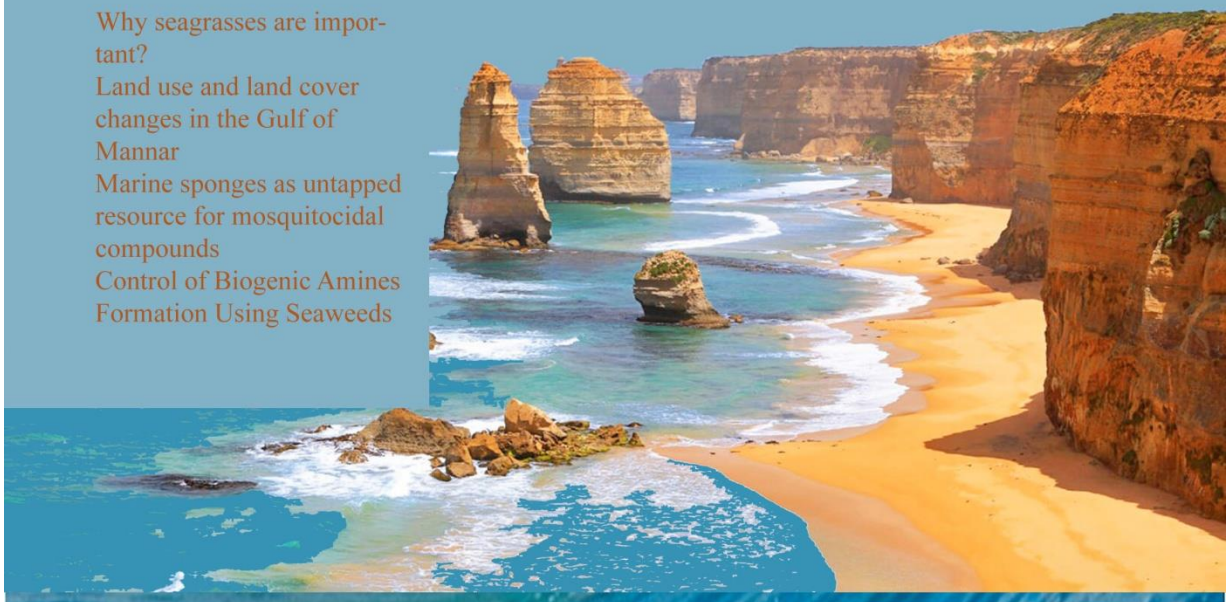
Control of Biogenic Amines Formation Using Seaweeds



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Why seagrasses are important?

Introduction

Seagrass meadows produce a variety of goods (finfish and shellfish especially crustaceans) and provide ecological services (preservation of marine biodiversity, directive of the quality of coastal waters, guard of the coast line) which are directly used or beneficial to humans and condition the economic development of Indian coastal zones. Seagrasses are an artificial grouping of grass-like plants that grow in or around aquatic marine ecosystems. The name seagrass is purely descriptive as is the name seaweed with respect to marine algae. Seagrass leaf canopies dampen water movement and favour the retention of suspended particles, both living and dead, becoming a sort of a filter for coastal waters (Ward *et al*., 1984). The particle trapping capacity of seagrasses is enhanced by the organisms living on the leaves either through filter feeding and active capture, or through the direct attachment of the suspended particles to the mucus-covered seagrass surfaces which result from their activity. However, the term seagrass aptly defines a group of angiosperms that are specially adapted to grow in estuaries and marine ecosystems. In addition, seagrasses are indicators of the status of the coastal zone which can be used in coastal management strategies aiming at preserving or improving the environmental quality of the coastal zone (Govindasamy and Arulpriya, 2011).

Distribution and diversity

Seagrasses, marine flowering plants, are widely distributed along temperate and tropical coastlines of the world. Seagrasses have key ecological roles in coastal ecosystems and can form extensive meadows supporting high biodiversity. The global species diversity of seagrasses is low (< 60 species), but species can have ranges that extend for thousands of kilometres of coastline. Seagrass bioregions are defined here, based on species assemblages, species distributional ranges, and tropical and temperate influences. Six global bioregions are presented: four temperate and two tropical (Hemminga and Duarte, 2000). The global distribution of seagrass genera is remarkably consistent north and south of the equator; the northern and southern hemispheres share ten seagrass genera and only have one unique genus each. Some genera are much more species than others, with the genus Halophila having the most seagrass species. There are roughly the same number of temperate and tropical seagrass genera as well as species. The most widely distributed seagrass is *Ruppia maritima,* which occurs in tropical and temperate zones in a wide

variety of habitats. Seagrass bioregions at the scale of ocean basins are identified based on species distributions which are supported by genetic patterns of diversity. Seagrass bioregions provide a useful framework for interpreting ecological, physiological and genetic results collected in specific locations or from particular species.

The Republic of India is in South Asia and comprises of the majority of the Indian subcontinent. It has a coastline of over seven thousand kilometres, borders Pakistan to the west, the People's Republic of China, Nepal, and Bhutan to the northeast, and Bangladesh and Myanmar to the east. On the Indian Ocean, it is adjacent to three island nations - the Maldives to the southwest, Sri Lanka to the south, and Indonesia to the southeast. India also claims a border with Afghanistan to the northwest. The Seagrasses of India consist of 14 species belonging to seven genera. The main seagrasses are *Cymodocea serrulata*,*C. rotundata,Enhalus acoroides, Halodule pinifolia, H. uninervis,Halophila ovalis, H. ovata, Syringodium isoetifolium,* and *Thalassia hemprichii*.Species such as *Halophila spp*. occur in patches as mixed species. The Tamilnadu (southeast) coast harbours all 14 species, while 8 and 9 species have been reported from Lakshadweep and Andaman-Nicobar groups of islands, respectively (Kannan and Thangaradjou, 2006).The mainland eastcoast supports more species than the west coast of India.The major seagrass meadows in India exist along the southeast coast (Gulf of Mannar and Palk Bay) and in the lagoons of islands from Lakshadweep in the Arabian Sea to Andaman and Nicobar in the Bay of Bengal especially Palk Bay region.

Seagrasses as promoters of biodiversity

Seagrass meadows produce a variety of goods (finfish and shellfish) and provide ecological services (maintenance of marine biodiversity, regulation of the quality of coastal waters, protection of the coast line) which are directly used or beneficial to humans and condition the economic development of marine and coastal zones. In addition seagrasses are indicators of the status of the coastal zone which can be used in coastal management strategies aiming at preserving or improving the Environmental quality of the coastal zone (Hemminga andDuarte, 2000).Seagrass leaves have been used as soil amendment and to feed pigs, rabbits and hens in several areas. The large knowledge about the biology and ecology of seagrasses gained during the last third of the 20thcentury has driven increased awareness of the economic value of seagrasses to humans. The

biological resources and ecological services provided by seagrasses are based on the physical structure of the plants themselves and the underwater meadows they form, their biological activity, and that of the associated fauna and flora (Costanza *et al.,* 1997).

Seagrasses as promoters of biological productivity

Seagrasses provide habitat for a large set of organisms which cannot live in a stagnated bottoms. The leaf canopy and the network of rhizomes and roots provide substratum for attachment, which is scarce in unconsolidated bottoms, stabilize the sediment, and reduce irradiance producing an array of microhabitats not present in unvegetated bottoms. In addition, the three-dimensional structure of seagrasses creates hiding places to avoid predation (Hine, et al., 1987. The abundance and diversity of the fauna and flora living in seagrass meadows are consistently higher than those of adjacent a deteriorated areas. Seagrasses, therefore, increase habitat diversity and the biodiversity of the coastal zone especially bottom of intertidal zone. Seagrasses feature high rates of primary production.Seagrass leaves have for centuries been used as soil amendment, cattle feed and as filling and building material. Here leaves of *Cymodocea serrulata*used for roof covering on a farm house. The primary production of epiphytic algae growing on seagrasses andof benthic algae living in seagrass meadows is comparable to that of the seagrasses themselves. Together with the secondary production of associated fauna, those contribute to make seagrass ecosystems as productive as many agricultural crops and forests on land. The coastal zone is a dynamic environment and currents and waves detach part of seagrass biomass and transport it to adjacent marine and terrestrial ecosystems(Pearce, 1998). These inputs of organic matter may locally be quite high (i.e., to the point that they sustained direct exploitation by humans as described previously), and contribute significantly to the function of biological communities of adjacent habitats (such as beach fauna). In addition, migrating birds use shallow and intertidal seagrass meadows as resting and feeding areas during their travels. Brent geese, wagons and pintails feed preferentially on seagrasses, other birds feed on associated fauna. Seagrasses as filters improving water quality.

Seagrasses as coastal protection elements

The leaf canopy and the network of rhizomes and roots fix and stabilize the sediment over which seagrasses grow, and reduce the re-suspension of

the sediment by currents and waves. This role is 10 driven by reduced water motion due to canopy friction and by the structural frame that rhizomes and roots provide to the sediments (Bulthuis *et a*l., 1997). Sediments vegetated by seagrasses are less likely to be mobilized by waves and currents, so that seagrasses can reduce the erosion of the coastline. Detached seagrass leaves, which are lost either at the end of their life or earlier due to waves and storms, and their accumulation in the beaches represent another way by which seagrasses have a role in the protection of the shoreline. Large accumulations of leaves, such as those of *Posidonia oceanicain* the Mediterranean and eelgrass in northern Europe, dissipate wave energy and directly protect beach sediments from the impact of waves. Seagrasses are importantelements of coastal protection not only because they protect the sediments from being eroded but also because they actually may produce sediment (Gacia and Duarte, 2001). In the Palk Bay for example, the particles that constitute the sediment have in many cases a biological origin being fragments of the skeletons,shells or spines of marine animals or being the calcareous remains of benthic algae. As seagrasses waterfront a large diversity of marine organisms, the meadows can be considered a net source of new sediment.

Conclusions

Why are seagrasses important? - Seagrass meadows produce a variety of goods (finfish and shellfish, sediment) and provide ecological services (maintenance of biodiversity, water-quality control, shore-line protection) that are directly used or beneficial to humans. The presence and abundance of seagrasses, can be considered, therefore, as indicators of the overall environmental quality of the coastal zone.Goods and services provided by seagrass meadows 9 carbon to sustain seagrass growth and biomass production. Seagrass meadows produce a variety of goods (finfish and shellfish, sediment) and provide ecological services (maintenance of biodiversity, water-quality control, shore-line protection) that are directly used or beneficial to humans. The presence and abundance of seagrasses, can be considered, therefore, as indicators of the overall environmental quality of the coastal zone. In addition to fisheries, urban development, tourism and other recreational activities are significant parts of the economy of Asian and Indian countries with access to the sea, and these activities are highly dependent on the quality of the coastal water and the stability of the coastline, conditions which are strongly supported by healthy, well-developed seagrass meadows. Seagrasses are,

therefore, an important and valuable resource amenable to economic quantification and their conservation should be given high priority in coastal management.

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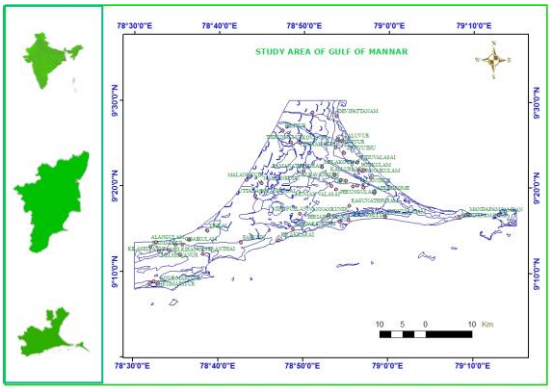
Land use and land cover changes in the Gulf of Mannar using GIS Techniques

1. Introduction

Human-dominated environments include various types of land use such as managed forests, agricultural fields, grasslands and pastures used to produce food for livestock but also oceans, seas, lakes, rivers, coastlines, and deltas used for transport, fishing, and irrigation as well as urban environments with varying amounts of vegetation. All these environments have significant and in some cases crucial interactions with climate, air quality, ecosystem services and biodiversity of the region on a potentially very large range of spatial and temporal scales. Land use / Land cover change has become an important component in current strategies for managing natural resources and monitoring environmental changes. The advancement in the concept of vegetation of the spread and health of the world's fores`t, grassland and agricultural resources has become an important priority. Although the terms land cover and land use is often used interchangeably, their actual meanings are quite distinct. Land cover refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or other. Identifying, delineating and mapping land cover is important for global monitoring studies, resource management, and planning activities. Identification of land cover establishes the baseline from which monitoring activities (change detection) can be performed, and provides the ground cover information for baseline thematic maps. Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture. Land use applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the land use changes from year to year. This knowledge will help develop strategies to balance conservation, conflicting uses, and developmental pressures. Issues driving land use studies include the removal or disturbance of productive land, urban encroachment, and depletion of forests. Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy.

1.1 Study area Description



Latitude: 9º 5′ To 9 º 30′

Longitude: 78 º 30′ To 79 º 15′

Total area covered: 1024 sq.km.

Ramanthapuram District has an area of 4123 km², and a population of 1,183,321 (as of 2001). It is bounded on the north by Sivaganga District, on the northeast by Pudukkottai District, on the east by the Palk Strait, on the south by the Gulf of Mannar, on the west by Thoothukudi District, and on the northwest by Virudhunagar District.

Figure 1. Study area Location map

2. Materials and Methodology

2.1. Data Products Used

The data products for the study used both Satellite data and Survey of India toposheets. Survey of India Toposheets-58K/ 11, 12, 15, 16&58O/ 3, 4 on 1: 50,000 scale.

2.2. Data Acquisition

Table 1. Data Products

Satellite data	Date of pass	Product Scale
IRS – 1B LISS II	22,May 1995	1: 50,000
IRS – 1B LISS III	08,January 1979	1: 50,000
LANDSAT ETM	2006	1: 50,000

2.3. Software Used

Arc GIS 9.3(GIS S/W)

3. Data Base Generation

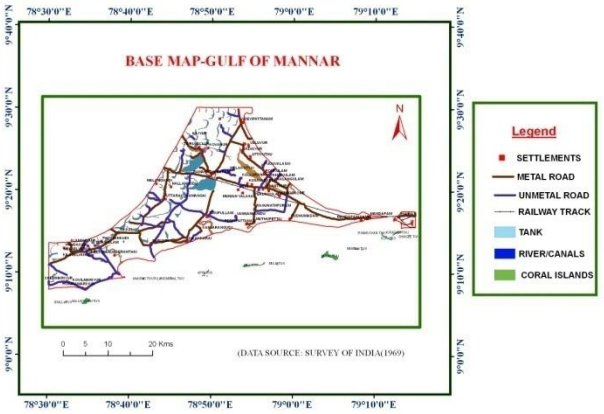
The development and assessment of geology, geomorphology ecology, land cover, natural resources need précised maps. The specific purposes maps are often referred as "thematic" maps because they contain f\information about a single object or theme, to make the thematic data easy to understand. The namely sensed data provides more reliable information on the different themes. Hence in the present study various thematic maps were prepared by visual interpretation of geo-code satellite imagery, SOI Toposheets. All the thematic maps are prepared in 1: 50,000 scale.

3.1. General Methodology for Preparation of Thematic Maps Using SOI Toposheets

The survey of India Toposheets No - 58K/ 11, 12, 15, 16&58O/ 3, 4 has been used. From the SOI Toposheets the following basic thematic maps prepared. Base Map, Drainage Map, Slope Map.

Base Map: Base map were prepared using SOI Toposheets, the following details were included; settlements, major roads, Railway line, major land marks and reserved forest boundary etc. All these details extracted from SOI Toposheets and the prepared map scanned using A0 colour scanner input

into Arc GIS for on-screen vector conversion. Based on the features different layer of data were formed, then these layers were geo-referenced so



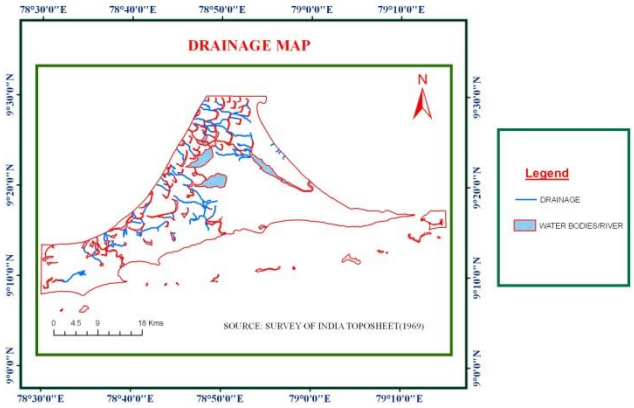
as to overlay one over the other.

Figure 2. Base map

Drainage Map: A drainage system that develops on a regional surface is controlled by the slope of the surface, the types, and attitudes of the underlying cracks. Drainage patterns which are visible on aerial photographs and satellite images. Drainage depends mainly on the type, distribution, attitude, attitude of the surface rocks, lines of weakness etc.

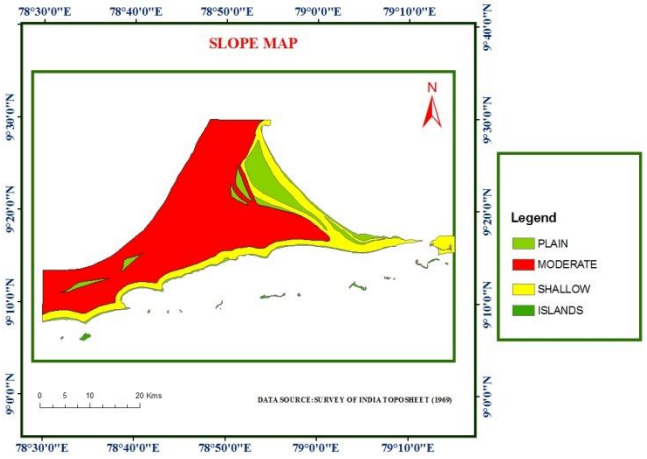
Figure 3. Drainage map

Slope Map: The slope is moderate to shallow degree there is a chance for more run of infiltration less automatically erosion is more in the present study slow prepared using toposheet data. Slope study classified on the two classes. The study area is found



to be very gently slope the slope show the different slope categories obtained and there are distributions in the study area. Slope classes: Moderate, Plain.

Figure 4. Slope map



3.2. General Methodology for Preparation of Thematic Maps Using Satellite Data

Land Use/Land Cover

The term land use means how a parcel of land is used, such as for agriculture, plantation, residences or industry etc. Land cover means the type of feature present on the surface of the earth like natural vegetation, water bodies, rock soil, artificial cover and others resulting due t land transformations. Cultivated land: The land which is used for intensively farming activities for

production of food, fibre, other commercial and horticultural crops.

Crop land: The lands with standing crop as on the date of the satellite imagery.

Fallow land: The agricultural land which is taken up for cultivation but is temporarily allowed to rest, without cropped for one or more seasons but not less than one year. These lands are particularly those which are seeing devoid of crops at the time, when the imagery is taken of both seasons.

Forest plantations: Generally forest plantations are species of forestry importance and are raised on notified forest lands, casuarinas plantations are grown so as to with stand high velocity winds, which accompany cyclones and other meteorological conditions and to present the coastal erosion.

Land with scrub: Lands which is in arid, semiarid and sub-tropical regions will have less water source as a result contains only scrubs, thorny bushes, grasses, hedges and small trees, normally not used for cultivation.

Sandy area: The area will typically contain sandy soils. Coastal areas such as beaches, sand bars and shoals are included in this category.

Marshy/swampy land: Permanently or periodically inundated by sea water and is characterized by vegetation which includes grasses and weeds.

Water bodies: Area of impounded water, includes man-made reservoirs/lakes/tanks/canals, natural lakes, rivers/streams and creeks.

Waste lands: Degraded land which can be brought under vegetative cover with reasonable effort and which is deteriorating due to lack of appropriate water and soil management or on account of natural causes.

Salt affected land: The land has adverse effects on the growth of most plants due to the action or presence of excess soluble or high exchangeable sodium and leaching out of minerals from soils.

Water logged land: Water logged land is the area where the water is at or near the surface and has been stagnant for most part of the year. Such lands usually occupy low-lying areas, topographically. In the study area around the northern part of Rameswaram Island some waterlogged lands have been observed. In the areas like Pillaikulam, Surantidal and Mangaud, this type of features has been observed. The total water logged land in the study area has been calculated to be 5.96 km^2.

Plantations: It is described as an area where tree crops are planted. Such plantations are basically divided in to forest and agricultural plantations.

Normally found in areas like sands to marshy.

Aquaculture: It is an art and science of growing and cultivating fishes and its varieties. It is otherwise called as fisheries. Aquaculture is predominant along the areas surrounding tidal creeks, present mud flats and palaeo mud flats.

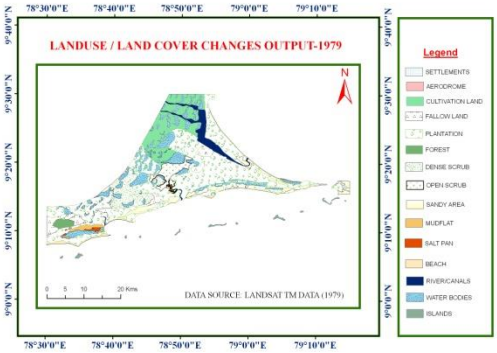


Figure 5. Land use land cover changes 1979

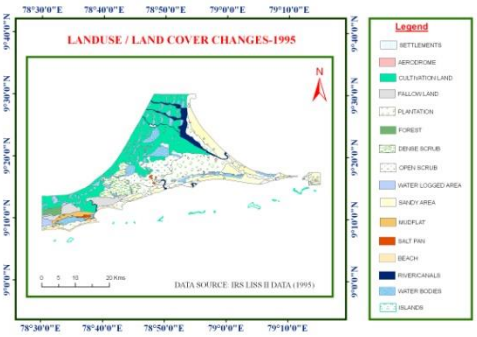


Figure 6. Land use land cover changes 1995

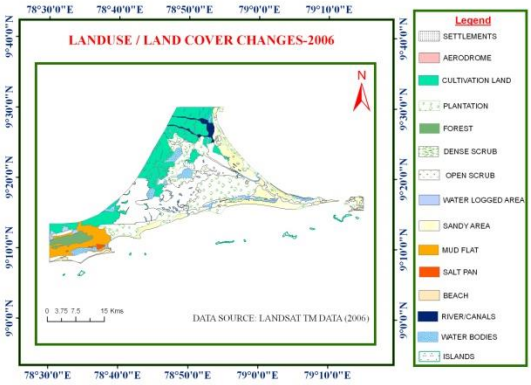


Figure 7. Land use land cover changes 2006

Results and Discussion

The current scientific technology of remote sensing and visual image interpretation is extremely useful in periodic assessment of the land use land cover studies. Land use/ land cover mapping serves as a basic inventory of land resources for all levels of government environmental agencies and private industries throughout the world (Shuck 2003). The classification was done under the following heads Settlements, Aerodrome, Cropland, Fallow land, Plantation, Forest area, Land with scrub, Land without scrub, water logged area, Swampy area, Sandy area, Mud flat, Salt pan, Beach, Water bodies In present years, the mechanical detection and analysis in multi temporal remote sensing images have assumed an ever increasing strategic role in numerous domains. This is direct result of the wide range of real world

applications that benefits from these methodologies, as proved by an impressive amount of literature published in the field (Singh 1989; Chavez and Mackinnon 1994; Bruzzone and Fernandez Prieto 2000). Land Use/Land cover mapping is of great significance in scientific, scholarly research, planning and management. Regional land use pattern reflects the character of interaction between man and environment and the influence of distance and resources based on mankind's basic economic activities. Remotely sensed satellite images provide a synoptic overview of the whole area in a very short time span. This leads to quick and truthful representation of the real world in the best possible manner. National Remote Sensing Agency (NRSA), India, Level II classification scheme has been adopted for the present study.

Conclusion

Ground truth verification was carried out to check the result obtained using a GPS system for validating the locations of different vegetation classes. In the study area traditionally rice, cotton, leguminous crops and chilies are being cultivated. However, the income generated through the yield from these crops was not guaranteed as the region is rain fed. This made the farmers to leave their lands uncultivated and promoted the growth of Prosopis juliflora scrub. The invasions of this woody scrub occupied the wetlands and water bodies. Regrettably the water bodies have also been affected by human induced land use changes. Invasive vegetation can affect wetlands by changing habitat structure, nutrient cycling productivity, food web composition and tropic level dynamics and by reducing biotic diversity (Andrew J. Rodusky et al., 2013) The agricultural land is converted into scrub land and wetlands decreased. The present study demonstrated the adaptability of remote sensing and GIS technology for mapping and monitoring the Land Use / Land cover dynamics and to understand the negative impacts on the environment over time with very low cost and short time. The rapid growths of Prosopis juliflora weed itself as a localized problematic scrub jungle. The invasions of this woody scrub occupied the wetlands and water bodies. Also it can be decrease moisture of atmosphere and ground water level. Continuous monitoring of these biological invasions is necessary for proper management. The efforts need to be taken to avoid the destruction of the wetlands and water bodies by this invasive plant.

Acknowledgements

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Marine sponges as untapped resource for mosquitocidal compounds

Sponges (phylum Porifera) are one among the oldest metazoan animals of aquatic environment since Precambrian period (Hentschel et al 2002). Sponges are living in diversified habitats like polar, deep oceans, freshwater lakes and streams. Eighty-five percent of the 6000 formally described living species belong to the class Demospongiae (demosponges) and other species represented by the classes Hexactinellida (glass sponges), Calcarea (calcareous sponges) (Fiesler et al 2004). Sponge-microbial associations synthesize clinically significant bioactive compounds havebeen discovered from geographically different regions such as Great Barrier Reef of Australia,South China Sea, Mediterranean Sea, Indonesia, Papua New Guinea, Indo-Pacific region *etc*. Members of the class Demospongiae are the richestproducer

of pharmacologically significant bioactive compounds in association with microbes.Only one family from the class Calcarea has been identified as asource of pharmacologically significant bioactive compounds. None of the bioactive compounds has been reported from the classHexactinellida (Remya et al 2010).Occurrence of the sponges in various shapes like encrusting, rope, ball, tube, barrel, vase and represented in different colours namely white, yellow, green etc. and variable in size (a few millimetres to nearly two metres) are reported (Hentschel et al 2006).Taxonomy of sponges was difficult due to the scarcity of consistent morphological parameters. Microbes compose up to 50% of sponge tissue volume. The bacterial load in sponges seems proportionally correlated with the irrigation status of the sponge. Sponges with a poor irrigation system contain high bacterial numbers while the well-irrigated sponges have fewer bacteria within their tissues (Wang et al 2006). Abundant colonization of extracellular bacteria in the mesophyl of many demosponges called 'bacteriosponges' or 'high-microbial-abundance (HMA) sponges) is contraryto the'low-microbial-abundance(LMA) sponges withless microbialcommunity (Hentschel et al 2006).

The presence of large numbers of bacteria within marine sponges was first established by microscopic studies. Early studies determined the association of bacteria with sponges based on bacterial morphology and recognized three types of associations of bacteriawith sponges. The first group composed of bacteria nonspecific to sponges which aresimilar to those of ambient seawater, intracellular bacteria that are specific to sponges belongs to second group and the third group consisted of specific bacteria for the sponge mesophyll (Taylor et al 2007).Cyanobacteria producing phycobili protein has greater influence over the coloration of the sponge host (Hentschel et al 2006). Low level of attention has been given tomarine fungi. Ecologically, they are importantintermediaries of energy flow from detritus to higher trophiclevels

and play an important role in nutrient regenerationcycles as decomposers of dead and decayingorganic matter (Wang et al 2006)

Role of symbionts in sponges

As a living fossil, sponges may contain genetic fingerprints for the origin of their microbes and could be good hosts for study of microbial evolution and biogeography.Sponge metabolism produces ammonia and host phagocytosis resulted in carbohydrates and amino acids synthesis. So, microbial communities utilize this resource of nutrients and colonize in their respective habitat sponges. Microbial association in sponges involved in nutrition, nitrogen fixation, nitrification, defense, skeleton stabilization of the invertebrate host (Hentschel et al 2002). FISH contributed the identification of metabolically active microbes living in sponge. Coevolution of microbes in sponge habitat is revealed by mitochondrial cytochrome oxidase and other studies etc. Selective absorption of specific symbiontsfrom marine environment or vertical transmission from parent sponge to larvae was documented.The necessity of microbial symbiont transmission in both female and male sponges has been documented (Webster et al 2012).Association of microbial communities in sponges was detected initially by electron microscopy and molecular techniques like 16SrRNA gene library, DGGE, FISH andmetagenomics.Recent report of Pyrosequencing revealed that *Chloroflexei*, *Acidobacteria*, *Actinobacteria* and*Proteobacteria* as major communities associated with Great Barrier Reef sponges which coincided with the earlier conventional 16srRNA libraries reported by Taylor et al 2007.Recent discovery of novel phylum'*Poribacteria*'wasreported inverongid sponges (Fieseler et al 2004) and later their specificity was disapproved in the recent study by Ian et al 2013.Analysis of 12 million 16SrRNA gene pyrotags concluded that the presence of sponge specific clusters with in the *Acidobacteria*, *Actinobacteria*, *Chloroflexei*,*Cyanbobacteria*, *Gemmatimonadetes*, *Alphaproteobacteria*, *gammaproteobacteria*associatedwith sponge host. Previously reported

Sponge specific clusters found in association other than sponge host in the marine environment. Advent of next-generation sequencing technologies will also evidence the same innear future (Taylor et al 2013). Environmental stress like rise in temperature, heavy metals induce shift in normal microbial community associated with sponge host. Loss of symbiotic microbes and abundant growth of motile, nutrient scavenging bacteria noticed due to elevated temperature in the sponge *Rhopaloeidesodorabile* (Fan et al 2013). Functional mechanism due to symbiosis may be disturbed and is mandatory to understand the consequences of microbial shift in response to environmental stress. Role of marine sponges in marine eco system and being arepository of different classes of pharmacologically important compounds has to be protected for future research.

Mosquitocidal activity of marine microbes other than sponge host

B thuringiensis from marine sediments has been reported in two different studies(Baig et al 2010, Maeda et al 2000). Being active genera of novel compounds synthesizer, *Streptomyces sp* from marine environment also proved mosquitocidal potential (Saurav et al 2013, Karthik et al 2011). *Bacillus thuringiensis*, *Bacillus subtilissubspsubtilis*, *B amyloliquefaciens*, *Pseudomonas flourescens* has been isolated from the mangrove eco system in Andaman nicobar islands and their pupicidal, mosquitocidal activity due to biosurfactant, metabolite/exotoxin was well documented (Geetha et al 2010,Geetha et al 2011, Prabhakaran et al 2003). Mosquitocidal strains from marine environment seem to be scanty and exploration of this diverse environment is a challenging task. *Bacillus thuringiensis* produces insecticidal crystal protein during stationary phase and likely to exist in different ecological niches like Soil, grain, insect cadaver, marine environment. Presence of *B thuringiensis* in marine sediments was reported by Maeda et al 2000. Toxic potential of the

B thuringiensis isolates were screened by PCR amplification of Cry genes profile of the isolates (cry1, cry4, cry7, cry8, cry9 and cry10). Half of the isolates had shown the presence of cry1 genes. Seventeen different profiles of cry genes were observed and revealed combination of cry genes. Molecular characterization of these isolates from marine habitat has shown the possibilities of potential strains for novel bioinsecticidal products (Baig et al 2010). Identification of *Actinobacteria*from marine sponges acclaimed forsynthesizing secondary metabolites. *Streptomyces gedanensis* crude extracts has shown activity against larvae of *Culexgelidus* (LC50-108.8ppm, LC90-609.15ppm) and against larvae of *C tritaeniorhynchus* (LC50=146.24 ppm and LC90=762.69 ppm). Repellent activity of the marine *S roseiscleroticus*, *S gedanensis* was reported at 1000ppm for 4 hours. So, Marine actinobacterial extracts has proven the greener strategy for the mosquito control (Karthik et al 2011). Larvicidal activity of the crude extract of *Streptomcyessp* has been reported with *Astephensi* (LC50=169.38 ppm); and *C tritaeniorhynchus* (LC50=198.75 ppm).5-(2,4-dimethylbenzyl) pyrrolidin-2-one (DMBPO), novel compound from this study resulted maximum activity against larvae of *A stephensi* (88.97 ppm)and *C tritaeniorhynchus* (74.95 ppm) (Saurav et al 2013).

Mosquitocidal activity of marine sponge extracts

Identification of 3500 (out of 12,000) novel marine natural products during 1985 to 2008, accelerated thedrug discovery and bioprospecting of marine sponges(Hu et al 2011).Novel compounds from marine origin have been reported with the good candidate sponges such as *P. purpurea*and *H.cribricutis with*LC50 at < 50 ppm against *A. aegypti*larvae. Other sponges like*Dendrillanigra*, *Petrosiatestudinaria*, *Petrosiasimiles*, *Haliclonapigmentifera*, *Irciniafusca*, *Sigmadociafibulata*showed LC50 values at <100 ppm. Significant activity was observed in both larvicidal and insecticidal assays with the Sponge extracts of*P. purpurea, H. cribricutis, D. nigra, H. pigmentifera*and *P. testudinaria.*

(Rao et al 2008). In India,*Dendrillanigra,Clathriagorgonoides, Axielladonnanihas* shown larvicidal potential against second instar larvae of *Culexsp* (Sonia et al 2012).The sponge extracts of *C. longitoxa*and *C. diffusa*were reported effective against *C. quinquefasciatus*larvae with the LC50 values at < 50 ppm. However, other extracts of *Dendrillanigra*(Den.), *Petrosia similes*, *Haliclonapigmentifera*, *Irciniafusa*, *Sigmadociafibulata*revealed LC50 values at <100 ppm (Joseph et al 2010).Methanol extract of*C. celata* showed the highest larvicidal activity at 500 ppm against *A agypti* and *C quinquefasciatus*.The LC50 and LC90 values of *C. celata*methanol extract were recorded for 95.63 and 242.16 ppm against *C. quinquefasciatus*larvae and 158.40 and 780.16 ppmagainst *A. aegypti*larvae, respectively. Methanol extract of *C. celata*possess 100% ovicidal activity against *C quinquefasciatus*and 72% ovicidal activity was noted in *Aaegypti* at 500ppm. The hexane extract of sponge was shown effective protectant against the adult mosquitoes of both species.The mean protection time recorded in hexane extract was up to 273 and 165 min at 5mg/cm2 dosage against *C. quinquefasciatus*and *A. aegypti*, respectively. Based on the observations in the study, *C. celata*could be exploited for newerpesticidal molecules (Reegan et al 2013).

Exploitation of marine sponges for novel leads &methodology for drug discovery

Marine sponges have been documented for mosquitocidal compounds evidenced by the recent findings of Indian researchers. Mosquitocidalactivity from extracts of marine sponges has been revealed by most of the studies. There is no other work emphasize the sponge associated microbes for mosquitocidal lead compounds. Earlier reports strongly suggested the existence of diversified microbial community associated with marine sponges and discovery of novel compounds served as anti-inflammatory, anti-tumor, anti HIV activity etc (Devi et al 2010, Selvin et al 2012). Bioactive compounds synthesis by fungi accounted for 65.71% followed by 34.28% was contributed by bacteria

associated with marine sponge. Among bacterial association with sponges, Actinobacteria as major contributor followed by *Proteobacteria*, *Firmicutes*and*Cyanobacteria*has shown the synthesis of novel bioactive compounds (Remya et al 2010). Previous research reports revealed that the microbial population in sponges was responsible for bioactive compounds and microbe cultivation enhances the production of novel compounds.So, marine sponge symbionts could be exploited for novel compounds with mosquitocidal activity. Isolation of sponge, cultivation of sponge associated bacteria and explored for antimicrobial activity, anticancer activityetc… (Thiel et al 2007,Rajdasa et al 2007, Gandhimathi et al 2009, Selvin et al 2009, Baker et al 2009, Schneemann et al 2010, Englehardt et al 2010, Devi et al 2010,Inbaneson et al 2011, Zhou et al 2011,Ravikumar et al 2012, Kiran et al 2014,Abdelmohesen et al 2014).

Importance of Marine sponge symbionts in search of bioactive compounds

Symbiotic microorganisms in marine sponges involved in the synthesis of bioactive compounds (Proksch et al 2002, Zhang et al 2005). Antibiotic isolated from the sponge *Dysideaherbacea* was actually synthesized by the symbiontCyanobacterium, Oscillatoria*spongeliae*. Sponge associated microbes like α-*Proteobacteria*, *Pseudoalteromonas* and *Actinobacteria*have been proven with antimicrobial activity against fungi, bacteria, virus and parasite and an immense source of novel compounds. Genus *Halichondria* was known for synthesis of diversified metabolites like Protein phosphatase inhibitor okadaic acid, macrolactam antibiotics, antitumor compounds, antioxidants, antifungal compounds due to the microbial association (Remya et al 2010). Presence of PKS (polyketide synthase) and NRPS (nonribosomal peptide synthetase) genes in *Actinobacteria*, *Bacillus*, *Sulfitobacter*and *Pseudovibrio*revealed the potential for secondary metabolite production. Synthesis of pharmacologically important compounds by marine sponges associated bacteria has been

proven itsnovelty. So, the microbial community in sponges should be exploited for mosquitocidal metabolites by laboratory cultivation.

Conventional approach for detection of bioactive compounds

Dereplication process is used to screen the compound with the already reported compounds using morphological, molecular characterization and techniques like HPLC-MS, NMR spectrum (Rocha martin et al 2014). Similarly Valinomycin, Staurosproine, butenolide were isolated from marine sponge associated *Streptomyces sp*. has been identified with anti-parasitic activities (Elardo et al 2010). Lobophorin C, D was isolated from sponge symbiont*Streptomyces carnosus* exhibited anticancer property (Wei et al 2011). Identification process is valuable for obtaining novel lead compound for mosquito control. Bioactivity guided screening has been used for direct detection of the antimicrobial, mosquitocidalactivity using the culture supernatant or extract of cell pellet (Devi et al 2010, Karthik et al 2011, Saurav et al 2013). Conventional methods like bioactivity guided fractionation need more time to obtain bioactive compound even at moderate quantity. Isolation of particular strain and bioactivity of the metabolite has to be checked(Bachmann et al 2014). So, it is essential to apply new detection methodology for identification mosquitocidal compounds.In this connection, genome mining will be the useful tool for screening metabolite encoding gene or NRPS and PKS gene cluster. Microbial genome size greater than 3Mb likely to possess one or more PK and NRP gene clusters (Boddy et al 2014). Conserved domains in PK and NRP gene clusters have been used for detection of potential isolates from the collection. 10 different actinomycetes isolated from Red Sea sponges were screened for PKS, NRPS genes and it has been proved active against bacteria,fungi,parasites (Abdelmohsen et al 2014,Schneemann et al 2010).

Gene-guided screening is a valuable tool to detect gene involved in the biosynthesis of the particular compound. For example, 24 out of 61

strains possess staD gene, which is essential for the synthesis of Staurosporine in *Streptomyces sp* and 15 strains were shown positive for KS domain involved in the synthesis of Salinosporamide

(Freel et al 2011). The combined strategy of gene and bioactivity based screens creates a more powerful tool which allows us to obtain valuable strains with the potential to synthesize new bioactive compounds. Sponge associated *Streptomyces sp* were screened for NRPS and PKS genes and most of the isolates possess antifungal and antibacterial activity using microwell culture. Thiopeptide antibacterial antibiotic was reported from *Nocardiopsissp*(Englehardt et al 2010, Zhou et al 2011).Biosurfactant encoding 'sfp' gene was used to screen many isolates of biotechnological potential from marine sediment samples (Porob et al 2013).

Applications of Genome mining approach& exploration for bioactive compounds

Rapid advancement in Bioinformatics and genome sequencing initiated the identification of gene cluster associated with the bioactive compounds and chemical structure prediction. In general, Genome mining defined as the process of technically translating secondary metabolite encoding gene sequences data in to purified molecules in tubes. Initiative should be the identification of genome encoded secondary metabolism in the process of genome mining.

Detection of PK or NRP biosynthetic gene cluster and investigation of a novel product encoding gene would be ideal task (Bachmann et al 2014).Comparative gene cluster analysis and structural prediction of NRPS/PKS products have been carried out by antiSMASH. It helped for Graphical display of query gene with the homolog in NCBI database and identification of gene cluster that encode for specific chemical moieties (Boddy et al 2014). AntiSMASH analysis of a bacterium *Actinokineosporasp* associated from marine sponge revealed 996 genes in 36 gene clusters for secondary metabolites synthesis. Genes for PKS, NRPS and hybrid NRPS-PKSII, lantipeptide, siderophore, ectoin, bacteriocin

identified. Diverse natural products like actinorhodin, tetronomycin were identified by another bioinformatics tool called NaPDoS from the same bacterium (Harjes et al 2014). Genes encoding bacteriocin, lantipepetide,Terpene were identified in three isolates of *Streptomyces sp* associated with Norwagian marine sponges (Ian 2014).Automated identification of Onnamide, Konbamides, Polytheonomaides encoding gene cluster was identified in sponge associated bacterium *Entotheonellasp* (Wilson et al 2014).

Most of the reports from marine sponges revealed the activity of sponge extracts. It is mandatory to study the origin of the compound synthesis and possible role of microbial association needs to be investigated thoroughly. Because most of marine natural products from marine realm and abundantly patented antitumor compounds originated from marine sponges (Koopmanns et al 2009). NRPS and PKS mega synthase enzyme complex was well known for the synthesis of diverse secondary metabolites and a conserved portion of this gene cluster used to screen potential symbiont associated with marine sponges. Potential isolate can be grown in optimized conditions in fermentor for the secondary metabolite of our interest (Fuerst, 2014). *Bacillus licheniformis*, sponge associated microorganism proved to synthesize biosurfactantsurfactin. Heterologous production of the biosurfactant increased from 2-3 fold than the original strain and could be used for bioremediation (Lawrence et al 2014), mosquitocidal agent (Geetha et al 2011, Geetha et al 2012). Use of chemical pesticides and increasing resistance of mosquito urged the researchers to find better alternatives for mosquito control. Marine sponges seem to harbor diversified community of microbes and potential mosquitocidal strain can be explored with the available genomics and bioinformatics tools.

In this connection, screening of marine sponge associated symbionts for mosquitocidal property could be done by NRPS or PKS based screening or known gene that encode for

mosquitocidal property. Biological actitvity of the compound has to be analyzed and genome mining of the particular isolate could be completed.Advantage of genome mining using bioinformatics tools will be used to identify novel gene clusters and their comparison with the existing database and their structure prediction.

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Control of Biogenic Amines Formation Using Seaweeds: A Mini Review

Biogenic amines of seafoods were extensively reported by various researchers because of their toxicological effects. Low levels of biogenic amines did not cause serious health risk to human and animal health, since the amines oxidase in human intestine can detoxify these amines. Histamine can also be detoxified by methylation by methyl trasnferases or acetylation (Lehane and Olley, 2000). But ingestion of higher levels of biogenic amines may result in toxicological problems (Ladero et al., 2010). The consumption of foods containing higher amount of biogenic amines can result in histamine fish poisoning and tyramine toxicity (Chong et al., 2011). Scombroid fish include, tuna, mackerel, bonito, skip jack, blue fish and saury, which contain high levels of free histidine in their muscle, are often implicated in scombroid poisoning incidents

when not properly processed and stored (Lehane and Olley, 2000). However, non Scombroid fish such as sardine, anchovy, herring, marlin, cap yellow tail, amberjack and sword fish have often been implicated in incidence of scombroid poisoning (Chang et al., 2008; Huang et al., 2010 and Lin et al., 2012).

Toxicity and defect action levels of histamine, established for mahi-mahi, tuna and related aquatic fish are 50 mg/100 g and 5 mg/100 g, respectively (FDA. 2011). In India, maximum legislation limit of histamine in all aquatic fishery products is 20 mg/100g (Sankar et al., 2014). Ten-Brink et al. (1990) stated that total biogenic amines level 10 mg/100g in foodstuffs was considered as dangerous to human beings and animal health. The most toxic food-borne intoxication caused by biogenic amines is histamine. Biogenic amines such as putrescine, cadaverine, spermidine and spermine in fish tissue could increase the toxic effects of histamine by inhibiting intestinal histamine-metabolizing enzymes such as diamine oxidase. The biogenic amines can increase histamine uptake and liberating endogenous histamine in intestinal fluid (Flick, Oria and Douglas 2001; Antoine et al., 2002). Histamine fish poisoning usually causes mild illness with symptoms such as nausea, respiratory distress, hot flushes, sweating, heart palpitation, headache, bright red rash, oral burning, hypertension as well as hypotension (Taylor, 1986; Lehane and Olley, 2000). The severity of symptoms depends on the concentration of poison ingested and the sensitivity of individual towards histamine (Lehane and Olley, 2000). Biogenic amines such as putrescine, cadaverine, spermidine and spermine in fish tissue could increase the toxic effects of histamine by inhibiting intestinal histamine-metabolizing enzymes such as diamine oxidase. The biogenic amines can increase

histamine uptake and liberating endogenous histamine in intestinal fluid (Flick, Oria and Douglas 2001; Antoine et al., 2002). Biogenic amines like putrescine, cadaverine, spermine and spermidine do not have any adverse health effects, but some time they react with nitrite to form carcinogenic nitrosamines (Onal et al., 2013).

Formation of biogenic amines in marine fish and fishery products requires free amino acids (EFSA, 2011; Zarei et al., 2011). Refrigerated storage at 4^{o}C will suppress mesophilic biogenic amine forming bacteria and will slowdown the growth of the less well know cold loving psychrophilic biogenic amines forming bacteria (FAO/WHO, 2012). The most important gram negative psychrophilic bacteria are *Pseudomonas* sp., *Vibrio* sp., *Falvobacterium* sp., *Moraxella* sp., and *Photobacterium* sp., which lead to microbial spoilage of seafoods (Khan et al., 2005). The psychrophilic bacteria can produce toxic levels of biogenic amines in seafoods at 2-5^{o}C of storage (Mendes, 2009). Moreover, the refrigerated storage insufficient to suppress the production biogenic amines in seafood products for longer duration (FAO/WHO, 2012). Naila et al. (2010) reported the emerging methods potentially applied as control measures of seafood's spoilage these including the addition of started culture, hydrostatic pressure, irradiation, food additives and packaging of Co_2. The natural antimicrobial food additives are approved in many countries, but the recent trend has been for the use of natural preservatives, which is necessities, the exploration of alternative sources of safe, effective and acceptable natural preservatives. Plants contain innumerable constituents and are valuable source of new and antimicrobial active molecules possessing in vitro antibacterial properties (Negi et al., 2012).

Several researchers have been proposed the antimicrobial activity of natural compounds on food have been published (Kanatt et al., 2010). Sea weeds, sea grasses, medicinal, aromatic plants and spices have traditionally been used in folk medicine as well as to extend the shelf life of traditional foods, showing promising inhibitory effects on marine and terrestrial bacteria. Seaweeds have been traditionally used in human and animal nutrition and it have a rich source of bioactive compounds. It exhibits a wide range in topography and climate, which has bearing on its vegetative and floristic composition (Jigne and Sumitra, 2006). Seaweeds are considered as source of bioactive compounds and produce a great variety of secondary metabolites characterized by a broad spectrum of biological activities such as Anti bacterial, anti viral, anti fungal, antitumor, anti hypercholesterolemic, anti coagulant and antioxidant activities many bioactive compounds have been extracted from seaweeds (Almeida et al. 2011; Bacero and Lobez, 2000; Nanthini et al., 2012). Seaweeds are possessing rich source of bioactive compounds like carotenoids, fiber, protein, essential fatty acids, vitamins, minerals and important polysaccharides such as agar, alginate and carrageenans obtained from halophytic seaweeds are used in pharmaceutical as well as in the food industries (Bocanegra et al. 2009 and Lavanya et al., 2011). Seaweeds are one of the important marine living resources could be termed as the futuristically promising plants and have a sources of food and medicine (Lavanya et al. 2011). Marine sources are receiving major attention, mainly because of the contents of functional ingredients such as polyunsaturated fatty acids, beta-carotene and pigment, carotenoids, sulphated polysaccharide and sterol (Rajasulochana et al. 2000). Hence, preservation of seafoods with seaweeds

extract will reduce the formation of biogenic amines, enhance the shelf life of seafoods and ensure the safety of the consumers.

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